Study Guide

Demonstrate knowledge of installing, securing, and maintaining water supply pipework in buildings

30605 | Version 1 | Level 4 | Credits 7v

Trainee Name

Grow by growing others

skills.

Unit Standards

Unit standard 30605

People credited with this unit standard are able to demonstrate knowledge of:

- determining water supply requirements in buildings
- the installation and securing of water supply pipework in buildings
- the maintenance and repair of water supply pipework in buildings
- regulatory requirements, selection of methods and materials, and underpinning concepts and principles, as applied to the installation, securing, and maintenance of water supply pipework in buildings

This study guide can also be used for unit standard 30606; Determine water supply requirements in buildings, and install, secure, and maintain pipework.

The best way to use this Study Guide is:

1. Read through the following information step by step.
2. Where other resources are mentioned (such as websites), find those and read them as well.
3. Complete the practice exercises, then check your answers.

Contents

Important words and terms used in this study guide

Word/term	Definition
Bonding strap	A metal strap used to bond or bridge the separate metal pipe sections so that any current flows safely through the strap to the earth.
Capillary attraction	The ability of liquids to adhere to solid surfaces.
Commissioning	Testing, flushing and checking the system has normal operation when first used.
Flow rates	A measure of how fast a quantity of water or gas moves in a measure of time.
Hard water	Contains higher concentration of minerals — calcium and magnesium.
High water pressure	For the purposes of this study guide, that means unable to contain water flow at a tap outlet by pushing a finger over the tap outlet.
Hydraulics	The science that deals with water in motion.
Hydrostatics	The science of fluids at rest.
Internal diameter	The measurement between the inside walls of a pipe.
Job specifications	Specify what methods and materials should be used in carrying out a job.
Legislation	Defines what work can be done legally.
Loading units	A factor that combines the flow rate, time and frequency that a fixture or appliance is used.
Metres head	The height, in metres, of water above a point of measurement.
PEX-AL-PEX	Cross-linked polyethylene with aluminium sandwiched between layers of PEX.
PEX pipe	Cross-linked polyethylene.
pH	A measure of the acidity of water, 7.0 being neutral.
Sanitary fixture	Any fixture permanently connected to the sanitary plumbing e.g. a hand basin.

Siphon	A continuous tube that allows liquid to drain from a reservoir through an intermediate point that is higher than the reservoir.
Sound	A leak free joint or pipe system.
Standards and Codes	Give specific detail of how things should be done.
Toby	A water shut off valve at the boundary (street toby) and sometimes beside the house (house toby).
Turbidity	Turbidity is a measure of cloudiness or haziness of a fluid. The more particles (suspended solids) in the water, the higher the turbidity.
Valve set	Hole through which water flows against a washer or other control.
WC	Abbreviation for water closet. Also called a pan, toilet or toilet pan.
Working pressure	The pressure a system is subject to in normal operation.

Readings

As well as this Guide you should be familiar with the following information sources:

- Building Act 2004
- Health Act 1956
- Health and Safety at Work Act 2015
- Plumbers, Gasfitters, and Drainlayers Act 2006
- Drinking Water Standards for New Zealand 2005 (revised 2008)
- AS/NZS 3500.1:2018 Plumbing and drainage – Part 1: Water services

The following clauses, and any related compliance documents, which are available at https://www.building.govt.nz/:

- New Zealand Building Code Clause G10 Piped Services
- New Zealand Building Code Clause G12 Water Supplies

and all subsequent amendments and replacements.

> ***Note**: All building code documents are free to download and print.*
>
> *Access to AS/NZ standards can be accessed for free through MySkills on our website: www.skills.org.nz. These are view only and cannot be printed or downloaded.*

The source of water

It is essential that a high-quality supply of water is readily available for all occupants within a building intended for human use. The majority of buildings will obtain this supply from the water mains system which is provided by the network utility operator. If a supply of water is unobtainable from the main, such as in rural areas, water may be sourced from natural sources, such as lakes, rivers, streams, wells, springs, and rainwater catchment areas (auxiliary water supplies).

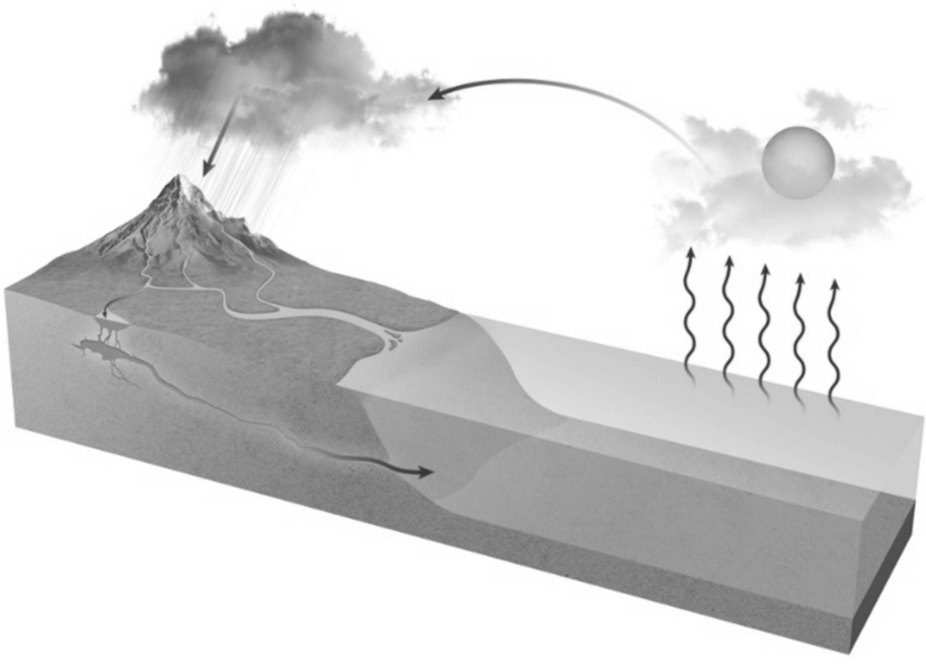
Auxiliary water supplies *are water supplies other than public supplies. The quality of the water will vary with the natural surrounds of the area and any domestic, industrial or agricultural influences within the catchment area.*

In the event of the water main supply being interrupted, stored water is required to supply buildings. The amount will depend on their classification. For example, hospitals require at least 50 litres per person.

The hydrological (water) cycle

Due to the sun's heat, water on earth is constantly evaporating and forming rain clouds. The water re-enters earth's atmosphere in the form of rain, hail or snow, and settles in the sea, lakes, rivers, streams or springs. Surface water soaks through the earth's crust and forms bodies of water up to 4.5 km below the surface. This source of fresh water is known as an 'aquifer' and contains more than 30 times the amount of water found in all rivers, lakes and streams located on earth.

Water is a good solvent and it has the ability to dissolve many substances in solid, liquid or gaseous form. By the time rainwater reaches earth it has absorbed gases such as oxygen, carbon dioxide or sulphur oxide, which prevents water ever being completely pure.



Shutterstock

Public water supply

The public water supply is provided by the network utility operator. In 2005 the Ministry of Health published the ‘Drinking Water Standards for New Zealand 2005’ (revised 2008) which ensures that all public water supplies are safe and palatable for the consumer.

The network utility operator will supply water as far as each property’s boundary isolation valve. At this point it is the responsibility of the plumber to provide water to every outlet within the property without reducing the quality of the water.

Quality of water

Potable water is a supply of water which meets the standards imposed by the Ministry of Health in the ‘Drinking Water Standards for New Zealand 2005 (revised 2008)’. Water for domestic use should fulfil the following conditions and be:

1. practically colourless, clear, sparkling and free from sediment
2. pleasant to taste and odourless
3. soft to touch, dissolve soap easily and contain small amounts of mineral matter if any
4. free of organic matter
5. free of organisms that may cause disease

Of these conditions, those involving organic matter and organisms require laboratory testing, while the remaining can be tested on-site immediately, and the results will determine whether further tests are justified. In some cases, it may be possible to treat and improve the quality of the water.

Contamination, pollution and infection of water supplies

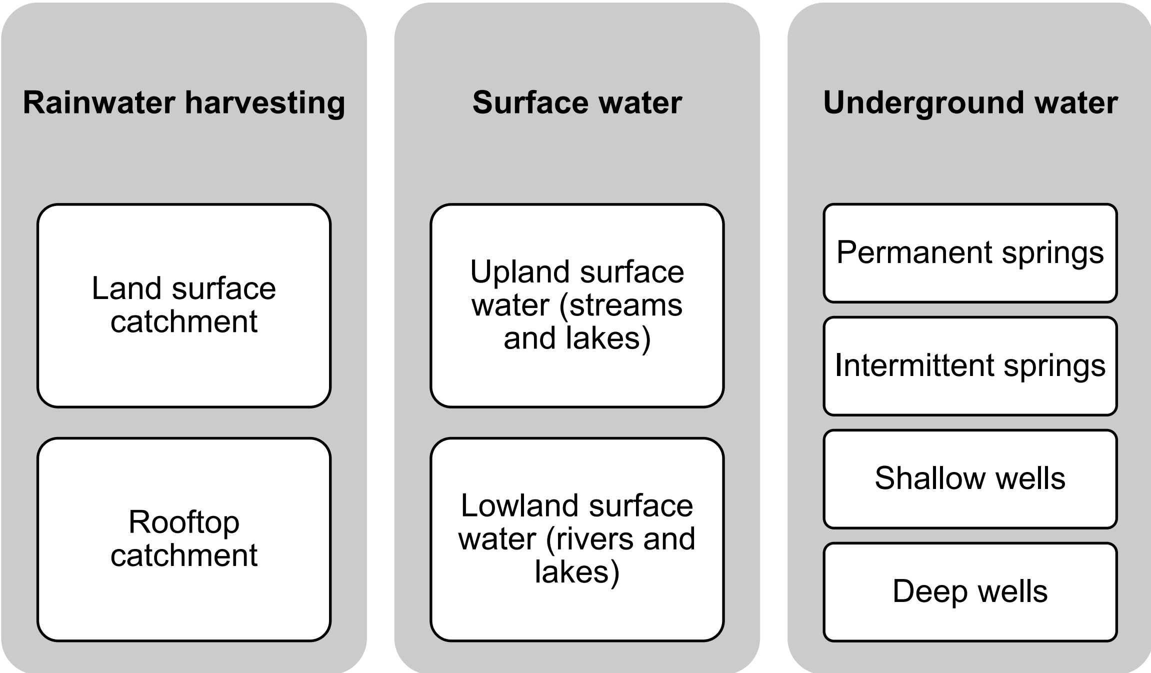
Water is **contaminated** when it contains more foreign substances than would normally be expected.

Water is **polluted** when it is so contaminated that the available oxygen is depleted and the natural process of purification cannot operate.

Water is **infected** when it contains specific organisms which cause disease.

Sources of water supply

Sources of water supply can be categorised under three main headings:



Rainwater harvesting

Rainwater harvesting is the gathering and storing of rainwater. Rainwater which is collected from a clean impervious surface in open country is one of the purest forms of natural water.

Rainwater harvesting systems provide a source of soft, high-quality water which would otherwise be wasted. The system reduces the usage of other sources and is cost effective, with water metering becoming common around New Zealand.

Land surface catchment

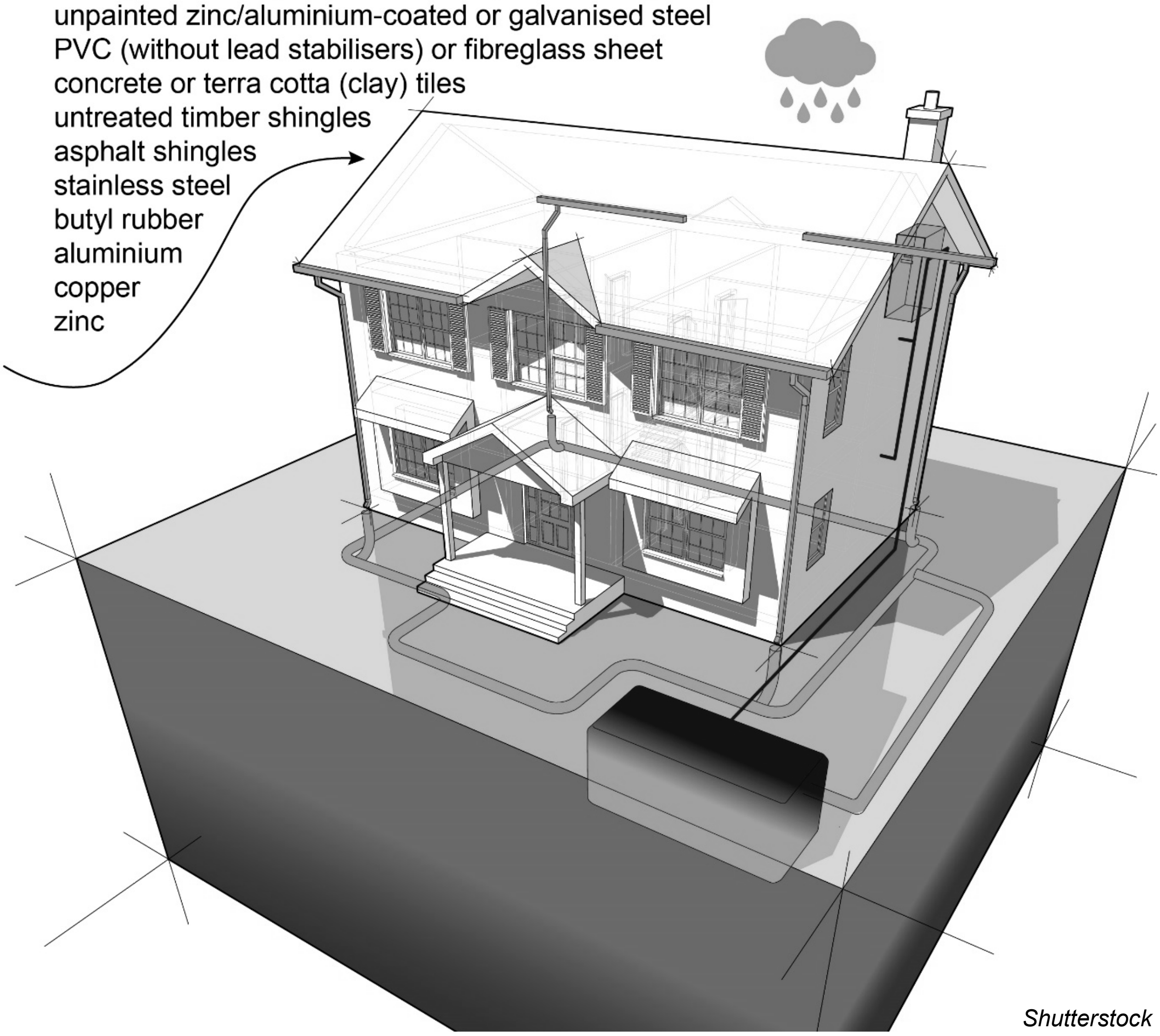
Land surface catchment areas are used for bulk storage in areas where rainfall is sparse. This method of harvesting water allows for the collection of water from a large surface area, so increasing the amount stored. This is common in the outback of Australia where droughts are a regular occurrence, but is not as common in New Zealand due to our climate. The system channels water from a prepared catchment area into storage. The catchment area can be paved or unpaved, or artificial materials including plastic sheets, asphalt or roofing iron can be laid.

Rooftop catchment

This form of harvesting rainwater is very common in rural New Zealand and is also becoming popular in built-up areas. It is a simple process where rainwater is collected in a storage tank at the edge of a roof. The amount and quality of water collected will depend on the size and type of roof.

Suitable roofing materials:

- factory-coated or painted Zn/Al alloy-coated or galv. steel
- unpainted zinc/aluminium-coated or galvanised steel
- PVC (without lead stabilisers) or fibreglass sheet
- concrete or terra cotta (clay) tiles
- untreated timber shingles
- asphalt shingles
- stainless steel
- butyl rubber
- aluminium
- copper
- zinc



Shutterstock

To ensure that the best quality water is maintained, roofs and guttering should be cleaned regularly to remove dust, leaves and bird droppings.

Consideration needs to be given to the quantity of water a household may require. This can be calculated on a yearly basis with allowance for seasonal variations.

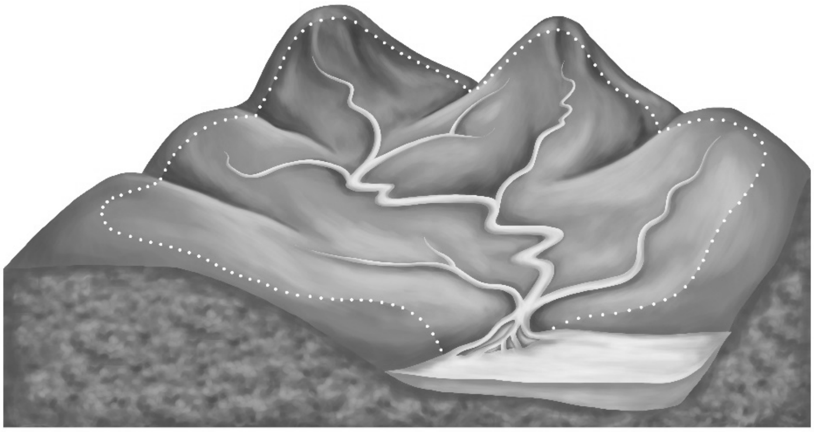
Yearly rainfall tables are available. These can be used in conjunction with the roof catchment area to determine the annual water harvest. Storage tanks need to be large enough to hold all the water collected during the heavy rain periods for use through any dry months.

The New Zealand Building Code E1 sets out rainfall intensity for different areas of New Zealand, as well as the sizes of the gutters and downpipes needed to convey this water to a tank. As the rainwater does not make contact with the earth’s surface, the water remains free of minerals. However older roofs coated with lead-based paint should not be used for rainwater harvesting. First flush devices should be fitted to take the initial rainfall and divert any contaminants to waste.

Surface water

Water that flows over the ground's surface before collection is referred to as 'surface water'. The catchment area for surface water is the point where water is drawn for processing.

The dividing line between two catchment areas is called the 'watershed'. For example, a range of mountains may form the watershed with a catchment area on either side.



Shutterstock

Upland surface water

Rivers, lakes and streams found at an altitude above human communities can be classified as upland surface water sources. This altitude helps to prevent the possibility of human contamination entering the water supply.

While accidental contamination will still occur due to animals and plant life living in and around the water source, this highly oxygenated water will continually purify, meaning any accidental contamination will be diluted and will not harm the source. However if foreign matter containing organisms enter the water source, then it may cause sickness or disease. Giardia has become a problem in upland water catchments used by tourists and trampers.

The size of the catchment area or watershed will determine the quantity of water available for processing. The size of the catchment area can be increased to suit the demand of the community utilising the water supply.

Upland surface water is less pure during wet weather as heavy rain will scour the land, causing silt and organic matter to flow into rivers, lakes and streams which supply the catchment areas. The land will not deteriorate as much if it has a covering of vegetation and therefore, it is an advantage for the catchment area surroundings to be vegetated.

When the water is collected it will pass through several screens to remove all foreign matter. The water will then be stored, and all remaining silt and organic matter will be allowed to settle and be removed from the supply. The water will go through several treatment processes before it is released to the community. As the upland surface water supply is above the community, it will be gravity fed to the consumer.

Lowland surface water

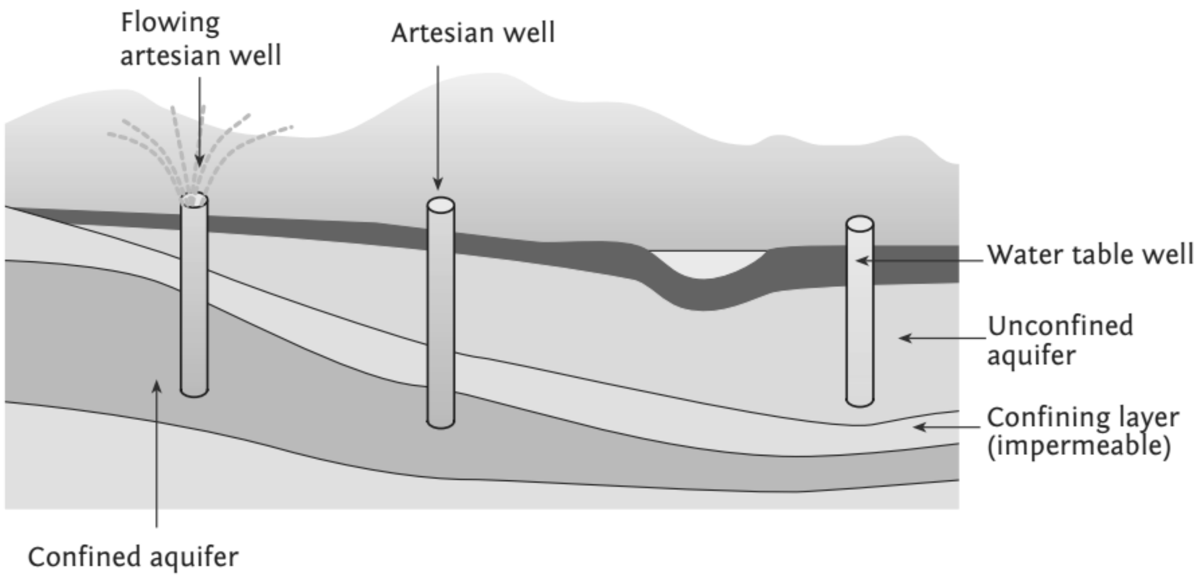
Rivers, lakes and streams running at low altitudes are referred to as lowland surface water sources. This supply of water is more likely to be exposed to harmful contamination from domestic, industrial and agricultural waste as the waterways can run through communities.

Bacteria within polluted water will absorb any oxygen present within the source, preventing any natural purification. Surface water from a lowland area is unsuitable for domestic use until sufficient treatment has destroyed all disease-producing organisms.

Underground water

By the time rainwater reaches the earth's surface it already contains dust particles and forms of organic matter. As it pools on the surface, it gathers more impurities prior to dispersing into the earth. While passing through the earth, organic matter including minerals, septic effluent and possible drainage leaks can also be collected. As the water continues its passage, the ground acts as a strainer and begins removing the impurities from the water.

The extent of purification will depend on a number of factors including the type of ground, the distance the water needs to travel and the amount of organic matter within the ground. Water passing through peaty ground will encounter a high content of organic matter so purification will be minimal. If the ground consists of shingle or fine sand the water will appear clear and sparkling.



Underground water

Ground which allows water to flow through it is known as permeable, whereas impermeable ground will not allow water to pass through it. Water will flow through the permeable layers of ground until it encounters an impermeable layer where it tends to accumulate. Water lying above the impermeable layer is called subsoil water, or ground water, and its surface is referred to as the water table. The water table rises and falls with variations in rainfall.

Springs

Due to ongoing pressure over time, the ground water works its way through the earth and creates an outlet called a spring. Springs can be either intermittent or permanent. An intermittent spring is situated at a higher level than the permanent spring and will release water only when the water table has risen sufficiently to allow water to flow through the opening to the surface. A permanent spring is situated below the lowest point of the water table so will constantly provide a supply of water. The low level of the permanent spring means the water produced has filtered a greater distance through the permeable layer, providing a better source of quality water than an intermittent spring.

Wells

The categories ‘shallow well’ and ‘deep well’ do not indicate the measured depth of the well, meaning it is possible for a shallow well to be deeper than a deep well.

A shallow well does not penetrate an impermeable layer so it draws its water from the same subsoil supply as a spring. This means a shallow well can run dry if the water table drops below the base of the well, and will need to be excavated further to maintain a supply of water.

A deep well penetrates at least one impermeable layer and draws water from an aquifer. Water within the aquifer has been extensively filtered due to the distance it has flowed, producing a clear supply of water. Although there may be traces of chemical impurities, biological organisms virtually do not exist in deep aquifers. Deep well water is not so dependent upon local rainfall to maintain its volume. This ensures that deep well water is a permanent and dependable water source.

The piezometric surface is a projected line which indicates the highest point of an underground water source. A well, positioned on land below the piezometric surface, will effectively produce a supply of water under pressure. This type of well is normally a metal pipe driven through the ground into a deep aquifer and is known as an artesian well. Artesian wells draw water from the same source as a deep well, so the water’s characteristics will be the same. Christchurch draws the entire city’s water from an artesian basin which underlies the city. The water quality is so good that treating the water is not necessary.

Purification of private water supplies

Purification of private water supplies begins at the catchment area. Installing a mesh screen in guttering will prevent large impurities entering the storage tank. The water at this stage may be potable but it is recommended that further purification takes place prior to consumption.

Filtration

In-line filters are granulated filters which are encased within a transparent casing so it is clear when a replacement is required. Water passes through the porous filter and all suspended matter greater than the filter’s pore size will be removed. This type of filter is for removing turbidity (cloudiness) but will not remove bacteria or dissolved minerals. The filters can be run in series with the largest pore size downstream, and smallest pore size upstream.

This method will extend the maintenance period as all three filters are operating in unison. In-line filters are easily maintained and relatively cost effective. The condition of the water source will determine the regularity of replacement. A wide range of filters is available, each with a specific purpose.

The pore size is expressed in microns. One micron is 1000th of a millimetre. Special filters are available to remove the chemicals in the water and activated carbon filters are used to improve the taste of the water.

Filters require maintenance at various times. Small domestic filters will be replaced when the flow rate drops to unacceptable levels or at specific intervals, such as annually or every three months, depending upon the type of filter and the filtration work it has done.

Distillation and boiling

Distillation is the boiling of water to filter out impurities through evaporation. Distillation effectively removes bacteria, organic chemicals, lead, nitrates and pesticides from water. It is a very reliable method of purification; however, it is both time and energy consuming.

Boiling has always been effective in purifying water, leaving a very low risk of infection. It is recommended that water is boiled for 10 minutes.

Ultraviolet radiation (UV)

Ultraviolet radiation lamps produce UV radiation with much more intensity than the sun. UV lights (enclosed in a transparent casing usually made from quartz) are designed to kill bacterial and viral pathogens. As water passes through the casing, harmful organisms are exposed to the UV rays. These rays kill any organisms by penetrating cells and destroying their ability to reproduce.

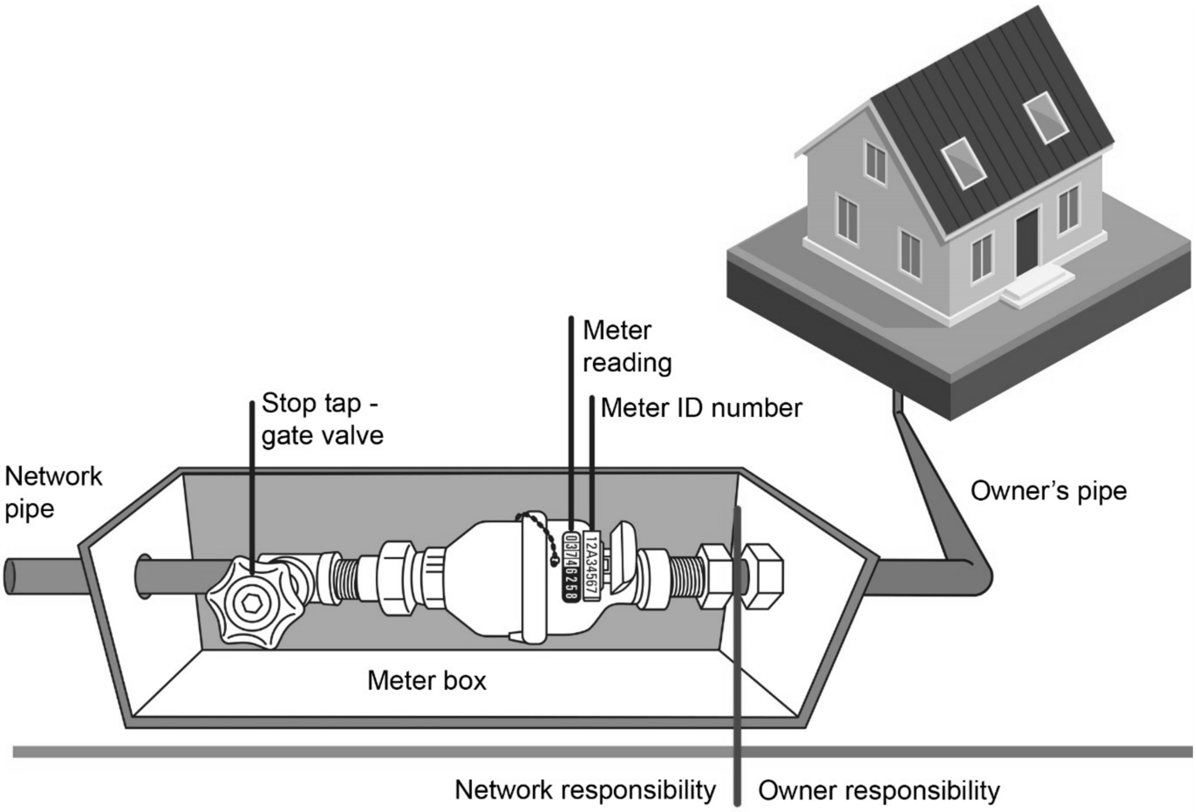
UV radiation lamps work in conjunction with in-line filters and are located downstream. If foreign matter passes through the UV casing, the particles could cause shadows creating a path for bacteria to pass through undetected.

UV radiation will not affect the taste or quality of the water. UV filters may be used in hot water flow and return systems to prevent *Legionallae* bacteria.

Water supply requirements in buildings

The correct pipe sizes must be selected to give sufficient water delivery to sanitary appliances and fixtures. If a pipe is too small it may restrict the incoming water supply and give an inadequate flow rate.

Usually the water supply pipework begins at the toby (shut off valve) located at the property boundary or where the water enters into the building.



At this point the water is available at a pressure determined by the head (height in metres) of the nearest reservoir, or the head delivered by pumping systems operated by the network utilities.

*The "**head**" means the height that the water would reach in a vertical open column.*

In normal conditions the network utility will supply water to a property at a pressure of no less than 250 kPa which equates to a head of around 25m. It should also have a flow rate of at least 25 litres per minute, based on a residential water meter being 15 mm.

Water supply and legislation

The most important piece of legislation for buildings in New Zealand is The Building Act 2004. For buildings to meet the requirements of the Act they must be built to The New Zealand Building Code. The code stipulates acceptable flow rates of water that sanitary fixtures and appliances must have in order to function properly in a building. Correctly sizing the water supply pipes is the key to achieving these required flow rates.

The minimum flow rate from showers and other sanitary fixtures is stated in the New Zealand Building Code (NZBC) G12 and AS/NZS 3500 part 1 Water Services.

Measuring flow rates

The flow rate is the amount of water flowing from a shower or tap.

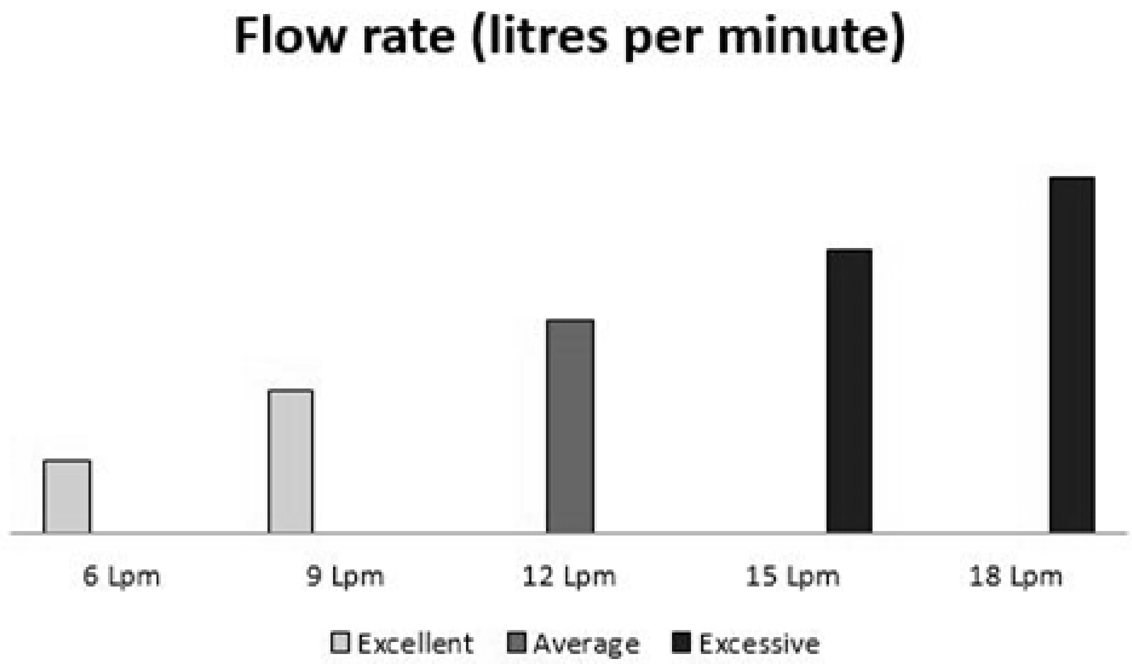
To measure flow rate you will need:

- A bucket or large jug with measurement
- A stopwatch (or count off 10 seconds).

Steps:

1. Turn the shower or tap on to its normal setting and let it flow into the bucket for 10 seconds
2. Measure the amount of water in the bucket and multiply it by six
3. Use the chart below to check whether your shower or tap flow rate is excellent, average or excessive.

Shutterstock



Different appliances or fixtures require different flow rates to work properly, check in NZBC G12 Water Supplies for Acceptable Flow Rates to Sanitary Fixtures.

The flow rate from an outlet not only depends on the pipe size, but also on the pressure. AS/NZS 3500, an alternative to the building code, gives minimum and maximum pressure requirements. The minimum (0.1 l/s) is to ensure that the fixtures operate as they should, and the maximum is to prevent damage from water hammer, reducing the life of the taps fittings or appliances or causing excessive noise in the system due to the velocity of the water.

*The **kitchen sink** must be included in the delivery rate requirements when measuring the minimum flow rates to be delivered **simultaneously** to sanitary fixtures.*

Flow rates can be measured using different units, such as litres per minute, cubic meters per hour or even imperial units such as gallons per minute (note that there is a difference between an imperial gallon and a US gallon).

1 L/min = 0.06 m^3/hr (1 m^3/hr = 16.67 L/min), 1 L/s = 60 L/min

Pipe sizes and flow rates need to be determined accurately, otherwise the outlets may have insufficient flow or pressure to operate as required.

When checking the flow and pressure from the incoming water supply from the network utility operator (NUO), use the exterior hose tap that is close to the incoming water supply.

Calculating pipe sizes

There are various methods used to calculate pipe sizes within a building.

Tables 3 and 4 of G12/ AS1 give the guidelines on flow rates required and the sizes of pipes to fixtures coming from the tempering valve.

Table 3: Acceptable Flow Rates to Sanitary Fixtures
Paragraph 5.3.1

Sanitary fixture	Flow rate and temperature l/s and °C	How measured
Bath	0.3 at 45°C	Mix hot and cold water to achieve 45°C
Sink	0.2 at 60°C* (hot) and 0.2 (cold)	Flow rates required at both hot and cold taps but not simultaneously
Laundry tub	0.2 at 60°C* (hot) and 0.2 (cold)	Flow rates required at both hot and cold taps but not simultaneously
Basin	0.1 at 45°C	Mix hot and cold water to achieve 45°C
Shower	0.1 at 42°C	Mix hot and cold water to achieve 42°C

* The temperatures in this table relate to the temperature of the water used by people in the daily use of the *fixture*.

Note:

The flow rates required by Table 3 shall be capable of being delivered simultaneously to the kitchen sink and one other *fixture*.

Table 4: Tempering Valve and Nominal Pipe Diameters Paragraphs 5.3.1 and 6.12.1	Low pressure (i.e. header tank supply or low pressure)	Low and medium pressure unvented (valve vented) and open vented	Mains pressure
Pressure of water at tempering valve (kPa)	20 – 30	30 – 120	over 300
Metres head (m)	2 – 3	>3 – 12	over 30
Minimum tempering valve size	25 mm	20 mm	15 mm
Pipes to tempering valve	25 mm (see **Note 3**)	20 mm	20 mm (15 mm optional) (see **Note 1**)
Pipes to shower	20 mm	20 mm (see **Note 4**)	20 mm (see **Note 5**) (15 mm optional) (see **Note 1**)
Pipes to sink/laundry (see **Note 2**)	20 mm	20 mm	15 mm
Pipes to bath (see **Note 2**)	20 mm	20 mm	15 mm
Pipes to basins (see **Note 2**)	15 mm	15 mm	10 mm

Notes:

1. If supplied by separate pipe from *storage water heater* to a single outlet.
2. This table is based on maximum pipe lengths of 20 metres.
3. 2 m maximum length from *water heater* outlet to tempering valve.
4. 15 mm if dedicated line to shower.
5. 10 mm if dedicated line to shower.
6. Table 3 pipe sizes have been calculated to deliver water simultaneously to the kitchen sink and one other *fixture*.

Because storage hot water systems need to have controlled inlet pressures, the sizes given in Table 4 relate specifically to the hot water systems. Controlled inlet pressures are usually lower than the incoming supply. Although by measuring the supply pressures at the inlet to the building, cold water can also be sized using “the rule of thumb” for the same values.

AS/NZS 3500 Part 1 provides a more accurate yet complex method of sizing which uses tables to select the correct pipe sizes.

To use the method described in AS/NZS 3500, several factors must be considered:

- the length of each section of pipe, for example from a boundary isolation valve to a garden tap
- static water pressure available at the boundary isolation valve
- the height of the highest outlet within the dwelling above toby height
- the type of pipe material selected e.g. polybutylene
- the allowable maximum velocity
- the probable simultaneous flow rates (PSFR)
- the fixture unit loading

The length of pipe must be considered when pipe sizing as there is restriction to water flow as it passes through the pipe. The sides of the pipe walls will cause the flow of water to slow as water is affected by the friction against the pipe walls.

If a water supply pipe is an incorrect length, then there could be insufficient flow and pressure.

Reading

Read the section sizing of piping for dwellings in Section 3 of AS/NZS 3500.1 and look for another worked example of how to pipe size.

Other important sections include loading units & PSFRs (Table 3.2.4), equivalent pipe sizes (appendix A), and pressure drop tables (appendix C1).

Pipe size example

Sizing of pipework for water supply is covered in more detail in your certifying level training. If you are interested in how they would calculate pipe sizing, refer to AS/NZS3500.1:2018 Appendix C.

Notes on pipe sizing and flow

The flow of water slows as it passes through pipe fittings. Pipe sizing charts and tables can take the number of pipe fittings into account.

It is unlikely that all sanitary fixtures will operate at the same time so the sizing of pipes can allow for a *probable simultaneous flow rate* (how likely it is that multiple flow rates will occur at the same time). In domestic situations it is unlikely all sanitary fixtures and appliances will operate at the same time.

The static water pressure available is the amount of water force the system has. Static pressure is measured when the water is not flowing, that is, with no taps open. It is often measured in metres head. It can have different units of measure.

The height of the highest outlet within the dwelling above toby height will determine how much pressure is available at that point.

The type of pipe material will affect the flow of water as some pipe materials have a smoother bore (hollow of the pipe). Different pipe materials will also have slightly different internal diameters (see glossary). A smaller internal diameter will restrict the flow of water more than a larger internal diameter.

Activity 1

1. From the information given above, calculate the approximate conversion factor between measuring in kPa to measuring in meters head.

2. List the **three** main categories of water supply systems.

3. What Standard ensures that all public water supplies are safe and palatable for the consumer?

For the following questions you will need to have access to G12 and AS/NZS3500.1.2018.

4. What is the minimum flow rate from a shower according to the New Zealand Building Code Clause G12?

5. According to G12 how is the flow rate measured from the following:

Shower	
Bath	
Laundry tub	

6. What is the required **minimum** and **maximum** pressure at the outlets according to AS/NZS3500.1:2018?

Check your answers at the back of the study guide.

Activity 2

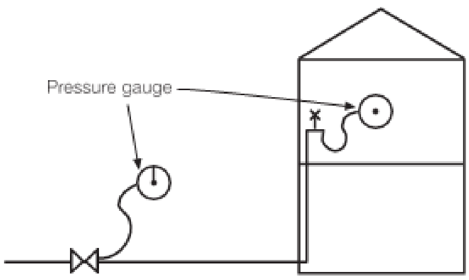
1. Complete the following conversion factors.

Capacity	1 m^3 = ______ ltr
Weight / Mass	1 ltr = __ kg
Pressure	1 mtr head = _____ kPa
	1 PSI = _____ kPa
	1 Bar = _____ kPa
Volumetric flow	1 ltr/ sec = ___ ltr/min which equates to 3.6m^3 / hour

2. You have been asked to install a 360 litre hot water cylinder in a roof. The cylinder shell weighs 76 kg. How much combined weight (cylinder and water) will the roof need to support?

3. You have just installed a basin and now need to check the flow rate. When turned on full bore you have timed the flow at 3 litres in 10 secs. What would the actual flow rate be in 1 minute?

4. Complete the sketch below. Indicate on the pressure gauge where the needle would be for the static pressure being measured at the outlet tap above the toby. (**Hint**: Should your sketch show the pressure at the outlet tap to be higher or lower than the pressure at the toby?)



Static pressure at toby and outlet at height above toby

Check your answers at the back of the study guide.

Install and secure pipework

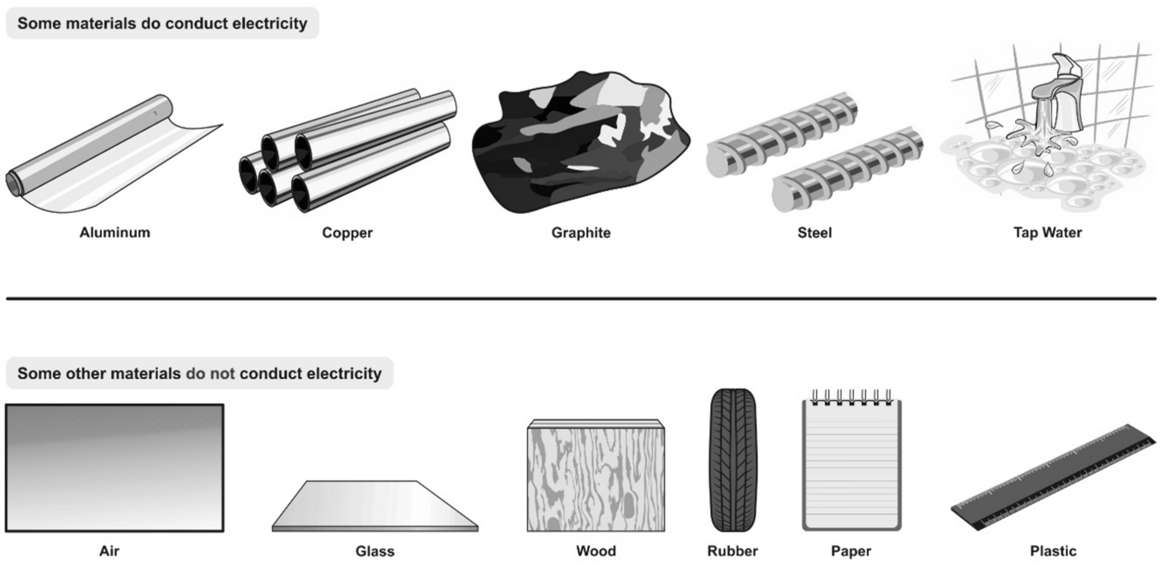
This section will discuss the various types of pipes and joints used by plumbers, gasfitters and drainlayers including support, allowance for expansion and contraction, and how to test the installed system.

Mechanical properties of materials

The choice of a material for use in water pipework must take into account its properties. Here is a summary of some of the mechanical properties of materials.

Conductivity

Conductivity is the ability of a material to transfer heat or electrical energy.



Conductivity is one of the causes of heat loss from pipes and cylinders that hold heated water. Metals are good conductors of heat and non-metals are poor conductors. This needs to be considered as it impacts insulation decisions.

Copper is widely used in the manufacture of solar collectors as it is such a good conductor of heat.

Metal	Conductivity
Copper	100
Aluminium	51
Brass	36
Zinc	28
Iron, wrought	16
Iron, cast	12
Tin	16
Lead	9

Metal pipes have been widely used as a conductor/ earth connection, and this is why a bridging strap should be used when cutting them.

Ductility

Ductility the property which allows a material to be drawn out to a smaller section without breaking. This is why some metals, e.g. copper, can be bent relatively easily.

Elasticity

Elasticity is the ability of a material to return to its original form after it has been stretched or compressed.

Fatigue

Fatigue is the tendency of a material to fail, generally by cracking, when subjected to repeated variations of stress.

Hardness

Hardness is the property of a metal which gives it the ability to resist being permanently deformed when a load is applied.

Malleability

Malleability is the ability of a metal to deform permanently under compression, without rupture.

A malleable metal such as lead may be “bossed” (manipulated with special tools) to allow it to be dressed (covering other materials like roofing). It could also be extruded (moulded through a shape) to allow it to fit properly over the roofing iron to form a weatherproof covering for example.

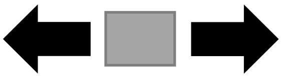
Copper is malleable but becomes hard when it is ‘worked’. It then requires softening by annealing (heating the copper till cherry red and allowing it to cool) before further work can be done on it.

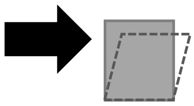
Depending on the application the copper is being used for it may need annealing several times. Half hard copper tube must be annealed before using a tube expander on it.

Strength

The strength of a material is how well it will withstand stresses or loads. The following types of strengths relate to the different types of force applied to the material.

Tensile strength	**Compressive strength**	**Shear strength**
• Tensile strength refers to the ability to resist stretching or pulling apart.	• Compressive strength is the ability to resist crushing or squashing.	• Shear strength is the ability to resist tearing.





Brittleness and plastic deformation

Brittle materials tend to ‘shatter’ when they fail, e.g. uPVC pipe is very brittle, especially if exposed to UV. Other materials which should not be used when subject to direct sunlight include ABS, macro-composite (PE-A1-PE), polybutylene, polyethylene, PE-X, polypropylene (fusiotherm), and chlorinated PVC.

Each material has an elastic range and, if overloaded, plastic deformation takes place.

Plastic pipe, e.g. polybutylene, is easily bent, but it has limitations on how much it can be bent before it deforms. A typical example of a deformed plastic pipe is when it folds over after being subject to too much force. Manufacturer’s instructions should be followed regarding minimum radius of curved pipework to prevent deformation occurring

ABS is a thermoplastic which has high impact strength and has been used for potable water. It is generally a dark brown or gray and was used for larger water pipes.

Shutterstock

Types of pipe

There are many different types of piping systems available for plumbers to use. Sometimes the specific materials may be specified in the plans or consent documents, other times it may be up to the plumber to consider.

The selection may be made by price and availability, the type of tools and equipment needed to install the pipe and join the fittings, or it may be personal preference. Whatever decision is made, the system needs to comply with the relevant legislation and be fit for purpose.

Some of the more common options used include:

- copper
- polybutylene (PB)
- polyethylene (PE or HDPE)
- polypropylene (PP)
- cross-linked polyethylene (PEX) or PEX/AL
- unplasticised polyvinylchloride (uPVC or PVC-U)

All of these are acceptable materials for water supply pipes.

What to consider

Pipe materials and components must not contaminate potable water. They must also be:

- suitable for the expected temperatures and pressures
- compatible with the water supply, to minimise the potential for electrolytic corrosion
- suitable for the ground conditions (if used underground) to minimise the potential for corrosion of the exterior of the pipe
- suitable for the local climate (if used outdoors) such as freezing conditions or atmospheric salt or sulphur
- able to withstand UV effects (if used outdoors)

When selecting materials for water supply pipes, consider water pressure, compatibility with water supply, water temperature, durability, support, ease of installation, and cost.

Copper

Copper has long been used for all types of domestic water services and distribution because it:

- is durable
- is corrosion resistant
- is malleable and easy to bend
- is self-supporting
- has good flow characteristics
- requires few fittings
- can be recycled.

Shutterstock

Copper may be annealed (i.e. heated, then cooled slowly) which improves its properties, for example making it less brittle and stronger.

Copper is corrosion resistant in most environments however, acidic conditions, either from the soil (if buried) or from the water can cause corrosion, so local pH levels should be checked before using copper pipes.

Polybutylene (PB)

Polybutylene is a plastic material that was introduced in the late 1970s and used extensively for water supply pipes until the mid 1990s. Unfortunately, one brand of polybutylene gained a reputation for failure, resulting in a significant drop in use.

Polybutylene has excellent properties for use as water supply pipework, including:

- low cost
- flexibility
- ease of installation
- ability to be used for both hot and cold water services
- frost resistance

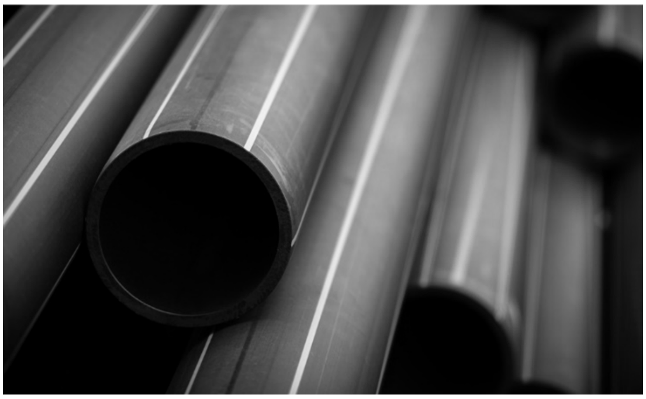
In outdoor situations, it must be protected from UV exposure.

Polyethylene (PE or HDPE)

High density polyethylene (often called alkathene or polythene) has been used since the early 1960s. It is suitable for both potable water and wastewater services, but it can only be used for cold water supply.

It is the most commonly used plastic pipe for supplying the mains water to a dwelling. It is:

- durable
- corrosion resistant
- has good flow characteristics
- lightweight and flexible
- easy to install
- good bending radius
- inexpensive
- requires few fittings.



Shutterstock

Polypropylene (PP)

There are three types of polypropylene:

- P-H – has good mechanical properties and excellent chemical resistance for use in industrial and sewerage waste pipes systems
- PP-R – has good resistance to high internal pressure so it is suitable for domestic pressure water supply systems and both hot and cold water services
- PP-B – is suitable for buried sewerage and wastewater drainage as it has good impact strength, particularly at low temperatures, and excellent chemical resistance

The use of polypropylene has been increasing since the late 90s as it is:

- chemical and corrosion resistant
- heat resistant
- lightweight
- easy to install
- frost resistant

In outdoor situations, it must be protected from UV exposure.

Cross-linked polyethylene (PEX)

PEX tubing is made from a cross-linked, high density polyethylene polymer, which results in a stronger material than polyethylene alone. Properties include:

- more durability under extremes of temperature and chemical attack
- greater resistance to cold temperatures, cracking and brittleness on impact
- suitable for hot water supply, hydronic heating systems, and potable water supplies
- flexibility
- ease of installation
- it can be used for indoor and buried outdoor situations

PEX is not recommended for outdoor above ground use – although it can withstand some UV exposure, this should not exceed the manufacturer's instructions.

Unplasticised polyvinylchloride (uPVC or PVC-U)

The plastic uPVC has been used extensively in New Zealand since the 1960s. Today in domestic construction it is used chiefly for drains, wastes and vents, and is rare for water supply in new individual houses. The primary jointing method for uPVC is solvent welding, where solvents soften the surfaces of the material, which then chemically fuse together. A rubber ring (elastomeric seal) joint system is also available. This piping:

- is inexpensive
- is easy to handle
- has low resistance to flow

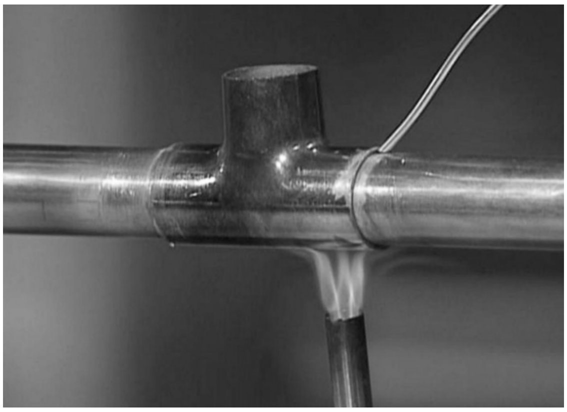
Jointing methods

Jointing methods vary for different types of pipe materials. The table below shows suitable methods for jointing different pipes for water supply.

Jointing system	Copper	PB	PP	uPVC	PE	PEX	Composite
Brazing	✓						
Manipulative mechanical jointing (e.g. Crox, sliding sleeve. flare)	✓ Cu to brass					✓	
Non-manipulative jointing (e.g. compression) the use of an olive ring or gland	✓ Cu to brass					✓	
Crimp Press fit fitting	✓	✓				✓	✓
Heat fusion welding			✓		✓		
Solvent cement welding				✓			

Brazing is the most common method for joining copper pipe in New Zealand.

Straight joins, tees and elbows are made watertight by using a silver solder (trade named as “Silphos or Silbralloy”) that comprises copper, phosphorus and 15% silver, to create a lapped capillary joint that is permanent and durable.



Manipulative mechanical jointing uses brass fittings to make copper pipe connections.

A nut is placed over the end of the pipe and a swaging (crox) tool is inserted to expand the pipe, creating a rolled groove to secure the nut in position. The joined ends are made watertight using plumbers' hemp or thread tape. This joint is most commonly used for connecting pipes to valves and fixtures. It is prone to loosening over time and should therefore not be used in concealed or inaccessible locations.

Another form is the sliding sleeve joint as used on some PEX products, the pipe is expanded out with a special tool and the fitting is pushed into the pipe. A sleeve is then mechanically slid over the fitting and pipe forming a watertight joint.

Non-manipulative jointing also uses brass fittings, but instead of expanding the pipe with a swaging tool, a brass 'olive' is placed over the pipe and compressed between the nut and fitting to create a secure joint that can easily be separated later.

Crimp ring jointing uses an external stainless steel or copper ring that is part of the fitting or placed over the pipe, then compressed with a hand tool.

As long as the ring is correctly placed and aligned, the resulting joint is very robust.

Electro/ Heat fusion welding is where the surface of the pipe and connection are melted together using a heating iron. As the two ends are overlapped and fused without the application of welding fillers, the result is effectively a continuous pipe.

Welding is used to join black mild steel pipes together. Note that flanges and screw threads are also used to join galvanised mild steel pipes together.

Solvent cement welding also overlaps and fuses the pipes but uses a solvent to 'glue' the pipes together.

Threaded joints include female threads (which have an internal thread) and male threads (which have an external thread).

Male threads can be cut on metal pipes with either:

- a hand operated die or
- a power-driven pipe threading machine.

PTFE tape should be applied to a pipe thread in the same direction as the thread. A similar method is used when applying plumber's hemp.

There are many examples of jointing compounds and sealants. Manufacturers' instructions should be followed carefully to ensure a watertight seal.

Cutting pipes

Pipework can be cut using a variety of tools and usually the cutting tool is specially designed for a particular pipe material. Always check that the cutting tool you plan to use is suitable for the material as this is not always the case.

For example, a hack saw should not be used to cut polybutylene as it leaves burrs on the cut pipe which could prevent a sound joint when connecting to a fitting. A ***burr*** *is a rough raised edge or surface left by a blade as it cuts.*

Measuring and marking

Measuring and marking the pipe with a pencil or chalk must be completed before cutting pipework. A hacksaw or other sharp instrument should not be used to mark pipes as they can weaken pipes at the point they are marked. Plastic pipes are notch sensitive — that means they are weakened when damaged by a shallow cut.

Hacksaws

Skill and care are required when cutting pipe using a hacksaw to ensure the cut is straight. The narrow blade can easily twist and make an angled cut.

Shutterstock

It is important that pipes are cut square for sufficient pipe to enter a joint. This is more difficult to achieve with a hacksaw than with a wide-bladed handsaw. Failure to cut square will allow a potentially weak or leaking joint. A pipe can be marked square by wrapping a piece of paper around the pipe so that its edges align, and clearly marking around the paper to show where the straight cut will be made.

Hacksaws and hand saws leave a rough cut and create debris (small loose sharp pieces of material) known as swarf.

Swarf created when cutting must be removed with a file or deburrer.

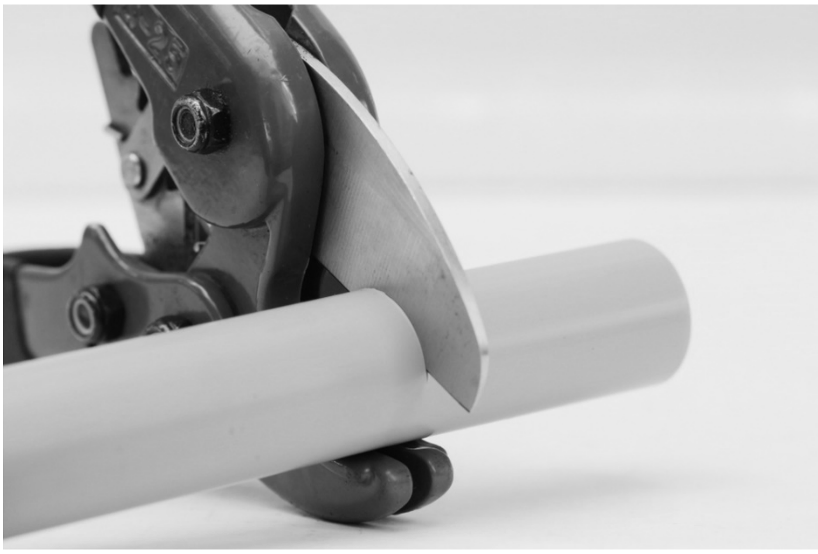
If swarf is not removed it can be responsible for a leaking joint or move in the water pipe to cause valve malfunction.

Special cutting tools

Special tools are designed to cut copper tube and polybutylene pipe.

The cutting tool below is used to cut a number of polybutylene pipe materials, as it leaves no burrs or swarf.

Some pipe systems have cutting tools which are specially designed for the product. The tool on the right is suitable for cutting PEXal tubing.



Shutterstock

Pipe and tube bending

When bending pipe to whatever angle or offset is desired, it is important to appreciate what changes occur to the pipe itself during bending. The major change is distortion of the pipe.

One essential bending requirement is that the material must have sufficient ductility for it to deform into the shape of the bend without seriously weakening the wall of the pipe. Each material will have manufacturer's instructions about the bending limits.

Support of pipework

Piping systems need to be supported adequately. They need to be allowed to expand and contract as necessary but should be secure enough not to jump around when internal forces on the pipes change, for example when a valve is suddenly shut off. This causes what is known as water hammer and can seriously damage pipes, fittings and building components, leading to possible failure.

Standards and Codes specify how water supply pipework should be secured.

For example, G12 AS1 table 7: Water Supply Pipework Support Spacing states the distance between supports. Graded pipes are pipes which have slope.

Look at the distance between horizontal and vertical supports.

Table 7: Water Supply Pipework Support Spacing
Paragraph 7.1.3

Pipe material	Pipe diameter (mm)	Maximum distance between supports (m) Vertical pipe	Graded and horizontal pipe
Copper	10 – 15 20 – 25	1.5 2.0	1.2 1.5
Galvanised steel	15 – 20 25	2.0 3.0	1.5 2.5
uPVC	15 – 20 25	2.0 2.4	1.0 1.2
Polyethylene and polybutylene (cold water supply)	15 – 20 25	1.5 1.8	0.75 0.9
Polybutylene (hot water supply)	15 – 18 20 – 22	1.0 1.4	0.6 0.7

Note:
The spacing for these pipe materials is based on the pipes being located within the *building* structure.

The installation of water supply pipework must meet the requirements of the Building Act 2004. If it complies with the Building Code, then the installation will also meet the requirements of the Building Act 2004.

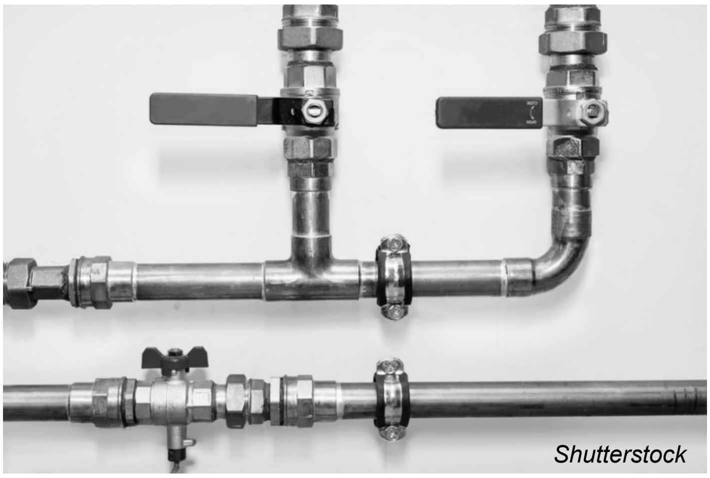
Supports and expansion

If a pipeline is operated at an elevated temperature it must be allowed to expand and contract. Where there is slight expansion or contraction, supports are required only to hold the pipe in place.

The supports will also have to serve as guides; as well as taking a share in the weight of the piping, they will have to permit endwise movement of the pipe with only a bit of sideways movement.

Heated pipe services move. They expand when heated and contract when cooling. This movement is mostly longitudinal (lengthways) and means the pipework must be free to slide in its supports.

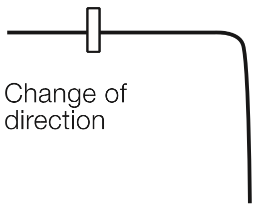
If such pipes are tightly secured, they will create noise from friction with the support and can wear to the point where they leak.


Shutterstock

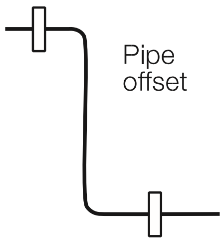
Typical allowance is made for where hot pipework penetrates timber framing. Allowance for both movement and adequate support is achieved by support with silicone. Where hot pipework penetrates steel framing, allowance is made by the use of rubber grommets.

The effects of expansion/contraction are usually absorbed by the system by leaving the pipe runs free to move at their ends or at changes of direction in the piping. However, pipe materials which have a high expansion rate sometimes require expansion loops or offsets in the pipework.

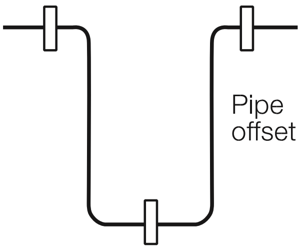
The three sketches below have small rectangles which represent sliding hangers or clips which allow movement.



On bigger installations which have long straight pipe runs, a pipe offset is used.



Or an expansion loop in the pipework is used.



For large diameter piping systems special expansion joints are available to allow for the expansion, such as the examples that are shown below.

Shutterstock

Protection of pipework

Installed pipework needs protection against physical damage. Protection is required from:

- expansion
- contraction
- traffic
- seismic activity
- freezing
- heating
- UV Light
- atmospheric corrosion

Traffic

Pipes need protection from traffic, that is, loads which can squash the pipework.

A simple means of protection is to ensure a fine bedding material, for example sand, surrounds the pipe.

Water supply pipes need to be buried with a minimum cover. For example, pipework must be buried deeper under driveways than gardens and lawns (600mm). G12 AS1 gives dimensions for the minimum cover of pipework.

Penetrations

G12 AS1 also describes suitable means of avoiding damage to pipelines which penetrate a concrete floor, wall etc. (penetrate means ‘installed by passing through’). Such penetrations require the use of a flexible collar, sleeve or duct. Pipework in or under a concrete slab must be installed to last 50 years.

Trenches

Another protection to consider is protecting pipework from damage while accessing other services in a trench. Water pipes can share a trench with other services but should not be laid directly above or below such services. This is to avoid accidental damage to the water service when accessing other services.

When installing water services adjacent to other services, pipes require specific separation distances as per AS/NZS3500.4:2018 Section 4.2. This applies to both above and below ground.

Shutterstock

Seismic activity

Seismic activity can damage pipework that has no allowance for movement.

Temperature

Pipes require protection from freezing, and excessive heating.

Pipes containing water will be damaged if the water freezes. As the water freezes it expands and can push the walls of the pipe to the point where the pipe splits. Insulating pipework can protect it from freezing and subsequent damage.

Closed cell polymer insulation

Shutterstock

Pre-slit adhesive insulation

Any external insulation should be protected from UV exposure. AS/NZS 3500.4:2015 sets out the level of insulation appropriate for each of the three climate regions in New Zealand. UV protection of external insulation can be achieved by painting, coating the insulation with UV stable tape or using proprietary UV stable pre-insulated piping.

Freezing spaces

Some Territorial Authorities require all pipework to be insulated outside the building envelope, and this includes ceiling space above the ceiling insulation.

In cases where cold water pipework is not required by the consenting authority to be insulated, runs of pipework should be avoided in potential freezing spaces, e.g. unheated roof spaces, unheated cellars, locations where cold draughts are likely to occur, locations near cold surfaces such as metal roofs, metal framework or metal cladding.

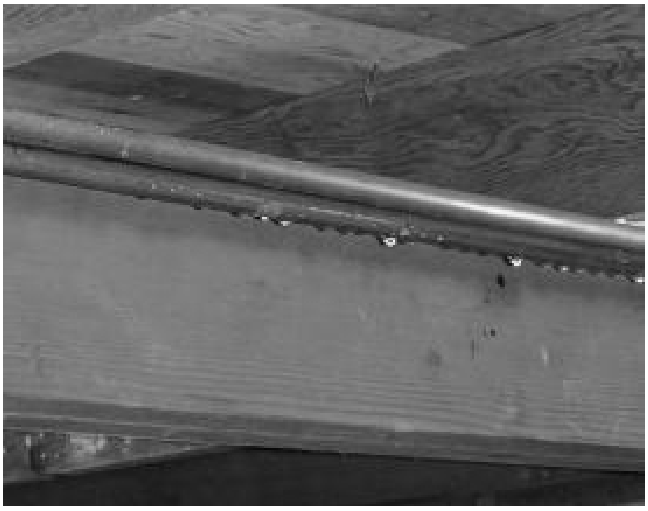
Pipe materials can also be damaged from excessive heat. Each product will have a maximum temperature rating. The insulation should be rated for its purpose. Plastic pipe has less tolerance to high temperatures than copper tube. For that reason, the first metre of tube from a hot water system will be copper and the remaining hot pipework can be polybutylene if protected by a tempering valve.

Pipes must also be protected from direct sunlight. Some pipe materials and pipe insulation are not UV rated and so may degrade if exposed to sunlight. A typical example of this would be most PEX, PEX-AL-PEX, uPVC, PB-1 pipes. The UV rays ultimately limit the life of these pipes.

Carry out some further research on the more common pipe systems that you may use on the job. Find out what installation practices you should carry out for the different systems for both insulation and UV protection.

Condensation

Insulating pipework (lagging or encasing) also prevents condensation forming on pipework. Condensation forms when a cold surface, such as a water pipe is in an environment with warm moist air. As the air cools it reaches what is known as its dew point. That is where the contained water vapour, in its gas form begins to change state into a liquid. It then forms on the surface of the cooler surface and forms water droplets.



We often see condensation or 'sweating' on toilet tanks, cold water pipes, and hot water storage cylinders.

Hot water storage cylinders need clearance between the hot water pipes and other services, to avoid heat damage and allow access for maintenance of the pipework.

If this 'sweating' is left for a long period of time, it can damage ceilings, floors, furniture or storage areas below. Condensation that drips from these areas can also lead to building rot, insect attack, or costly mould clean-up jobs.

The location of routing these pipes within a building is also important. Cold water pipes running next to or above electrical panels or boards, if not insulated properly, could drip and create corrosion on the breakers or contacts. This could eventually cause a serious hazard or fire. Un-insulated hot pipes running next to refrigerant lines or equipment could cause the exposed lines to 'sweat.'

Refresh your memory, AS/NZS3500.4:2015 gives specific clearances and insulation factors to help combat these issues.

Corrosion

Atmospheric corrosion of pipes and fittings occurs throughout New Zealand due to the geographical and environmental conditions of various regions. For example:

- Rotorua has geothermal conditions that can quickly corrode pipes and fittings because of the hydrogen sulphide gas that is present in the atmosphere.
- Coastal areas expose pipes and fittings to wind and rain that contain marine salts.
- High country mountainous areas can expose pipes to huge temperature swings creating 'thermal shock.'

Shutterstock

Whatever pipe system you are installing, always consult the installation guides as these will usually have reference to methods of controlling corrosion. Unprotected pipelines, whether buried in the ground, exposed to the atmosphere, or submerged in water, are susceptible to corrosion.

Without proper maintenance, every pipeline system will eventually deteriorate. Corrosion can weaken the structural integrity of a pipeline; however, technology exists to extend pipeline structural life indefinitely if applied correctly and maintained consistently.

Four common methods used to control corrosion on pipelines are:

1. Protective coatings and linings
2. Cathodic protection (technology that uses direct electrical current to counteract the normal external corrosion of a metal pipeline)
3. Materials selection (compatible pipes and fittings)
4. Inhibitors (only for closed systems such as central heating lines or solar closed loops)

Pipeline identification

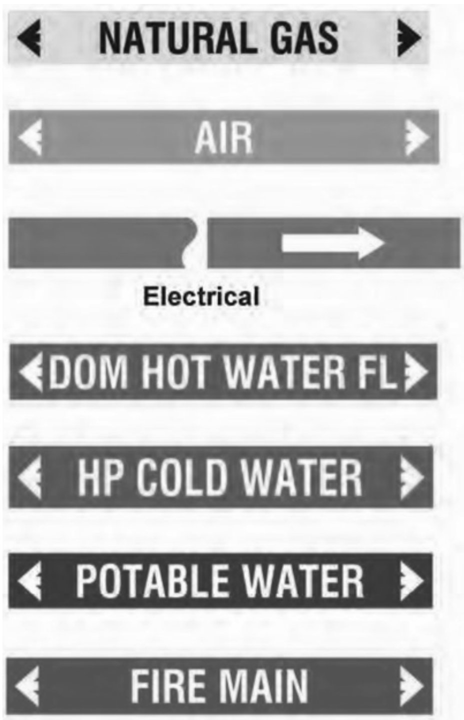
Pipelines need to be identified in certain circumstances by label and/or colour.

In domestic situations pipeline identification is not required unless the building also has a non-potable water supply.

In this situation both potable and non-potable need to be identified, with signage at the outlets of the non-potable water.

On most large industrial and some commercial sites identification is mandatory. Some sites may have their own specific coding for identification of their services.

This identification is required in order to isolate and maintain the appropriate section of pipework. Identifying pipework before cutting through a pipe avoids the potential danger of damage to property and harm to people.



NZ Standard 5807 gives methods for industrial identification by colour, wording and coding of pipelines.

You will see samples of pipeline identifying labels on this page (in black and white). For example, potable water has a purple label, and HP Cold water has a dark green label. The theory behind the double arrow is that if you cut one off before you apply the label, then you do not have to have a left or right version or fit separate arrows.

Testing Pipework

Pressure testing pipework is required to establish that the pipe and pipe fittings do not leak before and after commissioning.

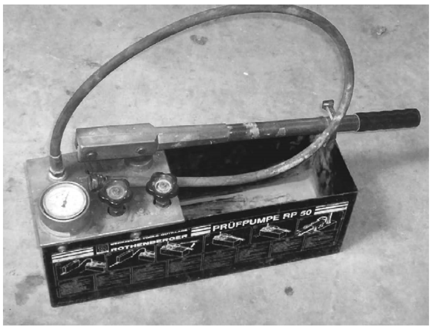
Before commissioning, the pipe will be tested to a greater pressure than its normal working pressure. This test should show the system would withstand the normal working pressure after commissioning.

The pressure testing procedure is stated in the New Zealand Building Code G12 AS1 and also in AS/NZS 3500 Part 1 Section 18.

On the completion of installing the pipework, a pressure test is carried out to ensure the installation is sound. The process for conducting a pressure test is as follows:

1. Ensure all outlets are capped or plugged
2. Loop the cold and hot supply
3. Check the pressure rating of the shower mixers and any other tapware installed. Remove them and loop the pipework together
4. Fill the system with water and pressurize to code or manufacturer’s requirements
5. Open capped outlets to relieve the system of air
6. Re-pump the system to code or manufacturer’s requirements, and test for not less than 15 minutes/NZ or 30 minutes/AU
7. Inspect all joins and fittings
8. If a leak is detected, repair the fault and start the procedure again

Some pipe materials have specific test procedures required by the manufacturer and the installer will provide a test certificate certifying that the test procedure has been followed.



Hand pump pressure tester capable of at least 1500 kPa

It is vital that the water main fixtures and appliances are capped off from the pipework being tested. If these components are subject to the high test pressure, they can be damaged. For example, tap seals can be damaged or blown apart.

It is also important to use the correct tools for the job. For example, a worn crimping tool will not clamp the fitting tight enough to meet manufacturer’s specifications, which could cause a leaking joint and a failed test.

Shutterstock

Pressure testing is essential to ensure this does not happen!

Activity 3

Using New Zealand Building Code G12 AS1, when pressure testing new pipework, what length of time should the pipework be pressurised for?

Check your answer at the back of the study guide.

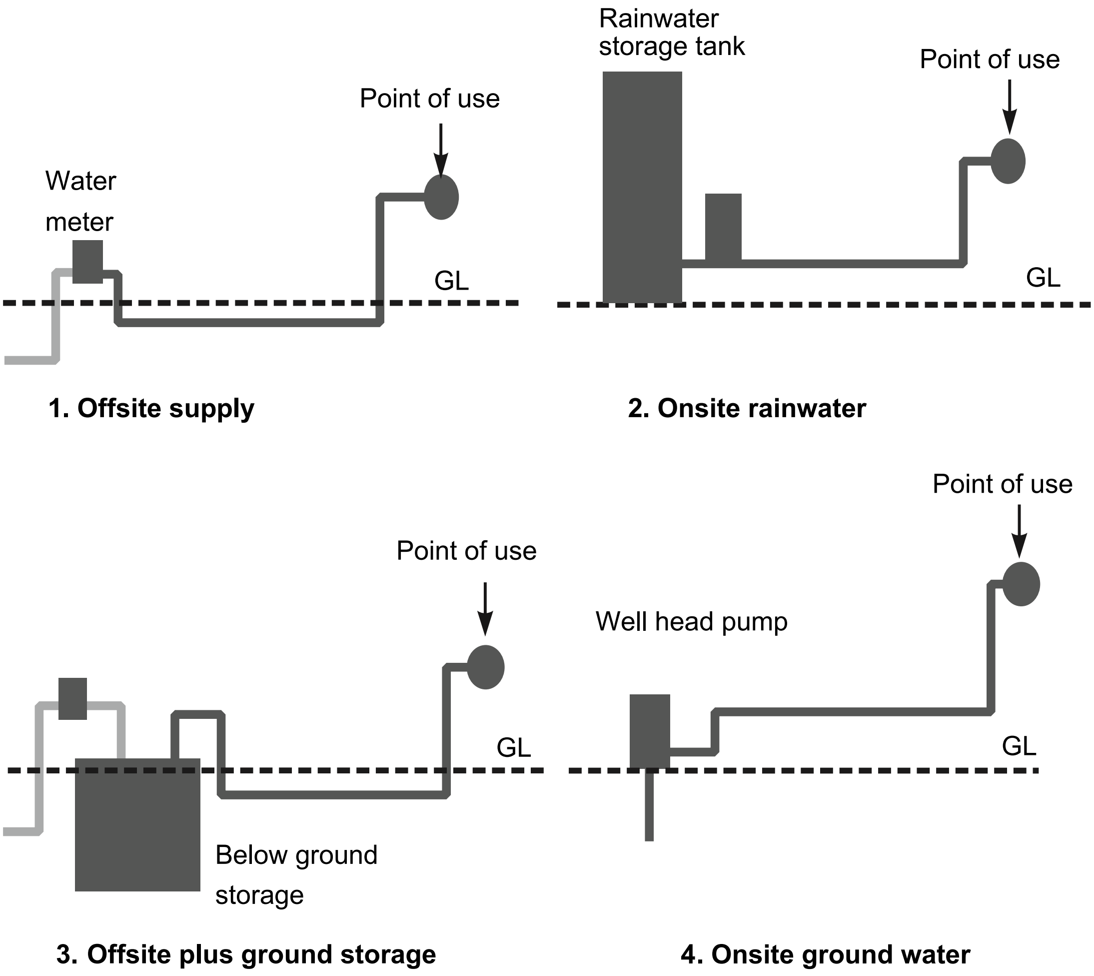
Commissioning the system

Pipework is commissioned and maintained so that its performance meets Standard and Code requirements. Commissioning of pipework takes place after testing the water service.

The system should be flushed before commissioning takes place to ensure any debris are removed from the pipework.

Commissioning will include charging the system with potable water and may include checking chlorination of the water supply. Tank supplies in particular will need initial and periodic chlorination.

Look at the water supply systems below.



Drinking water supply options

Commissioning includes operating valves, cisterns, taps, pressure relief valves and other components to confirm their correct performance. This testing should be completed to meet the requirements of ASNZS 3500.1.2015 Section 18 Testing and Commissioning.

Regular maintenance will include the same commissioning method as well as an assessment of the pipework components. Inspections will include checking for any degradation of pipes and fittings and that the system is sound.

The components of a water supply system most likely to require maintenance are water service control valves.

Water service control valves

Water service control valves are mechanical devices. They have moving parts and components which corrode or degrade. Eventually those moving parts will wear and require maintenance, and components such as rubber seals will perish.

Control valves often have similar components, and as a plumber you will need to dismantle these valves, recognise their components and perform maintenance.

Various types of valves control the flow of water in water service pipes. These are generally made of brass, bronze, plastics or stainless steel. In the plumbing trade, the terms cock, tap, and valve are used rather indiscriminately for all kinds of valves. Two examples of valves are found later in this guide under Friction.

Provision needs to be made for any maintenance of valves on a system. G12 requires that valves shall be installed in a manner which provides for easy access for replacement, servicing or maintenance of devices. Remember to position them in an accessible location.

Maintaining water supply systems in buildings

Often as part of the work you are doing as a plumber, you will be asked to do maintenance checks for customers on the water supply systems in their homes. For many older buildings, materials may be beginning to deteriorate, and the system may not be working as it was intended.

The following table provides some checks you should do to assess the performance of a system.

1.	**Turn off the water** Locate the toby or isolation valve for the building, check its operation and condition. Consider where the inlet pipe is laid and its entry point into the building, as there could be leaks or possible pipe fractures in this area. It also gives you an indication of where the pipes are routed.
2.	**Filters or strainers** Check for any other isolation valves, and the location of the limiting valves or pressure reducers. There should be strainers or filters installed at these, so it is best to turn off the water, remove the strainer, clean and replace.
3.	**Hot water systems** Have a look to see if the hot water is from a califont or cylinder. If it's a cylinder, check whether its low pressure or high. If it is low pressure, check if it is fed from a ceiling tank. Also have a look at the age of the cylinder, and any possible rust or scaling happening on the pipe connections. If it looks in poor condition you may need to mention to the owner that a replacement should be considered. Consider the location of the cylinder, and the ease of replacement. If it does start leaking, check if it may damage other parts of the building.
4.	**Incoming pressure** Find any exterior hose taps close to the incoming water supply line. By running these, you will get a good idea of the incoming flow and pressure being supplied to the building.
5.	**Pipes** Accessible water pipes should be looked at. Check under sinks and basins for signs of deterioration.
6.	**Water taps** Turn on the taps to check for rust. If the home has been sitting vacant, it's normal for a bit of rust to drain out, but if the house is occupied it could be corrosion occurring in steel pipes or in the cylinder.
7.	**Water pressure** Check the water pressure at all of the outlets. An easy way to do this is to turn the tap on and hold your finger over the outlet. If you can stop the flow of water with your finger, you have an indication of poor pressure.
8.	**Water flow** Check the flow of water at each outlet, remember NZBC G12 has tables with acceptable flow rates of water for sanitary fixtures that you can check against. When you are checking suitable flow, run several outlets at once to ensure outlets work when others are running.
9.	**Shower pressure** Although there are many models with varying pressure, make sure there is a solid stream of water. Remember the shower is usually the first indicator of problems with the water supply system so is a good indicator of problems.
10.	**Toilets** Check for leaks at the base, this can lead to significant damage. Sealing the leak will make the problem worse. Look for a rocking toilet, discoloration at base or warping. Flush each toilet to make sure there are no clogs and the float valve or ball cock is working correctly.
11.	**Ceilings and underfloor** Check any pipework you can locate in ceilings and underfloor for age and whether they have been added to. Take note of support for any pipework and the condition of lagging or insulation. Deteriorating or no insulation can result in poor energy efficiency or frost bursts. Look for signs of water damage, leaky pipes or inadequate repairs. If you find galvanised pipes, look especially for indications of rust on the pipe's exterior, as this is a sign it may start leaking soon.

12.	**Water hammer** When turning the tapware on and off, listen carefully for any noises in the system. Air locks making gurgling sounds or banging can indicate poorly graded pipework and insufficiently supported pipework. It also indicates that there is excessive water velocity in the system which could be the result of too high a water pressure or no PLV fitted.
13.	**Water temperatures** Check the temperature of the water at the outlets, it should usually be no more than 55°C at fixtures used for personal hygiene (check the codes).

Activity 4

1. What are **two** sources of onsite water?

2. Why do water service control valves eventually require maintenance?

Check your answers at the back of the study guide.

Work safely and with care

When installing and maintaining water supply pipework in buildings, practical activities should be carried out to avoid harm to people and damage to property, other services, materials, tools, and equipment.

Property damage is most likely to occur from water damage or fire.

The possibility of water damage to property from flooding, leaking or burst pipes is high. The leaks or bursts could be caused by, for example, excessive heat, faulty materials, or poor installation practice.

Property damage can also occur if naked flames are used near flammable materials without adequate protection. Flammable materials can be protected using a shield of metal or other non-flammable material e.g. a fibreglass woven mat.

Installing water supply pipework has the potential for personal harm and damage to property. Personal harm can occur, for example, by electrocution, burns, chemical exposure, or toxic fume inhalation.

Because metal water pipes have the potential to convey electric current this can prove fatal. A bonding strap is used to bond or bridge the separate metal pipe sections so that any current flows through the strap and not through you to the earth. See the section ‘electrical earthing and bonding’ for more information and pictures.

Galvanised pipe can be used as a part of the earthing system, so this may need to be checked before any work is done.

Insulation used with pipe systems will generate toxic fumes when subject to high temperature, so care is required to keep them away from a heat source, such as a gas flame when joining pipes.

Nitrile rubber (a synthetic black coloured rubber) insulation will burn, and polyethylene insulation (usually a grey colour) has an even lower melting temperature and so will generate fumes at a lower temperature. If primer is used to clean plastic pipe and solvent to join it, adequate ventilation is required.

Look at the quick reference guide on the next page and identify a suitable fire extinguisher for use with a wood fire.

When using a naked flame near combustible materials, ensure that a fire extinguisher is close by.

WORMALD

0800 4 WORMALD
www.wormald.co.nz

FIRE EXTINGUISHER QUICK REFERENCE GUIDE

FIRE EXTINGUISHER CHART

YES / NO

TYPE OF EXTINGUISHER
Colour scheme
Pre 1999 Post 1999

Type of extinguisher	A Wood, Paper & Plastics	B Flammable & combustible liquids	C Flammable gases	E Energised electrical equipment	F Cooking oils and fats	Comments
WATER	YES ★	NO	NO	NO	NO	Dangerous if used on flammable liquid, live electrical equipment and cooking oil/fat fires.
WET CHEMICAL	YES	NO	NO	NO	YES ★	Dangerous if used on energized electrical equipment.
FOAM	YES	YES ★	NO	NO	LIMITED	Dangerous if used on energized electrical equipment.
POWDER AB(E)	YES ★	YES ★	YES ★	YES	NO	Special Powders are available specifically for various types of metal fires. AB(E) unit has different capabilities than B(E) unit. (Seek Expert Advice)
POWDER B(E)	NO	YES ★	YES	YES	LIMITED	Special Powders are available specifically for various types of metal fires. B(E) unit has different capabilities than AB(E) unit. (Seek Expert Advice)
CARBON DIOXIDE	LIMITED	LIMITED	LIMITED	YES ★	LIMITED	Generally not suitable for outdoor use.
VAPORISING LIQUID	YES	LIMITED	LIMITED	YES ★	NO	Check the characteristics of the specific extinguishant.

★ Agent is the most effective in this class

NOTES

✱ Limited indicates that the extinguisher is not the agent of choice for the class of fire, but that it will have limited extinguishing capability.

Class D fires (involving combustible metals) use only special purpose extinguishers and seek expert advice.

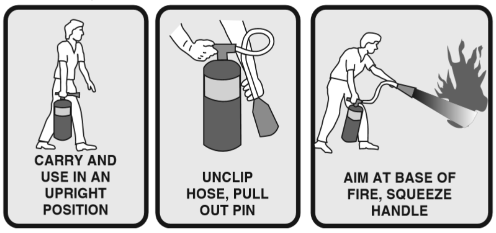
USING FIRE HOSE REELS

1. Ensure you leave a direct egress path between you and the nearest Exit Door / Egress Route.
2. Turn on the Stop Valve.
3. Run out the length of the hose as required.
4. Turn on the water at nozzle, direct the stream at base of fire.

Note: Fire Hose Reels should only be used if safe to do so.

USING FIRE EXTINGUISHERS

1. Ensure that you use the correct extinguisher.
2. Always keep an emergency exit behind you (away from the fire).
3. Stay low to avoid the effects of heat and smoke.
4. Direct the extinguisher stream at the base of the flames.
5. Move stream in a side to side, sweeping motion.
6. If the fire gets to the point where you are no longer able to control it, retreat and close the doors.



Note: Fire Extinguishers should only be used if safe to do so.

REFER TO P.A.S.S. INSTRUCTIONS

WHEN USING AN EXTINGUISHER...
REMEMBER
P.A.S.S.

P ULL THE PIN
BREAK SEAL AND TEST EXTINGUISHER

A IM AT BASE OF FIRE
ENSURE YOU HAVE A MEANS OF ESCAPE

S QUEEZE THE OPERATING HANDLE
TO OPERATE EXTINGUISHER AND DISCHARGE THE AGENT

S WEEP FROM SIDE TO SIDE
COMPLETELY EXTINGUISH THE FIRE

Protecting People & Property

Activity 5

1. Name **two** safety precautions to take when using solvents.

2. List fire extinguishers suitable for use with a wood fire in a ceiling and one type of fire extinguisher which is not suitable.

Check your answers at the back of the study guide.

Regulatory requirements

Legislation generally defines what work can be done legally. Standards and Codes give specific detail of how things should be done. For example, the distance between pipe supports is stated in Standards and Codes.

The relevant legislation, Standards and Codes are summarized below.

For a more detailed description of government legislation and building Codes you can visit the websites of various government departments, for example the New Zealand Building Code is available at https://www.building.govt.nz/.

Plumbers, Gasfitters, and Drainlayers Act 2006

- The purposes of this Act are to protect the health and safety of members of the public by ensuring the competency of persons engaged in the provision of sanitary plumbing, gasfitting, and drainlaying services; and to regulate those persons.

Plumbers Gasfitters and Drainlayers Regulations 2010

- Determine who is legally able to install and maintain potable water supply systems.

Health and Safety at Work Act 2015 (HSWA)

- It introduces new responsibilities for managing the work related risks that could cause serious injury, illness or even death. HSWA recognises that to improve our poor health and safety performance we all need to work together. Government, businesses and workers must establish better leadership, participation in, and accountability for the health and safety of others.

The Building Act 2004

- Sets out the law on building work.

The Health (Drinking Water) Amendment act 2007

- Aims to protect public health by improving the quality of drinking water provided to communities.

AS/NZS 3500.1 2018 Plumbing and Drainage: Water services

- Specifies the requirements for the design, installation and commissioning of cold water services and non-drinking water from a point of connection to points of discharge.

AS/NZS 3500.4:2018 Plumbing and Drainage: Heated water services

- Sets out the requirements for the installation of heated water services. It has restrictions on what pipes and fittings are deemed compliant for hot water services and lists suitable materials.

NZS 3604:2011 Timber Framed Buildings

- Provides suitable methods and details for the design and construction of timber framed buildings up to three storeys high.

NZS 5807:1980 Code of Practice

- For industrial identification by colour, wording or other coding. Part 1 of the Standard identifies signs, safety colours and fire extinguishers. Part 2 of the Standard identifies the contents of piping.

New Zealand Building Code

- The Building Code sets out the performance Standards that all new building work must meet. It includes Clause G10 Piped Services, and Clause G12 Water Supplies.

Selection of methods and materials

Pipe materials must meet the requirements of the NZBC. Read the performance criteria of Clause G12 — water supplies, which covers water supply systems. Look for requirements that determine pipe material selection. Plans do not always have detailed water supply pipe runs shown.

*A **pipe run** is the path the pipes will follow*

However, those plans are usually come supplied with job specifications. Job specifications specify what methods and materials should be used. The specifications or "specs", state which Standards or Codes are to be followed when installing the system.

For pipe installations which do not have job specification the methods and materials will still need to be selected so that the objectives of the Building Code are met. These job requirements will include the delivery of water at suitable flow rates, temperature and pressure.

Job requirements will also include taking water quality into account and the environment the pipework will be exposed to. For example, the water could be corrosive and/or installed in corrosive soil.

Once installed the system pipework is tested for integrity. This is "testing" or conducting a water tightness test.

The operation of the system and its components is "Commissioning." You must check the items as listed in the manufacturers literature and the codes to ensure the system performs correctly and safely: for example, a check should be made of any leaking pipe joins from newly installed appliances, flow rates, temperature and pressure, safety valve relief and drain operation, emergency shut valve operation etc.

Consult AS/NZS3500.1:2018 and G12 for more guidance.

The materials used in water supply pipework have been looked at in the installation of this guide. The different properties of the materials will dictate how they are cut, bent and joined.

Plumbing science concepts and principles

The next section covers various scientific concepts and principles you need to understand.

Some of these are quite complex, and you might like to search on the internet to help you understand them further.

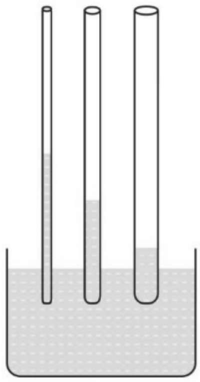
Capillary attraction

Capillary attraction is the ability of liquids to adhere to solid surfaces.

Surface tension and adhesion combine to create a capillary effect. Adhesion causes liquids to climb up, or along a solid it is in contact with.

An example is shown where water climbs up the sides of the thin tubes. This results in a meniscus or curved surface forming. The surface tension acts to hold the surface intact, so instead of just the edges moving upward, the whole liquid surface is dragged upward. This carries on until the weight of the column of water is too heavy for the surface tension to lift.

The thinner the tube, the further the liquid is drawn up by the capillary action. Capillary attraction is the effect that causes kerosene to be drawn up through a wick to the flame. This attraction occurs with sheets of metal, plastic, or glass as well.

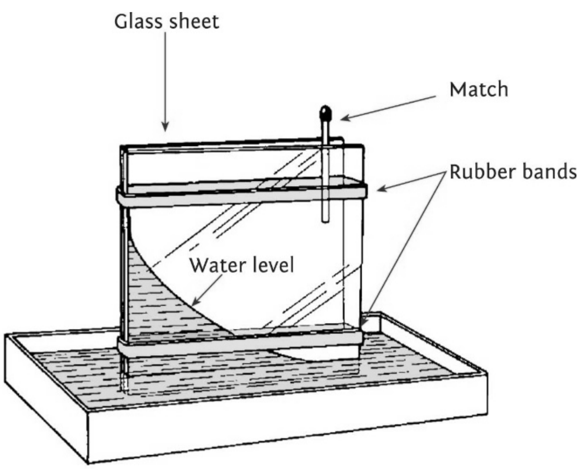


The rise of liquids in small bore tubes

> ***Note:*** *Water can get drawn up to 75 mm through capillary action.*

These show how capillarity acts between close surfaces, with the distance between surfaces affecting the distance the liquid travels. There are times in roof work where close smooth metal surfaces act on liquids with a capillary effect.

This capillary effect can be used to get strong solder joints. You do this by letting the solder ‘sweat’ into the joint. To ‘sweat,’ you heat the metal while letting the solder run over and into the joint. The strongest joint is where you get the best capillary draw, meaning a small distance between sheets.



Capillarity between close surfaces

Of course, we know that having overlapped surfaces where water accumulates is faulty work, unless soldered or made watertight with an approved sealer. Some ways of avoiding capillary attraction are:

- bending (breaking) the edge of the sheet,
- the use of beads, or
- the use of tilting fillets.

Galvanic action

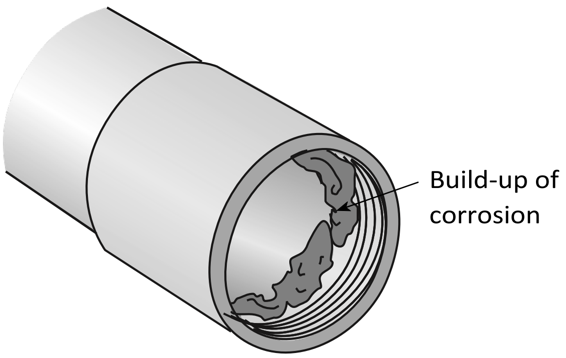
Corrosion of water pipes and fittings can create leaks and corrosive material can also build up inside pipework, restricting the flow of water. Corrosion takes place when dissimilar metals are in the presence of water, from the effects of atmospheric corrosion, and dissolved chemicals in the water.

Knowledge of plastic pipe systems which include metal fittings and their limitations is also required when installing and maintaining water supply pipe systems.

Corrosion of metal pipework occurs where dissimilar (different) metals join each other in the presence of water. For example, a joint between a steel hot water cylinder and a brass fitting.

The corrosion takes place as electric current is generated between the metals. This current flow, known as galvanic action, causes one of the metals to decompose.

Decomposition of some brasses by a process known as ‘dezincification’ is said to be due to galvanic action. Saltwater or water which contains carbonic or other organic acids acts as an electrolyte. Where brass contains a high proportion of zinc, and particularly where there is an excess of zinc (under such conditions as were explained in connection with the making of an alloy), the zinc decomposes and changes into a solution, leaving the copper as a porous mass. In this case the colour of the original brass changes to a copper like shade.



Deposit when brass thread attacks an iron socket

A similar corrosion of metal can occur when stray current from an outside source travels through pipework. This corrosion is termed electrolytic corrosion. In such cases metal pipework will need to be connected by an earth wire. This will earth the system to avoid corrosion.

Pipework is also connected to earth when metal plumbing fixtures, for example, stainless steel sink inserts are liable to be in contact with electric appliances, such as an electric jug.

This situation can place the user at risk of electrocution if the electric appliance is faulty. Connection of metal fixtures and piping to earth (via a wire to an earth stake) is known as electrical earthing. The connection between fixtures and pipework is known as bonding.

As previously discussed, the use of a bonding strap when working on metal pipework is important.

Atmospheric corrosion (oxidisation) of pipework and fittings can occur where unprotected pipework is exposed to the atmosphere.

Metals react with oxygen to form a coating of oxide. This process is known as oxidisation.

As a result of galvanic action, a deposit has accumulated at the point where a brass fitting has been screwed into an iron socket.

Atmospheric corrosion of pipework and fittings can be minimized by protecting it with coatings or insulation. Coatings, including paint and wrap products, will provide a protective layer over the metal surfaces. Insulation will generally be to retain or protect against excess heat but has the added advantage of protection against corrosion.

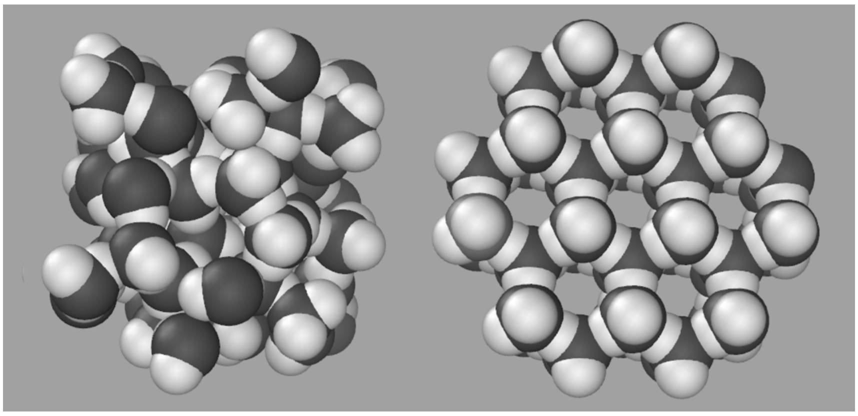
Corrosion can also take place within the pipework. Natural waters are never absolutely pure. This is because water is one of the best solvents and so it takes into solution (mixes with) substances in gaseous, liquid and solid form.

Natural waters, particularly those which have been in contact with the ground, contain salts of various kinds. These dissolved substances tend to cause corrosion. How corrosive the water is will dictate what pipe materials are suitable for a given water source.

Freezing

Preventing the water supply pipework from freezing was discussed in the section 'protection of pipework.' The behaviour of water is further discussed below.

Water is at its most dense at 4°C and as it freezes it expands by about 9%. This is because the water molecules (shown below left in free form) form rigid structures which take up more space as shown.



Molecules in a liquid state *Molecules in a frozen state*

As the water expands, it will push against the sides of the pipe walls and if the pipework itself is rigid, it can split and leak as the water thaws (unfreezes).

It is possible that pipework subject to frozen water may not show signs of leaking but may still be damaged and fail at a later time.

For example, annealed (softened) copper may stretch and retain its deformed shape without splitting, but the pipe walls will be made thinner and weaker.

Softer materials, such as plastic pipe may be more elastic but stress on joints may create damage or leaks.

It should be noted that water expands considerably (1700 times its original volume) when it becomes steam and for this reason, plumbers try to avoid the likelihood of steam production.

Friction

The effect of friction on pipe sizing water supply systems has been referred to in the pipe sizing section. There are several causes of friction in water supply pipework.

- friction between the moving water and the pipe or fitting surface
- disturbance to water flow caused by a sudden change in direction, or sudden enlargements or contractions in the pipework
- valves
- flow of water at intakes and outlets

When water flows over a surface, however smooth, friction will be created; the longer the pipe and the greater the velocity of flow, the greater the frictional resistance. This resistance is greater in smaller pipes than in those of large diameters.

Larger pipe diameters have much greater cross-sectional areas than smaller diameter pipes and this allows a much greater flow of water.

Obviously, a smooth surface will cause less friction than a rough surface. The surfaces of some materials such as drawn copper or plastic are usually smoother than, say, galvanised mild steel. Where corrosion occurs and deposits accumulate on the surface, the effective diameter is reduced. In a steel pipe deposits occur in any place where the steel is not protected. Deposits also occur as a result of galvanic action.

Friction in pipes is also caused by sudden changes in direction. Any change in direction within a pipe tends to cause turbulence in the water and so will restrict the flow.

The elbow shown below (which has a tight radius) has a much greater restriction to flow than the pipe bend (large radius) shown beside it.

A copper pipe elbow

A copper pipe bend

A PPR pipe elbow

The PPR elbow shown is an example of a plastic elbow which has a tight radius. An excessive use of such fittings will seriously affect pipe sizing calculations.

The resistance caused by a pipe fitting can be expressed in terms of an equivalent length of straight pipe which will cause the same resistance.

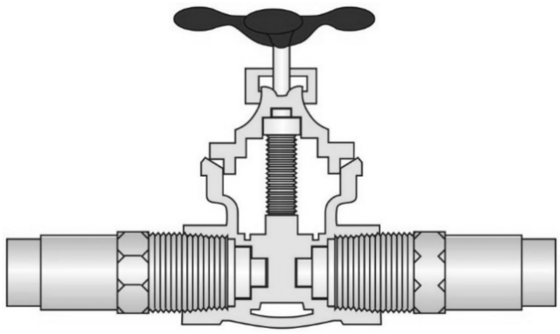
For practical purposes, the resistance of an elbow is equivalent to a length of pipe 36 times the nominal diameter of the elbow. For example, a 15mm diameter elbow will equal approximately 0.5 metres of straight pipe.

All fittings tend to restrict the flow to some extent. A tee branch has double the effect of an elbow. Bends generally have less effect than elbows. When a bend has a radius of 5 times its internal diameter, the frictional resistance is, for practical purposes, no more than that of the same length of straight pipe.

Sudden enlargements or contractions in a pipe cause the flowing water to break into eddies, affecting the velocity of flow. Typical contractions occur where burrs remain on unreamed pipe ends. Valves can also cause resistance to flow.

Look at the two water control valves below.

Ball Valve



Gate valve

As a rule, the full-way gate valve, or ball valve passes a higher volume than a screw-down stop valve.

The extent to which any valve is opened obviously affects the flow of water through it.

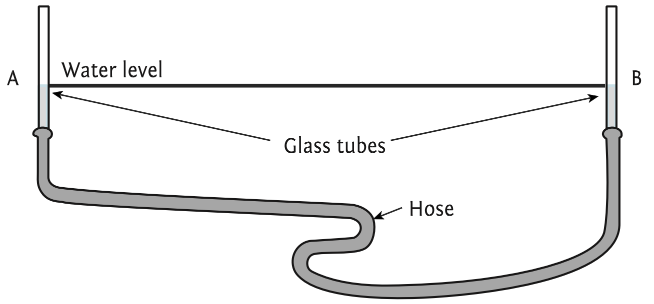
The shape of the outlet of a supply tank or reservoir also affects the rate of discharge into the pipework.

Hydrostatics and hydraulics

Hydrostatics

Hydrostatics is the scientific study of fluids at rest.

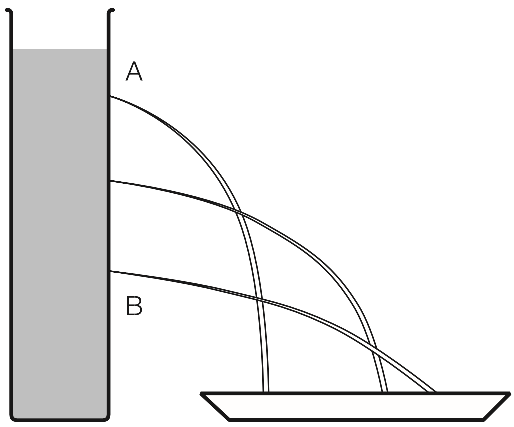
Water will always move to become level. This feature of water is commonly referred to as water finding its own level.



Using a hose to check water level

The height of water determines different pressures at different points in the system.

The water squirts the furthest at level B in the diagram below because the height of water (pressure) above this hole is greater than the height of water (pressure) above A.



Hydraulics

Hydraulics is the science that deals with moving water.

You have looked at how water flow rates can be affected by friction and pipe size. You know that Standards and Codes state the flow rates required and that flow rates can be measured in different ways. Further to this it is important to know that water supply pipework for low pressure systems needs to be designed even more carefully.

Low pressure systems should be designed to avoid air entering the system as the air can form an air lock (trapped air) which can completely stop water flow from outlets.

Water hardness and softness

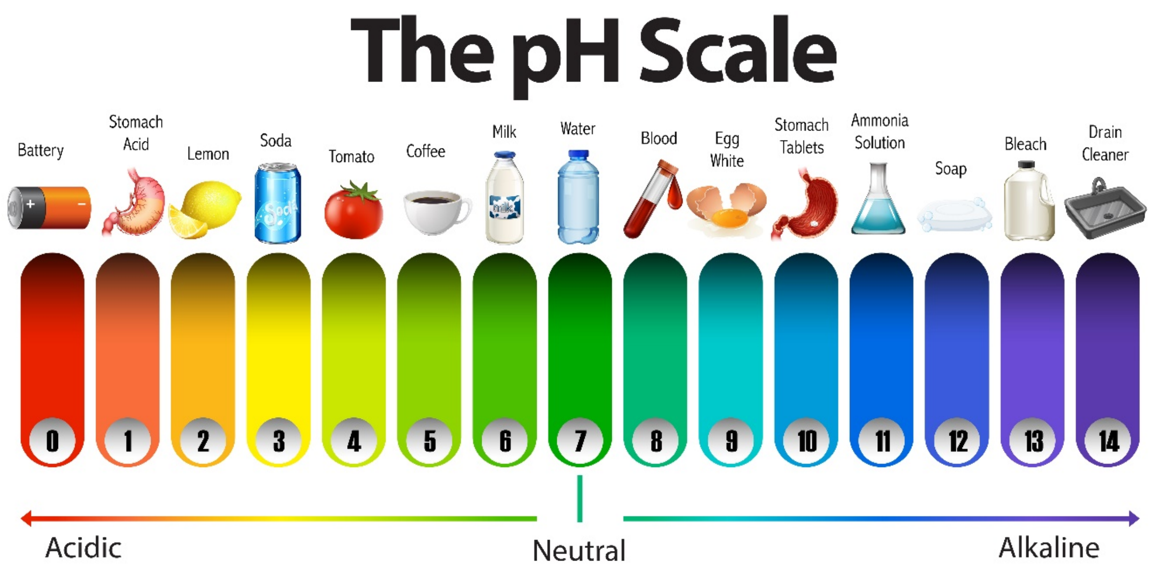
Water's hardness and softness is due to its concentration of minerals — calcium and magnesium. The lower the mineral concentration, the softer the water is.

Water hardness can be measured by the chemical quantity compared to the quantity of water, for example, milligrams per litre. When using water that is considered soft, you do not need to use as much dishwashing soap, laundry detergent, or other soaps.

Hard water areas will cause premature failure of hot water supply pipework and fittings. This is because of a build-up of calcium (lime) known as limescale. This can be overcome by on-site water treatment.

pH measures the amount of hydrogen ion activity in a substance. The pH scale is relative and runs from 0 to 14.

0 is the lowest, and most acidic, pH level 7 is neutral, and 14 is the highest and most alkaline pH level.

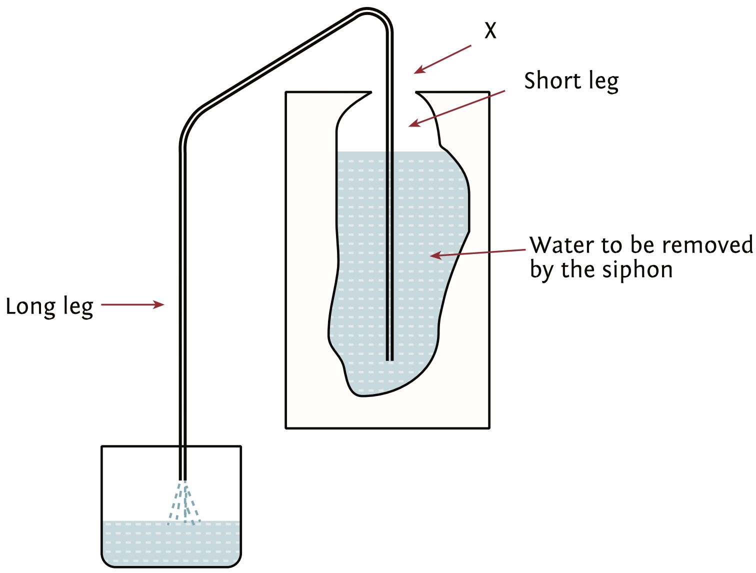


Shutterstock

Pure water is said to be neutral pH — the pH for pure water at 25°C is close to 7.0. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are said to be basic or alkaline.

Acid (soft) water can cause metal pipe materials to corrode. In some water supply areas, the acidity of the water supply will require the use of materials which will not corrode.

Siphons



A siphon (also spelt syphon) is a continuous tube that allows liquid to drain from a reservoir through an intermediate point that is higher than the reservoir. The flow is driven by the difference in hydrostatic pressure, so there is no need for pumping. As atmospheric pressure acts on the surface of the liquid, its density allows it to be drawn through an enclosed tube or pipe to a lower level.

Water supply pipework should terminate above containers to avoid the possibility of siphonage.

Such siphonage, called back-siphonage, can allow non-potable water back into the potable water supply, which puts the health of consumers at risk.

Back-siphonage can also create negative pressure inside closed cylinders, e.g. hot water cylinders, and cause the cylinder to collapse.

Electrical earthing and bonding

Equipotential bonding

Stray electrical currents within a building will always find the easiest route to earth. Water and metal are both excellent conductors of electricity, so a metallic water pipe provides an ideal passage for electricity to take.

A stray current in contact with metal fixtures or pipework has the ability to cause serious bodily harm or even death to an unsuspecting occupant. In cases where buildings utilise metal pipe, a licensed electrician is required to bond the pipeline along with any metal bench tops, shower trays and shower roses to an earth rod hammered into the ground.

Earth Rod

Metal pipe earthing

If faulty wiring comes in contact with a bonded fixture or pipework, the stray current will be harmlessly absorbed into the earth.

If you are required to cut into a metal pipeline on an existing building, there is potential for the pipeline to be conveying stray currents. As the current is looking for the fastest route to earth, the person cutting the pipe becomes the obvious route. To prevent being electrocuted in this manner, a bonding strap (car jumper leads are ideal) is clamped to the pipe on either side of the area to be cut. Stray currents will now pass through the bonding strap and terminate safely through the earth rod.

Earth bonding strap

Fire protection

Often plumbing pipework must run through fire rated building elements. If this occurs, then the pipework needs some sort of device to limit the spread of fire from one fire rated cell to another.

Fire rated cells are discussed in NZBC Clause C/AS1 Part 6 Control of Internal Fire and Smoke Spread. These devices fall under the category of passive fire control for penetration management.

These can range from:

- fire collars
- fire pipe wraps
- fire pillows
- fire silicone
- fire box (for multiple services).

Remember, be considerate of other services when running your pipework. Don’t run your pipes close to ducting or wiring that also require fire stopping devices.

When running your services make sure that you cut neat, snug fitting holes in wall cladding etc, according to NZBC Clause C/AS1 Part 6 Control of Internal Fire and Smoke Spread. There are strict guidelines on the size of gaps that fire silicone can seal.

The fire stop device needs to be fixed securely otherwise it won’t perform its job properly.

Activity 6

1. What is the difference between Legislation and Codes?

2. What other Clause of the NZBC states the durability requirements of pipe materials?

   Note: Answer cannot be Clause G12

3. Where does the oxygen come from which causes oxidisation?

4. What is the biggest effect of water freezing inside a pipe?

5. If a 15mm diameter elbow equals approximately 0.5 metres of straight pipe, how many metres of pipe are 10 elbows equivalent to?

6. What determines pressure at various points in the pipework?

7. Why does water supply pipework need more careful design for low-pressure systems?

8. How can water pH and water hardness affect metal pipework?

9. Read NZBC Clause G12 for more information on equipotential bonding, and then answer the following questions.
   a. What **four** conditions need to exist for equipotential bonding to be required within a building?

   b. Does polybutylene water supply pipe have to be equipotential bonded?

Check your answers at the back of the study guide.

Activity answers

Activity 1

1. From the information given above, calculate the approximate conversion factor between measuring in kPa to measuring in meters head.

250 ÷ 25 = 10 Multiply by 10 or 1kPa = 0.1 mtr head

2. List the **three** main categories of water supply systems.

Rainwater, surface water, Underground water

3. What Standard ensures that all public water supplies are safe and palatable for the consumer?

Drinking Water Standards for New Zealand 2005 (revised 2008)

For the following questions you will need to have access to G12 and AS/NZS3500.1.2018.

4. What is the minimum flow rate from a shower according to the New Zealand Building Code Clause G12?

0.1 l/sec (0.1 litres per second)

5. According to G12 how is the flow rate measured from the following:

Shower	*Mix H & C water to achieve 42*C*
Bath	*Mix H & C water to achieve 45*C*
Laundry tub	*Flow rates required at both hot and cold taps but not simultaneously*

6. What is the required **minimum** pressure at the outlets according to AS/NZS3500.1:2018?

Minimum 50 KPA (5 m head) and maximum 500 kPa

Activity 2

1. Complete the following conversion factors.

Capacity	1 m³ = *1000* ltr
Weight / Mass	1 ltr = *1*kg
Pressure	1 mtr Head = *9.81* kPa
	1 PSI = *6.89* kPa
	1 Bar = *100* kPa
Volumetric flow	1 ltr/ sec = *60* ltr/min which equates to 3.6m³ / hour

2. You have been asked to install a 360 litre hot water cylinder in a roof. The cylinder shell weighs 76 kg. How much combined weight (cylinder and water) will the roof need to support?

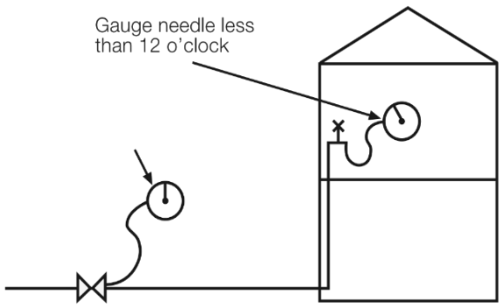
436 kg (1 ltr = 1kg   360 x 1 =360kg, 360 + 76 = 436 kg)

3. You have just installed a basin and now need to check the flow rate. When turned on full bore you have timed the flow at 3 litres in 10 secs. What would the actual flow rate be in 1 minute?

18 Ltrs/min (10 secs x 6 = 1 minute (60 secs): 3 x 6 = 18)

4. Complete the sketch below by indicating on the gauge where the needle would be for the static pressure being measured at the outlet tap above the toby. (**Hint**: Should your sketch show the pressure at the outlet tap to be higher or lower than the pressure at the toby?)

The pressure gauge needle should be at an angle between 6 o'clock and 12 o'clock, i.e. less than directly upward



Static pressure at toby and outlet at height above toby

Activity 3

Using New Zealand Building Code G12 AS1, when pressure testing new pipework, what length of time should the pipework be pressurised for?

15 minutes

Activity 4

1. What are **two** sources of onsite water?

Rainwater, recycled water and groundwater

2. Why do water service control valves eventually require maintenance?

They have moving parts which wear and components which perish

Activity 5

1. Name **two** safety precautions to take when using solvents.

The area should be well ventilated and appropriate PPE used

2. List fire extinguishers suitable for use with a wood fire in a ceiling and one type of fire extinguisher which is not suitable.

Water, (including hose reel) is most suitable. Any other type: foam, carbon dioxide, or fire blanket are all suitable for a wood fire (Class A). Dry chemical powder class B(E) is not suitable for a class A wood fire.

Activity 6

1. What is the difference between Legislation and Codes?

Legislation generally defines what work can be done legally. Codes give specific detail of how things should be done

2. What other Clause of the NZBC states the durability requirements of pipe materials?

   Note: Answer cannot be Clause G12

Clause B2 Durability

3. Where does the oxygen come from which causes oxidisation?

The atmosphere or air

4. What is the biggest effect of water freezing inside a pipe?

The pipe walls will expand and could split

5. If a 15mm diameter elbow equals approximately 0.5 metres of straight pipe, how many metres of pipe are 10 elbows equivalent to?

0.5 metres x 10 = 5.0 metres

6. What determines pressure at various points in the pipework?

The height of water above that point

7. Why does water supply pipework need more careful design for low-pressure systems?

The flow of water at low pressure is more affected by friction and pipe size than at high pressure

8. How can water pH and water hardness affect metal pipework?

Acidic water can corrode pipework and hard water can build up scale to block pipework

9. Read NZBC Clause G12 for more information on equipotential bonding, and then answer the following questions.

   a. What **four** conditions need to exist for equipotential bonding to be required within a building?

      Electricity is provided in the building

      The water supply is metallic

      Building users are able to make contact with the fixtures or supply piping

      The metal pipe is in contact with the ground and forms a continuous metallic link from the ground to those parts of the pipe exposed to the building user

   b. Does polybutylene water supply pipe have to be equipotential bonded?

      No. (For reference, see comment G12 paragraph 9.2)

Got questions?

If you have any questions, please contact your assessor directly.

www.skills.org.nz

skills.