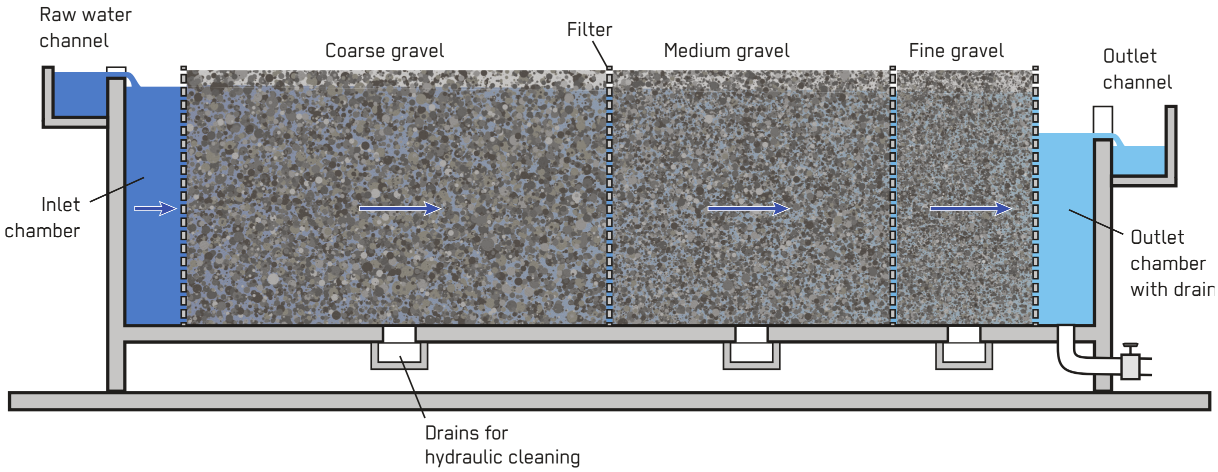
Roughing Filtration

Response Phase	Application Level	Management Level	Objectives / Key Features
* Acute Response ** Stabilisation ** Recovery	Household ** Neighbourhood ** City	Household * Shared ** Public	Turbidity removal, pre-treatment, and sedimentation
Local Availability	**Technical Complexity**	**Maturity Level**	
*** High	** Medium	*** High	



A Roughing Filter is used to remove suspended solids from very turbid (or muddy) water using differently sized filtration media ranging from coarse to fine gravel. It is a pre-treatment step prior to a final disinfection process, such as Chlorination (T.6), Slow Sand Filtration (T.9) or Ultrafiltration (T.10). It can be used in the stabilisation and recovery phases of an emergency.

Roughing Filters act less as 'filters' and more like sedimentation tanks with an extended surface area. A sedimentation tank is generally designed based on the time it takes for particles to settle out given the tank depth. With a Roughing Filter, the required distance for the settling process is much shorter since the tanks are filled with gravel. This feature, together with an increased available surface area for processes such as sedimentation and adsorption, helps trap particles to make it a more efficient form of sedimentation.

Design Considerations: Roughing Filtration uses filtration media that decreases in size, either in the same tank in three separated layers or more commonly/efficiently as three separate chambers in a horizontal tank. Media sizes range from 4–25 mm, with larger sizes towards the inflow (typically 12–25 mm and 8–12 mm) and smaller sizes at the outflow (typically 4–8 mm). For horizontal filters, the total length generally reaches up to 7 metres that is divided into three chambers of decreasing length at a ratio of 3:2:1 moving from coarser to finer media. For filters made from horizontal compartments, the flow can be both horizontal as well as up or down through each compartment. For filters with three layers in one compartment, water flows only in the upflow direction, as it is more efficient for hydraulic cleaning, which uses the force of gravity to drain sediments. Various types of filtration media can be used, though it should be relatively uniform in each chamber/layer and have a good porosity. Roughing Filters can effectively treat turbid water of up to 500 NTU (where NTU is a measurement of turbidity), reducing this turbidity by up to 90 % and bringing it to a level suitable for subsequent treatment processes. For example, when the next step is Slow Sand Filtration (T.9), a turbidity of about 10 NTU is desired. Additionally, Roughing Filters improve microbial water quality by reducing bacterial levels by between 60–99 %.

A key design consideration is a low water velocity throughout the filter, as sedimentation works most efficiently with a non-turbulent flow. To achieve this, the velocity needs to be within 0.3–1.5 m/hour (compaction of m^3/m^2/hour), though this should preferably be kept close to the most efficient rate of up to 0.6 m/hour. Water coming into or leaving the filter should also not be turbulent to avoid scour and short circuiting. At the intake, this requires inlet weirs covering the width of the filter or baffles to distribute water energy, and at the outflow, a full-width wall over which the water flows or a false filter bed below. A Roughing Filter must remain saturated, as cleaning becomes difficult if it dries out. The outlet control should thus be designed such that the water leaves the filter only at a certain height (e.g. a weir or raised effluent pipe). Hydraulic cleaning via gravity performs best when the drainage components are sized for a high flow of 60–90 m/hour over the filter bed.

Materials: Materials include the filter compartment(s), water inflow and outflow system with control mechanism, drainage system and filter media (gravel, burnt clay bricks, plastics, burnt charcoal or coconut fibres).

Applicability: Roughing Filters are suitable where the local capacities and finances are limited (e.g. rural or small- to medium-scale systems in urban and peri-urban contexts). They are more applicable to the stabilisation and recovery phases of an emergency, as they require set-up time. They can be a good replacement for Assisted Sedimentation **(T.4)** and Rapid Sand Filtration **(T.2)**, both of which are more common in the acute response but require higher ongoing inputs. The performance of Roughing Filters depends on the amount of colloidal matter in the water. Before scaling up, part of the design work will be to test the separation characteristics of solids in the water followed by a small pilot plant.

Operation and Maintenance: The main O & M task is to remove the accumulated solids that penetrate deep into the filter medium, usually through hydraulic cleaning that involves rapidly draining the filter. Shorter intervals between hydraulic cleanings are preferable (e.g. every few weeks) to minimise solid build-up, but manual cleaning will usually be required once every one to five years, depending on the raw water quality. This entails manually excavating the filter material, washing it separately and replacing it. Having two or more filters keeps water flowing during the time-consuming maintenance process. Other O & M tasks include applying anti-corrosive agents to metal parts (valves, rods and pipes) and lubricating the different valves.

Health and Safety: Roughing Filtration is a pre-treatment and should not be used as a single-step treatment process for drinking water. In emergencies, Chlorination **(T.6)** is always advised as a minimum post-treatment step. The sludge produced during filtration is easily disposable and does not cause health concerns.

Costs: Roughing Filters cost at least 150–200 USD per m^3 of installed filter volume. Ongoing costs are low because of the lack of required chemicals and the simplicity of the design. As an indication of required maintenance costs based on a filter treating 240 m^3/day, only 30 work hours would be required per year (including hydraulic cleaning every one or two months depending on the season and manual cleaning every 5 years). In comparison, a Slow Sand Filter **(T.9)** requires 300 % more time.

Social and Environmental Considerations: Roughing Filters tend to be well accepted by users and institutions where this is a known technology. Establishing it as a new technology requires training, O & M capacity development and willingness of local staff.

Strengths and Weaknesses:

- (+) Does not require chemicals or mechanical equipment
- (+) Can be constructed with local resources
- (+) Has low maintenance requirements and low operational costs

- (−) Varies in performance depending on the filter design, O & M and raw water characteristics
- (−) Not suitable for treating stable suspensions with high concentrations of colloidal matter
- (−) Comparably poor efficiency in colour removal compared to other pre-treatment methods
- (−) Requires more time and resources for installation than coagulation and sedimentation

→ **References and further reading material for this technology can be found on page 217**