AWWOA

Workshop
Edmonton, Alberta
October 29, 2026

Slow Sand Filtration – Demand Operated and Maintained Using Backwash

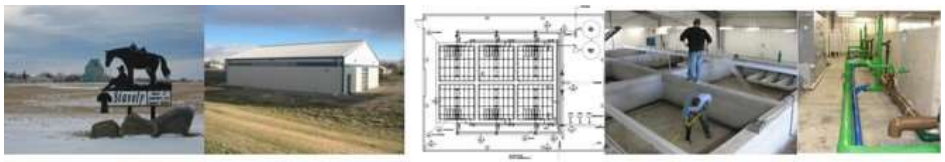
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President
Manz Engineering Ltd.



What is slow sand filtration, SSF?

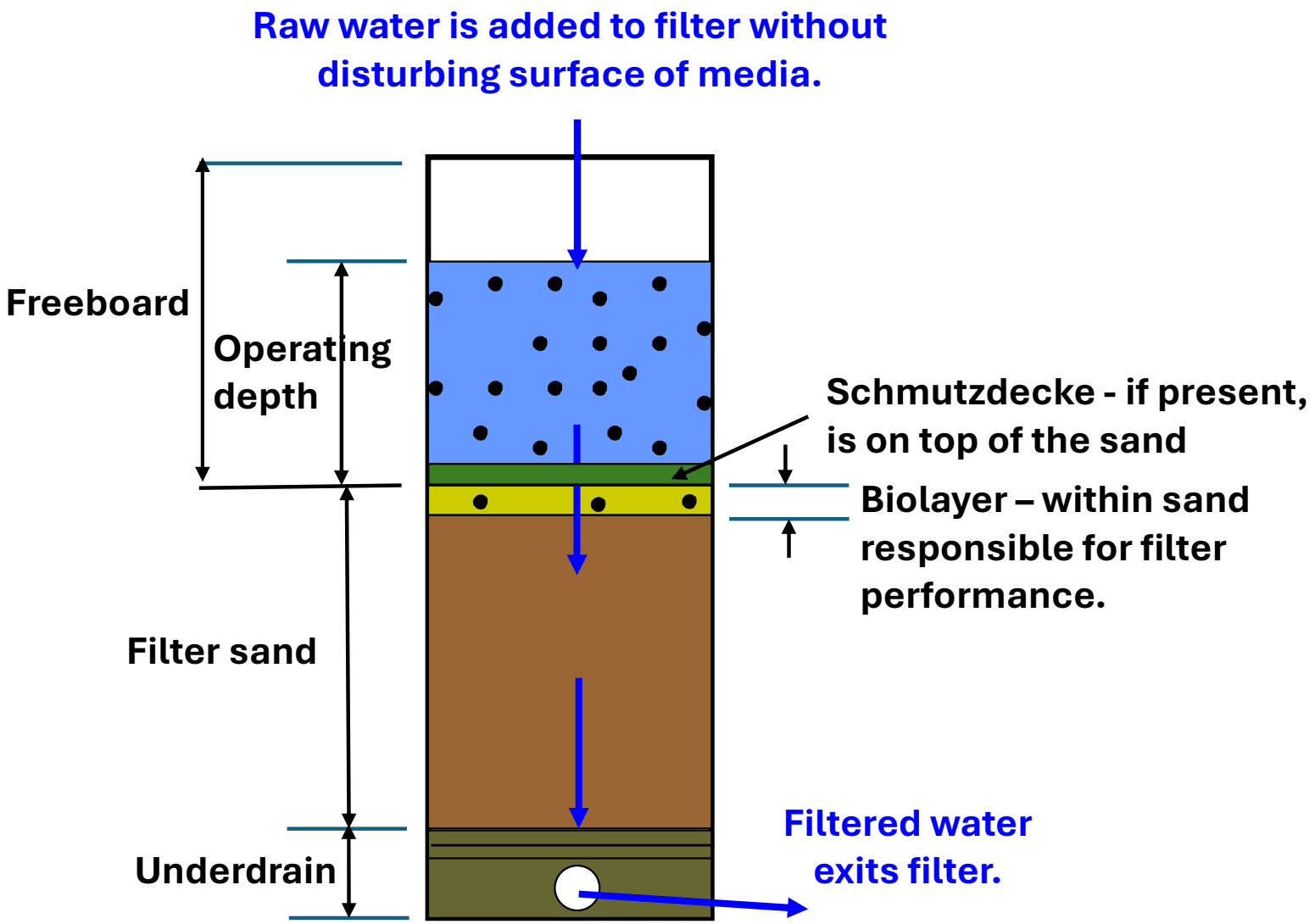
Slow sand filtration is a form of water treatment using fine sand to remove disease causing organisms and objectionable particulate matter to provide aesthetically pleasing water safe for human use and consumption.

Sand filters of various kinds have been used for thousands of years but the treatment technology known as slow sand filtration was first described and used on a community scale in Scotland almost 200 years ago. It is a well-defined technology that has not changed much since then.



Stavely Alberta

Elements of a Traditional Slow Sand Filter



Advantages of traditional slow sand filters

If the water supplied traditional slow sand filters satisfies the recommended quality as described in Table 1, traditional slow sand filters may be an option. The quality of the water produced using traditional slow sand filter is described in Table 2.

Traditional slow sand filters have the following advantages:

- **Provide effective pathogen removal.**
- **Provide effective particulate removal.**
- **Have minimum energy requirements.**
- **Are not complex - require limited operator skill to operate well.**
- **Do not require use of chemicals.**



Kyle Saskatchewan

Table 1. Quality of water to be treated using a slow sand filter.

Parameter	Quality	Comments
Turbidity	< 10 NTU and absent colloidal clays	
Suspended Solids	No clear recommendation	Because colloidal particles are part of suspended solids
True Color	< 5 platinum color units	Indicator of dissolved organic carbon, DOC
Coliform Bacteria	<800 CFU or MPN/100 ml	Cannot treat polluted water
Dissolved Oxygen (DO)	> 6 mg/L	Avoid anoxic and anaerobic conditions
Total Organic Carbon (TOC)	< 2.5 mg/L	Greater amounts will penetrate deeper into filter and consume oxygen
Iron and Manganese	< 1 mg/L	Greater amounts will result in frequent maintenance
Algae	< 200,000 cells/L (type dependent)	Greater amounts will result in frequent maintenance
BOD_5	< 5 mg/L	
Temperature of water		
Minimum range	10-15 ˚C	Ideal guideline. SSF's have been successfully used for hundreds of years in cold climates. (N. Europe and North America)
Maximum range	35-45 ˚C	
Optimum range	24-40 ˚C	

Table 2. Water treatment, using a traditional slow sand filter and a MEL-BF.

Parameter	Removal Alone at Loading Rates up to 0.4 $m^3/m^2/h$	Removal/ Deactivation with Post Filtration Disinfection (UV and/or Chlorine)	Comments
Helminths (schistosomiasis)	100%	100%	Removed without formation of biolayer.
Parasites (Giardia, Cryptosporidium)	99.9 – 99.99%	Increased depending on type and dosage	Effectively removed without formation of biolayer.
Bacteria (coliform, vibrio cholera)	90 – 99%	100%	There is growing evidence that bacteria removal occurs throughout depth of filter sand. Virtually 100% of cholera are removed as they are found in the digestive tract of helminths which are completely removed.
Viruses (norovirus, rotavirus, Hepatitis)	90 – 99%	100%	Removed within biolayer and deeper in sand.
Particulates (sand, silt, flocs of iron, manganese and aluminum)	Variable up to 100% (must be pilot tested)	Not applicable	Particularly effective removing sand, silt and flocs of iron and manganese.
Turbidity	Variable (must be pilot tested)	Not applicable	In the absence of colloidal clays and organics may achieve < 1 NTU. Must be pilot tested.
Algae	Variable depending on type of algae	Not applicable	Function of type of algae. Cyanobacteria is removed 97 – 99%.
Dissolved organic matter (DOC, NH_4^+, toxins)	Variable depending on substance.	Not applicable	DOC and NH_4^+ removed by biolayer and throughout sand layer.
Dissolved inorganic matter (arsenic, toxins)	Variable depending on opportunities for adsorption and co-precipitation.	Not applicable	Arsenic removed by coprecipitation with ferric hydroxide flocs which are removed at the surface of the slow sand filter.

The advantages of using traditional slow sand filtration for water treatment are significant but there are several limitations to its use.

Limitations to the use of traditional slow sand filters:

1. Maximum loading rate < 0.4 $m^3/m^2/h$. (Volume of water that can be applied to one square meter of filter surface per hour.)
2. Temperature constraints on water being treated (limiting microbiological activity).
3. Continuously operated to ensure biolayer receives adequate oxygen and so have proven impractical for small communities. If flow of water stops, flow of oxygen stops, and the microorganisms which form the biofilm on the particles forming the biolayer either die or go into dormancy. Once flow of water is resumed, several days or weeks are required for the biolayer to reform sufficiently to provide adequate treatment.
4. Filters are physically large – large footprint and tall - typically constructed in place and expensive to locate in a building.
5. Constructed outdoors – subject to influence of sunlight, weather (including freezing), and wildlife.
6. Only considered practical for treating low turbidity raw water (less than 10 NTU) because maintenance requires considerable effort and supplies of replacement sand.

7. **Maintenance is performed by removing approximately 5 cm of sand – performance is seriously impaired for several days or weeks. Filter beds have enough media for more than 10 cleaning operations. The waste sand must be disposed of. There must be a supply of replacement sand. An extended 'filter-to-waste' period is imposed to allow formation of biolayer. Maintenance is an onerous manual task which is performed as infrequently as possible.**
8. **Limited opportunity for automation and integration with other treatment elements.**
9. **Not considered practical for iron or manganese removal or use with coagulants because maintenance is difficult.**
10. **Air binding – serious problem without provision of reverse flow (upward flow through filter).**
11. **Contamination from wildlife/ environment if not constructed in a protected environment.**
12. **Limited use in remote or isolated communities if available sand is not suitable for use.**

Manz Engineering Ltd has developed two types of slow sand filters that eliminate or minimize the limitations to the use of slow sand filters.

Manz filters are demand operated and maintained using backwash. They are:

- **The MEL-BF which treats water similar to a traditional slow sand filter and**
- **The MEL-PF which treats water similar to polishing sand filter.**



Stainless steel: Island Lake Manitoba, Crane River Manitoba, Fauquier B. C.

- **The MEL-BF and MEL-PF filters can treat water, surface water or groundwater, for communities varying is population from as few as ten to several thousand, wherever they may be situated in Canada.** **The filters may be used alone (with disinfection) or with other pre- and post- treatment technologies to economically produce water that satisfies Canadian Drinking Water Guidelines.**

- **The primary difference between the MEL-BF and the MEL-PF is the loading rate. The MEL-BF uses the same loading rate as that specified for traditional slow sand filters, < 0.4 $m^3/m^2/h$, while the MEL-PF is intended to use loading rates much greater, up 1.0 $m^3/m^2/h$.**

MEL-BF filters bring important advantages over traditional slow sand filters.

- The MEL-BF filters are designed, operated, and maintained to enable the use of slow sand filtration treatment technology in circumstances where it might not otherwise have been used by eliminating or minimizing all, but the first two limitations listed.

- The quality of water that can be treated by MEL-BF filters includes water with greater concentrations of suspended solids including iron and manganese.

- Filter maintenance is much easier to perform.

- Filter operation and maintenance may be automated.

- The quality of the filtered water is the same as for traditional slow sand filters; that is, very good.

MEL-PF filters bring important advantages.

- **The filter is very effective at removing small particulates at concentrations much greater than traditional slow sand filters or the MEL-BF. (Including sand, silt, iron and manganese flocs and large microorganisms such as Cryptosporidium oocysts, giardia cysts, and helminths.) See Table 3.**

- **The filter is easy to maintain and produces relatively little wastewater – less than 2% of production.**

- **Water produced by the MEL-PF is of a quality that disinfection to kill or deactivate bacteria and viruses also provides further deactivation of Cryptosporidium and giardia using chlorine and/ or UV.**

- **MEL-PF technology is readily piloted to evaluate its treatment capability before implementation.**

Table 3. Water treatment using MEL-PF technology?

Parameter	Removal Alone at Loading Rates up to 1.0/ m^2/ h	Removal/ Deactivation with Post Filtration Disinfection (UV and/or Chlorine)	Comments
Helminths (schistosomiasis)	100%	100%	Removed without formation of biolayer.
Parasites (Giardia, Cryptosporidium)	99.9 – 99.99%	Increased depending on type and dosage	Effectively removed without formation of biolayer.
Bacteria (coliform, vibrio cholera)	Unknown - determined by piloting.	100%	Removal/ deactivation depends on post-filtration disinfection
Viruses (norovirus, rotavirus, Hepatitis)	Unknown – determined by piloting	100%	Removal/ deactivation depends on post-filtration disinfection
Particulates (sand, silt, flocs of iron, manganese and aluminum)	Variable up to 100% (must be pilot tested)	Not applicable	Particularly effective removing sand, silt and flocs of iron and manganese.
Turbidity	Variable (must be pilot tested)	Not applicable	In the absence of colloidal clays and organics may achieve < 1 NTU. Must be pilot tested.
Algae	Variable depending on type of algae	Not applicable	Function of type of algae. Cyanobacteria is removed 97 – 99%.. Must be pilot tested.
Dissolved organic matter (DOC, NH_4^+, toxins)	No effect	Not applicable	May be removed by coprecipitation with pretreatment using appropriate coagulants. Requires pilot testing.
Dissolved inorganic matter (arsenic, toxins)	No effect.	Not applicable	Arsenic removed by coprecipitation with ferric hydroxide flocs which are removed at the surface of the slow sand filter. Other dissolved inorganic substances may be similarly removed.

- **Water supplied to both the MEL-BF and MEL-PF may be pre- treated to remove larger particles which might interfere with the maintenance process (for example using self-cleaning mechanical filters).**

- **Both MEL-BF and MEL-PF filters produce water that can be followed by activated carbon filters and membrane filters, with minimum risk of fouling. Activated carbon filters may be used to remove dissolved organics and toxins. Membrane filters may be used to remove most dissolved substances (including dissolved organics, toxins, dissolved metals), colloidal particles and viruses.**

- **Filtered water may be disinfected using ultraviolet disinfection (may require reduction in DOC) and chlorination prior to potable water storage to achieve required reductions in Cryptosporidium, giardia, bacteria and viruses.**

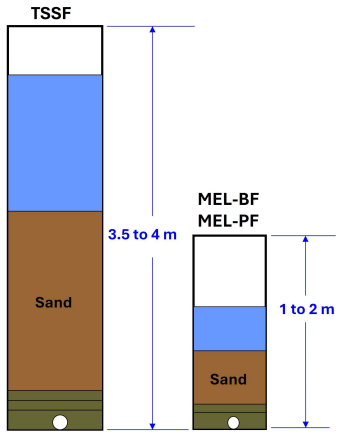
- **Filters may be operated and maintained manually on-site, remotely, or automatically.**

MEL-BF

The MEL-BF is an alternative slow sand filter to traditional slow sand filters.

- **The sand, underdrain and loading specifications conform to those cited in the Manual of Design for Slow Sand Filtration (reference 1).**

- **The primary differences are that the MEL-BF can be operated on a demand basis and its maintenance is performed using a backwash process – sand is not removed or replaced. Consequently, MEL-BF filters are much shorter and less expensive to locate in a dedicated building.**



Commissioning a MEL-BF.

All elements of the water treatment plant need to be operational before the filters can be commissioned. Once filters are constructed or located on-site and connected to the water supply, wastewater disposal and treated water storage, the filter underdrain system and sand are installed and commissioning can proceed.

Installing underdrain and filter sand



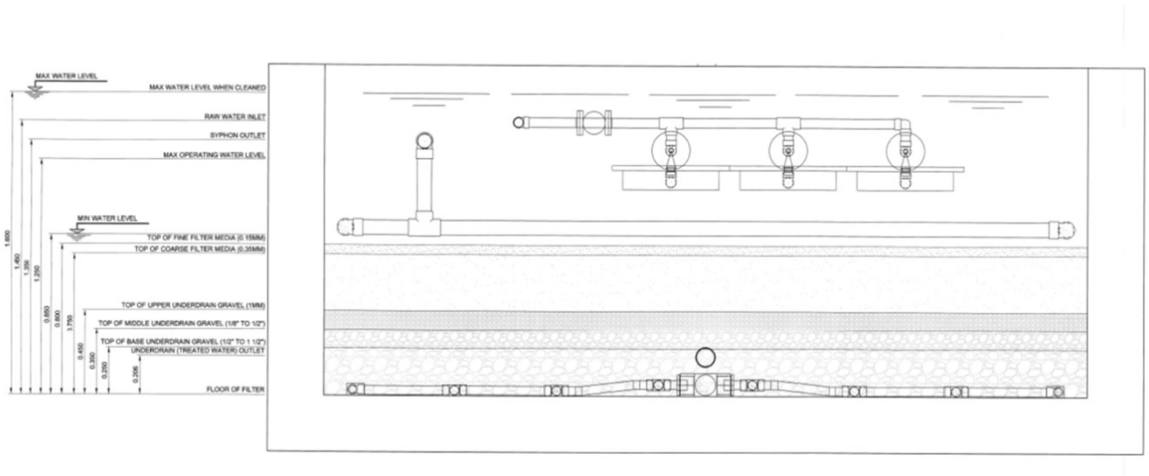
Underdrain
coarse gravel, small gravel, coarse sand

Filter sand

Filter sand and underdrain used in MEL-BF and MEL-PF filters



Demonstration model

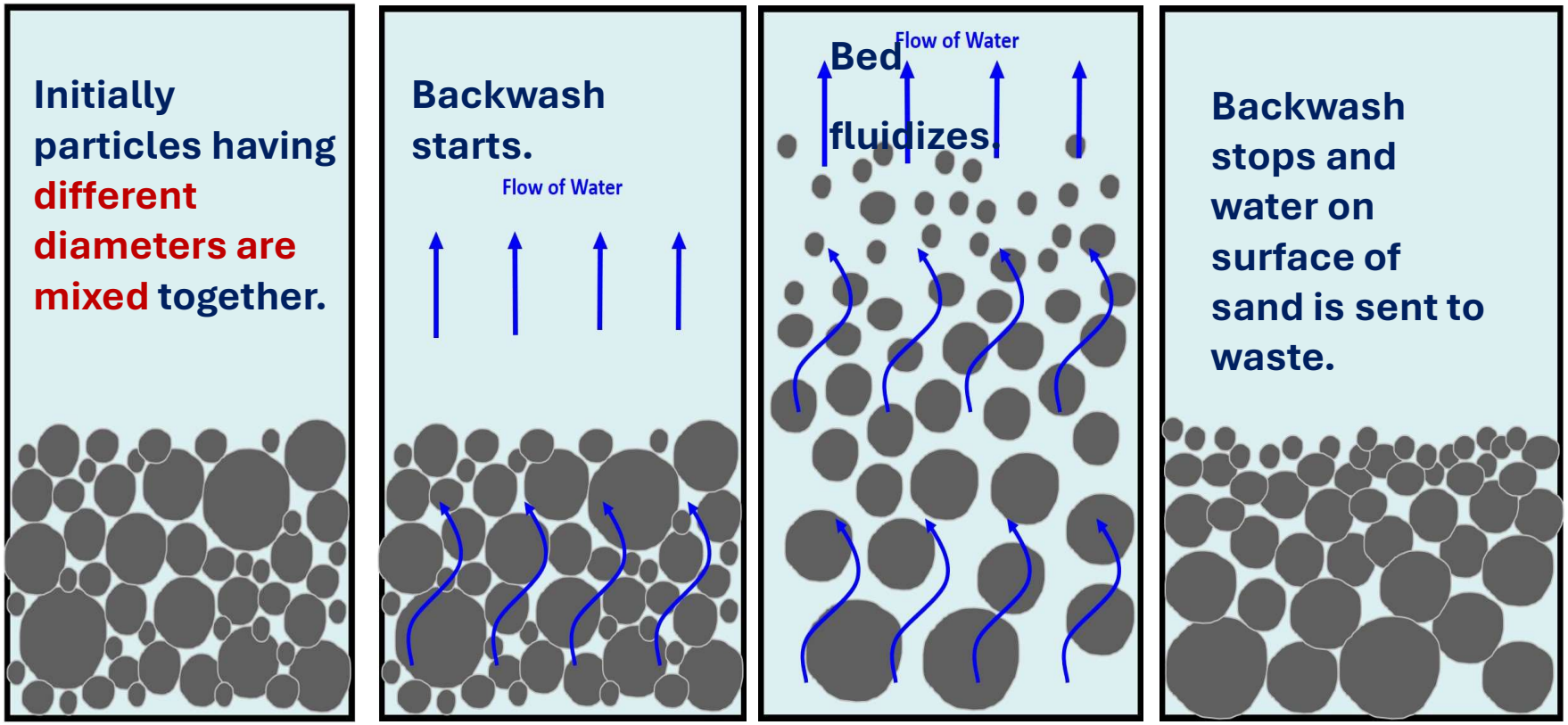


Cross-section of one cell of an actual 4m x 4m MEL-PF

Backwash of MEL filter



Commissioning Step 1: Backwashing to redistribute and wash sand particles.



The backwash process is repeated several times until the turbidity of water on the surface of the sand after backwashing has sufficiently low turbidity.

Step 2 of commissioning a MEL-BF: Filter ripening.

The objective of the 'ripening' process is to establish the biolayer on surface of the sand column. The biolayer is responsible for most of the filter performance.

The filter is operated normally (as required) at a loading rate of 0.2 to 0.4 $m^3/m^2/h$ or whatever loading rates are determined by piloting or specified by the regulatory authority.

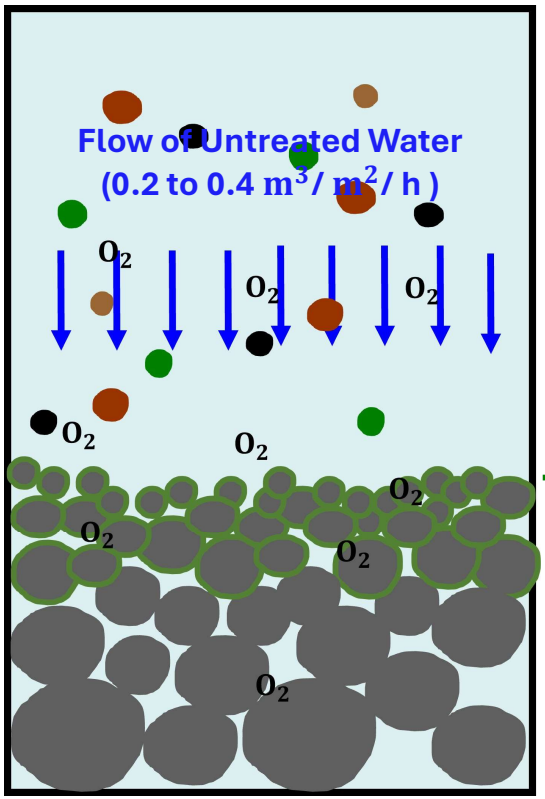
Filtered water is sent to waste (filter-to-waste) while the biolayer is developing (called filter ripening). Filtered water turbidity and bacteria levels in the filtered water are monitored. Once the quality of the filtered water meets objectives, the filter is put into production. (A variety of other treatment processes may follow.)

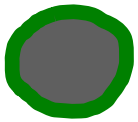


Kyle Saskatchewan

Commissioning Step 2: Developing the biolayer - filter ripening.

After Step 1 is completed, filter is operated using untreated water supply until filtered water meets treatment objectives.





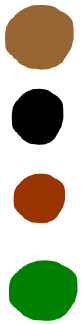
Media particle covered with an attached biofilm including bacteria and residual organic matter.

Biolayer (layer of mineral particles covered with a biofilm) in the process of developing.

Development of the biolayer is known as 'ripening'.

The same smallest diameter particles, coated with a biofilm, will be at or near the media surface after every backwash.

Particulates removed from water.



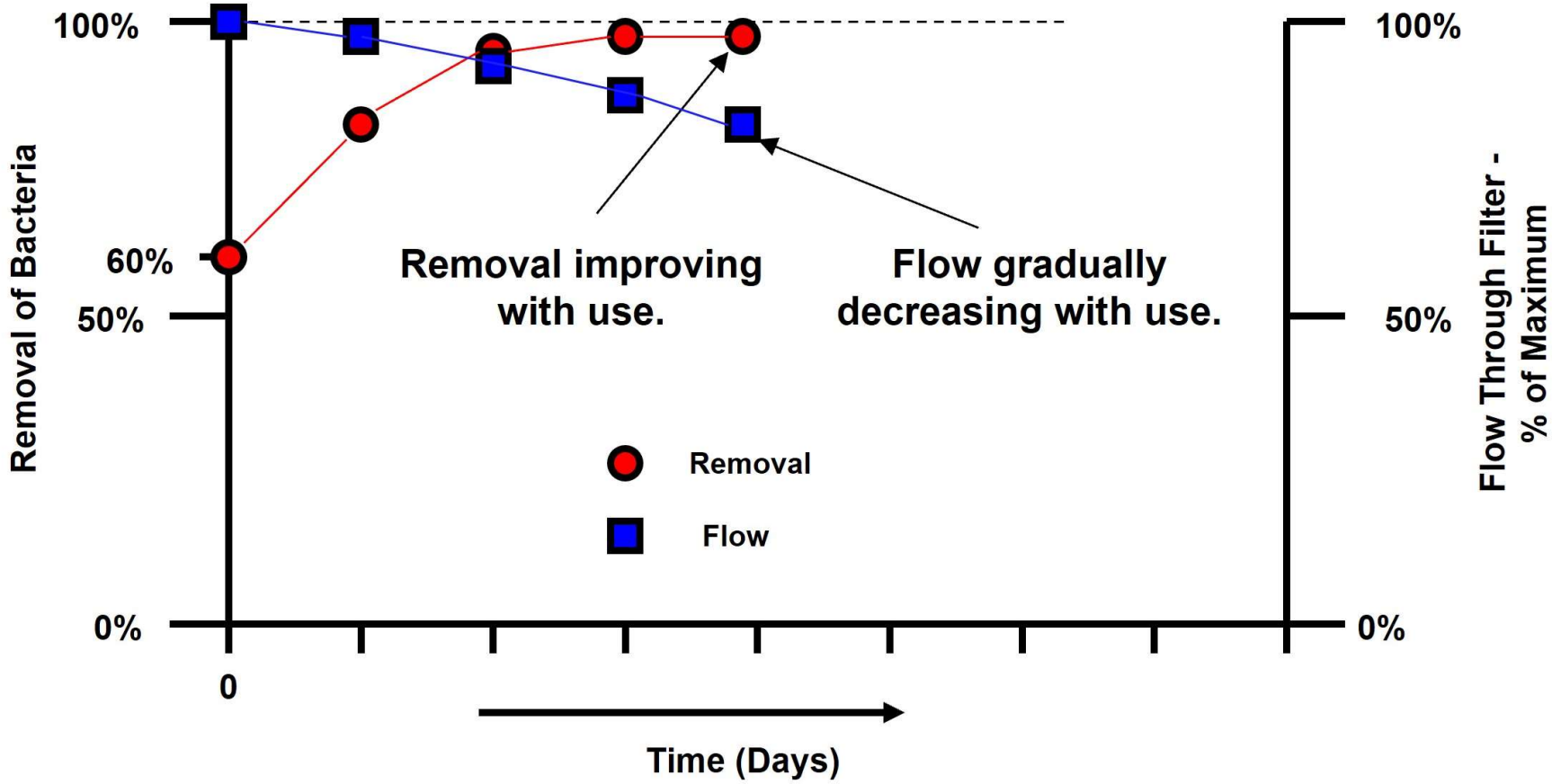
Mineral and organic particles or flocs of particles.

Large living organisms such as algae, helminths and the cysts of parasites.

Plus, bacteria and viruses.

O_2 Oxygen

Typical Performance of a MEL- BF before and after Commissioning



Demand Operation of the MEL-BF

(This is the same method of operation that is used by the BioSand Water Filter that has been proven successful by numerous research organizations and is now used in millions of households worldwide.)

- **The MEL-BF can be continuously operated like a traditional slow sand filter, or it can operate on a demand basis; that is, the filter can be used (operated) when treated water is required and stopped when it is not without losing any of its ability to treat water.**

- **Demand operation is possible because when raw water supply is stopped, the water level in the filter is allowed to decrease to a depth that allows oxygen from the air to diffuse through the layer of water to the biolayer. See following figure.**

Demand Operation of the MEL-BF

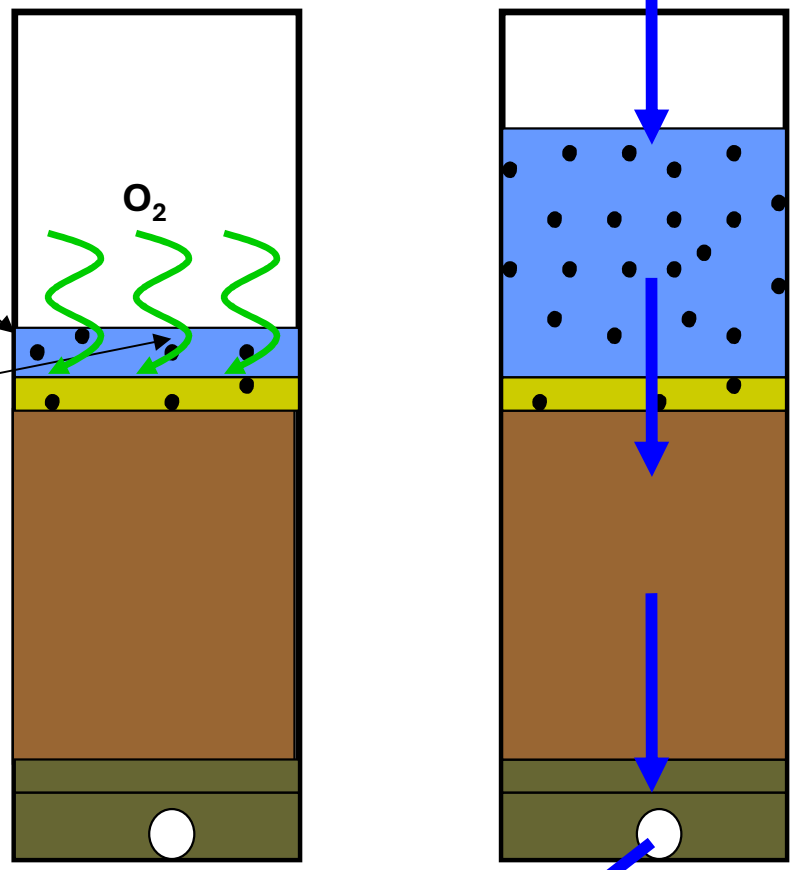
Operation when flow is stopped and resumes.

Flow to filter is stopped.

Flow to filter resumes.

Water level drains to paused or minimum depth – minimum 5cm.

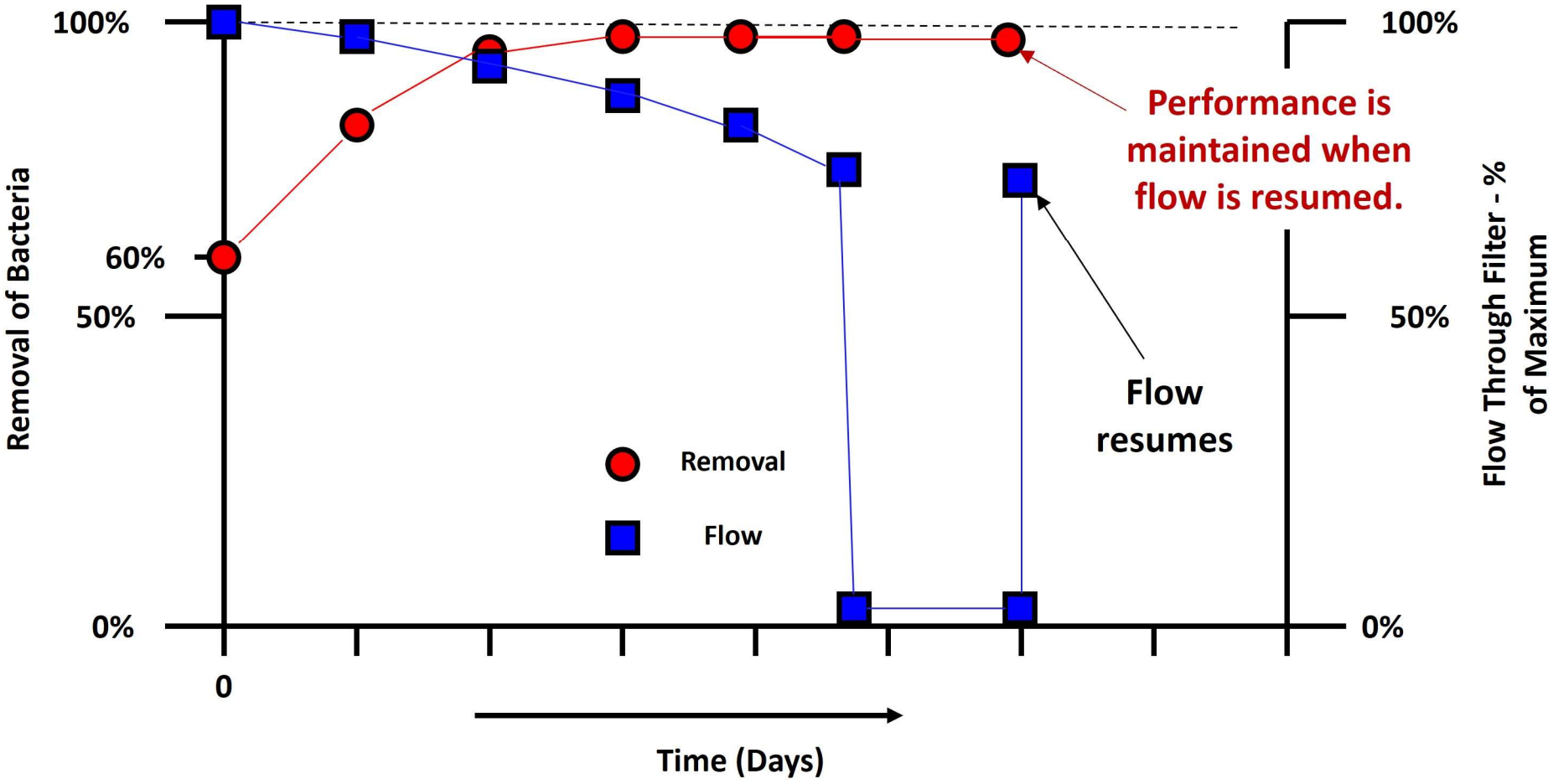
Sufficient oxygen can diffuse through the shallow layer of water to keep aerobic biolayer alive.



Mature healthy biolayer still present.

Filtered water exits filter.

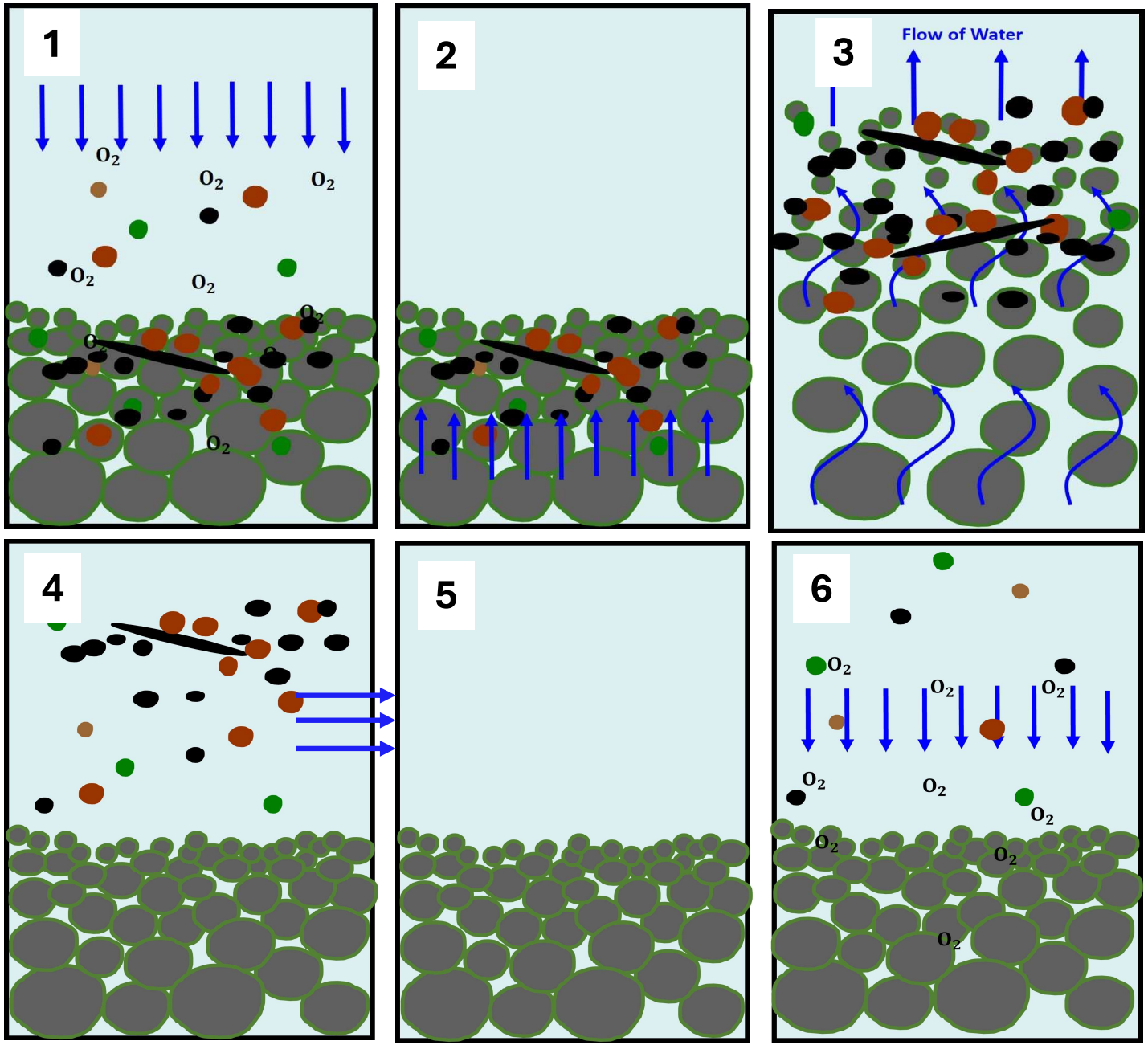
Typical Performance of a MEL-BF when Flow is Stopped and Resumed



Maintenance of MEL-BF using Backwash

Steps

1. Maintenance required.
2. Flow stopped and backwash begins using <u>unchlorinated water.</u>
3. Sand is fluidized.
4. Flow stopped - sand collapses and wastewater is decanted.
5. Filter ready to be put back into operation.
6. Filter put back in operation.
7. ***Filter production will be wasted until quality returns.***



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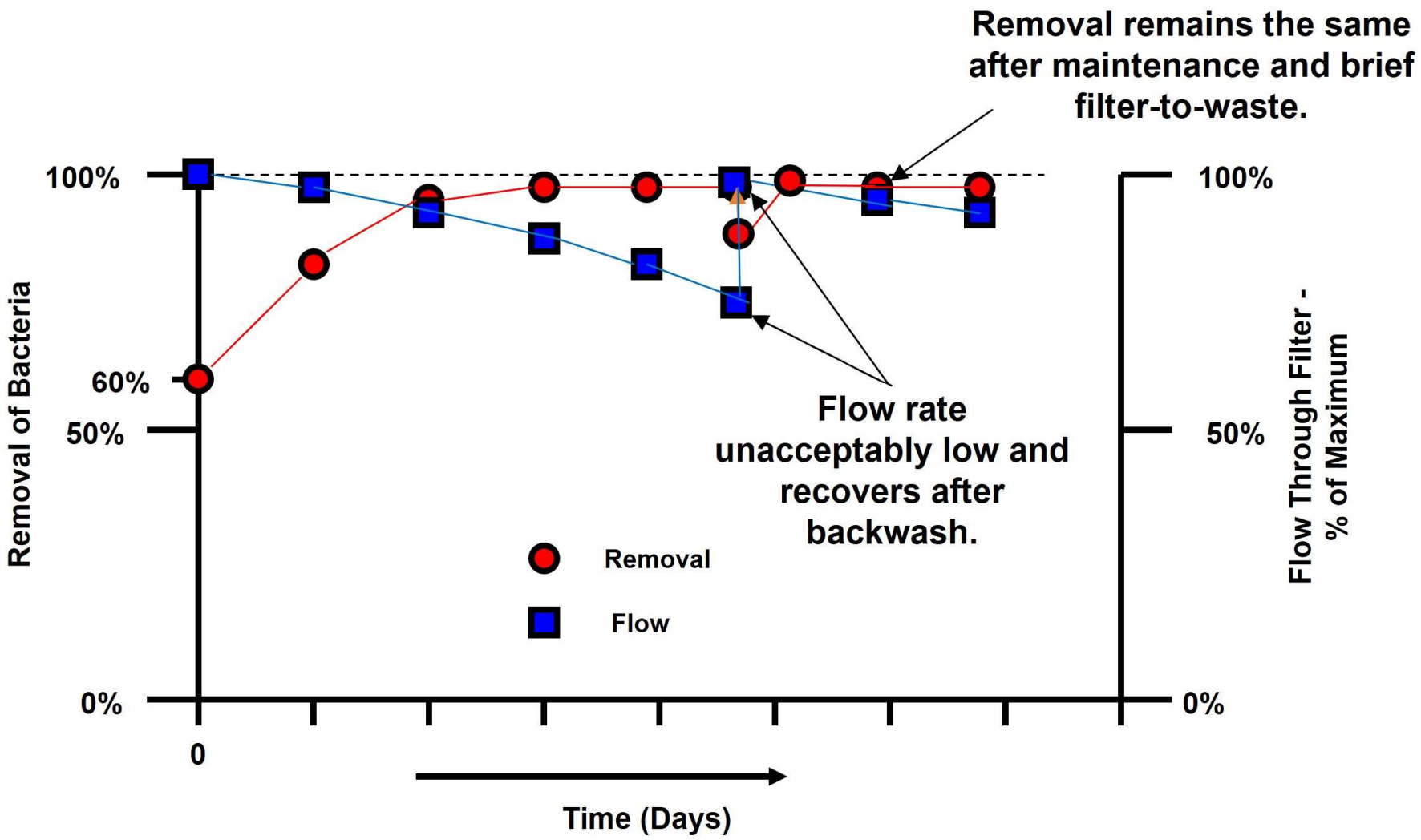
- **The backwash procedure may be performed more than once if one backwash is not producing satisfactory results. The operator must gain experience with the maintenance procedure.**

- **Very little wastewater is produced using the maintenance procedure – less than 1 or 2% of production, far less than any other filtration method.**

- **Disposal of wastewater is not complicated as no chemicals have been used in the treatment process. Rate of production of wastewater is operator controlled and can be adjusted to match available domestic sewer capacity if used.**

- **Frequency of maintenance will depend on the quality of water being filtered which may vary with season. Because the biolayer is not removed, the recovery of the filter to production of filtered water of satisfactory quality can be expected to be achieved quite quickly. The primary reason for the filter-to-waste procedure is that the backwash disturbs the entire filter bed loosening particles that now must be flushed similar to the media redistribution procedure used in commissioning.**

Typical Performance of a MEL- BF before and after Maintenance



MEL-PF

- **MEL-PF filters exploit the ability of slow sand filters to effectively remove particulates including, sand, silt, iron and manganese flocs and large microorganisms such as Cryptosporidium oocysts, giardia cysts, and helminths.**
- **The installation procedure is identical to the MEL-BF.**
- **The commissioning procedure includes the redistribution and cleaning of the sand particles.**
- **The MEL-PF does not require a biolayer to perform its filtration function, and it operates at flow rates up to 1.0 $m^3/m^2/h$.**
- **The filter is put into operation and production wasted until particulate material not removed from sand during backwash in Step 1 of commissioning process is flushed.**

- **Because a biolayer is not required, the water used for maintenance may be chlorinated. Otherwise, the backwash is identical to that used by the MEL-BF.**

- **Removal of larger organisms including Cryptosporidium oocysts and Giardia Cysts does not require the presence of a biolayer. Studies have demonstrated that these organisms are readily removed (3 and 4 log removal) from chlorinated water that has been filtered using by MEL-PF filters at maximum loading rates. (The feature is very important is large cities in developing countries which receive contaminated water from a municipal distribution system that is received cyclically chlorinated and unchlorinated but seriously contaminated by groundwater. Chlorination does not kill or deactivate parasites.)**

- **Removal of dissolved iron and manganese often requires pre-treatment by adding chlorine to the raw water to oxidize the metals to form small flocs which the MEL-PF can readily remove.**

- **An additional benefit of this process is that dissolved hydrogen sulfide gases are also oxidized and eliminated from the water. Unlike greensand or similar filters, the MEL-PF cannot be biofouled by sulfate reducing bacteria and short-circuited.**

- **Sand is never replaced.**

- **MEL-PF can be used to remove arsenic.** **If dissolved arsenic is present, arsenic (V) will associate with oxidized iron. (Arsenic (III) will oxidize to arsenic (V) in the presence of chlorine.) The arsenic is captured by adsorption and surface complexation and is removed with the iron. The process is called coprecipitation.**

- **If no chemicals are used, (usual case), wastewater disposal is relatively simple – use of soakaways is possible.**

- **It is possible to reduce/ essentially eliminate liquid waste using in-house clarifiers to separate solids and sending liquid fraction back to the filters.**

- **The coprecipitation technique may be used for removal of other dissolved metals.**

- **May have application for treatment of oil sands tailings ponds.**

Bench Scale and Piloting Evaluation

The first step in determining whether MEL-BF or MEL-PF technology has a role in the treatment of any raw water supply is bench scale evaluation. If this evaluation is positive, the next step is to proceed to piloting. If piloting is successful, full scale design proceeds.



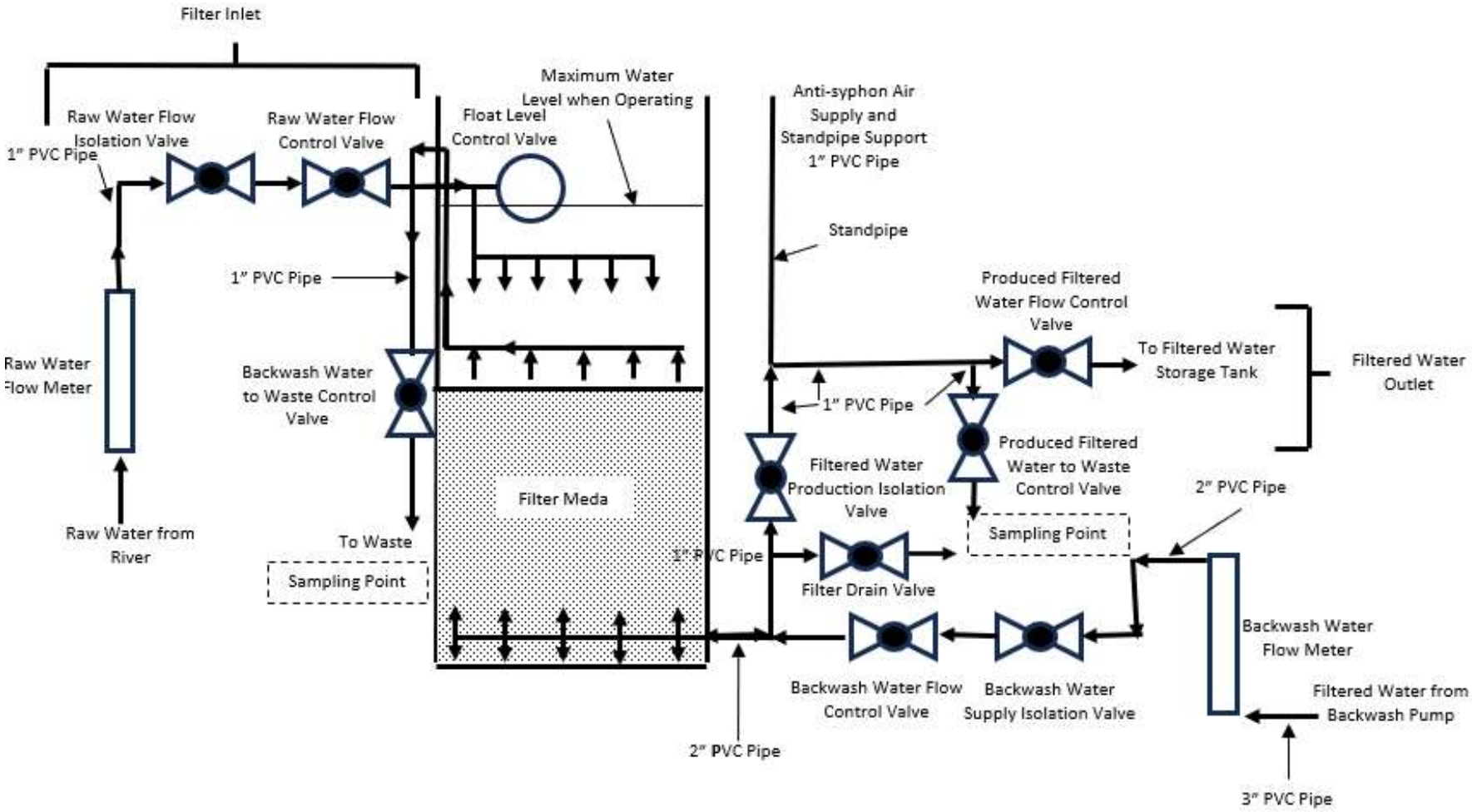
Bench Scale



Piloting

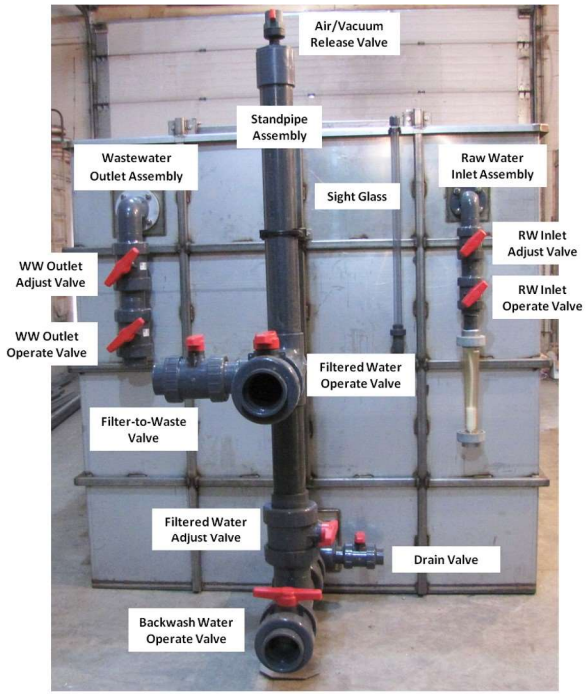


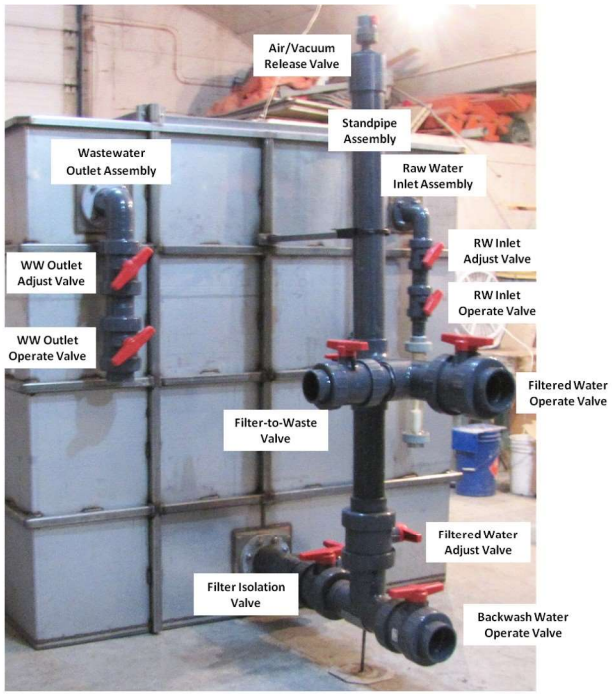
Piloting



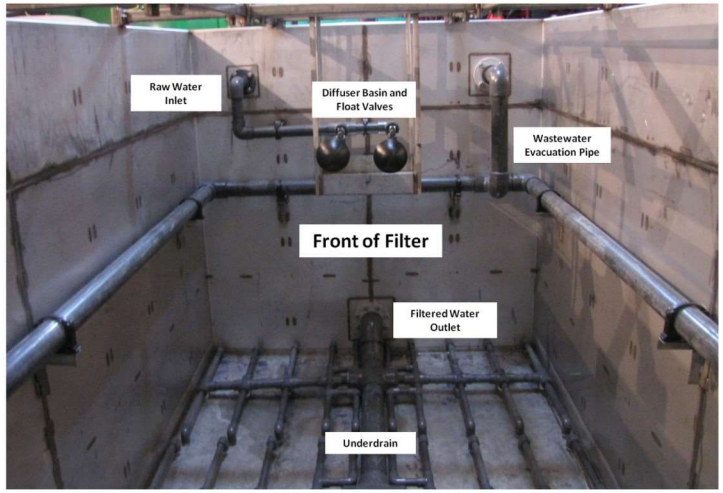
P and I diagram for a pilot study of a MEL-PF application.

Construction of a stainless-steel MEL- PF or MEL-BF filter. (Manufactured in Alberta.)





Front of 2m x 2m x 4m MEL-PF



Interior of 2m x 2m x 4m MEL-PF

Installation of MEL-PF filters



Examples of MEL Filters in use to treat a variety of surface and ground water in Western Canada

2017 Kainai (Blood) Reserve – St. Paul, Alberta, Canada

Treatment of well water to remove iron and arsenic using MEL polishing sand filters and provide pretreatment for removal of dissolved solids using reverse osmosis.



Kainai Reserve – St. Paul Water Treatment Plant

Design constraints and objectives:

- First Nations Community.
- Well water with iron, arsenic and high total dissolved solids.
- Iron and most arsenic removed by MEL filters.
- Remaining arsenic and dissolved solids removed by reverse osmosis.
- MEL polishing filters intended to reduce suspended solid load to reverse osmosis (minimize membrane maintenance and extend membrane life by several years).
- Two MEL filters each with minimum operating capacity of 6,000 L/h or 144,000 L/day. (Maximum operating capacity of each filter is 8,000 L/h or 192,000 L/day)
- Manual operation.
- Minimum complexity – Local operator with minimum training or experience.
- Minimum backwash. Wastewater disposed of in sewage lagoon.
- No media replacement.
- Performance verified using pilot testing on site.

Treatment Process

- Wells to treatment plant in response to water storage requirements.
- Addition of sodium hypochlorite (oxidize iron).
- Contact tanks (adsorb arsenic to oxidized iron).
- MEL polishing filters to remove iron and arsenic.
- Filtered water storage.
- Reverse osmosis to remove dissolved solids.
- UV disinfection.
- Chlorination.
- Treated water storage and distribution.



MEL filters



Reverse osmosis

- Two (prefabricated stainless steel 2m x 4m x 2m) MEL-PF filters.
- Each filter can treat a maximum of 8,000 L/h. (Surface loading of 1000) L/m^2/h when used as polishing filters).



Pilot testing treatment method.



Filters and tanks being transported to site.

Fauquier Water Treatment Plant

British Columbia, Canada 2015

Treatment of creek water - Pretreatment for UV disinfection

MEL polishing sand filters.



Fauquier Water Treatment Plant



Creek water source

Design constraints and objectives

- Small isolated community.
- Water source is local creek – subject to significant variations in turbidity and TOC.
- Turbidity to be reduced by MEL filters to less than 1 NTU.
- TOC to be removed by MEL filters (increasing UV transmittance and reducing production of THM).
- Cryptosporidium to be removed by MEL filters
- Cryptosporidium to be deactivated using UV disinfection (second process).
- 4 filters each with minimum operating capacity of 12,000 L/h or 288,000 L/day. (Maximum operating capacity of each filter is 16,000 L/h or 384,000 L/day).
- Creek water is gravity fed to filters which gravity feed to treated water storage.
- Community supplied with treated water by gravity from treated water storage.
- No chemical requirements (apart from chlorination).
- Manual operation.
- Minimum complexity – Local operator with minimum training or experience.
- Operation and performance monitored using SCADA system.
- Minimum backwash - Wastewater disposed of in local stream (bank infiltration).
- No media replacement.
- Performance capable of being verified using pilot testing on site.

Treatment Process

Creek to MEL polishing filters to UV disinfection to Chlorination to Treated water storage. (All by gravity – no pumps.)

After more than five years of operation the UV disinfection system had not been installed. All disinfection was provided by post filtration chlorination prior to storage and distribution. The only period where there were boil water orders was during the spring freshet (lasting a few weeks as expected and originally approved) when the turbidity of the filtered water was too high.

Even though the filters have been operating at almost three times that specified for slow sand filters (and certainly twice) the filters have been removing cryptosporidium and giardia. Simple chlorination to kill or deactivate any viruses or bacteria remaining in the filtered water was effective. This is consistent with MEL independent testing.

This is the first project to rely on this treatment capability.



Front of filters #1 and #2

- Four (prefabricated stainless steel 4m x 4m x 2m) MEL-PF filters.
- Each filter can treat a maximum of 16,000 L/h. (Surface loading of 1000) L/m^2/h).



Pilot filter pre- valuates MEL-PF performance



Filters sitting on flatbed ready for transport to site (800km/16hr road journey)

Crane River Water Treatment Plant

Manitoba, Canada 2014

Treatment of river water - pretreatment for nanofiltration (*MEL polishing sand filters*).



Crane River Water Treatment Plant to the right.

Design constraints and objectives:

- Remote community.
- River water (large river) – subject to significant variations in turbidity and TOC.
- Cryptosporidium to be removed by MEL filters, nanofiltration and UV disinfection.
- TOC to be removed by MEL filters and nanofiltration
- MEL polishing filters intended to reduce suspended solid load to nanofilters (minimize membrane maintenance and extend membrane life by several years).
- Use two filters each with minimum operating capacity of 6,000 L/h or 144,000 L/day. (Maximum operating capacity of each filter is 8,000 L/h or 192,000 L/day.)
- No chemical requirements.
- Manual operation.
- Minimum complexity – Local operator with minimum training or experience.
- Minimum backwash. Wastewater to be disposed of through existing sanitary sewer.
- No media replacement.
- Performance capable of being verified using pilot testing on site.

Treatment Process

River to Mechanical roughing filter to MEL polishing filters to Filtered water storage to Nanofiltration to UV disinfection to Chlorination to Treated water storage.



Filters producing to storage tank.



Filtered water pumped into nanofiltration system. (Similar to Island Lake)

- 2 (stainless steel 2m x 4m x 2m) MEL-PF
- Each filter can treat a maximum of 8,000 L/h. (Surface loading of 1000 L/m²/h)



Pilot Filter used to evaluate MEL-PF performance.



Filters being transported to site in Canadian winter.

Island Lake Water Treatment Plant

Manitoba, Canada 2014

Treatment of lake water - pretreatment for nanofiltration

MEL polishing sand filters.



Island Lake Water Treatment Plant

Design constraints and objectives:

- Remote community. Airplane and ice road access only.
- Source is large lake – normally low turbidity but subject to minor variations in turbidity and TOC. TOC is elevated throughout year.
- Cryptosporidium to be removed by MEL filters, nanofiltration and UV disinfection.
- TOC to be removed by MEL filters and nanofiltration.
- MEL polishing filters intended to reduce suspended solid load to nanofilters (minimize membrane maintenance and extend membrane life by several years).
- Two filters each with minimum operating capacity of 6,000 L/h or 144,000 L/day. (Maximum operating capacity of each filter is 8,000 L/h or 192,000 L/day).
- No chemical requirements (apart from chlorination).
- Manual operation.
- Minimum complexity – Local operator with minimum training or experience.
- Minimum backwash - Wastewater to be disposed of through existing sanitary sewer and sewage lagoon.
- No media replacement.
- Performance capable of being verified using pilot testing on site.

Treatment Process

Lake to MEL polishing filters to Filtered water storage to Nanofiltration to UV disinfection to Chlorination to Treated water storage.



Filters producing to storage tank



Filtered water pumped into nano-filtration system

- Two (prefabricated stainless steel 2m x 4m x 2m) MEL-PF filters.
- Each filter can treat a maximum of 8,000 L/h. (Surface loading of 1000 L/m²/h).

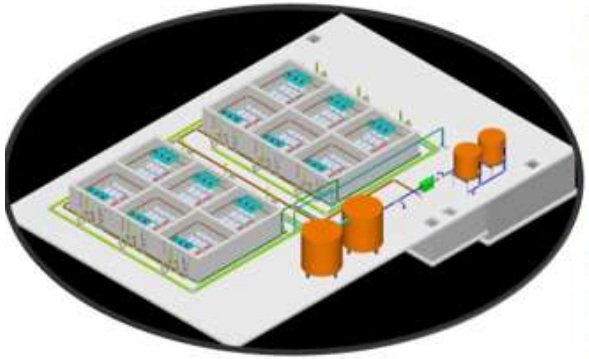


Loading filter and media on to flatbed



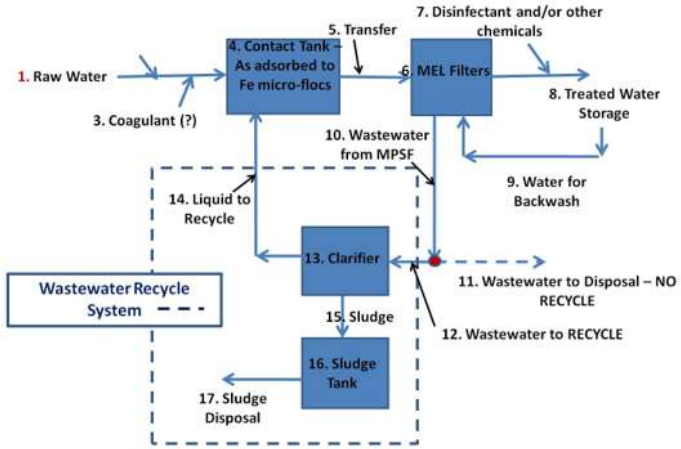
Filters loaded onto truck for transported to site (2,050km/48hr road & ice road journey)

Saskatchewan Landing (Kyle) Water Treatment Plant
Saskatchewan, Canada (Completion Spring 2014)
Iron and Manganese Removal using
MEL polishing sand filters





Process flow diagram for Fe and Mn removal with 100 % recycle of wastewater.



- 12 (4 m x 4 m) MEL-PF type filter cells
- Each cell can treat a maximum of 10,000 litres per hour (maximum loading of 0.6 $m^3/m^2/h$)

Design constraints and objectives:

- Groundwater supply not under direct influence of surface water.
- Iron above 0.30 mg/L.
- Manganese above 0.5 mg/L.
- Arsenic concentration near allowable limit.
- Significant complexing of both iron and manganese.
- Required treatment capacity of 2,400 m3/day or 100,000 litres per hour.
- Minimum chemical requirements.
- Minimum level of automation.
- Minimum complexity.
- Backwash water to be recycled.
- Sludge disposed of in Kyle sewage lagoon.



Exshaw Water Treatment Plant (2011)

Exshaw, Alberta, Canada

Iron, Manganese and H_2S Removal Using MEL-PF type filters.





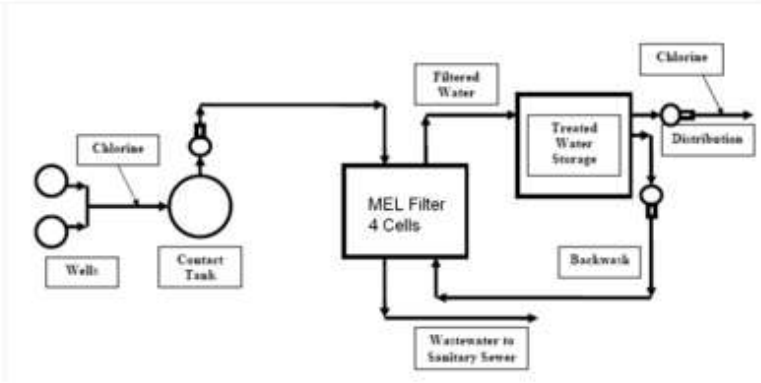
Design constraints and objectives

- Groundwater supply not under direct influence of surface water.
- Iron above 1.0 mg/L.
- Manganese in well water above 0.05 mg/L.
- Hydrogen sulfide (significant) and presence of sulfur reducing bacteria.
- Required treatment capacity of 1,200 m^3/day or 50,000 litres per hour.
- Expandable to 100,000 m^3/day.
- Minimum chemical requirements.
- Minimum level of automation.
- Minimum complexity – Operator Level 1.
- Minimum backwash water to be disposed of in town lagoon through existing sanitary sewer.

Advantages of Using MEL-PF type filters.

- Effectively reduces manganese to below 0.05 mg/L since commissioning (improving), no odour, no taste – community is completely satisfied with treated water.
- Credited with greater than log 4 virus removal.
- Low capital cost.
- No media replacement.
- Minimum maintenance (none since construction).
- Minimum energy consumption.
- Only chemical used is sodium hypochlorite.
- Wastewater is less than 1% of produced water.
- Life expectancy is greater than 25 years.
- Expandable as required

Process flow diagram for Fe and Mn removal.





- 4 (3 m x 5 m) MEL-PF type cells
- Each cell can treat a maximum of 15,000 L/h. (Loading of 1.0 $m^3/m^2/h$)



Stavely Water Treatment Plant (2007)

Stavely, Alberta, Canada

Manganese Removal Using MEL-PF type filters.





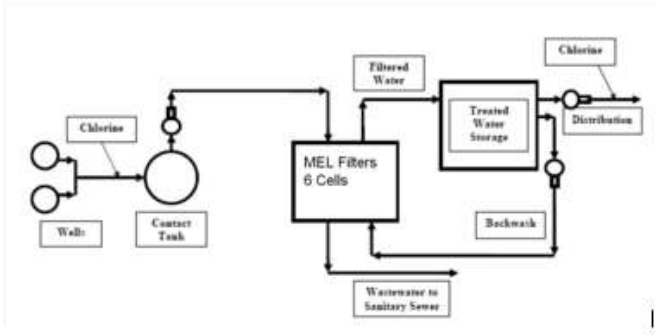
Design constraints and objectives

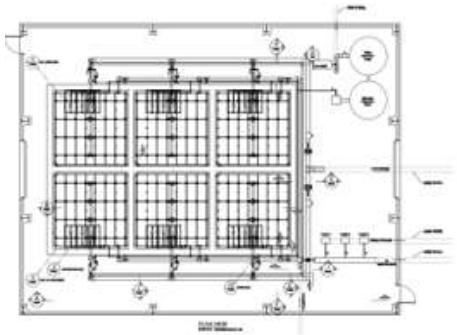
- Town of 700 people.
- Groundwater supply not under direct influence of surface water.
- Manganese in well water above 0.05 mg/L, presence of hydrogen sulfide and presence of sulfur reducing bacteria.
- Required treatment capacity of 1,200 m^3/day or 50,000 litres per hour.
- Minimum chemical requirements.
- Minimum level of automation.
- Minimum complexity – Operator Level 1.
- Minimum backwash water to be disposed of in town lagoon through existing sanitary sewer.

Advantages of Using MEL-PF type filters.

- Effectively reduces manganese to below 0.05 mg/L since commissioning (improving), no odour, no taste – community is completely satisfied with treated water.
- Credited with greater than log 4 virus removal.
- Low capital cost.
- No media replacement.
- Minimum maintenance (none since construction).
- Minimum energy consumption.
- Only chemical used is sodium hypochlorite.
- Wastewater is less than 1% of produced water.
- Life expectancy is greater than 25 years.

Process flow diagram for Mn removal.





- 6 (4 m x 4 m) MEL-PF type cells
- Each cell can treat a maximum of 10,000 L/h (Loading of 0.6 $m^3/m^2/h$)



References: Traditional Slow Sand Filters (TSSF).

The basic design of traditional slow sand filters hasn't changed for more than 200 years.

1. **One of the best references is the Manual of Design for Slow Sand Filtration by David Hendricks, AWWA Research Foundation and American Water Works Association, 1991.**

2. **U.S. EPA Area-Wide Optimization Program (AWOP), Water Quality Goals and Operational Criteria for Optimization of Slow Sand Filtration, EPA 815-B-24-011, 2024**

3. **Ten States Standards – Recommended Standards for Water Works, 2022 Edition**

4. **Alberta: Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, Part 2, Guidelines for Municipal Waterworks, April 2012.**

5. **British Columbia: Design Guidelines for Drinking Water Systems in British Columbia, Version 1.1, Revised January 2024, Ministry of Health.**

6. **Saskatchewan: Waterworks Design Standard, EPB 501, Water Security Agency.**

7. **Ontario: Design Guidelines for Drinking-Water Systems.**

The MEL-BF and MEL-PF filters can treat surface water or groundwater for communities varying is population from as few as ten to several thousand, wherever they may be situated in Canada.

Thankyou

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