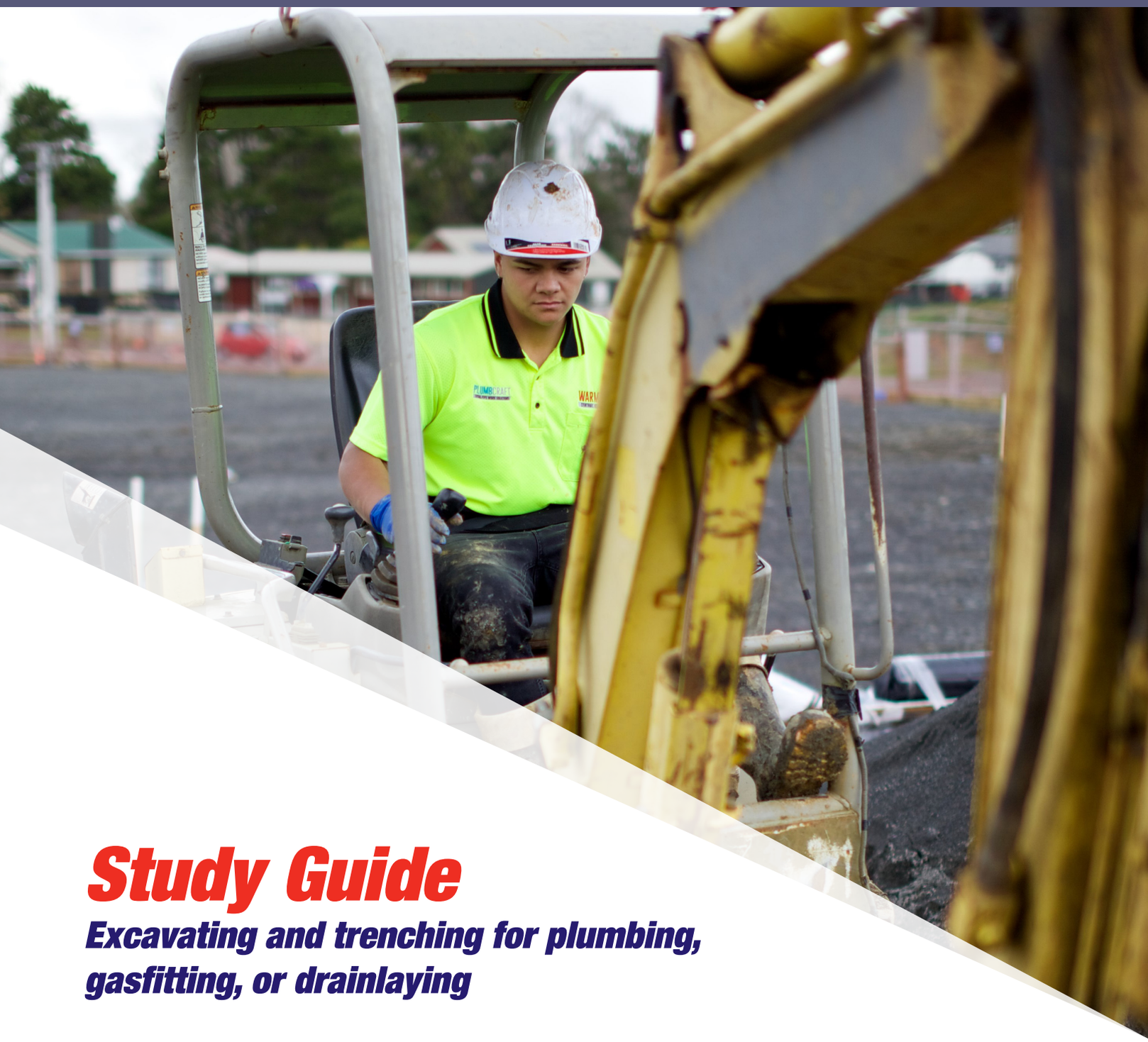


Study Guide

Excavating and trenching for plumbing, gasfitting, or drainlaying

30532 (Version 1, Level 3, Credits 5) | 30533 (Version 1, Level 3, Credits 4)

Trainee Name _____

Grow by growing others

skills.

Unit Standards

Unit standard 30532

People credited with this unit standard are able to:

- demonstrate knowledge of how to determine the position of the excavation or trench and allow for other services
- demonstrate knowledge of collapse control in respect of excavations
- explain excavation dewatering
- demonstrate knowledge of notification requirements and procedures for excavation and trenching
- demonstrate knowledge of concepts and principles underpinning excavation, trenching, and backfilling for plumbing and drainlaying

Unit standard 30533

People credited with this unit standard are able to:

- determine the position of the excavation or trench
- excavate to a stable sub-base
- carry out backfilling and clear the site

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 and read them as well.

Skills acknowledges the content and images provided by WorkSafe New Zealand to aid in the development of this resource.

Contents

Excavating and trenching

Because plumbers, gasfitters and drainlayers lay and repair systems used to supply water and gas, and to remove wastewater, they are often required to excavate and trench. All trenched piping systems need careful planning and consideration.

Pipes are usually installed in straight lines to avoid stress on joints and maintain suitable flow. Some piping systems may need to be installed level, but pipes carrying wastewater are usually installed on a slope, so water can move downhill by gravity.

Shallow trenches are not deep enough for you to get into and work. You will excavate (dig) these for laying gas and water pipes, being careful to avoid damaging other underground services when you do.

Deep trenches are deep (and wide) enough for you to get into and work. Deep trenches are usually used for laying drains. Care must be taken to avoid underground services when excavating, as well as to protect yourself and others against trench collapse and possible flooding.

Regulatory requirements for excavating and trenching

Legislation, Standards and Codes

Some of the important Legislation, Standards and Codes that you must acquire a working knowledge of are:

- Building Act 2004
- Health Act 1956
- Health and Safety at Work Act 2015
- Health and Safety in Employment Regulations 1995
- Plumbers, Gasfitters, and Drainlayers Act 2006
- Plumbers, Gasfitters, and Drainlayers Regulations 2010
- Resource Management Act 1991
- AS/NZS 5601.1 Gas installation
- AS/NZS 3500.2 Plumbing and drainage – Part 2: Sanitary plumbing and drainage
- Good practice guidelines – Excavation safety, Wellington: WorkSafe New Zealand, 2016
- Guide for Safety with Underground Services, Wellington: Department of Labour, 2002
- New Zealand Building Code Clause E1 Surface Water
- New Zealand Building Code Clause G12 Water Supplies
- New Zealand Building Code Clause G13 Foul Water

Code of Practice

A Code of Practice provides workers in the building industry with practical, common-sense, industry-acceptable ways of dealing with health and safety around a worksite and working safely.

Any work carried out in a place of work that has been issued an approved Code of Practice under the Health and Safety at Work Act 2015 (HSWA) and its Regulations, should be carried out in accordance with that Code.

There are three important publications from WorkSafe you should be familiar with when planning an excavation or a trench:

- *Guide for Safety with Underground Services*
- *Approved Code of Practice for Excavation and Shafts for Foundations*
- *Good Practice Guidelines for Excavation Safety*.

They are available from the website: http://www.worksafe.govt.nz/worksafe

As all excavations or trenches can involve a variety of unseen hazards, careful planning and awareness of these is a vital part of the job.

The *Guide for Safety with Underground Services* sets out agreed work methods and preferred work practices for the location and excavation of underground services.

It lists the hazards while working near underground services and gives advice on how to reduce the risks.

The *Approved Code of Practice for Excavation and Shafts for Foundations* covers safe work practices around trenches and excavations (Part 1) and shafts (Part 2).

A drainlayer will mostly use Part 1 of the Code of Practice. Part 2 of the Code of Practice covers shafts (vertical excavations) and drives (small tunnels).

The *Good Practice Guidelines for Excavation Safety* covers how to avoid underground services and not undermine nearby structures, checks on excavations for any effects on its stability, providing safe access, methods of preventing collapse, and how to prevent people and materials falling in.

> ***Reminder:*** *The Good Practice Guidelines for Excavation Safety describes general safety requirements involving trenching. It also describes causes of soil failure. Soil failure is where unstable ground moves, falls or collapses.*

General safety requirements

Workers have been killed in trenches shallower than 1.5 m deep. This can happen when a worker is working while bent over in the trench and the trench collapses.

Often such a collapse can be predicted by looking for the following before starting work each day.

- cracks in the ground 3–10 m back from the sides of the trench
- bulges in the trench walls
- surface water and/or ground water
- ground crumbling, ground too dry or drying winds
- pump not clear or not working properly
- ground not compacted in old trenches
- vibrations from machinery, trucks, trains, blasting, and so on.

Collapse can also be caused by loading materials on the side of excavations and undercutting to save excavation.

Other trench hazards include insufficient oxygen, toxic or hazardous gases, fumes and dust.

The *Good Practice Guidelines for Excavation Safety* has information on how to plan work to increase safety, such as:

- how to secure the work area
- managing traffic
- hazardous conditions
- confined spaces

Site access needs to be restricted from the public. If the work area will be open for an extended period (e.g. overnight or over multiple days), then the area needs to be even more secure. Check section 4.4 Planning the work: Securing the work area for more information.

Notifiable work

The Health and Safety in Employment Regulations 1995 require employers, as well as the person who controls a place of work, to provide at least **24 hours notice** to WorkSafe of particularly hazardous work. This is called a notification of particular hazardous work (notifiable work).

Trenches that are large enough to get into and work become notifiable work if they are:

- 1.5m or deeper, or deeper than they are wide, or
- an excavation has a face with a vertical height of more than 5m and an average slope steeper than a ratio of 1 horizontal to 2 vertical.

If the trench is notifiable work your employer or supervisor must:

- notify WorkSafe NZ before starting the job
- not allow anyone to work in the trench before WorkSafe NZ have inspected it

Other examples of notifiable work are included on the WorkSafe website and in the notification form online.

Before approving anyone to work in a trench, WorkSafe NZ inspectors will want to be satisfied with:

- type of shoring to suit soil properties
- barricades to prevent people falling in
- dewatering method if needed
- means of access and exit
- electrical safety for pumps, tools and equipment
- training and supervision of staff
- personal protective clothing and equipment
- emergency plan.

***Reminder:** The Hazardous Work Notification Form can be completed online at the Worksafe NZ website.*

Notifiable incidents

The Health and Safety at Work Act (HSWA) requires a person conducting a business or undertaking (PCBU) to notify WorkSafe if there is an unplanned or uncontrolled incident at a workplace that exposes a person (worker or otherwise) to a serious risk to their health and safety.

This could be an incident or event that results in immediate or imminent exposure to:

- a substance escaping, spilling, or leaking
- an implosion, explosion or fire
- gas or steam escaping
- pressurised substance escaping
- electric shock
- the fall or release from height of any plant, substance or object
- damage to or collapsing, overturning, failing or malfunctioning of any plant that is required to be authorised for use
- the collapse or partial collapse of a structure
- the collapse or failure of an excavation or any shoring supporting an excavation
- the inrush of water, mud, or gas in workings in an underground excavation or tunnel
- the interruption of the main system of ventilation in an underground excavation or tunnel
- any other incident declared in regulations to be a notifiable incident.

When a notifiable incident occurs, you must preserve the site and notify WorkSafe.

Records of the incident must be kept for at least five years from the date of the incident.

In an emergency

There should be an **emergency plan** in place for your workplace, outlining the steps you should take to deal with incidents.

Planning must determine all the potential emergency conditions and train workers on **emergency procedures** e.g. how to rescue workers from an excavation.

In all cases, quick and effective communication is essential.

What to do for each emergency changes depending on emergency plans and procedures, but in general some actions are to:

- call 111 / emergency services
- find the person on site trained in first aid, and give first aid as required
- tell the boss/foreman/supervisor
- block off the area to prevent further incidents, if needed

Positioning a trench

Determine the position of the excavation or trench and avoid other services

Before establishing the level and position of the trench, you need to consider the specifications of the project, the plans and drawings that you have, NZBC requirements, and identify the approved outfalls and connection points.

The main things to be considered before excavating a trench are;

- the position, line, level and gradient
- locating, identifying and, avoiding any other services
- avoiding or removing any obstructions.

Position, line and gradient

When planning for a trench or excavation to install a drainage, gas or water service pipeline you need to determine the position or pathway for the service. Considerations such as depths, slopes or gradients, and any obstructions need to be planned for.

Different services require differing depths of coverage, drains require fall, and buildings roadways and paved areas need consideration for protection of the pipes.

In the planning stages, a site plan of the area is an essential tool. Information on a site plan could include:

- boundary dimensions
- distances from the street to the boundary
- set back distances for the building
- contour lines
- positions of paths and driveways
- trees
- the direction of north
- a scale
- datum points

Marking out the proposed trench on the ground is a good way of identifying its position. You will also need to establish the location of any other services and plan to avoid or remove any obstructions.

Locating, avoiding and protecting other services

Before excavating you should obtain a site plan from the Territorial Authority (TA) showing all existing underground services, which may include:

- drain pipes
- water service pipes
- gas service pipes
- power cables
- telecommunications (phone, TV and internet cables).

If your intended trench runs parallel to any of these services, you may be able to reposition your trench to avoid them and continue to excavate with a digger. However, if your intended trench is near or will cross other services, then you will have to excavate carefully by hand until you reach the other service/s.

Note: *You should contact the Utility that owns the other service. Ask them to mark the position of the service, and then comply with their safety clearance requirements.*

A Safety Guide for Underground Services is available from the WorkSafe NZ website. This guide outlines the hazards that can arise from work near underground services and gives advice on how to reduce the risk.

Warning – If you damage another service, you will have to pay for the repairs!

Proximity to other services

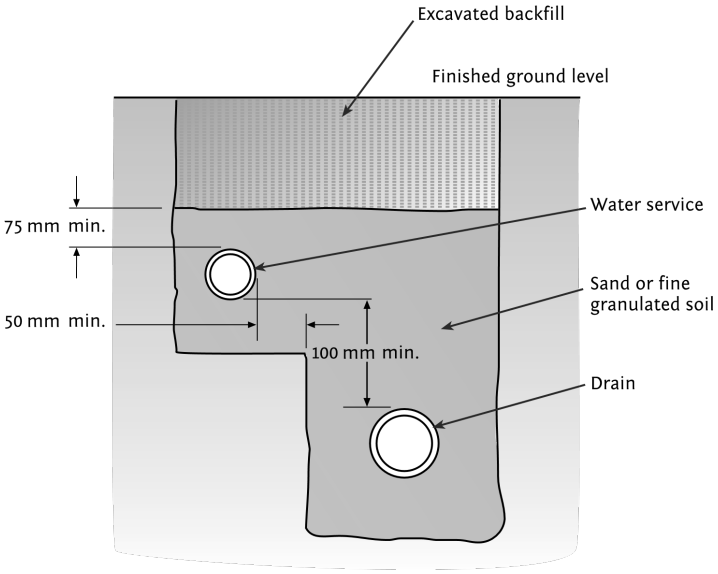
Pipes should not be installed above one another or above other services, such as foulwater drains, stormwater drains, communication cables, and water services.

The following picture shows an example of a uPVC drain crossing other drains, which does not allow room for future maintenance. The picture also shows telecommunication and water services that do not have the required 100 mm clearance from the drain.

Drains should not be installed above one another or other services.

Separation distances vary so you should check the Standards or Codes for all services that will be nearby. Generally, the distances are 100 mm from underground electrical conduit, electrical cable, gas pipe and water pipe.

However, when underground gas or electric services are not protected or identified, a 600 mm distance is required. The diagram below shows an example of a trench which is shared with other services.



Generally, any underground consumer piping crossing any other underground service must:

1. Cross at an angle of not less than 45°
2. Have a vertical separation distance of 100mm

You can identify other services by labelling or colour. When asked to mark their positions, owners of underground services use the following spray paint colours and letters on the ground above where the service is located:

Service	Symbols	Surface Marking Colour	Duct Colour
Telecommunications	T, CHOR, V/COM	Purple	Purple
Electricity	E	Orange	Orange
Gas	G	Yellow	Yellow
Water	W	Blue	Blue or white
Foul water drains	SS	Red	Light grey
Stormwater drains	SW	Pink	Dark grey

Commonly used service pipe and cable colours

It is not always obvious when you uncover an existing service which one it is. Some commonly used colours are listed below:

- Black plastic could be a power cable, older water main or telecoms cable.
- Blue is usually MDPE (medium density polyethylene) water main.
- Yellow is usually HDPE (high density polyethylene gas main).
- Cream plastic is usually drain pipe — look for writing on the pipe.
- Grey plastic may be older storm water drain pipe.
- Purple or lilac pipe is usually for non-potable water, such as reclaimed water supplies
- Older drain pipes may be red earthenware or concrete.

Underground services can be identified in various ways besides label and colour. They can be identified by:

Marker tapes

When backfilling a trench after installing a service, it is good practice to lay a marker tape of the same colour as the labelling with wording to identify the service below. Lay the tape above enough backfill over the service to prevent a spade or pickaxe penetrating the service if it penetrates the marker tape.

Metal detectors

You can hire or buy handheld metal detectors to help you mark out on the ground where existing underground services are located.

Tracer wire

It is also good practice when installing plastic pipe underground to lay a plastic covered metal wire just above it. This allows the wire to be detected by a metal detector and show the position of the existing plastic pipe. This is a requirement for non-metallic gas pipes.

Avoiding or removing obstructions

During your excavation you may come across obstructions. Examples of obstructions include wall foundations, boulders or old foundations in the ground, and other underground services.

If there is an obstruction blocking the path of the proposed trench, then you will have to either:

- avoid the obstruction, or
- remove the obstruction, but first obtain advice about passing through the obstruction, for example, a foundation

The obstruction could be avoided by:

- relocating the proposed trench to miss it
- going below it
- going above it if it still achieves the required depth of cover and fall
- penetrating the obstruction by drilling through it, as long as it is safe and practical to do so

Controlling trench collapse

Trench collapse is one of the main hazards during trenching or excavation work, particularly when working in/entering the excavation.

The *Good Practice Guidelines Excavation Safety, July 2016* provides several methods of controlling this hazard.

You should be familiar with this document, and you can obtain a copy by viewing or downloading it from the WorkSafe NZ website:

http://www.worksafe. govt.nz/worksafe

Safe slope – benching and battering

One of the simplest methods of controlling collapse is by providing a safe slope.

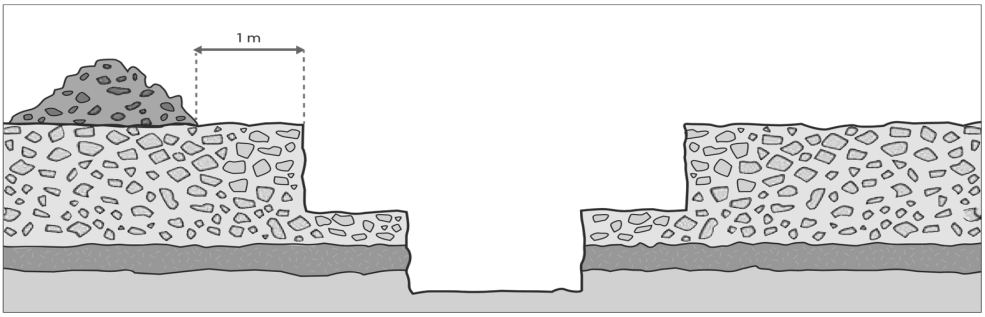
Safe slope is achieved by cutting the sides of a trench, either by benching (creating bench type steps) or by battering (cutting the sides on an angle).

The face of an excavation is the exposed sides or walls of an excavation. The safe slope is the steepest angle where the face of an excavation is stable.

The safe slope depends on the types of ground materials, its height or depth, any loads above, and the moisture and weather conditions.

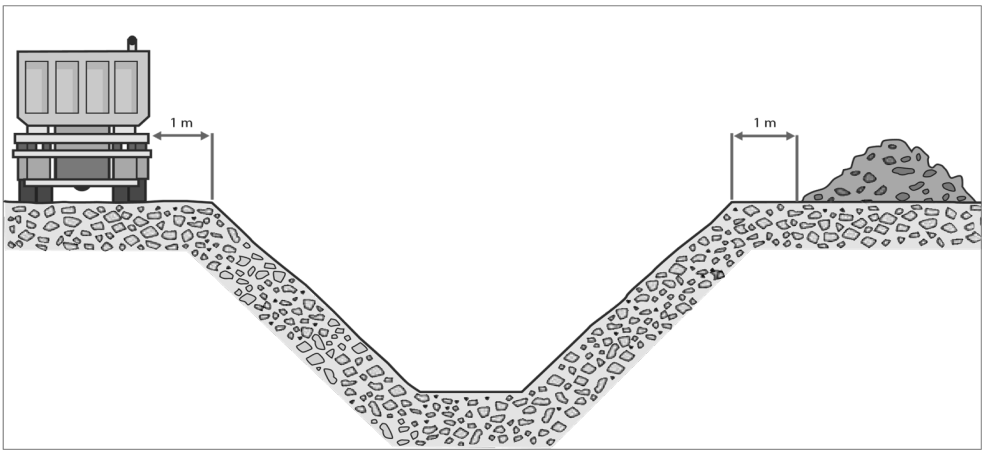
Benching and battering can be used separately or together to control collapse.

Benching is a method of preventing ground collapse by excavating the sides of an excavation to form one or more horizontal steps with vertical surfaces between levels.



Benching

Battering is where the wall of an excavation is sloped back to a predetermined angle to ensure stability. Battering reduces the risk of ground collapse by cutting the excavated face back to a safe slope.



Battering

The *Good Practice Guidelines for Excavation Safety* gives the safe distance for excavated spoil and loads as being 1m from the edge of the trench or excavation.

Shoring

Shoring is another method of preventing trench collapse.

There are several ways to shore an excavation as explained in the *Good Practice Guidelines for Excavation Safety*.

Shoring is a method of supporting the exposed face of an excavation to prevent soil moving and ground collapsing. This prevents collapse by maintaining positive pressure on the sides of the excavation.

Note: precautions are required even if excavation is less than 1.5m.

You can think about which excavations you felt safe in, or how they could have been made safer. For example, if you have worked on a pipe in a shallow trench with running sand walls, you may have felt unsafe. It is important that a competent person chooses the best method to prevent trench collapse. You will be required to follow these instructions, and shore the face as work progresses.

If you are standing and digging past where shoring is installed, then you are in still in danger of trench collapse.

Below is an example of trench shoring and a **soldier set** which is a stand-alone method. It is used mainly for rock, stiff clays and in other soil types with self-supporting properties, however this method of trenching does not provide positive ground support to the whole excavated face.

Trench shields

The use of trench shields is generally required when the excavation is wide, deep or the ground is unstable and likely to collapse. Shields are frequently used for the installation of large diameter pipes, where mechanical access to the site is limited. It is a steel-framed box with two vertical side plates permanently braced apart by cross frames or struts, to provide a safe working place. The limitations of the trench shield is that it is difficult to use where services cross the excavation.

A **trench box** and trench shield are very similar. A trench box contains timber components including sheeting, walings and struts. It can be used where metal shoring cannot be used, such as where services cross the excavation (or need to be worked around). The disadvantages of this method are the bulky components and the lack of strength when compared to a steel trench shield.

Steel sheet piling

Sheet piles are only used for commercial or major works (as it requires heavy equipment to assemble). Sheet piles are available in various lengths, thicknesses and profiles, and interlock to provide a continuous wall.

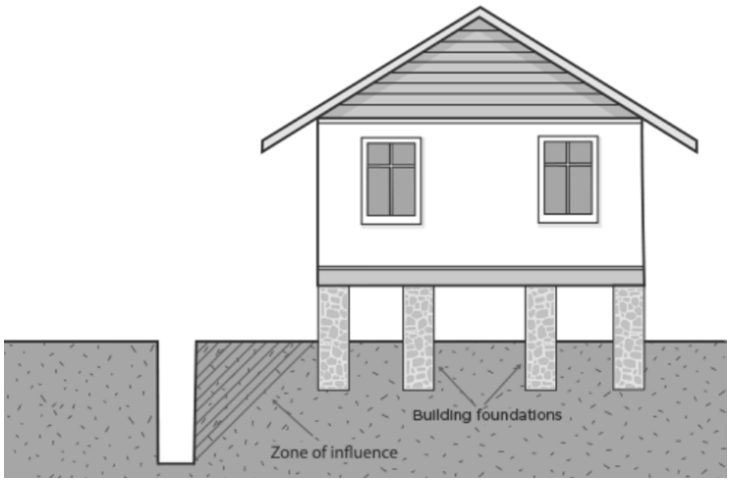
Zone of influence

This is the zone in which any excavated material or actions that you take (such as applying a load to the ground nearby) can affect the excavation's stability. The zone is normally from the base of an excavated face to the surface. The zone's angle will depend on site-specific factors such as soil strength and density. See the diagram below for an example of a zone of influence for a trench beside a building.

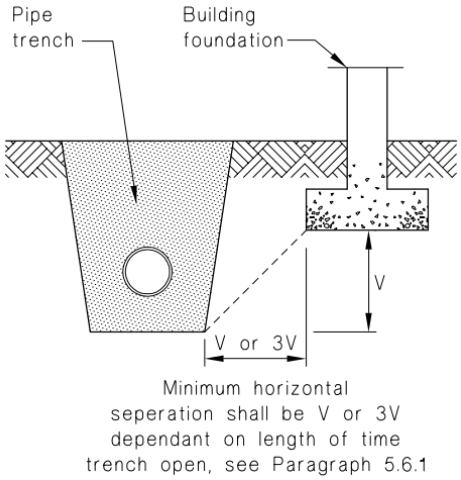
Undermining structures

Care must be taken to ensure that excavating will not erode the base or foundation of a structure, which will comprise its integrity.

For example, the diagram below shows the zone of influence when digging near building foundations. Other examples include retaining walls and multiple trenches dug in the same area.



G13/AS2 Drainage requires that the trench is a minimum distance from the foundation. These requirements increase if the trench is open for 48 hours or more.



Example:

If the trench base is 500 mm below the foundation, the corner of the distance between the trench and the foundation must be:

- 500 mm when the trench is open for up to 48 hours
- 1500 mm when the trench is open over 48 hours

Relationship of pipe trench to building foundation

Excavating the trench

Removing the surface material

After you have marked out a proposed trench line and before you begin excavation you first have to remove the surface material.

It is important to know who is going to do this work, you or another contractor. On a construction site, it may be another contractor. On a residential job it will often be you unless the owner or employer has sub-contracted that part of the work out.

Examples of surface material and handling are given in the table below.

Surface material	How to remove and reinstate
Unfinished ground	This ground usually contains unwanted weeds and debris. Usually, these are not wanted when backfilling, so the surface is scraped bare and permanently removed from the site to a landfill or dump point on a construction site.
Grass	Grass should be carefully cut in squares and placed out of the way, face down (they should also be watered regularly). They can be replaced after the trench is backfilled.
Concrete	You may need a contractor to neatly cut the concrete, then break up and remove the unwanted section from the site. The same contractor may also place new concrete after backfilling and compacting.
Tar seal	You may choose to cut, break and remove this yourself. However, it is wise to get a contractor to place new seal after backfilling and compacting.
Paving	It is wise to get a contractor to remove the pavers and re-lay them after backfilling and compacting.

When the surface material is removed, the spoil can then be excavated. The excavated trench should have a minimum depth and width and a slope with the correct gradient if required.

Controlling water should be a consideration before you begin your excavation. The trench should have good drainage of the trench floor to avoid ponding or flooding.

Too little water can cause sandy soil to flow in a process known as sand piping, but too much water can cause sections of soil or rock to slip.

See the section on dewatering for more information.

Calculating volumes, distances and diameters

Part of the planning process will involve working out how much material to remove, what you are going to do with it, and how much bedding or fill material may have to be brought in.

For most trenches or excavations, you will need to calculate:

- trench length, width and depth
- volume of soil to be removed
- volume that spoil will occupy
- diameters of pipes and protective sleeves or ducts

The information for these calculations can come from either site plans and specifications, or your own measurements.

If you need help with these calculations, ask your tutor or supervisor.

Important:

- *excavation swells, and*
- *backfill shrinks.*

Soil becomes compacted by its own weight and any weight or traffic upon its surface. When you excavate soil to form a trench, the excavated spoil (dirt, rock, mud or sand) crumbles and then occupies approximately twice the original volume of the trench. The volume of the spoil depends on the material. See the next section ‘excavate spoil’ for more information.

You have to compact (compress) soil used for backfilling by using mechanical compacters often called thumpers or whackers. Therefore, you need approximately twice the trench volume of backfill material (depending on the material). See ‘bedding and backfill materials’ for more information.

Excavate spoil

When spoil is excavated, remember to allow for it to swell (bulk) to about twice the size of the trench. This **bulking** will affect how many truck loads are needed to remove it from site, and/or how much space must be available to store it, ready to be used as backfill.

When spoil is placed on the ground, it tends to form a long heap of roughly triangular shape. The size of this heap should be estimated allowing for swelling, and the area marked out where the spoil is to be placed.

Toe boards should be pegged to the ground around the heap to prevent the base from spreading. If rain is likely, a tarpaulin should be placed over the top and secured with pegs, to prevent the spoil from turning to mud and washing away or back into the trench. The spoil should also be placed far enough away from the trench to prevent it pouring back in, particularly if it rains.

Excess material needs to be stored away from the excavation's zone of influence (plus 1m) and placed on the lower side of the excavation, to be disposed of safely.

There are other important conditions to be aware of when excavating or trenching.

Slippage

This refers to the soil slipping back into the trench and/or causing trench collapse. For example, the sides of a trench dug in dry ground may remain stable. However, if it rains and the ground becomes waterlogged, it can turn to mud and slip into the trench.

Other causes of slippage include:

- crumbling soil
- heavy loads placed too close the edge of the trench
- inadequate shoring
- inadequate dewatering

Scouring

This occurs when running water washes the soil away or scours it out. Dewatering is one way to prevent scouring.

Scouring can:

- cause trench collapse
- undermine foundations
- remove bedding material
- change trench depths, and
- change trench gradients.

Soil properties

The ground that you excavate may contain top soil, sand, clay, rocks and gravel.

You have to select your methods and materials to best suit the ground conditions. Important soil properties include:

- friability
- porosity
- compactability

Friability

Soil and sand are said to be friable. This means the sides of the trench will crumble and fall back into the trench unless you shore it up to keep it in place.

Porosity

Porous ground such as soil, sand or rotten rock absorbs water. Saturated porous soil turns to mud if the water can't drain through it to a porous layer below.

Non porous ground such as clay or solid rock will not absorb water.

Broken rock (gravel) won't absorb water but allows water to drain through the gaps in between it.

A trench dug in clay or solid rock can fill up with rainwater and hold it. Therefore, it must be dewatered. A trench dug through soil or sand that has clay or solid rock below will absorb water sideways, weakening the trench wall. Therefore, both shoring and dewatering will be needed.

Compactability

You must be able to compact any soil or spoil you use for backfilling. That means you must be able to compress it with mechanical compacters.

Compacted ground is hard and should not sink with time or traffic.

Uncompacted ground is soft and it will sink with time or traffic.

Check the job requirements to make sure that you backfill for the intended usage of the area.

Visually identifying a stable base

Drainpipes need a strong base to support their weight and to avoid sinking.

You need to excavate deeper than the required trench base to allow for a certain amount of bedding material (support) under the pipe.

Below this material is the bottom of the trench, or sub base (stable foundation). You can visually inspect the trench bottom and probe it with a steel bar to see if it is firm and stable. If it isn't then you may need to excavate deeper until you do find a stable sub-base, and then partially backfill and compact with firm material before laying the bedding material.

A more accurate method of measuring the stability of the base material is by using a **pentrometer**.

A penetrometer works out the density of the base material, whether it is hard or soft. It has a weight which slides freely down a steel rod and delivers an impact to the point. The device registers a measure of how far the rod penetrates the ground.

While a penetrometer is easily used, the measurements may need to form part of an engineer's report in the consent process.

An engineer may also be required to design a stable sub-base.

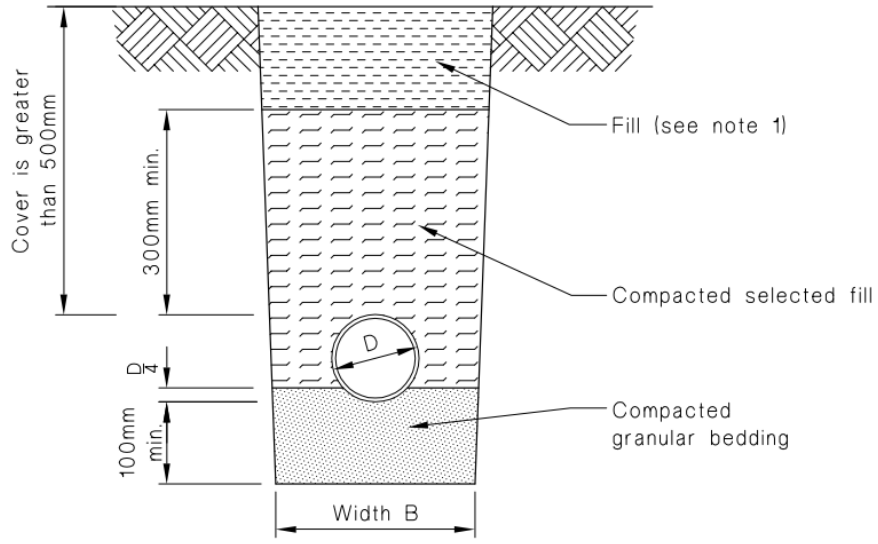
The trench width, depth and cover

The depth of a trench is largely determined by what ground cover is available. Whether the trench is for drains, gas pipes or water supplies the trench must be deep enough to allow the services to be covered. The pipes must be protected from physical damage.

Each service has its own specific requirements for trench depth, coverage, and identification.

The relevant code or standard should be consulted to ensure the trench depth, width and cover comply with **minimum** requirements.

The diagram below shows an acceptable method of bedding and backfilling of drainage pipes, according to G13/AS2. The trench width is represented as B and the pipe diameter as D.



Acceptable method of bedding and backfilling of drainage pipes where cover is greater than 500 mm

The width of the trench shall be no less than the pipe diameter plus 200 mm. This is the same width as given in AS/NZS 3500.2 Sanitary Plumbing and Drainage.

If installing drainage pipes, NZBC G13/AS3 Plumbing and Drainage states that trenches must be no wider than 600 mm. This will prevent the unnecessary removal of natural ground and keep the ground stable if the drain is laid around structures. Removal of unnecessary ground also makes compaction more difficult if the sides of the trench are sloped.

Backfilling and clearing the site

A pipe can be installed in a trench after you have:

- excavated to below the required depth
- found a stable sub base
- laid suitable bedding material
- provided the required gradient if it is a drainpipe
- surrounded the pipe with a non-abrasive material such as sand.

Once installed, backfilling of the trench and compacting can occur. Backfill needs to be compacted in layers until level with the ground, ready for the surface to be reinstated (put back as it was before).

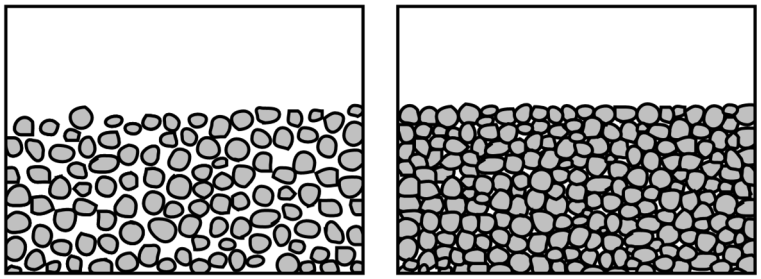
Bedding and backfill materials

Protection of in-ground piping services includes considering the type of bedding and backfill materials used. The type and quality of materials selected should not have an adverse effect on the pipe or coating. For example it should be free of materials such as stones that could damage the pipe.

It is important to remember that excavation swells and backfill shrinks.

Soil becomes compacted by its own weight and any weight or traffic on its surface. When soil is excavated to form a trench, the excavated spoil crumbles and then occupies approximately twice the original volume of the trench.

If the soil is not compacted it will settle over time to leave an uneven surface. If spoil is used for backfilling, approximately twice the amount of trench volume is required, as illustrated in the diagram below.



Loose soil
(poor load support)

Compacted soil
(improved load support)

However, backfill with gravel may be as low as 1.25% compaction. Selection of material will depend on the depth of cover and the intended usage, as well as the expectation of the finished surface.

Compaction rate

When ground is compacted, additional material is added to the original volume. This increases the density of the ground as the molecules are closer together. The compaction rate may be expressed as a percentage (%).

As an example, a trench has a volume of 60 m³ and a compaction rate of 120%. To calculate the volume of material required for backfilling:

Total volume required = actual trench volume x compaction rate

= 60 m³ x 120%

= 72 m³

To backfill, you place the first layer of material, such as soil or sand, into the trench and compact it. Then install the marker tape. Then continue backfilling and compacting layer by layer, until level with the ground ready for the surface to be reinstated (put back as it was before).

After backfilling, you must clear the site of all construction debris and your working equipment. On a construction site there may be skips or dump points you can use. You must also remove all rubbish from residential jobs, either by transporting it to the tip yourself, or hiring a skip which will then be removed by its supplier.

Refer to: Good Practice Guidelines Excavation Safety, July 2016.

***Remember** that under the Health and Safety at Work Act (HSWA) and its Regulations, you are always responsible for work safety.*

Dewatering an excavation

What looks like a safe work area may be very dangerous due to the amount of water present in and around the excavation.

Dewatering means removing any water that runs into and accumulates in trenches. It can also mean removing surface water from the ground above a trench to avoid the sides of the trench becoming soaked. If the sides of the trench get soaked, they will become heavy and unstable and may collapse (fall inwards).

It is also not practical to work on submerged pipes and equipment. Laying and jointing pipework will be difficult, as the pipes may float or move out of place. Even a shallow trench that has been dug could fill up with rainwater. Then you will have to bail it out just as you would water from a boat.

Water should discharge to an approved outfall, with silt and solids screened from it to protect the outfall. You must also consider Resource Management Act requirements.

Other examples of situations that may require you to dewater an excavation are when a high groundwater table is seeping into the excavation, when there is surface runoff after heavy rain, or overflow from stormwater drains, nearby swamps, dams, lakes or rivers.

To dewater (empty of water) deep trenches, you will need to install and operate dewatering equipment.

Installing dewatering equipment

To dewater a deep trench, you will need to pump the water out.

Portable pumps must be mounted on a suitably wide timber platform or feet to prevent the pump from rotating when its electric motor starts.

A strainer must be fitted to the inlet of the suction hose of a surface pump, or to the inlet of a submersible pump. This is to prevent stones and gravel from damaging the pump’s impeller.

Once the pump is started, the hoses become pressurised and will move. Therefore, you must stake the hose ends to the ground and if needed place securing stakes at intervals along the hoses to keep them in position.

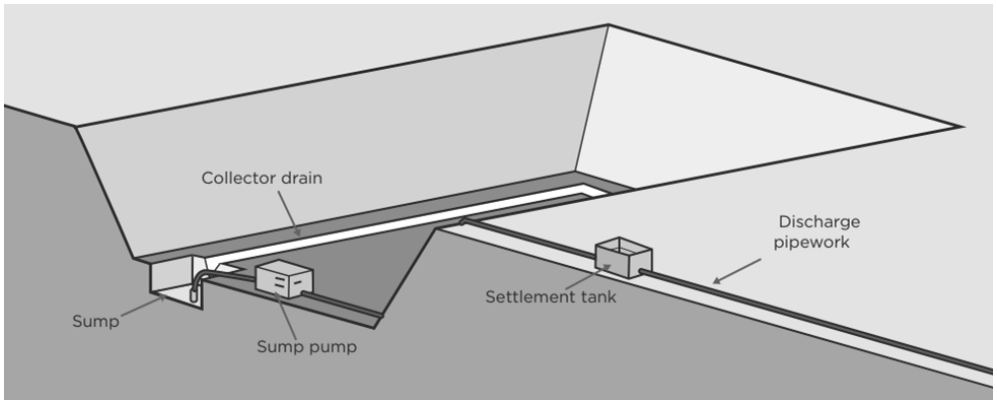
Calculate the trench volume to determine how much water you need to remove then select a suitable pump by its flow rate to ensure that water can be pumped out in a reasonable amount of time (preferably faster than rain can flow in).

Dewatering equipment could include;

- surface pumps, or
- submersible pumps.

Surface pumps

These are installed on the ground above the trench. The pump's suction hose is dropped into the trench to suck out the water. Run the discharge hose to a place where the discharged water can safely drain away without running back towards the trench or causing a nuisance or property damage.



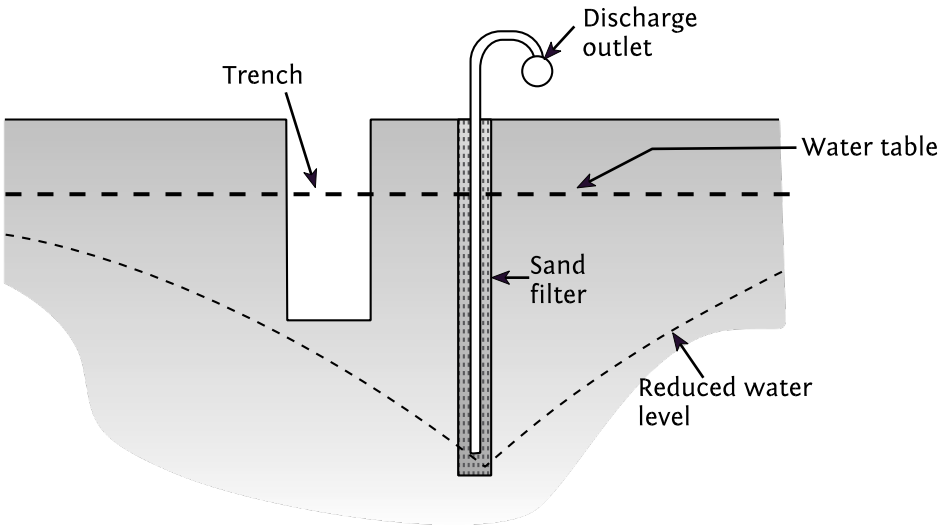
Suction lift pump system

Submersible pumps

These are designed to be installed and to work under water. The pump is placed in the trench and the discharge hose run out of the trench to a safe discharge point. If submersible pumps are used in a trench, shoring should be installed to stabilise the sides of the excavation.

Pumps can also be made to suck trench water from a well made of steel pipe.

Well pointing means using steel riser pipes that have holes drilled through their sides at one end.



Well pointing

The perforated (drilled) end of the pipe or spears are driven alongside and deeper than the base of the trench (sometimes in a shaft or bore).

Water flows into the pipe through the perforations, forming a well. The suction hose of a surface pump which is a vacuum type pump is dropped down this pipe and secured. When the pump starts, it creates a vacuum and sucks water from the well point. The pump must be above ground level.

On larger excavations a series of well points may be used to control the water and these would be pumped through a header/manifold system.

Header manifold is a manifold used to connect a series of well-point spears to the suction or vacuum pump.

Factors affecting the choice of dewatering equipment

Four of the most common factors are listed below.

Factor impacting on choice of equipment	Impacts on the equipment choice
Size of excavation	Depending on the size of the excavation, you may need more equipment or bigger pumps, such as multiple pumps or well pointing (which has multiple heads).
Amount of water for removal	You will need a pump design which can move enough water fast enough, such as a pump with more power/size, with the pump discharge diameter the correct size for the amount. More pumps could also be used.
Rate of water for removal	The higher rate means that more equipment is needed that is a larger size. You must make sure that the flow rate of the pump system is adequate for the water rate.
Quality of water for removal	Water quality may affect the pump's operation. There may also be health and safety or RMA issues. The pump needs an inlet filter basket/strainer and a trash pump.

Other equipment used for dewatering

Shoring is used to support the sides of an excavation, preventing ground collapse.

Spears are a pipe with perforated holes driven into the ground, used as the inlet to the pumping system from which the ground water is drawn.

Shafts are a bole hole drilled into the ground, where the submersible pump is installed.

Vacuum pumps are used for well pointing. They create a partial vacuum in the suction side of a well point system drawing water from the spears. Vacuum pumps will draw air as well as water, thus eliminating cavitation problems that may occur with conventional suction style pumps.

Got questions?

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

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