B1
Water

Guiding principles

Access and equity: Factors that most reduce access to water supply in remote areas are climatic and seasonal (such as drought and dry seasons). Also, communities have been established in locations, such as central Australia, where little water is available. To remain sustainable, such communities will always have a restricted water supply.

Health and safety: A drinking water system should prevent hazards or contamination. The quality and amount of water supplied to a community should be negotiated between the residents, service providers and relevant government agencies.

Environmental health: Access to a safe and reliable water supply is fundamental for healthy living. Those managing a community's water systems should consider the community's aspirations, and the security and sustainability of the water supply.

Appropriateness: Choice and design of water system technology is appropriate when it:

- blends within site-specific and regional management strategies
- minimises the effect of identified hazards and risks
- supplies the current and future water needs of the community.

Affordability: Capital and recurrent cost considerations should be considered when managing water supply.

Sustainable livelihoods: Managing water supplies may involve some trade-offs to ensure that the supply is reliable and sustainable. The quality and quantity of water available may vary due to a community's location and climate. A water supply is adequate when it provides a sufficient volume of water at a suitable quality for the purposes for which it will be used.

Systems overview

In the *National Indigenous Infrastructure Guide*, the term ‘water supply system’ refers to the entire infrastructure — from source to tap. The components of a typical water supply system include:

- water source
- storage
- reticulation
- pumps
- treatment.

Current service delivery arrangements

Most remote and rural Indigenous communities have water supplies that are considered ‘small’ or ‘private’ in a regulatory sense because they are not connected to a town supply. In the 2006 Community Housing and Infrastructure Needs Survey (ABS 2007), 209 of 1079 individual communities (approximately 20%) were connected to a town water supply. Nine small communities (communities with a population of less than 50) did not have an organised water supply (ABS 2007).

The sophistication of a community’s water supply is usually related to the size of the community and the type of service:

- **Main towns** are usually on town supply, with water quality compliant with the A*ustralian Drinking Water Guidelines*. The service provider treats the water and has it tested, possibly weekly or monthly.
- **Major communities** usually have a locally sourced water supply, such as a bore. Often, major communities have their supplies treated and managed by a service provider. The water may be tested monthly or quarterly.
- Minor communities generally rely on small or private water supplies; such supplies are rarely treated. In minor communities, supplementary supplies (such as a secondary bore or rainwater tanks) for drinking or garden purposes are common. Few communities have their water tested, possibly monthly or quarterly.

In larger communities (with a population of more than 100), a service provider (such as a water utility or shire council) is usually responsible for delivering safe drinking water. The service provider must report to the health agency that has the regulatory role for water quality in that jurisdiction.

The service provider must maintain the water system to ensure that the supply meets agreed quality standards, and must have a management plan to ensure that the system works effectively. Someone who lives in the community may be responsible for identifying and managing everyday risks, and for alerting the service provider or similar authority if there is a problem with the water supply.

In smaller communities (with a population of fewer than 100), residents often maintain and manage their own water supplies, and may share responsibility for managing risks and responding to emergency situations with a resource agency or similar organisation.

State and territory organisations responsible for water supply arrangements and associated key legislation are listed in Tables B1.1 and B1.2.

Table B1.1: Organisations responsible for water supply arrangements

State/ territory	Large communities (population more than 100)	Small communities (population fewer than 100)
NSW	Local shire councils	Local Aboriginal land councils
NT	PowerWater Corporation; the NT Government monitors service provision	Outstation resource centre or community council
Qld	Local shire councils	Outstation resource centre or community council
SA	SA Water on behalf of the SA Department of Premier and Cabinet	Outstation resource centre or community council, Land Council Works, Anangu Pitjantjatjara Yankunytjatjara (APY) Services
WA	Remote Area Essential Services Program (RAESP); service provision is contracted to three regional service providers that are either Indigenous organisations or Indigenous–private partnerships	Outstation resource centre or community council

Table B1.2: Health authority and legislative arrangements for large water supplies

Organisation responsible	Key responsibilities	Key legislation and policy documents	Relevant drinking water guidelines
New South Wales NSW Department of Health	Develop standards for water quality for different purposes including drinking water standards and monitoring programs Monitor public water supply schemes according to the *Australian Drinking Water Guidelines* (2004)	*Public Health Act 1991* NSW Drinking Water Monitoring Program	*Australian Drinking Water Guidelines* (2004)
Northern Territory NT Department of Health and Community Services Utilities Commission	DHCS sets standards and monitors compliance for drinking water under *Water Services and Sewerage Supply Act* 2001	*Water Supply and Sewerage ACT 2001*	*Australian Drinking Water Guidelines* (2004)
Queensland Qld Department of Natural Resources and Water (Office of the Water Supply Regulator)	Regulate water supply activities Approve strategic asset management plans under *Water Act 2000*	*Water Supply (Safety and Reliability) Act 2008*	Department of Health encourages suppliers to meet *Australian Drinking Water Guidelines* (2004)
South Australia SA Department of Health	Administer and enforce the *Food Act 2001*	*Food Act 2001* Drinking Water Quality Management System	*Australian Drinking Water Guidelines* (2004)
Western Australia WA Department of Health	Health (food hygiene) Regulations 1993 The Department of Health advises on health standards for drinking water	*Country Areas Water Supply Act 1947* *Metropolitan Water Supply, Sewerage and Drainage Act 1909* *Water Services Licensing Act 2005*	*Australian Drinking Water Guidelines* (1996)

Source: Adapted from the National Water Commission (www.nwc.gov.au)

Relevant Australian guidelines and standards

The *Australian Drinking Water Guidelines* (NHMRC 2004) are of key importance in water system management. The guidelines incorporate the Framework for the Management of Drinking Water Quality. Fundamental to the framework is a risk management approach that identifies all hazards to a water supply and assesses the risk of harm from each hazard.

The framework promotes the use of infrastructure that incorporates multiple barriers as protective measures. Multiple barriers are designed to reduce the incidence of water supply contamination. Barriers in the design of infrastructure include concrete aprons surrounding bore heads, backflow prevention devices or treatment technologies. Additional barriers include activities such as regular surveillance and monitoring and measures such as the use of isolation valves to protect sections of the water system while maintenance is carried out. Effective use of barriers in community water supplies prevents water system failure and protects public health.

Priority should be allocated to reducing the hazards of greatest risk; however, small and incremental improvements can be an affordable means to prevent water system failure, and can have an enormous impact on protecting the water from contamination.

Other Australian guidelines and standards for water system management are show in Table B1.3.

Table B1.3: Australian guidelines and standards for water system management

Guidelines and standards	Topic
ANSI/NSF 53	Health effects of drinking water treatment units
AS 14001	Environment management systems
AS 1477:1999	PVC pipes and fittings for pressure applications
AS 1657:1992	Design, construction and installation of fixed platforms, walkways, stairways and ladders
AS 2032:1977	Cover to pipework
AS 2070:1999	Plastic materials to be used in contact with food
AS 4020	Materials in contact with drinking water
AS 4360	Risk management standards
AS 4765:2000	Modified PVC (PVC-M) pipes for pressure applications
AS/NZ 3500.0	Plumbing and drainage
AS/NZ 4020:2005	How to test products that will be in contact with drinking water
AS/NZ 4348:1995	Performance requirements for domestic type water treatment appliances
AS/NZS 4766:2006	Polyethylene storage tanks for water and chemicals
Australian Drinking Water Guidelines (2004)	Drinking water
Guidance on Use of Rainwater Tanks (2004)	Rainwater tanks
Minimum Construction Requirements for Water Bores in Australia (2003)	Water bore construction
National Water Quality Management Strategy: Guidelines for Groundwater Protection in Australia (1995)	Groundwater protection

Involving the community

In most communities, water supply management is shared: residents or essential service officers (ESOs) carry out the day-to-day operation of the supply, and service providers carry out larger maintenance tasks.

Small outstations generally do not have to report water management practices or compliance and methods. However, ensure that your management plan for small communities includes:

- availability of back-up support
- contacts for emergencies
- signs to alert residents to potential water supply contamination sources.

Plans can be developed using the *Australian Drinking Water Guidelines: Community Water Planner — a tool for small communities to develop drinking water management plans* (NHMRC 2005). The planner provides a systematic approach to water management, with the protection of the water supply as its first priority. Using the planner, activities to reduce the risk of the most serious hazard are conducted daily.

In large communities, health professionals, engineers and hydrogeologists are usually involved in decisions about risk management.

Ensure that:

- in smaller communities, community members are involved in decisions about risk management.

Appraising community requirements

Most communities will already have a water supply, so decisions will generally relate to upgrading or modifying existing systems to suit changing needs or circumstances. Sources of water supply and the water system design should meet both current and future needs of the community.

What are the community's water requirements?

Consider:

Current supply

- amount of water used
- causes of peak and low periods of supply (such as water restrictions)
- advantages and disadvantages.

Consumers

- size and profile of the population to be served
- predicted low and peak-load periods (for example, visitors or external users such as miners or tourists)
- the health of the population, especially vulnerable groups (such as children, the elderly, those with disabilities).

Water source

- likely uses of water (such as drinking, stock, gardens)
- location of available water source(s)
- quality and quantity of water at the source
- cost of augmenting the water supply
- recurrent maintenance costs of supplying the water.

Appraisal of water supplies should be done with a flexible approach that takes into account the security and sustainability of the supply and the aspirations of the community. The quality and amount of water available should be negotiated between the community, service providers and appropriate government agencies. The final decision may depend on factors such as affordability or community preference.

If the water is to be used for drinking purposes, the state or territory health department must be involved to ensure that water quality complies with regulatory requirements.

How can water requirements be managed?

The minimum amount of water required for drinking and hygiene purposes is 50 litres per person per day (L/p/d). Remote community water supplies are usually designed to deliver between 250 and 1000 L/p/d.

Both quality and quantity will affect decisions about water supply:

- 20–50 L/p/d of high-quality water is required for drinking and cooking
- 100–150 L/p/d of lower quality water is appropriate for bathing or washing, cleaning and swimming
- higher amounts of poor-quality water are appropriate for outdoor uses such as landscaping, washing cars and firefighting.

A water system design that caters in this way for the differing water quality requirements is more sustainable, reliable and affordable.

The sustainability of a water supply can also be improved using demand management, which involves reducing the overall or peak demand for water. Measures include:

- increasing the efficiency of the water system by reducing water loss (for example, repairing and replacing leaky pipes, tanks, taps and toilet cisterns)
- increasing end-use efficiency by installing water-saving plumbing fixtures and hardware (such as AAA rated showerheads and dual-cistern toilets)
- using several sources of water (for example, drawing water from a bore and harvesting rainwater)
- reducing overall water requirements (such as diverting air conditioner wastewater onto the garden)
- encouraging residents to contribute toward the costs of supplying the water.

This chapter outlines demand management options associated with each element of the water management system; such options include installing water meters and taking a whole-of-system approach to water management.

Additional information on demand management is provided in the *National Indigenous Housing Guide* Part C1.

Case study 3 — Choosing a water supply

A small community in an arid region needed to make choices about their water supply. Drinking water at the community was provided by large (20 000 L) rainwater tanks located at each of the five houses. The water for all other uses was sourced from a bore. The water from the bore was gravity fed to a storage tank, where a small pressure pump was located to pump water to the houses.

The bore water was very salty and hard: the total dissolved solid or salt content was over 1800 mg/L (ppm). The hardness in the water caused excessive scale on taps, showerheads and toilet cisterns. The scale led to leaks, and high water use meant that the small pump at the storage tank was operating constantly. Eventually the pump burnt out.

The community was approached by a salesman who described the benefits of a reverse osmosis (RO) water treatment system. The RO system would remove the salts from the water and relieve the scaling and maintenance problems caused by the hard bore water.

The community discussed the benefits of using an RO system to treat the water. However, once the up-front and ongoing maintenance costs were calculated, they reconsidered. The maintenance tasks were significant; the energy requirements for an RO system would be high and a contractor would need to change the filters and check the system regularly. There were also environmental considerations, such as how to dispose of the concentrated salty wastewater stream from the unit on their small property.

(continued)

The community compared the maintenance requirements of the current untreated water supply to a situation that included the RO unit. They decided that a regular routine of replacing taps and showerheads would be significantly cheaper. They realised that maintenance had been neglected and that there was nobody in the community who had the skills to do it regularly. The community members participated in a basic plumbing training course, then purchased plumbing hardware and replaced parts themselves.

Choosing appropriate solutions

The environmental conditions and location of a community are the most important factors for a water supply. The quality, quantity and reliability of the water will influence all further decisions about the water system.

Most communities will not require a new water supply system; most will only require repairs or upgrades. This section provides information on water system components, emphasising that water supplies should meet the needs of the community and meet minimum standards. The *National Indigenous Housing Guide* provides information on housing-specific areas, including rainwater harvesting and housing hardware (such as taps and isolation valves) — see Parts B1, B4 and C1.

Water sources

Water sources can be broadly categorised as surface water and groundwater.

Surface water

Surface water includes lakes, rivers, dams and rainwater. Potential hazards are:

- growth of blue-green algae
- high levels of microorganisms
- high levels of organic matter (for example, broken down plant and dirt particles)
- high levels of turbidity
- activity in the catchment that creates pollution (such as herbicides, septic tanks and fire retardants).

The hazards and risks can be reduced by understanding the activities within the catchment. Information is needed on:

- catchment (size, geology and soils, topology and drainage patterns)
- rainfall, meteorological and weather patterns
- vegetation
- animal populations (native, feral and domestic)
- water flow
- barriers (for example, fencing)
- water quality tests
- previously contaminated sites.

This information can provide a baseline so that seasonal variations in water quality and flow can be anticipated. The effects of unusual events, such as floods, can be anticipated by using historical data.

Establishing a baseline for data about water sources is an important aspect of the management of water supply.

The water system design for surface water must include multiple barriers such as intake screens and disinfection.

Ensure that:

- licence requirements are considered (where applicable) when pumping water from a river or creek
- intake screens are fitted for any surface water supply (such as a river intake or spear) and on submersible bore pumps (if there is no slotted casing on the bore)
- disinfection is included in the water system design
- the water source is fenced.

In most remote communities, rainwater is used either for drinking or to supplement the main supply for outdoor uses. Rainwater harvesting involves capturing water from a roof. Information required to design systems for rainwater harvesting includes:

- rainfall data for the region
- measurement of the roof area
- condition of the roof area
- water storage capacity
- daily consumption rate for intended use (for example, drinking or gardening).

Ensure that:

- gutters and pipes are large enough to handle maximum expected rainfall
- barriers are installed (such as first flush devices, gutter guards, settling tanks)
- storage capacity is sized for intended use (for example, drinking or gardening)
- tanks have screens on all outlets.

Consider:

- water treatment if the water is used for drinking purposes
- a water level indicator.

For further information, including descriptions of rainwater tank fittings, design and specifications, see the *National Indigenous Housing Guide* Part B4.

Rainwater harvesting is most effective when the water is used between rainfall events so that the tanks can refill during rainfall events.

Ensure that:

- the following maintenance tasks are conducted regularly
  - clean gutters and empty first flush devices
  - inspect and clean tank and roof area
  - disinfect the water after maintenance (such as sludge removal) or problems with the water quality (such as a dead animal in the tank).

Groundwater

Groundwater includes bores and springs. Bores tap into aquifers and aquifers are affected by the surrounding rock formation: quartz, sandstone, limestone, fractured granite or other rock. Each of these will affect an aquifer differently. In general, there are two types of bore: shallow and deep. Bores in northern Australia are similar to soaks, because they are generally shallow and are heavily affected by rainfall.

Hazards and risks of groundwater include:

- high levels of chemical contamination
- sewage contamination
- animal wastes
- industrial pollution
- seepage from landfill (rubbish tips)
- polluted stormwater.

Be conservative when estimating the amount of groundwater available due to the risks of over-pumping and contamination; any resulting damage will incur high costs. Conduct a comprehensive assessment of the potential hazards and risks of the bore. Information required about a bore includes:

- location
- registration number
- date drilled
- depth (total depth and water level)
- pump level and standing water level
- casing construction and diameter
- pump test data and water flow (in litres per second)
- safe yield (in litres per second)
- technical drawing of bores in region and strata information
- water-quality tests
- historically contaminated sites.

Bores should only be drilled by a licensed driller, in accordance with the National Minimum Bore Specifications. This should include an airlift test and a pump test. The most common bore casing materials are listed in Table B1.4.

Table B1.4: Common bore casing materials

Material	Advantages	Disadvantages
Unplasticised polyvinylchloride (uPVC)	■ cheap and resistant to corrosion	■ easily damaged
Fibreglass reinforced plastic (FRP)	■ strong and resistant to corrosion	■ more expensive than uPVC
Steel	■ very strong	■ easily corroded in some areas ■ usually used in deep bores

Information on all registered bores, including depth, casing material, water quality and flow rates is generally available at the relevant state or territory natural resource or environment department. Note that this information originates from drilling records and is limited by the requirements of that activity.

Ensure that:

- extraction licences comply with the state or territory water Act
- a concrete apron or plinth of at least 1 square metre in area is built around the bore head
- the bore is fenced
- the headwork and surrounds are sealed and well drained to prevent contaminants from entering the gap between the pump column and casing
- the source is located uphill and at least 250 metres away from any wastewater disposal system, such as a septic tank or soakage trenches
- a sampling tap is installed.

Consider:

- testing the soil for iron bacteria if in northern Australia (iron bacteria are more common in northern Australia; they discolour the water, make the water taste and smell unpleasant and produce thick slime layers that can block submersible pumps and other components of the water system)
- installing a pressure gauge
- designing the system to allow disinfection (particularly for shallow bores).

Management and maintenance

- Keep accurate records of bore performance, including weekly readings from the water meter, of the flow rate and of when the pump is run.
- Measure the standing water level (SWL) in a bore twice each year and compare measurements with previous data to calculate how much water is used and whether the source is being depleted (that is, the extraction rate is faster than the recharge rate). To measure the SWL, wait until the pump has stopped and the water level has had time to recover (usually a few hours). Lower a weighted cord (such as a fishing line) down the bore until you hear the splash. Mark the cord at ground level. Pull the cord out of the column and measure the length. SWL or water depth is this measured length below ground level.
- If the volume of water pumped decreases over time, check the total bore depth by dropping a weighted cord into the bore until it hits the bottom. If the total depth decreases over time, the bore may be silting up.
- If there are problems with the bore, use a process of elimination to discover the cause. First pull the pump out of the bore (‘pull the bore’), then examine the motor and measure the SWL and total bore depth.
- Water is held for less time in shallow bores than in deep bores. Shallow bores are therefore more likely to be contaminated by bacteria, because there is less time for sand to act as a natural filter. When managing a shallow bore, consider the effect of seasonal changes and whether disinfection is required.

Case study 4 — Selecting a solar pump to increase water supply

A small community in the north of Australia drew their water supply from a shallow bore. The standing water level was 7 metres below ground level and the flow rate was 0.5 litres per second. The water was pumped to the community each morning for about an hour using a portable diesel generator.

The community sought advice because the water pumping regime could only just provide enough water for the daily community needs. In addition, the community recognised the hazard to the water supply from potential fuel spills. The bore head was not adequately protected to prevent any fuel spills from entering the bore column and contaminating the water source.

The community decided to invest in a solar pump because it could operate all day and maximise the extraction rate for a bore with a low flow rate. Switching to a solar pump would also lower the ongoing fuel costs. The increase in pumping time meant that the community could increase their storage capacity and have stored water available for cloudy days or for emergencies.

The community successfully applied for a grant to fund the change to a solar pump, but kept their portable generator for backup. They erected additional storage tanks. To protect the bore, a concrete apron was built around the bore head with bunding to capture any fuel spills from the generator.

Benefits to the community include preventive water management through the improvements at the bore, a saving of at least an hour each day in labour to pump the water and greater water security through additional storage capacity. The additional water storage provides security if the water supply requires maintenance or water is needed for firefighting.

Storage (tanks)

Design

Tanks are most commonly made from plastic, galvanised iron, concrete, steel (with liners) or fibreglass. Polyethylene (poly) tanks are used increasingly in remote areas; poly tanks don't require protection from corrosion, are light to freight and have a predicted longer lifespan than galvanised iron.

Ensure that:

- tanks are sized with excess capacity to
  - provide backup water if supply is interrupted (for example, if a pump breaks)
  - provide supply for emergencies (such as firefighting)
  - increase the amount of time water is held in the tank, allowing sediment to settle
  - provide for unexpected increases in demand
  - allow for long-term community plans.

- tanks are sized to store at least 2 days' water supply; up to 7 days is preferable (see storage capacity requirements in Tables B1.5 and B1.6).

Table B1.5: Storage capacity required for 2-day supply (kilolitres)

Population (max)	Consumption (litres per person per day)			
	100	200	300	400
10 people	2	4	6	8
20 people	4	8	12	16
50 people	10	20	30	40
100 people	20	40	60	80
200 people	40	80	120	160
500 people	100	200	300	400

Table B1.6: Storage capacity required for 7-day supply (kilolitres)

Population (max)	Consumption (litres per person per day)			
	100	200	300	400
10 people	7	14	21	28
20 people	14	28	42	56
50 people	35	70	105	140
100 people	70	140	210	280
200 people	140	280	420	560
500 people	350	700	1050	1400

Hazards that may damage tanks include animals, high winds, earth tremors and flooding. To reduce the effect of hazards:

- support tanks with earth rings, concrete plinths or stands
- secure tanks with wire ties or bolts
- site the tanks above predicted flood levels.

The tank design must be secure but it must also allow for safe and regular maintenance such as cleaning or disinfection.

Ensure that:

- overflow outlets direct water away from the tank so the base is not undermined
- isolation valves are installed so the water can be isolated when pipes are cleaned or fixed
- the tank area is fenced to protect the water system from damage by animals, cars or vandalism
- the lid is secure.

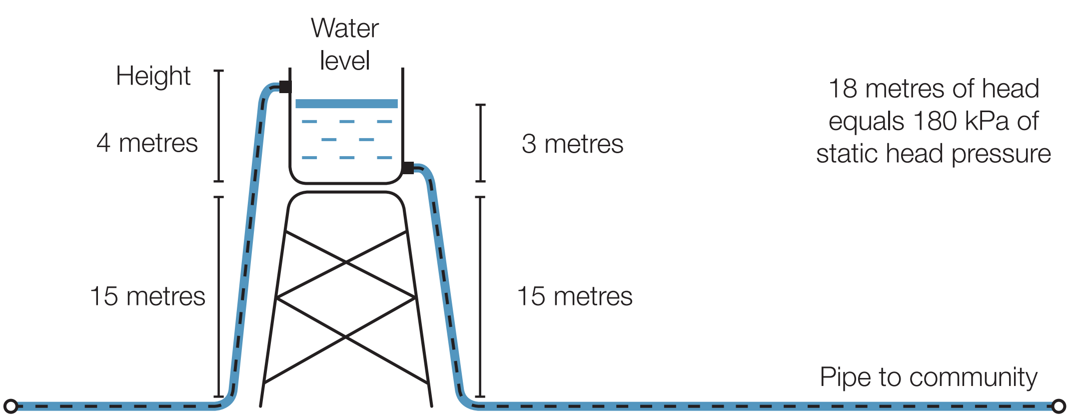
Consider:

- installing the following features
  - a water level reading device (such as a transparent pipe fitted externally) so that lids need to be removed less often
  - a float level indicator
  - a ladder and platform to enable safe access, and provide an area for maintenance
  - cages, landings and a fence with a gate that can be locked
  - dual tanks that can be isolated in case of failure or maintenance
  - a sampling tap
- following AS 1657:1992 — *Design, construction and installation of fixed platforms, walkways, stairways and ladders* when designing, constructing and installing fixed platforms, walkways, stairways and ladders (cost may be a limiting factor).

Installation

In gravity-fed systems, elevation determines the water pressure. One metre of height or head equals 10 kilopascals (kPa) of static head pressure (Figure B1.1).

Figure B1.1: Specifications for a gravity-fed watertank

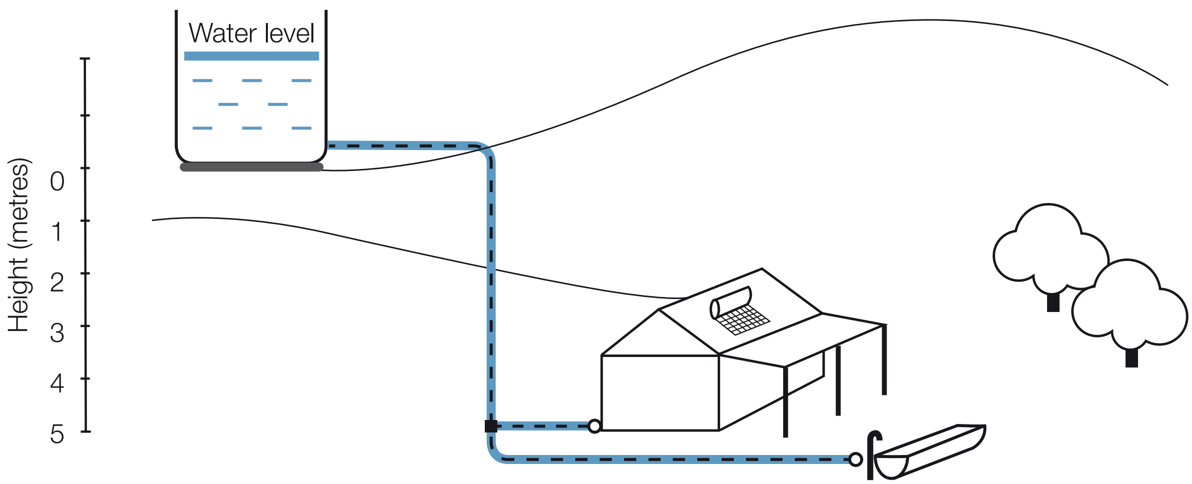


Source: Centre for Appropriate Technology, 2009

Site tanks a minimum of two metres above the highest outlet and five metres above what is known as the 'most hydraulically disadvantaged' outlet. Note that the most disadvantaged outlet may not always be the outlet furthest from the tank. For example, there may be a number of other outlets along a pipe or a washing machine at an intermediate outlet that can interrupt water flow; these can make an outlet more 'disadvantaged' than the one furthest from the tank.

Siting tanks on a hill or on high ground will eliminate the need for a large stand. For ease of maintenance and access, avoid siting tanks on the roofs of structures in the settlement (Figure B1.2).

Figure B1.2: Ideal siting of a watertank



Base of tank is situated a minimum of 2 metres above highest outlet (solar hot water system) and 5 metres above furthermost outlet (stock trough)

Source: Centre for Appropriate Technology, 2009

Maintenance

All tanks have a limited life span; however, some can last 25 years or more with correct maintenance.

Reticulation

Pipes

Groundwater is often acidic, and can leach metals from metallic pipes and taps. Plastic pipes are recommended for cold water reticulation and for corrosive water or hard water. The most commonly used plastics are unplasticised polyvinylchloride (uPVC), low-density polyethylene (alkathene), medium-density polyethylene (MDPE), high-density polyethylene (HDPE) (often called 'poly' or 'blue line') and polybutylene. Modified PVC pressure pipe is interchangeable with uPVC.

Consider:

- the following features when selecting pipes
  - application (pressure versus gravity)
  - affordability
  - availability in the size required
  - robustness for outdoor and high sun exposure applications
  - strength for trenching and loads
  - flexibility and ease of laying
  - ease of connection
- selecting oversized pipes initially so that pipes do not need to be replaced if the tank size is later increased.

Pipe diameters are usually up to 75 millimetres (DN75 or 'diameter nominal') for main reticulation in small communities and DN100 in larger communities, with DN25 pipes for the branch to a household and DN19 pipes for the branch to the hot water system (Table B1.7). In some hard-water areas, 'blue line' pipe is recommended from the water meter to the house. Reticulation to the community should use plastic pipes for cold water and copper or copper and polybutylene pipes for hot water. The pipes throughout the reticulation system should be the same. All pipework should be designed to at least standard class 12 PVC (pressure rated to 120 pounds per square inch).

Table B1.7: Typical pipe diameters for community water distribution

Community size	Main	Branch
1–2 houses	DN40	DN25
3–8 houses	DN50	DN25
8–20 houses	DN75	DN25
20+ houses	Minimum DN100	DN25

As communities and outstations grow, the demands on reticulation increase. Most communities and outstations have a low head pressure of between 45 and 90 kilopascals (equivalent to 4.5 metres and 9 metres of head). Larger pipes reduce the loss of head pressure between storage and outlet, and allow greater volume of flow for the available head. As communities grow, most will need to upgrade their reticulation. The material cost of increasing pipe size is usually small compared to the total cost of installation, so it is better to oversize water mains than to install the minimum size.

Water main identification markers (either bollards or concrete markers) should be installed every 200 metres and at change of direction. Bury pipes at least 450 millimetres from the source to the storage tank to reduce damage from fires, animals and cars. Pipes may also need to be buried to keep water cool. Other cover requirements are provided in Table B1.8.

When replacing reticulation systems, end-of-life PVC pipes are generally left in place (consider AS 2032:1977 — *Code of practice for installation of UPVC pipe systems* for cover to pipework).

Table B1.8: Cover required for buried pipes

Loading	Cover (mm) top of pipe to ground
No vehicular loading	300
Incidental vehicle traffic (ie not a roadway)	450
Sealed roadway	600
Unsealed roadway	750

Ensure that:

- pipe diameters are 40–50 millimetres for small communities and DN100 for larger communities
- detailed drawings of pipework are provided to residents and service providers
- pipes are covered to at least 300 millimetres
- pipes are suitable for the quality of the available water
- access points are available so the distribution can be cleaned regularly (for example, flushed and scoured).

Consider:

- burying identification tape that can be detected by metal detectors 150–200 millimetres above the pipework, so that the pipework can be easily located
- oversizing water mains to allow for population growth
- covering pipes from the source to the storage tank at 450 or 600 mm
- installing sampling taps at appropriate locations around the reticulation system
- using stainless steel for fittings and above-ground pipes for water systems in northern Australia, because the water is often acidic in these areas.

Fittings

Fit water meters at the source and end points in the pipe system (such as at houses). Reading the water meters regularly and recording the results will provide valuable information about the amount of water used in the community. This information can also help identify and locate water loss in the pipelines.

An isolation valve should be fitted at every house to allow the water to be cut off for maintenance or repair. Isolation valves can be fitted near the water meter (below ground with a concrete pad around the valve) or above ground (firmly saddled to the wall near the wet areas of the house). (For details on isolation valves, see the *National Indigenous Housing Guide* Part B1.)

Backflow prevention devices should be installed between the drinking water tap and any place where the water supply is connected to equipment containing chemicals (such as treatment systems) or other potential sources of contamination, including low water flow outlets (such as animal troughs).

Ensure that:

- a water meter is fitted at every house
- an isolation valve is fitted on each water meter
- overhead fill points and flushing points are provided to assist with firefighting
- only licensed companies install fire hose reels
- all plumbing materials used in the water supply are approved for use with drinking water and certified to the appropriate Australian standards
- backflow prevention devices comply with standards to manage backflow/cross-connections.

Consider:

- fitting isolation valves at each house and at the water meter
- installing a backflow prevention device with a meter and isolation valve at the house boundary, to prevent water returning to the main from the house.

Maintenance

Intake screens can become clogged with debris and require regular cleaning.

Pumps

Pumps lift and move water from the source to the storage tank.

Above-ground bore pumps come in a variety of forms and usually rely on creating a partial vacuum on their inlet side to ‘suck’ or draw the water up from the bore source, using atmospheric pressure on the groundwater body to displace water into the vacuum chamber.

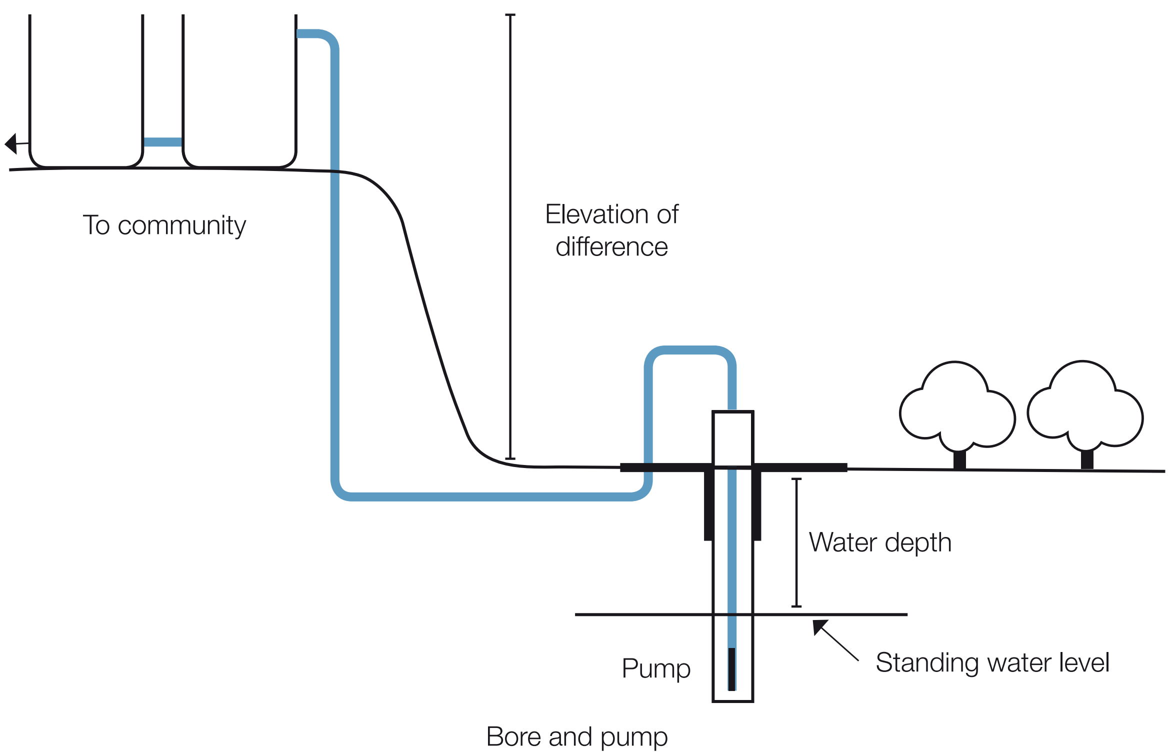
Below-ground submersible bore pumps sit in the groundwater body and ‘push’ the water up to ground level and through pipework to the destination. Pumps used for community applications are often selected to suit low flow rates and powering from renewable energy sources such as solar photovoltaic DC (direct current) systems.

Pumps can also be used to boost the pressure in the distribution system for water treatment or for household services (for example, solar hot water systems installed on the roof). For household services, a pressurised line with a pressure switch to control the pump is suitable.

Seek specialist advice when selecting a pump. The information required to select an appropriate pump is (see Figure B1.3):

- the height difference or water depth between the standing water level and ground level
- the height difference between the ground level at the pump site and the end point (such as the tank inlet for gravity systems) or the highest point (see 'elevation of difference' label in the diagram below)
- the maximum flow rate required through all possible outlets and the minimum pressure required at the outlets (for pressurised in-line systems); estimate the length and diameter of the pipeline on both the suction and delivery sides of the pump to find the friction head
- the number of pipe fittings along the pipeline
- whether control systems are installed.

Figure B1.3: Information required to select an appropriate pump



Source: Centre for Appropriate Technology, 2009

Tools to assist with pump sizing and selection are available free of charge on the internet.

The information required to select pumps for pumping water out from a storage tank is the:

- daily flow out of the tank
- internal diameters and types of pipe
- total length of pipes on both the suction and discharge sides of the pump.

In areas where the water temperature is high, pumps should be constructed from heat-resistant materials. If the water is corrosive, the pump should be made from resistant materials. Check the pH of the water and consider the information in Table B1.9 as a general rule, although other pump materials are available.

Table B1.9 Recommended pump materials for different water quality

Water quality	pH	Pump material
Acidic	5–6.5	Stainless steel with poly fittings
Neutral	6–8.5	Cast iron with bronze fittings
Alkaline or hard water	8.5 and above	Cast iron or stainless steel

Treatment

Water treatment and regular testing can form an important part of a water management plan. Water treatment can reduce hazards while water testing can verify that water systems and management plans are operating properly. However, regular treatment and testing may not be affordable in a small community, especially if there is a good-quality water source and an effective management system. In every situation, the first priority is to comply with the risk management principles of multiple barriers, regular surveillance and prompt action in response to any hazard or water contamination event.

The Community Housing and Infrastructure Needs Survey (ABS 2007) found that drinking water was treated in only 141 of 1079 individual Indigenous communities; 80% of these communities used chlorination to treat the water, while 164 of 1079 communities had water samples tested regularly.

Water treatment includes procedures (such as shock chlorination) and technological systems to make the water suitable for human consumption and use. The most suitable treatment process depends on the quality of the raw water.

In small communities, water treatment usually involves removing a specific type of contaminant rather than using a comprehensive treatment system. In remote areas, it is often more affordable to treat only a small amount of water to a high quality for drinking (for example, by using in-line filters at the house); lower quality water can be used for other purposes. For additional information on water quality and treatment, see the *National Indigenous Housing Guide* Part C1.

Treatment may be a short-term measure to deal with supply contamination or an ongoing requirement. Treatment must be part of a whole-of-system multiple barrier approach; treatment alone is insufficient to guarantee that a water supply will stay safe or will consistently deliver high-quality water.

Before installing water treatment technologies, consider other less expensive options such as diluting or ‘shandying’ the supply, or supplementing a water source with an additional supply (such as a rainwater tank).

Disinfection is the most important type of water treatment because microbiological contamination is the most acute risk to human health. The most common methods of disinfection in communities are ultraviolet radiation and chlorination (Table B1.10). Chlorination can be supplied in three forms: gas, sodium hypochlorite solution or calcium hypochlorite powder. Chlorination is considered the most cost-effective disinfectant and is highly successful at killing bacteria. Manual dosing of sodium hypochlorite is considered the cheapest and easiest form of disinfection.

Table B1.10: Disinfection systems

Disinfection system	Applications	Limitations	Benefits	Cost	Particular considerations
Calcium hypochlorite	■ kills bacteria and viruses	■ long shelf life ■ automatic dosing requires power supply	■ available in granular and tablet forms; can be automatically or manually dosed ■ manual dosing does not require a power supply	low	■ dry chemical requires some handling but operators need little training
Chlorination by gas	■ kills bacteria and viruses ■ can be used to remove bad odours, taste and colours	■ stored as liquefied gas which is hazardous ■ medical aid must be available ■ automatic dosing requires power supply	■ long shelf life ■ most efficient and can be automatically or manually dosed ■ manual dosing does not require a power supply	low	■ residual chlorine levels can provide disinfection protection throughout distribution system ■ chlorine affects the taste of water and generates disinfection byproducts ■ operator training is required
Chlorination by sodium hypochlorite	■ kills bacteria and viruses	■ limited shelf life ■ automatic dosing requires power supply	■ can be automatically or manually dosed ■ manual dosing does not require a power supply	medium	■ few training requirements ■ low hazard and easy to handle

(continued)

Disinfection system	Applications	Limitations	Benefits	Cost	Particular considerations
On-site hypochlorite generation	■ kills bacteria and viruses	■ generated on-site and required control of electrolytic cell and solution of salt water	■ minimal chemical storage and transport	medium	■ high level of maintenance and expertise ■ byproducts generated ■ high capital cost ■ requires power
Ultraviolet (UV)	■ kills bacteria and viruses	■ not suitable for water with high turbidity or low UV absorption or slow water flow ■ UV lamp requires cleaning and replacement ■ reliant on power supply	■ no effect on taste ■ low maintenance ■ no chemical handling ■ no known byproducts	medium	■ can deliver water that is not treated if UV source fails because there is no residual (chemical) protection

No single treatment system can remove all bacteria, chemicals and minerals from a water supply; water treatment technology can also introduce toxic micropollutants that may have other public health impacts. When considering water treatment, seek assistance from a specialist (preferably a scientist, not a salesperson). Test the water source before choosing a treatment to ensure that the treatment is correct for the water quality problems present. Water treatment systems are described in Table B1.11.

Ensure that:

- alternative methods to deal with water quality issues have been properly investigated before considering a water treatment technology
- water test results (from a laboratory) inform the decision to purchase a water treatment system
- all treatment systems are protected from the elements and from damage; a small shed for centralised systems or locked cupboards or cages for small systems are appropriate
- operational requirements are considered (such as power and access to replacement parts)
- water treatment systems are approved for use with drinking water and certified to the appropriate Australian standards.

Consider:

- the range of treatments possible (for example, is partial treatment possible?)
- pretreatment options
- product ratings
- the size of the required treatment system (such as whole supply, household or single tap)
- water system requirements (for example, water pressure and water quality)
- capacity of the technology to produce enough water to meet the community needs
- maintenance requirements
- the risk that the treatment system may fail (and appropriate safeguards)
- upfront and maintenance costs (such as filter or bulb replacement and servicing)
- power requirements
- expected life of the system and required operating conditions.

Table B1.11: Water treatment systems

Treatment system	Applications	Limitations	Cost	Considerations
Activated carbon	■ removes taste and odour-causing contaminants and reduces trace levels of organic chemicals like pesticides	■ the carbon can act as a medium for growth of microorganisms so the water must be pretreated	high	■ if not maintained, the filter can become a source of bacteria and create taste and odour problems
Aeration	■ removes iron		low	■ cheap and effective periodic cleaning of the storage tank to remove iron sludge; preferable to have two storage tanks so one can act as a sedimentation tank
Ceramic filters	■ removes bacteria and parasites, but not viruses	■ chlorination in addition to ceramic filters required to remove viruses ■ raw water must have low turbidity and salts	medium	■ regular replacement of filters required ■ needs adequate flow rate ■ cannot deliver untreated water
Sand filtration	■ removes silt, sediment, small organisms and organic matter ■ removes moderate amounts of iron and manganese	■ unsuitable for removing viruses	medium	■ needs regular backwash ■ some (small) systems are biological and need no power or chemicals to operate
Softeners (ion exchange)	■ treats hard water, removes dissolved iron, manganese, barium and radium ■ can remove some bad odours, colours and tastes	■ not suitable for removing microbes or most chemicals	medium	■ resins must be specific to the contaminant ■ treated water will have increased sodium levels ■ requires periodic replacement of softener salt and disposal of concentrated salty water
Reverse osmosis	■ removes dissolved solids and organic matter; also nitrates, radionuclides, most dissolved minerals and metals, most microbes, particles and some pesticides	■ prefiltration and softening may be required ■ silica in the raw water causes fouling of membranes ■ rate of removal efficiency decreases over time ■ needs good water pressure to operate	high	■ membranes need regular replacement and generally needs a contractor ■ high energy requirements ■ disposal of concentrated salty water

Managing and maintaining services

The following information can be combined with local knowledge of the water supply to create a water management plan, using the *Australian Drinking Water Guidelines: Community Water Planner — a tool for small communities to develop drinking water management plans* (NHMRC 2005).

Plans to maintain and repair water supply infrastructure should be included in a whole-of-system approach. A breakdown in any component can have effects further along the system and compromise the quality and quantity of water available.

The following points, previously discussed in this chapter, should be considered when managing a water system:

- Water use may vary with the season.
- Maintenance of infrastructure can increase water system reliability (or reduce water supply interruptions).
- Water treatment can be an effective way to remove contaminants if used as one of a series of barriers.
- Water testing is only valuable if the results verify that management operations are effective.

The quality and quantity of water available can change over time, and there are often warning signs that the supply is changing. If you have established a baseline, it will be easier for you to respond accurately. Deterioration of system function can be an early sign. Indicators include:

- change in pump flow rate
- loss of water pressure
- variation in water meter readings
- change in water level measurements.

Change in water quality such as pH, turbidity or total dissolved solids can indicate changes in the water source. For example, if the water tastes ‘flat’ or ‘bitter’ the pH may have changed or the amount of tannin from leaves in the water source may have increased (especially in northern Australia, after the wet season); an increase in the total dissolved solids in bore water may indicate that the water level is dropping.

Access to information about the water supply is critical.

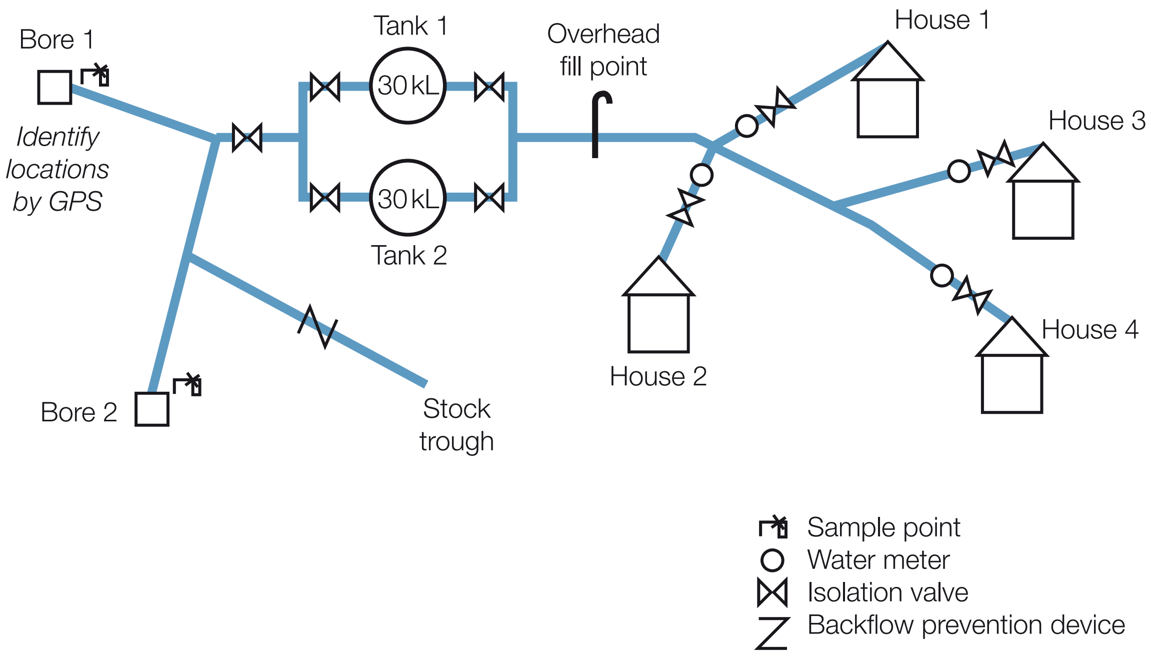
Ensure that:

- service manuals, plans and diagrams are accurately recorded and backed up with signs to mark the location of pipework and other infrastructure
- all relevant documents are handed over to the community and safely stored
- additional copies are provided to relevant agencies at the end of a project
- distribution systems are maintained and cleaned, and pipes and other equipment (such as water meters) are replaced towards the end of their useful lives.

Consider:

- creating a schematic or drawing of the supply that includes global positioning system (GPS) readings to locate all significant parts (Figure B1.4)
- recording operational requirements, such as how much fuel is required to operate the pump each day to deliver water.

Figure B1.4: Example water supply schematic for a small community



Source: Centre for Appropriate Technology, 2009

Table B1.12 lists the minimum management tasks required to maintain a water supply. Additional tasks should be added as required.

Table B1.12: Water supply management tasks

Regularity	Example of activity
Daily	■ check water levels in storage tanks ■ check and maintain chlorine residual levels ■ inspect river for algae ■ top up storage tanks to ensure adequate storage in case of emergency
Weekly	■ record data — hours pump is run, metering, etc
Monthly	■ microbiological water testing (depending on location, fortnightly or quarterly for some larger communities) ■ visual checks of pipeline ■ check storage tanks for holes and damage
Six monthly	■ clean intake screens or gutters ■ measure bore water level ■ prune trees near storage tank ■ grease and tune pump
Annually	■ flush distribution system and replace taps ■ audit and review practices ■ chemical water testing ■ review water meter information ■ clean out sediment at base of storage tank ■ service pump and treatment device (if applicable) as per manufacturer's specifications ■ check and flush hose reel

Useful terms

AAA	'Triple A'
Activated carbon	A form of charcoal that has been treated to make it porous and reactive.
AS	Australian Standards
Backflow prevention (device)	Stopping the reverse flow of water back into the mains. Backflow can be caused by back pressure or back siphonage.
Corrosive water	Corrosive water will slowly dissolve metal pipes and cylinders, and also cause taste and staining problems. Most natural waters, particularly bore and rain waters, are corrosive to some extent. Problems caused by corrosion include damage to plumbing, leaks, bitter taste and staining of fixtures and laundry.
Cross connection	A link or point in the water system where potable water is exposed to non-potable water. Cross connections are usually unintended and can be caused by plumbing errors such as connecting the kitchen sink outlet to the main.
Diameter nominal (DN)	A code for pipe size.
Hard water	Hard water is water that contains high concentrations of dissolved minerals, particularly of calcium and magnesium. It is not harmful to health. Soap will be hard to lather and the water will cause scaling of plumbing fixtures and hardware. Problems associated with hard water include reduced efficiency of hot water heaters, reduced water flow, blocked pipes and valves.
Hazard	A biological, chemical, physical or radiological agent that has the potential to cause harm.
kPa	kilopascals
L/p/d	litres per person per day

Multiple barriers	The use of more than one preventive measure (planned activity, action or process) as a barrier against hazards.
Potable water supply	Water intended primarily for human consumption.
Preventive measure	Any planned action, activity or process that is used to prevent hazards from occurring or reduce them to acceptable levels.
PVC	polyvinylchloride
Risk	The likelihood of a hazard causing harm in exposed populations, in a specific timeframe, including the magnitude of that harm.
Scale	A solid precipitate (usually a white crust), which forms on the elements of jugs and hot water cylinders and around the insides of hot water cylinders and pipes. It usually occurs when hard water is being used. Scale consists of calcium carbonate and magnesium oxide, which are harmless to health. Scale can cause electric heating elements to burn out, hot water cylinders to perform poorly and pipes to become blocked.
Spear	A sunken pipe to tap artesian water.
SWL	standing water level
Total dissolved solids (TDS)	Organic and inorganic compounds that are dissolved in water. The TDS value, measured in milligrams per litre (mg/L) or parts per million (ppm) refers to the saltiness of a water — less than 80 mg/L is excellent, 500–800 mg/L is fair and usually can be tasted, above 800 mg/L is usually considered poor quality. It is, however, often acceptable up to 1200 mg/L in remote areas if combined with good management to deal with potential scaling of hardware.
Turbidity	The cloudiness of water caused by the presence of fine suspended matter.
UV	ultraviolet
uPVC	unplasticised polyvinylchloride

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