# Urban water supply

## Contents



## 1. Scope

What is meant by **urban water supply** is **facilities** for **meeting the water requirements** of an **urban population**, of the **public sector**, and of **trade** and **industry**. The **distribution of the water** may take place via either **distribution systems** (piped supply) or **non-piped supply points** (e.g. wells).

In many countries the term "urban" is not necessarily related to the size of the community in question and for that reason the **type of supply** is defined as follows

| | **Type of supply** | **Consumption in litres per inhabitant per day (l/i/d)** | |
|---|---|---|---|
| 1) | Non-piped supply | | 15 - 40 l/i/d |
| 2) | Piped supply from stand pipes | up to | 40 l/i/d |
| 3) | Piped supply from yard taps | up to | 60 l/i/d |

| | | | |
|---|---|---|---|
| 4) | Piped supply from house taps | more than | 60 l/i/d |
| 5) | Piped supply to special customers such as trade, industry, public sector | varies widely | |

In the context of development efforts, **consumers in groups 2) and 3)** above should be **accorded priority treatment**, as also should consumer group 1) where there are plans for them to be connected to the piped supply. To the **figures in the overview table** must be added **allowances, considerable in some cases**, for wastage and for the water losses that affect the majority of existing **piped supplies**. The figures **considered** for **sizing the component parts** of an urban water supply system should be **peak demand figures** (e.g. at the day and hour of maximum demand). In many countries, it is only seldom that allowances for water supplied for fire-fighting (the peak measured demand) will enter into the calculations.

**Water abstraction** breaks down into the following **sub-divisions**:

- abstraction from groundwater sources,
- abstraction from surface water sources.

**Hybrid forms** of abstraction should also be allowed for:

- abstraction via bank river intakes using infiltration drains
- artificial infiltration with recovery.

The following are the **component parts** of the **urban water supply layout**:

- **abstraction** (wells, infiltration galleries, spring tappings, abstraction structures, storage basins/reservoirs)
- **treatment** (e.g. iron removal, chlorination, desalination)
- **storage** of the treated water
- **distribution system** (pipe network, long-distance supply facilities).

In the case of **artificial infiltration** with recovery, this layout has inserted into it at the upstream end the

- **infiltration system** (basins, recharge wells, drain ducts).

## 2. Environmental impacts and protective measures

### 2.1 Overview

What should be considered in connection with urban water supply are the **environmental impacts** both on the **volume of water available** and on the **quality of the water**.

In many countries, and particularly in **zones of varying climate**, the **problem of water availability** is beginning to take **precedence over the problem of water quality**.

As with the parts of the urban water supply system, impacts can be broken down into the following groups:

- impacts from water abstraction
- impacts from conveyance and treatment of raw water
- impacts from piped distribution.

In addition to the above, there are also secondary impacts in the form of

- consequential effects of an urban water supply system.

### 2.2 Impacts from water abstraction

2.2.1 Groundwater

The **abstraction of groundwater** will cause a **change in the aquifer water balance** and there are a large number of consequential effects that this may have. The **balance is between**
- inflow-side components (groundwater recharging from precipitation and surface water, subsurface inflow from adjoining aquifers, artificial infiltration) and
- outflow-side components (outflow to surface water, drains, abstraction intakes, etc.).

It is essential to remember that, due to hydraulic interaction, the changes caused by water abstraction in components on both sides of the equation may even be lasting ones (e.g. an increase in the inflow from adjoining aquifers).

Thought must also be given to the **interaction between availability and use and between groundwater and surface water**. **Greater use of surface water** may cause a **reduction** in **infiltration** into the subsoil, and the **remaining volume of surface water** may be more heavily polluted in particular ways. The **consequence** may be an **increasing requirement** for **groundwater use** (2.2.2).

The **environmental impacts** that a **change in the components contributing to the balance** may have are:

a) Quantitative depletion of groundwater resources

Increasing quantitative depletion of groundwater resources results from:
- **increasing consumption of drinking water** due to a growing population and an improvement in the standard of the supply
- **more rearing of livestock**
- **increasing demand for industrial water** (for trade and industry)
- **wasting of water**
- **water losses** from defective distribution systems.

Other **factors** that need to be taken into account are ones that lead to a **temporary** or **permanent reduction in groundwater resources**, such as **declines in precipitation in aquifer watersheds** (due to deforestation, steppification). It should also be borne in mind that, under the **traditional urban water supply strategy**, it is peak demand that has to be met, but that this demand often occurs in the **dry season**. The **high consumption during dry periods** and the **vast water losses** from some piped systems, only a proportion of which is returned to the groundwater, then give rise (seasonally) to a particularly **severe depletion of groundwater resources**.

b) Long-term changes in groundwater quality

These may be caused by:
- **mobilisation** (leaching out) and subsequent **spread** of previously immobile pollutants
- **increases in flow velocity** (e.g. in natural gypsum beds or man-made pollutant deposits)
- **changes in groundwater flow** (resulting in interception of charges that previously flowed harmlessly away, inducement of infiltration from contaminated surface waters)
- **inducement of widespread infiltration** from overlying or underlying groundwater storeys in which **groundwater quality** is **poorer**.
- **entry of pollutants** due to the use of fertilizers and pesticides
- **intrusion of salt water** into aquifers close to coasts
- **deterioration in groundwater quality** caused by seepage of untreated waste water from open, unsealed roadside ditches, leaking sewers or poorly built cesspits, or by seepage of pollutants and toxins from liquid industrial and commercial waste.
- **charging with minerals** from irrigated areas, caused by the high evaporation in arid and semi-arid areas and subsequent entry into the groundwater as a result of periodic mobilisation.

- **leakage of pollutants** from storage depots and transport systems for liquid and mineral products.

c) Localised and extensive lowering of the water table

In the case of **groundwater abstraction**, **lowering of the water table** is **inevitable for hydraulic reasons**. However, the **size and physical distribution** of the lowering will depend on **local conditions**, e.g. the positions of the wells, the structure and nature of the aquifer, recharge conditions. Typical **consequential impacts of water table lowering** are:

- **drying up** of ecologically important wetlands,
- **reduction in soil moisture content** (field capacity), with plant- specific impacts on plant cover (change in the natural and cultivated flora, e.g. steppification) and with consequential effects on the fauna,
- **total depletion of groundwater resources** during sustained dry spells (drying up of wells),
- **drying up of springs and watercourses**,
- **soil settlement**.

The **environmental impacts** of **water table lowering** are usually **less severe** where there was a **low water table (> 10 m)** even before abstraction.

**Environmental protection measures** to **minimise the harmful effects** of **groundwater collection** will be concerned mainly with **selection of suitable locations for wells** and the **design** and **modes of operation of the wells**. The **adverse impacts** of excessive abstraction of groundwater may also be **mitigated** or **prevented** by **efficient use of water**, by **seasonal control of water consumption** (rainy season vs. dry season) and by **introducing and operating systems of consumption-dependent tariffs and charges**.

To **boost** the **efficiency of environmental protection measures** in dealing with the impacts of groundwater abstraction, it will be necessary not only to carry out the appropriate **hydrogeological reconnaissances** and to **assess the total water balance** (groundwater and surface water), but also to provide continuously operating **measuring and monitoring facilities**, the purpose of which will be:

- to ensure an ongoing improvement **in evaluations of and statements on questions of hygiene and hydrogeology**,
- to watch for **changes in the groundwater supplies** (volume and quality) by constantly checking groundwater levels, groundwater quality and volumes of groundwater abstracted,
- to keep a constant watch for **waste of water** of all kinds and for **water losses** from piped urban water supplies, by means of continuously operating measuring facilities (district water consumption, consumption from stand pipes and domestic connections), and to take action to counter both of these (by repairing damage in good time, by tariff setting and by penalising the wasting of water),
- to apply **restrictions on the water allocation** to other, competing user groups in order to ensure that a supply is available for human beings (emergency supply),
- to put in hand **rehabilitation work** on existing parts of the urban water supply system (to replace defective water mains and domestic service pipes, faulty taps and cocks, and overflowing cisterns and domestic storage tanks),
- to monitor the **efficient execution** of rehabilitation work by checking the results.

2.2.2 Surface water

The **use of surface water** will cause a **change in the water balance** and this, as in the case of groundwater abstraction, may have a wide range of consequential impacts. What will need to be considered in this case are **two-way effects** between **surface water and groundwater availability and use**. **Also** of importance are the **following factors**:

- **In some regions**, **more surface water** may become available in the future, due for example to **changes in the (micro)climate** (such as an increase in precipitation due to the effect of artificially created reservoirs), to an **increase in surface runoff** caused by changes in the vegetation in the surface water catchment area (deforestation), to **building over** (roads, buildings) producing greater surface runoff, or even to the **discharge of (cleaned) wastewater** from towns and smaller communities into the surface water.
- In other regions, a **climate-related decline in precipitation** may occur, and in this way **surface water runoff** may be **reduced** and the **quality of the water degraded**, in which case the situation will be even worse in countries where surface water is not available throughout the year anyway.
- **Increasing abstractions** from flowing waters (by means of river intakes) will cause a reduction in the **availability of water** in many regions, particularly at periods of low water, and in the **self-cleaning action of the body of water** and in **infiltration into the subsoil.**
- If **demand for water** increases and the quantity available in flowing or dormant surface waters is **reduced** and at the same time the **quality of the water** is degraded, a **requirement** often arises **for water to be brought into the region in need from remote areas** or for the **demand for water to be met from more plentiful or less plentiful groundwater resources.** In particular **borderline cases**, **emergency situations** may arise, i.e. where supply of even the minimum amount of water required for the human population can be guaranteed only at high cost.

a) Quantitative depletion of surface water resources

The demand-side components listed in 2.2.1 are likely to cause **an increase in the use of surface water**. Account should also be taken **of climatic changes and changes in the vegetative cover in the watershed**, as these may result in some regions **in reductions in the amount of surface water available or in an adverse time-related runoff distribution** (greater runoff at periods of high water with a higher charge of suspended matter and sediment, but lower runoff at periods of low water).

What is often lacking for **checking the volume of runoff**, the **extent of the resources and the volumes abstracted is an adequate network of measuring stations** within the watersheds (for precipitation) and at particular points on the bodies of water (for level)**, and expert staff to analyse the measurements and monitor the multi-sectoral use of surface water resources and to draw up water balance sheets** (for ground and surface water) and **water management plans**.

b) Changes to ecosystems caused by water abstraction

Relatively **large reductions in flow**, particularly at times of low water, may have **impacts on all the ecological processes in a body of water or watercourse and on its shores or banks**. **Biotopes** of value to the landscape or ecology may be **adversely affected** or even totally **destroyed**; under certain circumstances the **ecological equilibrium**, with its balanced variety of floral and faunal species, may be **altered**. However, **such impacts only occur** when the **abstraction of water**, measured against the total flow, is **substantial**, i.e. such that an ecosystem no longer receives its minimum water requirement. Also, the **impacts of water abstraction** are, as a rule, **not spread over a wide area** but (depending on the topographical situation) **confined to small areas** (strips along banks and shores, floodplain meadows).

c) Intrusion into the water supply of unknown or undetected hazardous constituents

The **use of surface water to provide a water supply** is fundamentally a **problem of water quality**. **In properly designed treatment plants,** suitable **monitoring facilities** ensure that **safe feed into the distribution system** is possible. However, a risk **of damage to health and impacts on hygiene** may occur if **pollutants remain undetected in the water**, the pollutants being for example the **result of uncontrolled discharge of substances into the water**. The **pollution** may possibly take the form of a **concentrated dose of a discharge** which at other times is continuous and relatively harmless (e.g. when toxic pollutants are being drained off). Another risk is that, due to their **low detectability, constituents may evade the existing monitoring and testing facilities**. **Substances** that **are difficult to detect** in this way include a range of **industrial solvents that are considered to be carcinogenic** even **at extremely low concentrations** if **continuously ingested by humans**. **Where there is a risk of exposure to such pollutants, the requirements to be met in water-protection zones** must be particularly stringent, as also must the **checks made in the zones**, and **provision** must also be **made for sensitive early-warning measuring devices** to be introduced in stages and for **embargoes on abstraction** to be applied.

In the event of **surface water abstraction**, the **following protective measures** need to be borne in mind:

- the introduction of suitable **measuring and monitoring systems** to keep a watch on water levels, runoff volumes, charges of sediment, sand and suspended matter, chemical, physical and biological water quality, and pollutant charges, and also to monitor an extremely wide diversity of parameters applicable to ecosystems in the watersheds,
- **collection and analysis** of the data acquired by the measuring and monitoring systems, and preparation of hydrogeological appraisals,
- **collection and analysis of hydrogeological data**, including continuous measurements made at observation and producing wells in regions where use is made of both groundwater and surface water resources, with the object of producing water budgets to show the **volumes of water available for use** and of checking that **distribution conditions are being complied with**.
- **monitoring of water quality** and of the **self-cleansing action** of surface waters,
- **analysis of data** to allow the introduction in good time of protective regulations, statutory provisions to safeguard resources, and conditions governing supply in emergencies,
- **appraisal of existing uses** of surface water, for the purpose of preventing harm to persons further downstream as a result of fresh abstractions of surface water and/or the discharge of used water,
- the **prevention of waste of water**, the **introduction of restrictions** on water allocated, and the **execution of rehabilitation work** on the drinking water distribution system (see section 2.2.1 on Groundwater).

**2.3 Conveyance and treatment of raw water**

When **raw water is conveyed in open channels**, and particularly when it is withdrawn from **contaminated or hygienically unsatisfactory surface waters**, it can be expected that **health problems** will arise as a result of illicit use of the raw, contaminated water and of human beings coming into contact with it in other ways.

In the course of **treatment of raw water**, **adverse environmental impacts** may arise due to **incorrect plant operation** (inattentiveness by operating staff, absence of alarm devices) or as a result of, for example, the **disposal of sludge from settling basins, of filter cakes, and of chemicals from stocks held** (e.g. disposal of old stock), **excessively high doses of chemicals** (e.g. chlorine), and the **disposal of alkali concentrates used in desalination processes**.

Factors of significance in connection with the **treatment of raw water** are therefore the **efficiency of the treatment process**, the **operation of the monitoring and alarm facilities**, and the possibility of **gearing treatment to the seasonal variation in the quality of the raw water**. Another factor that has an important bearing on the possibility of **achieving proper treatment** of the water (meaning the pumping and pretreatment of the raw water, metering in of chemicals, flocculation, filtering and disinfection, and analysis) and on the possibility of **guaranteeing hygiene in treatment plants** is the **standard of training** of the staff employed in such plants.

**Environmental protection measures** that may be envisaged are as follows:

- measures to **prevent access to systems conveying raw water** for the purpose of extracting water for use (as drinking water) by humans, and/or warning the population of the dangers of using contaminated water,
- **codes** governing the **quality of the discharge from treatment plants**, with due consideration for the seasonal capacity of receiving waters and the rights of use and expected requirements of persons further downstream,
- installation or retrofitting of **environmental protection facilities in water treatment plants**, such as detention basins, sprinkler systems for chlorine stations, secure storage for fuels and chemicals.
- installation of **measuring and monitoring facilities** for monitoring water flowrates and quality and for reporting incidents in the course of water treatment (e.g. damage to a tank of chlorine gas).

**2.4 Piped distribution**

Where the **environmental relevance of distribution** lies is in the following **impacts**:

a) Due to the **poor technical standard** of the urban water supply system in many countries and particularly the poor technical standard of the distribution pipes (inferior materials and bad laying as a result of mistaken low-cost policies), the **incidence of defects is very high** in **buried pipes**. In industrialised countries, the average incidence is 0.2 to 0.3 defects per km per year, whereas in other countries figures of up to 9.1 defects per km per year have been found.

**Water losses** from **dilapidated distribution pipes** are often **many times greater than consumption**.

b) Simply due to **high water losses**, it is often the case that the capacity of urban water supply plants is exceeded well before they achieve their designed output to consumers. It then becomes impossible to maintain a 24 hour supply and an **intermittent supply is introduced**.

c) When the supply is interrupted at times (intermittent urban water supply), the consequent lack of outward pressure allows **contaminated water** to makes its way into the distribution network through **fractures in buried pipes**, the contaminated water coming for example from ditches carrying wastewater, leaking roadside channels carrying wastewater, leaking sewage pipes, defective/overflowing settlement basins, badly designed dumps for waste and toxic materials, etc. This constitutes a **risk to the state of health of the population**.

d) **Water may become foul** due to **stagnation in runs of pipe** where the hydrodynamics of the system are poor or in clean-water tanks in the distribution system through which there is insufficient flow.

e) **Contamination of the water** in dilapidated distribution systems is **often so bad** that the water, despite being heavily disinfected (e.g. by high chlorine dosage rates) at the input to the distribution network, becomes so contaminated with organic matter on its way from the input to the consumer that there is a **permanent health risk**.

The following are suitable measures which can be applied to **minimise the impacts of piped distribution**:

- **critical assessment** of the **techniques for reducing water losses** developed in industrialised countries and **adaptation** of these techniques to meet the particular circumstances in the country and the special requirements that exist (e.g. use of leak detectors on pipes where the pressure is low, quantitative determination of water losses from intermittent water supplies, execution of measurements by district metering to determine water losses in distribution districts only sparsely equipped with gate valves and hydrants).
- introduction of **appropriate measuring and monitoring systems and pipe network improvements** (e.g. installation of essential gate valves) to allow a constant watch to be kept on water consumption, water waste, illegal extraction of water, and water losses by monitoring the supply being fed to distribution districts and the pressure within the districts and to check the effectiveness of improvements to the pipe network (reductions in water losses, etc.).
- monitoring of the **incidence of defects** in the distribution districts in the urban water supply system.
- establishment of **priorities for the permanent upgrading of the distribution system** in the urban water supply system (early detection and repair of defects and rehabilitation or replacement of sections of the pipe network where there is evidence of a high incidence of defects etc.).
- **improvement of the standard of materials used** and the standard of the laying work in the distribution system.
- **introduction of a continuous water supply** (meaning adequate 24-hour pressure in the pipe network) once the distribution system has been upgraded.
- **monitoring of the bacteriological quality of the water** (e.g. for excess chlorine) at the consumer connections/stand pipes.

**2.5 Consequential impacts of urban water supply projects**

The **purpose of an urban water supply system** is to **distribute reasonable quantities of water of a satisfactory hygienic standard** to consumers. Using good drinking water eliminates the health risks that occur because the water being drunk is unhygienic. However, any **rise in water consumption** also means an increase in **wastewater arisings** and thus, **in the absence of appropriate provisions for disposal**, a **greater potential danger to health** posed by an increase in water-borne diseases.

In the current state of the art, **100% of the water** from an urban water supply system is **produced to good drinking water quality standards**, whereas in fact only **5 to 15% of the water needs to be of drinking water quality**. It is therefore on cost grounds as well that it is important to make **sparing use of drinking water**. By **introducing suitable** (consumption-related, cost-covering) **tariffs** and possibly even by having **separate distribution networks** for drinking and other water it will be possible to achieve **sparing, efficient use of hygienically acceptable water**.

A **special problem** is posed by the **unhygienic treatment** of the water as it is being transported from stand pipe to user and its **unhygienic storage** in homes, and/or by defective domestic installations (e.g. defective roof tanks) that pose a permanent threat of disease.

**Adverse consequential impacts** of urban water supply projects arise mainly as a result of errors and shortcomings, such as:

- shortcomings in the quality of the materials used and in the standard of work done,
- shortcomings in operation, maintenance and rehabilitation,

- overrunning of the designed capacity of the urban water supply system as a result of waste and losses of water,
- shortcomings in the instruction given to the population and particularly to women, who often bear responsibility for hygiene-related matters such as transporting water, storing water in the home, cleaning, and the preparation of food.

A frequent source of **dissatisfaction among consumers** is a **decline in the standard of the supply caused by defects**. Grievances of this kind then lead to **increasing unwillingness to pay bills** and hence to a **falloff in income from the sale of water** and, what is more, to such things as **lack of interest in motivating and instructional campaigns** (to involve the population, to promote efficient use of water and to provide education in hygiene and health).

There are **special demands** that the **planning and execution of maintenance and rehabilitation measures**, based on the collection and analysis of data and information, must be expected to meet. This applies particularly to **non-visible parts of the water supply system** such as buried pipes. Serious mistakes are often made here, such as replacing old pipes (i.e. ones more than 50 years old) when the incidence of defects in old pipes of this kind is often lower than in pipes laid in the past 20 years.

In many cases new water abstraction and treatment works are built before dilapidated drinking water distribution networks have been upgraded.

One basic consideration that should be borne in mind is that the **consequential impact** of a proper urban water supply system will be **beneficial** to the state of health of the population when it is not simply **waste water disposal** but **solid waste disposal**, **housing conditions**, and **food hygiene** etc. too that are improved with the aim of producing a permanent effect on the state of health and living conditions of the population. The **following aspects** also deserve special attention in this connection:

- changing the population's traditional attitudes to the scarcity and importance of water as a resource (water is not a "free" commodity),
- enlightening and involving target groups, and particularly women, with respect to the costs and value of a proper urban water supply system and improved sanitary conditions and what they can expect from them.

To **minimise the consequential effects of projects** in the field of urban water supply, all the facilities should be planned, constructed, operated and maintained to a standard appropriate to local conditions and in line with the current **state of the art**. There must be a guarantee that the **operation of water supply systems** (for water abstraction and distribution) can be maintained **for the full 24 hours** in order to **prevent** any **contamination** of the water being distributed. It must be **ensured** that the water distributed is **used sparingly**, either by introducing and making active use of **metering and monitoring facilities** and/or by bringing into force appropriate **tariffs** and **charges** commensurate with the sparing use of water.

**At the same time**, **provisions for waste water disposal** and **other sanitary provisions** will also need to be made.

By the **proper maintenance and rehabilitation** of existing water supply facilities, and particularly of buried water pipes with their known susceptibility to defects, it will be possible both to **reduce water losses** and to **prevent consumer dissatisfaction** (caused by disruptions to the supply resulting from frequent repair work and by an intermittent supply) plus any related **drop in income from charges for water**.

Other essential **prerequisites** for **preventing adverse consequential impacts** are as follows:

- the introduction of **measuring and monitoring systems** for logging flowrate and pressure parameters and for the **early detection of defects in water supply systems** (distribution networks),
- the introduction of **measuring and monitoring systems** for **monitoring** the **quality of the drinking water being distributed**,
- the **involvement of the population**, and particularly women, in a very wide variety of **watchkeeping tasks** such as reporting defects (leaks) and water waste, and the **giving of instruction** in **good hygienic use of water** (containers for carrying water, the carrying itself, and storage of water in the home),
- the systematic **introduction** of improvements in systems which are to be integrated into new systems in the future,
- the introduction of **efficient operating and maintenance systems**,
- the **planning of expansions from a practical point of view**,
- the **avoidance** of past errors and of the uncritical acceptance of techniques from industrialised countries.

# 3. Notes on the analysis and evaluation of environmental impacts

## 3.1 Limits and guidelines in Germany and other industrialised countries

**Existing quality standards** in the Federal Republic of Germany, in the member states of the European Community (EC) and in other industrialised countries are mainly focussed on the question of **supply with satisfactory drinking water**. In the main, these standards lay down **limits or guideline or maximum values** for constituent concentrations and bacterial counts which must be observed for certain uses in order to **rule out risks to the health of humans**. Consequently, the **environmental relevance** of these standards lies chiefly in their aim of **preventing repercussions on health and hygiene from an unsatisfactory supply**.

In the **Federal Republic of Germany**, **drinking water supply** is governed by the **standards and guideline values in the Trinkwasser-Verordnung (TVO - drinking water regulations)**, but these cover only the **most important types of substances** (of the 650 or more that have so far been classified as hazardous to water). In addition to this, there are generally **sectoral codes** in the Federal Republic of Germany for assessing and, where applicable, preventing impacts generated by water supply on environmental resources. For historical reasons, the Republic has a federal structure and because of this structure it is possible that the **implementing regulations** in particular may be **different** in different federal states. For this reason alone, there may be **major problems** in **transferring** standards to other countries.

The **most important sectoral statutory instruments** are concerned with **water management** (the "*Wasserhaushaltsgesetz*" (Federal Water Act) and the water laws of the individual federal states), and **nature conservation** and **care of the landscape** (*Landespflege und Naturschutzgesetze*). However, the sectoral division means that **other statutory instruments**, such as mining law, may also have an **indirect bearing** on the question of limiting environmental impacts generated by water supply.

The most important guidelines relating to the **setting up of supply wells** are concerned with the **laying down of so-called water protection areas**.

The areas are divided into **three hazard zones** and in them **restrictions on use** are laid down. The aims of these restrictions are as follows:

(1) to prevent pollutants from entering the soil and groundwater in the vicinity of wells.

(2) to ensure that pollutants are properly degraded as they pass through the soil and are carried into the groundwater (the 50-day line).

(3) to ensure that if accidents occur outside the protection zones, enough time is available for countermeasures to be implemented.

The implementing provisions that apply in the Federal Republic of Germany (e.g. DIN standards) help to ensure that, for example, there is no uncontrolled entry of pollutants into the groundwater when wells are being sunk and, by providing authoritative directions for assessment and analysis, that decisions likely to create environmental stress are not made later on.

**Guidelines and standards from other industrialised countries** are, on the whole, intended to achieve **similar objectives** to those in the Federal Republic of Germany.

However, depending on the intensity of use and the historical background, laws and regulations in given countries may be very **different**, especially **with regard to the precise values** laid down and the **number of quality requirements specified for drinking water**. In the **EC**, there have already been some **initial successes** in **harmonising the drinking water standards** of the member states.

### 3.2 Other national guidelines

**Specific laws and guidelines** applicable to the environmental impacts of water supply are as yet **unknown in many countries**.

**In some regions** there are **traditional codes** relating to the **abstraction and distribution of water** that govern matters such as:

- the use of water from springs,
- the limits set for the withdrawal of water from wells and well fields,
- recharging of groundwater
- use of suitable wastewater for irrigation,
- management of the water from impoundments,
- distribution of surface water for irrigation,

These may very well be **important for environmental protection** and an endeavour should be made to **take them into account on appropriate projects**.

However, it should be remembered that there is often only an inadequate foundation for:

- water budgets,
- forecasts of multi-sectoral water requirements,
- forecasts of future water quality,
- priority needed to be given to the allocation of water resources for human use,
- statutory water regulations,

due to a **lack of basic data**.

**Internationally**, it is chiefly the **World Health Organisation (WHO) International Standards for Drinking Water** that serve as a main **reference tool**. However, it should be remembered when carrying out projects in countries where conditions are extreme that the **WHO standards** are only **recommendations** and that exceptions may be allowed in cases where there are good grounds for doing so. Over past years **greater importance** has been attached to the **WHO's minimum hygiene requirements** (bacterial counts, pathogens) than to the maximum concentrations of water constituents.

It is often the case that, although **broad guidelines** and **regulations** may already have been laid down at national level, there are no **mechanisms or resources for implementing** them.

### 3.3 Rating of environmental impacts

For rating environmental impacts, there are **different priorities** that may be adopted at the outset. In countries where there is already a **scarcity of water resources**, overriding priority may be given to assessing **how much water will be available in the medium and long term**. Where **water resources are adequate in terms of quantity**, then priority in evaluating the environmental impacts of urban water supply will be given to the **hygiene** and **compatibility with good health of the water distributed** for human consumption, bearing in mind that if the resource is **not adequately safeguarded for the future** or **is not adequately protected**, this may **jeopardise** the urban water supply's **long-term benefit** to those supplied.

A very **negative** view should be taken of **uncontrolled** and **wasteful use of water**, e.g. where, in an arid region, the private growing of wheat by irrigation is allowed to take precedence over long-term use of scarce groundwater resources for general human consumption.

**2.6 Environmental protection measures and recommended options.**

| Area/problems and traditional measures | Recommended options |
|---|---|
| 1. Technicalities of urban water supplyAdoption of standards from industrialised countries, modification of standards for reasons of cost, lack of resources to finance higher subsequent costs in the area of operation & maintenance (O&M), problems caused by low-cost policies | - Changes in grades of materials with the aim of improving quality<br>- Temporary increase in O&M expenditure<br>- Auditing of results<br>- Adjustment of O&M expenditure<br>- Inclusion of O&M costs in the financing of the project |
| 2. Introduction of water quality standards, of statutory provisions for protection areas, of bylaws, and of laws and codes<br>Adoption of standards from industrialised countries or international recommendations, where there are no national requirements | - Start with minimum requirements that can be achieved without any changes in legislation.<br>- Decide on the steps towards more comprehensive requirements on the basis of local priorities<br>- Bring in local specialists and legal experts |
| 3. Groundwater abstraction | - Introduction of permanent measuring facilities to monitor groundwater levels and volumes abstracted<br>- Introduction of permanent metering facilities to monitor consumption (district metering) in the distribution network<br>- Legal codes to lay down different per capita consumption levels (rainy season/dry season)<br>- Introduction of different, cost-covering tariffs for rainy season and dry season |
| **4. Surface water abstraction and water treatment plants**<br>- as for 3. Groundwater abstraction, amended as appropriate - | |

| | |
|---|---|
| 5. Water abstraction and traditional measures<br>High water losses caused by defective pipes due to mistaken low cost policies, hence severe depletion of the resource and an adverse effect on health, particularly where supply is made intermittent, problems solved by constructing new water abstraction facilities, pipes replaced on the basis of age, sporadic leak detection covering the entire distribution network and/or introduction of intermittent distribution | - Systematic defect logging and analysis<br>- Application of new methods of assessing water losses<br>- Replacement of vulnerable sections of piping network from defect analysis findings (demonstrable requirement)<br>- Installation of permanent metering facilities (for flow rate and pressure) to monitor consumption and losses and to track down defects<br>- Early detection of defects by means of the metering facilities and repair of the defects in good time<br>- Improvement of the overall standard of the network (installation of essential stop valves)<br>- Drawing up of plans of existing network on the basis of priorities<br>- Motivation of women and children to report defective supply facilities (defective stand pipes, overflowing house tanks, defects in supply pipes) |
| 6. Covering water demand from the urban water supply<br>Increased water demand due to<br>- increased consumption<br>- high water losses<br>- waste of water<br>- illegal withdrawal<br><br>Solution to problem attempted by constructing new water abstraction facilities, setting up of stand pipes rather than connections serving individual homes and/or introduction of intermittent supply. | - Introduction of metering and monitoring facilities in the districts of the urban water supply system<br>- Improvements to system for metering domestic water supplies<br>- Systematic introduction of metering of domestic and stand pipe supplies<br>- Improvement of system for releasing air from pipe network<br>- Introduction of consumption-reducing taps, etc.<br>- Reduction of water losses as detailed in 5.<br>- Introduction of (per capita) consumption level standards for rainy and dry seasons as detailed in 3.<br>- Monitoring of restrictions on consumption in dry season and results of action to cut water losses<br>- Introduction of cost-covering tariffs and improvements to payment collection system<br>- Involvement of population (women) in a wide range of watch-keeping functions |

## 4. Interaction with other sectors

**Projects in the urban water supply sector** have a **multiplicity of interactions with other sectors**; the **most important** of these occur where there are:

a) **competing uses** for the water resource (urban water supply, irrigation, consumption by trade and industry, power generation) or other stress-creating demands on it,

b) activities that may pose a **threat of pollution to the water resource** (use of fertilisers and pesticides, incorrect storage of refuse and trade and industry waste, pollutant-charged precipitation caused by emissions, non-secure transport of pollutants),

c) plans, and their physical results, that make it necessary for the **waste water disposal system** to be improved,

d) planning that causes **interference with groundwater recharge** (impoundment or diversion of surface waters, changes to vegetation, drainage operations, building).

**Table 1** is an **overview** of the sectors that interact with urban water supply and contains **cross-references to other environmental briefs** that are of crucial importance for evaluating consequential impacts.

The **urban water supply** system is a **essential part** of any overall **town-planning scheme**. The best opportunity for avoiding consequential environmental impacts therefore lies in **balanced planning for urban development** with **due consideration for regional planning** and for **water framework planning**. This is particularly true of the interactions between urban water supply and water disposal and the rule that should be followed in practice is that **supply with drinking water** and **discharge of waste water** should be planned **together** to rule out the possibility of overloading. It is only in the last few years that the **later consequences of incorrect waste disposal**, and particularly the disposal of industrial waste, to urban water supplies have been realised in the **industrialised countries**. Given the industrial development that is going on in many countries, it is clear that **consideration** also needs to be given to **choice of location** and **waste water disposal** when **urban water supply projects** are in prospect.

*Table 1* - **Environmental impacts from related sectors**

| Sectors where interaction exists | Nature of intensified or added impacts | Environmental briefs to be studied |
|---|---|---|
| Water abstraction for other purposes<br>- supply of water for agriculture<br>- supply of water to industry | *greater resource depletion and water table lowering<br>*adverse effects on other users<br>*reduction of quality | Rural Water Supply<br>Briefs relating to agriculture<br>Large-scale Hydraulic Engineering<br>Rural Hydraulic Engineering<br>River and Canal Engineering |
| Hydraulic engineering activities<br>- Construction of storage reservoirs<br>- River engineering, river | * ecological and sociocultural changes<br>* sociocultural changes<br>* water pollution<br>* long-term threat to | Provision and Rehabilitation of Housing<br>Specific briefs in the "Trade and Industry" field, e.g. Sugar, Pulp and |

| | | |
|---|---|---|
| straightening | groundwater caused by pollutant incursions from waste storage and leaks and by agricultural activities, including nitrate incursions into groundwater and pesticide/feed incursions into reservoirs<br>* overloading of the infrastructure all its consequential impacts<br>* reduction in groundwater replenishment<br>* greater surface runoff | Paper<br>Petroleum and Natural Gas<br>Wastewater Disposal<br>Planning of Locations<br>Solid Waste Disposal<br>Structural and Regional Planning<br>Water Framework Planning |

## 5. Summary assessment of environmental relevance

Generally speaking, it will not be possible to assess the **severity of the impacts** created by urban water supply systems by following a standard, fixed procedure and it will be more a matter of **weighing** the **good intention** of developing a life-preserving resource against the related **consequences of interfering with the ecological equilibrium** that will follow under the laws of nature. Those responsible for the project also need to be aware of the fact that **drinking water** performs the **role of a pacemaker**, in the widest sense of the word, for **sociocultural and socioeconomic conditions** and care therefore needs to be exercised in bringing it into play as a contributory factor to structural improvement.

An **assessment of the environmental relevance** of urban water supply can be undertaken by **considering the following questions**:

- the appraised water resources, and multi-sectoral use,
- evidence for efficient water use in present and planned urban water supply systems combined with efficient disposal,
- planning considerations of significance for environment-orientated urban water supply projects.

5.1 Appraised water resources, and multi-sectoral use

- Evaluation of the **current availability and quality of water resources** in the light of multi-sectoral use and seasonal variations in availability, quality and use.
- Reliable appraisal of the **future availability and quality of water resources** and reliable monitoring of their present availability and quality (constant measurement, hydrogeological, hydrological, chemical, physical and biological checks, and professional analyses and appraisals).

5.2 Evidence for efficient water use in existing or planned urban water supply systems coupled with efficient disposal

- Constant **monitoring of the use of water resources** by the body operating the urban water supply system in collaboration with other water resource users.
- **Consumption monitoring**, **control of consumption** (during dry periods), **monitoring of water losses,** and **quality monitoring** of the water supplied from the urban water supply system.
- Evidence of the need for **rehabilitation work** to be done on the urban water supply system, and particularly on the water distribution system, classified by priority.

- Efficient **implementation of statutory codes and regulations**,
- Efficient **disposal** and disposal monitoring,
- Effective provisions for **improving the availability of water resources** by means of artificial infiltration, retention basins, dams.
- Efficient **re-use of cleaned water**.

**5.3 Curative measures for inefficient water use in existing urban water supply schemes and inefficient disposal**

Curative measures may need to be applied to one or more of the items listed in 5.2

**5.4 Important planning considerations for environment-orientated urban water supply projects**

There is no fundamental reason why **urban water supply systems** should not be planned and constructed **in an environment-orientated way**. However, for this to be the case, there are a number of **preconditions** that have to be met which, in particular cases, may sometimes entail severe restrictions on water consumption.

The **planning of environment-orientated urban water supply projects** will call for:

- the environmental impacts of planned urban water supply systems to be checked for improvements, amendments and extensions likely to affect the acceptability of a project and the considered need for and benefits from it, against the background of **country-specific value systems**. (Simple unquestioning adoption of standards from the industrialised countries may lead to major planning errors.)
- an attitude of **problem-awareness** directed to regional conditions to be created among project planners and population in connection with the environmental implications of water consumption. (Policies restrictive of consumption in areas short of water and areas at risk ecologically, the importance of introducing cost-covering tariffs, the implementation of statutory codes and regulations).
- **careful on-site investigation of conditions**, such as what the requirement is, water availability and quality, the regenerative capacity of the resource, the risk of pollutant intrusion, and impacts of water abstraction on the ecology, with the services of specialist multi-disciplinary bodies being called upon to deal with particularly involved questions (depletion of water resources, consequences of water table lowering).

These **on-site investigations** must also cover the **condition of existing systems** and an assessment of existing shortcomings and obvious errors in the techniques employed likely to have repercussions on the improvement of the existing systems and practices.

The local investigations should pay particular attention to **socio-economic questions**, such as family income, income of women, stress on women caused by transporting water, attitude of the population to the scarcity and importance of water as a resource, willingness to pay, and other questions such as the willingness of the population to **assist in keeping a watch** on the **efficient use** and **distribution of water** and to play some part in **repair work**.

- assistance with the **setting up of indigenous monitoring bodies** to ensure that the requisite environmental precautions specific to the project are taken.

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