(Mineral Resources Infrastructure Work)

NTQF Level -I

Learning Guide -39

Unit of Competence: - Carry out manual excavation

Module Title: - Carrying out manual excavation

LG Code: MIN MRI1 M11 LO2-LG-39

TTLM Code: MIN MRI1 TTLM 0819v1

LO2: Dig small excavations by hand

Instruction Sheet	Learning Guide 39

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Confirming location and specifications of the intended excavation area
- Identifying service markers or taped areas
- Determining location *of underground services to avoid damage* or interference
- Using hand tools
- Excavating trench and pits by using hand tools
- Undertaking trench collapse prevention procedures
- Placing barricades around the excavation

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, **you will be able to –**

- accesses, interpret and apply compliance documentation relevant to the work activity according to organizational requirement
- obtain safety requirements from the site safety plan and organizational policies and procedures, and applied to the allotted task
- Identify and obtain signage requirements from the project traffic management plan and implemented according to organizational policies and procedures organizational policies and procedures.
- select appropriate tools, plant and equipment to carry out tasks consistent with the requirements of the job, checked for serviceability and rectified or report any faults
- Identify environmental protection requirements from the project environmental management plan, and applied to the allotted task

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 7.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1” in page 6, self-check 2 in page9-, , self-check 3 in page 12, , self-check 4 in page23, , self-check 5 in page27, , self-check 6 in page32, , self-check 7 in page 37.

5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1 to 7).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Confirming location and specifications of the intended excavation area

1.1. Definition of location and specification

Location is used to identify a point or an area on the Earth's surface or elsewhere. The term location generally implies a higher degree of certainty than place, the latter often indicating an entity with an ambiguous boundary, relying more on human or social attributes of place identity and sense of place than on geometry. Two types of location

A. Relative location

A relative location, or situation, is described as a displacement from another site. An example is "3 miles northwest of wukiro".

B. Absolute location

An absolute location is designated using a specific pairing of latitude and longitude in a Cartesian coordinate grid — for example, a Spherical coordinate system or an ellipsoid-based system such as the World Geodetic System. GPS (Global positioning system) is used to know absolute location of an area.

What is GPS?

The Global Positioning System (GPS) is a satellite-based locating and navigating utility that determines a user's precise latitude, longitude and altitude by tracking signals from satellites. Depending on the type of receiver and certain other conditions, it is possible to achieve real-time position accuracies within meters or even centimeters, with position calculations several times per second.

Fig 1Different models of GPS

Specification is a detailed document providing information about a designed product or process. For example, the design **specification** must include all necessary drawings, dimensions, environmental factors, ergonomic factors, aesthetic factors, maintenance that will be needed, etc

1.2 Dimensional specifications in excavation

Measurement: Length, width, height, depth

Length: the measurement or extent of something from end to end; the greater of two or the greatest of three dimensions of an object.

Width: the measurement or extent of something from side to side; the lesser of two or the least of three dimensions of a body.

Depth: the distance from the top or surface to the bottom of something.

Fig 1.2.Dimensional specifications in excavation

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define what location means? What is the difference between relative and absolute location? (3 pts.)
2. Which of the following instruments are used to measure location of an area?2pts
   A.GPS B. Compass C. Altimeter D. Mobile
3. _____ is a detailed document providing information about a designed product or process.(2pts)
4. The distance from the top or surface to the bottom of excavated surface is called_____.(2pts)

A. Length B. Width **C.** Depth

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	Identifying service markers or taped areas

2.1 Concepts of service markers or taped areas

Marking Services offers a full complement of identification markers designed for nearly any environment. Whether you're looking for indoor, outdoor, industrial grade or harsh chemical environment markers, marking service has the standard and custom products to meet your specific needs.

Barricade tape/service markers is brightly colored tape (often incorporating a two-tone pattern of alternating yellow-black or red-white stripes or the words "Caution" or "Danger" in prominent lettering) that is used to warn or catch the attention of passersby of an area or situation containing a possible hazard. It acts as a minor impediment to prevent accidental entrance to that area or situation and as a result enhances general safety. Barricade tape is also known as construction tape or barrier tape or in reference to the safety hazard involved as caution tape, warning tape, danger tape or hazard tape. When used by a police force, the tape is named police tape.

The tape is often wrapped and affixed as a visual warning sign and demarcation, for instance against entering a dangerous area, such as an industrial or commercial building site, a road works construction site or the scene of an accident or a crime (for crime scene preservation), or against handling inoperative machinery or appliances.

The following symbols and colors used barricade tape colors

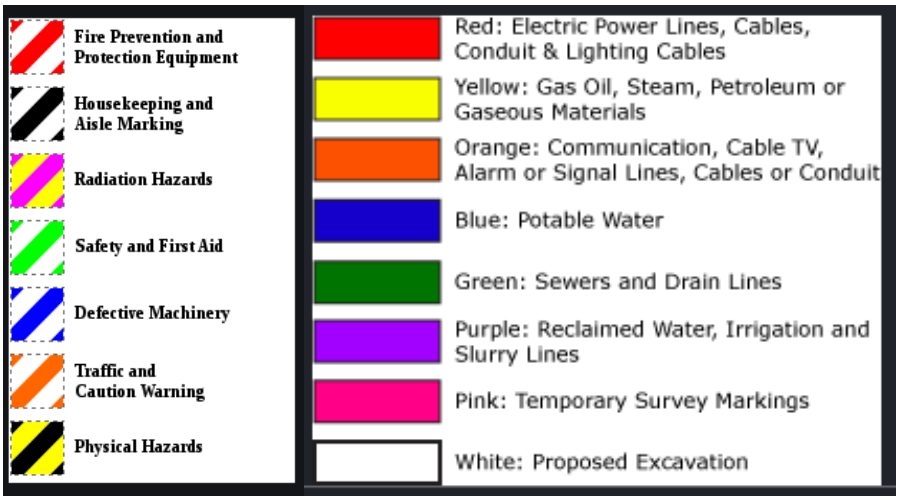

Fig 2.1. Symbols and colors used barricade tape

2.2. OSHA (Occupational Safety and Health Administration)-specified barricade tape colors

1. Red / white for Fire Prevention and Protection Equipment.
2. Black / white for Housekeeping and Aisle Marking
3. Magenta / yellow for Radiation Hazards
4. Green / white for Safety and First Aid
5. Blue / white for Defective Machinery
6. Orange / white for Traffic and Caution Warning
7. Black / yellow for Physical hazards

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are tape/service markers? (3 pts.)
2. What white colors barricade tape /service markers indicate? (3pts.)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Determining location of underground services to avoid damage or interference

3.1. Basic definitions

Underground services include all underground pipes, cables and equipment associated with electricity, gas, water (including piped sewage) and telecommunications; as well as other pipelines which transport a range of petrochemical and other fluids.

Damage to underground services can cause fatal or severe injury as well as significant disruption and environmental damage; it can also delay the project and incur considerable costs.

3.2. The main dangers which may arise from work near underground services are summarized below:

a. Electricity Cables

Injuries resulting from damage to live electricity cables are usually caused by the explosive effects of arcing current, and by any associated fire or flames which may follow, when the sheath of a cable and the conductor insulation is penetrated by a sharp object such as the point of a tool. Such damage can also occur when a cable is crushed or bent severely enough to cause internal contact between the conductors or between the sheathing and one or more of the conductors.

b. Gas Pipes

Damage to gas pipes can cause escapes which may lead to fires or explosions if an ignition source is present.

There are two types:

(a) Damage which causes an immediate escape; and,

(b) Damage that causes an escape some time later. The damage may occur at the time the work is carried out (for example damage to a pipe wrapping may eventually lead to corrosion).

c. Liquid Petroleum Services or Oil Pipelines

Damage to these services is similar to that for gas pipelines. In addition, there are significant environmental risks, particularly near waterways.

d. Water and Waste Water Pipes

Damage to water and waste water pipes is less likely to cause injury, but a jet of water from a high-pressure water main can injure personnel or damage adjacent services. A leak from an underground pipe can wash away subsoil and reduce the support for adjacent services, highways and structures. Similarly, leaks can wash away support for thrust blocks making them unstable.

e. Telecommunication Cables

With the exception of fiber optic cabling, there is little ‘direct’ risk of personal injury from damaging a telecommunications cable. There is, however, the potential for ‘indirect’ danger if emergency services cannot be contacted. All business is now absolutely reliant on electronic communication and a damaged circuit can cause extensive disruption to services. Loss of data results in loss of revenue and repairs to optical fiber and multi-pair cables can be extremely costly.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are Underground services?
2. What are the main dangers which may arise from work near underground services?3pts

Note: **Satisfactory rating – 3.5 points** **Unsatisfactory - below 3.5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

Information Sheet-4	Using hand tools

4.1. Characteristics of Suitable Hand Tools

Hand tools should be of good quality and designed so that they are efficient in use. The tools should be strong enough to withstand intensive use at the work site, and resistant to wear so that they have a long working life. For most tools this means that the metal head should be made from carbon steel, heat-treated to give the correct strength and wear characteristics. For the main excavation and striking tools such as hoes, pickaxes, mattocks and sledgehammers, the tool heads should be forged in a single piece. Cast or fabricated and welded tool heads do not provide sufficient quality.

4.2. Importance of Tools and Equipment

Proper tools and equipment are essential for the effective operation of any mining works site. Equipping the excavation site with the correct tools and equipment plays an essential role in achieving timely and good quality results. For every construction activity there is an optimal combination of tools, equipment and labor. Depending on the nature and content of the works, the technical staff needs to know which tools to use and how to effectively combine them with manual labor.

4.3. Basic Safety Rules for using Hand Tools

- Always wear eye protection.
- Wear the right safety equipment for the job.
- Use tools that are the right size & right type for your job.
- Follow the correct procedure for using every tool.
- Keep your cutting tools sharp and in good condition.
- Don't work with oily or greasy hands.

4.4. Detail of using Hand Tools

4.4.1. Hoe

The hoe is probably the most useful and widely used hand tool in the world. It is mostly used in agriculture for tilling virgin land, preparing the soil for planting and for weeding and harvest. But the hoe is also a very important and useful tool for road workers and in all other kinds of work which involves excavation.

The hoe consists of a blade and a handle. The blade can be fastened to the handle with an eye or a spoke.

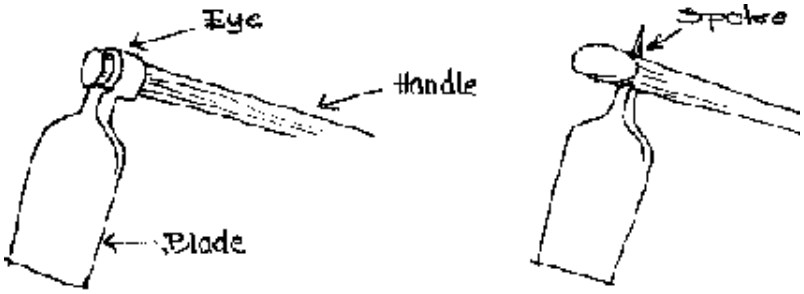

Fig.4.1. Parts of hoe

The eyes can be of different types: round or oval.

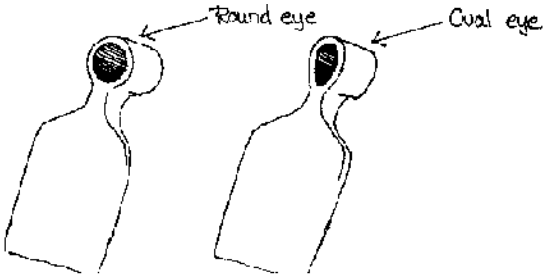

Fig.4.2. Hoe eyes

The round eye makes it easier to replace the handle but cannot hold the handle in place very well - the handle tends to rotate.

Oval eyes need oval-shaped handles which means more work in making the handle. But the oval handle prevents the blade from twisting and the handle itself will not twist in the hands of the worker. Oval eyes and handles are therefore preferable. The blade of the common hoe has a straight cutting edge and is usually forged.

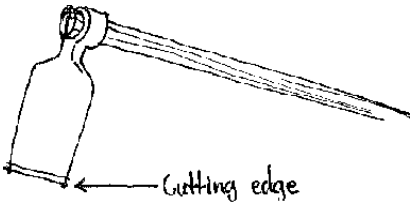

Fig.4. 3. Cutting edge of hoes

Handles

Handles must be well dried before they are shaped and fitted. One end of the handle should be bigger than the rest of the handle to prevent the blade from loosening. This type of handle is called conical.

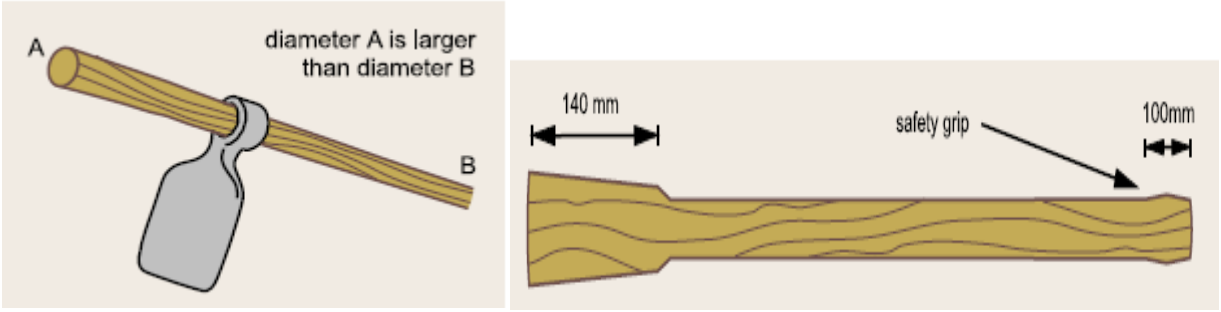

Fig.4.4. handles use for hoe

The length of the handle should be such that it is comfortable for most workers to use. It is recommended to use wedges to fix the handle effectively to the blade. This can be done like this:

(1) A small slot is sawn in the "blade" end of the handle:

(2) The blade is pushed in place:

(3) A wooden wedge is hammered into the slot:

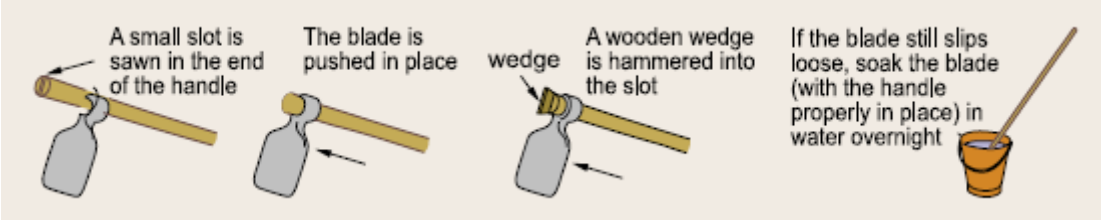

Fig.4.5. mechanisms of fix the handle

If the blade still slips loose, it helps to put the blade (with the handle and wedge properly in place) in water overnight.

Using the hoe

Hoes can be effective in:

- Excavation;
- loading of baskets or trays;
- spreading.

In excavation the plain hoe is best for rather soft soils with only little or no stones, while forked hoes are better on cohesive or hard and stonier soils. When excavating it is least exhausting to work if one does not have to bend the back all the time.

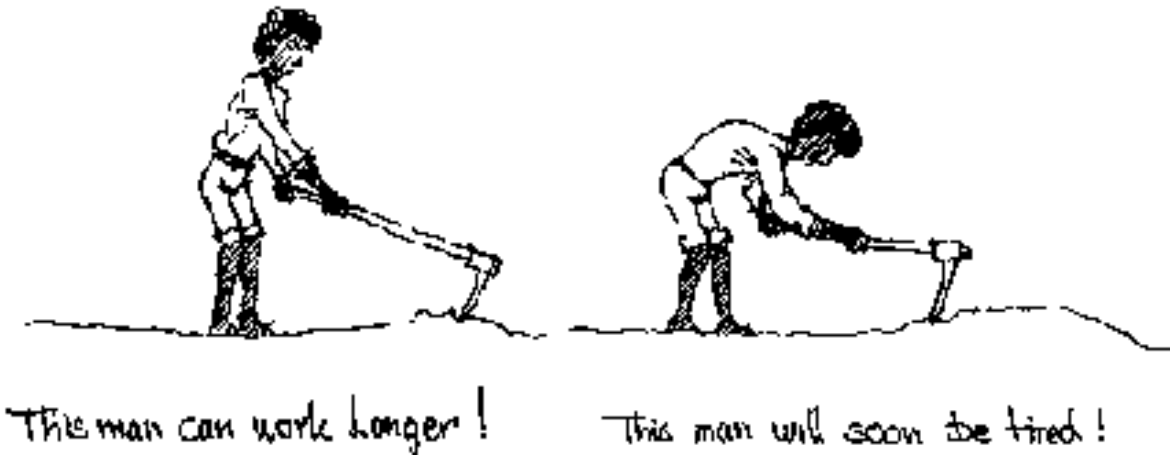

Fig.4.6. mechanisms using the hoe

4.4.2. Pickaxes, mattocks and crowbars

Pickaxes and mattocks

Pickaxes and mattocks are also tools for excavation. They are more specialized for construction work than hoes and suitable for excavation in more stony soils. Many different designs of pickaxes and mattocks are produced. The most common for road works are, however:

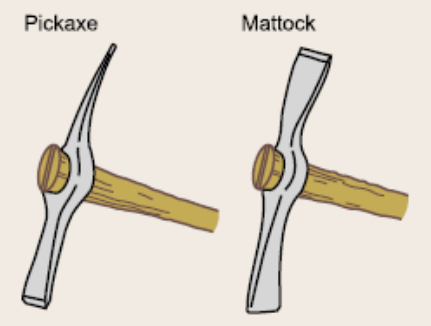

Fig.4.7. Pickaxes and mattocks

These tools always have an oval eye. Both the pickaxe and the mattock are rather heavy; the pickaxe usually between 2.7 and 3.6 kg and the mattock between 1.8 and 2.7 kg.

Using pickaxes and mattocks

Pickaxes are used to loosen stony material, mostly in quarries. It is important to stand somewhat lower than the level which is excavated. This helps to avoid unnecessary strain.

4.4.3. Crowbar

The crowbar is, like the pickaxe, used mostly in stony or very hard soils. The crowbar looks like a very simple tool but it has to be of a very strong material and have a good design to function well. Reinforcement rods can never make good crowbars! The bar itself is often round while the working end of the crowbar is either pointed or chisel formed. A pointed end is perhaps most common but the chisel end is more useful for leverage. The weight depends on the length and diameter. The diameter should be sufficient to give a good, firm grip (approximately 50 mm).

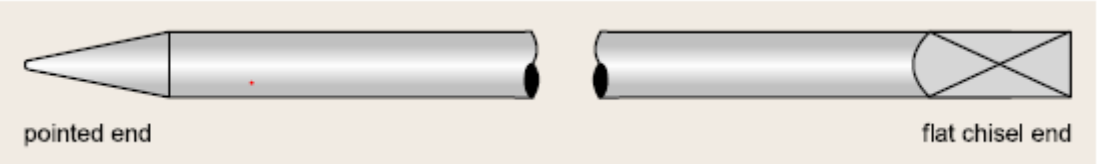

Fig.4.8. Crowbar

To straighten a crowbar it should be held in both hands and struck against a rock as shown in figure 4.9. Hold the crowbar loosely in the hands when doing this. The vibrations can be very strong!

Fig.4.9. Holding crowbar

Using the crowbar

The crowbar is mostly used for:

- Breaking loose hard material in quarries;
- moving stones or other heavy things.

In quarries the crowbar is, combined with the pickaxe, an excellent tool for loosening the gravel. When stones or other heavy things have to be moved, the crowbar is very useful if it is applied correctly as a lever.

Fig.4.10. Using the crowbar

4.4.4. Shovels and spades

The shovel is effective for scooping up material and throwing it either onto a trailer, truck or wheelbarrow or directly to where the material is needed. Contrary to a shovel a spade can also be used for loosening the soil. Spades have stronger blades than shovels. The blades are curved only in one direction. The handle should be long enough to allow the worker to throw the soil with little effort. For workers with an average stature a length of 65-70 cm is recommended.

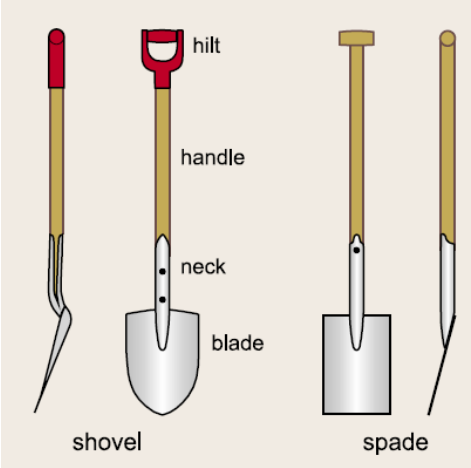

Fig.4.11. Shovels

Shovels and spades should not have sharp rivets or joints which damage the hands of the user. When buying shovels or spades ensure that the joint blade/handle is smooth.

Using shovels and spades

When the soil is loose, the shovel can be used directly to scoop it up and throw it elsewhere. With harder soil the spade is more useful, because it can be pushed into the ground without bending the blade. To help to push the blade into the ground, the worker can put his foot on the top of the blade and press down. To be able to do this the worker should have shoes with strong soles. Alternatively, a broad slotted piece of wood can be fitted onto the top of the blade to allow a barefooted worker to push the blade into the soil without hurting his foot.

4.4.5. Spreaders

Spreaders are tools used for spreading out the soil on fills. A spreader can be a heavy rake but the best spreaders are specially made for the purpose. They can be made of sheet metal (5-4 mm thickness) and have a ridge on the back for crushing lumps of soil. The optimum size of the teeth depends on the type of material to be spread and should be determined by experimentation. Hoes and shovels are also sometimes used for spreading but they are less effective and more tiresome to use than a special spreader or heavy rake.

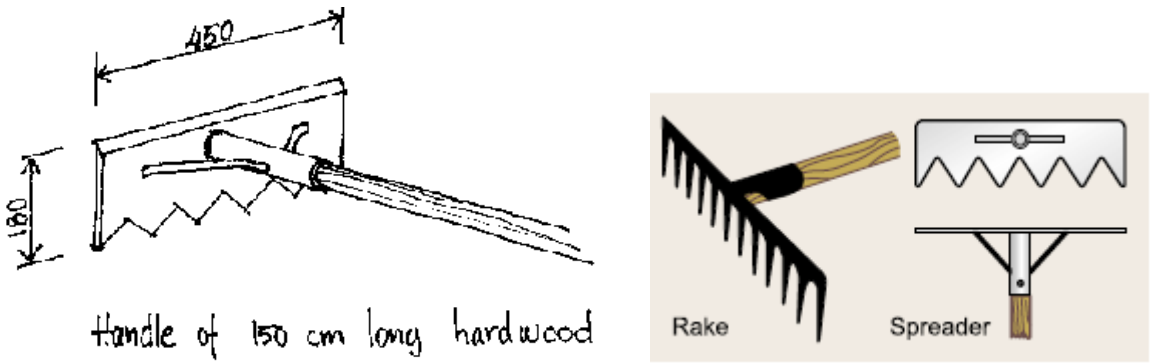

Fig.4.12. Spreaders

Using the spreader

The spreader is very useful when forming a camber from soil which has been heaped along the center-line. The soil should be raked from the centre towards the shoulders and lumps crushed with the back of the spreader.

Fig.4.13. Using Spreaders

4.4.6. Rammers

The rammer is used for compacting soil and consists of a weight with a handle. It can be made of different kinds of material although rammers who totally consist of wood are usually not heavy enough. There are two things which determine the effectiveness of a rammer: its weight and the area of the end which hits the ground. Ideally, the weight should be as large as possible and the area as small as possible. A rammer which can be handled by a worker should therefore have a weight of some 8-10 kg and a diameter of the bottom end of less than 10 cm. The handle must be long enough to allow the worker to lift the rammer without bending his back.

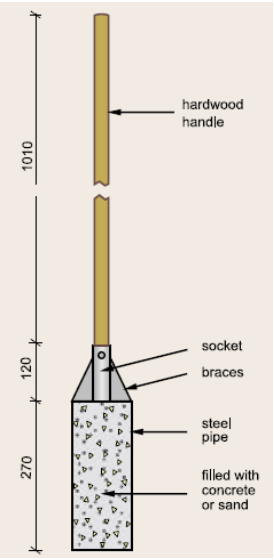

Fig.4.14. Parts Rammers

4.4.7. Wheelbarrows

The wheelbarrow is one of the most useful and economic forms of transportation over short distance (usually not exceeding 150 meters). Wheelbarrows can be of many different types and qualities. A good wheelbarrow should take a big load (struck capacity approximately 70 litres) and be easy to balance, push and tip. Unfortunately, many of the wheelbarrows which are made are small, of poor quality and difficult to push. A wheelbarrow consists of a body or tray which rests on a chassis with attached handles and a wheel. It also has a stand. The strongest and most comfortable wheelbarrows have pneumatic rubber wheels and a tray made of 1.6 mm steel sheet. The tray should be reinforced around the rim and attached to the chassis with bolts, nuts and washers. The clearance between wheel and tray should be minimum 50 mm.

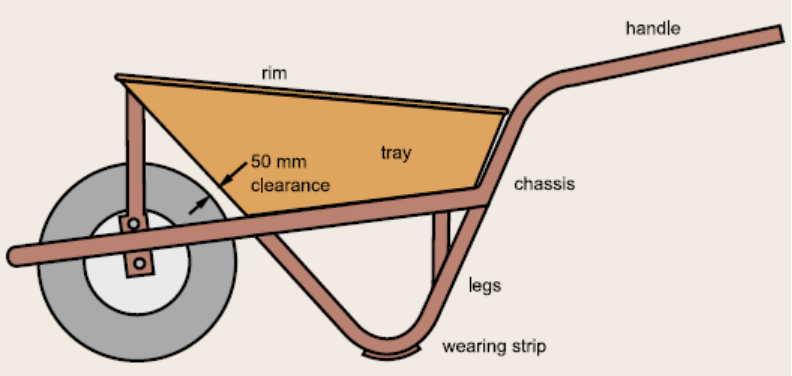

Fig.4.15. Parts Wheelbarrows

4.4.8. Saws

Saws are manufactured in a number of varieties. Cutting trees and bushes requires a crosscut saw, i.e. a saw with a blade designed to cut wood at a right angle to the direction of the grain.

The size of the trees will obviously determine the size of the saw. Larger saws require two operators while smaller versions can be used single-handedly.

Steel framed bow saws are commonly used for cutting small trees and branches. A narrow blade is held in tension by the frame. A quick release lever applies tension to the blade. The lever, combined with an oval sectioned frame, provides a comfortable handgrip. Blades are 20-25mm wide and are produced in a standard length.

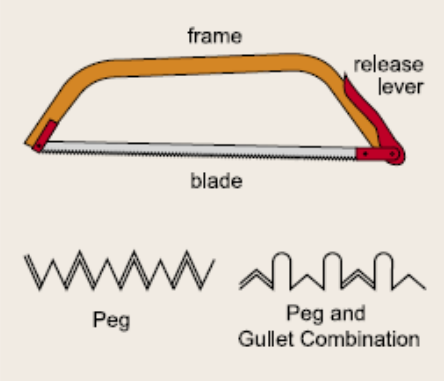

Fig.4.16. Parts Saws

4.8.9. Axes

Axes are essential tools when felling trees. They are also useful during bush clearing for cutting tree branches and stripping branches of felled trees. The head of the axe can be shaped with a single or a double cutting edge. Although the single bit is safer to use, the double bit with its two blades can be used for a longer duration before it needs to be sharpened.

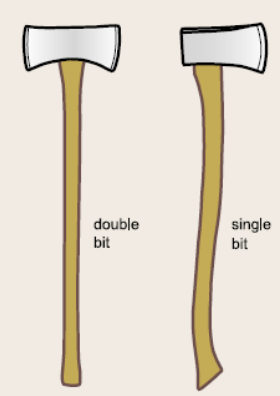

Fig.4.17. Axes

4.5. Some basic guides when using hand tools

- Ensure that employees are properly trained in the safe use of hand tools.
- Always provide training on how to choose the right tool for the job, how to correctly use each tool, and how to identify when tools need repair.
- Select the right tool for the job. Substitutes increase the chance of having an accident.
- Use tools designed to allow wrist to stay straight. Avoid using hand tools with your wrist bent.
- Use good quality tools.
- Keep tools in good condition at all times.
- Inspect tools for defects before use. Replace or repair defective tools.
- Keep cutting tools sharp and cover sharp edges with a suitable covering to protect the tool and to prevent injuries from unintended contact.

- Replace cracked, splintered, or broken handles on files, hammers, screwdrivers, or sledges.
- Ensure that the handles of tools like hammers and axes fit tightly into the head of the tool.
- Replace worn jaws on wrenches, pipe tools and pliers.
- Redress burred or mushroomed heads of striking tools.
- Pull on a wrench or pliers. Never push unless you hold the tool with your palm open.
- Point sharp tools (e.g., saws, chisels, knives) laying on benches away from aisles and handles should not extend over the edge of the bench top.
- Maintain tools carefully. Keep them clean and dry, and store them properly after each use
- Carry tools in a sturdy tool box to and from the worksite.
- Wear safety glasses or goggles, or a face shield (with safety glasses or goggles) and well-fitting gloves appropriate for the hazards to which you may be exposed when doing various tasks.
- Keep the work environment clean and tidy to avoid clutter which may cause accidents.
- Use a heavy belt or apron and hang tools pointed down at your sides, not behind your backs
- Keep the work space tidy. Store tools properly when not in use.

4.6. What should you avoid when using hand tools?

- Do not use tools for jobs they are not intended to do. For example, do not use a slot screw driver as a chisel, pry bar, wedge or punch, or wrenches as hammers.
- Do not apply excessive force or pressure on tools.
- Do not cut towards yourself when using cutting tools.
- Do not hold the stock in the palm of your hand when using a cutting tool or a screwdriver. Always lay it on a workbench or in a vice.
- Do not wear bulky gloves to operate hand tools.
- Do not throw tools. Hand them, handle first, directly to other workers.
- Do not carry tools in a way that interferes with using both hands on a ladder, while climbing on a structure, or when doing any hazardous work. If working on a ladder or scaffold, tools should be raised and lowered using a bucket and hand line.
- Do not carry a sharp tool in your pocket.
- Do not use tools during electrical work unless they are designed for electrical work (e.g., properly insulated).
- Do not leave tools lying around on elevated structures such as a platform or scaffold as they may be bumped and fall.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What safety instructions are to be taken while using hand tools? (3 pts.)
2. What are the different types of hand tools? Choose three hand tools and discus how to use them. (3pts)
3. Safety goggles should always be worn whenever you are using hand tools. (True) (False).(2pts)
4. What should you avoid when using hand tools? (2pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-5	Excavating trenches and pits by using hand tools

5.1. Definitions

Excavation is the process of moving earth, rock or other materials with tools, equipment or explosives. It includes earthwork, trenching, wall shafts, tunneling and underground. Excavation has a number of important applications including exploration, environmental restoration, mining and construction

A **Trench** is a type of excavation or depression in the ground that is generally deeper than it is wide (as opposed to a wider gully, or ditch), and narrow compared with its length (as opposed to a simple hole). ... **Trenches** have also often been dug for military defensive purposes.

Fig.5.1. trenches

A **pit** is (usually) a concavity. A "pothole" is a place on the paved surface of a road where the paving has been worn away, revealing the underlying layer. The top layer has been worn away. But there are times when concavities are called **holes**, and times when tears or (earth) penetrations are called **pits**.

Fig.5.2. pits

5.2. **How to Excavate a Trench and pits holes**

For minor ditches or trenches, you can grab a shovel and start digging. Excavating a deep trench for sanitary sewer installations or other projects, however, requires special consideration. Plan the project in advance and learn how to complete each phase safely and successfully.

1. Call the local or government utility location service. Before you begin any digging project, call a utility location service. This will locate underground gas, electric, water, and communications pipes and cables in the area, to protect you from injury or liability in the event they are damaged.

2. **Plan a route that causes minimal damage.** Take your time in the planning phase to find a layout that meets your needs, avoids utility lines, and minimizes damage to valuable property. With careful planning, the materials you purchase should be sufficient to complete the trench, and you won't have to change your plan after you start digging.

- ✓ Trees, shrubs and other plants may suffer injury or die if their roots are damaged in excavation. Driveways, sidewalks, and structures can collapse if they are undermined.
- ✓ Small plants, even turf grasses, can be removed and stored for replanting with proper care.

3. Determine the depth your project requires. The trench's depth requirements (for example, the required depth of a utility line) are a factor in choosing excavation equipment and other materials.

- Some plumbing systems are gravity operated, and require a slope so the waste or water will flow unaided to the discharge location. In this situation, you may find the trench will be deeper on one end than the other.

4. Determine the type of soil you will be digging in. Sandy soils, loose stony soils, and wet, mucky material will make excavating a straight, deep ditch difficult and dangerous. In these scenarios, you may have to plan additional measures to complete your project successfully:

Shoring: This process uses a support structure for your ditch sides so they do not cave in and injure anyone, or undo the digging you have done before the project is complete. For example, a small excavation could use sheets of plywood supported by posts. Large excavations could use steel trench boxes or sheet piling. Anything deeper than 3 feet (0.91 m) should be shored up. Never enter a trench deeper than your waist if it is not shored up.

De-watering: This removes the excess water from the soil to help stabilize it while working. This can be accomplished either with a well point system or a sock pipe and mud-hog type diaphragm pump to remove the water as it seeps into the excavation.

Benching the excavation: If you are digging in loose soil, a deep vertical trench wall is at risk of collapse. Benching involves digging the trench in steps or tiers instead, so the banks do not have to support more material than they are capable of. These benches are usually at intervals 2.5–3 feet (0.76–0.91 m) deep and twice as wide. They do take quite a bit of sidewall digging, which can require extensive area to complete. Keep in mind that it can still collapse the deeper the trench goes.

5. **Get the excavation equipment.** Shovels, pickaxes, and other hand tools will suffice for minor excavations, but renting a mini excavator can save a lot of work on large jobs. Backhoes and even track hoes may be needed if the project requires a very deep and/or long trench.

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define trench and pits. 2pts
2. What is the difference between a trench and pits? 2pts
3. How do you excavate a trench?3pts

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-6	Undertaking trench collapse prevention procedures

6.1. Introduction

If a Trench collapse happens unfortunately it does cause a lot of injuries to the workers digging the trench. Such injuries include broken leg or arm, death due to lack of oxygen when weight of collapses trench is on the buried worker leaving very little or no space for the proper supply of oxygen. Construction workers working on trenches face high risk of Trench collapse dangers and there are many reasons contribution in Trench collapses. Some of the commonly recognized reasons are that trench walls are not supported by shoring or trench boxes, trenches dig on previously disturbed soil, vibration of the land around the trench area due to the vehicles running too close to the trench, unsafe distance between spoil pile and the lip of the trench, dried trench walls that make trenches weak and heavy rain falls.

6.2. Causes of trenches Collapse

The following are some of the reasons for trench collapse. Detail of each cause is discussed below:

a. Layered soil failure

The above graphic illustrates two different trench collapse scenarios. The left side depicts a “strong over weak” shear failure in which the top layer will collapse over the weaker bottom layer. The second, “weak over strong” shear failure finds the weaker top layer caving into the trench.

Fig. 6.1. Layered soil failure

b. Soft zone failure

This graphic depicts a trench collapse caused by a soft zone failure. The soft zone is a layer of soft soil, sandwiched horizontally between two layers of stable soil. The soft zone causes the top layer of stable soil to have a weak foundation, leading to collapse. The introduction of water to a stable trench can undermine the soil, creating a soft zone. Soft zones also occur naturally over time as soil layers are formed.

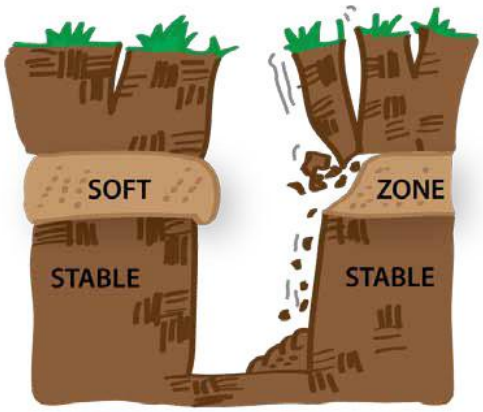

Fig. 6.2. Soft zone failure

c. Sloughing [air drying]

Sloughing occurs when a trench wall becomes so dry that it creates a weak area. Wind blowing into an open trench is a common cause of sloughing. This weak area cannot support the weight of the soil above and will eventually cause the trench to collapse.

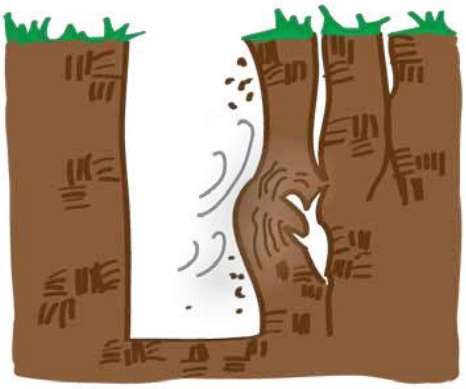

Fig. 6.4. Sloughing

d. Soft pockets

When an area containing varying soil types is trenched, soft pockets may be encountered. While the trench walls consist of mostly stable soils, soft areas of sandy soil are exposed at depths under the surface. These soft, sandy areas are weak spots and will cave in, creating a void beneath more stable soils. Gravity and time will combine to fill the void by way of a trench collapse.

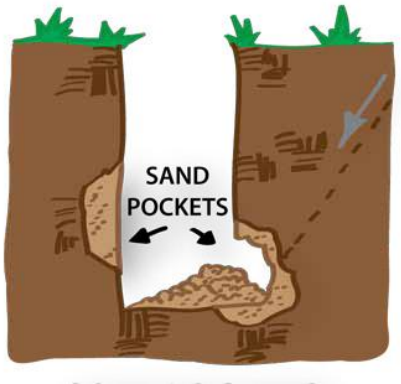

Fig 6.5. Soft pockets

e. Wedge failure

One of the ways that the void will be filled by a wedge failure. A large section of the trench wall will collapse by sliding down the shear failure surface and into the trench. The wedge failure begins as fissures along the surface of the ground. Gravity then acts to create a fracture that continues from the surface down to the area of the void, causing the wedge of soil to collapse into the trench in an angular fashion.

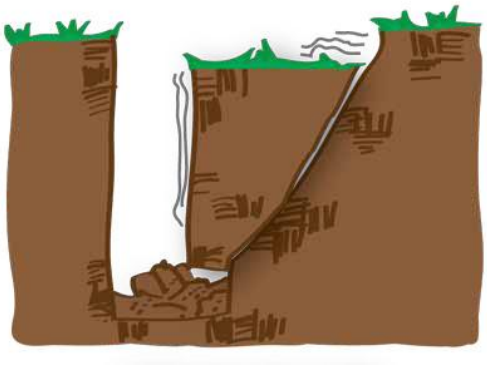

Fig 6.6.Wedge failure

f. Rotational failure

Another way collapsed soft pockets fill voids is a rotational failure. Here, the wedge failure area doesn't slide to the bottom of the trench at an angle, but rather rotates downwards in a circular fashion along the shear failure surface and into the bottom of the trench. Soil failure first occurs at the bottom of the trench which can be seen as budging of the side of the trench.

Fig. 6.7.Rotational failure

6.3. The hazards related to trench collapse

The following are some of the hazards related to trench collapse

- Cave-ins or collapses that can trap workers.
- Equipment or excavated soil falling on workers (e.g., equipment operated or soil/debris stored too close to the excavation).
- Falling into the trench or excavation.
- Flooding or water accumulation.
- Exposure to a hazardous atmosphere (e.g., gas, vapors, dust, or lack of oxygen).
- Contact with buried service lines such as electrical, natural gas, water, sewage, telecommunications, etc.
- Contact with overhead electrical lines.
- Slips, trips and falls as workers climb on and off equipment, or from inappropriate access and egress methods.
- Being struck by moving machinery, or by falling or flying objects.
- Hazards related to materials handling (e.g., lifting, struck by, crushed between, etc.)

6.4. Preventing trench collapse

A trench collapses when its walls fail to contain the pressure of the tones of soil pressing on it. Even though this can be problematic in any depth, it can accelerate if other materials are piled at the edge. To prevent trench collapse due to the extra weight:

- Move extra excavation materials at least 2 feet away from the trench
- If there isn't room, remove the materials from the site
- Remove personnel from the edge of the trench who are not working on it
- Keep all equipment away from the site to prevent cave-ins and blunt force trauma
- How trench workers can stay safe on-site
- Workers who work in or around trenches should follow these steps to remain safe:
- Don't enter trenches that have not been reinforced or inspected at the start of the day or after a rainstorm.
- Don't work under suspended loads
- Never start digging till all underground utilities in the area have been accounted for.
- Keep materials and soil piles at least 2 feet away from the edges
- Make sure air tests are carried out if the trench is more than 4 feet deep. Oxygen deprivation is the second leading cause of fatalities in unregulated trenches.
- Evacuate the trench immediately if you smell a strange odor or see rainwater accumulating at the bottom. Either of these could compromise trench structure or weaken it thus making a cave-in imminent.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is Trench Collapse?2pts
2. List and discus the causes of trench collapse 4pts
3. What are some of the hazards associated with trenches? 3 pts.
4. How can Trench Collapse be prevented? 3pts

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-7	Placing barricades around the excavation

7.1. Definitions

Barricades Means a physical barrier, usually temporary, erected or placed to restrict the entry of persons to an area and/or prevent personnel being exposed to a hazard.

Barricades can be **classed as eithe**r a soft barricade or a hard (solid) barricade.

A. **Soft barricades** are those that use an approved tape to prevent or restrict access to an area. They are suitable in situations where physical protection by use of a safety barrier system is not warranted.

B. **Hard barricade** is a self-supporting fence, or a self-supporting series of continuous plastic, concrete or other solid barriers, erected or placed to restrict the entry of persons to an area. Examples include scaffold tubes, concertina/expandable barriers, and water filled plastic or concrete modular devices (Jersey type barriers).

Note: Hard barricades can provide a safety barrier system capable of physical protection of workers e.g. from the impact of an out-of-control vehicle / mobile plant, or preventing a person from falling off / into an unprotected edge / surface penetration. Where a risk assessment determines that physical protection from a hazard is required, the barricade system shall be designed in accordance with relevant Ethiopian Standards.

7.2. Barricading Requirements

Barricading controls shall be implemented and authorized as part of the safe work system to protect persons from hazards such as:

- ✓ Being struck by falling objects;
- ✓ Being struck by moving plant;
- ✓ Fall from height, including falling into open excavations, penetrations, and falls from unprotected edges such as removed flooring, walkways, stairs and / or hand railings.
- ✓ Exposure to hazardous chemicals;
- ✓ unauthorized entry into a confined space or work area; and
- ✓ Any potentially hazardous work processes, for example, hot works, scaffolding, radiation work and work involving asbestos.

Barricading controls shall also be implemented and authorized as part of the incident management and emergency response procedures.

7.3. Selection of Barricade

When selecting the type of barricade (soft or hard), the following factors are to be considered as part of a risk assessment:

- ✓ Risk associated with the hazard;

- ✓ Visibility of the hazard;
- ✓ Required strength of the barrier, for example, impact potential; and
- ✓ The amount of clearance provided from the hazard by the barricade.

In addition it shall be ensured that hard/solid barricading is used for:

- ✓ A fall from height risk greater than two meters; and
- ✓ Excavations greater than 1.5 meters deep.

7.4. Erection and Use of Barricade

The barricade shall encompass the entire potentially affected area of the hazard and take into account factors such as:

- ✓ Possible deflection of an object if it falls;
- ✓ Slag or sparks created from hot work activities;
- ✓ Distance from the hazard; and
- ✓ Creating an additional hazard, for example, access and egress. Sites shall make sure that
- ✓ Barricades are erected so that all sides of the hazard are protected from unauthorized access.

All barricades shall be accompanied by an appropriate sign.

Signs or tags shall clearly display the following information:

- ✓ the name of the person in charge of the barricaded area;
- ✓ the hazards that are within the barricaded area;
- ✓ the date; and
- ✓ the contact details of the person in charge of the area

7.5. Barricading Selection Requirements

Type	Access Conditions & Application	Examples of types of barricades
Caution	Access permitted, caution required. The caution tape is to be used to highlight hazards to other personnel that may need to access the area. Any person may access into a caution barricaded area, as long as they have familiarised themselves with the hazards detailed on the barricade signage and implemented any controls indicated on the signage. This tape is not appropriate for medium, high or extreme risk hazards e.g. unprotected edges, falling objects, electrical hazards.	
Restricted Access / Danger	Access permitted under instruction and authority given from the Safe Work Coordinator / Person Responsible detailed on the signage. The restricted access tape restricts access to the barricaded work area. Only personnel authorised by the Safe Work Coordinator are permitted to enter. This barricade is suitable to use to restrict access from hazards such as: • hot work; • persons working above / falling objects; • spills / leaks; • unprotected edges creating a fall risk of less than 2m; and • over 2m may be used to delineate a hard barrier.	
Restricted Access / Electrical Work	Used to barricade off and restrict access to electrical hazards. This tape is commonly used for switchboard maintenance. Only the work party and personnel authorised by the Safe Work Coordinator in charge of the barricaded area (as indicated on the signage) are permitted to access through the barricade. Danger tape with appropriate signage can also be utilised.	
Radiation	Access permitted under instruction and authority given from Radiation Safety Officer / assistant / delegate. Radiation tape restricts access to the barricaded work area. Only personnel authorised by the Safe Work Coordinator / Radiation Safety Officer are permitted to enter.	
First Response Team Incident Scene	No access for unauthorised persons. Can be erected by site first response personnel and/or investigation team. This tape is erected to secure an incident scene.	

Fig 7.1 Barricading Selection Requirements

7.6. Appropriate Signage for Barricading

All barricades shall be fitted with signage at appropriate spacing intervals along the barricade to ensure the signage is visible from all entry points. The following table indicates the type of signage that is appropriate for each type of barricade.

Type of Barricade	Examples of Signage Note signs may not be exactly the same as the sign shown.
Caution Barricade Tape (soft barricade) 	
Danger Tape (soft barricade) 	
Restricted Access Electrical Work Barricade Tape (soft barricade) 	
Restricted Access (hard / solid barricade) 	

Fig7.2. Appropriate Signage for Barricading

Self-Check -7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are Barricades? List and differentiate types of Barricades? **3pts**
2. When selecting the type of barricade (soft or hard), what are the factors are to be considered? **3pts**
3. All barricades shall be accompanied by an appropriate sign. True/false **1pt**

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Operation Sheet-1	Confirming location and specifications of the intended excavation area

Procedures how to use GPS

Fellow the following procedures to use GPS

Step1. Turn on the GPS

Before you turn on your GPS, go outside where you have a clear view of the sky. Because the GPS determines your location by receiving signals from satellites, it won't work indoors. On the right side of your GPS, press and hold the Power button. The GPS will start, and it will show you the Satellites page. You should see something like the image below.

Step2. Looking Your GPS for satellite signals. When it has connected to three or more satellites, it will have your location.

Fig 1.1. GPS screen after power is on

Step 3. See the main menu once your location is determined, the Satellite screen will disappear

Fig 1.2. GPS screen showing main menu of GPS

- The GPS has different screens and menus that allow you to do different things.

  Step 4. Switch between screens, press the button marked "X", just above the power button on the right side of the device. This button also serves to go back. If you press something by mistake and would like to cancel or go back, press the "X" button.

  Step 5. Press the X button; you should be able to flip through different screens.

- If you return to the Satellites page, you can see that you are connected to three or more satellites. In the upper left corner are your coordinates, your latitude and longitude.

Operation Sheet-2	Excavating trench and pits

Steps to dig small excavations by hand

Step 1. Wear personal protective equipment and select hand tools

Step 2. Remove the topsoil. Excavate 10–20 centimeter (3.9–7.9 in) of soil, depending on the depth of the topsoil layer. Store the topsoil away from other spoil material to avoid contamination. Ensure that the topsoil heap does not exceed 1–1.5 meter (3.3–4.9 ft) in height to avoid compaction.

Fig 2.1. Removing the topsoil

Step 3. Begin the digging. Line your workers or equipment up with the ditch line, and start to dig. Be careful to observe soil conditions so that the trench embankments do not yield, allowing them to cave in.

Fig 2.2. Starting the digging

Step 4. Dig your first cut to the appropriate depth. If the trench needs to be "benched" (excavated in steps), dig to the depth of the first bench. Otherwise, dig the first section to the full depth of the trench.

Fig.2.3 Dig your first cut to the appropriate depth.

Step 5. Keep the removed soil as far from the excavation as possible. Throw the spoil (the removed soil) far enough that it will not encumber you while working in and around the trench. This will also prevent the removed material from creating an overburdening of the trench's banks or sides, which would increase the risk of collapse.

Fig 2.4. Keep the removed soil as far from the excavation as possible.

Step 6. Move along the length of your trench as each section is excavated to the required depth. Check the depth with a laser level or builder's level where the grade is critical to ensure the finished trench will not require adjustments.

Step 7. Check the completed trench. Once the entire trench has been excavated, recheck the depth throughout its length. Check the embankments for stability, and do any smoothing or finished grading of the trench bottom necessary to install the material the trench was dug for.

Step 8. Complete the project. For example, you may be removing an obsolete utility line, installing a new one, or installing a drainage system or sanitary sewer.

Step 9. Backfill the trench. If you have access to one, a gasoline operated plate tamp will enable you to pack the soil as it is replaced in the trench. For deep trenches, backfilling in *lifts* (layers) of about 8–10 inches (200–250 mm) and compacting the material as it is placed will reduce the amount of settling that will occur after the project is completed.

Step 10. **Replace topsoil as soon as all the spoil has been back-filled.** Roll out a heavy geotextile barrier over the soil first to prevent topsoil from mixing with gravel in the trench.

Then replace the topsoil in the trench. This will ensure fertile soil and easy re-vegetation without having to resort to costly fertilizers.

Step 11. Regrade and re landscape **the area.** Attend to surface conditions after connecting any utilities you have installed.

Fig 2.5.Reclamete the excavated area

Operation Sheet-3	Undertaking trench collapse prevention procedures

Steps to Prevent Trench Collapses

Here are five simple steps you can take to protect your workers.

Step #1 – Have a Trained and Authorized “Competent Person” On Site.

Step #2 – Follow OSHA’s General Requirements:

Step #3 – Carefully Analyze the Soil

Step #4 – Use a Protective System

Step #5 – Inspect the Excavation

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2-4 hours.

Task 1: Locate a point by using GPS

Task 2: Dig and excavate by using hand tools

Task 3: Prevent trench collapse to protect the workers

List of Reference Materials

- ✓ Best Practice Guide for Locating Underground Services. Australia's national referral service for information on infrastructure networks.
- ✓ Environmental Guidelines for Major Construction. Sites Environment Protection Authority,1996
- ✓ Excavations, Safe practices for small business owners and contractors
- ✓ working safely and avoiding danger from underground services and other utility apparatus

1- WEB ADDRESSES (PUTTING LINKS)

https://www.smartickmethod.com/blog/math/learning-resources/dimensions-length-width-height/

https://www.google.com/imgres?imgurl=https%3A%2F%2Fpahistoricpreservation.com%2Fwpcontent%2Fuploads%2F2019%2F08%2FStudents-begin-thedig.jpg&imgrefurl

http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0cdl--00-0----0-10-0---0---0direct-10---

4-------0-1l--11-en-50---20-about---00-0-1-00-0--4----0-0-11-10-0utfZz-8

00&cl=CL1.45 &d=HASH6f6c5 b7233856b 445b303.9&gt=1

https://www.cleaner.com/online_exclusives/2017/05/5_steps_to_prevent_trench_collapses

https://www.ccohs.ca/oshanswers/hsprograms/trenching_excavation.html

https://learnosm.org/en/mobile-mapping/using-gps/