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Water Facilities and Drinking Water Availability

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ABSTRACT

Access to adequate and safe drinking water is essential for public health, human dignity and sustainable development. Water facilities include the sources, treatment systems, storage structures, pipelines, public standposts and household connections through which water is collected and supplied. However, the presence of a water source or tap connection does not by itself guarantee a dependable drinking-water service. Water must be available when required, supplied in sufficient quantity and meet applicable quality requirements. This review examines the major types of water facilities, drinking-water availability, treatment and quality monitoring, distribution infrastructure, common challenges and sustainable management practices, with a focus on the Indian context. It discusses the role of source protection, regular testing, operation and maintenance, rainwater harvesting and community participation. The paper also considers the Jal Jeevan Mission and the importance of evaluating water services through measurable indicators. The review highlights that reliable drinking-water access requires an integrated approach combining infrastructure, water quality, continuity of supply, affordability and long-term local management.

KEYWORDS

Drinking water; water facilities; water supply; water quality; availability; water treatment; Jal Jeevan Mission; rainwater harvesting; sustainable water management.

1. INTRODUCTION

Water is a basic requirement for drinking, cooking, hygiene, sanitation, agriculture and industrial activities. A reliable drinking-water system supports health, education, economic productivity and the overall quality of life. In many areas, however, households face irregular supply, seasonal shortages, long collection distances, contamination or dependence on private sources. These problems may be caused by limited infrastructure, declining groundwater, pollution, population growth, climate variability and inadequate maintenance.

Water availability should therefore be understood as more than the physical presence of water. A useful drinking-water service must provide water close to users, make it available when needed and protect it from microbial and chemical contamination. The WHO/UNICEF Joint Monitoring Programme uses these service conditions to define safely managed drinking water. This paper reviews water facilities and drinking-water availability, focusing on infrastructure, quality, access, operational challenges and sustainable solutions.

2. OVERVIEW OF WATER FACILITIES

2.1 Definition and basic components

Water facilities are the physical and institutional arrangements used to collect, treat, store, distribute and monitor water. A typical supply system includes a source, intake structure, pump or gravity conveyance, treatment unit, clear-water reservoir, transmission and distribution pipelines, valves, meters and delivery points. Household taps, public standposts, community tanks and institutional connections form the final service interface. The design capacity of each component should match the population served, local demand, source yield and expected future growth.

2.2 Common sources of drinking water

The principal sources include surface water from rivers, lakes and reservoirs; groundwater from borewells, tubewells and protected dug wells; springs in hilly regions; and rainwater collected from roofs or other suitable catchments. Piped supply, public taps, protected wells, packaged water and delivered water are examples of improved source types recognized in global monitoring. Source selection must consider seasonal reliability, contamination risks, yield, energy requirements, distance from users and the cost of operation and maintenance.

2.3 Types of water-supply facilities

Rural facilities: village-level piped schemes, borewells, overhead tanks, hand pumps, community standposts, household tap connections and local water-quality testing arrangements.
Urban facilities: water-treatment plants, pumping stations, service reservoirs, trunk mains, distribution networks, metered connections and public fountains or standposts.
Decentralized facilities: rooftop rainwater harvesting, local storage tanks, community filtration units and small-scale treatment systems for institutions or remote settlements.

2.4 Drinking-water availability and service levels

The WHO/UNICEF service ladder distinguishes safely managed, basic, limited, unimproved and surface-water services. Safely managed drinking water comes from an improved source that is accessible on premises, available when needed and free from faecal and priority chemical contamination. A basic service uses an improved source with a round-trip collection time of 30 minutes or less, including queuing. If collection takes longer, the service is classified as limited. Unprotected wells or springs are unimproved sources, while direct use of rivers, ponds or lakes is classified as surface-water use.

These categories show why a tap connection alone is not a complete measure of service quality. Continuity, quantity, collection time and water safety must also be assessed.

3. DRINKING-WATER QUALITY AND TREATMENT

3.1 Importance of water quality

Drinking water may contain physical impurities, dissolved chemicals and disease-causing microorganisms. Turbidity, colour, taste and odour can indicate changes in water quality, while microbial contamination may cause diarrhoeal diseases and other infections. Chemical concerns can include excessive fluoride, arsenic, nitrate, iron or salinity, depending on local geology and human activities. Clear-looking water is not necessarily safe; laboratory or field testing is required to assess important parameters.

3.2 Common treatment processes

Conventional surface-water treatment generally includes screening, aeration where required, coagulation and flocculation, sedimentation, filtration and disinfection. Screening removes large debris. Coagulation and flocculation help small suspended particles form larger flocs, which settle during sedimentation. Filtration removes remaining particles, while disinfection—commonly using chlorine or another validated method—controls harmful microorganisms. Groundwater may need treatment based on its specific chemical and microbiological characteristics. Treatment should be selected after source testing rather than applying the same process to every source.

3.3 Water-supply system flow

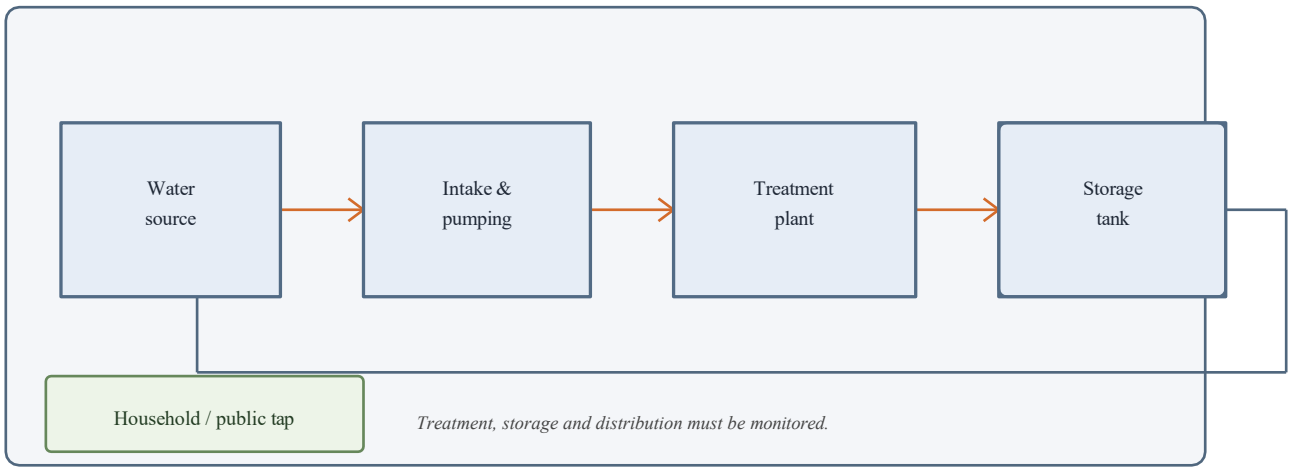


Figure 1. Simplified sequence of a drinking-water supply system from source collection to household or public delivery.

3.4 Quality standards and monitoring

In India, IS 10500:2012, Drinking Water—Specification, is the principal national reference for drinking-water quality and has been reviewed by the Bureau of Indian Standards. The applicable standard, amendments and local regulatory requirements should be checked during design and operation. Monitoring should include source-water testing, treatment process checks, residual disinfectant where relevant, distribution-system sampling and consumer-end testing. Field Test Kits can support preliminary community-level surveillance, but confirmatory laboratory testing is important for parameters that require accurate measurement.

3.5 Prevention of contamination

Sources should be protected from sewage, animal waste, agricultural runoff, industrial discharge and poorly managed solid waste. Wells should have suitable platforms, drainage and sanitary protection. Storage tanks require secure covers, periodic cleaning and protection against entry of insects or contaminants. Pipelines should be maintained to prevent leakage and intrusion, particularly when supply pressure is low.

4. AVAILABILITY AND ACCESS TO DRINKING WATER

4.1 Rural and urban access

Rural settlements may depend on groundwater, village reservoirs, springs or multi-village piped schemes. Distance between homes and sources, electricity supply, pump breakdowns, seasonal source depletion and local water quality can affect availability. Urban areas generally use larger treatment plants and interconnected distribution networks, but may still experience unequal pressure, intermittent supply, leakage, unauthorized connections and shortages in rapidly growing or informal settlements. Both settings require reliable infrastructure and transparent service monitoring.

4.2 Indian initiatives and the Jal Jeevan Mission

The Government of India launched the Jal Jeevan Mission in August 2019 to support rural household tap-water connections providing potable water in adequate quantity, of prescribed quality and on a regular, long-term basis. The mission is implemented in partnership with States and Union Territories, while planning, implementation, operation and maintenance of water-supply schemes remain primarily with State/UT authorities. A Government of India release reported that, as of 10 February 2026, approximately
15.69 crore of 19.36 crore rural households (81.02%) were reported to have tap-water supply at home. This is a reported connection-coverage figure and should not be interpreted by itself as proof of continuous supply or safe water at every tap.

4.3 Factors affecting availability

Factor	Effect on availability
Seasonal rainfall and drought	Reduces source yield and groundwater recharge during dry periods.
Population growth	Increases demand and may overload existing treatment and distribution capacity.
Leakage and pipe damage	Causes water loss, low pressure and possible contamination entry.
Power and pump failures	Interrupts pumping, treatment and delivery, especially in elevated areas.
Pollution and poor sanitation	Makes sources unsafe or increases treatment requirements.
Weak operation and maintenance	Leads to breakdowns, delayed repairs and unreliable service.

4.4 Equity, affordability and public facilities

Water services should be accessible to all households, including remote communities, low-income settlements, schools, health centres and people with disabilities. Public standposts and community facilities remain important where household connections are not yet feasible. Tariffs and user charges should support sustainable operation without making essential water unaffordable. Collection time, queue length, seasonal interruptions and the burden

placed on women and children should be included in access assessments.

5. SUSTAINABLE WATER MANAGEMENT AND FACILITY OPERATION

5.1 Source conservation and rainwater harvesting

Rainwater harvesting can supplement conventional sources by collecting roof runoff or surface runoff and directing it to storage tanks or recharge structures. Rooftop systems generally include a catchment surface, gutters, downpipes, a first-flush arrangement, a filter and a storage tank or recharge pit. Stored rainwater should be protected from contamination and treated appropriately before drinking. Groundwater recharge measures, watershed development, rejuvenation of local ponds and protection of catchment areas can improve long-term source resilience.

5.2 Operation and maintenance

A water facility needs routine inspection and planned maintenance throughout its service life. Important activities include checking pumps and motors, monitoring electrical panels, cleaning reservoirs, inspecting valves, repairing leaks, flushing pipelines, maintaining treatment equipment, managing chemical stocks and keeping records of water quality and supply hours. Spare parts, trained operators, emergency repair arrangements and a defined maintenance budget reduce the risk of prolonged service interruptions.

5.3 Community participation and governance

Local communities can contribute to source protection, demand management, reporting breakdowns and monitoring service quality. In rural India, Gram Panchayats and Village Water and Sanitation Committees can play an important role in local planning and oversight. Community participation is most effective when responsibilities, complaint channels, water-quality information, operating costs and repair procedures are clearly communicated.

5.4 Challenges and practical improvement measures

Challenge	Recommended measure
Intermittent supply	Improve source assessment, storage capacity, pump scheduling and distribution planning.
High non-revenue water	Conduct water audits, active leak detection, pressure management and metering where suitable.
Water contamination	Protect sources, validate treatment, disinfect as required and conduct regular sampling.
Groundwater depletion	Promote recharge, rainwater harvesting, demand management and sustainable abstraction.
Poor maintenance	Use preventive maintenance schedules, trained staff and dedicated repair funds.

5.5 Limitations and implementation considerations

New infrastructure may require significant capital investment, land, energy, skilled operation and long-term funding. A technically sound scheme can underperform if the source yield is overestimated, treatment is not suited to local water chemistry, pipelines are poorly designed or maintenance responsibilities are unclear. Projects should assess life-cycle cost, climate risks, energy use, water losses, community needs and environmental impacts before implementation.

6. IMPLEMENTATION METHODOLOGY

Step 1 – Assess demand: Estimate present and future population, daily demand and institutional requirements.
Step 2 – Identify sources: Examine source yield, seasonal variation, water quality and protection needs.
Step 3 – Design facilities: Select intake, treatment, storage, pumps, pipelines and delivery points.
Step 4 – Plan quality control: Define sampling locations, testing frequency and corrective actions.
Step 5 – Implement and commission: Construct, test and verify each component before public use.

Step 6 – Train and maintain: Train operators and community representatives; establish maintenance schedules.

Step 7 – Monitor performance: Review supply continuity, water quality, complaints, losses and operating costs.

7. PERFORMANCE EVALUATION

Water facilities should be evaluated using baseline information and regular operational records. Useful indicators include the percentage of households served, hours of supply, quantity delivered per person per day, number of water-quality samples meeting standards, frequency of breakdowns, repair time, leakage and consumer complaints. The following simple indicators can support local assessment:

Household coverage (%) = (Households served / Total households) × 100 Supply reliability (%) = (Actual supply hours / Planned supply hours) × 100
Water loss (%) = [(System input volume □ Billed/authorized consumption) / System input volume] × 100

These indicators should be interpreted together. A high connection-coverage figure does not necessarily mean that water is safe, continuous or sufficient. Performance assessment should combine service quantity, quality, accessibility, affordability and user feedback.

8. RESEARCH GAP AND SCOPE FOR FURTHER WORK

Many water-supply programmes report infrastructure creation and household connections, but comparable information on continuity, quantity, water quality and long-term functionality may be less consistently available. Further field studies are needed to examine the difference between reported connection coverage and the actual service received by households. Local assessments should include seasonal source performance, hours of supply, pressure at consumer points, water-quality results, repair response time and user satisfaction.

Future work may compare rural and urban water facilities, evaluate the effectiveness of rainwater harvesting and groundwater recharge, measure leakage in distribution networks, and study low-energy treatment technologies. Digital flow meters, water-quality sensors and geographic information systems may support better monitoring, but their use should be supported by trained staff, reliable calibration, data transparency and clear maintenance plans.

9. CONCLUSION

Water facilities are essential for delivering safe and dependable drinking water to households and public institutions. A complete water-supply system requires a reliable source, suitable treatment, adequate storage, well-designed distribution and regular monitoring. The availability of a tap or improved source is important, but it must be supported by sufficient quantity, continuity and compliance with drinking-water quality requirements.

In India, initiatives such as the Jal Jeevan Mission have expanded rural household tap-water coverage. However, the long-term success of water services depends on functionality, source sustainability, quality surveillance, community participation and effective operation and maintenance. Rainwater harvesting, groundwater recharge, leakage reduction and preventive maintenance can strengthen local water security. A sustainable approach must therefore combine infrastructure development with water conservation, public health protection and accountable local management.

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