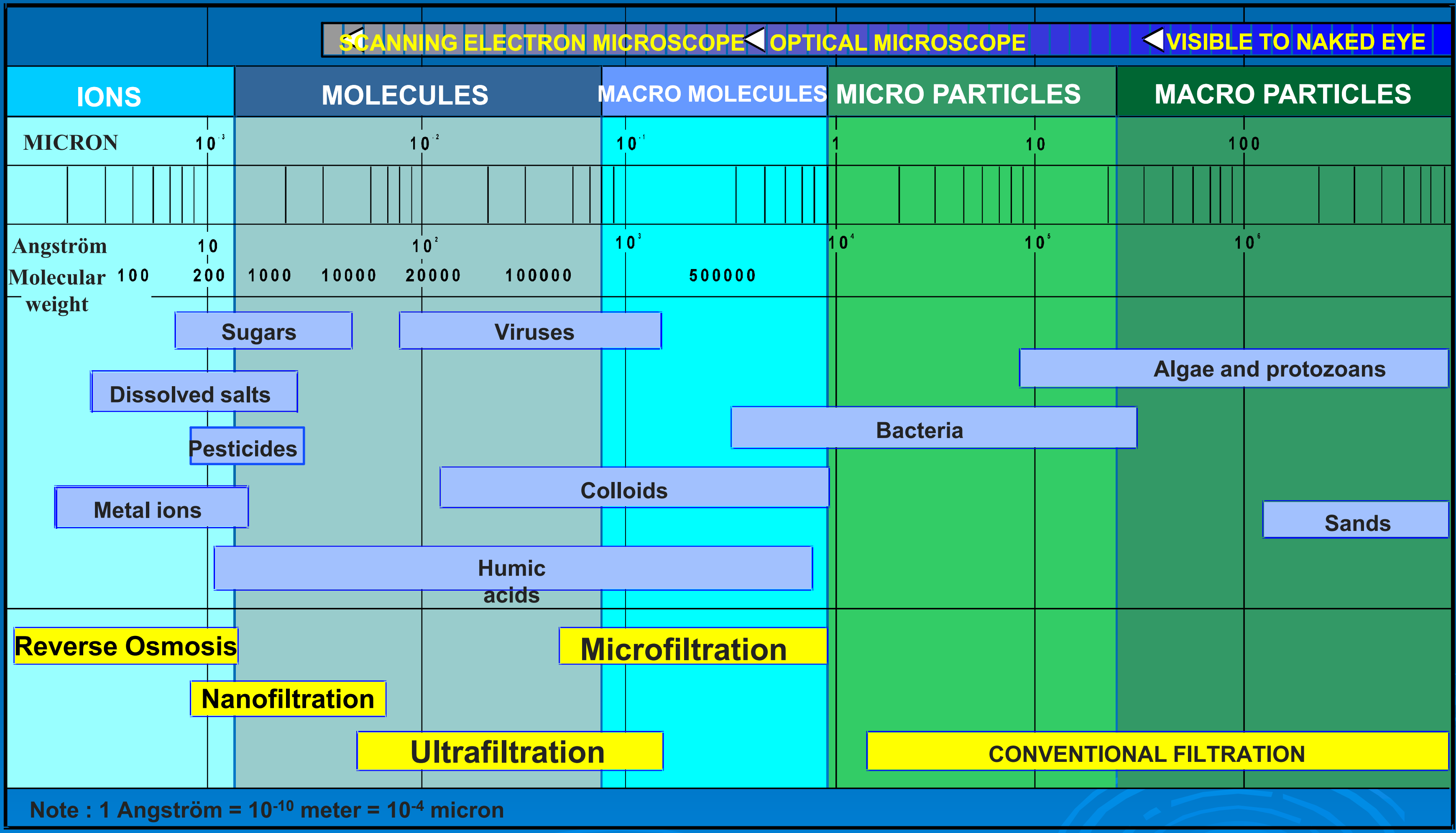
FILTRATION

CE326 Principles of Environmental Engineering
Iowa State University
Department of Civil, Construction, and Environmental Engineering
Tim Ellis, Associate Professor
March 10, 2010

Definitions

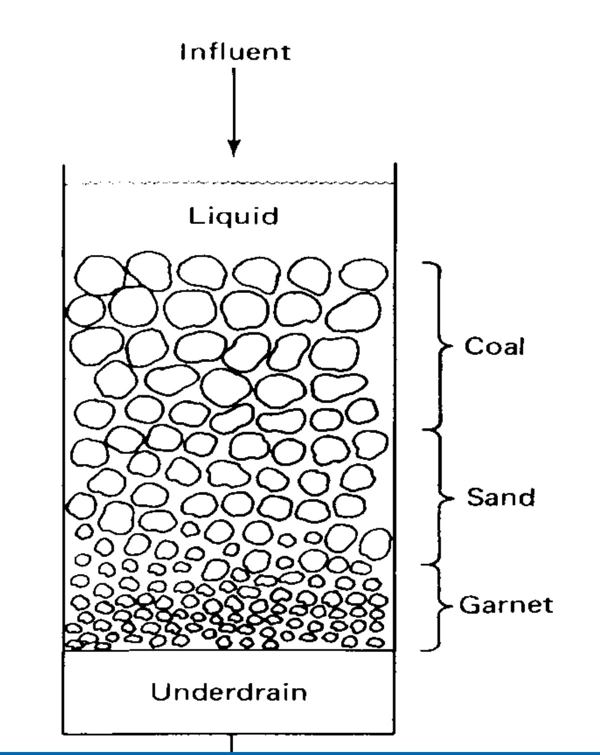
- **Filtration:** A process for separating s<u>uspended</u>___ and c<u>olloidal</u>___ impurities from water by passage through a p<u>orous</u>___ medium, usually a bed of s<u>and</u>___.
- Most particles removed in filtration are much s<u>maller</u>___ than the p<u>ore</u>___ s<u>ize</u>_ between the sand grains, and therefore, adequate particle d<u>estabilization</u>___ (coagulation) is extremely important.

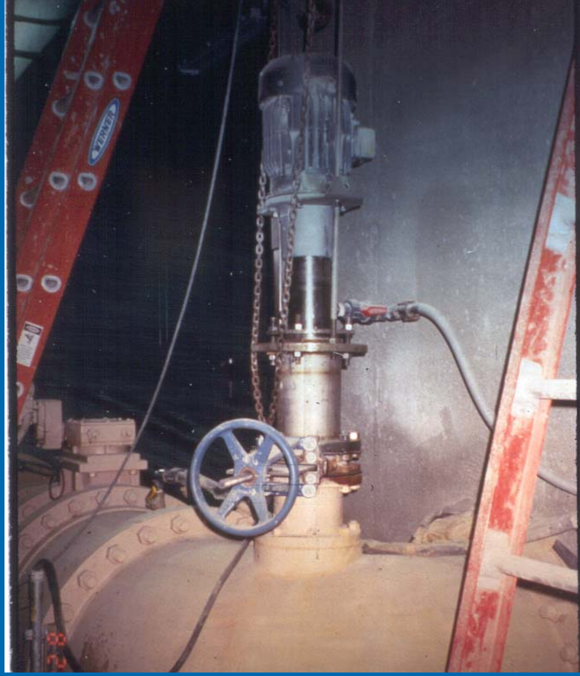
Filtration Spectrum



Performance

- The influent turbidity ranges from 1 - 10 NTU (nephelometric turbidity units) with a typical value of 3 NTU. Effluent turbidity is about 0.3 NTU.





Media

Medium	SG
sand	2.65
anthracite	1.45 - 1.73
garnet	3.6 - 4.2

History

- Slow sand filters were introduced in 1804:
- sand diameter 0.2 mm
- depth 1 m
- loading rate 3 - 8 $m^3/d \cdot m^2$

Slow Sand Filters

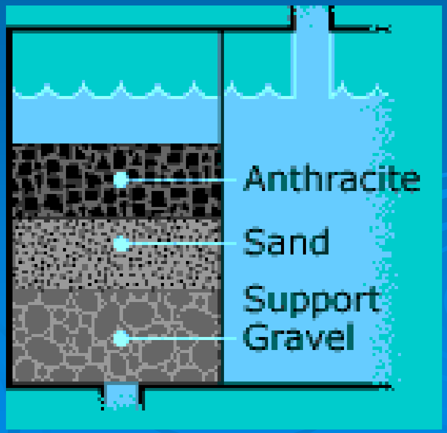
- S chmutzdecke
  - gelatinous matrix of bacteria, fungi, protozoa, rotifera and a range of aquatic insect larvae.
- As a *Schmutzdecke* ages, more algae tend to develop, and larger aquatic organisms may be present including some bryozoa, snails and annelid worms.

http://water.shinshu-u.ac.jp/e_ssf/e_ssf_link/usa_story/12Someyafilteralgae.jpg

- Rapid sand filters were introduced about 1890:

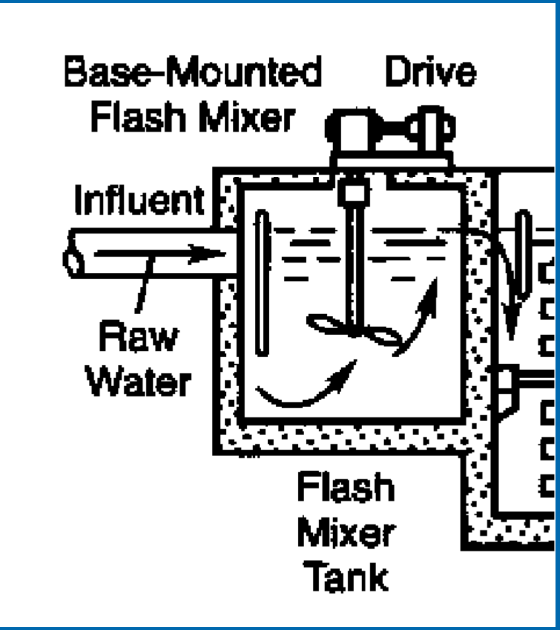
effective size	0.35 - 0.55 mm
uniformity coef.	1.3 - 1.7
depth	0.3 - 0.75 m
loading rate	120 - 240 $m^3/d \cdot m^2$

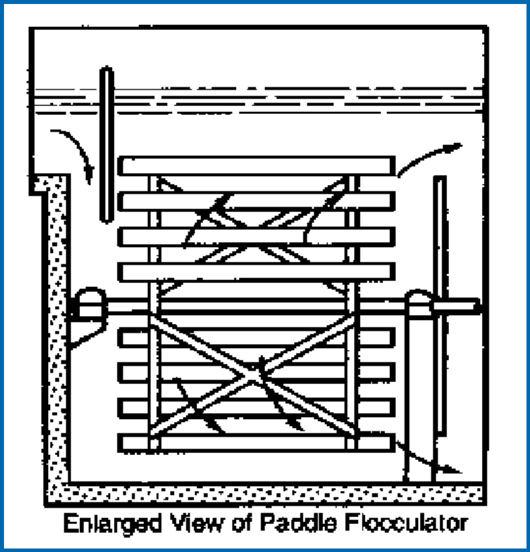
- Dual media filters introduced about 1940:
- Depth:
- anthracite (coal) 0.45 m
- sand 0.3 m
- loading rate 300 $m^3/d \cdot m^2$

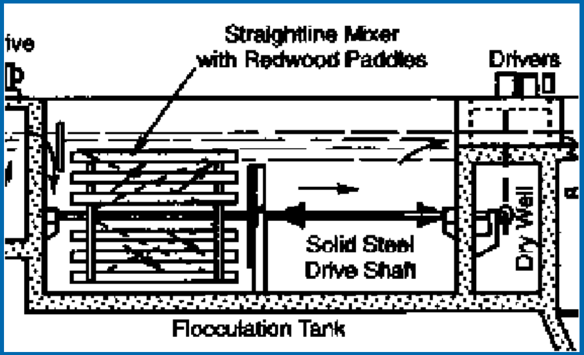


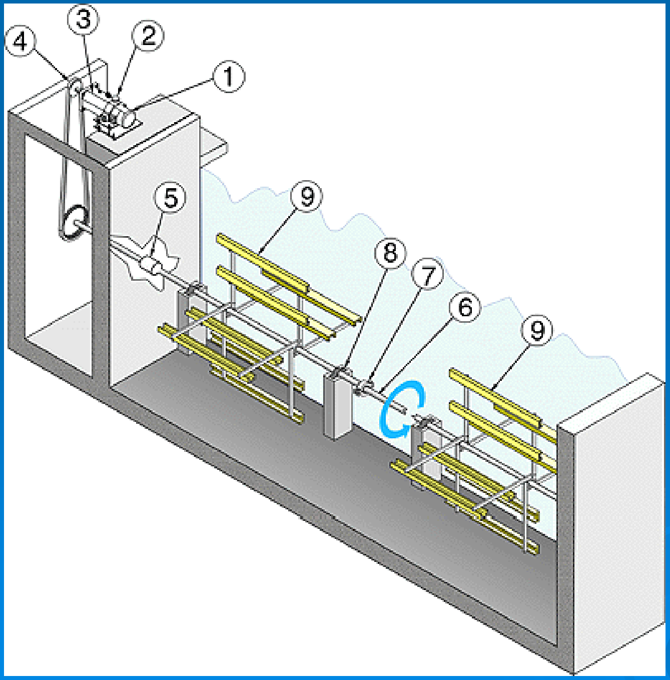
Pathogen Removal During Filtration

- poliovirus removal with filtration but without coagulation: 1-50%
- poliovirus removal with filtration and with coagulation: 90-99%
- *Cryptosporidium* oocysts removal with filtration without coagulation: 90%


Base-Mounted Flash Mixer
Drive
Influent
Raw Water
Flash Mixer Tank


Enlarged View of Paddle Flocculator


Straightline Mixer with Redwood Paddles
Drivers
Solid Steel Drive Shaft
Dry Well
Flocculation Tank


1
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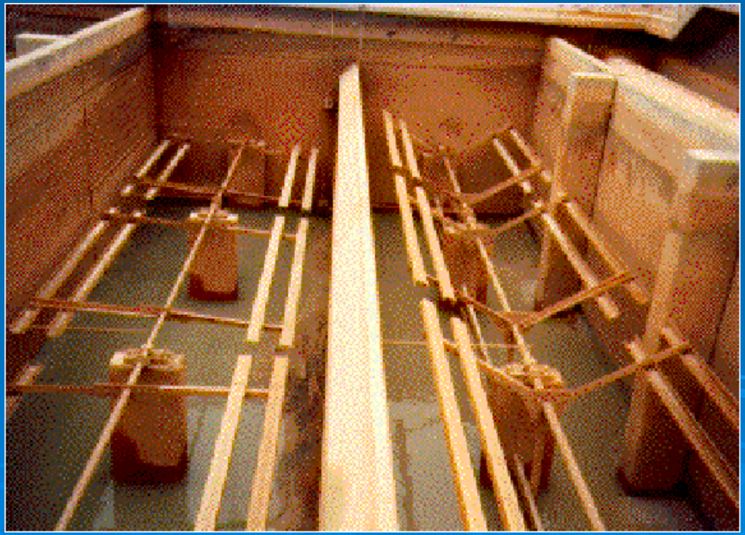


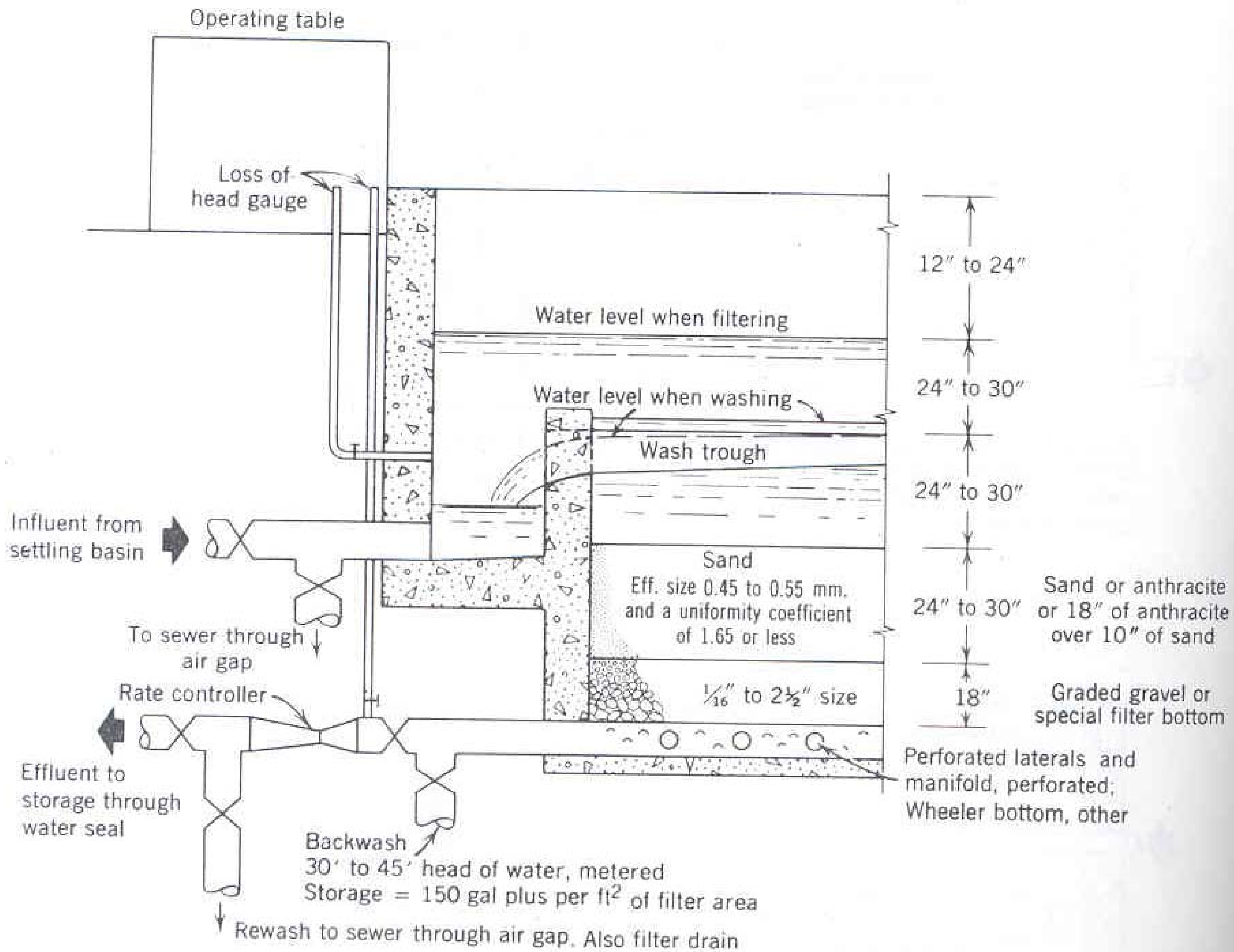
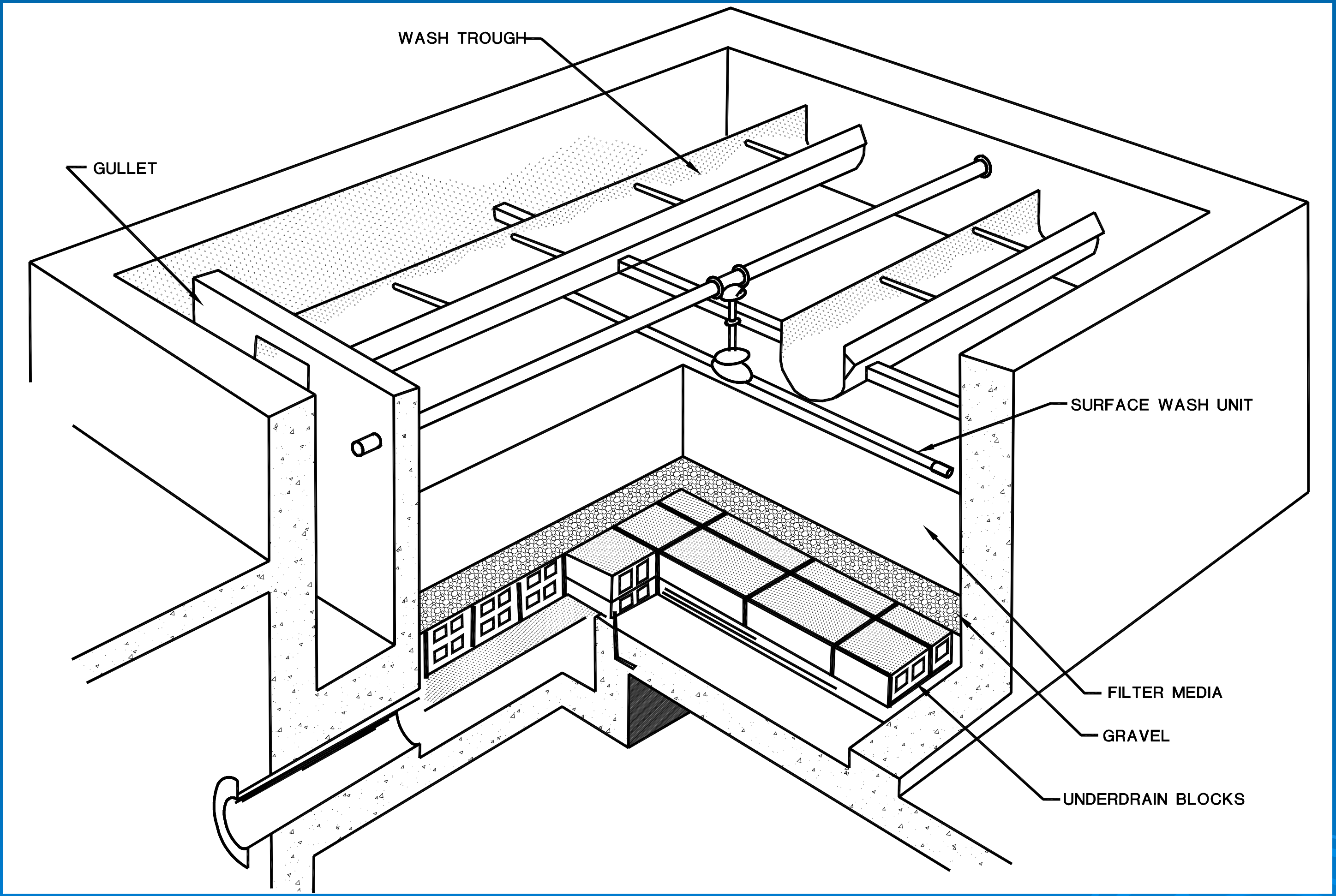
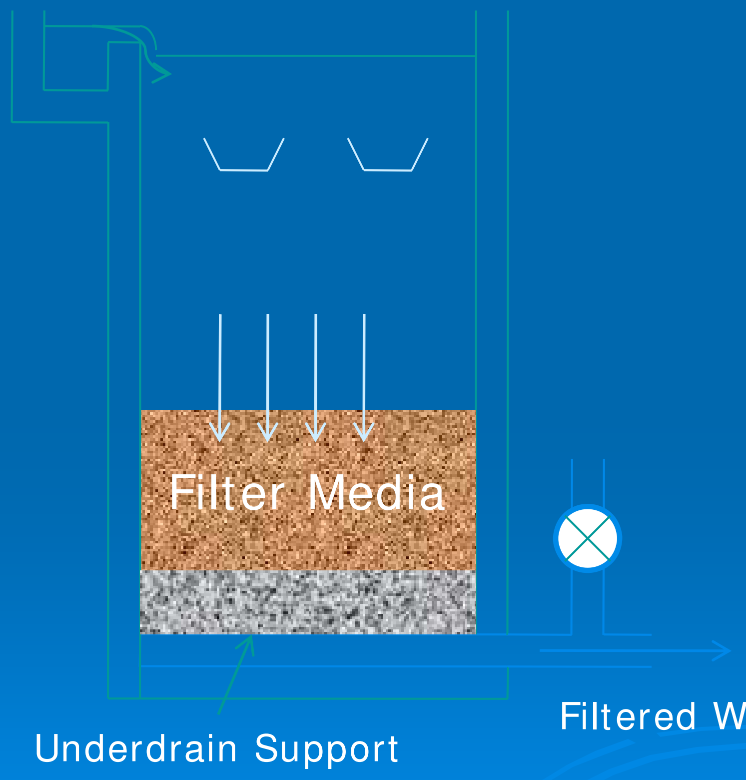


Figure 3-19 Essential parts of a rapid sand filter. The minimum total depth is $8\frac{1}{2}$ ft, 12 ft preferred.

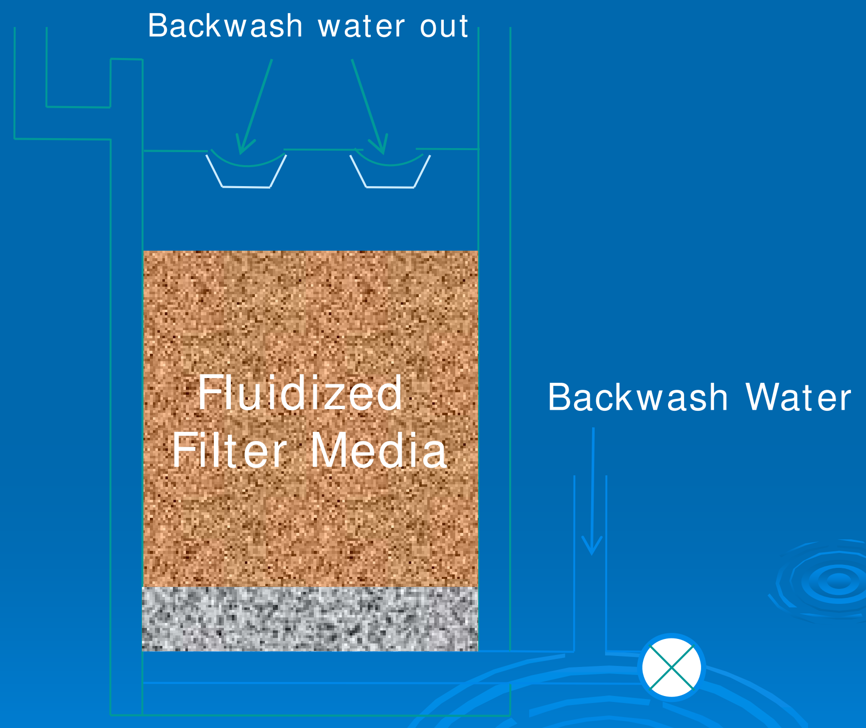

WASH TROUGH
GULLET
SURFACE WASH UNIT
FILTER MEDIA
GRAVEL
UNDERDRAIN BLOCKS

Operation

Filtration

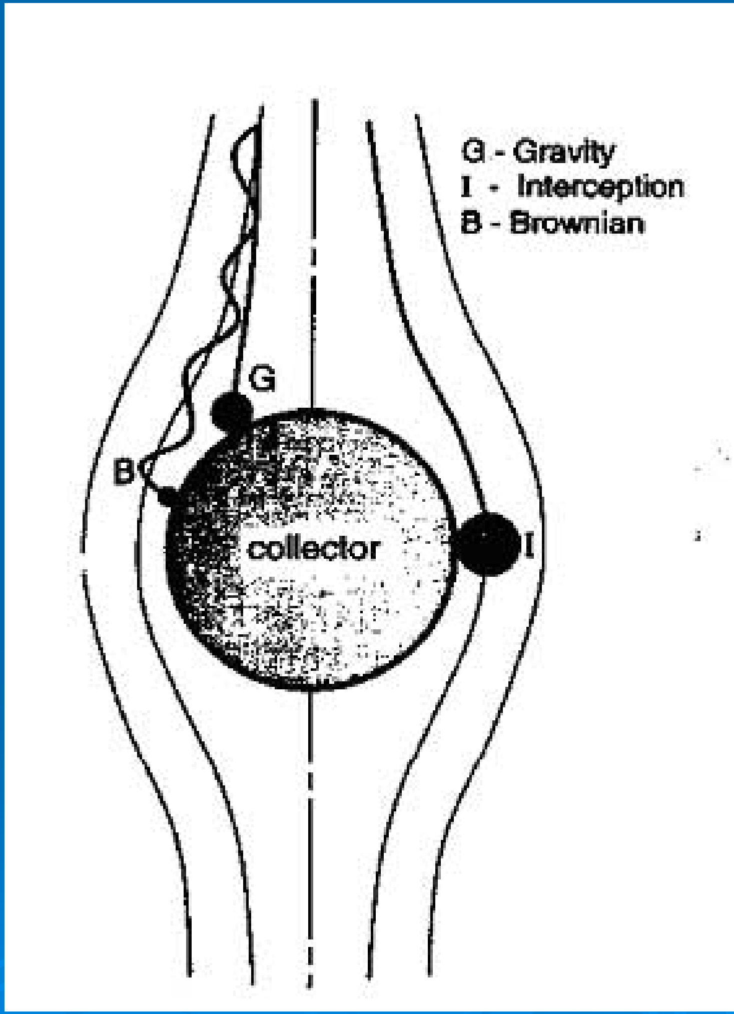


Backwash

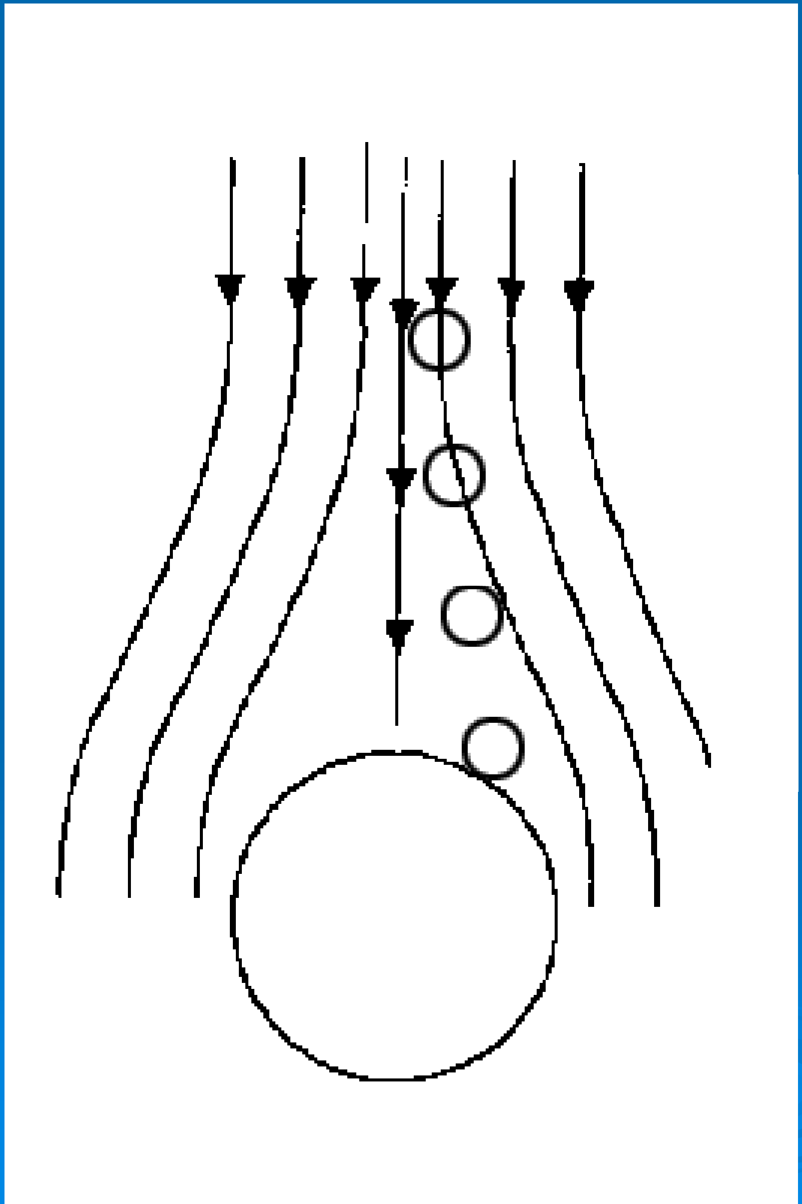


Particle Removal Mechanisms

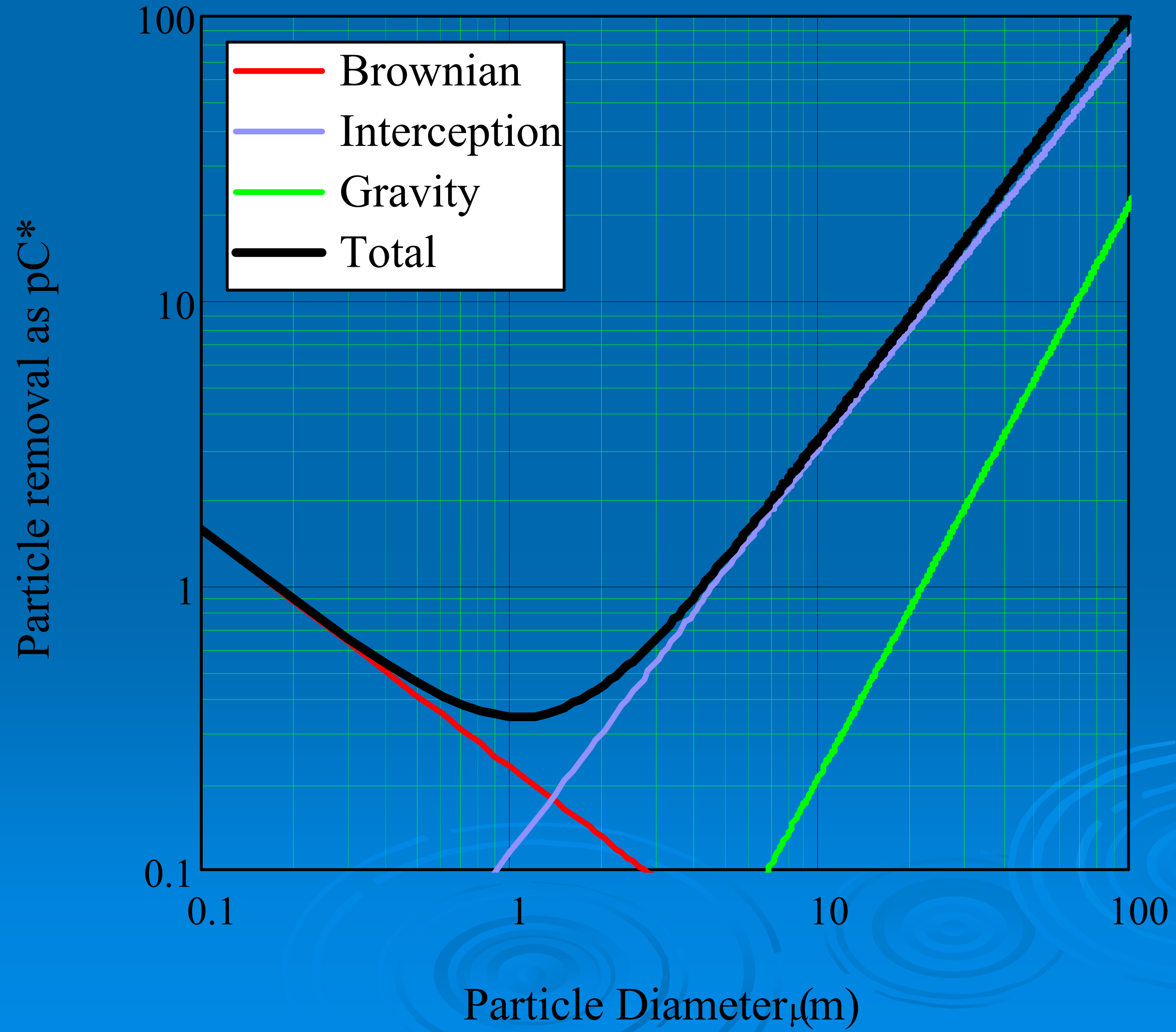
- Gravity
- Inertial
- Interception
- Diffusion



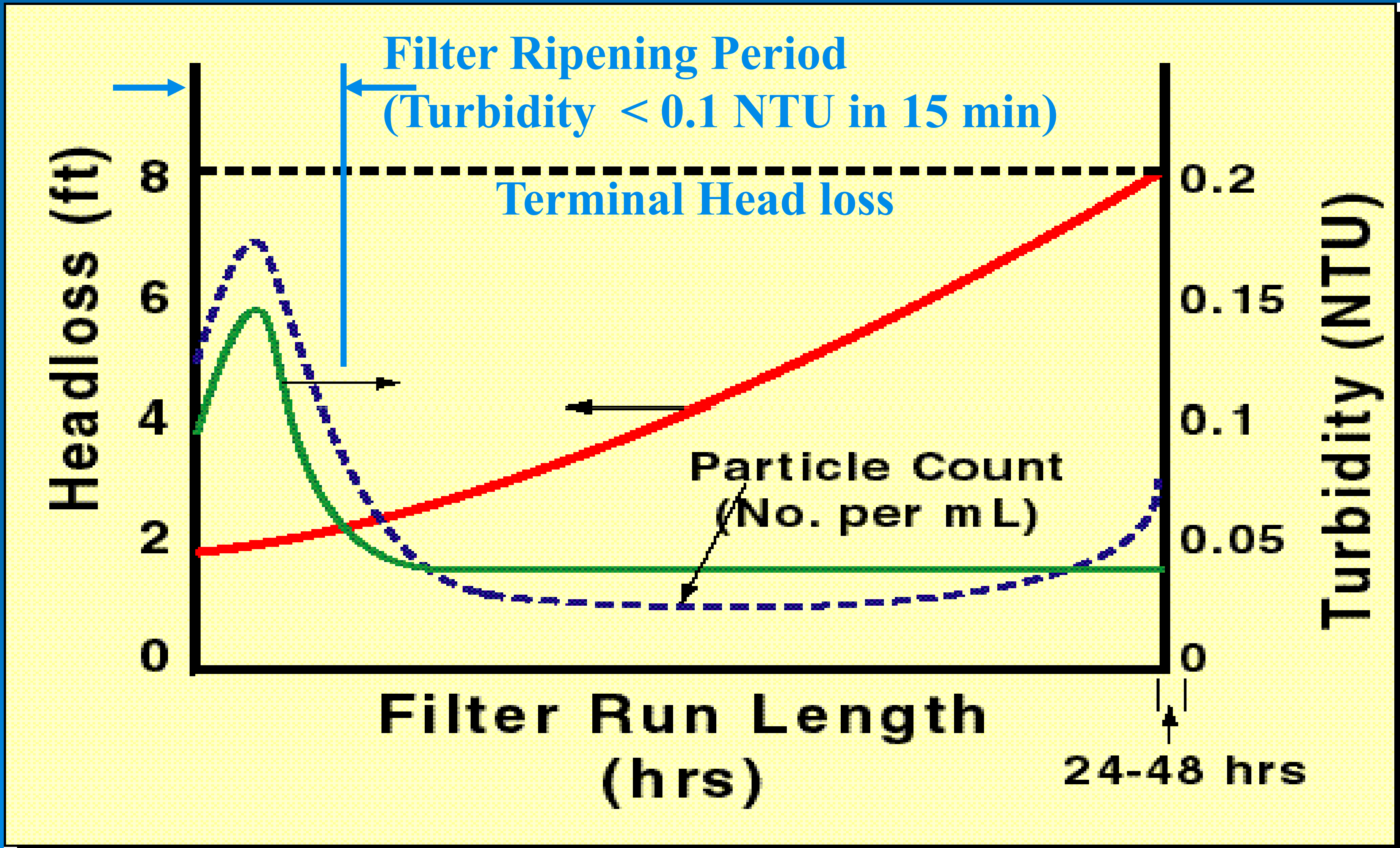
Inertia



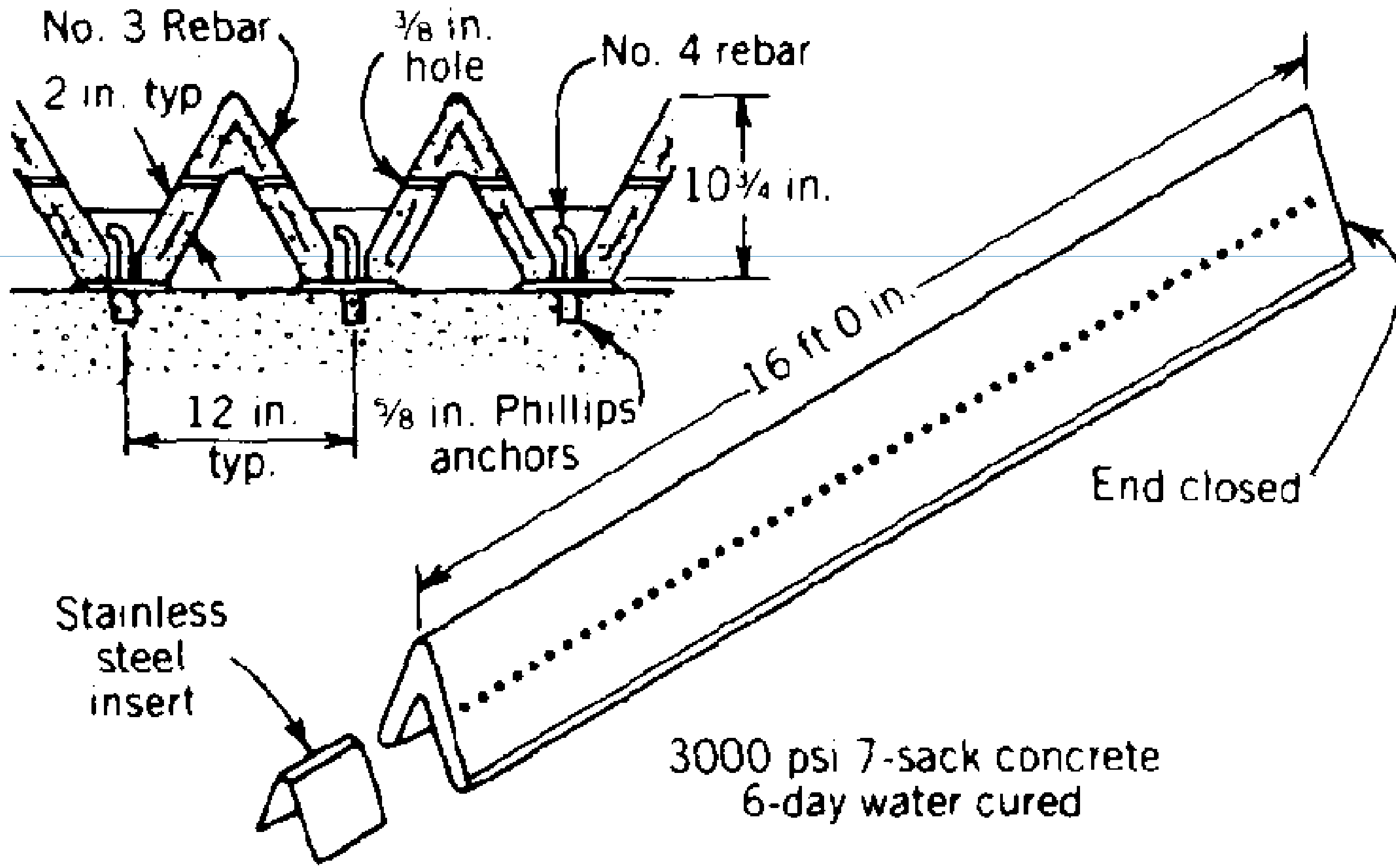
Particle Removal Mechanisms



Ideal Filter Run

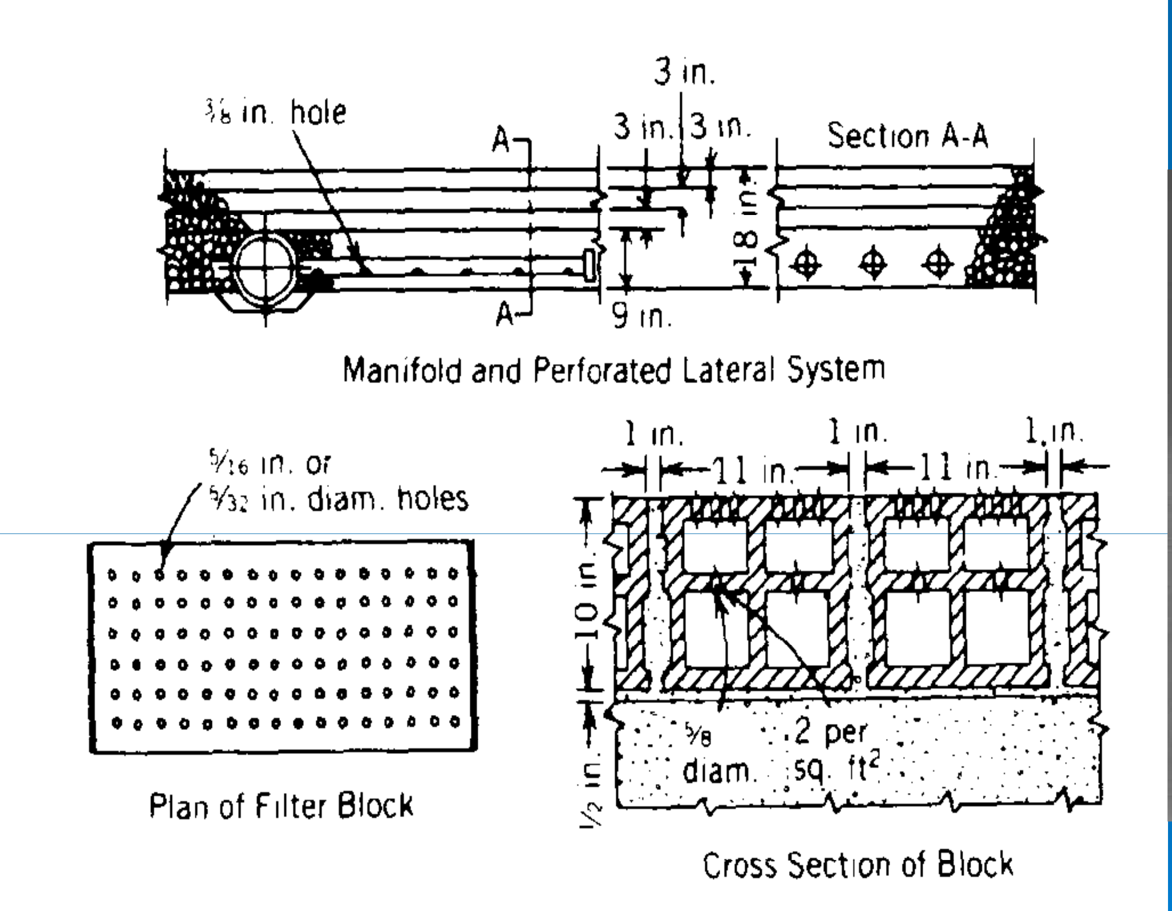


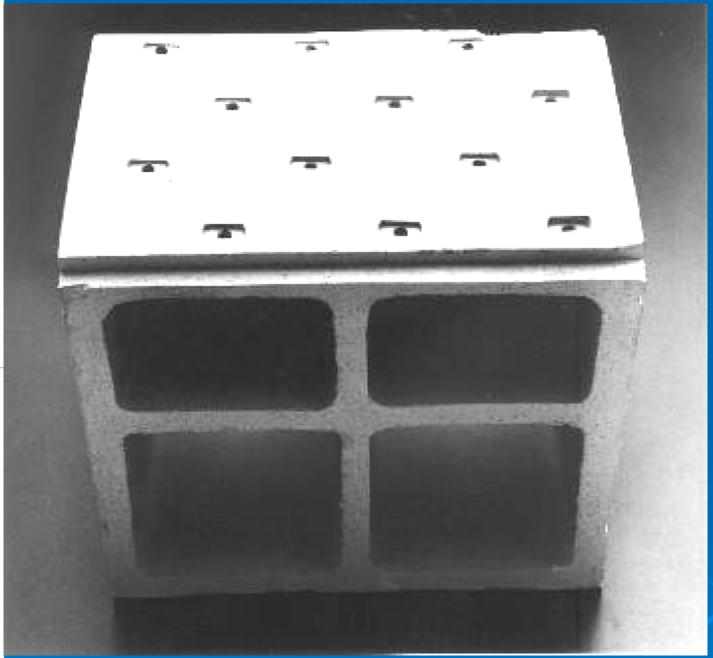
Non-Air-Scouring Underdrain



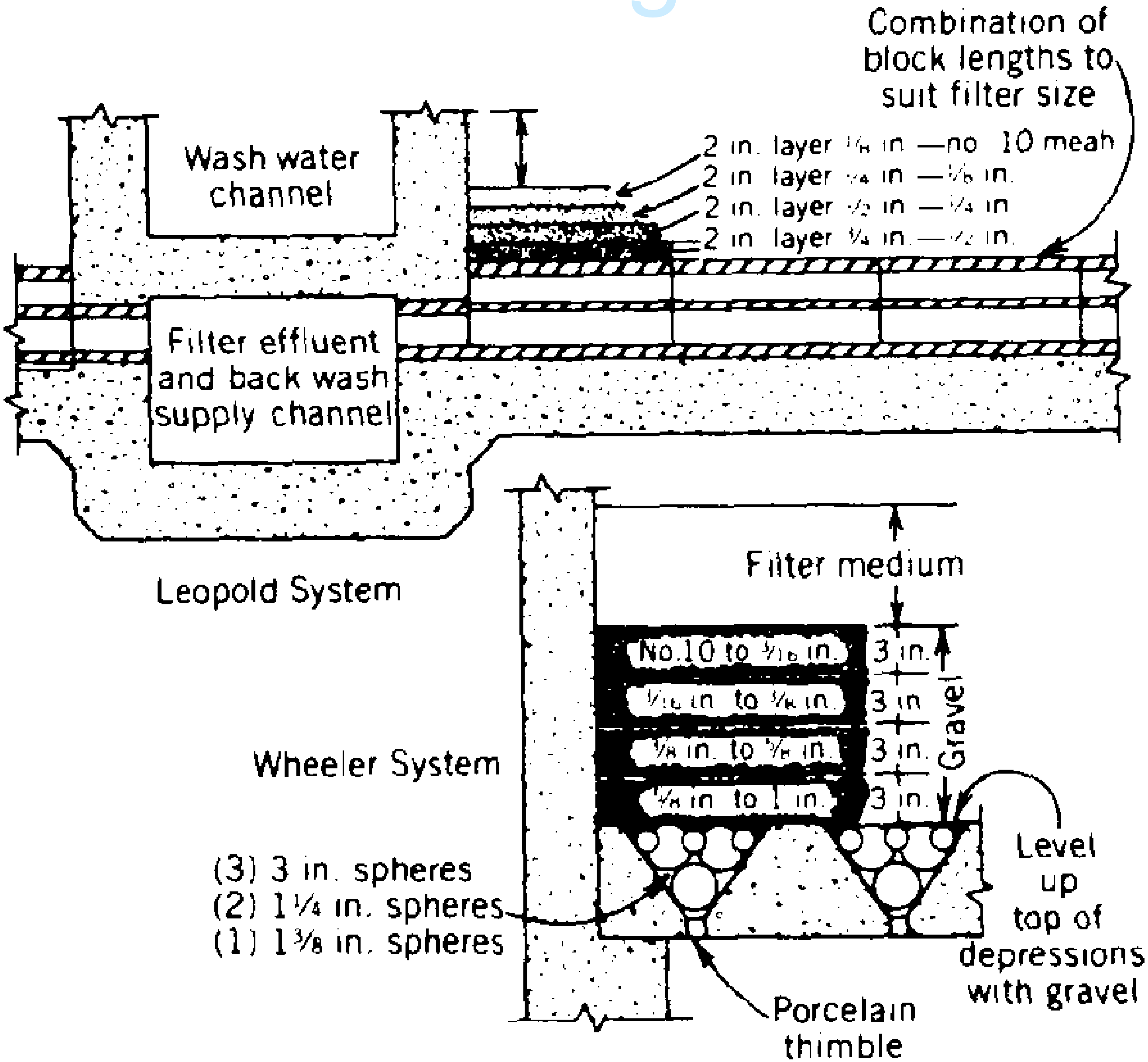
Precast Concrete Perforated Lateral System

Non-Air-Scouring Underdrain



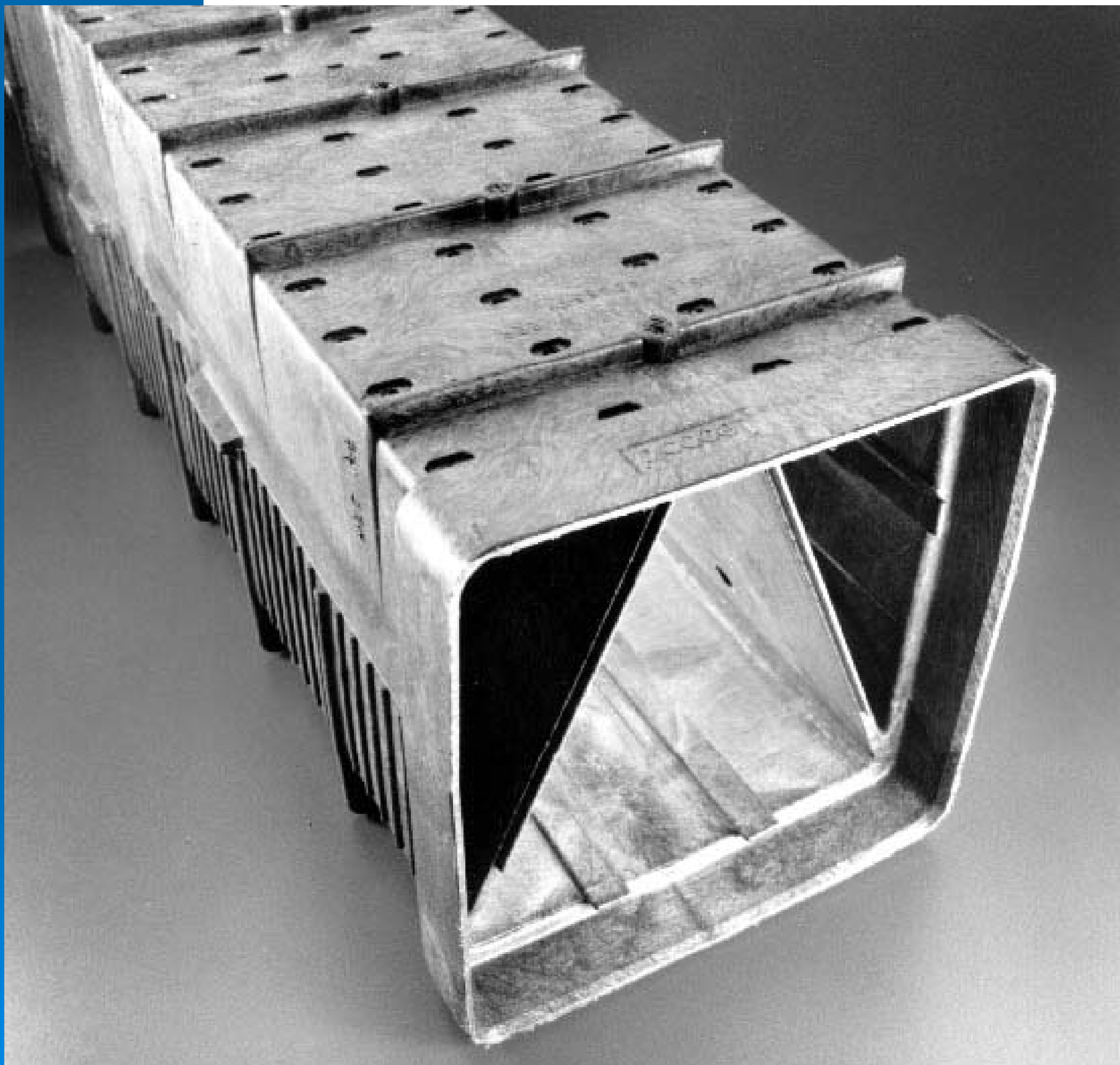


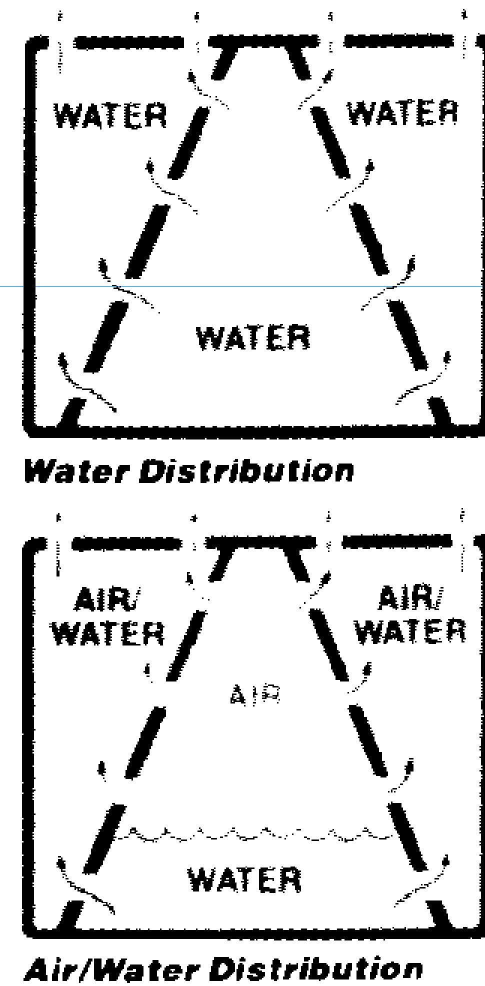
Non-Air-Scouring Underdrain



Wheeler Block

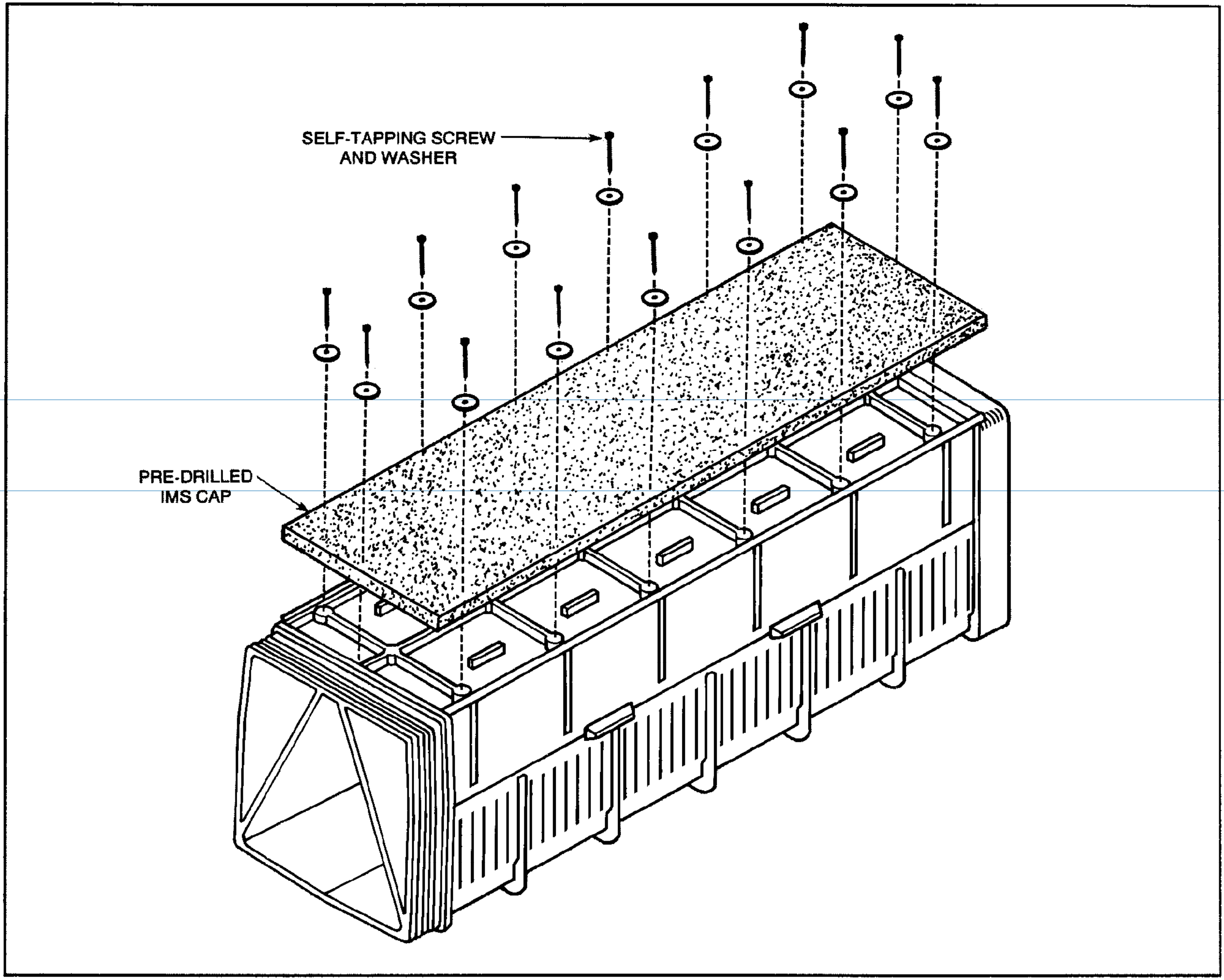
Air-Scouring Underdrain



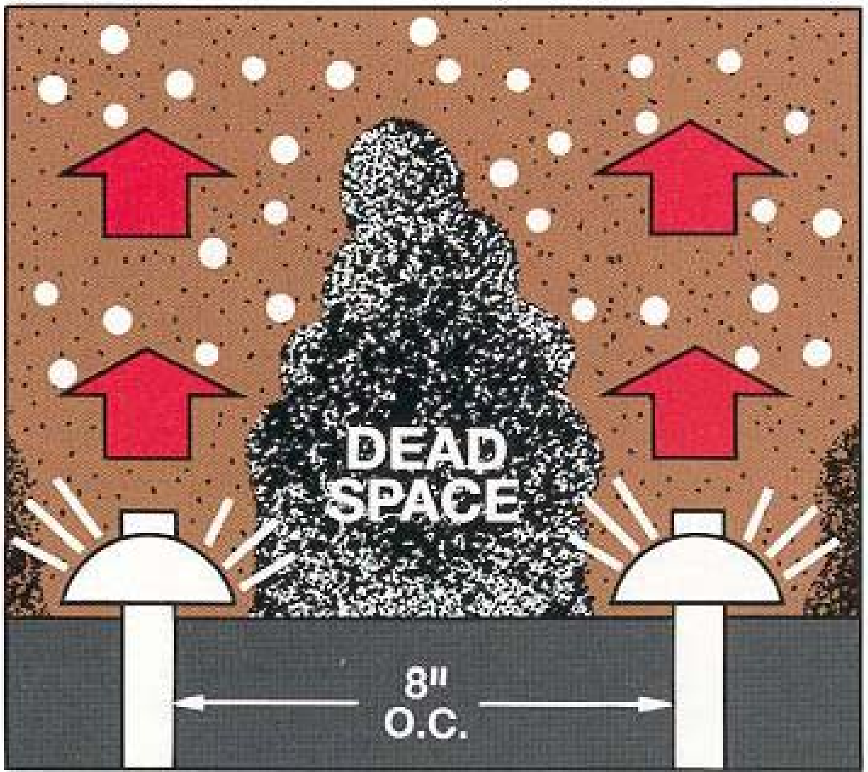


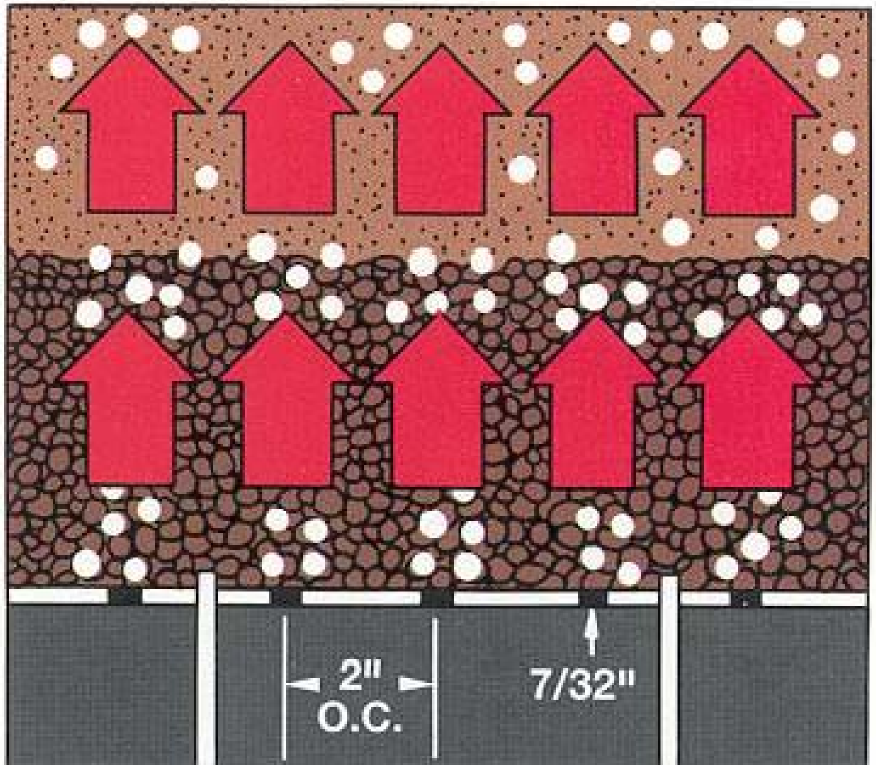
Leopold Type S™ Technology Underdrain

Air-Scouring Underdrain



Bachwash Efficiency



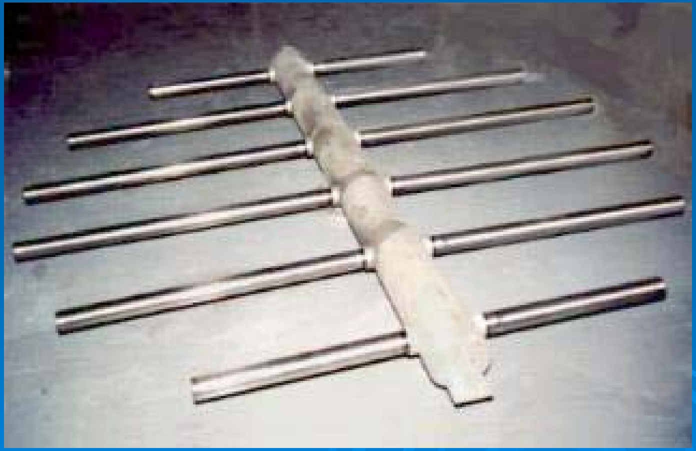


- 5 nozzles/ft^2 or 55 nozzles/m^2 - acceptable
- < 4 nozzles/ft^2 or 40 nozzles/m^2 – large dead zones

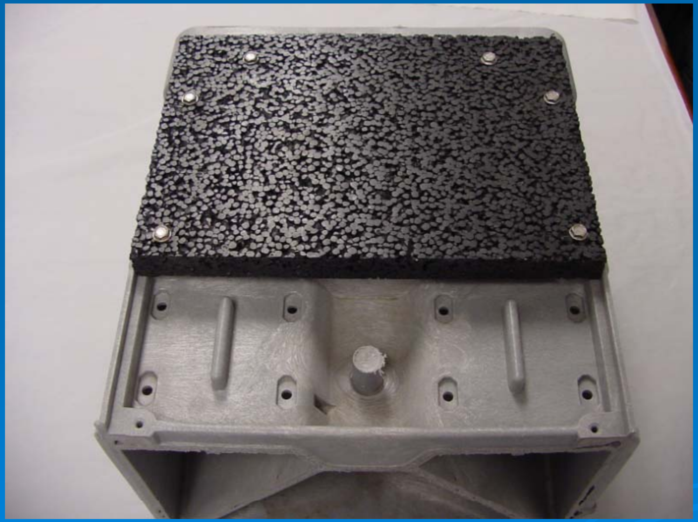
- 24 nozzles/ft^2 or 268 nozzles/m^2 - good







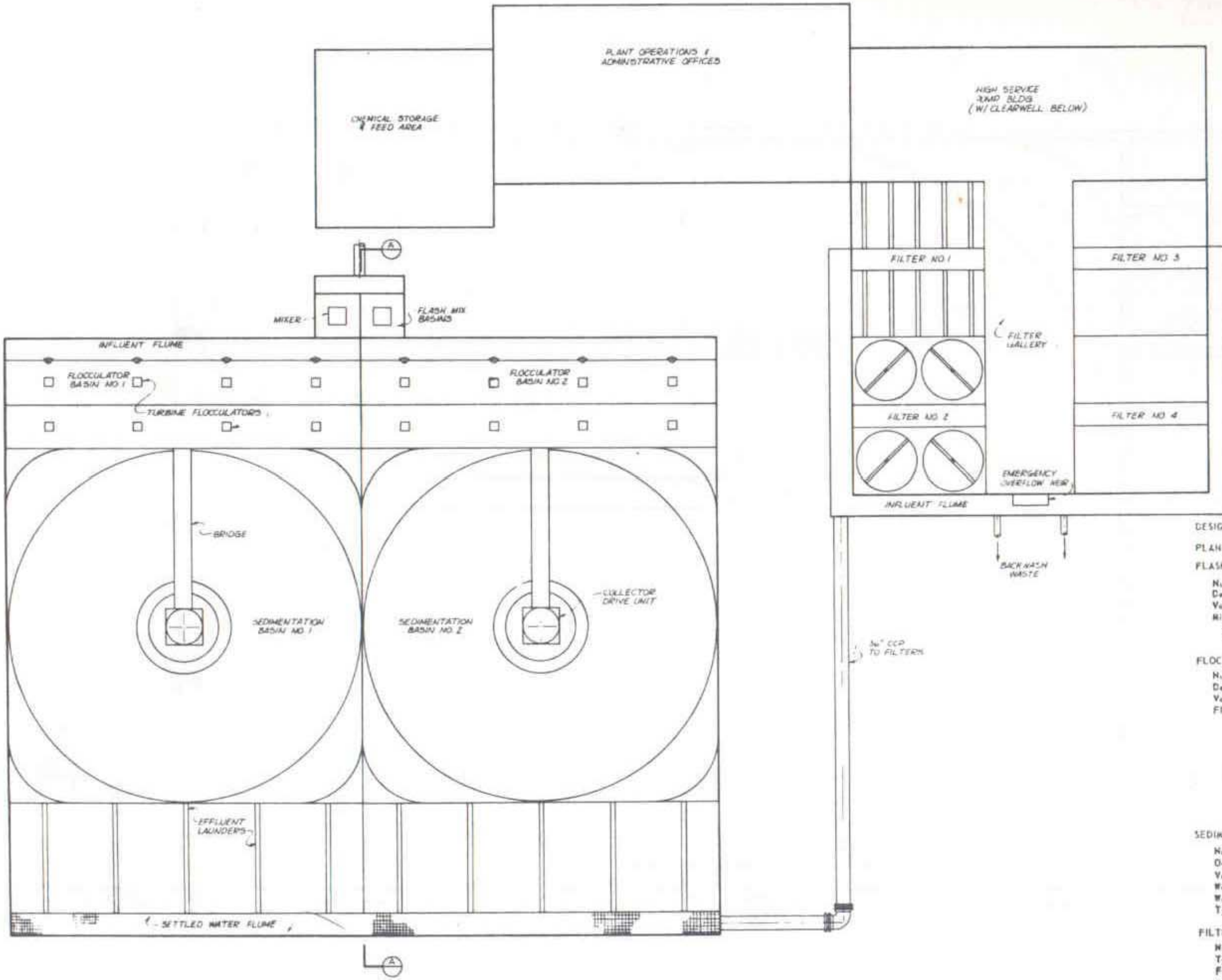










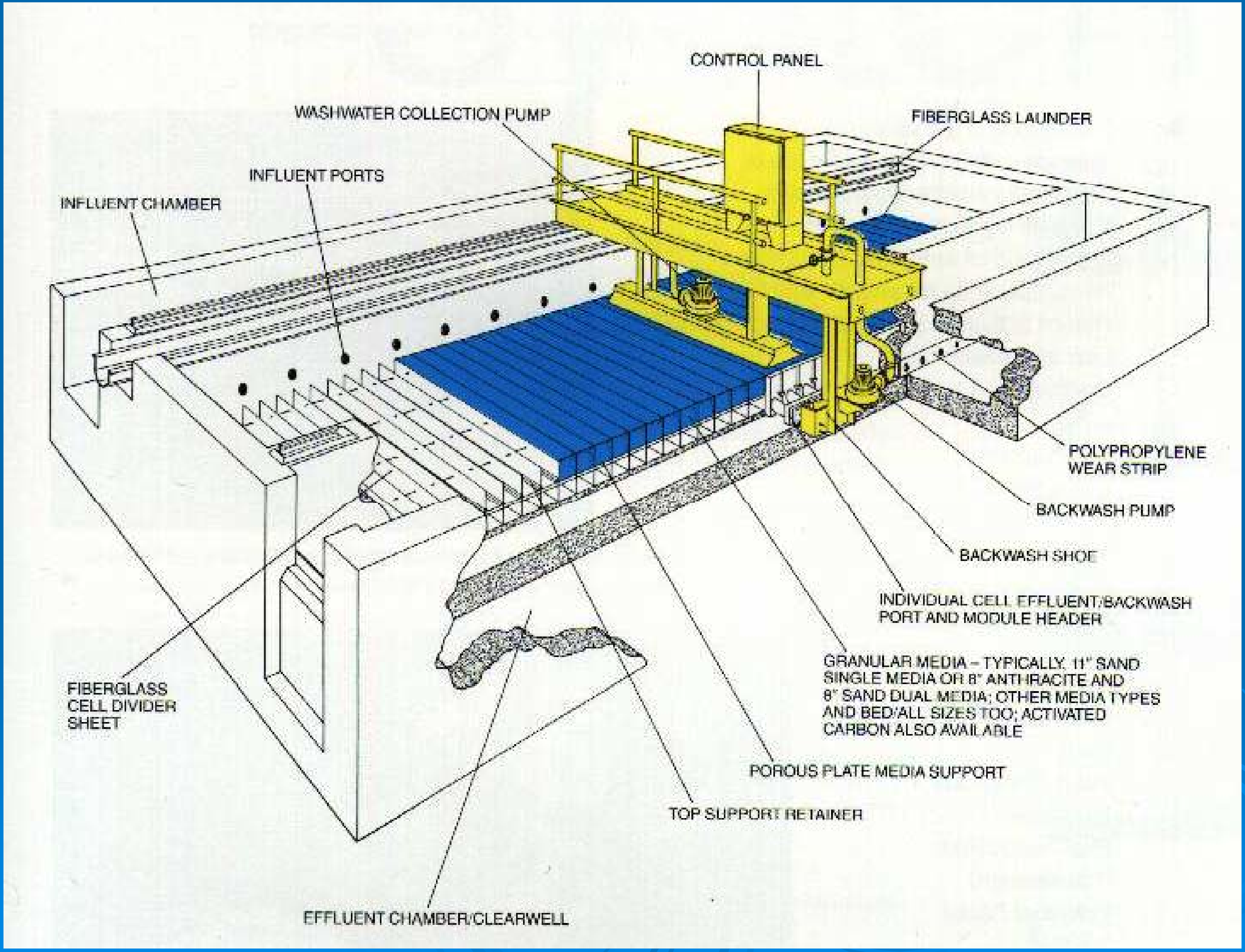



DESIGN CRITERIA

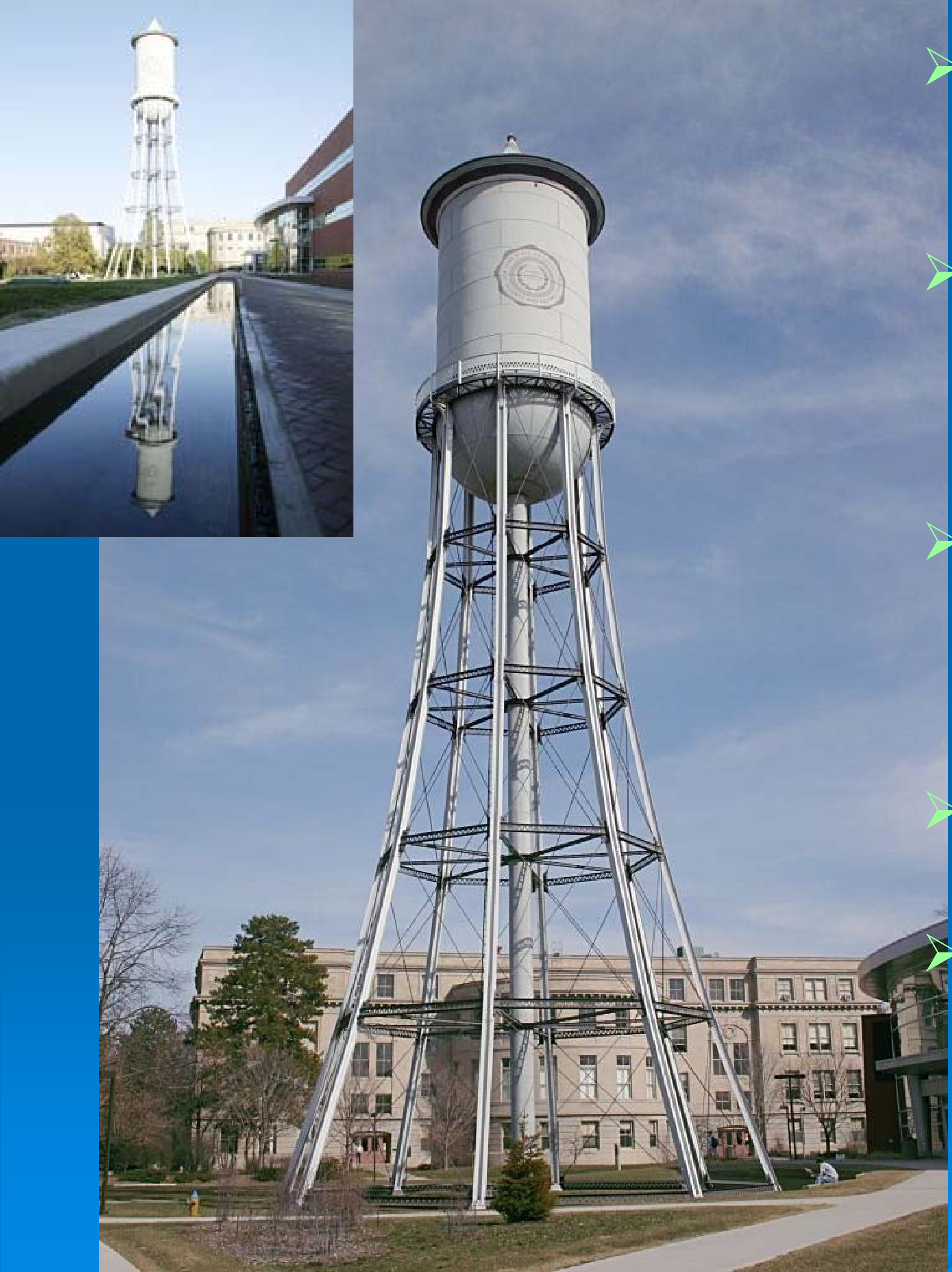
PLANT FLOW:	10
FLASH MIX BASINS:	
Number	2
Detention	1 min
Volume	3500 gal
Mixers:	2
Hp	5
Velocity gradient	700 sec^{-1}
FLOCCULATION BASINS:	
Number	2 (two compartment)
Detention	30 min
Volume	210,000 gal
Flocculators:	16
Number	16
Type	Vertical turbine
1st stage:	
Velocity gradient	75 sec^{-1}
Hp	¼
2nd stage:	
Velocity gradient	25 sec^{-1}
Hp	½
SEDIMENTATION BASINS:	
Number	2
Overflow rate	600 gpd/ft^2
Volume	800,000 gal each
Weir length	250 ft/basin
Weir overflow rate	20,000 gpd/lin ft
Type collector	Circular w/corner sweeps
FILTERS:	
Number	4 (2 cell)
Type	Rapid sand
Filter rate	2 gpm/ft^2
Backwash rate:	
Nominal	15 gpm/ft^2
Maximum	18 gpm/ft^2

Figure 220. Facility layout for 10-mgd water treatment plant.

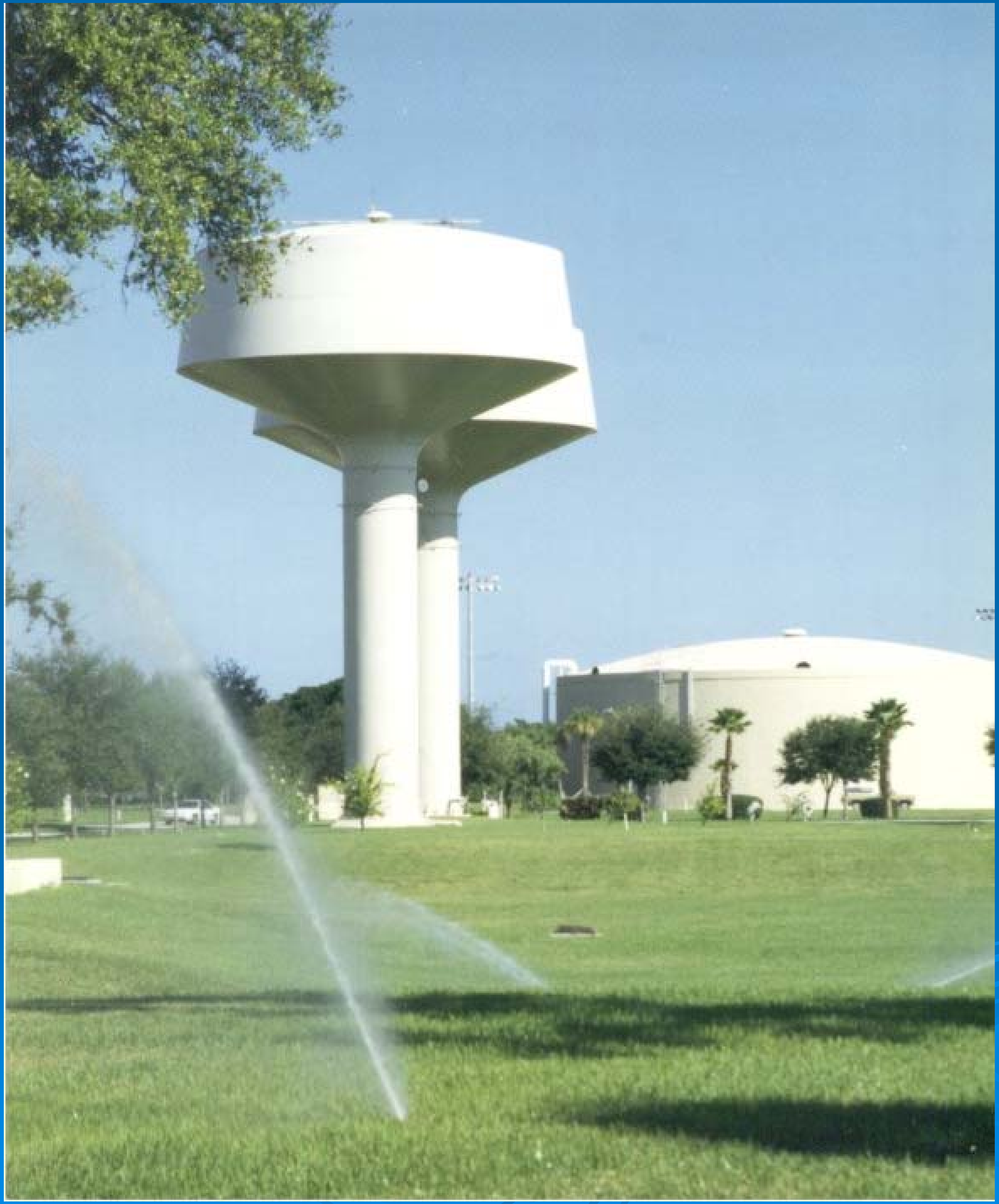
Automatic Backwash Filter



Automatic Backwash Filter

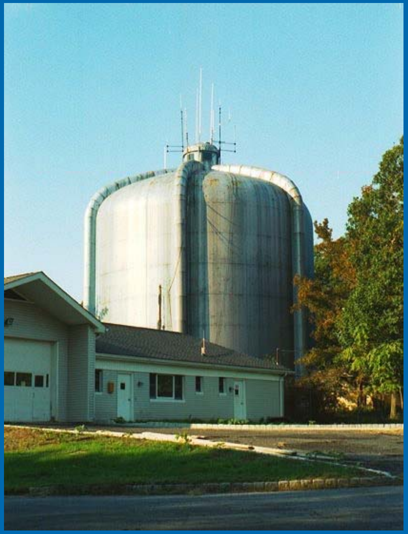


- first elevated steel water tank west of the Mississippi River
- erected in 1897 under the supervision and design of Anson Marston
- constructed due to a severe water shortage in 1895 that required cancellation of classes
- tank holds 162,000 US gallons
- 1978, the water tower was disconnected when the university switched to municipal water



If it's emblazoned on the town's water tower, is it true?


LULING




USA

Water Towers, 1951-1970, Water District No. 54
Located on the north side of the Des Moines Field House, near the current skateboard park

Hollywood screen and TV personality Virginia Christine, "Mrs. Olson" of coffee commercial fame, was one of Stanton's famous daughters. At the time of our centennial in 1970, Virginia came home to be our parade marshal. During the celebration she served coffee to the public. Stanton's water tower was converted to a giant Swedish coffeepot the following year.

Stanton, Iowa

- 96 feet tall.
- holds 2,400,000 cups of coffee (150,000 gals.)
- completed in time for Homecoming 2000.

Atlanta, Illinois

Helm, California

Adair, Iowa

Markle, Indiana

Ironwood, Michigan


Elizabeth Herndon

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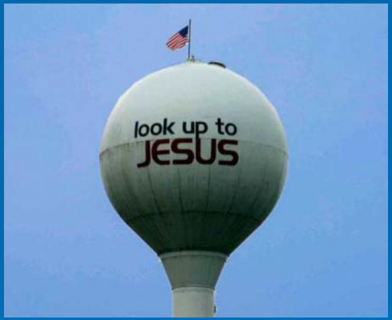
HOT
COLD
© roadsideamerica.com

look up to
JESUS