Manz Polishing Sand Filter

Overview of Removal of Iron and Manganese using MPSF Technology – Recent Alberta Experience

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Manz Slow Sand Filter (MSSF) and the Manz Polishing Sand Filter (MPSF) are important adaptations of traditional slow sand filtration that allow:

1. **Demand operation**
2. **Cleaning using backwash**

The MSSF preserves the 'schmutzdeke' or 'biolayer' in order to enable removal of pathogens. The MPSF does not require the development of a schmutzdeke or biolayer to function.

The MPSF exploits the ability of traditional slow sand filters (SSF) to remove very small particulate material. The ability to be cleaned using backwash greatly expands the use of SSF for 'polishing' purposes – iron, manganese and arsenic removal in particular.

Both the MSSF and MPSF technologies are unique and patented.

Manz Slow Sand Filter – MSSF Treatment Systems effectively remove/reduce:

- Particulate matter (sand, silt and clay sized with or without use of coagulants)
- Protozoa including Giardia Cysts and Cryptosporidium Oocysts
- Helminthes and their eggs
- Spores
- Bacteria
- Viruses
- Toxins
- Algae

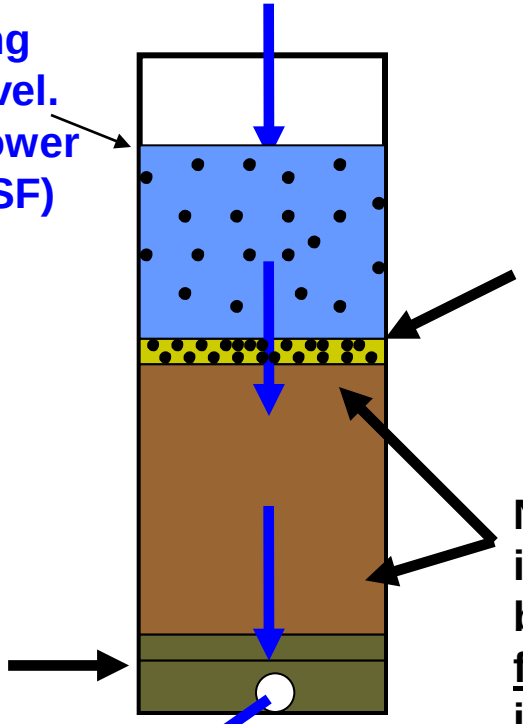
Meets all of the design requirements for traditional slow sand filtration (preserves all treatment characteristics of traditional slow sand filtration without operational or maintenance disadvantages).

Manz Polishing Sand Filter – MPSF Treatment Systems effectively remove/reduce:

- Iron
- Manganese
- Iron bacteria
- Hydrogen sulphide
- Arsenic (and other heavy metals)
- TOC/DOC (taste, odour, colour)

Embodies the filtration characteristics of slow sand filtration but does not need to meet many of the restrictive design requirements of slow sand filtration (filter bed depth and higher surface loading rates in particular).

Basic design and operation of the MSSF and MPSF technology.

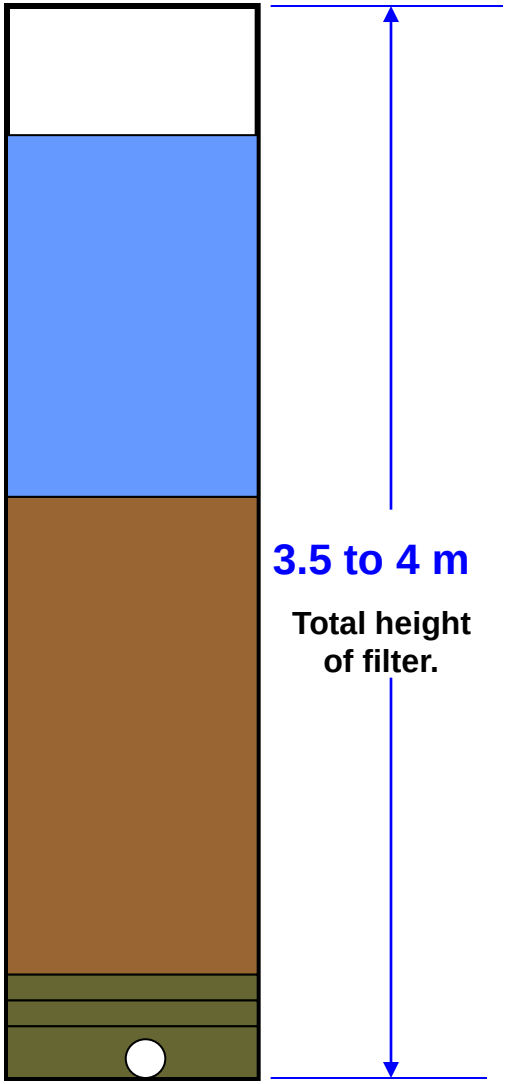


Comparison of the vertical scale of the Traditional SSF and MSSF and MPSF technologies.

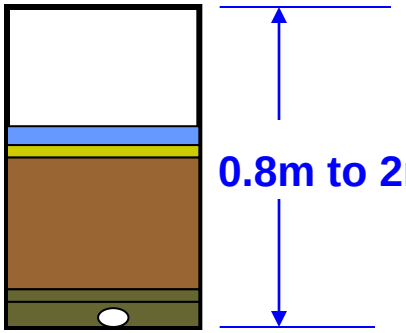
All filters meet AWWA Guidelines or Standards for 'slow sand filter design' and 'specification of filter media'.

Loading up to 0.4 m^3/m^2 of surface per hour when used as a slow sand filter to remove bacteria and viruses. Loading can be increased to 0.6 $m^3/m^2/h$ or more for most other applications.

TSSF



MSSF of MPSF



The depth of the filter bed in the MSSF or MPSF is equal to the minimum depth recommended for the TSSF.

Basic treatment process for iron and manganese removal:

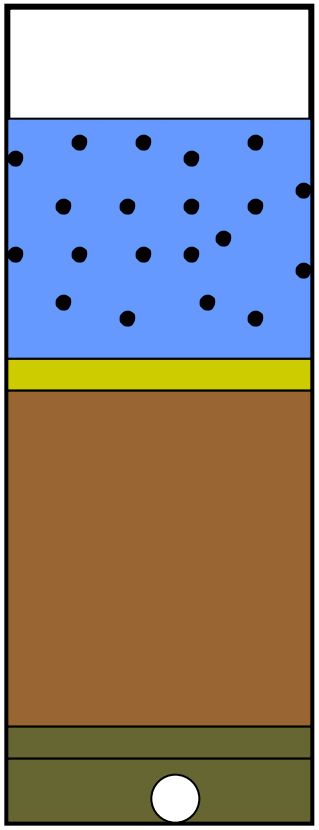
1. Oxidation of iron and manganese (preferably using sodium hypochlorite).
2. Formation of micro-flocs.
3. Filtration using MPSF.
4. Storage and distribution.

(Possible to add additional pre- and post-treatment as required.)

First Understand Basic Principles of the Commissioning of the MPSF.

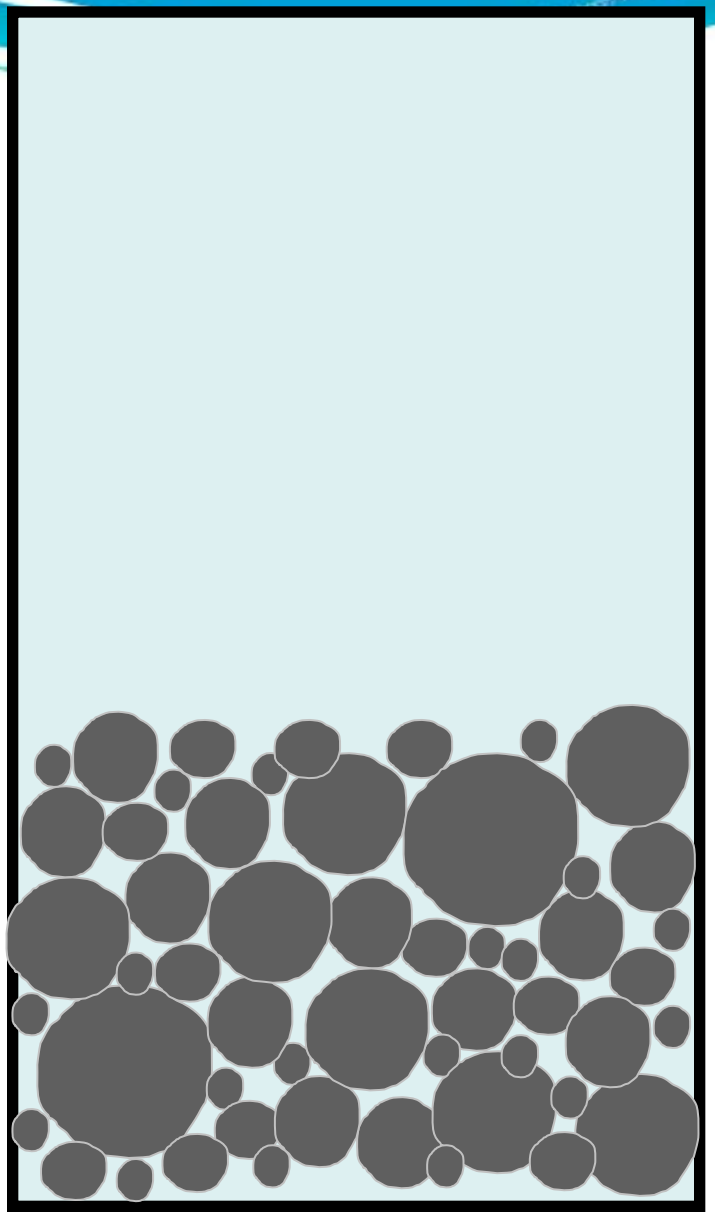
Note that an MPSF is backwashed as part of the commissioning process to insure that smallest sand/media particles (< 0.1 mm in diameter) are at the filter surface.

Almost ALL treatment occurs at or near the sand surface.



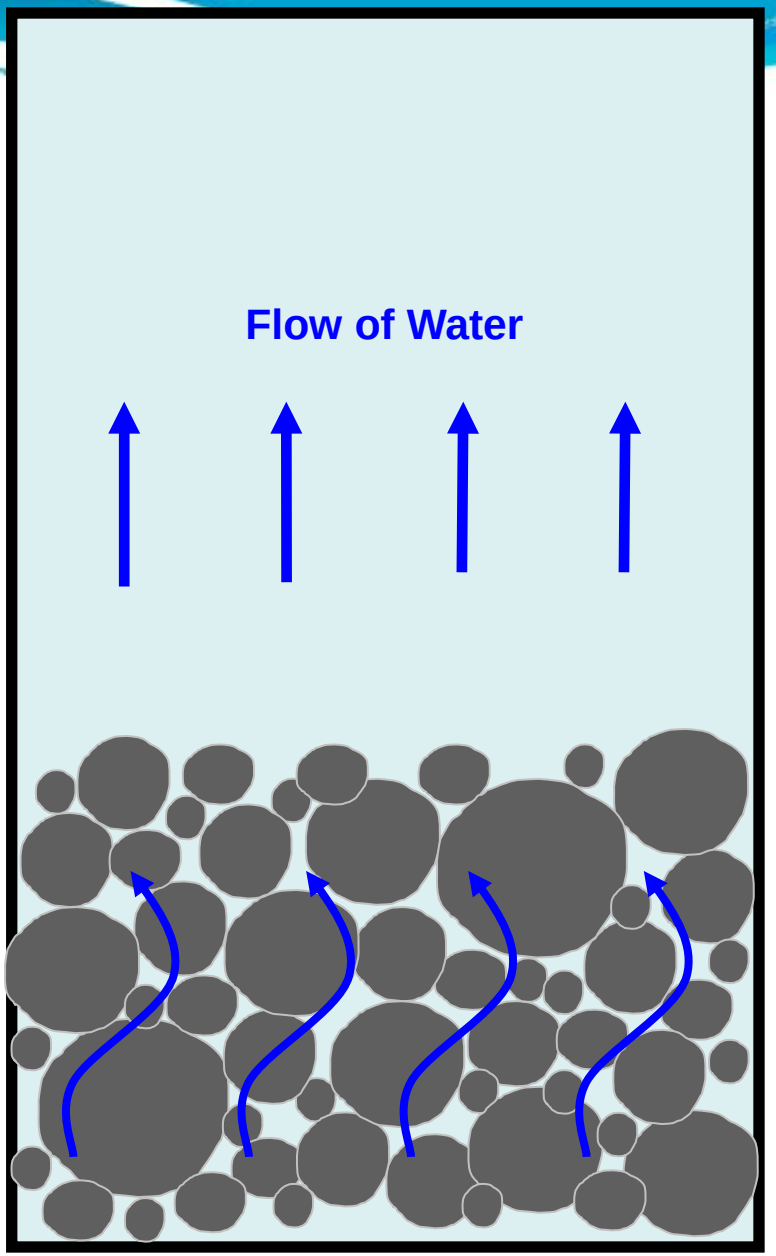
Review of Backwash Process

Consider a typical sand filter when first backwashed:

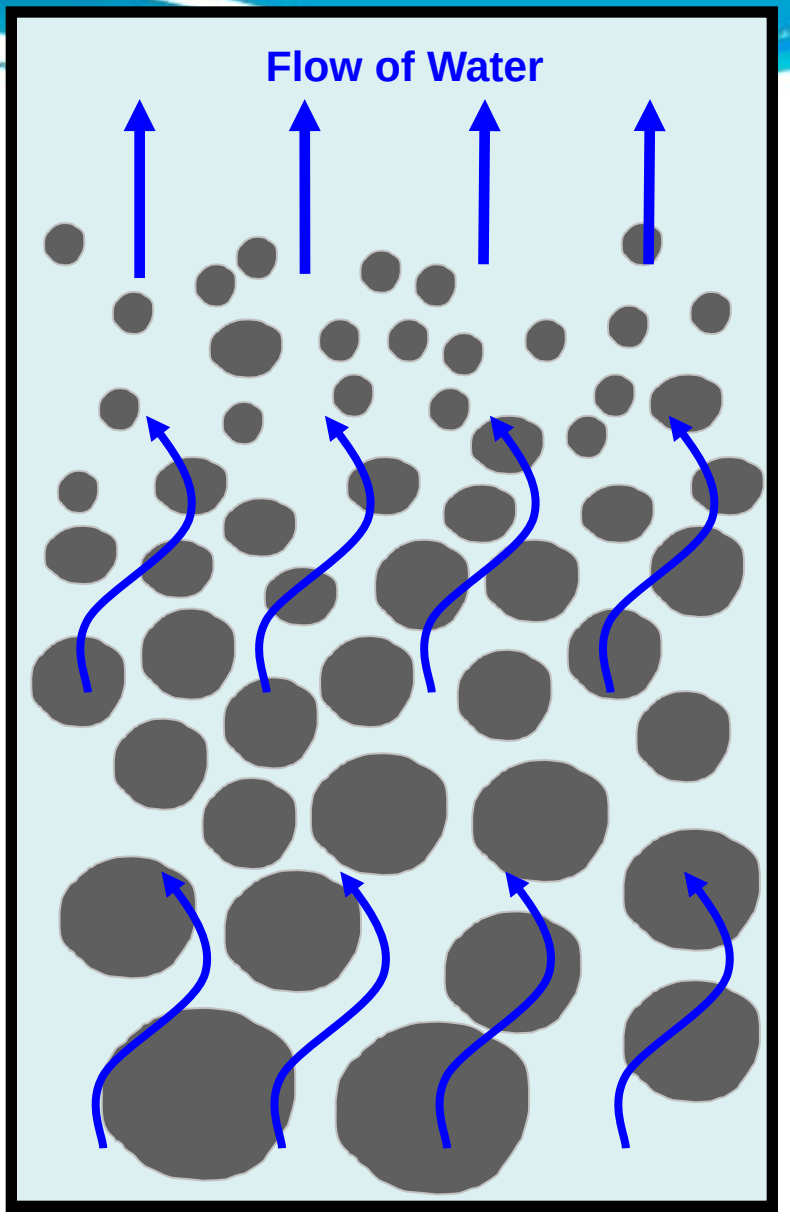


Initially particles having different diameters are mixed together.

Backwash starts.



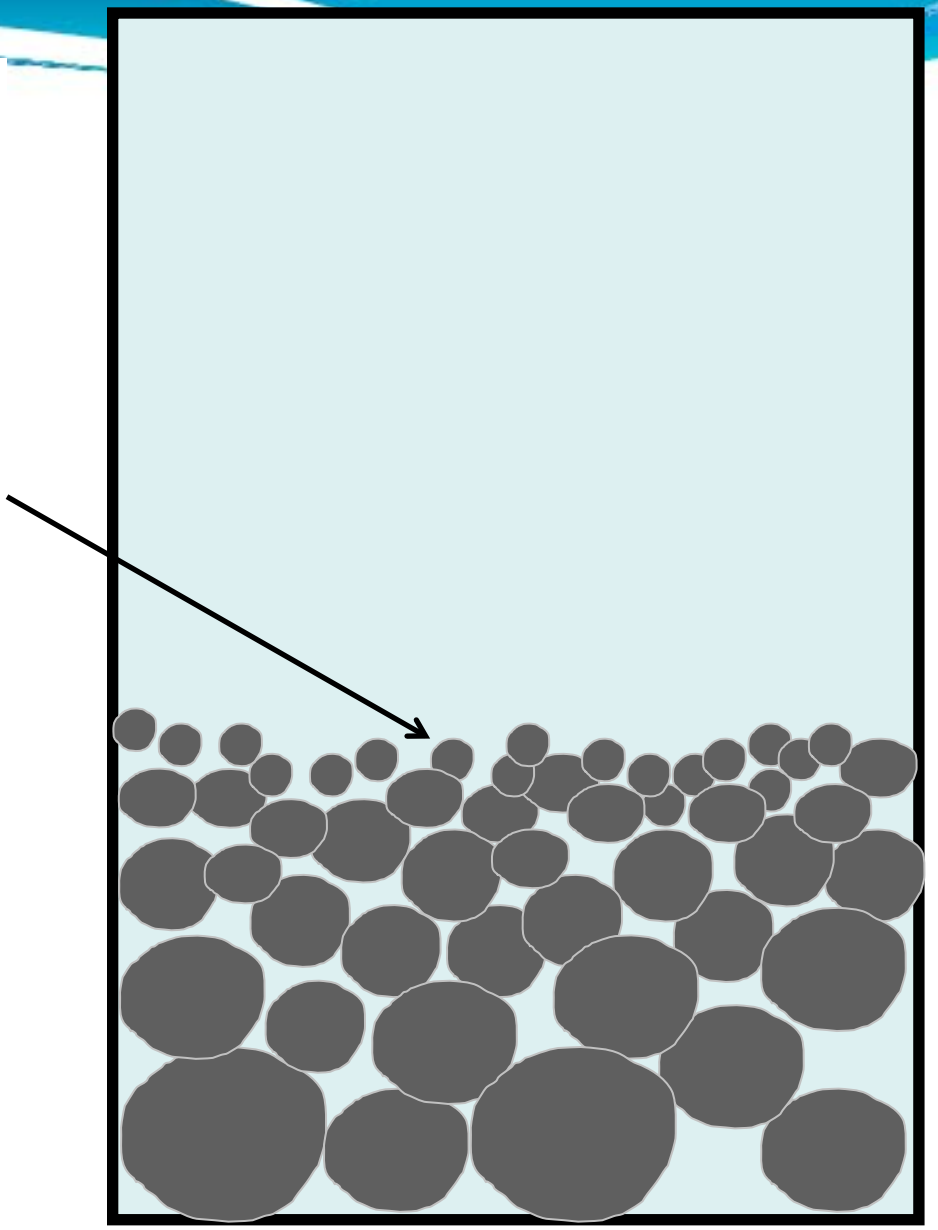
Bed fluidizes.

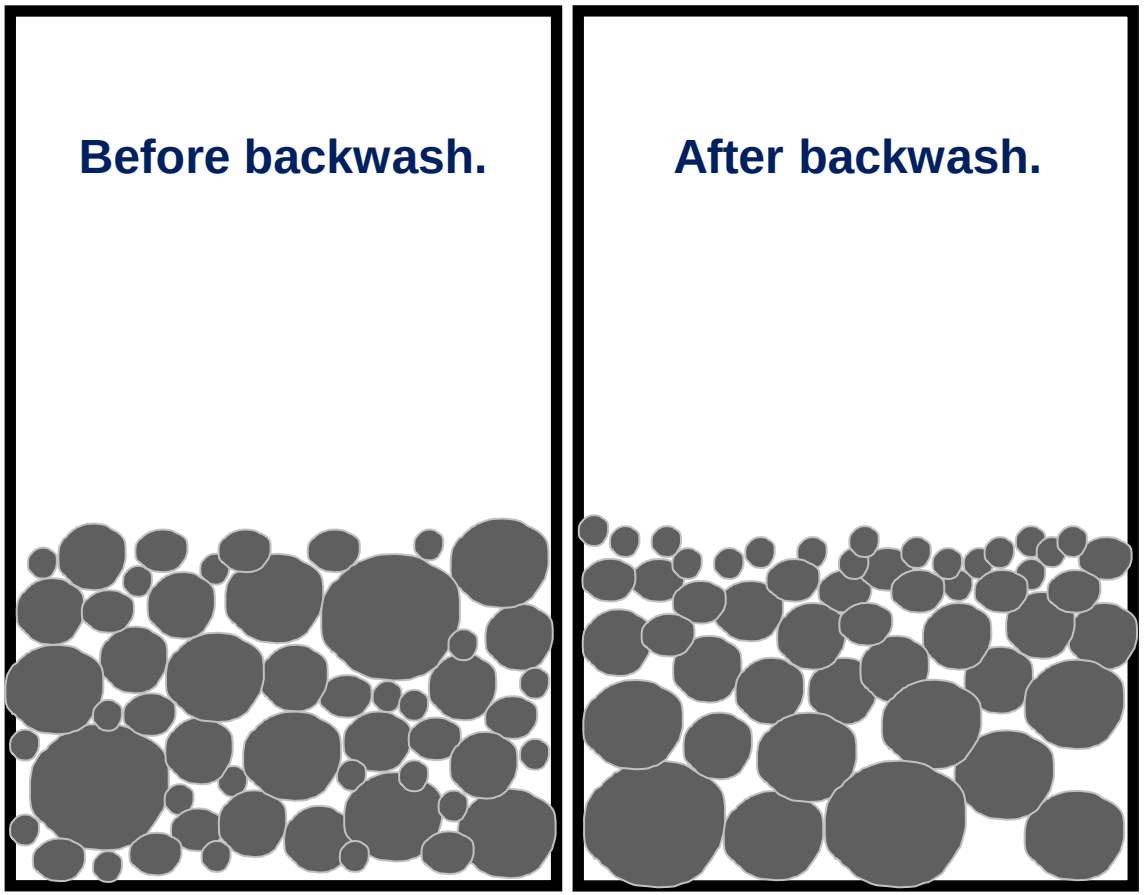


Backwash stops.

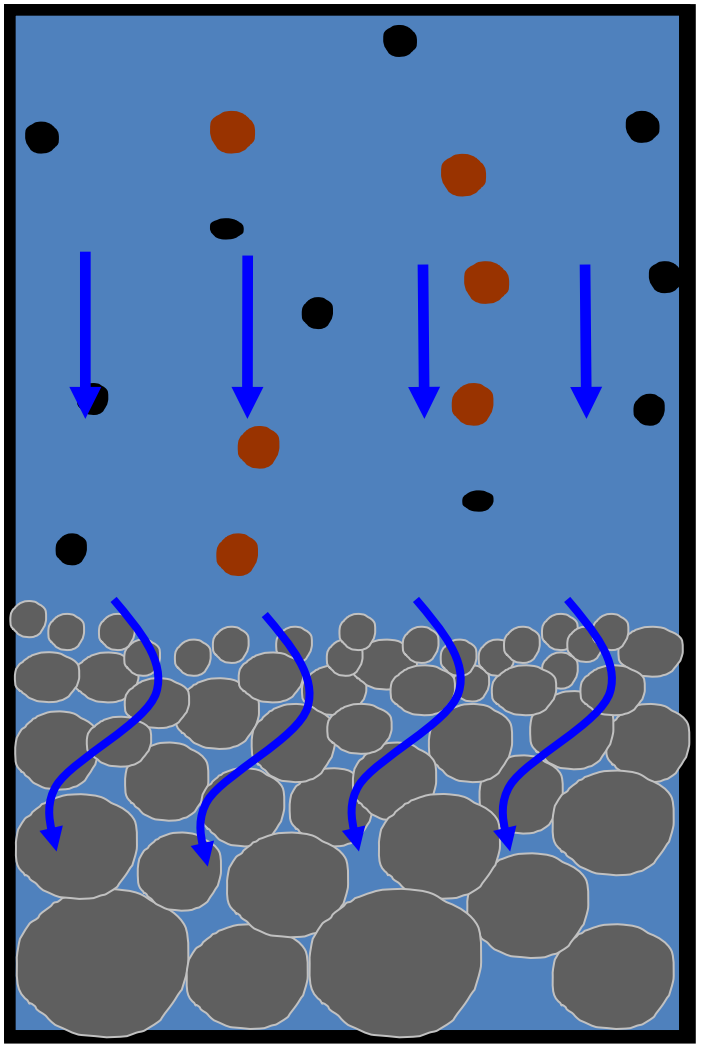
The same ‘smallest diameter particles’ will be at the media surface after every backwash.

The backwash of an MPSF is unique in that filter media can never be lost.





Operation of the MPSF when used to remove iron and manganese.

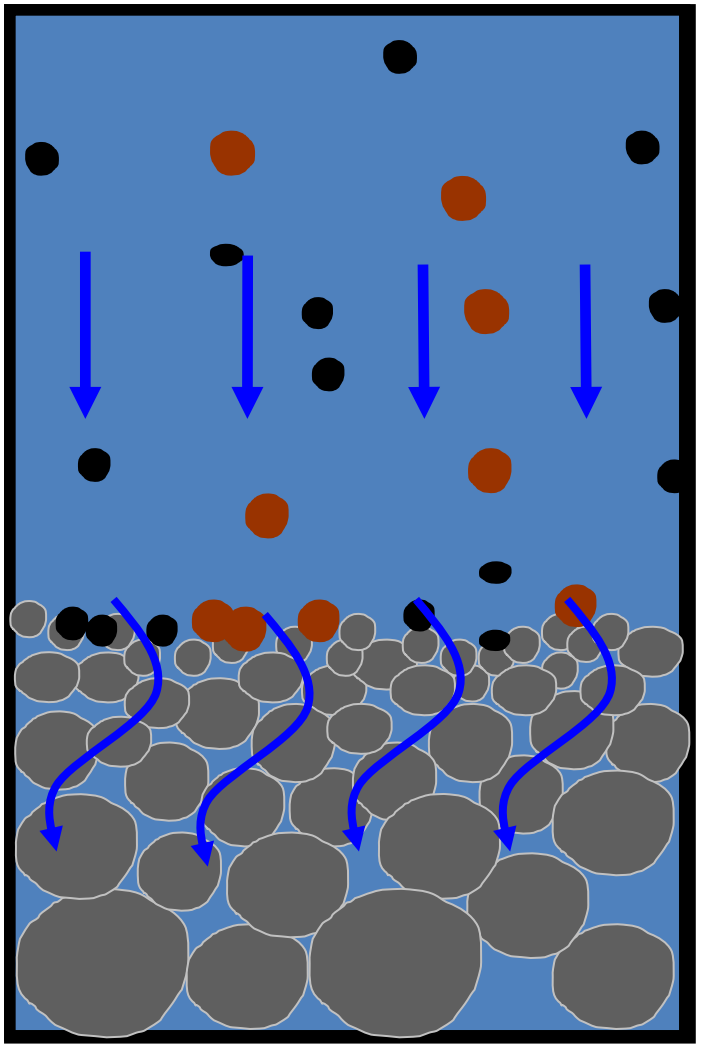


Oxidized iron

Oxidized manganese

Note: Iron and manganese need to be oxidized and allowed to form micro-flocs before attempting filtration.

Operation of the MPSF when used to remove iron and manganese.

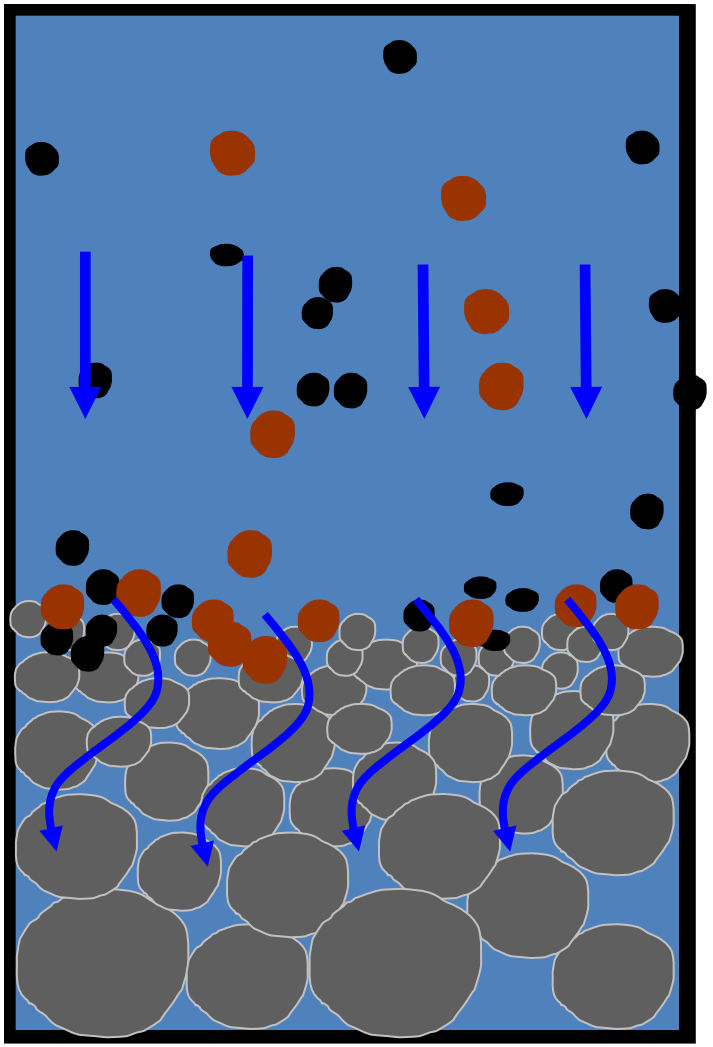


Oxidized iron

Oxidized manganese

Iron and manganese are captured at the surface of the media – a mechanical filtration process that does not require formation of the 'schmutzdeke' that is developed by a traditional slow sand filter when removing micro-organisms.

Operation of the MPSF when used to remove iron and manganese.

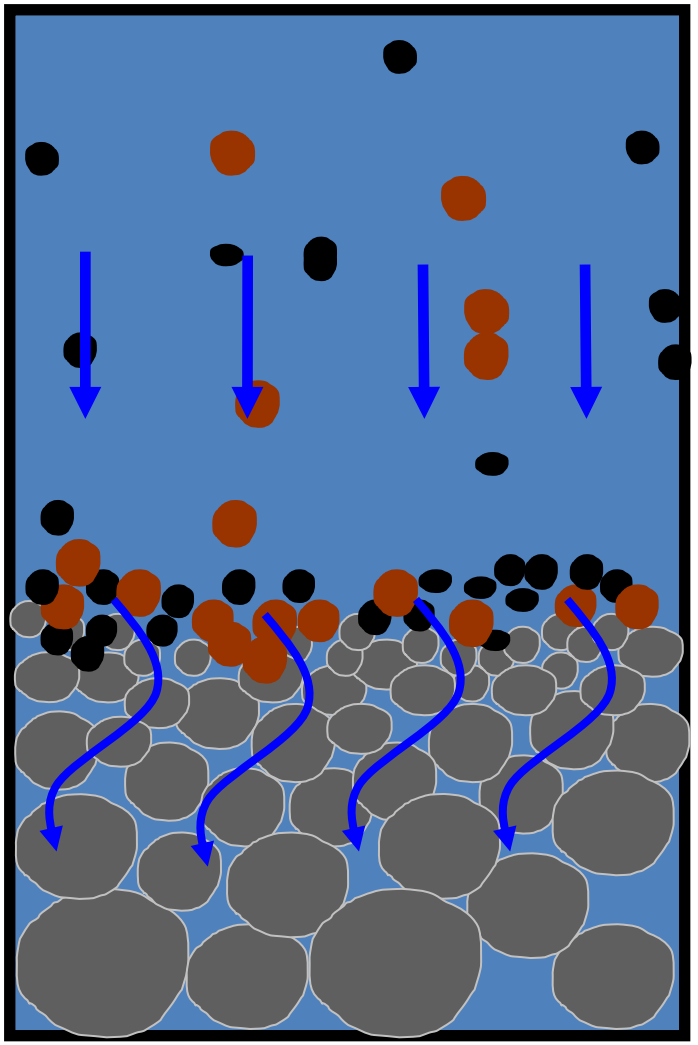


Oxidized iron

Oxidized manganese

Iron and manganese continue to be captured on the filter sand/media surface.

Operation of the MPSF when used to remove iron and manganese.



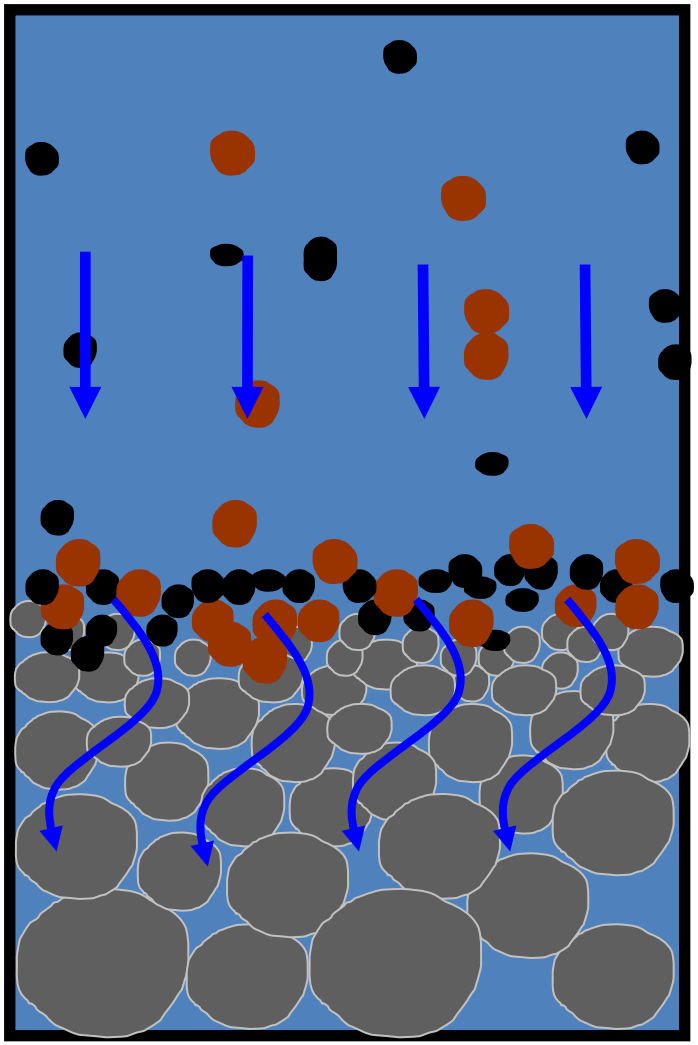
Oxidized iron

Oxidized manganese

Iron and manganese continue to be captured on the filter sand/media surface.
Flow through filter will gradually decrease.

Operation of the MPSF when used to remove iron and manganese.

Filter cleaning required.



Oxidized iron

Oxidized manganese

Iron and manganese continue to be captured on the filter sand surface until such time as the filter sand surface is 'plugged off' and the flow through the filter is reduced to unacceptable rates. The filter needs to be cleaned.

Normal Cleaning of MPSF

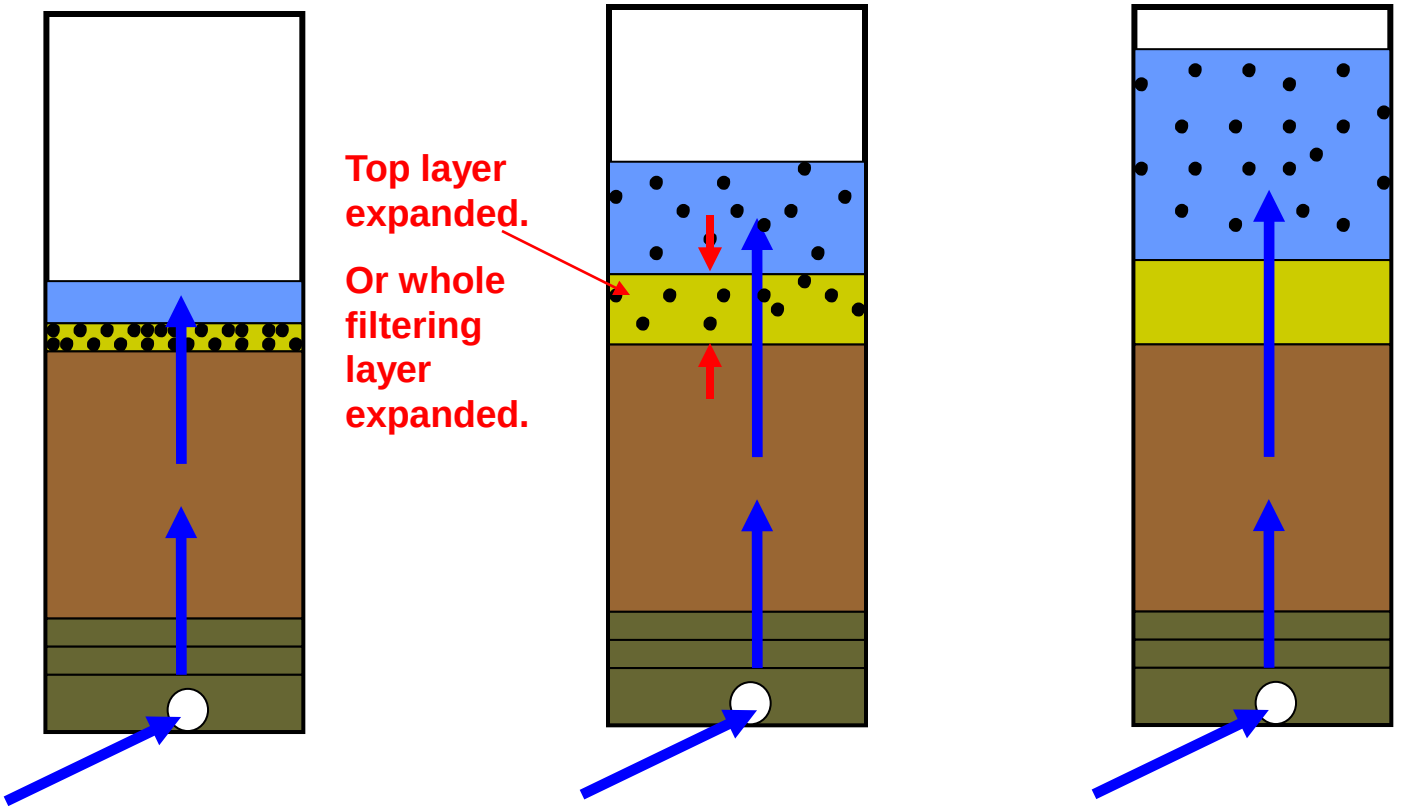
1. Filtered water is added into bottom of filter – backwash flow.
2. Surface layer of media is fluidized and expanded.
3. Backwash flow is stopped and media settles back into position.
4. Water containing captured iron and manganese is flushed out.

Entire cleaning process takes less than 30 minutes even for very large filters.

No media is removed or needs to be replaced.

Normal Cleaning of MPSF

Backwashing suspends particulate material that had blocked flow from top of sand/media.

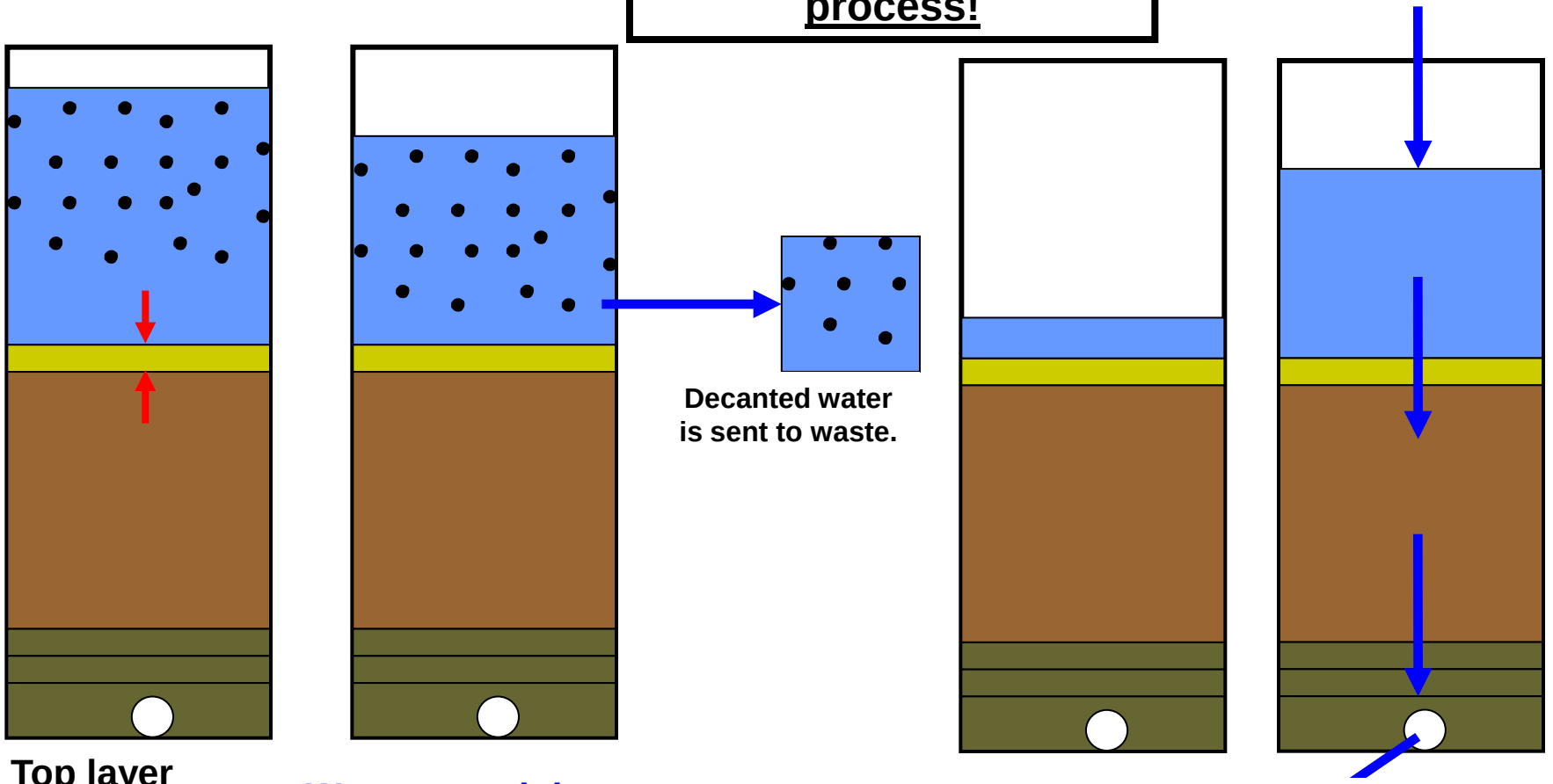


Filtered water enters filter.

Only the layer of fine filtering sand/media <u>needs</u> to be expanded and <u>captured particles are flushed</u> from it.

Backwash is stopped – smallest sand particles remain at surface.

Not possible to lose media during backwash process!



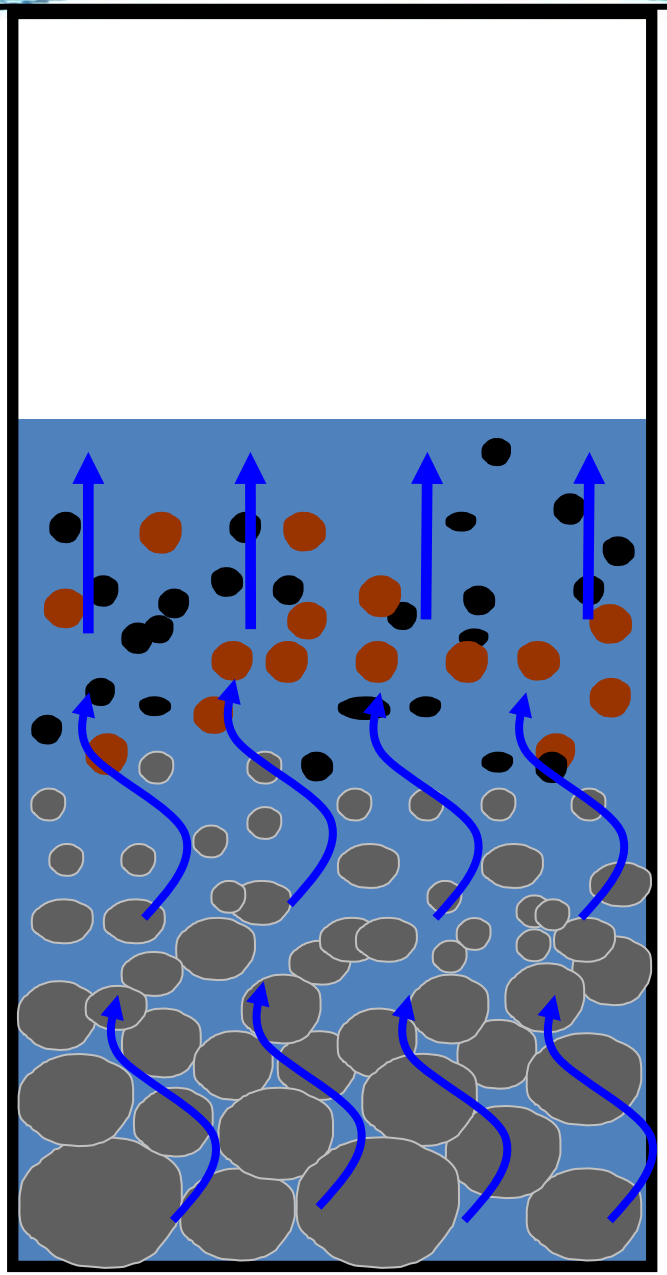
Top layer collapses to original depth.

Water containing all of the captured material is decanted from filter.

Decant is complete.

Filter is put into production without filter-to-waste cycle.

Backwash of the MPSF to remove captured iron and manganese.

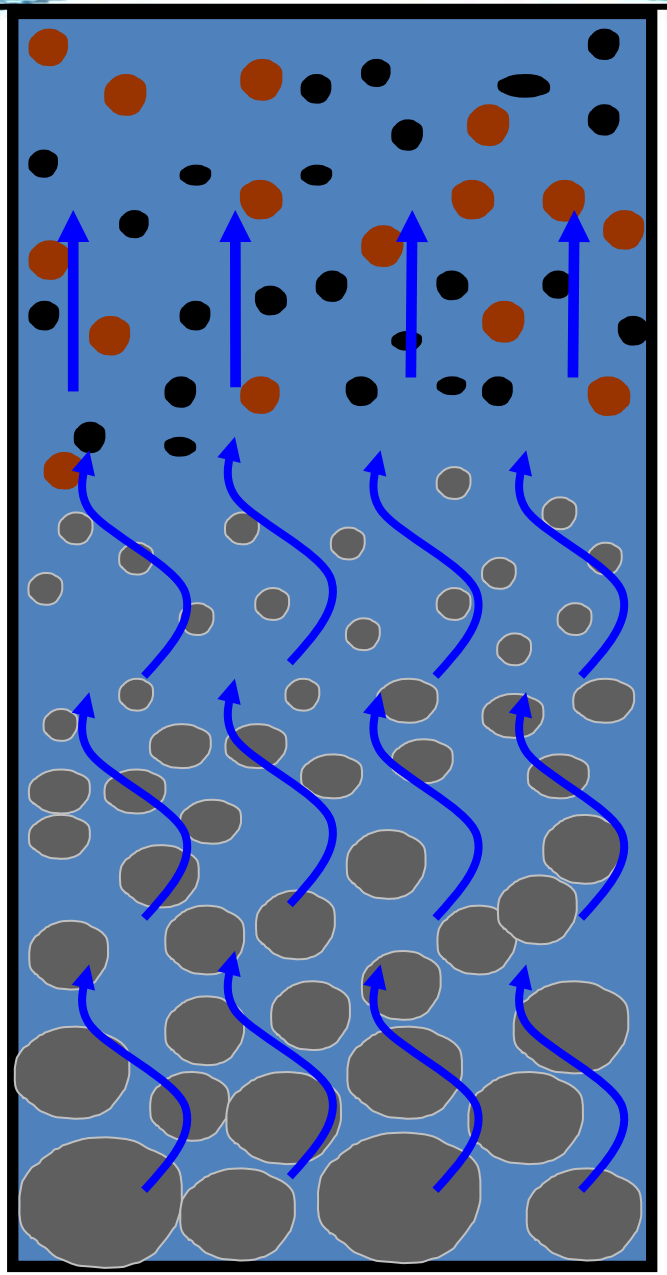


Oxidized iron

Oxidized manganese

1. Production is stopped.
2. Filtered water is forced through the underdrain and upward through the filter sand/media at approximately 3 metres head and a flow rate between 1 – 3 L/s/square metre of filter surface.
3. Sand/media is fluidized.

Backwash of the MPSF to remove captured iron and manganese.

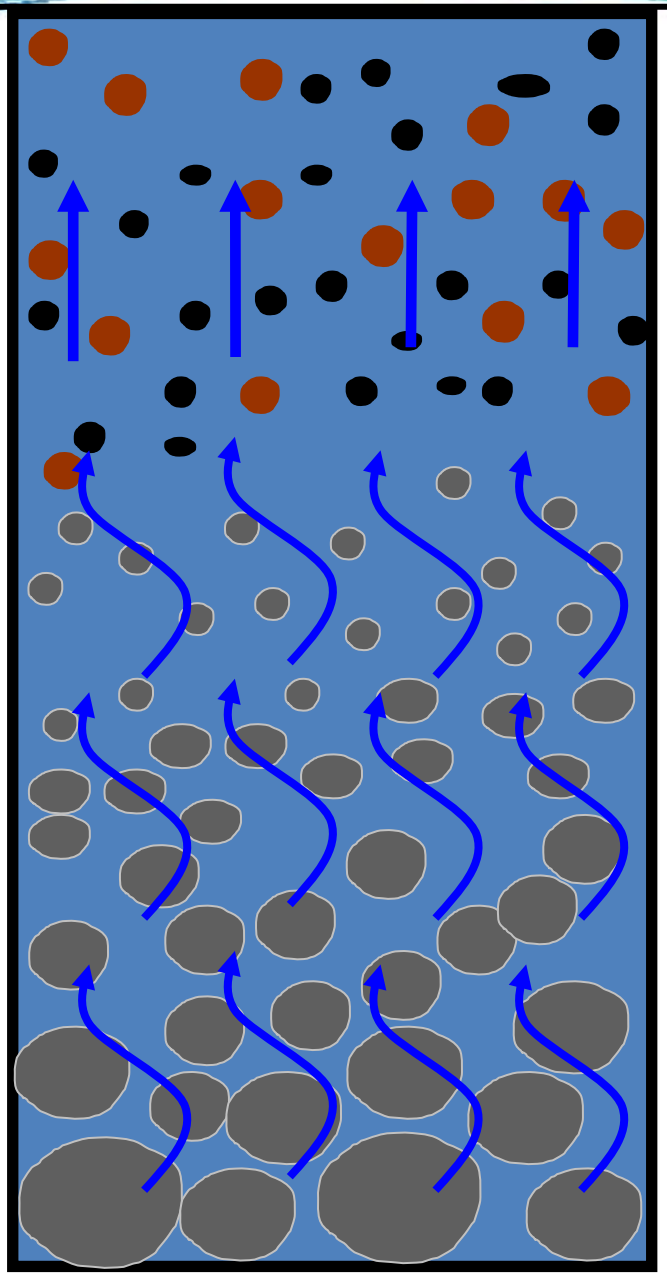


Oxidized iron

Oxidized manganese

1. Backwash continues until all of the iron and manganese is suspended in the water above the fluidized sand/media.
2. Water is not wasted during the backwash process.

Backwash of the MPSF to remove captured iron and manganese.

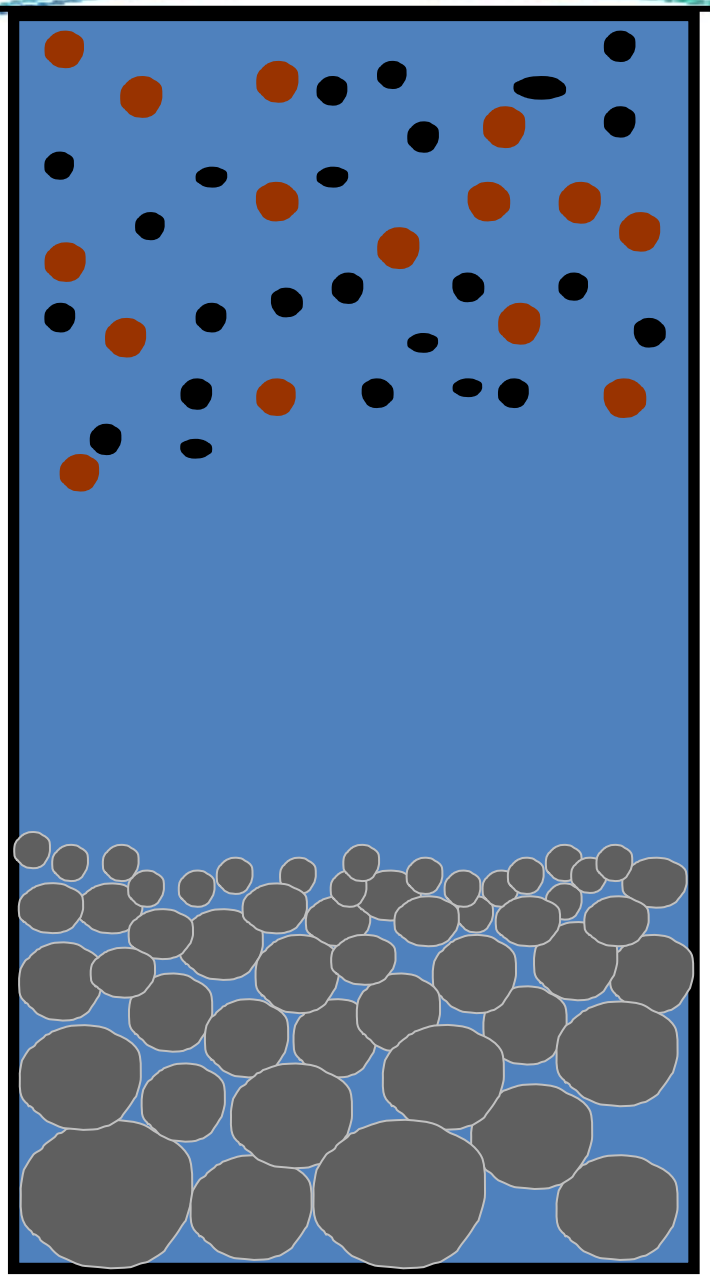


Oxidized iron

Oxidized manganese

1. All of the iron and manganese that was captured on the sand/media surface is suspended in the water above the filter sand/media (less than 1 metre depth).

Backwash of the MPSF to remove captured iron and manganese.



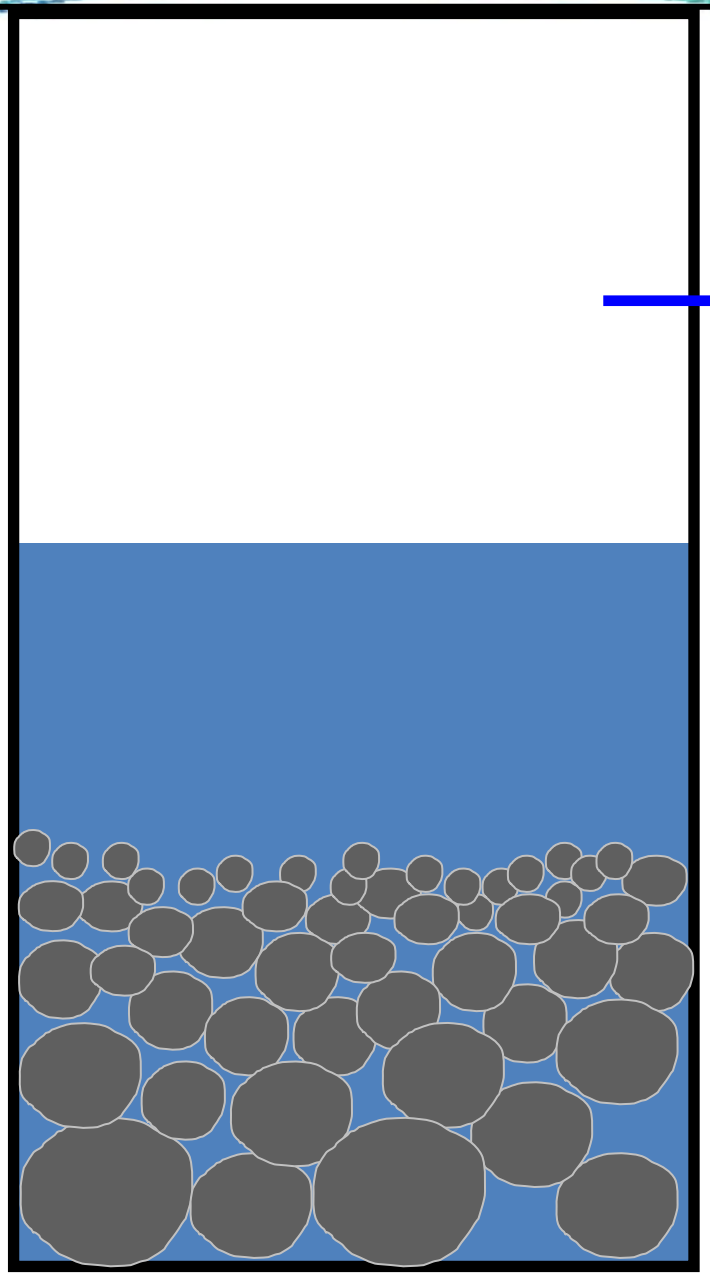
Oxidized iron

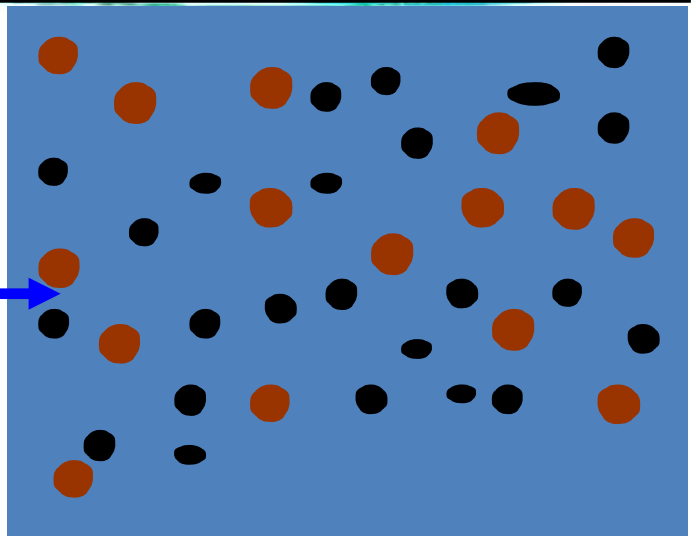
Oxidized manganese

Note:

1. Backwash is stopped.
2. Sand/media settles back to original position with finest particles at the top.

Backwash of the MPSF to remove captured iron and manganese.





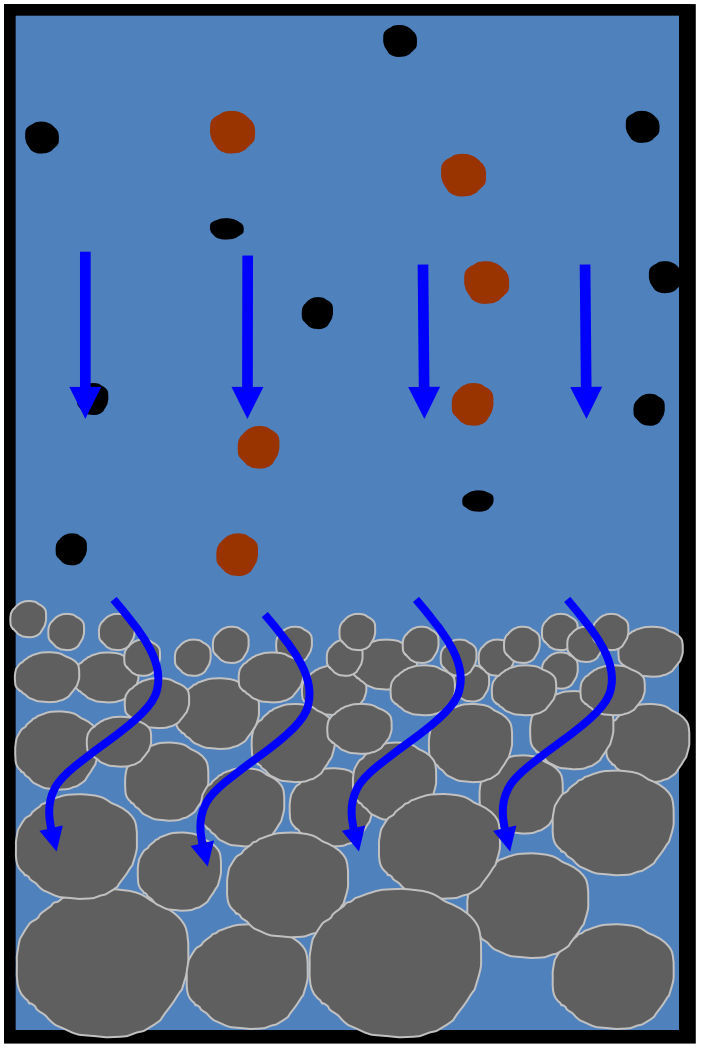
Oxidized iron

Oxidized manganese

Note:

1. Water with the suspension of iron and manganese is drained from the filter (to waste) at desired rate without use of pumps.

Filter is put back into production.



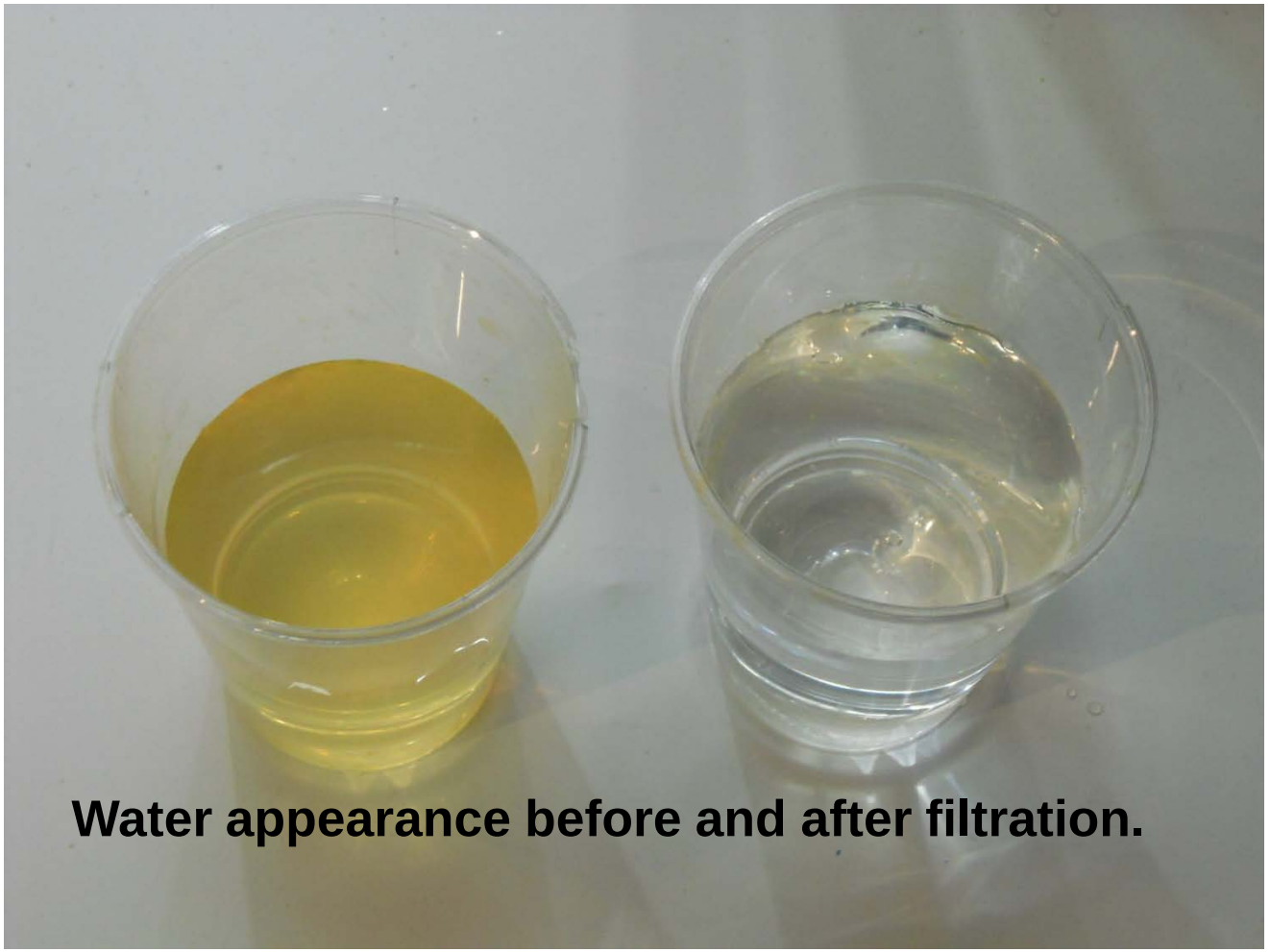
Oxidized iron

Oxidized manganese

Note: Entire backwash process may take 30 minutes - more or less.

Consider the operation and cleaning of a pilot scale MPSF.

Water with oxidized iron or manganese is introduced to the top of the filter.
Note that ALL iron or manganese is captured at sand/media surface.



Water appearance before and after filtration.

Starting the backwash process.

Backwash process suspending captured iron and manganese.

Backwash process suspending captured iron and manganese.

Note that the surface of the sand is free of iron and manganese and backwash can stop.

Backwash is stopped and the sand/media is allowed to settle.

Sand returns to original position.

Water with iron and manganese is drained from filter.

Water with iron and manganese is completely drained from filter.

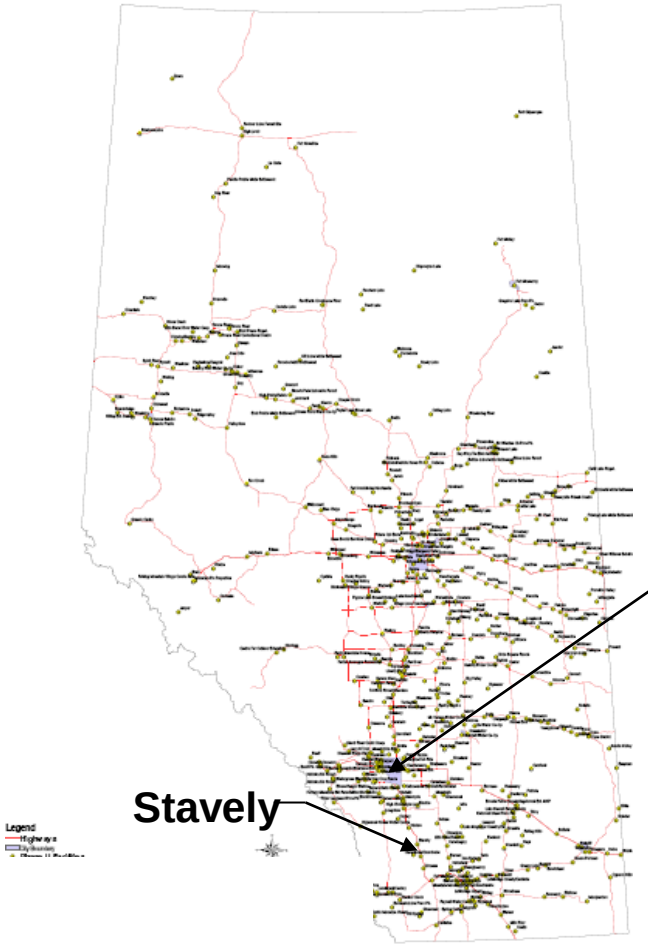
Captured iron and manganese in the backwash water will settle quickly allowing the clarified water to be recycled leaving very little sludge for disposal.

Filter is put back into production.

No sand/media is lost during the backwash process.

Stavely Water Treatment Plant
Alberta, Canada
Manganese Removal Using MSPF Technology

Stavely is typical of thousands of small communities across Canada.



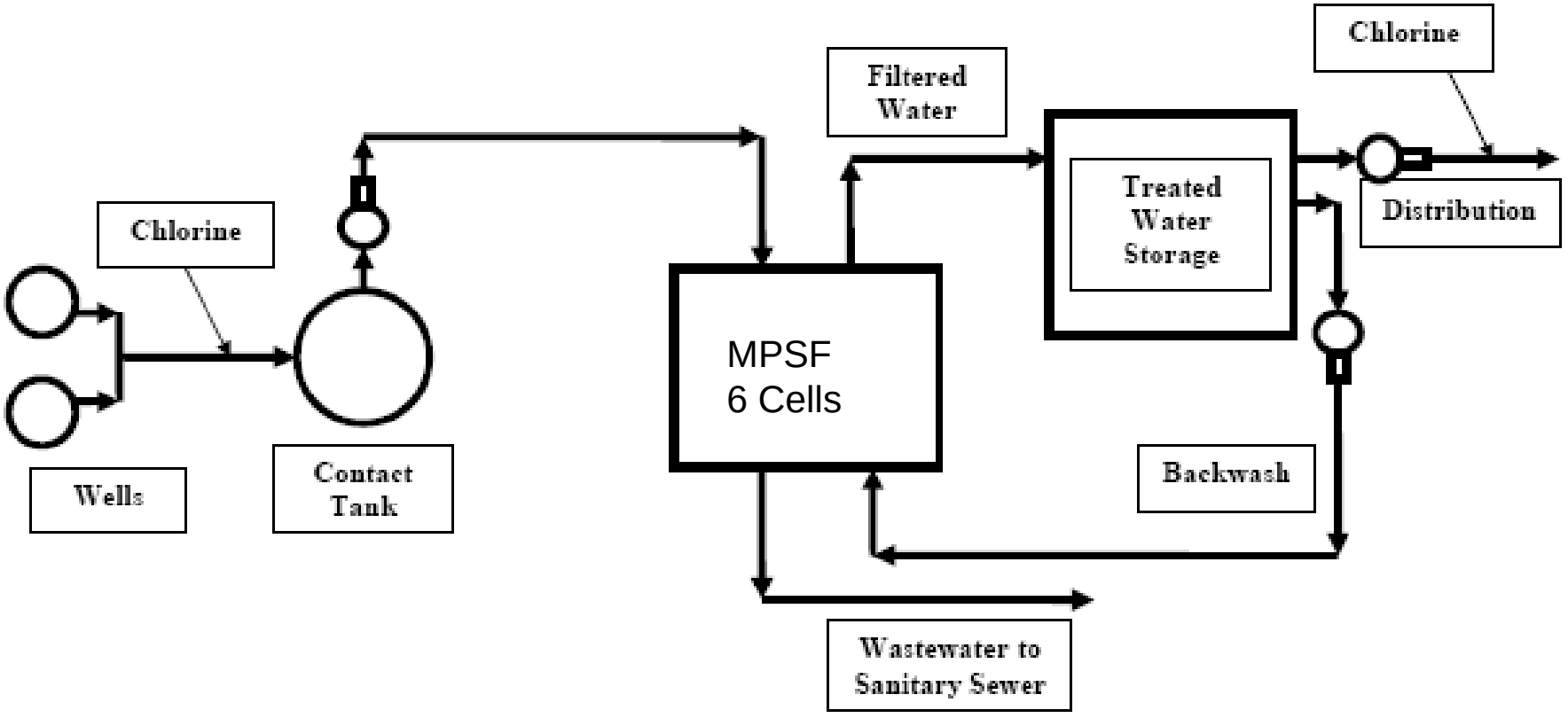
Summary of design constraints and objectives

- Groundwater supply not under direct influence of surface water.
- Manganese above 0.05 mg/L (as high as 0.4 mg/L), hydrogen sulfide (detectable odor) and presence of sulfate reducing bacteria.
- Required treatment capacity of 1,200 m3/day or 50,000 litres per hour.
- Minimum chemical requirements.
- Minimum level of automation.
- Minimum complexity – Operator Level 1 if possible.
- Backwash water to be disposed in town lagoon through existing sanitary sewer.

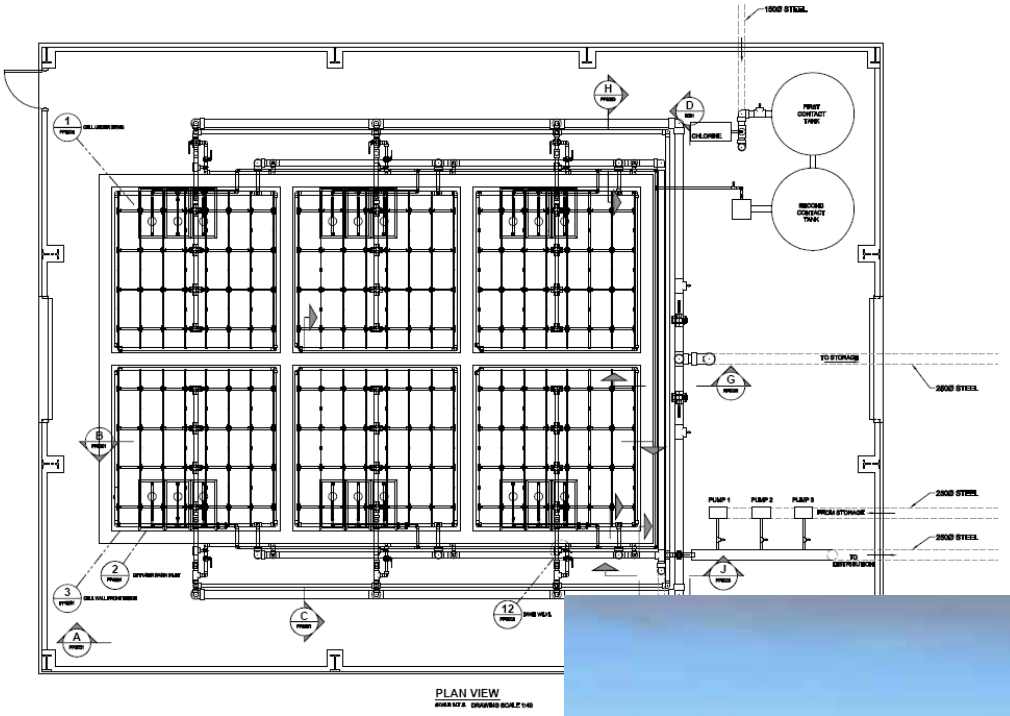
After piloting the MPSF technology was selected considering:

1. Effectiveness. Able to remove iron, manganese, hydrogen sulfide and iron and sulfur reducing bacteria (IRB and SRB). Arsenic will also be removed if it becomes a consideration.
2. Impossible to short circuit or foul.
3. Comparable capital cost. Constructed using local contractors.
4. Low operating cost. (Very low operating, energy and maintenance costs. Media is never lost or replaced.)
5. Minimum use of chemicals (only sodium hypochlorite which must be used regardless to meet minimum chlorine residual targets). Unnecessary to use of other chemicals such as potassium permanganate or use ozone which can be difficult to control.
6. Very little wastewater to dispose of (less than 1 per cent of production).
7. Operator friendly – easy to operate well – difficult to damage. Level One Certification required – requires one or so hours of attention each day freeing operators to perform numerous other tasks and providing job opportunities for local people.
8. Capacity can be easily increased.
9. Treatment process is easily upgraded.

Process Flow Diagram - Stavely



Layout of water treatment plant - Stavely



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

- Building approximately 20 m by 16 m.

Inlet from well, flow meter and chlorine dosing equipment. (Note lab bench and equipment at left.)

Two contact tanks – ensure formation of micro-flocs and transfer pumps.

View of raw water inlet, contact tanks, transfer pumps and lab.

Operating filters in Stavely water treatment plant.

Interior of Stavely water treatment plant.

Raw water inlet, filtered water outlet, backwash water inlet and wastewater outlet. (Note MCC.)

Operation consists of fully opening or closing a valve named the 'Operate Valve'.

Flow adjustment consists of setting the valve named 'Control Valve'. This valve is typically set at time of commissioning and not adjusted again (at least not often).

Inside of a filter cell.

Testing the underdrain.

Installing the media.

Adding media using ‘Stone Slinger’.

Underdrain (bottom layer)

Underdrain (second layer)

Installing the media.

Operating Filter

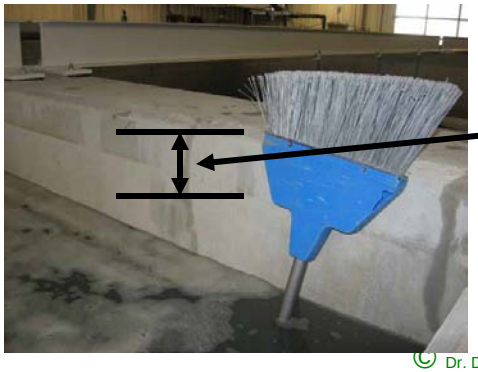
Backwash in Progress

Backwash once every six weeks – one cell per week (30 min.).

Produce 6 m^3 wastewater per backwash per cell.

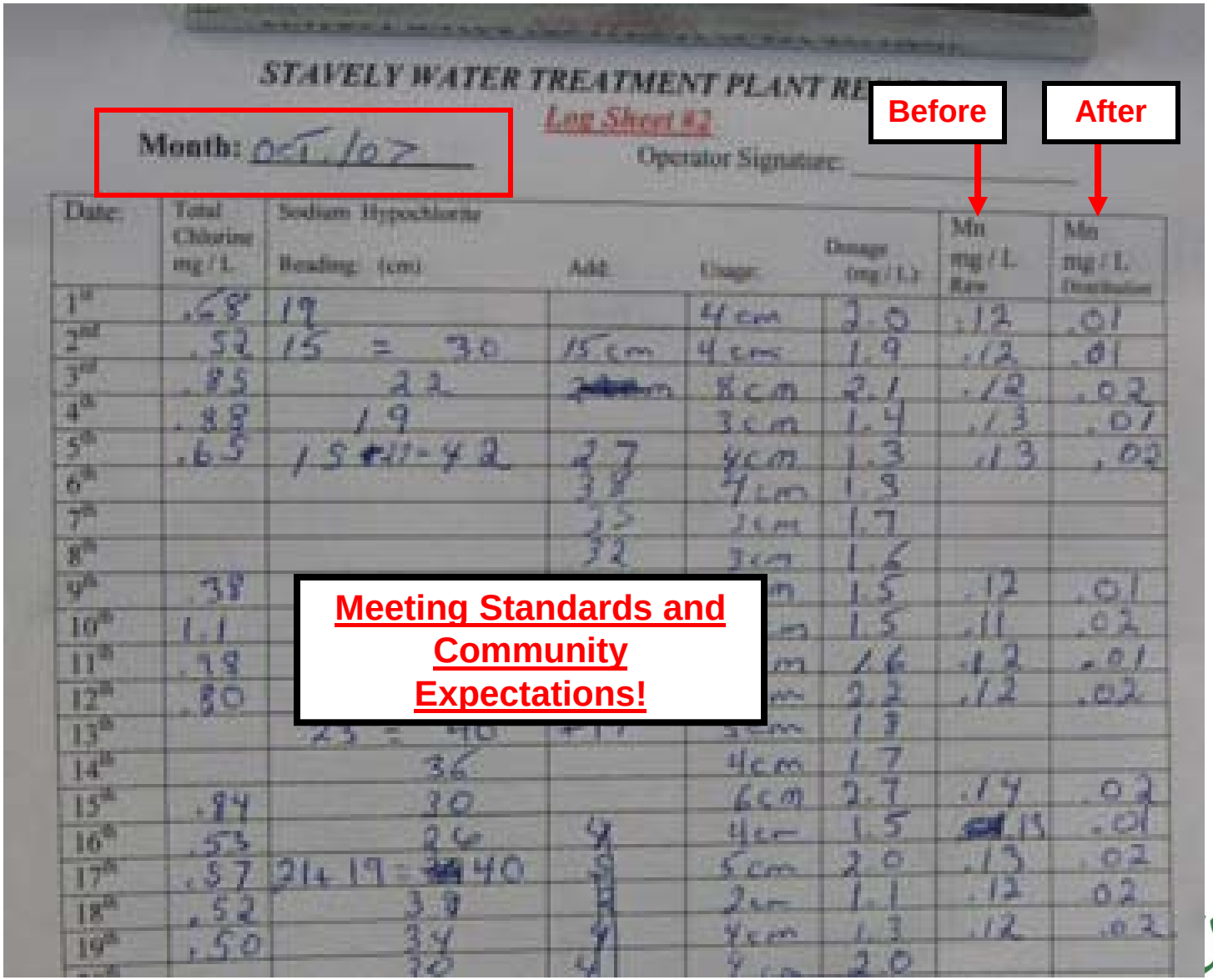
Wastewater is less than 1 % of production.

(36 m^3 of wastewater with 42,000 m^3 of production.)



Depth of bed fluidization.

Operations Log



STAVELY WATER TREATMENT PLANT RE

Log Sheet #2

Month: Oct. 107

Operator Signature: _____

Before

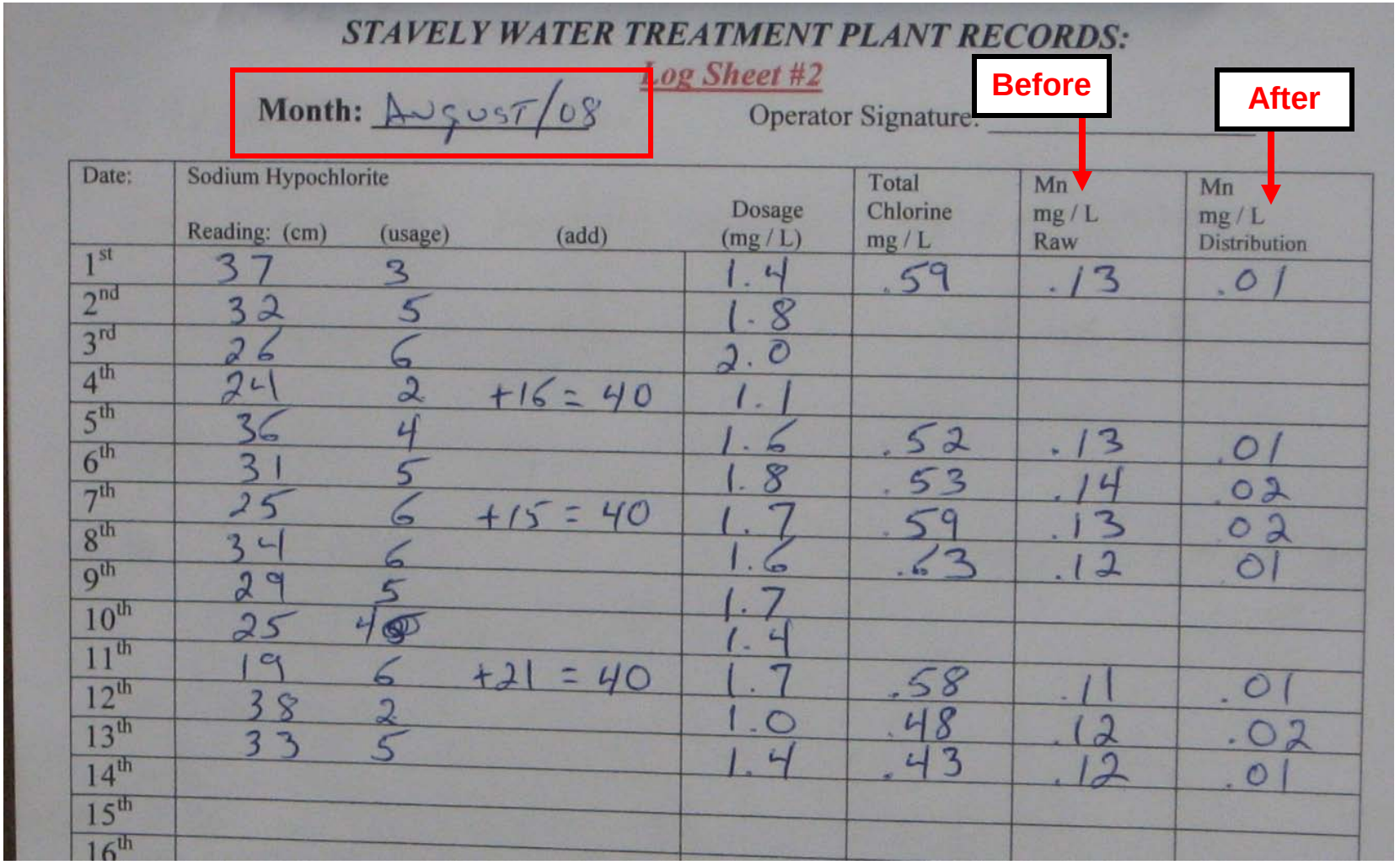
After

Date:	Total Chlorine mg/L	Sodium Hypochlorite Reading (cm)	Add	Usage	Dosage (mg/L)	Mn mg/L Raw	Mn mg/L Distribution
1st	.68	19		4cm	2.0	.12	.01
2nd	.52	15 = 30	15cm	4cm	1.9	.12	.01
3rd	.85	22	[illegible]	8cm	2.1	.12	.02
4th	.88	19		3cm	1.4	.13	.01
5th	.63	15 [illegible] 42	27	4cm	1.3	.13	.02
6th			38	4cm	1.9		
7th			25	2cm	1.7		
8th			32	3cm	1.6		
9th	.38			m	1.5	.12	.01
10th	1.1			m	1.5	.11	.02
11th	.39			m	1.6	.12	.01
12th	.80			m	2.2	.12	.02
13th		23 = 40		cm	1.3		
14th		36		4cm	1.7		
15th	.84	30		6cm	2.7	.14	.02
16th	.53	26	4	4cm	1.5	.13	.01
17th	.57	21+19 = 40	5	5cm	2.0	.13	.02
18th	.52	30	3	2cm	1.1	.12	02
19th	.50	34	4	4cm	1.3	.12	.02
		30	4		2.0		

Meeting Standards and Community Expectations!

Oasis Filter International Ltd.

Operations Log



STAVELY WATER TREATMENT PLANT RECORDS:

Log Sheet #2

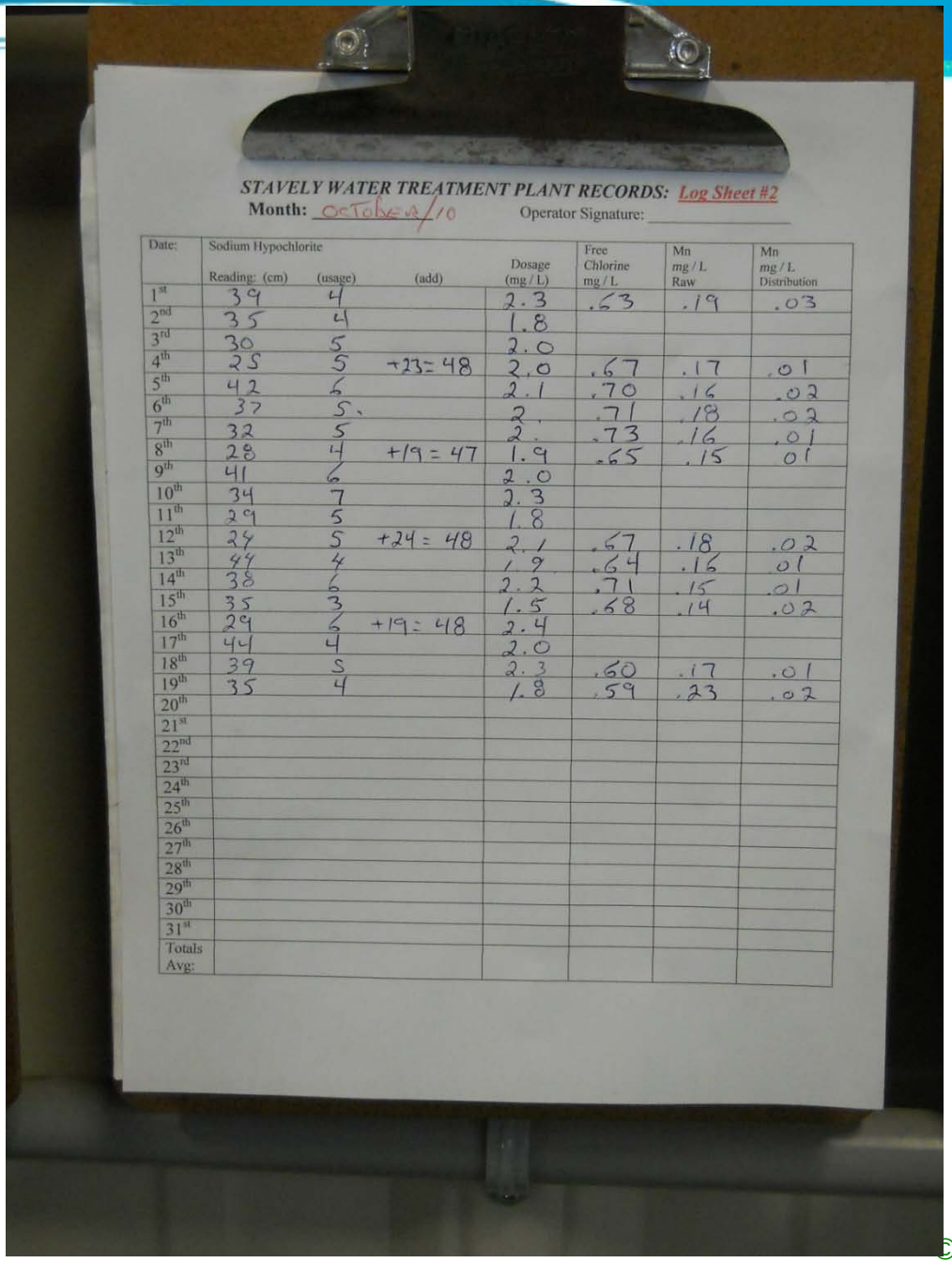
Month: AUGUST/08

Operator Signature: _____

Before

After

Date:	Sodium Hypochlorite Reading: (cm)	(usage)	(add)	Dosage (mg / L)	Total Chlorine mg / L	Mn mg / L Raw	Mn mg / L Distribution
1st	37	3		1.4	.59	.13	.01
2nd	32	5		1.8			
3rd	26	6		2.0			
4th	24	2	+16 = 40	1.1			
5th	36	4		1.6	.52	.13	.01
6th	31	5		1.8	.53	.14	.02
7th	25	6	+15 = 40	1.7	.59	.13	.02
8th	34	6		1.6	.63	.12	.01
9th	29	5		1.7			
10th	25	4		1.4			
11th	19	6	+21 = 40	1.7	.58	.11	.01
12th	38	2		1.0	.48	.12	.02
13th	33	5		1.4	.43	.12	.01
14th							
15th							
16th							

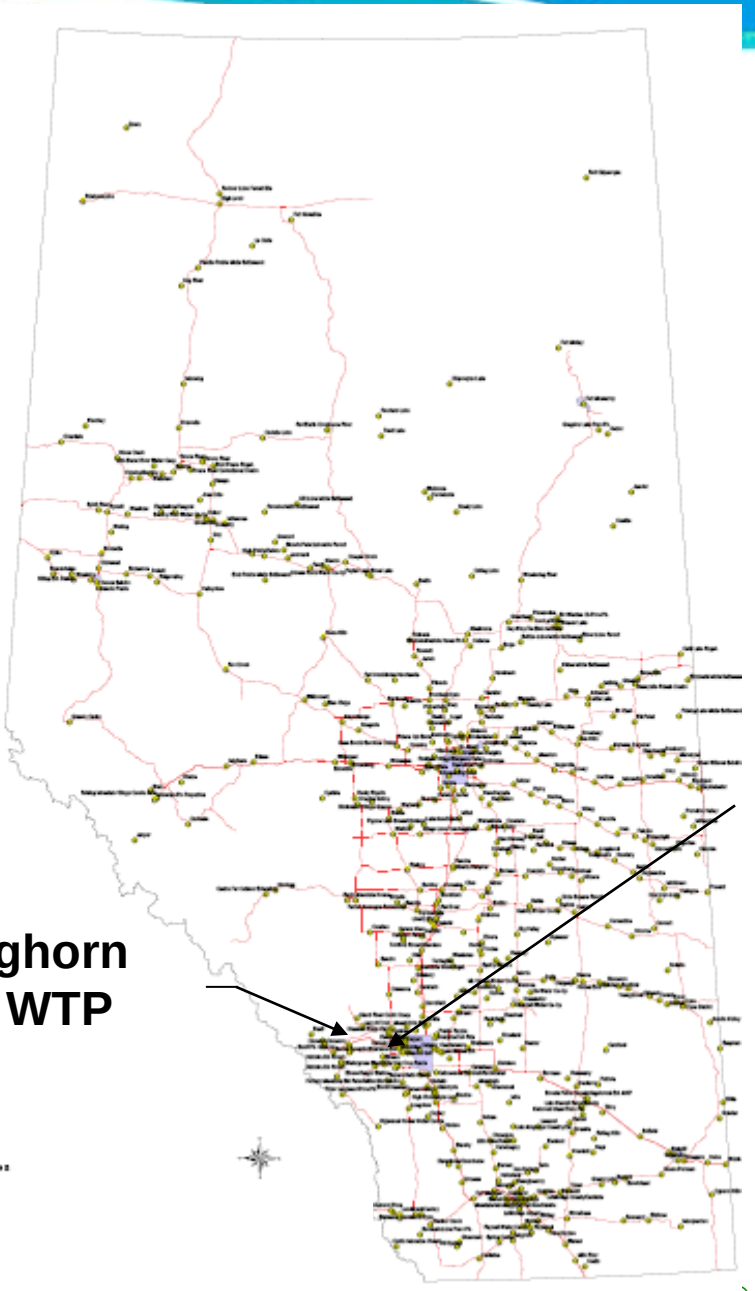


STAVELY WATER TREATMENT PLANT RECORDS: Log Sheet #2

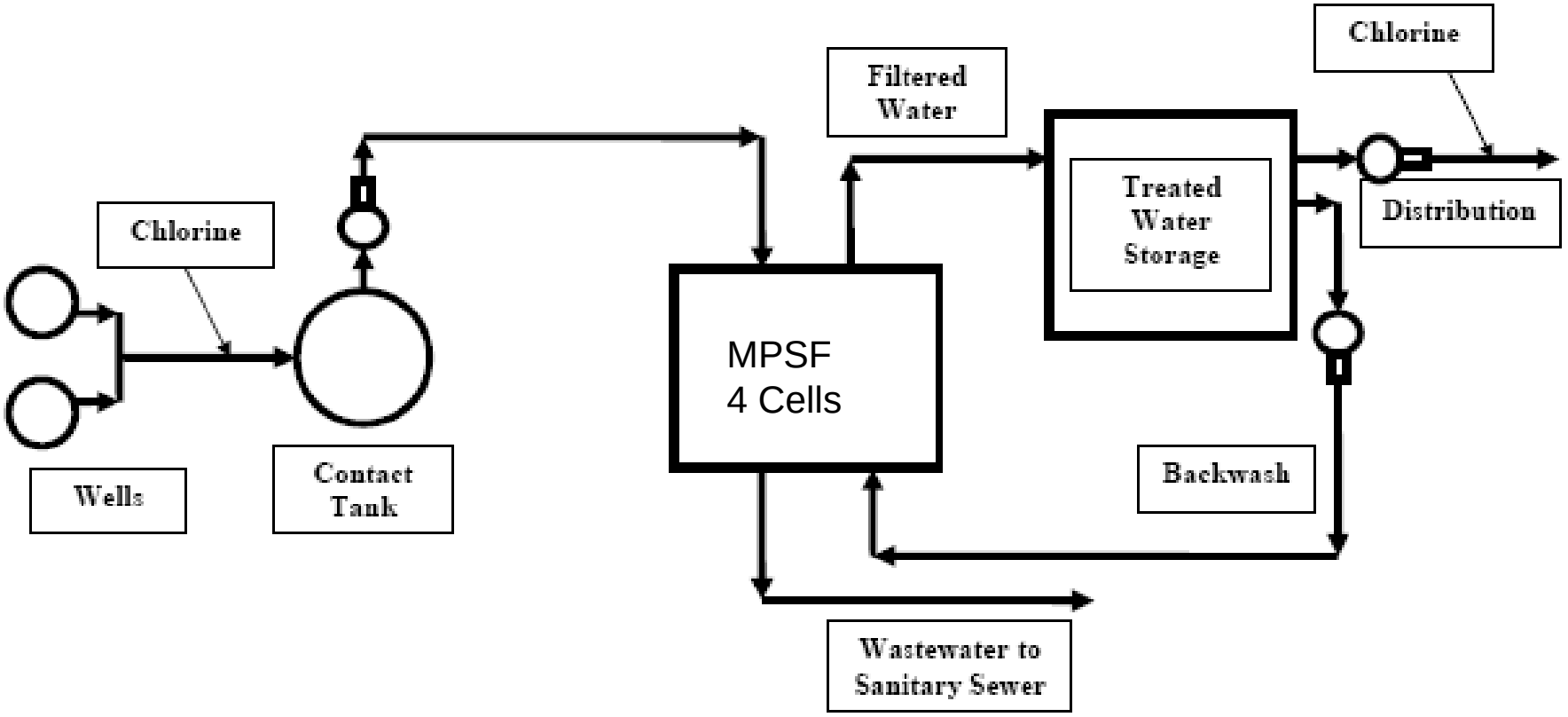
Month: October/10 Operator Signature: _____

Date:	Sodium Hypochlorite				Free Chlorine mg / L	Mn mg / L Raw	Mn mg / L Distribution
	Reading: (cm)	(usage)	(add)	Dosage (mg / L)			
1st	39	4		2.3	.63	.19	.03
2nd	35	4		1.8			
3rd	30	5		2.0			
4th	25	5	+23=48	2.0	.67	.17	.01
5th	42	6		2.1	.70	.16	.02
6th	37	5		2.	.71	.18	.02
7th	32	5		2.	.73	.16	.01
8th	28	4	+19=47	1.9	.65	.15	01
9th	41	6		2.0			
10th	34	7		2.3			
11th	29	5		1.8			
12th	24	5	+24=48	2.1	.67	.18	.02
13th	44	4		1.9	.64	.16	01
14th	38	6		2.2	.71	.15	.01
15th	35	3		1.5	.68	.14	.02
16th	29	6	+19=48	2.4			
17th	44	4		2.0			
18th	39	5		2.3	.60	.17	.01
19th	35	4		1.8	.59	.23	.02
20th							
21st							
22nd							
23rd							
24th							
25th							
26th							
27th							
28th							
29th							
30th							
31st							
Totals Avg:							

MD of Bighorn Exshaw WTP



Process Flow Diagram - Exshaw



Summary of design constraints and objectives

- Groundwater supply not under direct influence of surface water.
- Iron above 0.3 mg/L (during pilot testing concentration was above 1.4 mg/L).
- Manganese above 0.2 mg/L.
- Hydrogen sulfide (and presence of sulfate reducing bacteria) present during pilot test.
- Required treatment capacity of 1,200 m3/day or 50,000 litres per hour.
- Minimum chemical requirements.
- Minimum level of automation.
- Minimum complexity – Operator Level 1 if possible.
- Backwash water to be disposed in town lagoon through existing sanitary sewer.

After piloting the MPSF technology was chosen for same reasons the MPSF technology was chosen in Stavely.

Bench scale evaluation is performed prior to pilot scale studies – normally at no cost to client.

Piloting based on results of bench scale testing.

Pilot testing the MPSF in Exshaw.

Exshaw water treatment plant.

Inside Exshaw water treatment plant showing four filters and three contact tanks.

Interior of one filter cell in Exshaw water treatment plant.

Flow metre and chlorine injection point for raw water entering Exshaw water treatment plant.

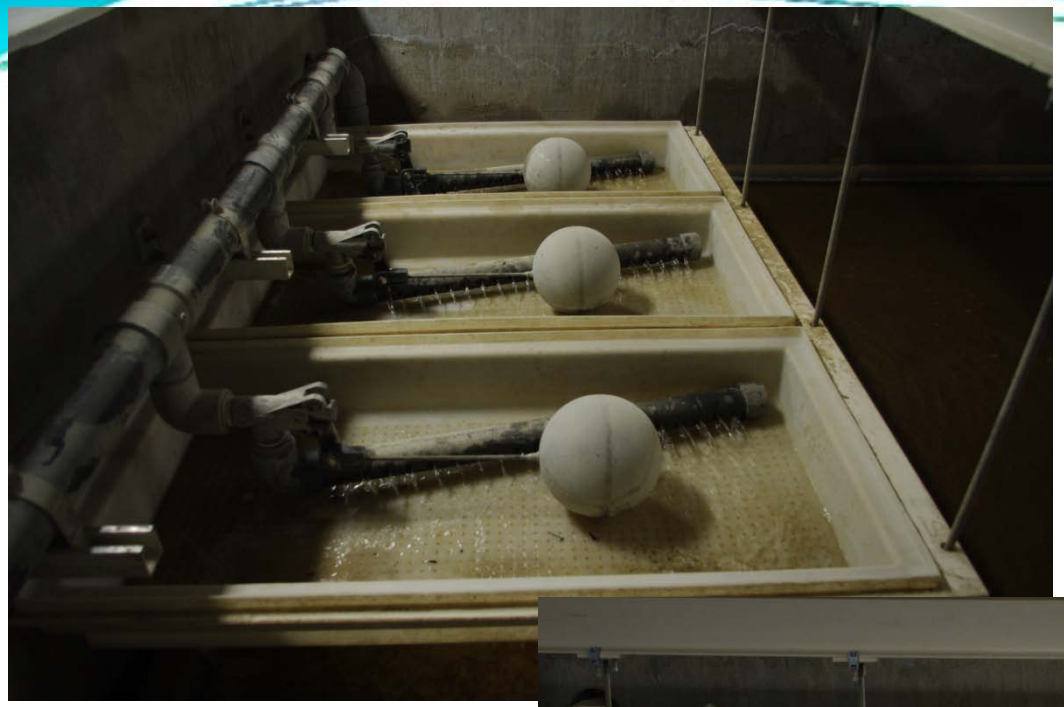
Three contact tanks and transfer pumps in Exshaw water treatment plant.

Transfer of chlorinated water into filters.

Raw water inlet and wastewater removal.

Filtered water outlet and backwash water inlet system.

Filtered water outlet and backwash water inlet system.



Diffuser basins showing mechanical float valves that control the flow of raw water into filter.

Operating filter in the Exshaw water treatment plant.

Initial wetting of filter media.

Beginning of first backwash.

First backwash continuing.

First backwash continuing.

Backwash completed – sand/media allowed to settle.

Filter after removal of backwash water.

Degassing (burping) a filter cell (air binding easily eliminated without backwash).

Performance of Exshaw WTP:

1. Sodium hypochlorite dose approximately 1.0 mg/L at inlet to contact tanks.
2. Iron removal to less than 0.05 mg/L.
3. Manganese removal to less than 0.05 mg/L.
4. Free chlorine in filtered water approximately 0.6 mg/L.

MPSF based treatment systems can be adapted to treat:

1. **GWUDI that also has elevated iron and manganese concentrations.**
2. **Groundwater with arsenic (and other heavy metals).**
3. **Groundwater with ammonia.**
4. **Groundwater with elevated concentrations of fluoride.**
5. **Groundwater with elevated NOM (TOC or DOC).**
6. **Surface water with elevated concentrations of iron or manganese.**

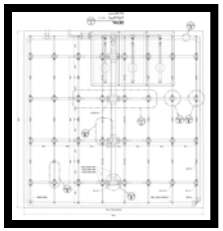
Pre-treatment or post-treatment can be used as required (such as the use of alum, PAC or other coagulants, roughing filters, GAC, UV and specialized oxidants).

It is important to emphasize the advantages of using the MPSF technology include:

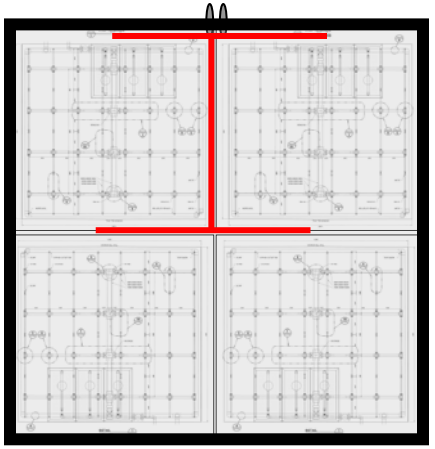
1. **Iron and manganese removal water treatment plants can be operated by Level 1 operators greatly facilitating staffing and local employment.**
2. **Typically meet 2012 standards without significant or any modification.**

MPSF filter cells can vary in capacity.

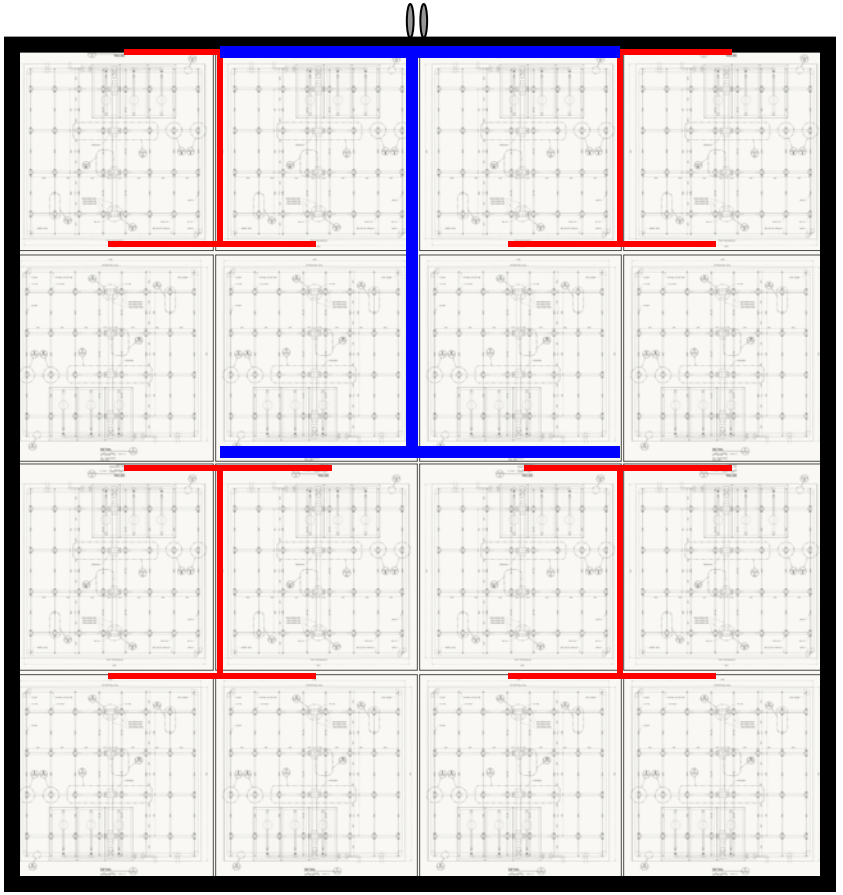
300 - 15,000 L/h



60,000 L/h



240,000 L/h

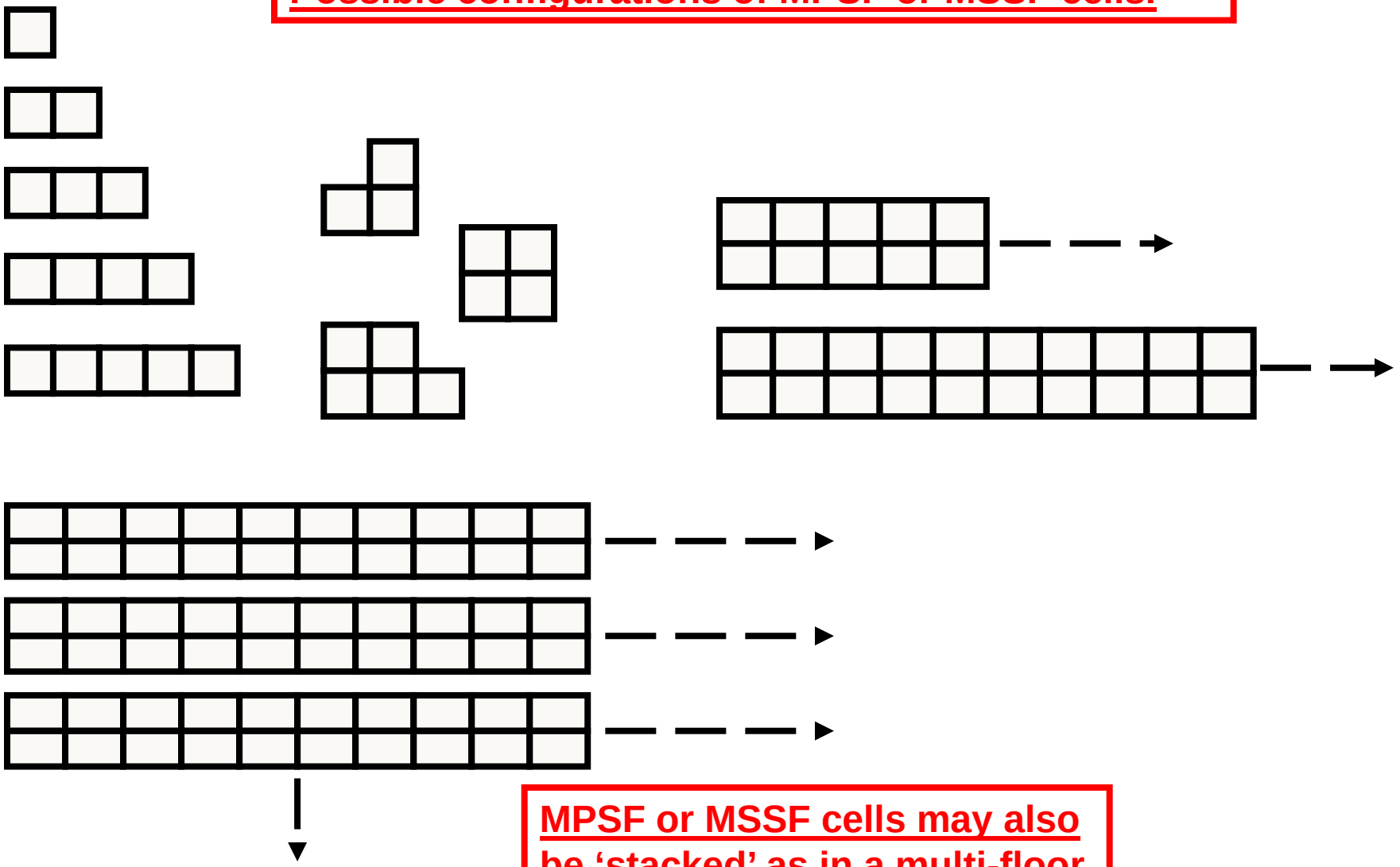


Any shape.

Designs have been evaluated at proto-type scale.

Retrofitting existing traditional slow sand filtration.

Possible configurations of MPSF or MSSF cells.



MPSF or MSSF cells may also be 'stacked' as in a multi-floor building.

The MPSF and MSSF units can be constructed using concrete, aluminum, stainless steel, medium density polyethylene, fibreglass and concrete block technology depending on clients needs (remoteness of community, etc.).

Oasis can provide entire filter units or only the critical piping and media (vessel would be constructed to Oasis specifications).

Oasis works closely with client consulting engineers and regulatory bodies.

The MPSF technology provides significant opportunities for small communities to meet their water treatment needs (iron, manganese and arsenic removal) at low cost in a manner consistent with local values and recruitment of operators from their own community.

The MSSF technology provides similar advantages.

MPSF Water Treatment Systems are ideal for small communities:

- Can be built on site or supplied as a package or partial package.
- Reliably operated and maintained using trained local staff.
- Easily cleaned without scraping and need for re-sanding.
- Minimal energy use.
- Minimum use of chemicals.
- Minimum production of wastewater.
- Can be operated manually or automatically.
- Can be monitored locally or remotely.
- Appropriate for isolated communities
- Existing traditional SSF's can be retrofitted to use MSF technology to achieve
    - Greater capacity.
    - Significantly less effort to clean.
- Appropriate for treatment of a wide variety and range of water quality (well beyond that of traditional slow sand filtration).
- Easily evaluated (bench scale and pilot).

Thank you.

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