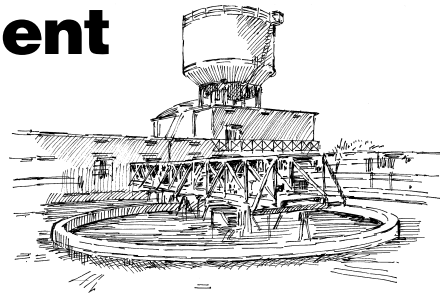
# **Rehabilitating water treatment works** after an emergency



**World Health Organization**

In urban areas, the population may be entirely reliant on the public water supply system for their drinking water. Modern water treatment works (WTWs) rely on inputs of chemicals, electricity and skilled operators as well as the constructed plant and machinery. Clean water then needs to be delivered but piped systems can be prone to leaks, intermittent operation and contamination.

Managing a water supply system is a complicated task and it is strongly recommended that a suitably qualified engineer is responsible for the rehabilitation of any system.

## Collecting basic information

- Find out who runs the water system – operators and managers.
- How does the system work?
- What is not working?

Identifying local WTW operators who understand the system is a priority; this will provide knowledge (of the works and sources of supplies) and a skilled work force. Efforts should be made at an early stage to find, recruit and pay the operators and managers.

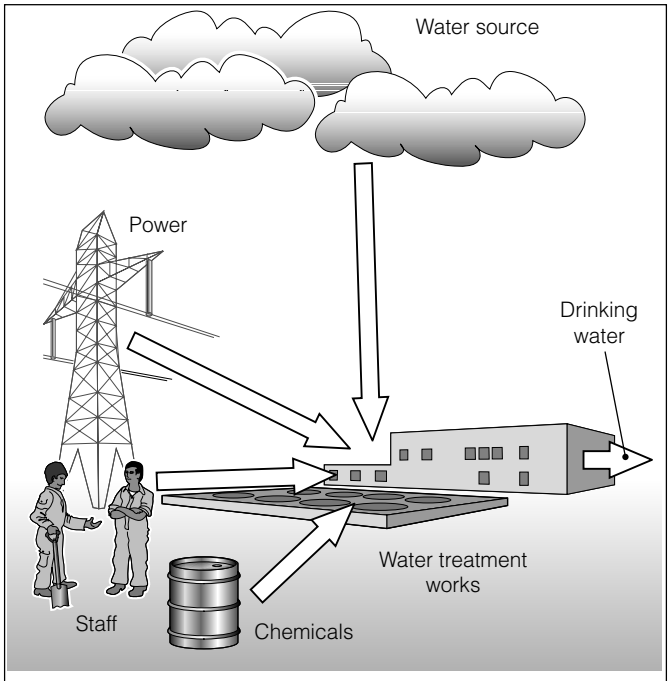



**Figure 1. WTW requirements**

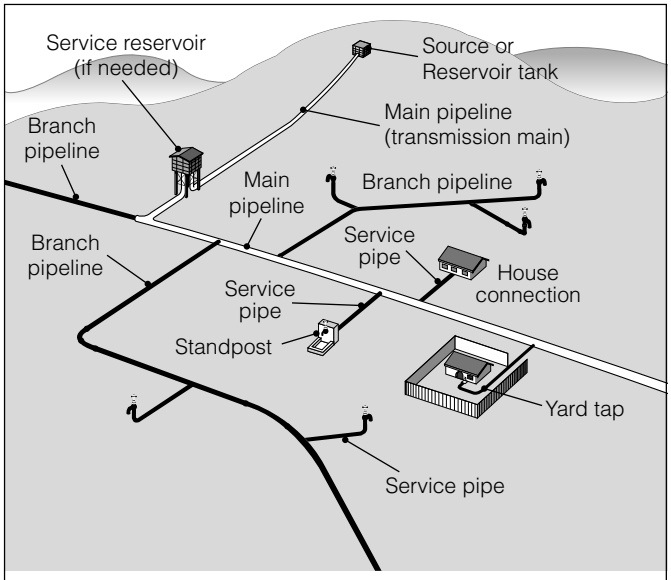



**Figure 2. A distribution network**

In order to repair a water supply it is important to understand how the system works. Individual WTWs will vary in design, but most are based on a variety of basic components that fit together. These improve the quality of water in stages

The condition of each component needs to be assessed. Repair and renovation are faster than replacement because any existing staff will know how to use existing plant and finding replacement parts is generally quicker than building a new unit.

Distribution systems are based on a series of large (trunk) water mains that feed into smaller pipes. Concentrate on trunk mains before moving onto local distribution networks. Reservoirs are needed at various points in the system to ensure continuous supplies of water. Both pipes and reservoirs need to be physically undamaged and clean.

## Setting priorities

- Provide a basic supply
- Identify risks of contamination
- Improve quality in stages

## Distribution first

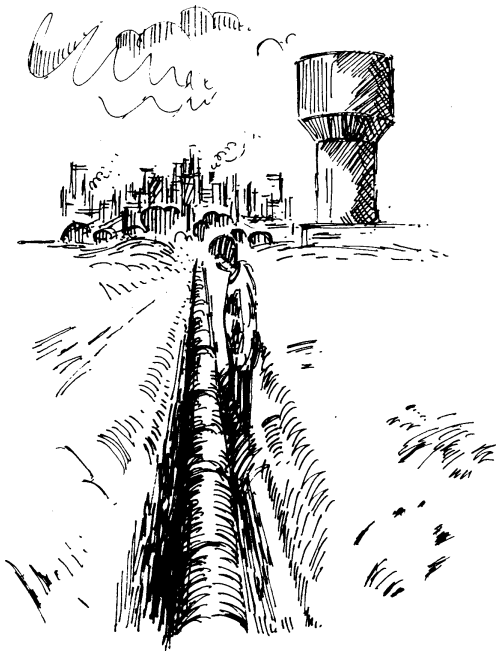
The first requirement is to get water into the distribution system, with only enough treatment to ensure that the water is free of gross contaminants that may block or damage the pipes and pumps used. The order of rehabilitation should be:

1. Intake
2. Pumps and trunk water mains
3. Local distribution pipes
4. Storage reservoirs
5. Water treatment

This may involve by-passing all or part of the WTW. Initially water may be pumped directly from the source into the distribution system, without any treatment apart from the intake screens or simple sedimentation without chemicals. Storage in service reservoirs is important as it can ensure a continuous supply – intermittent supply can lead to contamination of water in the pipes and deprive people at the end of the pipes of water.

## Checking for leaks

Reducing leakage can improve both the quantity and quality of water available to the public, but the distribution system is difficult to assess because it will be buried and spread out over the whole urban area. Repair obvious leaks first as they are likely to be the largest. Ask the public to report problems and sightings of leaks and puddles. Offer a small reward for information – this will be cost effective as it will quickly identify problem areas in the distribution network. Meters and pressure tests may also identify leaks and broken pipes.



**Water distribution is the first priority**

## Risk assessment

There are many chances for water to become re-contaminated once it leaves the WTW (such as improper handling or pollution through leaking pipes) so investments in water quality improvements need to be assessed by looking at the whole system and seeing the impact *at the point of use.* If water in the distribution system cannot be guaranteed to stay clean, it may be better to supply some users (such as hospitals) with water in a tanker, that can be disinfected and the quality maintained. Simple treatment can be provided at a more local level, such as chlorinating local water storage tanks.

Pumps may be used at various stages, such as pumping water from the intake to the WTW or from the WTW to the distribution system. In some cases the water can flow for all or part of its way through the WTW under gravity. Replacement parts may take time to be delivered, so ask an engineer to make an early assessment of the state of the pumps.

Power for pumps should be given priority over every other use – even over hospitals.

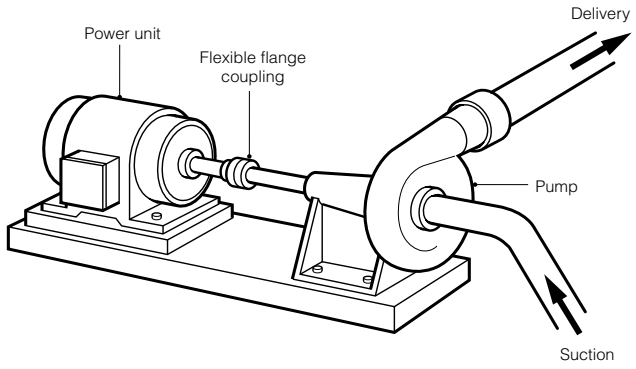



**Figure 3. Centrifugal pump driven by a shaft connection**

## Providing treatment in stages

The order of water treatment is important – for example coarse filtration needs to take place before finer filtration and chlorination needs to take place only once the water is physically clean and there is little chance of re-contamination during delivery or use. The order of WTW rehabilitation activities
should be:

1. Source protection (preventing pollution in the first place)
2. Physical treatment (screening, aeration, settlement, filtration)
3. Chemical treatment (coagulation, pH correction)
4. Disinfection (chlorination)

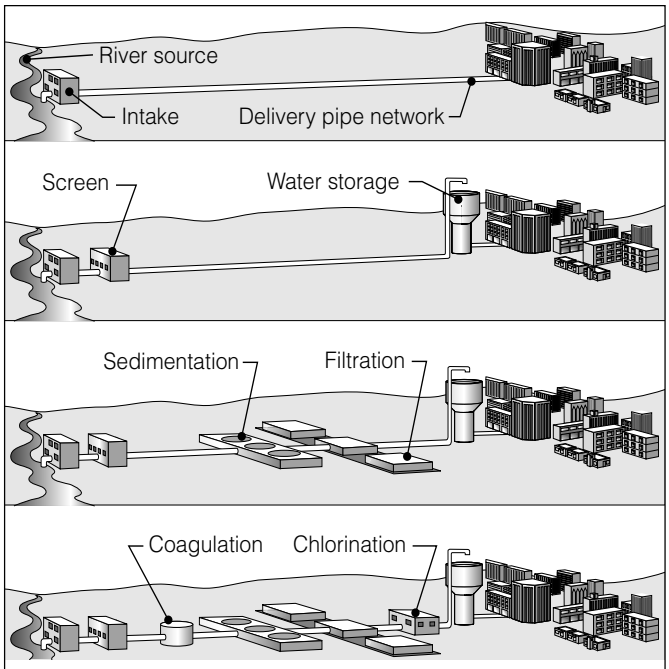



**Figure 4. Treatment in stages**

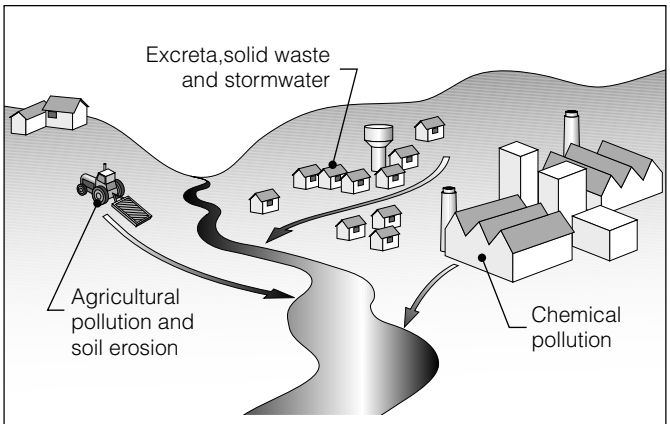



**Figure 5. Preventing pollution upstream reduces the need for treatment**

## Repairs, restoration and operation

The damage to a water supply system will vary according to the cause of the emergency. Floods may inundate and pollute the whole system, necessitating cleaning of the whole WTW and piped system and repairing or replacing electrical equipment. Damage to the electric motors for water pumps are a main cause of failure of the whole system. Earthquakes or landslides may leave machinery unharmed but break pipes or tanks. War or civil unrest may lead to looting or wanton damage, especially to mechanical and electrical plant. Any precarious situation may disrupt inputs of chemicals, electricity and technical expertise.

Once part of the WTW has been re-commissioned, it will need to be operated. Other tasks include measuring the quality of the water to ensure that the WTW is being operated efficiently. Spare parts, water quality testing kits and other consumables will all be required.

- **Chemicals:** Modern WTW rely on the addition of chemicals to aid the treatment process. These include alum to help settlement, lime for adjusting the pH of the water and chlorine for disinfection. There may be a long time delay in gaining new supplies so the need for chemicals should be identified and suppliers contacted. A reduced level of treatment can be provided if chemicals are in short supply, using what materials are available where they are most needed (e.g. for disinfecting water supplies to hospitals).
- **Power** can be supplied by mobile generators if mains supplies are not available or unreliable.
- **Maintenance:** This includes manual tasks, such as cleaning screens, removing settled sludge and lubricating pumps The filters will begin to get clogged with solids. Pipes need to be checked for leaks.

## Other actions

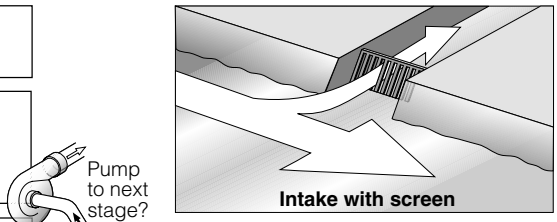
- **Pollution prevention:** A more effective way of increasing the quality of water may be to reduce the need for treatment in the first place. Preventing pollution from occurring in the first place by providing environmental sanitation (management and disposal of excreta, solid waste and rainwater), controlling erosion and restricting public access to the catchment of the water source can reduce the amount of contaminants that have to be removed from the water. Restoring sewage collection and treatment may be more important than a complete WTW.
- **Public information:** The public should be kept informed of developments in the availability and quality of water. They can help in reducing wastage and identifying leaks in the distribution system.

### Further information

Twort, A.C. et al. (2000) *Water Supply,* 5th ed. Arnold with IWA Publishing: London

**Source**: Water may be from surface water (river or lake) or groundwater. Prevent pollution to reduce the amount of treatment needed later.

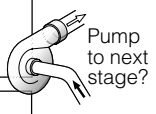
**Intake**: Some simple treatment may take place at the intake, such as a coarse screen or aeration. Storage at this stage allows some solids to settle out before treatment and provides a limited reservoir of water if the source fails (e.g. an oil spill in a river).

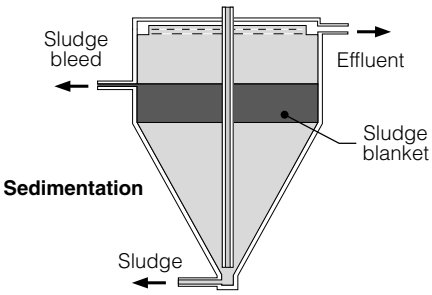






**Settlement/clarification**: If the water is stored for a while, solids will fall to the botton of the tank and scum will float to the surface. This process can be enhanced by mixing a coagulant into the water (such as alum), to make small solids stick together (flocculate) and settle faster. Water can either slowly flow horizontally through a tank or vertically, with the sediment forming a horizontal suspended layer.




**Filtration**: Various types of filters may be used:

Roughing filters have a coarse media, and actually promote settlement as well as filtration within the media. They are used for treatment early in the WTW.

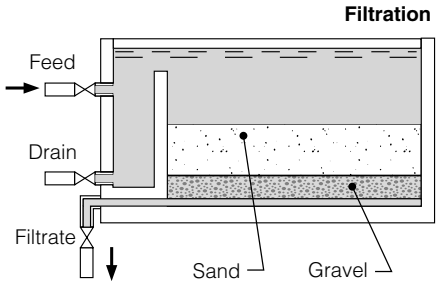
Rapid gravity filters are a standard method of treating water. Settled water is passed through a layer of coarse sand to remove silt.

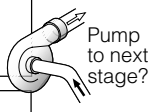
Direct filtration is rapid filtration without any settlement stage before it. These filters require backwashing frequently.

Pressure filters operate in an enclosed vessel under pressure. This reduces the need for pumping in some circumstances, but requires careful operation.

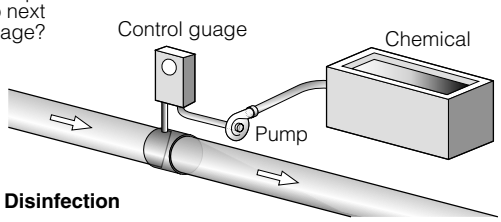
Slow sand filters have a fine sand media and can also reduce pathogens. They are simple to use.

Membranes are complex to operate but can provide a high quality level of treatment.

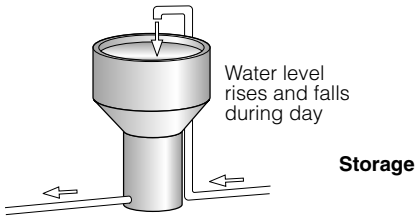



**Disinfection**: Adding chlorine to the water not only kills many pathogens, but also provides a level of protection from recontamination in the distribution system. Complex chlorine dosing systems use chlorine gas, but liquid or solid chlorine compounds are also available and can be used manually. The treated water needs to be stored for a while to allow the chemical to work. The effectiveness of chlorination is reduced for water that is dirty or will be re-contaminated, so priority should be given to cleaning the water and ensuring it stays clean before disinfecting it.




**Treated water storage**: The supply and demand for water varies throughout the day; to cater for this variation, a tank is used. This also provides water for use in emergencies - such as for fire fighting or for short breakdowns in the WTW.




**Distribution**: Once the WTW is producing water, this can then be distributed to the population. Tankers may be used if the piped system is out of use.

**Figure 6. A water supply system at a glance**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