



# Ethiopian TVET-System



## Irrigation & Drainage Construction

### Level II

Based on, March 2017 G.C. Occupational Standard

**Module Title: Carrying Out Manual Excavation**

**TTLM Code: EIS IDC2 TTLM 09 20v2**



## **This module includes the following Learning Guides**

### **LG 58: Prepare for work**

LG Code: EIS IDC2 M14 0920LO1-LG-58

### **LG 59: Dig small excavations by hand**

LG Code: EIS IDC2 M14 0920LO2-LG-59

### **LG 60: Complete and isolate the excavation**

LG Code: EIS IDC2 M14 0920LO3-LG-60

### **LG 61: Clean up**

LG Code: EIS IDC2 M14 0920LO4-LG-61

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<b>Instruction sheet</b>	<b>Learning guide 53: Prepare for Work</b>
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Accessing, interpreting and Applying compliance documentation relevant to the work
- obtaining and confirming Safety requirements
- Identifying and obtaining Signage requirements
- Selecting plant tools and equipment's
- Identifying Environmental protection requirements

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 –

- access, interpret and apply Compliance documentation relevant to the work activity
- obtain and confirm Safety requirements to the allotted task
- identify, obtain and implement Signage requirements
- select Plant, tools and equipment to carry out tasks
- Identify Environmental protection requirements

### Learning instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4 and Sheet 5” ” in page 3, 11, 33, 43 and 48 respectively.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3,Self-check 4 and Self-check 5” in page 9, 31, 41, 47 and 55 respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, in page 57.
6. Do the “LAP test” in page 58 (if you are ready).

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<b>Information Sheet-1</b>	<b>Accessing, interpreting and applying compliance documentation relevant to the work</b>
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## 1.1 Legislative, organisational and site requirements and procedures

During your general and site specific inductions you would have been familiarized with organizational and site policies and procedures. These have been developed in accordance with legislation and are designed to ensure that work is undertaken safely. Gather and read all relevant documents and procedures for the task that you are doing. Ensure that you understand the documents and how they apply to your work.

The following actions will help you to do this.

- Ensure that you are physically and mentally fit for work before starting any job.
- Do not attempt any task unless you are qualified and authorized to perform the task.
- Make sure that you have the required licenses and permits to perform your work and that they are current. Advise your supervisor immediately if you lose your license or permit.
- Select, check and use the correct personal protective equipment (PPE). Make sure that the PPE fits properly and is suitable for the task.
- Identify and report unsafe conditions, activities, incidents or near misses to your supervisor or safety representative.
- Report damaged or defective equipment for repair.
- Use manual tools with in manufacturer specifications and limitations and according to site procedures.
- Adhere to site environmental guidelines to prevent damage to the natural environment and designated heritage sites.

A number of stakeholders will have requirements in place that must be taken into account in any risk management process. This is especially so where the environment or human life is at risk. Legislators and regulatory bodies are stakeholders in any risk management process.

Examples of legislative and regulatory requirements may include:

- legislation dealing with

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- ✓ disasters, emergencies
- ✓ occupational health and safety
- ✓ the environment
- ✓ equal employment opportunity
- local government requirements dealing with
  - ✓ land use planning
  - ✓ building and planning permits
  - ✓ business permits
  - ✓ community interaction
  - ✓ noise limits
  - ✓ traffic management
  - ✓ Use of community facilities and event permits....

## 1.2 Manufacturer's guidelines and specifications

This guideline is intended to help manufacturers implementing modern quality systems and risk management approaches to meet the requirements of quality products to ensure their intended purpose and to protect the public health. The requirement in this guideline is established based on the mandate given to the Authority as stipulated in the Proclamation Number 661/2009 for the establishment of Food, Medicines and Healthcare Products in Ethiopia.

- **Quality assurance:** -is a wide-ranging concept, which covers all matters, which individually or collectively influence the quality of a product.

Quality Assurance therefore incorporates Good Manufacturing Practice plus other factors outside the scope of this Guide.

Good Manufacturing Practice for Products (GMP) is that part of Quality Assurance which ensures that Medicinal products are consistently produced and controlled to the quality standards appropriate to their intended use and as required by the marketing authorization or product specification.

The basic requirements of GMP are that:

- All manufacturing processes are clearly defined, systematically reviewed in the light of experience and shown to be capable of consistently manufacturing medicinal products of the required quality and complying with their specifications and/or marketing authorization;

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- Critical steps of manufacturing processes and significant changes to the process are validated;
- All necessary facilities for GMP are provided including:
  - I. appropriately qualified and trained personnel;
  - II. adequate premises and space;
  - III. Suitable equipment and services;
  - IV. correct materials, containers and labels;
  - V. approved procedures and instructions;
- ✓ Instructions and procedures are written in an instructional form in clear and unambiguous language, specifically applicable to the facilities provided;
- ✓ Operators are trained to carry out procedures correctly;
- ✓ Records are made, manually and/or by recording instruments, during manufacture which demonstrate that all the steps required by the defined procedures and instructions were in fact taken and that the quantity and quality of the product was as expected.
- ✓ Records of manufacture including distribution which enable the complete history of a batch to be traced, are retained in a comprehensible and accessible form;
- ✓ The distribution (wholesaling) of the products minimizes any risk to their quality;
- **Quality control:** - Quality Control is that part of Good Manufacturing Practice which is concerned with sampling, specifications and testing, and with the organization, documentation and release procedures.

The basic requirements of Quality Control are that:

- ✓ Adequate facilities, trained personnel and approved procedures are available for sampling, inspecting and testing starting materials, packaging materials, intermediate, bulk, and finished products, and where appropriate for monitoring environmental conditions for GMP purposes;
- ✓ Samples of starting materials, packaging materials, intermediate products, bulk products and finished products are taken by personnel and by methods approved by Quality Control;
- ✓ Test methods are validated.
- ✓ The finished products contain active ingredients complying with the qualitative and quantitative composition of the marketing authorization, are of the purity required, and are enclosed within their proper containers and correctly labelled.

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- ✓ Records are made of the results of inspection and that testing of materials, intermediate, bulk, and finished products is formally assessed against specification.
  - ✓ No batch of product is released for sale or supply prior to certification by an authorized person that it is in accordance with the requirements of the relevant authorizations;
  - ✓ Sufficient reference samples of starting materials and products are retained to permit future examination of the product if necessary.
- **Product quality review:** -reviews should normally be conducted and documented annually, taking into account previous reviews, and should include at least:
    - ✓ A review of starting materials including packaging materials used in the product, especially those from new sources.
    - ✓ A review of critical in-process controls and finished product results.
    - ✓ A review of all batches that failed to meet established specification(s) and their investigation.
    - ✓ A review of all changes carried out to the processes or analytical methods.
    - ✓ A review of Marketing Authorization variations submitted/granted/refused, including those for third country (export only) dossiers.
    - ✓ A review of the results of the stability monitoring programme and any adverse trends.
    - ✓ A review of all quality-related returns, complaints and recalls and the investigations performed at the time.
  - **Quality risk management:** - Quality risk management is a systematic process for the assessment, control, communication and review of risks to the quality of the product.

### 1.3 Employment and workplace relations legislation

The employment relationship is a legal notion widely used in countries around the world to refer to the relationship between a person called an employee (frequently referred to as a worker) and an employer for whom the employee performs work under certain conditions in return for remuneration.

Applicants to and employees of most private employers, state and local governments, educational institutions, employment agencies and labour organizations are protected under Federal law from discrimination on the following bases:

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- **Disability:** -Disability discrimination includes not making reasonable accommodation to the known physical or mental limitations of an otherwise qualified individual with a disability who is an applicant or employee, barring undue hardship.
- **Age:** -The Age Discrimination in Employment Act of 1967, as amended, protects applicants and employees 40 years of age or older from discrimination based on age in hiring, promotion, discharge, pay, fringe benefits, job training, classification, referral, and other aspects of employment.
- **Sex (wages) :** -In addition to sex discrimination prohibited by Title VII of the Civil Rights Act, as amended, the Equal Pay Act of 1963, as amended, prohibits sex discrimination in the payment of wages to women and men performing substantially equal work, in jobs that require equal skill, effort, and responsibility, under similar working conditions, in the same establishment.
- **Genetics:** - Genetic information includes information about genetic tests of applicants, employees, or their family members; the manifestation of diseases or disorders in family members (family medical history); and requests for or receipt of genetic services by applicants, employees, or their family members.
- **Retaliation:** -All of these Federal laws prohibit covered entities from retaliating against a person who files a charge of discrimination, participates in a discrimination proceeding, or otherwise opposes an unlawful employment practice.

#### 1.4 Equal employment opportunity and disability discrimination legislation

The principle of equality is closely related to the notion of human dignity. It is grounded in the idea that all human beings, regardless of physical, mental and other differences, are of equal value and importance. The principle of equality, as well as its corollary, namely the prohibition of discrimination, can be defined in various ways in law.

- **Formal equality:** - In a formal approach to equality, persons who are situated alike should be treated in the same way. Such an approach frequently ignores individual and contextual differences and disadvantages, as if these were irrelevant.
- **Equality of opportunity:** - This concept provides for equal chances, but not necessarily equal results. In this way of looking at equality, the importance of individual and group differences is acknowledged and account is taken of external barriers experienced by disabled people, which may inhibit social participation.

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- **Equality of results:** -Equality of results is concerned with securing the same outcomes for all. When equality is viewed in this way, individual and group differences are acknowledged. For example, account is taken of any additional costs a disabled worker has, in examining the question of whether they receive equal pay. This concept of equality has several weaknesses.
  - ✓ It does not clearly indicate where responsibility lies for meeting the needs of disabled persons so as to guarantee true equality of results with the State, with the private sector or with the individual.
  - ✓ In addition, it is not clear in this approach whether an individual's merits are understood to justify unequal results.

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<b>Self-check 1</b>	<b>Written test</b>
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**Directions:** all the questions listed below. Choose the best answer and write your Answer in the answer sheet provided below

1. How do you communicate with employees about the risks and control measures on the work floor?
  - A. Through discussion among all employees in a department.
  - B. Through discussion among the immediate supervisor and his/her operational employees.
  - C. Through discussion among all of the immediate supervisors in all departments.
2. What increases the probability of unsafe behavior on the part of an employee?
  - A. The work order is incomplete.
  - B. There is discord between the employer and the works council.
  - C. Arrangements concerning the execution of the work have been made.
3. As a supervisor how can you ensure that unsafe behavior becomes less likely?
  - A. By planning the work differently.
  - B. By imposing sanctions on unsafe behavior.
  - C. By giving in to employees more quickly
4. What must a safety inspection or safety observation report contain?
  - A. A description of the time required to complete the identified actions.
  - B. A description of the progress of activities.
  - C. A description of the findings of the inspection or observation.
5. What is the purpose of general safety rules?
  - A. They identify the correct barriers to be installed for work activities.
  - B. They govern reporting in and out at the work site.
  - C. They govern the use of safety harnesses for working at height.

**Note: Satisfactory rating – 5 points**

**Unsatisfactory - below 5 points**

**Answer Sheet-1**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Multiple Choice Questions**

- |          |          |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ |          |

Score = _____
Rating: _____

## 2.1. Safety requirements or OHS

- **Protective clothing and equipment**

PPE is equipment that will protect the user against health or safety risks at work. It can include items such as safety helmets and hard hats, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses.

- **Types of PPE used.**

All personal protective clothing and equipment must be of safe design and construction for the work to be performed and must be maintained in a clean and reliable condition.

Protective clothing and equipment used must meet NIOSH (National Institute for Occupational Safety and Health) or ANSI (American National Standards Institute). Newly purchased PPE must conform to the updated ANSI standards, which have been incorporated into the OSHA PPE regulations, as follows:

- ✓ Eye and face protection
- ✓ Head protection
- ✓ Foot protection
- ✓ Hand protection, there are no ANSI standards for gloves, however, selection must be based on the performance characteristics of the glove in relation to the tasks to be performed.

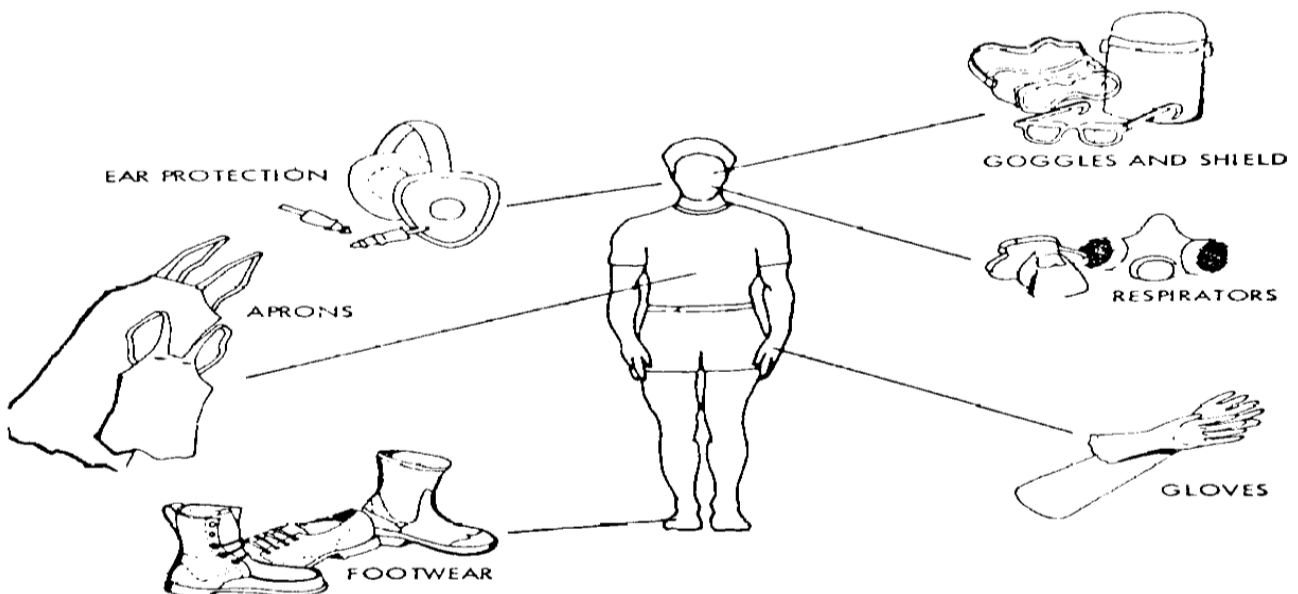


Figure 1: Personal protective equipment

- **Eye and face protection**

Prevention of eye injuries requires that all persons who may be in eye hazard areas wear protective eyewear. This includes employees, visitors, researchers, contractors, or others passing through an identified eye hazard area. To provide protection for these personnel, supervisors of such areas shall purchase a sufficient quantity of goggles and/or plastic eye protectors, which afford the maximum amount of protection possible. If these personnel wear personal glasses, they shall be provided with a suitable eye protector to wear over them. Suitable protectors must be used when employees are exposed to hazards from flying particles, molten metal, acids or caustic liquids, chemical liquids, gases, or vapors, bio aerosols, or potentially injurious light radiation.

## 2.2. Site safety plan

Workplace conditions are not good and contribute negatively to employees' health. Many submissions indicate that chronic illness, stress and addictions are the result of unsafe office practices, long hours of work and harassment in the workplace. Others think environmental causes such as smoking, exposure to asbestos, and improper office cleaning techniques increase the risk to workers. Most accidents can be prevented by taking simple measures or adopting proper working procedures. Many people believe that introducing new rules and regulations will make the workplace safer.

Things that are needed in the site safety plan will be

- ✓ The names, positions and health and safety responsibilities of all persons at the workplace whose positions or roles involve specific health and safety responsibilities in connection with the project.
- ✓ The arrangements in place, between any persons conducting a business or under taking at the workplace where the construction project is being undertaken, for consultation, cooperation and coordination of activities in relation to compliance with their duties.
- ✓ The arrangements in place for managing any work health and safety incidents that occur.
- ✓ Any site-specific health and safety rules, and the arrangements for ensuring that all persons at the work place are informed of these rules.
- ✓ The arrangements for the collection and any assessment, monitoring and review of safe work method statements at the workplace.

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- ✓ The plan must be written so it is easy to understand.
- ✓ It must be signed and dated by the principle contractor.
- ✓ It must be available for the length of the project.

### 2.3. Basic rules for safety

- **Tidy up construction sites**

- ✓ Keep passages clear all the time.
- ✓ Sort out materials and pile them up safely
- ✓ The stacks should not be too high.
- ✓ Be aware of floor openings and ensure that they are fenced or covered.
- ✓ Remove refuse as soon as possible.
- ✓ Provide sufficient lighting.
- ✓ Familiarizewiththelocationandtheoperationoffire-fightingequipment.

- **Safety measures**

- ✓ Before you operate a machine, ensure that the dangerous part of the machine has been installed with a guard.
- ✓ Avoid going to any area within sufficient lighting as there may be some dangerous places which have not been provided with fencing.
- ✓ Keep vigilant all the time and watch out for moving cranes, hooks or other lifting equipment.
- ✓ Before you use any electrical installation or tool, check the condition of its electric cables.
- ✓ Avoid dragging electric cables on the ground or allowing the cables to come in to contact with water.
- ✓ Use electrical tools installed with an earth leakage circuit breaker.
- ✓ Use and handle chemicals with care.

- **Personal safety**

- ✓ Wear protective equipment.
- ✓ Do not drink or take drugs while working.
- ✓ Pay attention to personal hygiene.
- ✓ Do not play in the work place.
- ✓ Report to your supervisor immediately if you notice any unsafe condition.

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## 2.4. Project safety plan

To improve our project safety we will apply the following plan approaches.

- **Work activity safety planning approach:** – Is an approach that may include safety awareness, risk assessment, and planning. Needs to be both proactive and ongoing in the dynamic work environment and changing conditions often encountered by WSDOT employees.
- **Pre-activity safety plan (PASP) (also known as activity hazard analysis or job hazard analysis) :-** A written review of the activity to be performed, including environmental conditions, tools and/or equipment to be used, the associated hazards and their method of control.
- **Priority of hazard control (also known as hierarchy of hazard control):** –A systematic order of hazard control with preference to the most effective at eliminating hazards.
- **Most effective to least effective hazard controls**
  - ✓ Elimination or substitution: - elimination and substitution, while most effective at reducing hazards, also tend to be the most difficult to implement in an existing process. If the process is still at the design or development stage, elimination and substitution of hazards may be inexpensive and simple to implement.
  - ✓ Engineering controls: - engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.
  - ✓ Training and administrative controls: - administrative controls and personal protective equipment are frequently used with existing processes where hazards are not particularly well controlled.
  - ✓ Personal protective equipment

## 2.5. Guidelines of protective eyewear

- Wearers of contact lenses must also wear appropriate eye and face protection devices in a hazardous environment. Side protectors shall be used when there is a hazard from flying objects.
- Goggles and face shields shall be used when there is a hazard from chemical splash.

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- Face shields shall only be worn over primary eye protection (safety glasses or goggles)
- Eye protection must not interfere with the function of other required PPE.
- Eye protection must not restrict vision or movement.
- Eye protection should be easy to clean and disinfect.
- It must be reasonably comfortable to wear.
- Equipment fitted with appropriate filter lenses shall be used to protect against light radiation.
- Tinted and shaded lenses are not considered filter lenses unless they are marked or identified as such.
- Eye and face PPE must be distinctly marked to facilitate identification of the manufacturer.
- Prescription Safety Eyewear
- OSHA regulations require that each affected employee who wears prescription lenses while engaged in operations that involve eye hazards shall wear eye protection that incorporates the prescription in its design, or shall wear eye protection that can be worn
- Over the prescription lenses (goggles, face shields) without disturbing the proper position of the prescription lenses or the protective lenses.

## 2.6. Head protection

Head protection will be furnished to, and used by, all employees and contractors engaged in construction and other miscellaneous work. Head protection must also to be worn by engineers, inspectors, and visitors at construction sites when hazards from falling or fixed objects, or electrical shock are present. Bump caps/skull guards will be issued and worn for protection against scalp lacerations from contact with sharp objects. However, they will not be worn as substitutes for safety caps/hats because they do not provide protection from high impact forces or penetration by falling objects.

In general, protective helmets or hard hats should Resist penetration by object, be water resistant and slow burning, absorb the shock of a blow, and come with instructions explaining proper adjustment and replacement of the suspension and headband.

Hard hats require a hard outer shell and a shock-absorbing lining. The lining should incorporate a headband and straps that suspend the shell from 1 to 1 ¼ inches away from the users head.

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This design provides shock absorption during impact and ventilation during use.

Protective helmets purchased after July 5, 1994, must comply with ANSI Z89.1-1986, those purchased before this date must meet the ANSI Z89.1-1969 standard. Employers should train their employees in the proper use and maintenance of the hats including daily inspections. This will help to prolong the helmets effective use and save the employer money from purchasing new helmets frequently. If employees identify any of the following defects, remove the hard hats from service:

- ✓ The suspension system shows signs of deterioration such as: - Cracking, tearing, or fraying
- ✓ The suspension system no longer holds the shell from 1 to 1 ¼ inches away from the employee's head.
- ✓ The brim is cracked, perforated, or deformed.
- ✓ The brim or shell shows signs of exposure to heat, chemicals, ultraviolet light, or other radiation.

## 2.7. Foot and leg protection

Employers must provide foot and leg protection if the workplace hazard assessment reveals potential dangers to these parts of the body. The type of foot or leg protection needed will depend upon the specific hazard you identify and the specific part of the foot or legs exposed to potential injury. Safety footwear must meet the minimum compression and impact performance standards and testing requirements by ANSI. All safety footwear must comply with ANSI Z41- 1991, "American National Standard for Personal Protection - Protective Footwear."

Safety shoes or boots with impact protection are required to be worn in work areas where carrying or handling materials such as packages, objects, parts or heavy tools, which could be dropped; and for other activities where objects might fall onto the feet. Safety shoes or boots with compression protection are required for work activities involving skid trucks (manual materials handling cars) or other activities in which materials or equipment could potentially roll over an employee's feet. Safety shoes or boots with puncture protection are required where sharp objects such as nails, wire, tacks, screws, large staples, scrap metal etc., could be stepped on by employees causing a foot injury.

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## 2.8. Hand protection

Suitable gloves shall be worn when hazards from chemicals, cuts, lacerations, abrasions, punctures, burns, biological, and harmful temperature extremes are present. Glove selection shall be based on performance characteristics of the gloves, conditions, duration of use, and hazards present. One type of glove will not work in all situations. The first consideration in the selection of gloves for use against chemicals is to determine, if possible, the exact nature of the substances to be encountered. Read instructions and warnings on chemical container labels and MSDSs before working with any chemical. Chemicals eventually permeate all glove materials.

However, they can be used safely for limited time periods if specific use and other characteristics (i.e., thickness and permeation rate and time) are known.

## 2.9. Body protection

Employers must provide body protection for employees if they are threatened with bodily injury while performing their jobs, and if engineering and administrative controls have failed to eliminate these hazards. Workplace hazards that could cause bodily injury include the following:

- ✓ Intense heat or cold;
- ✓ Splashes of hot metals or liquids;
- ✓ Impact from tools, machinery, and materials;
- ✓ Cuts;
- ✓ Hazardous chemicals;
- ✓ Contact with potentially infectious materials; and
- ✓ Radiation.

Employers need to provide PPE only for the parts of the body exposed to possible injury. Depending on the hazards in the workplace, the employer may provide employees with one or more of the following: vest, jackets, aprons, coveralls, surgical gown, and full body suits. The use of PPE especially full body suits can add to the heat stress and workload of the employees. Workers must be monitored closely for heat stress if required to wear full body suits.

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- **Selection guidelines for head protection**

All head protection (helmets) is designed to provide protection from impact and penetration hazards caused by falling objects. Head protection is also available which provides protection from electric shock and burn. When selecting head protection, knowledge of potential electrical hazards is important. Class A helmets, in addition to impact and penetration resistance, provide electrical protection from low-voltage conductors (they are proof tested to 2,200 volts). Class B helmets, in addition to impact and penetration resistance, provide electrical protection from high-voltage conductors (they are proof tested to 20,000 volts). Class C helmets provide impact and penetration resistance (they are usually made of aluminum which conducts electricity), and should not be used around electrical hazards.

Where falling object hazards are present, helmets must be worn. Some examples include: working below other workers who are using tools and materials which could fall; working around or under conveyor belts which are carrying parts or materials; working below machinery or processes which might cause material or objects to fall; and working on exposed energized conductors

- **Selection guidelines for foot protection**

Safety shoes and boots which meet the ANSI Z41-1991 Standard provide both impact and compression protection. Where necessary, safety shoes can be obtained which provide puncture protection. In some work situations, metatarsal protection should be provided, and in other special situations electrical conductive or insulating safety shoes would be appropriate.

Safety shoes or boots with impact protection would be required for carrying or handling materials such as packages, objects, parts or heavy tools, which could be dropped; and, for other activities where objects might fall onto the feet. Safety shoes or boots with compression protection would be required for work activities involving manual material handling carts, around bulk rolls (such as paper rolls), and around heavy pipes, all of which could potentially roll over an employee's feet. Safety shoes or boots with puncture protection would be required where sharp objects such as nails, wire, tacks, screws, large staples, scrap metal etc., could be stepped on by employees causing a foot injury.

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- **Selection guidelines for hand protection**

Gloves are often relied upon to prevent cuts, abrasions, burns, and skin contact with chemicals that are capable of causing local or systemic effects following dermal exposure. OSHA is unaware of any gloves that provide protection against all potential hand hazards, and commonly available glove materials provide only limited protection against many chemicals. Therefore, it is important to select the most appropriate glove for a particular application and to determine how long it can be worn, and whether it can be reused.

It is also important to know the performance characteristics of gloves relative to the specific hazard anticipated; e.g., chemical hazards, cut hazards, flame hazards, etc. These performance characteristics should be assessed by using standard test procedures. Before purchasing gloves, the employer should request documentation from the manufacturer that the gloves meet the appropriate test standard(s) for the hazard(s) anticipated. Other factors to be considered for glove selection in general include:

- ✓ As long as the performance characteristics are acceptable, in certain circumstances, it may be more cost effective to regularly change cheaper gloves than to reuse more expensive types; and,
- ✓ The work activities of the employee should be studied to determine the degree of dexterity required, the duration, frequency, and degree of exposure of the hazard, and the physical stresses that will be applied. With respect to selection of gloves for protection against chemical hazards:
- ✓ The toxic properties of the chemical(s) must be determined; in particular, the ability of the chemical to cause local effects on the skin and/or to pass through the skin and cause systemic effects;
- ✓ Generally, any "chemical resistant" glove can be used for dry powders;
- ✓ For mixtures and formulated products (unless specific test data are available), a glove should be selected on the basis of the chemical component with the shortest breakthrough time, since it is possible for solvents to carry active ingredients through polymeric materials; and,
- ✓ Employees must be able to remove the gloves in such a manner as to prevent skin contamination.

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- **Cleaning and maintenance**

It is important that all PPE be kept clean and properly maintained. Cleaning is particularly important for eye and face protection where dirty or fogged lenses could impair vision.

For the purposes of compliance with 1910.132 (a) and (b), PPE should be inspected, cleaned, and maintained at regular intervals so that the PPE provides the requisite protection. It is also important to ensure that contaminated PPE which cannot be decontaminated is disposed of in a manner that protects employees from exposure to hazards

## 2.10.Safe operating procedures including recognizing and preventing hazards

- **Eye Protection**

- ✓ A wise worker will certainly take good care of his eyesight.
- ✓ A small fragment may cause serious consequences if it enters one's eyes.
- ✓ When there is a risk of eye injury, such as in concrete breaking or using abrasive wheels, you should wear suitable eye protectors.
- ✓ Take proper care of the eye protectors provided to you.
- ✓ Replace damaged or defective eye protectors immediately.
- ✓ Ensure that eye protectors are comfortable to wear, and keep clean.
- ✓ Use eye protectors for eye protection — do not put it on your head or hang it on your neck.
- ✓ Bear in mind that eye protectors are replaceable, but not your eyes.

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Figure 2: Eye Protection glass

- **Noise**

- ✓ Wear ear protectors in areas with high noise levels.
- ✓ Properly wear ear protectors according to the manufacturer's instructions.
- ✓ Do not reuse disposable ear plugs.
- ✓ Clean ear protectors regularly.



Figure 3: Ear Protection equipment

- **Personal protective equipment**

- ✓ For your own safety and interest, use the personal protective equipment provided by your employer.
- ✓ Wear gloves when handling or contacting chemicals.
- ✓ Remember to wear a mask when working in a dusty environment.
- ✓ Wear eye and ear protectors whenever necessary.
- ✓ Wear a safety harness and secure it to a safe anchorage point when working at height.
- ✓ Wear safety shoes to prevent foot injury.
- ✓ Consult your supervisor if in doubt.

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Figure 4: Personal Protective Equipment

- **Safety helmet**

- ✓ Wear a safety helmet on a construction site.
- ✓ Keep the harness of the helmet clean and make sure that it fits well.
- ✓ Do not drill any holes on the helmet or use it for pounding



Figure 5: Safety helmet on a construction site

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Generally personnel be required to wear Hi-Visibility clothing

- ✓ Only while performing Traffic Control Duties or working on the Travelled Pathways
- ✓ While on or adjacent to the travelled path, or other potential hazardous area
- ✓ When dusty conditions make it hard to see personnel
- ✓ Anytime different companies are working together
- ✓ At all times when on site as per WHS and company policies and procedures.

## 2.11.Safe parking practices

It describes ensuring access ways to clear, equipment/machinery away from overhangs and refueling sites, safe distance from excavations, and secured from unauthorized access or movement.

- **Load shifting machinery**

Unless you are a worker concerned,

- ✓ Do not work in an area where a loader, an excavator, etc. is in operation.
- ✓ Do not operate any load shifting machinery without training and approval.
- ✓ Operators of forklift trucks, bulldozers, loaders, excavators, trucks or Lorries should possess appropriate certificates.



Figure 6: Wear a safety helmet on a construction site

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- **Portable power tool: -**

- ✓ Do not use a portable power tool (such as saw, grinder and drill) unless its dangerous parts have been effectively guarded.
- ✓ Place the electric cable and hose of a tool at an appropriate position to avoid tripping hazards.

- **Compressed air**

- ✓ Use compressed air only for specified purposes.
- ✓ Do not use any compressed air equipment, pipes and relevant devices unless they are of good construction and have been examined and certified safe by a competent examiner before use.
- ✓ Fix the connectors properly.
- ✓ Do not twist the pipes.
- ✓ Do not abuse the use of compressed air for cleaning purpose. Use a brush or a vacuum cleaner to remove dust from clothing and skin.



Figure 7: se compressed air equipment in specified purpose

- **Electric tool**

- ✓ Before using an electric tool, check the tool and its plug and connecting cable.
- ✓ Do not use a damaged tool.
- ✓ Do not use an electric tool unless its connecting cable is well protected.
- ✓ Do not use an electric tool unless its metal casing is earthed and its power supply is provided with an earth leakage circuit breaker.
- ✓ Do not repair or alter any electrical installation unless competent to do so.
- ✓ If you meet any fault or problem, report it to your supervisor immediately.

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- **Excavations**

- ✓ Keep the fence on all sides of an excavation intact.
- ✓ Use safe access for ingress and egress.
- ✓ Do not pile soil or any other materials at the edge of an excavation.
- ✓ Make sure that a trench is securely shored before working in it.



Figure 8: Excavation tools

- **Gas welding and flame cutting**

- ✓ Do not use the equipment for gas welding or flame cutting unless you have attained the age of 18 years and hold a valid certificate.
- ✓ Do not use any gas cylinder unless it has been fitted with flashback arrestors.
- ✓ Wear personal protective equipment.
- ✓ Keep the workplace clean.
- ✓ Place fire extinguishers within reach.
- ✓ Keep gas cylinders in an upright position and secure it properly to avoid overturning.
- ✓ If gas leakage is detected, report it to your supervisor immediately.

- **Public safety**

- ✓ Pay attention to public safety. Members of the public are often unaware of or do not understand the work carried out on construction sites and the risks involved.
- ✓ Take great care to prevent the fall of materials from height.

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- ✓ Do not stack materials on floor edges or on scaffolds.

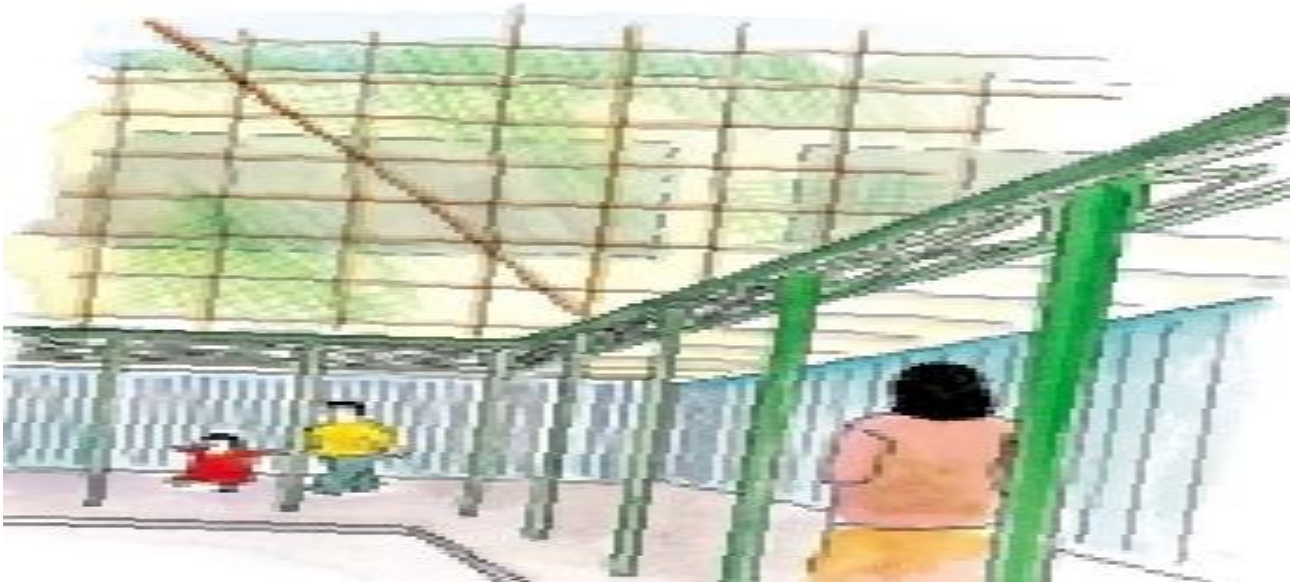


Figure 9: public safety

- **Waste disposal**

- ✓ Dispose all wastes, and unwanted materials must be disposed of at a designated place.
- ✓ Notify your supervisor of the requirement for the separate disposal of chemical or inflammable wastes.
- ✓ Do not leave planks with nails on passageways.



Figure 10: Waste disposal area

## 2.12. Recognizing hazards and risks

- **Manual handling operations**
  - ✓ Avoid manual handling operations as far as possible to minimize the risk of injury.
  - ✓ Estimate the weight of the load.
  - ✓ Lift an object with a correct posture.
  - ✓ Wear suitable protective equipment. Put on gloves as far as possible to protect your hands from any cut, scratch or puncture, and wear safety boots or shoes to prevent injury to toes by heavy falling objects.
  - ✓ Seek assistance from someone in lifting a load if necessary.



Figure 11: Manual handling operation

## 2.13. Emergency procedures related to equipment operation

- **First Aid**

For most patrons and employees, an injury doesn't mean a trip to the emergency room. It usually means a trip to the first aid kit with a skinned knee, bump, bruise, cut or a scratch. The attending agency employee might apply an ice pack or a band aid, and the appreciative patron or employee then goes back to play or work. However, in some situations providing first aid goes beyond applying an ice pack. It could mean controlling severe bleeding, or even dealing with a potential life or death situation.

If you sustain an injury or feel not well while at work, even if it is minor, go to the first aid room right away for medical treatment and notify your supervisor.

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- ✓ **Personnel:** -At least one person, and preferably two or more, trained in first aid and CPR should be available at the agency. The trained first aid responder(s) should be designated, and the other workers should know who they are and how to contact them. The trained employee should receive regular in service training and remain certified. In all first aid and emergency situations, CPR and first aid trained employees should not attempt any medical treatment that exceeds their training level. Contact your local fire department if there are any doubts about a person’s health or injuries.
- ✓ **Location:** -a first aid kit is no longer just a tin box gathering dust in a corner. At a minimum, each building or facility should have a designated location for a well-stocked highly visible first aid kit. Supplemental kits could be developed for a particular location (fixed or portable), person, activity or use, be it a pool, day camp, bus, camping trip, maintenance garage, or special event. The size and contents of the first aid kits depend on the intended use and the type of injuries that are anticipated.

Consideration should be given to storing the first aid kit in places that are out of the reach of children, but easily accessible for adults. Inspection/Maintenance providing first aid is the first step in emergency care and everyone and everything needs to be prepared, including the first aid kit. Just like first aid providers need to be prepared through initial training and frequent in service training, the first aid kit needs in service as well. The problem with most first aid kits is that they become “functionally incomplete” as soon as they are opened, unless there is an adequate replacement program, which includes a designated person to inventory and replace used items. Contents each first aid kits should contain items that may be needed for a particular location or activity. Over the past years, the question of what should be in a first aid kit has gotten complicated. It is recommended that members work with safety equipment vendors to discuss what types of first aid kits and equipment are adequate for specific risks and activities. The following is a listing of contents to consider in purchasing first aid kits:



Figure 12: First aid kits

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- **Fire risk**

There is always a fire risk. However, the chances of fire can be reduced, and you will know what to do when a fire breaks out if you:

- ✓ Always keep the workplace clean and tidy.
- ✓ Handle machinery and tools that may generate sparks or heat carefully.
- ✓ Do not smoke or use naked flames in any area where flammable and explosive substances are stored.
- ✓ Know where fire extinguishers are located and how they are used.
- ✓ Know the place of assembly for fire evacuation.

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<b>Self-check 2</b>	<b>Written test</b>
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**Instructions:** Answer all the questions listed below. Choose the best answer from the alternative and Write your answers in the answer sheet provided in the next page.

1. An accident without serious injury has occurred. What should be done in this case?
  - A. Steps must be taken to prevent the accident's recurrence.
  - B. The accident must be reported to the Emergency Services by dialing 112.
  - C. This must be reported to the government's Health and Safety Inspection Service within 24 hours.
2. What is an example of a personal factor that can lead to an accident?
  - A. Inadequate preparation.
  - B. An incorrect working method.
  - C. Insufficient stress-resistance.
3. What technical measure prevents accidents involving grinders within a company?
  - A. Appointing an experienced technical director.
  - B. Establishing clear procedures.
  - C. Selecting a sound ergonomic design.
4. What is the best safety rule?
  - A. Immediately sort the waste generated during the work by type.
  - B. Keep the workplace tidy and keep passages clear.
  - C. Mark all hazards at the workplace with red-white tape.
5. You come across an unsafe situation at your work. What is the first thing you must do?
  - A. Remain near the unsafe situation.
  - B. Try to remove its cause.
  - C. Inform the government's Health and Safety Inspection Service.

**Note: Satisfactory rating – 5 points**

**Unsatisfactory - below 5 points**

**Answer Sheet-1**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Multiple Choice Questions**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

Score = _____
Rating: _____

### 3.1. Tools and equipment's selection

The following are the materials used for the earthwork for foundation.

Spade, Kassie, Pick Axe, Crow Bar, Rammer, Wedge, Boning Rod, Sledge Hammer, Basket, Iron Pan, Line and Pins.

- **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. A mattock looks similar to a pick. However, the head of the tool has an axe-type cutting tool as well as a digging implement.

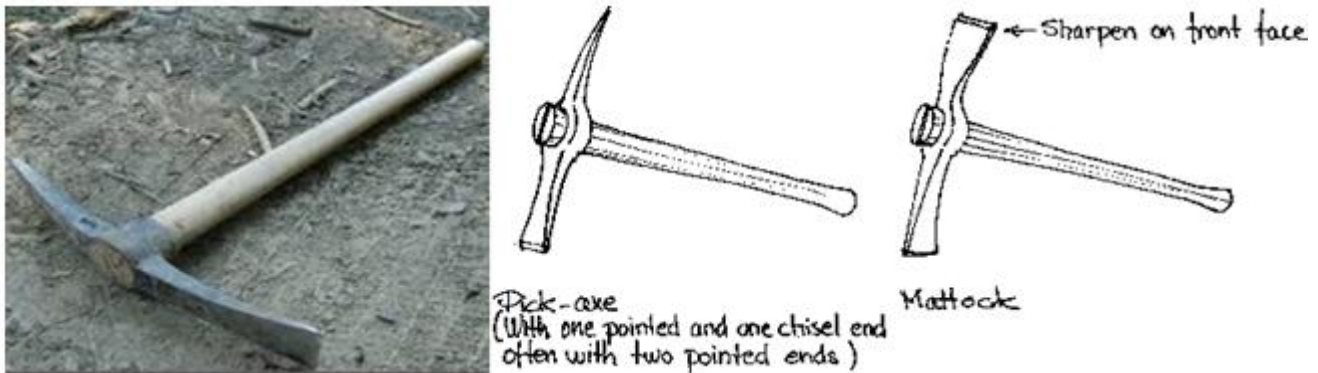


Figure 13: pickaxes and mattocks

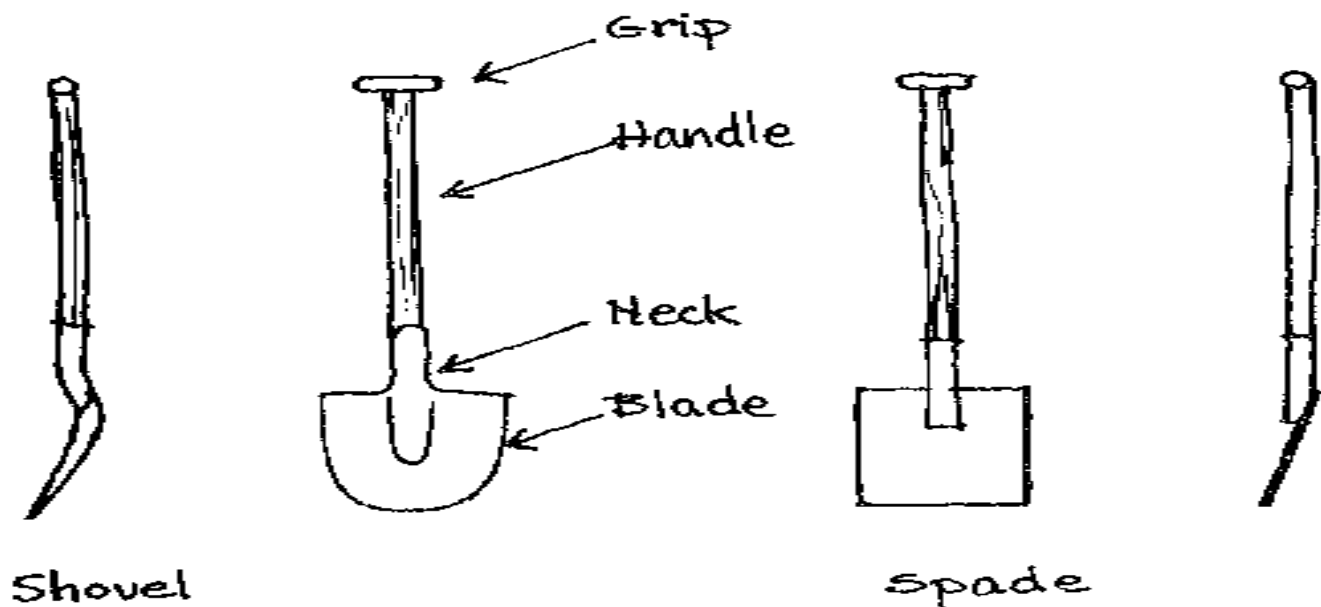
- **Shovels and spades**

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.





Figure 14: shovels and spades



Shovel

spade

Figure 15: Body component of shovel and spades

- **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.

- **Spreaders**

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These tools 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.

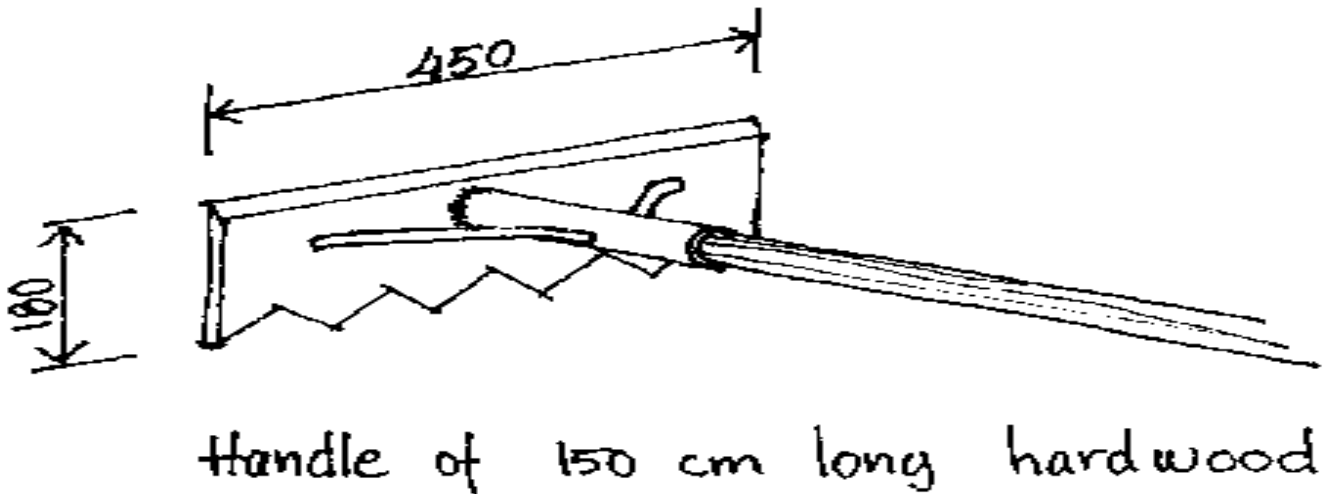


Figure 16: spreaders

- **Rake**

A rake can be used to level ground and to pull materials together. Never leave rakes lying on the ground with the prongs or tines up where people can stand on them.



Figure 17: rake

- **Screed**

Similar to a rake (but a lot larger), a screed is used to level the ground and smooth over the soil. It has a long handle and is usually about a metre across.



Figure 18: screed

- **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 which 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.

- **Spirit level**

A sealed glass tube is almost filled with colorless liquid but has a small air bubble. The glass tube is marked so that, when the bubble is positioned between the marks, the spirit level is precisely flat (horizontal) or upright (vertical).

- **Hand augers**

Hand auger drilling is one of the most common hand drilling techniques. Worldwide it is being used in environmental research for soil sampling and for drilling boreholes for drinking- and irrigation. The hand auger is an excellent tool for drilling shallow wells and for quick site investigation. It can also be used to make starter holes for use in combination with other manual drilling techniques.



Figure 19: different types of hand auger

- **String line**

It is a tool used for leveling across longer distances. They can be attached to a tightly pulled string to find level between two stakes in the ground to find level ground.

We use the following steps to Use a String Line Level

- ✓ Gather the materials for the job: a line level, a length of string, a tape measure and some means of securing both ends of the string (usually two wooden posts in the ground).
- ✓ Secure the string to one side or corner of the area you want leveled.
- ✓ Attach the line level to the middle of the string using the small hooks on the line level.
- ✓ Pull the string tight while sliding the level up the string within eyesight.
- ✓ Pull tightly enough to avoid any sag in the string. Even the slightest dip in the string will negatively affect your reading.
- ✓ Hold the end of the string against the post or wall and adjust up and down until the bubble rests between the black lines on the line level.
- ✓ Secure the string.
- ✓ You have found level between the two points. You can use these marks on the posts or walls to make further measurements for your home construction projects. More information refers to the video link below

- **Pegs**

Are used to mark out residential boundaries and indicate points and positions of a site. They are usually made of wood (although some are made of metal or plastic) and come in different sizes and colored tops.

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- **Tape measures**

Is a flexible ruler and used to measure distance. There are two basic types of tape measures with cases.

- ✓ Spring return pocket tape measures will generally fit in a pocket. They are small, the case is up to about three inches across. The tape is returned to the case by a spring mechanism. Pocket tape measures have a tape one foot to fifteen feet in length and  $\frac{1}{4}$  to  $\frac{3}{4}$  inches across.
- ✓ A second tape measure design is what is called the long tape. These are cased tape measures with tapes of 25, 50, 75, 100, 200, 300, and even 500 feet in length, designed for engineers and builders.



A millimeter-only metric roll-up tape measure being used.



Plastic tape measure (cm)

Figure 20: two types of tape measure

- **Jack hammer and scrabbles**

For construction purposes, cutting through the wood and other industrial tasks, the jack hammers are trusted equipment. It would cut through the toughest materials smoothly and present with the expected results.



Jack Hammers for Concrete Breakers ...  
primates2016.org



Bits & Heavy Duty Metal Case ...  
sites.google.com

Figure 21: Jack hammers and scrabbles

<b>Self-check 3</b>	<b>Written test</b>
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**Instructions:** Answer all the questions listed below. Choose the best answer from the list alternatives and write your answers in the sheet provided in the next page

- \_\_\_\_\_ is type of scraper consists of a four wheeled scrapper bowl towed behind crawler Power unit.
  - Three axle
  - Two axle
  - Crawler drawn
  - Four axle
- \_\_\_\_\_ is type of excavator carries Shovel at its lower end.
  - Power shovel
  - Dragline
  - Clam shell
  - Back actor



- What's the name of this digging tool shown in the figure?
  - Pick-mattock
  - Crowbar
  - Grub-hoe
  - Spade

- Pruning shears are used for...



- cutting bamboo poles and pegs
  - cutting branches of planting materials and branches of plants
  - cutting trunks or branches of trees and bigger posts
  - loosening soil
- It is used for loosening or cultivating the soil around the growing plants and putting a small amount of compost in the soil.



- A. Hand fork
  - B. Hand cultivator
  - C. Hand spoon
  - D. Hand trowel
6. Which one is used for measuring height of plants?
- A. Weighing balance
  - B. Seed tray
  - C. Meter stick
  - D. Chisel

**Note: Satisfactory rating – 6 points**

**Unsatisfactory - below 6 points**

### Answer Sheet-1

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Multiple Choice Questions

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_
- 4. \_\_\_\_\_
- 5. \_\_\_\_\_
- 6. \_\_\_\_\_

Score = \_\_\_\_\_

Rating: \_\_\_\_\_



#### 4.1. Introduction to environmental protection

Environmental protection is a practice of protecting the natural environment on individual, organizational or governmental levels, for the benefit of both the natural environment and humans. Due to the pressures of population and technology, the biophysical environment is being degraded, sometimes permanently. This has been recognized, and governments have begun placing restraints on activities that cause environmental degradation. Since the 1960s, activity of environmental movements has created awareness of the various environmental issues. There is no agreement on the extent of the environmental impact of human activity, and protection measures are occasionally criticized.

#### 4.2. Component of environmental management plane

- **Organizational/project environmental management plan**

An environmental management plan (EMP) can be defined as “an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented; and that the positive benefits of the projects are enhanced”. EMPs are therefore important tools for ensuring that the management actions arising from environmental impact assessment (EIA) processes are clearly defined and implemented through all phases of the project life-cycle.

The overall purpose of the guideline is twofold: to inform and guide the preparation and implementation of EMPs in a manner that promotes the effectiveness of EMPs; and to assist authorities and other reviewers in objectively evaluating the quality of EMPs. This guideline for EMPs describes the key components that should be included in an EMP, drawing from relevant existing guidelines as well as South African EMP experience.

- **Waste management**

Waste management is the collection, transport, processing or disposal, managing and monitoring of waste materials. The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. All waste materials,

whether they are solid, liquid, gaseous or radioactive fall within the remit of waste management.

Waste management practices can differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Management of non-hazardous waste residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator subject to local, national or international authorities.

- **Water quality protection**

Water quality refers to the chemical, physical and biological characteristics of water.<sup>[1]</sup> It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose.<sup>[2]</sup> It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water.

Water quality is measured by several factors, such as the concentration of dissolved oxygen, bacteria levels, the amount of salt (or salinity), or the amount of material suspended in the water (turbidity). In some bodies of water, the concentration of microscopic algae and quantities of pesticides, herbicides, heavy metals, and other contaminants may also be measured to determine water quality.

Although scientific measurements are used to define water quality, it is not a simple thing to say “that water is good” or “that water is bad.” So, the determination is typically made relative to the purpose of the water – is it for drinking or to wash a car with or for some other purpose? Poor water quality can pose a health risk for people. Poor water quality can also pose a health risk for ecosystems.

- **Noise pollution**

Noise pollution is the disturbing or excessive noise that may harm the activity or balance of human or animal life. The source of most outdoor noise worldwide is mainly caused by machines and transportation systems, motor vehicles, aircraft, and trains.<sup>[1][2]</sup> Outdoor noise

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is summarized by the word environmental noise. Poor urban planning may give rise to noise pollution, since side-by-side industrial and residential buildings can result in noise pollution in the residential areas.

Indoor noise is caused by machines, building activities, music performances, and especially in some workplaces. There is no great difference whether noise-induced hearing loss is brought about by outside (e.g. trains) or inside (e.g. music) noise.

High noise levels can contribute to cardiovascular effects in humans, a rise in blood pressure, and an increase in stress and vasoconstriction, and an increased incidence of coronary artery disease. In animals, noise can increase the risk of death by altering predator or prey detection and avoidance, interfere with reproduction and navigation, and contribute to permanent hearing loss.

- **Component of environmental protection:**

- ✓ **Erosion control:** - Appropriate sediment controls must be used during all excavation operations to prevent storm water pollution. Examples of sediment controls that may be used include covering stockpiles, use of drain inserts or covers and/or wattles.
- ✓ **Disposal of excavated material:** -Excavated material such as soil, asphalt, concrete, base rock, and slurry, must be disposed of as specified in the excavation permit.
- ✓ **Backfill and restoration:** - Backfilling and pavement or surfacing restoration must be in accordance with the excavation permit and project specifications. If excavated material is listed as re-use, the permit will specify if it is to be used as backfill or if it can be relocated on-site. In all instances, guidance and oversight by EP and the Building Inspection Office (BIO) is required.

### 4.3. Project traffic management

Barricades, trench plates, or other measures must be placed over an open excavation to prevent workers from falling in and to prevent damage to any exposed utilities. Use of trench plates must be approved by a civil engineer and in accordance with approved building and construction plans. Trench plates used to bridge excavations over which vehicles will travel must be secured against displacement. Personnel exposed to public vehicular traffic must

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be provided with and wear warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation and the operator does not have a clear and direct view of the excavation's edge, a warning sign must be used such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

- **Traffic management**

Prior to commencement of excavation affecting roads or traffic movement, a documented traffic control management plan should be prepared that includes, where necessary, traffic controller, barricades and any road closures. This traffic management plan should be available on site at all times when work is carried out.

Traffic management at the work site is essential to control traffic hazards and ensure safe work. The purpose of traffic management is to move people and vehicles through or around the work site as safely and efficiently as possible. Hazards associated with working near traffic include:

- ✓ Close proximity of workers to road traffic
- ✓ High traffic volumes
- ✓ Motorists approaching at high speed and/or with limited visibility of the work
- ✓ Mobile plant and equipment on site
- ✓ reduced visibility due to shade, light and glare throughout the day
- ✓ Parked vehicles, plant and equipment.

The site or project traffic management plan assists personnel to manage risks and documents information about the control measures.

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<b>Self-check 4</b>	<b>Written test</b>
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**Instructions:** Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. Define the following words
  - Environmental protection?
  - Environmental management plan
  - Traffic management
2. Write the component of Environmental Protection?
3. Write Hazards associated with working near traffic?
4. How to improve quality management of any construction plan

**Multiple choose question**

5. What is an explosion-hazardous environment?
  - A. An environment with too much gas and too little air.
  - B. An environment in which an explosive mixture can occur.
  - C. An environment where explosions are a frequent occurrence.

**Note: Satisfactory rating - 4 points**

**Unsatisfactory - below 4 points**

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

Answer Sheet

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Score = _____
Rating: _____

**Short Answer Questions**

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_

<b>Information Sheet-5</b>	<b>Identifying and obtaining signage requirements</b>
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### 5.1. Introduction

Crossing streets at uncontrolled (i.e., no traffic signal or STOP sign) locations can pose a serious risk to pedestrians. Pedestrians who cross at midblock account for as much as 26 percent of all motor vehicle-pedestrian crashes, according to a 1996 review of 5,000 pedestrian crash reports from six different states. That study found that another 32 percent of motor vehicle pedestrian crashes were intersection-related. Ninety-three percent of the midblock crashes and 40 percent of the intersection crashes occurred at uncontrolled locations (Hunter et al., 1996).

### 5.2. Escort vehicle

An escort vehicle, also called a pilot vehicle in most areas, is an automobile used to escort trucks with large loads, convoys of large vehicles, guide motorists through construction sites, and assist aircraft in taxiing from the runway to the tarmac at many airports. In most instances, pilot vehicles are provided by companies that specialize in convoy escort, although escort duties are occasionally performed by police vehicles (especially for parades and funeral processions or shipments that require a high level of security during transit). Some escort companies have special authority for traffic control through state approval.



Figure 22: Escort vehicle

### 5.3. Highway traffic signs

It is the same definition with traffic signage but we applied in high way roads. The symbol and the meaning is shown below the figure.

## Warning signs

Mostly triangular



Figure 23: Highway traffic signs

### 5.4. Site safety signage

Safety signs are a medium of communication that convey information or instructions regarding the physical safety of people. Signs in workplaces may be posted in a variety of areas in order to draw attention to them, such as on walls, on doors, on machinery and products, or as floor markings. They usually have a symbol and text, although there are safety signs that have only one of the two.



Figure 24: Site safety signage

### 5.5. Temporary signage for the benefit of motorists and pedestrians

Africa Road Furniture offers a great choice of different types of temporary (portable and suitable for road works) road traffic signs. Our wide selection allows us to cater to almost all budgets of construction service providers and individual requirements. Our temporary sign product range includes; yellow diversion signs and warning signs that have directions for vehicles to navigate around street works and construction areas safely.





Figure 25: Temporary signage for the benefit of motorists and pedestrians

## 5.6. Traffic conditions signage

Traffic signals are designed to ensure an orderly flow of traffic, provide an opportunity for pedestrians or vehicles to cross an intersection and help reduce the number of conflicts between vehicles entering intersections from different directions. Properly designed, located and maintained traffic signals have one or more of these advantages:

- Provide for orderly movement of traffic.
- Increase traffic-handling capacity of an intersection.

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- Reduce frequency and severity of certain types of crashes, especially right-angle collisions.
- Provide for continuous movement of traffic at a definite speed along a given route.
- Interrupt heavy traffic at intervals to permit other vehicles or pedestrians to cross.

Traffic signals are not a solution for all traffic problems at intersections, and unwarranted signals can adversely affect the safety and efficiency of traffic by causing one or more of the following:

- Excessive delay;
- Increased traffic congestion, air pollution and gasoline consumption;
- Disobedience of signals;
- Increased use of less-adequate streets to avoid traffic signals;
- Increased frequency of crashes, especially rear-end collisions.

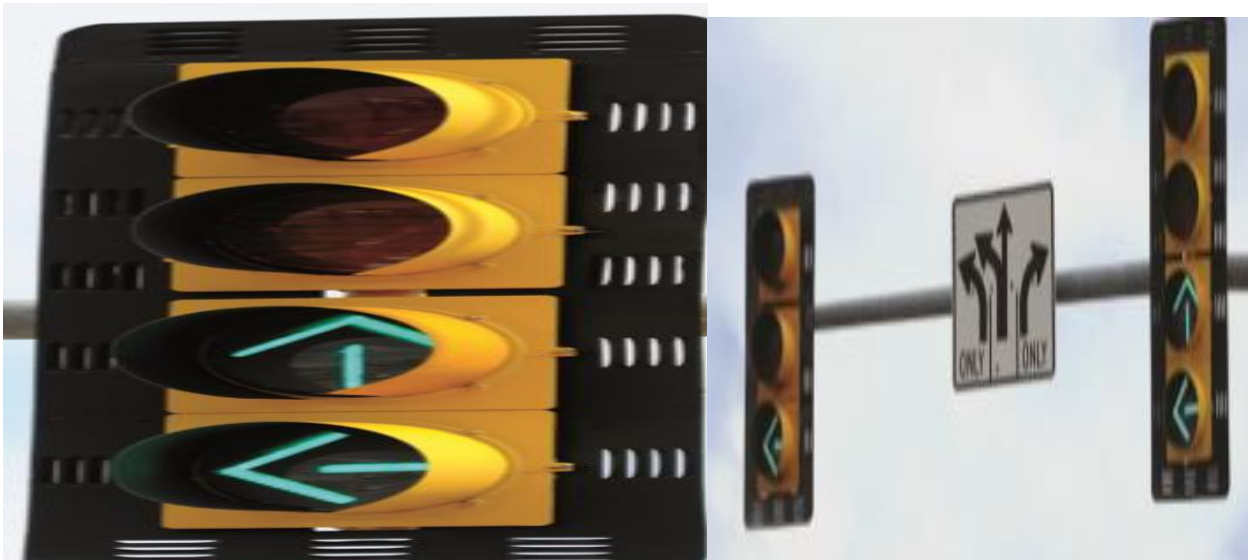


Figure 26: Traffic conditions signage

### 5.2.1. Basic traffic signal operations

- **Steady red arrow**
  - ✓ No left turns are allowed during red. STOP and wait for flashing yellow arrow or green arrow. Steady yellow arrow
  - ✓ Signal is about to turn red. Be prepared to STOP.
- **Flashing yellow arrow**

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- ✓ Left turns are permitted but not protected. Proceed with caution after yielding to oncoming traffic.
- **Steady green arrow**
  - ✓ Left turns are protected from oncoming traffic. The green arrow can come at the beginning or end of the signal sequence

**Start crossing**

- Watch for vehicles



**Don't start**

- Finish crossing if started



**Don't cross**



**Don't start**

- Finish crossing if started
- Time remaining to finish crossing



Figure 27: Basic traffic signal operations

<b>Self-check 5</b>	<b>Written test</b>
---------------------	---------------------

**Instructions:** Answer all the questions listed below. Choose the best answer and Write your answers in the sheet provided in the next page.

1. At an intersection where there is a flashing amber traffic light you must:
  - A. Stop if making a left turn?
  - B. Continue at the same speed?
  - C. Slow down and proceed with caution?
  - D. Stop if making a right turn?
  
2. Identification plates which must be placed in an upright position in front and rear of a motor vehicle must be painted in:
  - A. Yellow background with black letters and numbers?
  - B. Black background with white letters and figures or white luminous background with black letters and figures?
  - C. Black background with yellow letters and figures?
  - D. Does not matter what colour once it is large enough?
  
3. When driving a motor vehicle on the highway at night, you should use low beam headlights (dim lights) when:
  - A. Another driver dims his lights?
  - B. Blinded by the headlights of an approaching vehicle?
  - C. Approaching an intersection?
  - D. Meeting or following another vehicle?
  
4. If a Traffic signal changes while a pedestrian is still in the intersection, which of the following has the right of way?
  - A. The pedestrian
  - B. Motorists coming from the right.
  - C. Motorists coming from the left.
  - D. Motorists making turns.
  
5. A flashing red light at an intersection means:
  - A. Stop, proceed only when it is safe to do so
  - B. Slow down and yield right of way to car approaching from your left or right?
  - C. Stop, proceed only when the light changes to green?
  - D. Slow down and drive with increased caution?

**Note: Satisfactory rating – 6 points**

**Unsatisfactory - below 6 points**

### Answer Sheet-1

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Multiple Choice Questions

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Operation Sheet 1	Selecting plant tools and equipment's
-------------------	---------------------------------------

**Procedures:**

- Step 1:** wear appropriate personal protective equipment.
- Step 2:** Select the required tools
- Step 3:** Go to the material stores and select Shovels,
- Step 4:** Select Picks,
- Step 5:** Select Shovels Hammers,
- Step 6:** Select Hydraulic jacks
- Step 7:** Select Pinch/lever bars.
- Step 8:** Clean all tools before use any purpose
- Step 9:** Use the tools for the required purpose properly
- Step 10:** clean all tools after use the
- Step 11:** store all tools properly in the store

<b>LAP test</b>	<b>Practical demonstration</b>
-----------------	--------------------------------

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

Task 1: Select and use necessary tools in manual excavation activity properly and appropriately

Instruction sheet	Learning Guide 54: Dig Small Excavations By Hand
-------------------	--

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

- Conforming location and specifications of intended excavation on the ground
- Identifying service markers or taped areas
- Determining location of underground services
- Using hand tools correctly to dig post holes, small pits and trenches safely.
- Under taking 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 –

- Confirm the location and specifications of the intended excavation on the ground before commencing work
- Identify service markers or tape areas
- determine or confirm Location of underground services
- use correct Hand tools to dig post holes, small pits and trenches safely and to the required dimensions
- take trench collapse prevention procedures where excavation is in unstable ground
- place Barricades around the excavation

**Learning instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5, Sheet 6 and Sheet 7” ” in page 3, 13, 20, 26,38 ,47 and 49respectively.
4. Accomplish the “self-check 1, self-check 2, self-check 3, self-check 4, self-check 5, self-check 6 and self-check 7” in page 11, 19, 24, 36, 45, 48 and 53 respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, and Operation Sheet 2, in page 54 and 55 respectively.
6. Do the “LAP test” in page 56 (if you are ready).

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Information sheet-1	<b>Conforming Location and Specifications of Intended Excavation</b>
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## 1.1 Introduction to manual excavation

**Excavation** is any man-made cut, cavity, trench, or depression in an earth surface that is formed by earth removal.

- **Safe digging practices**

Excavation work should be carried out carefully and follow recognized safe digging practices. Once a locating device has been used to determine cable positions and routes, excavation may take place, with trial holes dug using suitable hand tools as necessary to confirm this. Excavate a long side the service rather than directly above it. Final exposure of the service by horizontal digging is recommended; as the force applied to hand tools can be controlled more effectively. Insulated tools should be used when hand digging near electric cables

## 1.2 Important civil construction terminology

- **Backfill-** The replacement of excavated earth into a trench around or against a basement /crawl space foundation wall.
- **Estimate-** The amount of labor, materials, and other costs that a contractor anticipates for a project as summarized in the contractor's bid proposal for the project.
- **Estimating-** The process of calculating the cost of a project.
- **Foundation-** The supporting portion of a structure below the first floor construction, or below grade, including the footings.
- **Adjacent:** - the area within a horizontal distance from the edge of a vertical sided equal to the depth of the excavation.
- **Benching:** - a method of sloping the side of an excavation by forming a series of steps.
- **Cave-in:-** the separation of a mass of soil or rock from the face of an excavation in to an excavation.
- **Competent person:** - a person capable of identifying existing and predictable hazards in the surroundings or working conditions and who has authorization to take prompt corrective measures to eliminate the hazards.

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- **Cross brace:** - horizontal members of a shoring system installed perpendicular to the sides on an excavation the end of which bears against up rights or wales.
- **Excavation:** - a manmade cut cavity or depression in the earth's surface.
- **Face:** - The side of an excavation.
- **Hazardous atmosphere:** - an atmosphere that could cause an injury or illness.
- **Previously disturbed soil:** - soils that has been disturbed from excavation work or other digging.
- **Protective system:**-a system designed to protect workers in excavation. Sloping and benching, shores and shields are example of Protective system.
- **Ramp:** - an inclined walking or working surface constructed from earth or from structural materials such as steel or wood.
- **Sheeting:** - component of a shoring system that prevents soil from sliding into an excavation.
- **Shield:** - a structure able to withstand forces caused by a cave-in shields can be manufactured or custom built in accordance with 1926.652(c) (2)-(c) (4).
- **Shore:** -a structure that supports the side of an excavation and prevent cave in.
- **Sloping:** - a method of inclining the face of an excavation to minimize the risk of a cave in. the maximum allowable slope varies with soil type, environment and work done at the excavation side.
- **Soil:** - weathered rock, gravel, sand or combination of clay, silt and loam.
- **Stable rock:** - natural solid mineral material that can be excavated with vertical sides and with remain will remain intact while exposed.
- **Surcharge:** - a load exerted on ground adjacent to an excavation.

### 1.3 Understanding work instructions including plans and specifications

**Location plan:** -it shows the location size and nature of the plot on which the Building is to be constructed and the immediate surroundings in scale the exact Position of the building and the boundary is marked by the building line which defined by the municipality of the town or city before the building can be started all the required drawing has to be ready.

- ✓ The site plan
- ✓ Top view ,elevation, details
- ✓ Surrounding , sketches , work drawing

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- ✓ Static calculation, bill of quantity and other specification

Long-range work plans are work plans which cover a fairly long period of time from, say, 2-5 months up to a year or more. These plans are made by headquarters or site engineers. They are usually not very detailed but give a general picture of what is to happen in the period.

## 1.4 Analyzing project quality requirements & operational details

### 1.4.1. Understanding work instructions including plans and specifications

- **Dimension :- is**
  - ✓ A measure of spatial extent, especially width, height, or length.
  - ✓ Extent or magnitude; scope. Often used in the plural: a problem of alarming dimensions.
  - ✓ Aspect; element: "He's a good newsman, and he has that extra dimension" (William S. Paley).
- **Dimensioning is:-**
  - ✓ To cut or shape to specified dimensions.
  - ✓ To mark with specified dimensions.

## 1.5 Measurement of civil works

To estimate the quantities of work to be done, a simple Bill of Quantity will have to be made. One way to do this is as follows:

- The alignment is set out with pegs every **X** meters. These pegs should also show the level of the area.
- At each section the height and width of excavation is estimated (by eye) and noted. Alternatively, the cross fall gradient can be measured either by meter or with an abbey level and boning rod.
- The average height and width cross fall is calculated for each kilometer.
- The approximate volume to be excavated is calculated for each kilometer.
- Rates of work are assumed; for example, 3 m<sup>3</sup> of excavation of firm soil per man/day.
- Inputs in number of man/days are noted (step 4 divided by step 5).
- The quantity of the other main activities is judged. Rates of work are assumed and the input in number of man/days is noted on the Survey Form.

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- Fifteen percent extra man/days are added to cover supporting activities such as camp building, water hauling, etc.
- The sum of these man/days represents the total input for each kilometer of excavation area.

The "Survey Form" now gives a rough estimate of the amount of work for each kilometer or section and the number of man/days required to carry out this work. To make it easier to control and adjust, this information is transferred to a graph. Here the length of the excavation area is shown on the horizontal axis and the estimated required input (in man/days) on the vertical axis.

The total number of man/days required for each. The number of working days required to complete each kilometer is calculated by dividing this number of man/days by the average number of laborers available for the work. The target can then be set. This target is expressed as the date or working day when each kilometer should be completed and indicates how many man/days should be spent on the work. The construction supervisor then has to plan how his laborers and equipment should be organized in order to reach the target. His planning is called weekly/daily work planning.

## 1.6 Aliment of construction costs

When, with the construction of a. new excavation, several alignments are possible, the engineer will take his decision based on an estimate of:

- Construction costs - e.g. an alignment of a. certain length with suitable conditions will be cheaper to construct than an alignment of the same length difficult situation. For the latter, the necessary earthworks will be far more extensive
- Maintenance costs - the costs to maintain steep gradients are higher than the costs to maintain gentle gradients during excavation.
- Social costs and benefits - in many cases the higher construction costs of a longer alignment may be justified if the excavation would serve a public facility (e.g. school, health center).

The cost of each item of work is to be worked out, and then adding all the cost items will give the total cost of the project.

The basic parameters considered during cost estimate for each item of work are;

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- Material cost
- Labor cost
- Machinery and vehicles rental or depreciation cost
- Cost of construction equipment's
- Overhead costs
- Profits

## 1.7 Basic principles of soil technology for civil work

For soil resources, experience has shown that a natural system approach to classification, i.e. grouping soils by their intrinsic property (soil morphology), behavior, or genesis, results in classes that can be interpreted for many diverse uses. Differing concepts of pathogenesis and differences in the significance of morphological features to various land uses can affect the classification approach. Despite these differences, in a well-constructed system, classification criteria group similar concepts so that interpretations do not vary widely. This is in contrast to a technical system approach to soil classification, where soils are grouped according to their fitness for a specific use and their edaphic characteristics.

Natural system approaches to soil classification, such as the French Soil Reference System are based on presumed soil genesis. Systems have developed, such as USDA soil taxonomy and the World Reference Base for Soil Resources, which use taxonomic criteria involving soil morphology and laboratory tests to inform and refine hierarchical classes.

Another approach is numerical classification, also called ordination, where soil individuals are grouped by multivariate statistical methods such as cluster analysis. This produces natural groupings without requiring any inference about soil genesis.

In soil survey, as practiced in the United States, soil classification usually means criteria based on soil morphology in addition to characteristics developed during soil formation. Criteria are designed to guide choices in land use and soil management. As indicated, this is a hierarchical system that is a hybrid of both natural and objective criteria. USDA soil taxonomy provides the core criteria for differentiating soil map units. This is a substantial revision of the 1938 USDA soil taxonomy which was a strictly natural system. Soil taxonomy

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based soil map units are additionally sorted into classes based on technical classification systems. Land Capability Classes, hydric soil, and prime farmland are some examples.

In addition to scientific soil classification systems, there are also vernacular soil classification systems. Folk taxonomies have been used for millennia, while scientifically based systems are relatively recent developments.

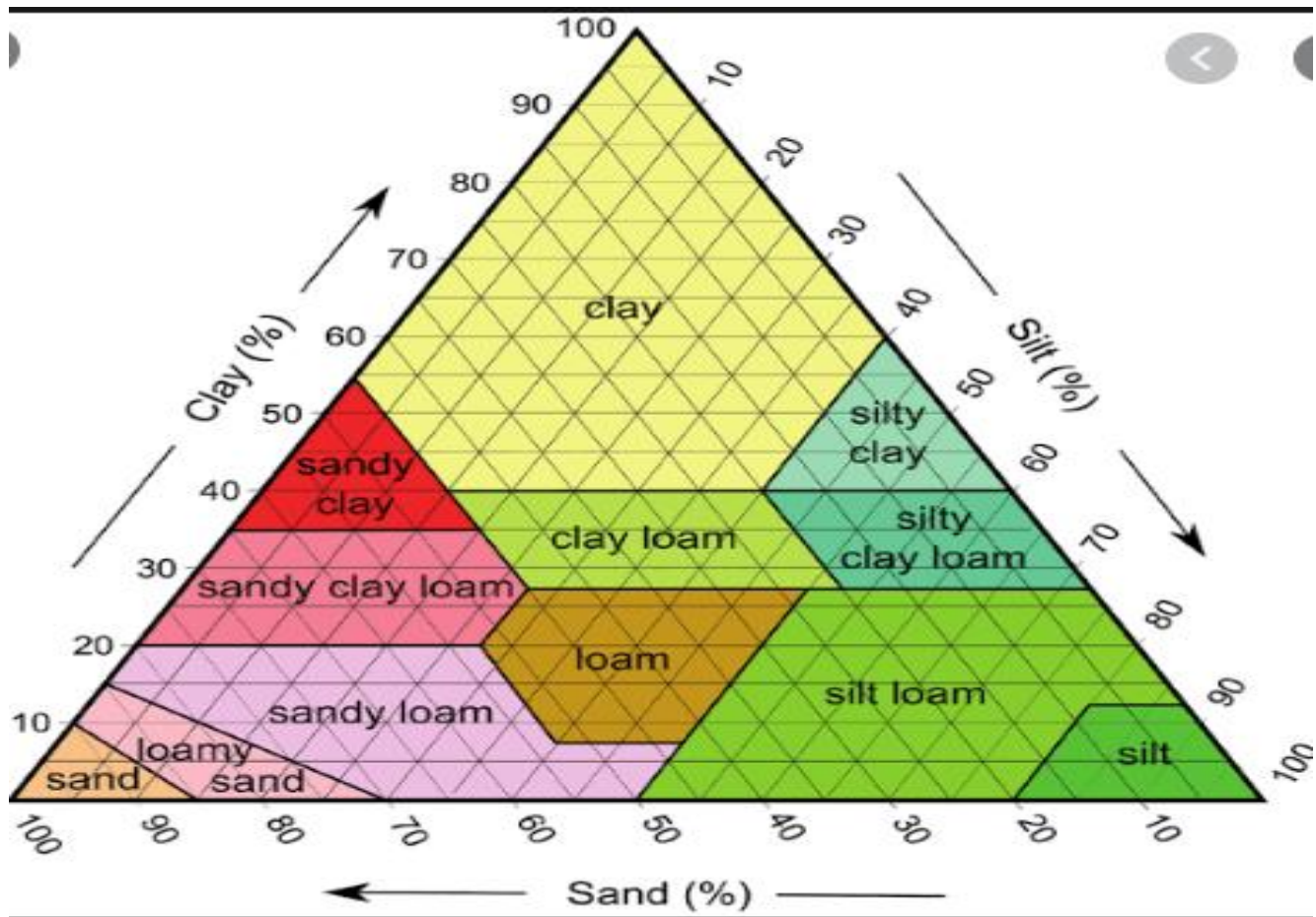


Figure 28: soil classification taxonomy

• **Soil and stability**

Some soils are more stable than others. The type of soil is one of the factors that determine the chance that an excavation will cave in. There are three basic soil types that you may encounter in Oregon:

- ✓ Type A – very stable. Clay is an example.
- ✓ Type B – less stable than type A soil. Crushed rock, silt, and soils that contain an equal mixture of sand and silt are examples.
- ✓ Type C – less stable than type B soil. Gravel and sand are examples.

Soil has other qualities that affect its stability. These include granularity, saturation, cohesiveness, and unconfined compressive strength.

- ✓ Granularity refers to the size of the soil grains; the larger the grains, the less stable the soil.
- ✓ Saturation means how much water soil will absorb.
- ✓ Cohesive ness means how well soil holds together; clay is a cohesive soil.
- ✓ Unconfined compressive strength is determined by a test that shows how much pressure it takes to collapse a soil sample. For example, type A soil must have an unconfined compressive strength of at least 1.5 tons per square foot.

- **Soil tests**

The competent person must make at least one visual and one manual soil test as a basis for soil classification.

- ✓ **Visual test:** Visual analysis is conducted to determine the qualitative information regarding the excavation site in general.
  - I. The soil adjacent to the excavation,
  - II. The soil forming the sides of the open excavation, and
  - III. The soil taken as samples from the excavated materials.
- ✓ **Manual tests:-**Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil to provide more information in order to classify soil properly.

Examples: Thumb penetration, Pocket penetrometers, Drying tests, Sedimentation

- **Why mechanics of soils?**

Like other solid materials (e.g. metals, rock), soils deform when they are exposed to forces Unlike many other materials in our environment, soils show a wide range of possible mechanical behavior which influences considerably their use for Understanding soil deformation behavior is crucial to:

- ✓ design slopes and retaining walls
- ✓ build tunnels in 'soft' rock
- ✓ assess hazards due to land slides
- ✓ prevent soil from compaction

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**Self-check 1**

**Written test**

**Directions:** all the questions listed below. Choose the best answer and write the Answer in the answer sheet provided in the next pages

2. From the soil textural triangle the percentage of sand silt and clay will be 40 40 and 20 respectively then the soil type will be -----?
  - A. Sandy loam soil
  - B. Loam soil
  - C. Clay loam soil
  - D. Sandy clay loam soil
3. Which one is civil construction terminology?
  - A. **Excavation**
  - B. Cave-in
  - C. Backfill
  - D. Estimating
  - E. None of the above
4. During Reading drawing plans what is the main point to read?
  - A. The site plan
  - B. Top view ,elevation, details
  - C. Surrounding , sketches , work drawing
  - D. Static calculation, bill of quantity and other specification
  - E. All of the above
5. The estimate which prepared using any rough method to get the approximate cost construction anticipated in a project is called an \_\_\_\_\_estimate.
  - A. Approximate
  - B. Precise
  - C. Exact
  - D. rough
6. The excavation exceeding 1.5 m in width and 10 sq. m in plan area with a depth not exceeding 30 cm, is termed as \_\_\_\_\_.
  - A. Excavation
  - B. surface dressing
  - C. surface excavation
  - D. cutting



**Note: Satisfactory rating – 6 points**

**Unsatisfactory - below 6 points**

### Answer Sheet-1

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Multiple Choice Questions

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

## 2.1. Identification of markers and taped areas

Plans or other suitable information about all buried services in the area should be obtained from each service owner before excavation work starts. The service owner should do everything that is reasonably practicable to ensure that such information is made available to parties making inquiries.

Many service owners will, on request, offer a service to trace and mark-out their services on the ground, and you should avail yourself of this service and be familiar with the telephone numbers to call.

Account should be taken of any indications that buried services exist, such as the presence of street lights, illuminated traffic signs, valve pit covers, telecommunications chambers and service pillars, obvious signs of previous trench reinstatement, etc. However, the absence of such indications does not necessarily mean that there are no buried services a cable may be shown on a plan as a straight line, with measurements taken from fixed objects at the time of installation, whereas in practice the cable may twist and turn, or may have been moved out of position. Reliance on the plan alone would give a false position, but this could be alleviated by the correct use of a cable locator. If several cables are close together, a locator may show them as a single cable, whereas the plan would help give a more accurate picture. Once underground services have been uncovered, failure to identify them correctly is another common cause of accidents.

A wide variety of materials and colors for pipes, ducts, and cables have been used over the years. Water pipes, gas pipes, electricity cables and telecommunication cables may be of black plastic and if any black plastic service is found, it should be assumed to be a live electricity cable or gas pipe until proved otherwise. Some services run in ducts, making them difficult to identify.

Where there is any doubt about the identity of any exposed service, it should be treated as an electricity cable or gas pipe until proved otherwise. All services should be assumed to be live until disconnected and proved safe at the point of work.

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Written confirmation of disconnection should be obtained from the service owner before removing a redundant service. To establish uniform surface marking of underground services, it is recommended that utilities and road authorities use the following symbols and colors.

Table 1: types of markers and taped area

<b>Service</b>	<b>Duct Colour (Notes 1, 4 and 5)</b>	<b>Surface Marking Colour (Note 2)</b>	<b>Surface Marking Symbol (Note 3)</b>
Electricity	Orange	Orange	'E'
Gas	Yellow	Yellow	'G'
Telecommunications	Green	Purple	'T'
Water	Blue or White	Blue	'W'
Waste Water (Sewer)	Light Grey	Red	'SS'
Storm Water/Drainage	Dark Grey	Pink	'SW'

Avoid excessive or oversized marking, especially if marking outside the excavation area. Conditions permitting, use spray chalk paints, water-based paints, or equivalent, less permanent, type marking. Limit length, height, and interval of marks to those recommended. Letters and numbers must not exceed three to six inches in height. When paint is not used, use appropriately colour stakes, lath, pennants, or chalk lines. Select marker types that are most compatible to the purpose and marking surface.

If any marking information is omitted due to site conditions, communicate omitted data by direct contact, signs, phone, fax, etc. Mark the as-built drawings attached to the excavation permit.

Offset markings must clearly indicate the direction, distance, and path of facility or excavation. Delineate the area to be excavated. Delineated areas must be identified in white markings. Delineate the exact area of excavation through the use of dots or dashes, or a continuous solid line. Limit the size of each dash to approximately six inches in length and one inch in width, with interval spacing not less than approximately four feet. Dots of approximately one inch diameter are typically used to define arcs or radii and may be placed at closer intervals in lieu of dashes. Limit width of lines to one inch.

Mark centreline of planned excavation with six inch by one inch arrows (approximately four feet apart) to show direction of excavation. For boring or continuous operations were marked

paving is not to be removed, mark at critical points with maximum mark separation of approximately 50 feet. Mark lateral excavations with arrows showing excavation direction from centreline with marks at curb or property line if figures. Dots may be used for curves and closer interval marking.

Marks must be placed on either side of the facility to define the hand dig area, defined as the width of the facility itself plus the tolerance zone of 36 inches on all sides of the facility.

## 2.2. Marking out an excavation site

Consult the plan and drawings at the site to determine where the excavation should be marked out. Mark the boundaries of the excavation clearly using standard survey pegs, pins or tape.

- **Construction site pegs and markers:** - Pegs and markers are used to indicate proposed construction area work and ensure that construction quality requirements are met, such as dimensions, tolerances and technical specifications.
  - ✓ Markers are placed by engineers and surveyors, who identify locations using site drawings and survey equipment.
  - ✓ Surveyors refer to a bench mark, which is a wooden or steel pin that is tied into a grid that indicates location and elevation.
  - ✓ Survey and other reference control pegs are marked with information relating to the construction activity.
  - ✓ Construction site survey pegs are colored white, with a red top for easy visibility and identification.
  - ✓ Instructions, chain age and other measurements are written on the pegs.

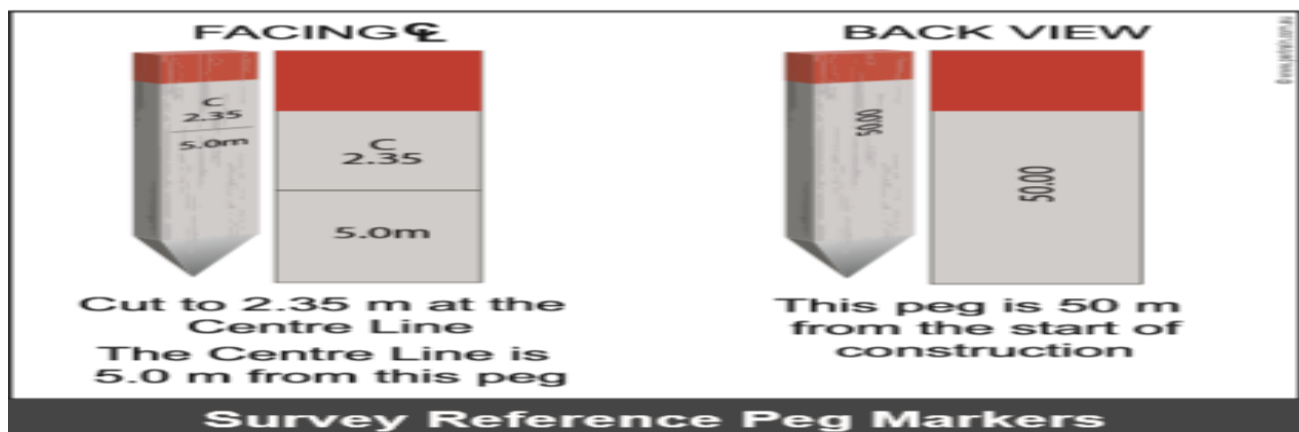


Figure 29: Construction site pegs and markers

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- **Excavation offset Pegs**:-Excavation offset pegs are used where nearby construction activity may disturb the excavation pegs or markers. In this case, there are two ways of marking out the excavation area.
  - ✓ Offset pegs 5 meters to one side of the excavation at half meter intervals.
  - ✓ . Offset pegs at regular intervals 100mm away from the excavation and joined by a string line.

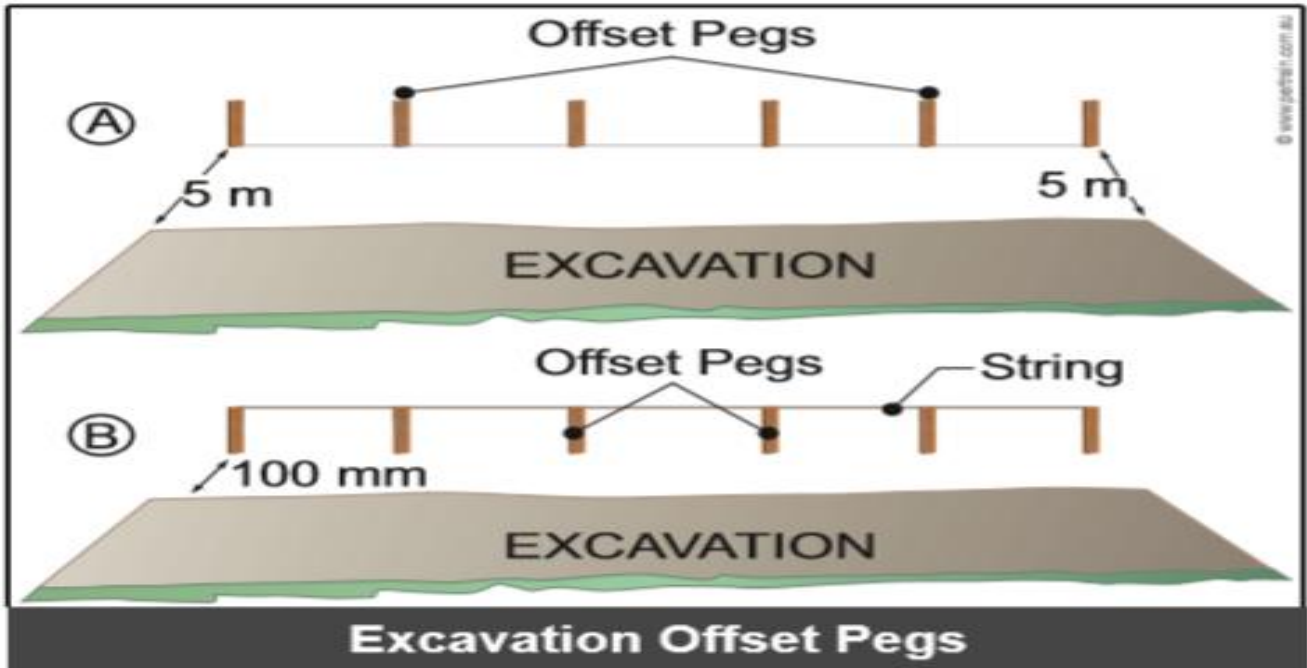


Figure 30: Excavation Offset Pegs

<b>Self-check 2</b>	<b>Written test</b>
---------------------	---------------------

**Instructions:** Answer all the questions listed below. Write your answers in the answer sheet provided in the next page.

1. What is the cooler indicator of water in marking?
  - A. Blue
  - B. Green
  - C. Yellow
  - D. Black
  
2. Which one is tolerances and technical specifications of marking?
  - A. Markers are placed by engineers and surveyors, who identify locations using site drawings and survey equipment.
  - B. Surveyors refer to a bench mark, which is a wooden or steel pin that is tied into a grid that indicates location and elevation.
  - C. Survey and other reference control pegs are marked with information relating to the construction activity
  - D. Construction site survey pegs are colored white, with a red top for easy visibility and identification.
  - E. All of the above

**Note: Satisfactory rating - 10 points**

**Unsatisfactory - below 10points**

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

Answer Sheet

Score = _____
Rating: _____

Name: \_\_\_\_\_ Date: \_\_\_\_\_

- 1.
- 2.

### 3.1. Locate underground services

The term 'service(s)' means all underground electricity, gas, water, steam, waste water (sewer, storm water), telecommunications plant, and liquid petroleum services and oil pipelines. It does not include underground structures such as brick sewers, railway tunnels, etc.

Plans can give a good indication of the location, configuration and number of underground services at a particular site, and will help subsequent tracing by locators. Those in charge of site work, and operators of locators, should be aware that plans may show spare ducts, and that the accuracy of plans is limited because:

- ✓ The position of reference points (e.g. the curb line) may have changed since the plans were drawn;
- ✓ Regarding of any surface may mean that the depths shown are now incorrect;
- ✓ Services, particularly cables, may have been moved without the authority or knowledge of their owners;
- ✓ In many cases service connections are not marked;
- ✓ Services, marked as straight lines may, in practice, twist and turn; and
- ✓ In order to avoid too tight a bending radius, cables may have been laid in horizontal loops outside substations, switch-rooms, and at the base of poles, etc.

Plans can give a good indication of the location, configuration and number of underground services at a particular site, and will help subsequent tracing by locators. Those in charge of site work, and operators of locators, should be aware that plans may show spare ducts, and that the accuracy of plans is limited because:

These devices are relatively inexpensive and should be available at all work sites. Compared to the cost of the repair of a damaged service, they are a good investment and will recover their cost very quickly. Locators will only detect metallic objects and will not detect plastic objects unless a tracer wire is incorporated with the pipe, or a tracing transmitter is able to be propelled through the pipe.

### 3.2. Underground installations

- Determine the estimated locations
- Contact the utility or owner
- Proceed cautiously
- Find the exact location
- Support, protect, or appropriately
- Remove the installation in open excavations
- Must be located prior to digging
- Determine the utilities exact location by hand digging or vacuum excavating only!
- Support, protect, or remove utilities in open excavations

Information provided by service providers and other sources is compiled on a site service plan. The plan does not indicate the precise location and depth of the buried cables or pipes, but is a guide to locating the services on the ground.

Locate underground services following these steps.

- ✓ Contact all concerned parties, for example service providers.
- ✓ Determine the location of the buried services on the ground using the available information and mark with survey pegs.
- ✓ Dig potholes to determine the exact location, alignment, depth and grade of the services.
- ✓ Mark out the exact location of the underground services.
- ✓ Based on this information, mark the excavation zone and determine the equipment required for the excavation or other job.

### 3.3. Common utility types

- **Gas lines (steel or wrapped steel, cast, copper plastic)**
- ✓ Steel lines locate well. Lengths are welded together so current flows freely. However, insulators are sometimes placed in the line to electrically isolate segments and reduce corrosion.
- ✓ Copper, not common for gas but easy to locate.
- ✓ Cast iron gas can be good or bad. Can also have insulators.

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- ✓ Plastic gas lines are required to be buried with a trace wire... good if you can find it to direct connect. Trace wires often corrode and / or are not continuous.
- **Water lines (ductile/ cast iron, steel, AC,**
  - ✓ If metallic (cast or ductile iron, steel, copper, etc.) can be located but generally buried deeper than other lines. Bell and spigot joints (push on with gasket) can resist current flow. Hard to trace for long distances because current travels to ground.
  - ✓ If non-conductive (plastic, asbestos cement, etc.) will need trace wire to detect. Acoustic methods might be used but carries some risk.
- **Gravity sewers**
  - ✓ Usually rely on surface features and direction / next connecting structure to determine location
  - ✓ Can be snaked or videoed and then detected (cost and labor intensive)
- **Other / less common...**
  - ✓ Steam or high temp water is usually welded steel i.e. good to detect.
  - ✓ Chilled water can be made from same materials as water lines with similar characteristics.
  - ✓ Irrigation almost always plastic. Can detect control wiring. Often considered expendable and/ or not costly to repair or replace.
  - ✓ Septic systems –challenging due to lack of access to system components and non-conductive materials



Figure 31: The need to know horizontal and vertical positions & type, size and location of existing subsurface utilities



Fig 32 Telephone and Sewerage

### 3.4. Influencing factors: electromagnetic pipe and cable locating

- **Depth of bury**
  - ✓ Shallow -stronger field easily detected
  - ✓ Deep –weaker field, more difficult to detect.
- **Physical access to utility**
  - ✓ Surface induction may be the only option for applying signal.
- **Utility type and material**
  - ✓ The easiest utilities to detect are conductive cables and pipes with minimal resistance to current travel.
- **Conductor congestion both above and below ground**
  - ✓ Interference and signal bleed to adjacent conductors making it difficult to interpret the multitude of magnetic fields present
  - ✓ Fences, guardrails, building walls and columns and overhead cable can all be sources of interference.

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<b>Self-check 3</b>	<b>Written test</b>
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**Instructions:** Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page

1. Which one of the following Influencing factors: electromagnetic pipe and cable locating?
  - A. Depth of bury
  - B. Physical access to utility
  - C. Utility type and material
  - D. Conductor congestion both above and below ground
  - E. All of the above
2. Which one of the following are common utility types?
  - A. Gas Lines
  - B. Water Lines
  - C. Gravity Sewers
  - D. All of the above
3. Which one of the following is component of Gravity Sewers?
  - A. Usually rely on surface features and direction / next connecting structure to determine location
  - B. Can be snaked or videoed and then detected (cost and labor intensive)
  - C. All of the above
  - D. None of the above

**Note: Satisfactory rating - 10 points**

**Unsatisfactory - below 10 points**

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

Score = _____
Rating: _____

**Answer Sheet**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Answer**

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_

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<b>Information sheet-4</b>	<b>Using hand tools correctly to dig post holes, small pits and trenches safely</b>
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#### 4.1. Digging small excavation by hand tools

People have been making wells without the use of power equipment for thousands of years. Each of the methods described in this section involve hard work, but most can be carried out using locally-available materials and skills.

- **Site clearing**

Remove any vegetation you will want to save and replace when the project is finished. Small plants, even turf grasses, can be removed and stored for replanting with proper care. Remove the topsoil to a depth of 10-20cm, depending on 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 - 1.5m in height to avoid compaction. For the same reason the topsoil heap should either be demarcated or placed away from frequent foot or vehicular traffic. If the topsoil is going to be stored for prolonged periods of time over-seed with non-invasive grass species to reduce erosion.

- **Setting out**

Setting out or ground tracing is the process of laying down the excavation lines and center lines etc. on the ground before the excavation is started. At the beginning of any construction activity the work must be carefully set out. This is also known as pegging out or lining out. Setting out means to put pegs in the ground to mark out an excavation; or to mark on the floors to locate walls.

#### 4.2. Preparing site for work and setting out

- **Building preliminaries**

Before anyone can actually start to erect a building, a number of preliminary steps must be completed. The very first step is the preparation of the plan.

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- **Plan**

The plan, also called the drawing, is a layout of a building drawn on paper. It contains all the information necessary to erect the house. The data and measurements given in the plan are essential for the builder to be able to construct the building so that it satisfies the customer's demands (4.1. 1 & 2).

- **Plot and site clearing**

A plot is an area of land containing one or more sites. It is determined and limited by boundaries

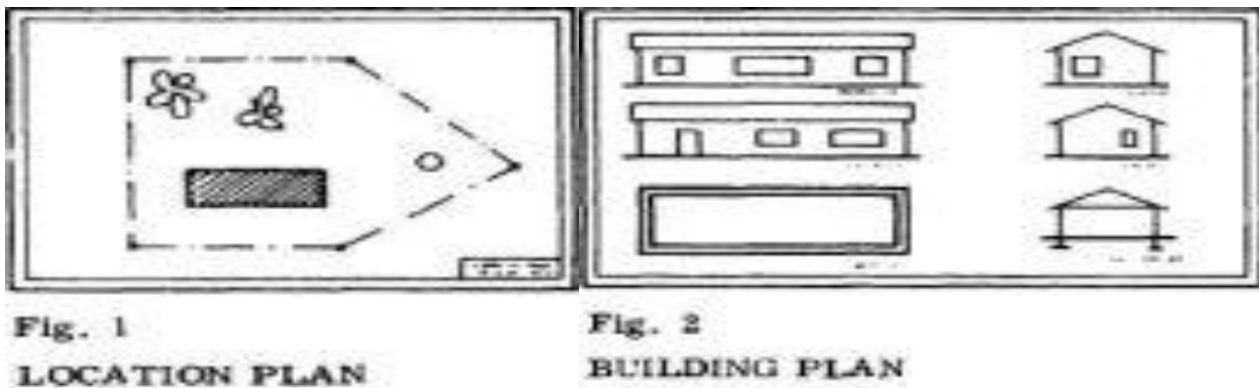


Figure 33: location plan of site clearing

The site is that area of land within the plot which is actually used for construction with the location plan in hand, the builder can prepare both plot and site for the construction of the building. The location plan tells him exactly where the trees and bushes have to be removed so that they don't interfere with the work. This preparation includes making a drive, cutting the grass, and leveling the surface of the ground. The builder must pay special attention to the roots of trees which are on the site or very close to it. These must be completely removed. If some roots, such as those of the neem tree, remain in the ground, they can grow again and damage the structure.

- **Site organization**

When the land clearing is completed, the building materials can be brought in to the building site. Temporary work-sheds and stores may be erected in suitable places (Fig. 3).

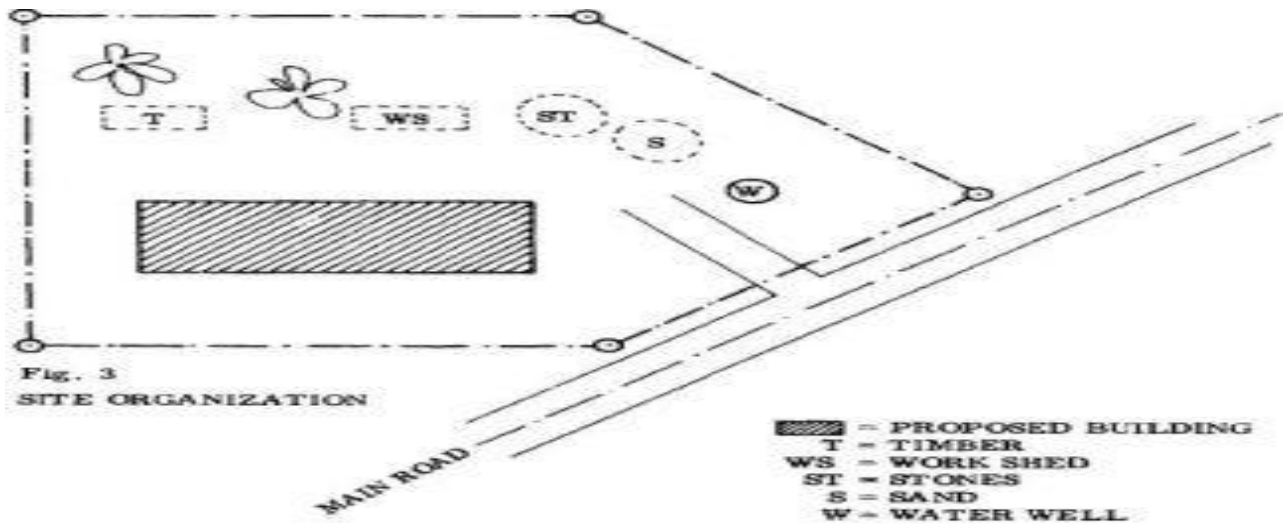


Figure 34: Site organization

- **Setting out**

At the beginning of any construction activity the work must be carefully set out. This is also known as pegging out or lining out. Setting out means to put pegs in the ground to mark out an excavation or to mark on the floors to locate walls.

- **3-4-5 method**

The first line to be set out is the front line of the carcass (Fig. 4.3). A "carcass" is the building when it is structurally complete but otherwise unfinished. In this case we mean that the front line marks the position of the outside face of the (future) unflustered wall. The lines of all the other walls are measured from this front line. If the building is rectangular, right angles are set off from the front line by using the 3-4-5 method.

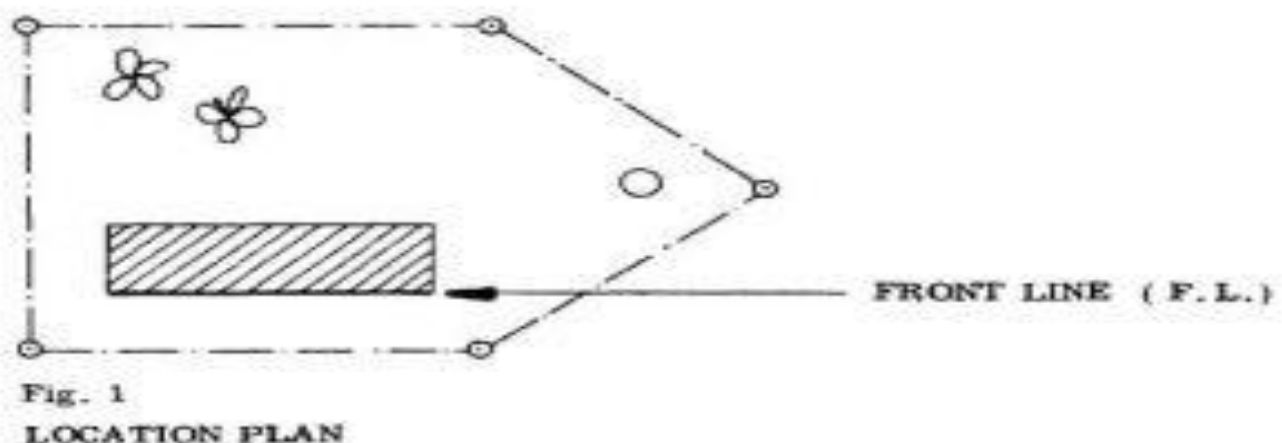


Figure 35: 3-4-5 method layout

The second line to be set out is the line of one of the side walls of the carcass. This line intersects the front line at the corner of the future building. To make sure that this corner is a right angle, we use the 3-4-5 method. Measure a distance of 4 m along the front line starting from point A, and mark this on the line (point B) (Fig.4.4).

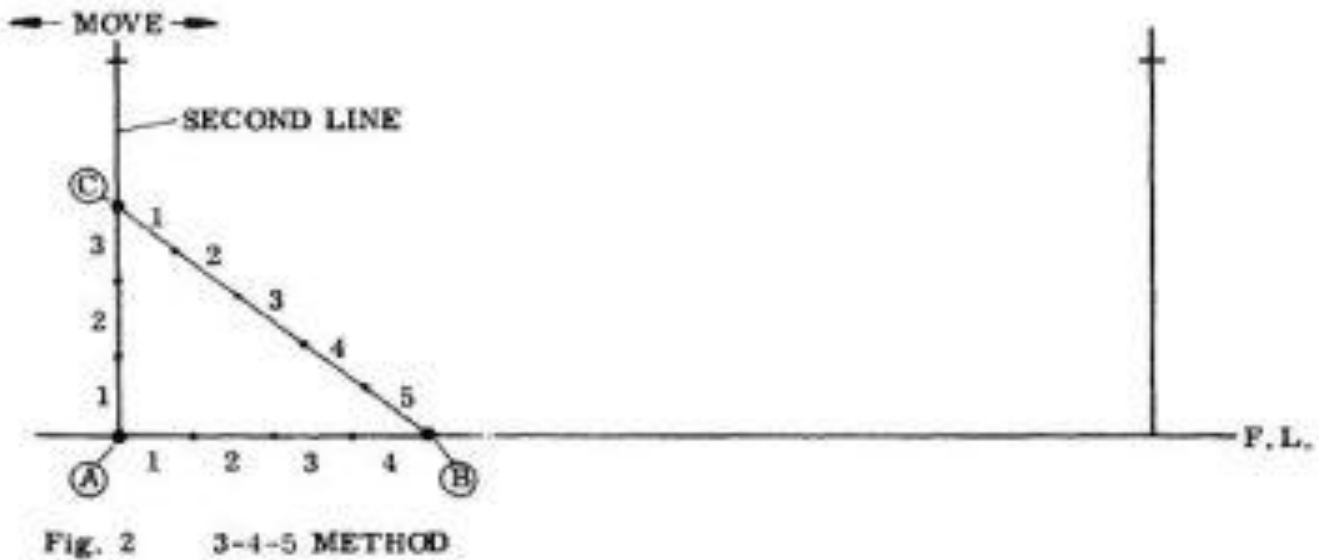


Figure 36: way of distance measuring method

- Measure a distance of 3 m along the second line, starting from the corner (point A) and mark this distance (point C).
- Now take a line which is marked with a distance of 5 m, and stretch it taut from point B towards the line with point C. Keeping the end points of both lines steady (points A & B) and the lines taut; move the free ends of the side line and the 5 m line until the 5 m mark and the mark at point C meet each other. This is best done with two men, one at the end of each line.
- The corner angle must now be a right angle.
- Measure the required length of the side line and insert a peg at the end. Set out the opposite side line in the same way.
- If the setting out has been done accurately, the length of the back line between the two pegs should be equal to that of the front line. Make a further check by measuring the diagonals, which must be equal (Fig. 3).

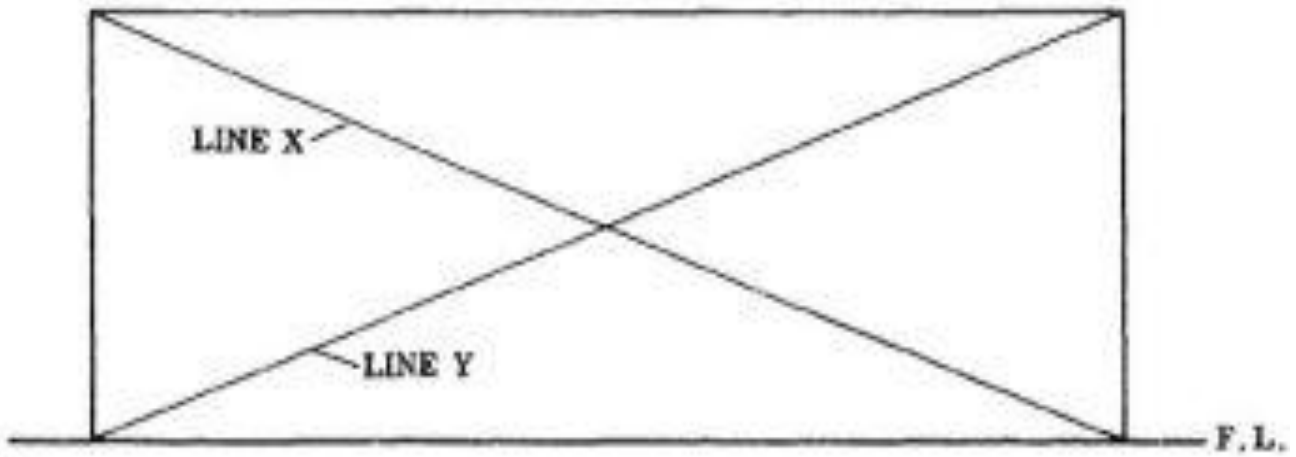


Fig. 3 LINES X AND Y ARE EQUAL IN LENGTH

Figure 37: checking ways of distance measurement

- **Lining out**

Once the positions of the corners and the distances between them are determined, the positions of the foundations, footings and walls as well as their thickness must be marked. A simple example of setting out and marking a foundation is shown in Fig 5. The more complicated and permanent methods will be treated later. These marks will be needed until the plinth course is completed, so they must be relatively durable, so that they remain accurate for a longer period and are not destroyed by rain or other influences.

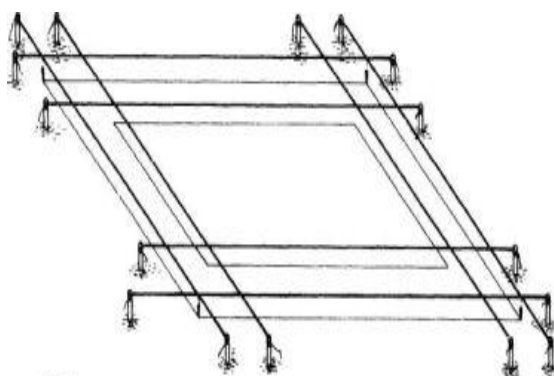


Fig. 1  
SETTING OUT THE LINES & MARKING THE GROUND

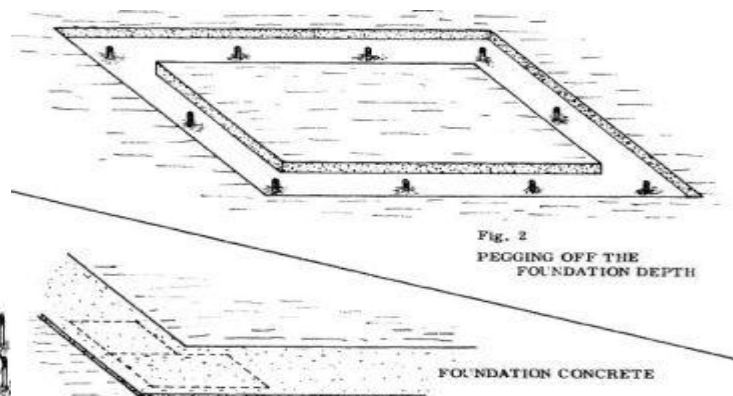


Fig. 2  
PEGGING OFF THE FOUNDATION DEPTH

Fig. 5  
SETTING OUT THE FOOTINGS (ENLARGED DETAIL)

Figure 38: Lining out methods

- Set out line B square to line A.
- Set out line C square to line A.
- Line D should be the same length as line A.



- **Using the plumb bob to mark the foundations**

Hold the plumb bob with one hand by the suspending line so that the tip of the cylinder is just off the ground. Move it slowly until the suspending line just touches the intersection of the lines stretched between the pegs (see A & B, Fig. 1). When the swinging movement of the plumb bob has stopped, mark the point directly below the tip of the cylinder by inserting a peg.

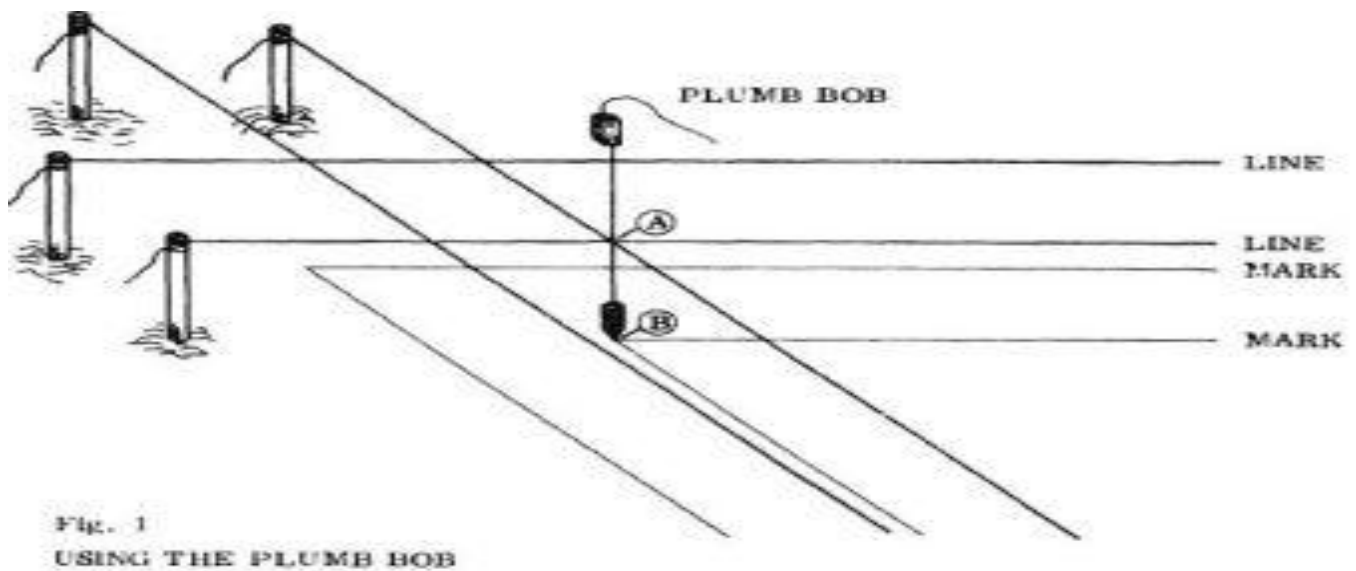


Figure 39: lining out using the plumb bob to mark the foundations

The peg is directly in line with the intersection of the lines above. This procedure is repeated at all inside corners and outside corners, so that the edges of the foundation trenches can be marked on the ground.

- **Using the large square**

The large square, may be used to set out and mark off the positions of inside walls. This is less time-consuming than using the 3-4-5 method.

Place the large square on the ground with one side along an already determined line, and mark off the corner on the other side (Fig. 4.8).

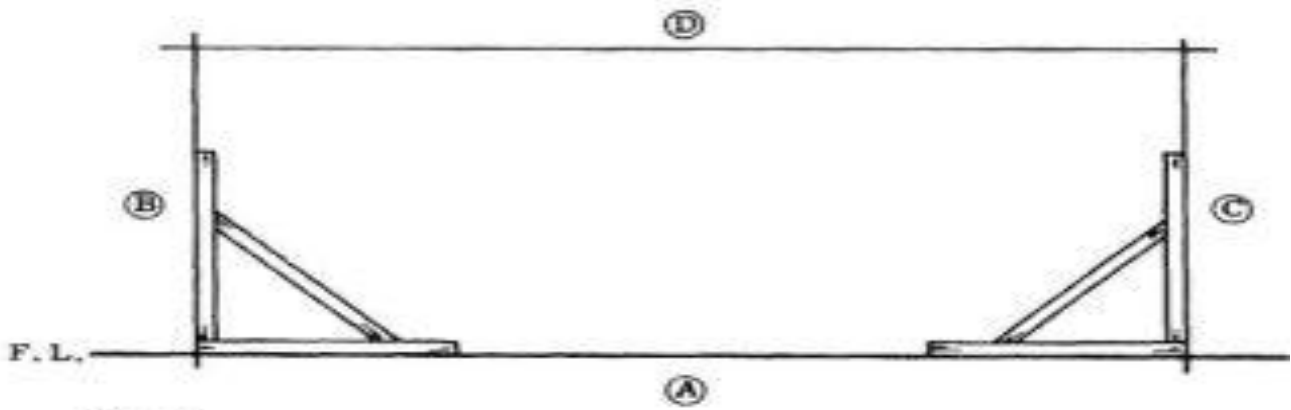


Fig. 2  
USING THE LARGE SQUARE

Figure 40: laying using the large square

Not only the whole building, but also each room in the building must be checked for squareness by comparing the diagonals, which have to be equal.

- **Interfering objects**

Not all sites are conveniently flat and level, and the Rural Builder will frequently face more difficult situations. While the construction of a right angle remains the same, the measurement of distances and the determination of directions might sometimes be difficult. There is also the case where there are trees or other buildings which should remain, but which are in the way when we are making a particular measurement

Provided that you have mastered the 3-4-5 method, it is relatively easy to by-pass interfering trees or buildings in setting out: It only requires a bit more time to construct the additional angles (Fig. 4.9).

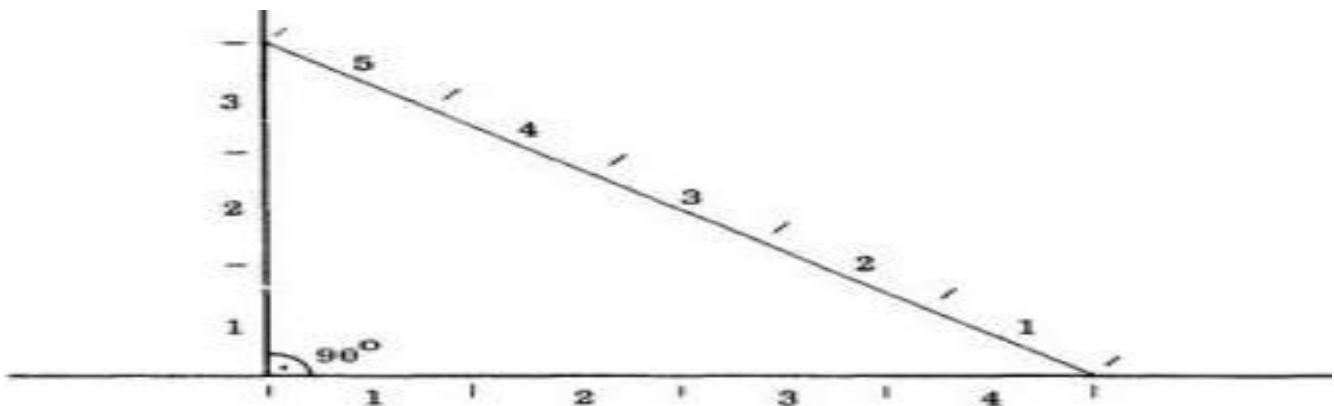


Fig. 1 3 - 4 - 5 METHOD

Figure 41: illustrates an example

The frontline of the existing buildings must be maintained in the new building, but It is difficult to set out directly because there are trees which are in the way. Rather than cut the trees down, we can by-pass them.

- **Excavation**

Site excavation is a process in which soil, rock, and other materials are removed from a site, typically with the use of heavy earthmoving equipment such as excavators and bulldozers. There are a number of reasons to conduct an excavation of a site, ranging from a desire to explore a site to learn more about its archaeological history to an environmental remediation project. Depending on the purpose of a site excavation, it may be conducted and supervised by various professionals.

During new construction on buildings, roads, and other structures, site excavation is one of the earliest stages. The site is excavated to create a level, clean area to work, with the foundations being established in the excavated area. A site may also be excavated and backfilled to confirm that the material directly under the site is of high quality. The depth of site excavation can vary, depending on what is being built and where the building is occurring.

- **Compaction**

Soil compaction is defined as the method of mechanically increasing the density of soil. In construction, this is a significant part of the building process. If performed improperly, settlement of the soil could occur and result in unnecessary maintenance costs or structure failure. Almost all types of building sites and construction projects utilize mechanical compaction techniques.

Compaction (Soil Compaction) is the process of applying energy to loose soil to consolidate it and remove any voids, thereby increasing the density and consequently its load-bearing capacity.

There are several means of achieving compaction of a material. Some are more appropriate for soil compaction than others, while some techniques are only suitable for particular soils or soils in particular conditions. Some are more suited to compaction of non-soil materials such

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as asphalt. Generally, those that can apply significant amounts of shear as well as compressive stress are most effective.

The available techniques can be classified as:

- ✓ Static - a large stress is slowly applied to the soil and then released.
- ✓ Impact - the stress is applied by dropping a large mass onto the surface of the soil.
- ✓ Vibrating - a stress is applied repeatedly and rapidly via a mechanically driven plate or hammer.
- ✓ Gyration - a static stress is applied and maintained in one direction while the soil is subjected to a gyratory motion about the axis of static loading. Limited to laboratory applications.
- ✓ Rolling - a heavy cylinder is rolled over the surface of the soil. Commonly used on sports pitches. Roller-compactors are often fitted with vibratory devices to enhance their ability.
- ✓ Kneading - shear is applied by alternating movement in adjacent positions. An example, combined with rolling compaction, is the 'sheep foot' roller used in waste compaction at landfills.

- **Checking out final dimension**

After the excavation completed you should be able to check whether the final excavation dimension is correct or not. When you can check consider the allowance given.

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<b>Self-check 4</b>	<b>Written test</b>
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**Instructions:** Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. Which one of the following is component of digging small excavation by hand tools?
  - A. Site clearing
  - B. Setting out
  - C. Plan
  - D. Site organization
  - E. All of the above
  
2. Which one of the following is benefit of compaction?
  - A. increase load bearing capacity
  - B. prevent soil settlement
  - C. reduce water seepage
  - D. reduce shrinkage and others
  - E. all of the above
  
3. \_\_\_\_\_ is the process of laying down the excavation lines and center lines
  - A. Setting out
  - B. Site clearing
  - C. Site organization
  - D. Compaction
  - E. None of the above
  
4. \_\_\_\_\_ is a process in which soil, rock, and other materials are removed from a site, typically with the use of heavy earthmoving equipment such as excavators and bulldozers.
  - A. Setting out
  - B. Site clearing
  - C. Excavation
  - D. Compaction
  - E. None of the above

**Note: Satisfactory rating – 5 points**

**Unsatisfactory - below 5 points**

### Answer Sheet-1

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Multiple Choice Questions

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

## 5.1. Trench collapse prevention

Trench and excavation collapses pose a significant risk to workers and can occur with little or no warning. Excavated ground that appears stable may not necessarily be stable. Even if the ground is stable, this may change over time. The following factors may contribute to unstable conditions:

- ✓ The depth of the excavation.
- ✓ The nature of the ground or soil, including its reaction to the elements (eg ground exposed to rain may become unstable).
- ✓ Slip planes in the soil and fractures/faults in rocks.
- ✓ Water content, including the inrush of water.
- ✓ Nearby in-ground services.
- ✓ The placement of and vibration from plant.
- ✓ The storage of excavated material near the edge of the excavation.
- ✓ The proximity of buildings and other structures.

## 5.2. Protective systems

The basic methods for protection from cave-ins are sloping, benching, shoring, and shielding. The method you should use depends on factors such as soil type and water content, excavation depth and width, the nature of the work, and nearby activities that could increase the risk of a cave-in. The competent person has the responsibility for considering these factors and for determining the appropriate protective system.

A registered professional engineer must design protective systems for all excavations that are more than 20 feet deep.

- **Sloping and benching**

Employees may not work on the faces of slopes or benches above other workers unless the workers at the lower level are protected from the hazard of falling, rolling, or sliding material or equipment. Sloping and benching will be

- ✓ Slope the excavation's sides to a safe angle
- ✓ Slope angle not be steeper than 1 1/2 horizontal to 1 or less vertical is safe

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- ✓ Soil classification may not be needed if sloped to this angle Other slopes may be used for other soil types
- ✓ Benching systems excavate the sides of an excavation to form a series of horizontal levels or steps
- ✓ Benching systems have vertical or near-vertical surfaces between levels

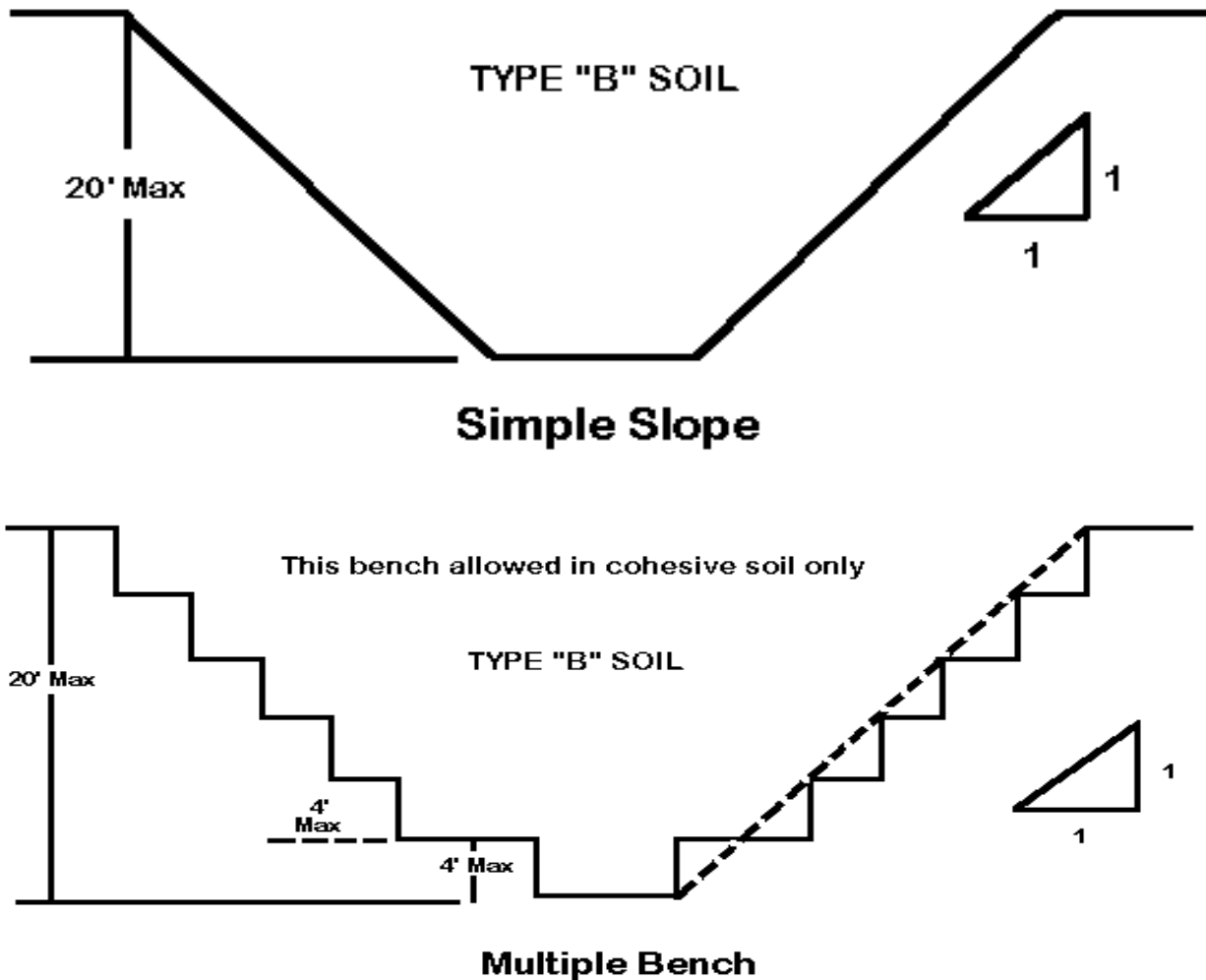


Figure 42: Sloping and benching of trench collapse system

- **Shield system:**

Shields shall be installed in a way that will restrict lateral or other hazardous movement of the shield in the event of sudden lateral pressures.

The following procedures shall be followed by contractor in sequencing the work:

- ✓ No more than one hundred fifty (150) feet of trench shall be left open at any time.



- ✓ The entire trench shall be backfilled to within fifty (50) feet of the open trench upon conclusion of each day's work.
- ✓ The trench shall not be backfilled until the pipe installation is found acceptable by Engineer.
- ✓ Trench shall be backfilled within one hundred (100) feet of the pipe installation at all times.
- ✓ Clean-up shall be maintained within four hundred (400) feet of the trench excavation.

Prior to placement in the trench, all pipes, fittings, and appurtenances shall be cleaned and examined for defects by contractor.

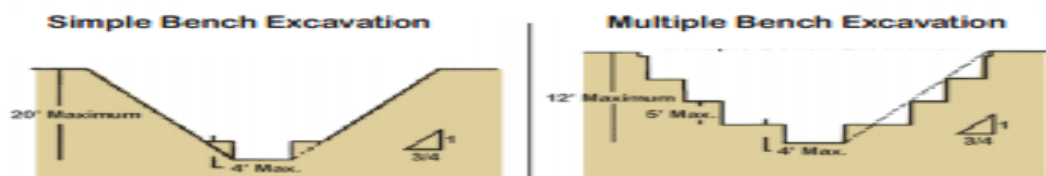
- ✓ If found defective, contractor shall reject the defective pipe, fitting, or appurtenance.
- ✓ Contractor shall advise engineer of all defective materials.

- **Surplus excavation:**

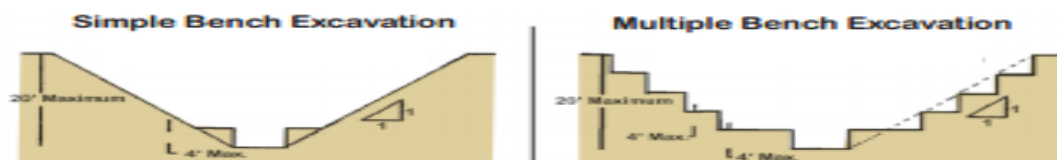
- ✓ All surplus excavation shall be placed, in an orderly manner.
- ✓ If material is stockpiled on private property, written permission shall be obtained from the property owner and provided to engineer.

**What do benched slopes look like in type A, type B, and type C soil?**

- **Type A soil: simple and multiple benches**



- **Type B soil: simple and multiple benches**



- **Type C soil: simple and multiple benches**

Benching in type C soil requires a registered professional engineer.

Figure 43: Slope types in different soils to prevent trench failure

Stepped benched excavations can also be used to protect deeper trenches; however, when using stepped benched excavations a larger area might be need to perform the excavation. As the trench is excavated, the sides step down so the banks do not have to support more material than they are capable of.



Figure 44: Stepped benched excavations

## Shoring and shielding

Shoring and shielding systems can prevent cave-ins in excavations with or without sloped or benched faces. The safest way to install and remove them is from outside the excavation.

*Shores* are vertical or horizontal supports that prevent the faces of an excavation from collapsing. Vertical shores are called uprights. They're easy to install, relatively inexpensive, and often used in stable soil or in shallow excavations that have parallel faces. Vertical shores must be sized for the excavation's dimensions and soil type.

Horizontal shores are called *walers*. Walers are often used when unstable soil makes sloping or benching impractical and when sheeting is necessary to prevent soil from sliding into the excavation.

*Shields* provide employees a safe work area by protecting them from collapsing soil. Shields don't prevent cave-ins but "shield" workers if a face does collapse. They are usually placed in the excavation by heavy equipment.

Shoring and shielding systems are available from manufacturers in a variety of dimensions, usually aluminum or steel, or they can be custom-built from *tabulated data* approved by a registered professional engineer. Manufacturers will also provide tabulated data with their systems that includes engineering specifications, depth ratings, special instructions, and system limitations. Only by carefully studying and understanding the manufacturer's tabulated data can the competent person choose the correct protective system.

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**Horizontal shore**



*Photo credit: Speed Shore Corp.*

**Vertical shore**



*Photo credit: Speed Shore Corp.*

**Trench shield**



Figure 45: Shoring and shielding of cave in

- **Battering**

Sometimes, and if you have the space available, the most economical way, safer and faster way to protect an excavation is to cut slopes at a safe angle of repose, verify by a geotechnical analysis. Different types of soils might need different angle and when water is present additional considerations shall also be evaluated. It is important to install guardrail or a solid enclosure at each open side of an excavation or trench.

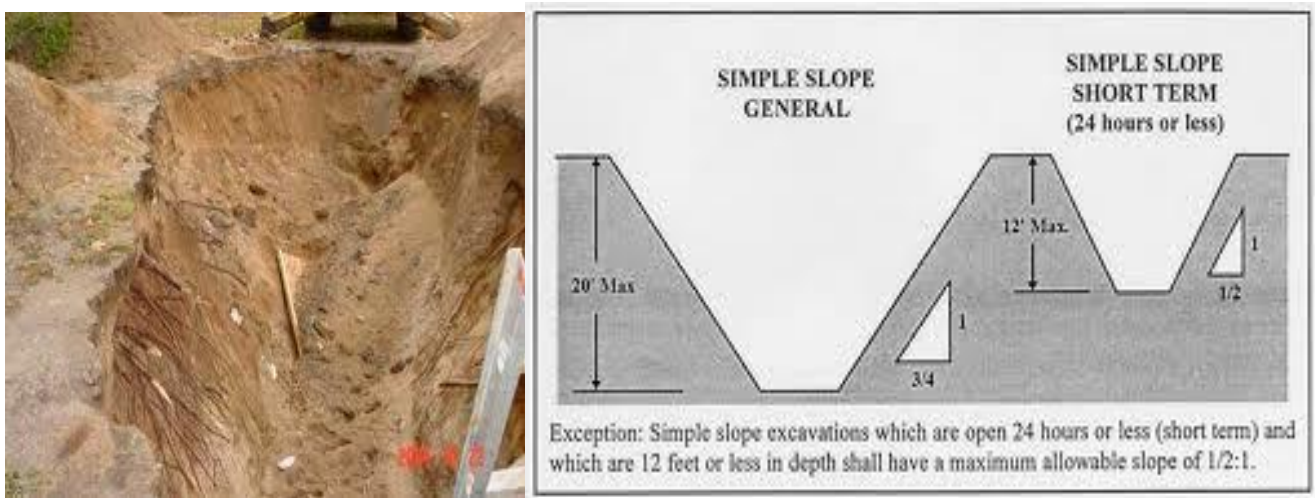


Figure 46: common ways of battering

### 5.3. Trench excavation

- All existing asphalt or concrete surfacing shall be saw cut vertically in a straight line, and removed from the job site prior to starting the trench excavation. This material shall not be used in any fill or backfill.
- Clearance:
  - ✓ The trench shall be excavated so that a minimum clearance of six (6) inches is maintained on each side of the pipe for proper placement and densification of the bedding or backfill material.
  - ✓ The maximum clearance measured at the spring line of the pipe shall be eighteen (18) inches regardless of the type of pipe, type of soil, depth of excavation, or the method of densifying the bedding and backfill.
- Except as otherwise dictated by construction conditions, the excavation shall be of such dimensions as to allow for the proper pipe installation and to permit the construction of the necessary pipe connections.
- Care shall be taken to ensure that the excavation does not extend below established grades.
  - ✓ If the excavation is made below such grades, the excess excavation shall be filled in with sand or graded gravel deposited in horizontal layers not more than six (6) inches in thickness after being compacted and shall be moistened as required to within two percent (2%) of the optimum moisture content required for compaction of that soil.
  - ✓ After being conditioned to have the required moisture content, the layers shall be compacted to the required density.
- Contractor shall stockpile excavated materials in a safe manner. Stockpiles shall be graded for proper drainage.
- Contractor shall place and grade the trench base to the proper grade ahead of pipe laying. The invert of the trench shall be compacted to provide a firm unyielding support along entire pipe length.
- Surplus excavation shall be disposed of by CONTRACTOR at contractor's expense.

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<b>Self-check 5</b>	<b>Written test</b>
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**Instructions:** Answer all the questions listed below. Write your answers in the sheet provided in the next page.

1. Which one of the following factors may contribute to trench collapse?
  - A. The depth of the excavation
  - B. Slip planes in the soil and fractures/faults in rocks
  - C. Water content, including the inrush of water
  - D. Nearby in-ground services      E. All of the above .
  
2. What needs to be done before you start to excavate?
  - A. Evaluate soil conditions.
  - B. Construct protective systems.
  - C. Utility locate
  - D. Provide safe access      E. All of the Above
  
3. How far away from an excavation should spoils be placed?
  - A. Right next to excavation as long as it doesn't fall back in.
  - B. At least 2 feet from the excavation.
  - C. Wherever is the most convenient
  - D. Within a foot to allow for reach of excavator.
  
4. How is this trench in violation?
  - A. No barriers to prevent entry
  - B. Insufficient means of egress
  - C. Unacceptable Shoring
  - D. All of the Above      E. Looks great.

**Note: Satisfactory rating – 5 points**

**Unsatisfactory - below 5 points**

**Answer Sheet-1**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Multiple Choice Questions**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

Score = _____
Rating: _____

### 6.1. Placing barricades around excavation

Use barricades to indicate restricted access into areas that contain holes, excavations, openings or areas in which a danger from falling objects is present. Anyone who creates a hole, opening or is working at height, is responsible for erecting a barricade. Barricade or cover wells, pits, shafts will be applied the following procurer's

- Adequate barrier physical protection must be provided at all remotely located excavations.
- All openings such as wells, pits, and shafts must be barricaded or covered and when the work is complete any such temporary opening must be backfilled.
- Each worker within six feet of the edge of an excavation that is six feet or more in depth must be protected from falling by guardrail systems, fences, personal fall arrest systems, or barricades.

Situations where safety barriers are required will be:

- ✓ To protect pedestrians from falling in open excavations.
- ✓ To separate road traffic from work areas.

<b>Self-check 6</b>	<b>Written test</b>
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**Instructions:** Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. List two (2) situations where safety barriers are required?
2. How to placing barriers around excavation

**Note: Satisfactory rating - 10 points                      Unsatisfactory - below10points**

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

Answer Sheet

Score = _____
Rating: _____

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Short Answer Questions

- 1, \_\_\_\_\_  
\_\_\_\_\_
- 2, \_\_\_\_\_  
\_\_\_\_\_

### 7.1. Machinery tools for soil excavation

These are the tools which are operated by mechanical force and are used for the larger depths of excavations. There are so many types of machine tools with ease of operation are designed in this modern day period. Example of machinery tools are list below.

- Tracked excavator
- Wheeled excavator
- Back hoe excavator
- Bulldozer
- Dragline excavators
- Trenchers

### 7.2. Concreting tools, plant and equipment

- **Plate compactor**

A plate compactor is a large motorized tool that is used to compact granular surfaces, such as a gravel or sand sub-base, to create a dense, tightly packed surface for a concrete slab to rest on. They are most useful on uneven or unstable soils, where it is essential to achieve a stable base upon which to pour the concrete.



Figure 47: plate compactor



- **Concrete saws**

- ✓ Are used in demolition and removal of old concrete and sometimes are used to cut control joints the concrete is hardening. Essential when using a concrete saw is a good-quality diamond blade designed for cutting concrete.
- ✓ Standard portable woodworking saws, such as circular saws and mitre saws, are needed to cut parts for wood forms.
- ✓ Reciprocating saws or chop saws with metal-cutting blades are used to cut rebar or other metal reinforcement materials.



Figure 48: concrete saws

- **Groove cutters and edger's**

Groove cutters, also called grooves, are used to create control joints on sidewalks, walkways, driveways, and residential slabs, where a concrete saw typically is not used. Many grooves have a horizontal plate with a vertical fin for cutting the groove. The plate often has rounded sides for shaping the edges of the groove. A similar tool is an edger, which has one rounded edge that serves to mould a slightly rounded-over edge along the sides of a slab or sidewalk.



Figure 49: Groove Cutters and Edger's

- **Portable mixer**

A portable mixer allows you to mix small amounts of concrete at the job site. Mixers come in handy for pours that are too small to warrant an order of ready-mix, but larger than what you can conveniently mix in a wheelbarrow or mixing tub. Portable mixers come in a range of sizes, from units that fit in the back of a pickup truck to those that can be towed to the job site. Both electric and gas-powered models are available.



Figure 51: portable mixer type

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- **Wheelbarrows**

Wheelbarrows are needed to move small amounts of concrete or to carry tools around the site. They are also useful for taking concrete samples for slump tests or other assessment. Wheelbarrows for concrete work should be heavy-duty tools with sturdy pneumatic tires that will hold up to the heavy loads and constant duty required on job sites. Trays made of steel or heavy poly are typical, with a capacity of 6 to 8 cubic feet.



Figure 42: Wheelbarrows

- **Water pump**

Rain, snow, or drainage can lead to concrete forms full of water. Bailing out water by hand can use up precious time before a pour. A motorized water pump can get rid of the water much faster and with very little manpower.

- **Power hammers and drills**

A great many jobs will require the use of contractor-grade power drills and rotary hammers. Both corded and battery-powered tools are now available. They are essential for many finishing tasks, such as mounting posts and railings to poured steps, or attaching sill plates and ledgers to foundations.

<b>Self-check 6</b>	<b>Written test</b>
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**Instructions:** Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in the sheet provided in the next page.

1. List four (4) machinery tools for used soil compaction?
2. Write the purpose of plate compactor?
3. Write the purpose of Wheelbarrows?
4. Write the purpose of portable mixer?

**Note: Satisfactory rating –4 points**

**Unsatisfactory - below 4points**

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

Answer Sheet

Score = _____ Rating:
-----------------------------

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Short Answer Questions**

1. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
2. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
3. \_\_\_\_\_  
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 \_\_\_\_\_  
 \_\_\_\_\_
4. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Operation Sheet 1**

**Using Hand Tools Correctly to Dig Post Holes, Small Pits And Trenches Safely**

**Activity: techniques of hand digging small pits/ post holes**

**Step1.**wear appropriate personal protective equipment

**Step2.** Select all tools and equipment's to use in these activity

**Step3.** Clean the tools and equipment properly before use the tools

**Step4.** Select the location site

**Step5.** Clean the working site properly

**Step6.** Identifying the location of underground services.

**Step7.** Creating a temporary drainage to allow rainwater and run-off water to flowfreely away from intended site for machine dug excavation.

**Step8.**Digging postholes, small pits and trenches to the required dimensions.

**Step9.** Applying trench collapse prevention procedures in unstable ground

**Step10.**Collect the tools properly

**Step11.**Clean all tools and equipment's before storing

**Step12.** Storing all tools properly in appropriate area



**Figure 43: graphical presentation of operation sheet1**

**Operation Sheet 2**

**Procedures Of Undertaking Trench Collapse Prevention**

Activity: Procedures of trench collapse prevention

Step 1: Select a trained and authorized “competent person” on site

Step 2: Wear appropriate personal protective equipment

Step 3: Select important tools and equipment

Step 4: Follow OSHA’s general requirements

Step 5: Take soil sample and carefully analyze the soil

Step 6: Use a Protective System

Step 7: Inspect the excavation

Step 8: Clean the tools and stored appropriately



**Figure 45: graphical presentation of operation sheet2**

LAP test	Practical demonstration
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Name: \_\_\_\_\_ Date: \_\_\_\_\_

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 8hr.

- ✓ Dig postholes by use hand tools
- ✓ Undertake trench collapse prevention

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

- Cleaning loose material out of excavation
- Checking Excavation confirmation with the specification

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 –

- Clean Loose material out of excavation by use hand tools
- Check Excavation with the specification or work instruction

**Learning instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1 and Sheet 2” ” in page 3 and 7 respectively.
4. Accomplish the “self-check 1 and self-check 2” in page 6 and 9 respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, in page 11
6. Do the “LAP test” in page 12 (if you are ready).



<b>Information sheet-1</b>	<b>Cleaning Loose Material Out Of Excavation</b>
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### 1.1. Clean out loose material of excavation

Loosen stony material or soil with Pickaxes is scooped up and thrown it either on a trailer, truck or wheel barrow or directly where the material is needed using shovel or spades. When the soil is loose, the shovel can be used directly to scoop it up and throw it elsewhere.

When throwing the soil, the worker should throw it as far as possible towards where the loading or spreading is taking place.

### 1.2. Clearing

Remove obstructions to the proposed construction, including trees and other vegetation, debris, and structures, over the width of the excavation to a depth of 1 ft. below the bottom of excavation. If abandoned storm drains, sewers, or other drainage systems are encountered, remove as required to clear the new structure, and plug in an approved manner. After removing obstructions, restore the bottom of the excavation to grade by backfilling in accordance with this Item.

Before starting grading operations, it is necessary to prepare the work area by removing all trees, brush, buildings, and other objectionable material and obstructions that may interfere with the construction of the roadway. From the standpoint of roadside appearance and control of erosion on the right of way, it is advantageous to preserve natural growth where possible. When shown in the Plans, the first order of work shall be the installation of high visibility fencing (HVF) to delineate all areas for protection or restoration.

The Project Engineer should double check the placement of the HVF and ensure it matches the locations indicated on the Joint Aquatic Resource Permit Application. In addition, the Project Engineer should discuss with the Landscape Architect the preservation of natural growth which will not interfere with roadway and drainage construction before starting clearing operations. If vegetation outside the clearing limits is damaged during the clearing or grubbing operations, or if pruning is required, the Landscape Architect or State Horticulturist may be contacted for assistance. Areas to be omitted from clearing or extra areas to be

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cleared should be determined before starting work and an accurate record made during staking operations.

- **Staking**

Clearing stakes at least 4 ft long and marked “Clearing” should be set at the proper offset marking the limits of the area to be cleared. These stakes normally should be set at 100-ft intervals on tangents and at shorter intervals on curves, depending on the sharpness of the curve. Where slope treatment is provided, clearing normally should be staked to a distance of 10 ft beyond the limits of the slope treatment with a distance of 5 ft being considered the absolute minimum distance required. Normally, grading stakes should not be set until clearing and grubbing work in a given area is completed. The method of measurement used at interchange areas should be such as to preclude the possibility of duplication or overlapping of measured areas.

- **Grubbing**

Grubbing provides for additional preparation of the work area by removal of remaining stumps, roots, and other obstructions which exist on or in the ground in all areas designated for grubbing. It should be noted that complete grubbing is not required under embankments where the fill height above natural ground, as measured to subgrade or embankment slope elevation, exceeds 5 ft. This exception does not apply to any area where a structure must be built, sub drainage trenches are to be excavated, unsuitable material is to be removed, or where hillsides or existing embankments are to be terraced. Grubbing is important to the structural quality of the roadway and every effort should be made to obtain a thorough job. Grubbing should be completed at least 1,000 ft in advance of grading operations.

- ✓ Removal of undisturbed stumps and roots and nonperishable solid objects with a minimum of 1 meter below subgrade or slope of embankments will not be required.
- ✓ In areas outside of the grading limits of cut and embankment, stumps and nonperishable solid objects shall be cut off not more than 150 mm (6 inches) above the ground line or low water level.
- ✓ In areas to be rounded at the top of cut slopes, stumps shall be cut off flush with or below the surface of the final slope line.
- ✓ Grubbing of pits, channel changes and ditches will be required only to the depth necessitated by the proposed excavation within such areas.

- **Roadside cleanup**

This work consists of cleaning up, dressing, and shaping the roadside area outside the limits of construction. In advance of completion of other work on the project, the Project Engineer and the Contractor need to determine the work to be done, the equipment and labor necessary, and estimate of the cost of the work. Do not use this item for any work to be paid under “Trimming and Cleanup,” or any other item. Any trees or snags outside the limits of areas to be cleared which may endanger traffic on the roadway itself should be removed under this work. Before removing danger trees outside of the right of way, the matter should be referred to the Regional Office for negotiations with the property owners. If, however, an emergency arises, which endangers traffic, the danger trees may be removed immediately and the Project Engineer shall notify the Region as soon as possible. The work required in shaping the ends of cuts and fills so they appear natural with the adjacent terrain will be greatly reduced if proper warping of the cut and fill slopes has been accomplished during the grading operations.

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<b>Self-check 1</b>	<b>Written test</b>
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**Directions:** all the questions listed below. Use the Answer sheet provided in the next pages

1. During cleaning of the site which one is the first step the person to do?
  - A. Wear personal protective equipment
  - B. Select the tools used during the activity
  - C. Clean or remove any thing found from the site
  - D. All of the above
  
2. -----is additional preparation of the work area by removal of remaining stumps, roots, and other obstructions which exist on or in the ground?
  - A. Grubbing
  - B. Staking
  - C. Clearing
  - D. All of the above
  
3. Which one is the purpose of cleaning the site before construction start?
  - A. To increase the strength of structure
  - B. Improve productivity of the contractor
  - C. Increase the economy of the country
  - D. All of the above

**Note: Satisfactory rating - 4 points**

**Unsatisfactory - below 4 points**

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

Answer Sheet

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

**Answer**

- 1.
- 2.
- 3.

<b>Information Sheet 2</b>	<b>Checking Excavation Confirmation with the Specification</b>
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## 2.1. Measurement

When the contract provides for measuring clearing and grubbing by the acre, it is the intent of the specifications to measure all areas actually cleared and grubbed. Minor un cleared areas within the clearing limits may be included in the quantity if they are less than 50 ft long, measured parallel to the centerline and contain an area less than 2,500 sq ft. Small, isolated areas to be cleared, located between areas excluded from measurement and which contain less than 2,500 sq ft, shall be measured as containing 2,500 sq ft. Where isolated areas occur intermittently, the sum of the areas allowed by this method of measurement shall not exceed the total area (containing the several isolated areas) when measured as continuous clearing. This condition can occur when clearing narrow strips less than 25 ft in width.

Measurement will be by one or more of the following alternate methods:

- ✓ Area Basis. The work to be paid for shall be the number of hectare and fractions thereof acceptably cleared and grubbed within the limit indicated on the Plans or as may be adjusted in field staking by the Engineer. Areas not within the clearing and grubbing limits shown on the plans or not staked for clearing and grubbing will not be measured for payment.
- ✓ Lump-Sum Basis. When the Bill of Quantities contains a Clearing and Grubbing lump sum item, no measurement of area will be made for such item.
- ✓ Individual Unit Basis (Selective Clearing). The diameter of tree will be measured at a height of 1.4m (54 inches) above the ground. Tree less than 150 mm (6 inches) in diameter will not be measured for payment.

## 2.2. Removal of structures and obstructions

- **Construction requirements**

Buildings, foundations, structures, fences, and other obstructions which are on the right of way and are not designated to remain, shall be removed and disposed of in accordance with the Standard Specifications. Foundations shall be removed to the designated depth and basement floors shall be broken to provide drainage of water. Basements or cavities left by

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their removal shall be backfilled as specified, and if the areas are within the roadway prism, care shall be taken to see that the backfill is properly compacted.

When water wells or septic tanks are encountered, the Project Office needs to ensure they are meeting all the required environmental considerations for leaving in place or abandonment. Contacting the Regional Environmental Office for guidance is suggested. Wells having artesian characteristics will require special consideration to avoid water entrapment. Care shall be taken to see that pavements or other objects which are to remain are not damaged during this operation.

The Engineer considers necessary for the complete preparation of the overall project site, as follows:

- ✓ Plug any water wells that are encountered within the right-of-way and that are to be abandoned.
- ✓ Level the terrain outside the limits of construction for purposes of facilitating maintenance and other post-construction operations.
- ✓ Trim trees and shrubs within the project right-of-way that are identified in the Contract Documents.

### 2.3. Critical aspects required to check work instruction

- Location, interpretation and application of relevant information, standards and specifications.
- Compliance with site safety plan, OH&S regulations and State/Territory legislation applicable to workplace operations.
- Compliance with organizational policies and procedures including quality requirements.
- A minimum of two separate manual excavations in different dirt types requiring:
  - ✓ the location, marking and avoidance of underground services
  - ✓ trenching
  - ✓ post-holing to services depth
  - ✓ basic trench collapse prevention techniques including benching and battering, and
  - ✓ the isolation of the excavation sites

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<b>Self-check 2</b>	<b>Written test</b>
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**Instructions:** Choose the best answer all the questions listed below. Write your answers in the sheet provided in the next page.

1. What are the necessary important points for the complete preparation of the overall project site Engineers considers?
  - A. Plug any water wells that are encountered within the right-of-way and that are to be abandoned.
  - B. Level the terrain outside the limits of construction for purposes of facilitating maintenance and other post-construction operations.
  - C. Trim trees and shrubs within the project right-of-way that are identified in the Contract Documents.
  - D. All of the above
2. What are the main checking parameters of excavation?
  - A. Location
  - B. Compliance with site safety plan
  - C. Compliance with organizational policies and procedures
  - D. All of the above
3. Measurement will be by one or more of the following alternate methods which one?
  - A. Area Basis.
  - B. Individual Unit Basis (Selective Clearing)
  - C. Lump-Sum Basis
  - D. All of the above

**Note: Satisfactory rating - 3 points and above**

**Unsatisfactory - below 3points**

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

Answer Sheet

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

1. \_\_\_\_\_

3. \_\_\_\_\_

2. \_\_\_\_\_

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Operation Sheet 1	Techniques of checking excavation confirmation with the specification
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Activity techniques of checking excavation confirmation with the specification

**Step 1:** Surveying the work area and ground conditions for ease of access and safe movement of materials.

**Step 2:** wear appropriate personal protective equipment

**Step 3:** Identifying the excavation standards and requirements for the task (confirm work instructions).

**Step 4:** selecting the appropriate materials, hand tools and equipment for the job, then checking them for faults and reporting/isolating the issues.

**Step 5:** Setting out the job and establishing profiles to line and level (use the pegs/profiles to identify service markers and set out service point's and excavation limits).

**Step 6:** Apply measurements and calculate as required.

**Step 7:** Excavate using the hand tools to ensure correct route, line and depth using safe work practices

**Step 8:** Establish a temporary drainage system to divert any surface /sub-surface water from excavation

**Step 9:** Monitor material stabilization and take action where required, including:

- ✓ Stabilizing materials.
- ✓ Identifying, removing and storing unsuitable materials.
- ✓ Placing replacement/stabilized materials.

**Step 10:** Place barricades around the excavated site area and signage as required

**Step 11:** Clearing the tools and restoring the store site



<b>LAP test</b>	<b>Practical demonstration</b>
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Name: \_\_\_\_\_ Date: \_\_\_\_\_

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_ total time 8hrs

**Instructions:** Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 8hrs.

Task1: Check excavation confirmation with the specification?

Instruction sheet	Learning guide #56
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Clearing loose material from the edge of excavation
- Clearing Work area and disposing or re materials
- Cleaning, checking, maintaining and storing Tools and equipment

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 –

- clear Loose material away from the edge of excavation
- clear Work area and materials are dispose of or recycle in accordance with project environmental management plan
- clean, check, maintain and store Tools and equipment's

**Learning instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3” ” in page 3, 6 and 14respectively.
4. Accomplish the “self-check 1, self-check 2 and self-check 3” in page 5, 12 and 24 respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, and Operation Sheet 2, in page 26 respectively.
6. Do the “LAP test” in page 27 (if you are ready).

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<b>Information Sheet-1</b>	<b>Clearing Loose Material from the Edge of Excavation</b>
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## 1.1. Introduction

Clearing and grubbing are specified on projects to eliminate all unsuitable material from roadway excavation material and embankments. If organic material is allowed to remain, it will rot and create voids within or under the compacted embankment material. As the embankment material settles to fill the voids, a pavement failure will generally occur. In addition, all branches within 20-foot clear height above the subgrade must be pruned and the cut surface properly treated.

## 1.2. Key points

- Avoid underground services and make sure not to undermine nearby structures – use safe digging practice and dig away from them.
- Check the excavation each day before starting work and after any event that may affect its stability.
- Provide safe access to get in and out.
- Prevent collapse – shore, bench, or batter back. Do not assume ground will stand unsupported.
- Prevent people and materials falling in – with barriers strong enough not to collapse if someone falls against them.

The influence of any loads near the excavation can cause ground collapse. Any excavated material and external actions applying a load to the ground nearby can affect the excavation's stability through the zone of influence. The zone is normally from the base of an excavated face to the surface. The zone's angle will depend on site-specific factors. Mechanical plant, vehicles, spoil, or heavy loads should not be in the zone of influence plus 1 m from an excavation unless specific design can show it can support the surcharge load.

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### 1.3. Clean edge of excavation

Workers must be protected from excavated or other material or equipment that could pose a hazard by falling or rolling into excavations. Protection must be provided by placing and keeping such materials or equipment at least two feet from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavation, or by a combination of both if necessary. If a retaining device is to be used, it must be placed at least two feet from the edge of the excavation.

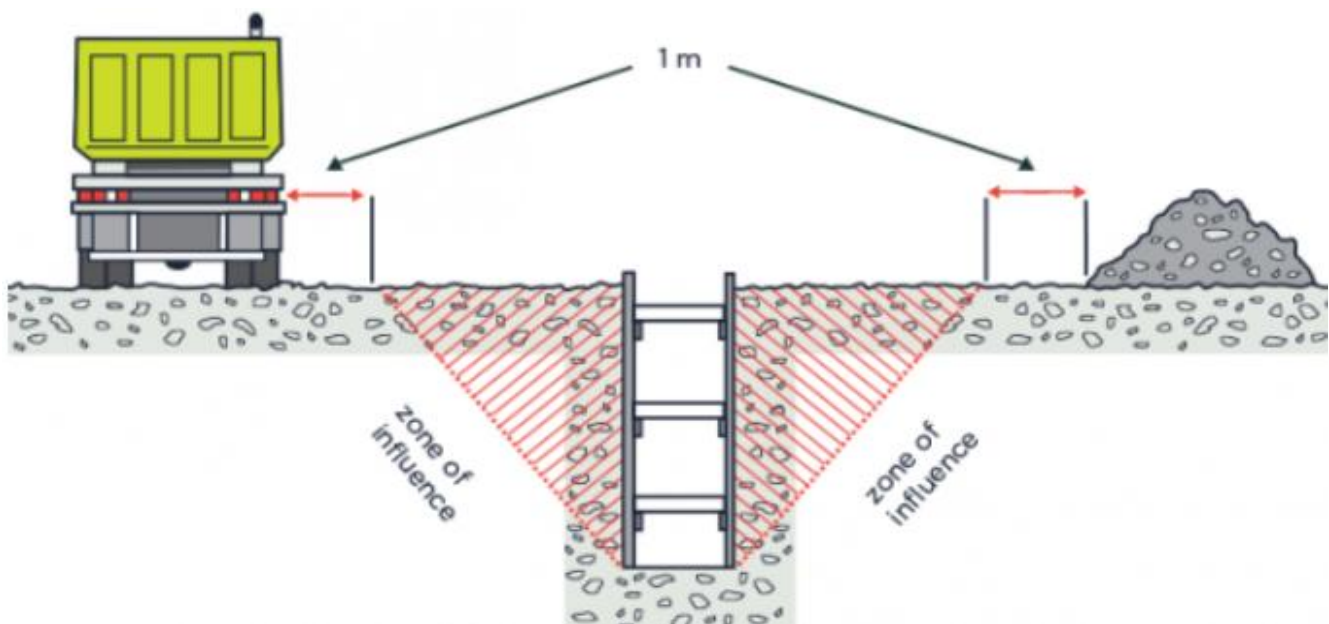


Fig 46: a shored excavation designed to carry soil loads only

<b>Self-Check 1</b>	<b>Written test</b>
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**Directions:** all the questions listed below. Use the Answer sheet provided in the next pages

1. How to do clean edge of excavation?
2. How to affect the influence of any loads near the excavation can cause ground collapse?
3. How to protect ground collapse of excavation?
4. What is the purpose of clean edge of excavation?

**Note: Satisfactory rating - 4 points**

**Unsatisfactory - below 4 points**

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

Answer Sheet

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Name: \_\_\_\_\_ Date: \_\_\_\_\_

### Short Answer Questions

1. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3. \_\_\_\_\_

\_\_\_\_\_

4. \_\_\_\_\_

\_\_\_\_\_

<b>Information Sheet 2</b>	<b>Clearing work area and disposing or re materials</b>
----------------------------	---

## 2.1. Clearing and grubbing

Completely remove and dispose of all buildings, timber, brush, stumps, roots, rubbish, debris, and all other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas, and all other structures and obstructions necessary to be removed and for which other items of the Contract do not specify the removal thereof, including septic tanks, building foundations, and pipes.

Perform standard clearing and grubbing within the following areas:

- ✓ All areas where excavation is to be done, including borrow pits, lateral ditches, right-of-way ditches, etc.
- ✓ All areas where roadway embankments will be constructed.
- ✓ All areas where structures will be constructed, including pipe culverts and other pipe lines.

- **Standard clearing and grubbing.**

- ✓ **Depths of removal of roots, stumps, and other debris:** In all areas where excavation is to be performed, or roadway embankments are to be constructed, remove roots and other debris to a depth of 12 inches below the ground surface. Remove roots and other debris from all excavated material to be used in the construction of roadway embankment or roadway base. Plow the surface to a depth of at least 6 inches, and remove all roots thereby exposed to a depth of at least 12 inches. Completely remove and dispose of all stumps within the roadway right-of-way. Remove all roots, etc., protruding through or appearing on the surface of the completed excavation within the roadway area and for structures, to a depth of at least 12 inches below the finished excavation surface.

Remove or cut off all stumps, roots, etc., below the surface of the completed excavation in borrow pits, material pits, and lateral ditches. In borrow and material pits, do not perform any clearing or grubbing within 3 feet inside the right-of-way line.

- ✓ **Trees to remain:** As an exception to the above provisions, where so directed by the Engineer, trim, protect, and leave standing desirable trees within the roadway area. Trim branches of trees extending over the area occupied by the roadway as directed, to give a clear height of 16 feet above the roadway.
- ✓ **Boulders:** Remove any boulders encountered in the roadway excavation or found on the surface of the ground. When approved by the Engineer place boulders in neat piles inside the right of way. The Contractor may stockpile boulders encountered in Department-furnished borrow areas, which are not suitable for use in the embankment construction, within the borrow area.

- **Selective clearing and grubbing.**

The Contractor shall remove and dispose of all vegetation, obstructions, etc., as provided above except that, where so elected, the Contractor may cut roots, etc., flush with the ground surface. Completely remove and dispose of stumps. Entirely remove undergrowth except in specific areas designated by the Engineer to remain for aesthetic purposes. Remove undesirable or damaged trees as so designated by the Engineer. Perform Selective Clearing and Grubbing only in areas so designated in the Plans.

- **Protection of Property Remaining in Place.** Protect and do not displace property obstructions which are to remain in place, such as buildings, sewers, drains, water or gas pipes, conduits, poles, walls, posts, bridges, etc.
- **Removal of buildings.**
  - ✓ **Parts to be removed:** Completely remove all parts of the buildings, including utilities, plumbing, foundations, floors, basements, steps, connecting concrete sidewalks or other pavement, septic tanks, and any other appurtenances, by any practical manner which is not detrimental to other property and improvements.
  - ✓ **Removal by others:** Where buildings within the area to be cleared and grubbed are so specified to be removed by others, remove and dispose of any foundations, curtain walls, concrete floors, basements or other foundation parts which might be left in place after such removal of buildings by others.
- **Removal of existing structures.**

Remove and dispose of the materials from existing structures. Remove the following:

- ✓ Those structures, or portions of structures, shown in the Plans to be removed,
- ✓ those structures, or portions of structures, found within the limits of the area to be cleared and grubbed, and directed by the Engineer to be removed,

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- ✓ those structures, or portion of structures, which are necessary to be removed in order to construct new structures, and Other appurtenances or obstructions which may be designated in the Contract Documents as to be included in an item of payment for the work under this Article.

- **Method of removal:**

Remove the structures in such a way so as to leave no obstructions to any proposed new structures or to any waterways.

- **Removal of existing pavement.**

Remove and dispose of existing rigid Portland cement concrete pavement, sidewalk, slope pavement, ditch pavement, curb, and curb and gutter etc., where shown in the Plans or ordered by the Engineer to be removed or where required because of the construction operations.

- **Disposal of materials.**

- ✓ Either stack materials designated to remain the property of the Department in neat piles within the right-of-way or load onto the Department's vehicles. Dispose of timber, stumps, brush, roots, rubbish, and other objectionable material resulting from clearing and grubbing in areas and by methods meeting the applicable requirements of all Local, State and Federal regulations. Do not block waterways by the disposal of debris.
- ✓ Burning Debris: Where burning of such materials is permitted, perform all such burning in accordance with the applicable laws, ordinances, and regulations. Perform all burning at locations where trees and shrubs adjacent to the cleared area will not be harmed.
- ✓ Disposal of Treated Wood: Treated wood, including that which comes from bridge channel fender systems, must be handled and disposed of properly during removal. Treated wood should not be cut or otherwise mechanically altered in a manner that would generate dust or particles without proper respiratory and dermal protection. The treated wood must be disposed of in at least a lined solid waste facility or through recycling/reuse.

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Figure 48: clearing of excavated site

## 2.2. Dispose or recycle work area materials

Work area is cleared and materials disposed of or recycled in accordance with project environmental management plan. Dispose of timber, stumps, brush, roots, rubbish, and other objectionable material resulting from clearing and grubbing in areas and by methods meeting the applicable requirements of all local, state and federal regulations. Do not block waterways by the disposal of debris.

- **Chemical waste**

Chemical Waste would be packed and held in containers of suitable design and construction so as to prevent leakage, spillage or escape of the contents under normal conditions of handling, storage and transport.

Containers used for the storage of chemical wastes would be: - Suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;

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Have a capacity of less than 450 litres unless the specifications have been approved by the EPD;

- **Storage**

The Contractors would provide a suitable area for temporary storage of chemical waste. The storage area would be specially constructed and bonded, and located close to the source of waste generation as far as is practicable. The storage area for chemical wastes would: -

- ✓ Be clearly labelled and used solely for the storage of chemical waste
- ✓ Be enclosed on at least 3 sides;
- ✓ Have an impermeable floor and bunding of sufficient capacity to accommodate 110% of the volume of the largest container or 20% of the total volume of waste stored in that area, whichever is the greatest;
- ✓ Have adequate ventilation;
- ✓ Be covered to prevent rainfall entering (water collected with the bund must be tested and disposed of as chemical waste if necessary); and
- ✓ Be arranged so that incompatible materials are adequately separated

- **Disposal**

Chemical waste would be disposed:

- ✓ Via a licensed chemical waste collector.
- ✓ To a facility licensed to receive chemical waste such as the Chemical Waste Treatment Centre. and
- ✓ To a reused of the waste, under the approval from the EPD.

- **Excavated material**

Excavated materials would be segregated from other wastes to avoid contamination thereby ensuring acceptability for internal reuse or tipping at public filling areas or reclamation sites and avoiding the need for disposal at landfill. Prior to the reuse or disposal of inert excavated material, it would need to be appropriately handled to avoid air quality (dust generation) and water quality (run-off) impacts.

Procedures to be followed during the storage of excavated materials would include:

- ✓ Wetting the surface of stockpiles as necessary, particularly during dry periods;

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- ✓ Minimise disturbance to stockpiles by enclosing and covering, particularly during prolonged wet, dry or windy periods; and
- ✓ Separate stockpiles from, and install silt traps into, the surface water drainage system.

Excavated material would be transported within the site by trucks. During truck loading and waste transportation, consideration would be given to potential environmental impacts caused by fugitive dust emissions. Accordingly, prior to transfer and transport, waste would be dampened and / or covered as necessary. For each and every vehicular trip transporting surplus excavated material off-site, a Construction and Demolition Material Disposal Delivery Form (DDF) would be produced and completed in duplicate.



Figure 49: waste disposal area



Figure 100: disposal of excavated material

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**Note: Satisfactory rating - 4 points**

**Unsatisfactory - below 4 points**

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

Answer Sheet

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

<b>Information sheet-3</b>	<b>Cleaning, Checking, Maintaining And Storing Tools And Equipment</b>
----------------------------	--

### 3.1. Cleaning tools and equipments

Cleaning heavy equipment is necessary for all construction equipment. Clean equipment lasts longer and pressure washing protects your investment by removing mud, grease and grime from heavy equipment faster than other cleaning methods. Cleaning heavy equipment is an underappreciated chore. It's messy and often delegated to a low-paid labourer on construction crews who see the job as just hosing down dirty machinery to remove most of the grease and grime. Well, there's far more to effectively and efficiently cleaning construction equipment and machinery than meets the eye.

Heavy equipment washing requires its own specialized equipment like water cannons or pressure washers. It also involves specific techniques that make the best use of cleaning time and materials. And then there's the safety factor to consider. Heavy construction equipment like excavators, loaders and gravel trucks are large, complicated machines presenting hazards to operators and those tasked to clean them on a regular basis.

There are many reasons to wash heavy equipment. Successful construction companies, equipment rental yards and heavy equipment dealerships realize great benefits from keeping their expensive machinery clean and in top-notch condition. Equipment efficiency and long service life are critical to making sure machines are always operating when needed. A non-working machine is a non-paying machine.

Regular cleaning is part of preventive maintenance. When construction equipment is regularly cleaned, there's far less strain put on fixed and moving parts. Dirty machines wear much faster than equipment that's regularly washed. It's also much easier to clean machines that are regularly washed.

Clean machines keep cooler than mud-caked and grease-soaked equipment. Although regulated heat is a necessary operating condition with heavy machinery, excessive heat is a

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killer. Overheated equipment has a shorter life cycle. In fact, hot machines can quit in mid-operation. This has a domino effect on other machines and workers in the production chain.

- ✓ Downtime is reduced by keeping construction equipment clean. Breakages caused by part failure due to dirty conditions are expensive in lost time and repairs. They're also unnecessary. Regular cleaning removes foreign matter like rocks and branches in tracks. It reduces weight added to booms and buckets that have heavy, dried sludge solidly adhered to their surface.
- ✓ Cleaning machines gives a great opportunity to inspect for potential problems. Metal fatigue cracks are exposed. So is oxidization or rusting. Worn or leaking fittings are obvious when machinery is clean. This allows mechanics to get on top of developing problems before they become serious issues.
- ✓ Regularly cleaned construction machinery enhances safety. Poorly-kept equipment is dangerous to the operator, work crew and others in the machine's line of fire. Contaminant build up around hydraulic and electrical systems can result in a serious blow-out of high-pressure oil or dangerous voltage.
- ✓ Mechanics are much more efficient when they work on clean machines. Cleaning dislodges foreign debris that's heavy, volatile or slippery. Effective washing removes objects and build-ups that can cause injury from slips and falls or being pinched in points that trap kinetic energy. Ergonomic accidents are greatly reduced when surfaces are clean and safe.
- ✓ Ownership pride is greatly affected when a company's fleet is kept clean and orderly. That goes for the business owner, supervisors, machine operators and service people. Operators take more care when running clean and well-looked after equipment. So does the maintenance department.
- ✓ Finally, clean equipment makes a loud and positive statement. It's clearly heard by clients, investors and future customers.

There is a distinct process for making equipment cleaning quick and easy. There are priority steps that speed things up and prevent doing the same task twice. Every equipment cleaner has their individual quirks and peculiarities but, essentially, the proper washing procedure goes this way:

- ✓ All washing products are assembled and the machinery is placed in a contained wash rack with a closed loop system. All necessary PPE is worn.

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- ✓ Large dry chunks of material like clay and rocks are manually pried loose from the undercarriage and chassis with a steel bar and spade. This is a much safer than immediately attacking the machine with high-pressure
- ✓ Debris chunks are collected and disposed of. This prevents a tripping hazard while navigating around the machine. It also stops dried debris from being liquefied making it more difficult to handle.
- ✓ The entire machine is sprayed with a water cannon removing large debris pieces that couldn't be dislodged by hand. Warm or hot water from a hot water pressure washer is often used in this early stage which is prior to adding detergent.
- ✓ Grease accumulations are hand-removed by pulling chunks off or wiping them with clothes. By now grease will have softened by water force and temperature.
- ✓ Detergent is applied sparingly, with special attention to visible contamination. This includes engine compartments and especially radiators.
- ✓ Cleaning solvents are allowed to sit for 15 minutes to ½ hour. This gives time for surfactant molecular action to chemically dislodge all bonding.
- ✓ Water cannon force starts again. It begins at the top of the machine and orderly flows toward the ground, letting gravity pull contaminants and wastewater to the wash pad floor.
- ✓ Detailing of tight places seams and joints follow overall cannon rinsing. Here smaller pressure washers might be used as well as hand scrubbing for detailing the equipment.
- ✓ Rubber tires and hoses are cleaned with a suitable surfactant. Glass surfaces are cleaned and polished.
- ✓ Cab interiors are vacuumed and hand wiped. High-pressure washing should never be used inside cabs or around controls.
- ✓ Once the machine is generally cleaned, it's allowed to air dry. Sometimes, compressed air is used to hasten the process.
- ✓ The machine is then removed from the wash rack and sent to its next operation. That might be maintenance, repair or put back into stock for sale or rent.
- ✓ All parts of the wash pad are inspected. Mud is cleaned off of the wash pad surface, solid waste is disposed of and gray water levels are topped. Finally, a perimeter check ensures that no contaminants escape.

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- **Personal protection equipment**

Personal protection equipment is the first product to consider when starting a machinery washing job. Safety is paramount at every construction company. That includes being on an actual construction site or back at the shop and yard. Personal safety must be taken seriously. Construction machinery and designated cleaning equipment are hazardous. A solid defines line is personally protecting workers with:

- ✓ Full-length coveralls that protect the entire torso, arms and legs. Today, practically all construction workers wear hi-visibility outerwear and often that's disposable or reusable coveralls. Specialized rainwear is suitable for machinery this can be overalls or two-piece jackets and pants. Insulated protection is important if using hot water washing.
- ✓ Protective footwear is vital. No matter what, the worker is going to get wet while washing machinery. Heavy equipment wash pads, also known as heavy equipment wash racks, are slippery places. The best footwear is commercial rubber boots with anti-skid soles and toe protection. Upper closure is also important. This prevents hot water from filling up boots.
- ✓ Face and eye protection are Splashes from dirt and grease dislodged under high pressure can be extremely dangerous. Eye contamination is a high risk as is skin burns and punctures. Chemical burns are also possible depending on what degreasing agent is used. At minimum, wrap-around eyewear must be used. Full face shields are better yet.
- ✓ Gloves are mandatory. Washing construction equipment is a hands-on task. Workers need to hand-remove chunks of clay and all sizes of stones. Grease globs need prying off and sharp edges on machine parts can give vicious cuts. Some workers wear leather gloves when washing but most find rubber or latex protects hands best.

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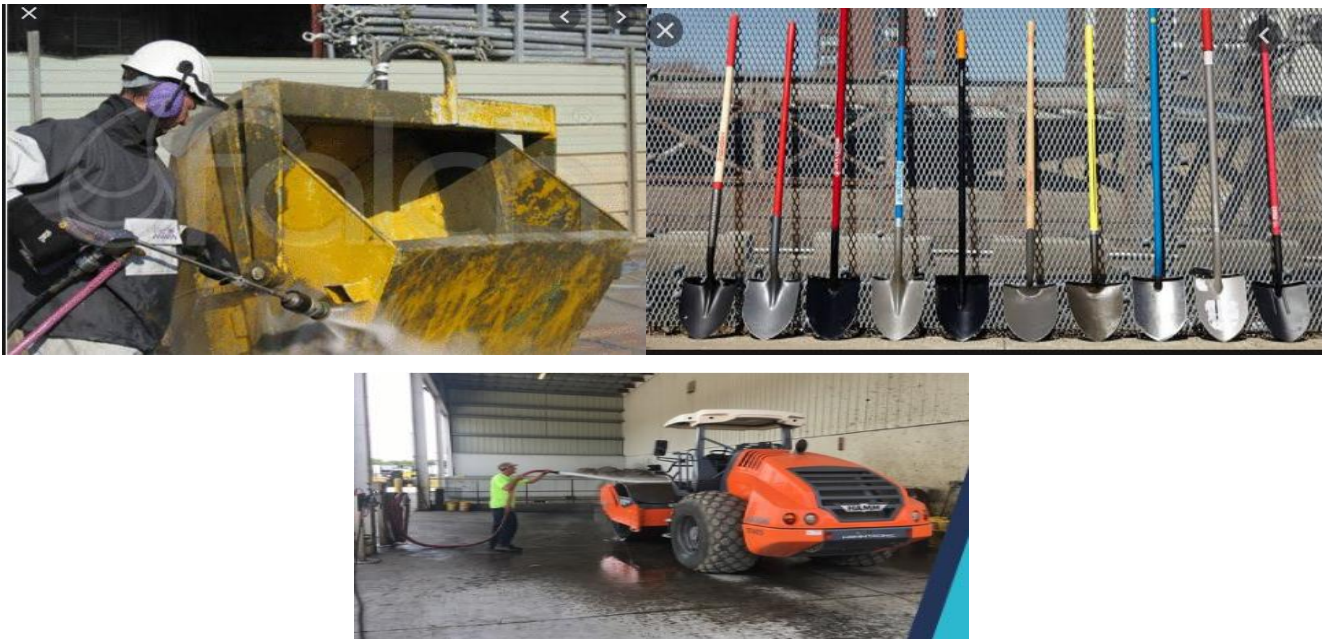


Figure 102: Cleaning of construction tools and equipment

### 3.2. Checking and maintaining tools and equipment's

- **Maintenance of manual excavation tools**

Maintenance can be defined as working on something to keep it in a functioning and safe state and preserving it from failure or decline. The “something” could be a workplace, work equipment, or means of transport (e.g. a ship).

Tools and equipment need regular maintenance, requiring good workshop facilities, a reliable supply of spare parts and qualified mechanical staff. Efficient tool heads should:

- ✓ Have the correct shape in order to work efficiently,
- ✓ Be of suitable weight for the strength of the workers, and
- ✓ Be properly sharpened along the working edges.

Most of the implements required to carry out maintenance and repair of tools are inexpensive and simple to use. Depending on the number and types of tools on site, a set of tools for repair work should be made available on site.

Although the hand tools on site may be of good quality, they still need regular maintenance to remain effective. When tools have been used for some time, handles eventually need to be replaced and cutting edges require sharpening. If the workers are equipped with poorly maintained hand tools, their performance will be compromised.

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Establishing repair facilities on site is therefore justified through the savings made by repairing tools rather than buying new ones, and through an increase in worker productivity when supplying the workforce with tools in good condition.

On projects with a large workforce, it is useful to employ a person specifically to maintain and repair the hand tools. Alternatively, it is always useful to check in the local villages if there are any blacksmiths or carpenters who can provide repair services.

The site camp will need a work place for repairing tools, equipped with effective sharpening instruments and a sufficient supply of spare parts.

The fine cutting edges of axes, bush knives and grass cutters are normally maintained by sharpening with whetstones.

The edges of earthworks tools, such as hoes, pickaxes, mattocks, shovels and spades should be sharpened with a grinding stone or by filing. The cutting edge of a hoe or a mattock should be sharpened on the side facing the operator of the tool.

Some ways of preventing excessive wear and damage to tools.

- ✓ Use the correct tool for the job.
- ✓ Keep tools clean and rust protected and
- ✓ Stored away at the end of day as per company rules and regulations.

Make inspections for damage and report so repairs can be arranged by supervisor and extend the life of the tool through preventative maintenance.

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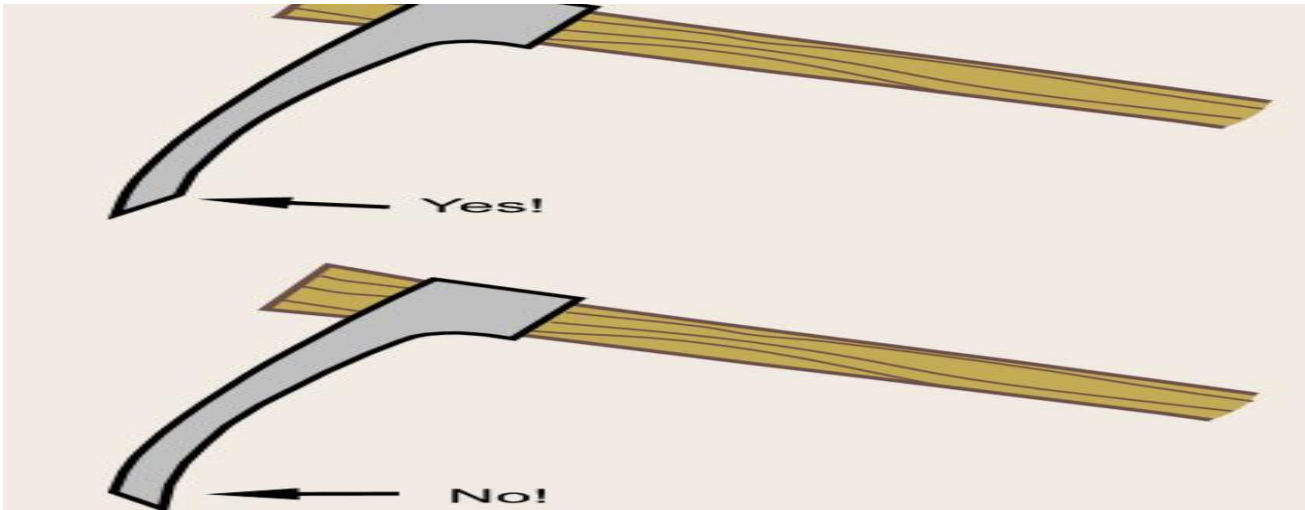


Figure 103: effected tools and maintenance of the tools

If the blade has been chipped or pieces broken off, the hoe should not be used until it is repaired. The repair can be done by cutting or filing off the edges to re-establish a straight edge and then sharpening it.

When the length of the blade is less than 150mm, the hoe is no longer efficient for digging. However, it can still be useful for other purposes, such as grubbing and levelling works. The blade of a good shovel will not bend or crack but will wear. The edge of the blade will eventually be so worn that it becomes blunt and for this reason difficult to push into the soil. To improve the worn blade it can be cut and sharpened so that the shovel can be used effectively again. This requires very strong tools and should be done in a workshop. The axe is fixed to a vice, to allow for the use of both hands when using a file for sharpening.

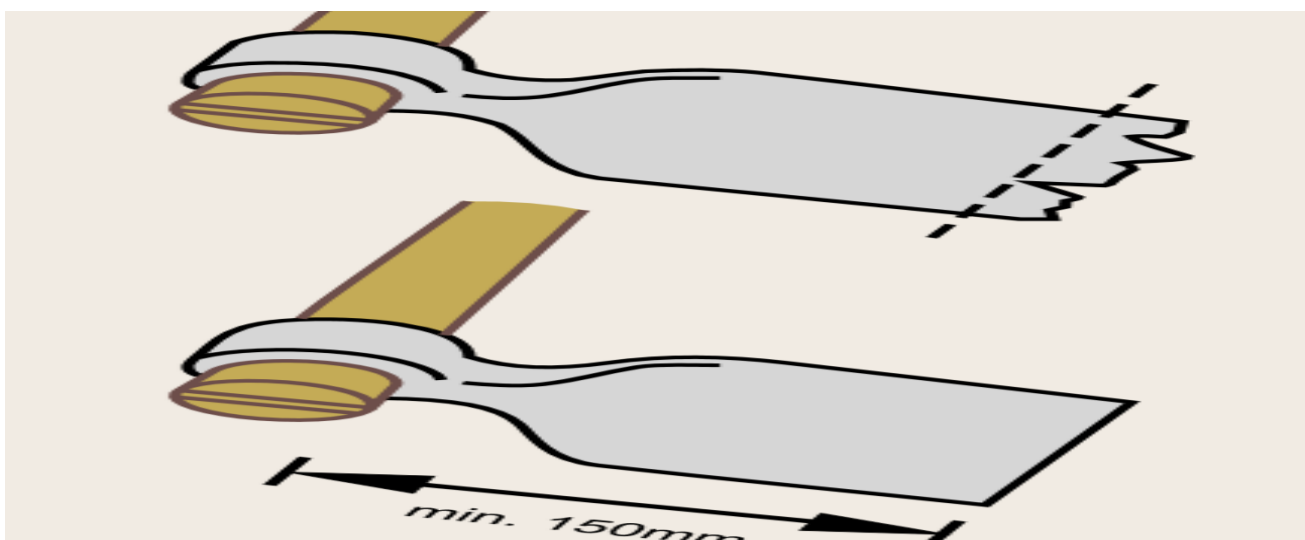


Figure 104: dimension of the maintained tools

The best tool when axes, mattocks, pickaxes, bush knives and similar tools need major reshaping works. Avoid using electric grinders, as it will most probably draw the temper from the steel, leaving it too soft to hold an edge. A grinding wheel is slow enough to avoid removing too much and as long as it is moistened with water, maintains cool temperatures.



Figure 105: broken tools in the site

### 3.3. Storing tools and equipments

An employer must ensure that all workplace materials, equipment, machines and tools are stored in a manner that does not create a risk to the safety or health of a worker or affect the safe operation of the workplace. To ensure that tools and equipment remain in good condition and last for a long time, store them properly. Properly stored tools and equipment will be easy to find when needed and are less likely to be lost. Putting tools especially large tools like power saws, in self-storage will keep them safe and away from children.

Regardless of where choose to store tools there are a few basic tool storage ideas and tips to keep in mind before put them away.

- ✓ **Follow the instruction:** - some manufactures will have a specific instruction for how to store tools, so consult manuals first foremost. It's important to follow these

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instruction, especially for large power tools like saws or drills, so they remain in good working conditions.

- ✓ **Clean them off:** - Tools should be cleaned each time you use them. Wipe them down with a damp rag or towel to get rid of any dirt, dust, grease or debris. Make sure garden tools are free of mud and grime. Everything should be completely dry before placing it in storage to avoid rust developing
  - ✓ **Use original cases:** - Power tools usually come in hard, plastic cases, and it's recommended to keep these cases for storage whenever possible. These cases will keep your power tools in storage safe from extreme conditions, plus all the parts can be stored right alongside them in the case. No more lost power cords or chargers
  - ✓ **Invest in sturdy storage containers:** - If you don't have the original container, or you're storing smaller hand tools, invest in some sturdy containers. This will not only keep your tools organized, but also allows them to be easily transportable to your next project area.
  - ✓ **Store in a safe, dry place:** - Along with having the right containers, another way to protect your tools is to ensure that area you're storing them in is safe and dry. Water or humidity can cause damage to tools, especially power tools.
  - ✓ **Go vertical:** - keep these tools storage ideas and tips in mind and your tool collection will be organized and accessible for that next home project.
- **Importance of proper storage of tools and equipment**
    - ✓ It is an important factor for safety and health as well as good business.
    - ✓ Improves appearance of general-shop and construction areas.
    - ✓ Reduces overall tool cost through maintenance.
    - ✓ This also ensures that tools are in good repair at hand.
    - ✓ Teaches workers principles of (tool) accountability.
  - **Pointers to follow in storing tools and equipment:**
    - ✓ Have a designated place for each kind of tools.
    - ✓ Label the storage cabinet or place correctly for immediate finding.
    - ✓ Store them near the point of use.
    - ✓ Wash and dry properly before storing.
    - ✓ Store knives properly when not in use with sharp edge down.
    - ✓ Put frequently used items in conveniently accessible locations.
    - ✓ Gather and secure electrical cords to prevent entanglement or snagging.
    - ✓ Cutting boards should be stored vertically to avoid moisture collection.

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- ✓ Metal equipment can be stacked on one another after drying such as storage dishes and bowls.
- ✓ Make sure the areas where you are storing the equipment are clean dry and not overcrowded.



Figure 106: storing area of tools and equipment

<b>Self-check 3</b>	<b>Written test</b>
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**Instructions:** Choose the best answer. Write your answers in the sheet provided in the next page.

1. Which one of the following is proper washing procedure?
  - A. The entire machine is sprayed with a water cannon removing large debris pieces that couldn't be dislodged by hand
  - B. Debris chunks are collected and disposed
  - C. Large dry chunks of material like clay and rocks are manually pried loose from the undercarriage and chassis with a steel bar and spade.
  - D. All washing products are assembled and the machinery is placed in a contained wash rack with a closed loop system.
  - E. All of the above
  
2. Which one of Pointers to follow in storing tools and equipment?
  - A. Wash and dry properly before storing.
  - B. Store them near the point of use
  - C. Label the storage cabinet or place correctly for immediate finding
  - D. Have a designated place for each kind of tools
  - E. All of the above
  
3. Which one is Importance of proper storage of tools and equipment?
  - A. Improves appearance of general-shop and construction areas
  - B. Reduces overall tool cost through maintenance
  - C. This also ensures that tools are in good repair at hand
  - D. Teaches workers principles of (tool) accountability
  - E. All of the above
  
4. Which one is basic tool storage ideas and tips to keep in mind before put them away?
  - A. Follow the instruction
  - B. Clean them off
  - C. Use original cases
  - D. Invest in sturdy storage containers
  - E. Store in a safe, dry place
  - F. All of the above



5. Which one is ways of preventing excessive wear and damage to tools?
- A. Use the correct tool for the job.
  - B. Keep tools clean and rust protected
  - C. Stored away at the end of day as per company rules and regulations
  - D. All of the above

**Note: Satisfactory rating - 5 points**

**Unsatisfactory - below 5 points**

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

### Answer Sheet

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

- 1.
- 2.
- 3.
- 4.
- 5.

Operation sheet 1	<b>Techniques of cleaning checking and storing construction tools and equipment</b>
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Activity 1 cleaning of construction tools and equipment

**Step 1:** Wear appropriate personal protective equipment

**Step 2:** Assess the tools and equipment to be cleaned

**Step 3:** Select appropriate cleaning equipment and chemicals

**Step 4:** Prepare the tools and equipment for cleaning

**Step 5:** Clean tools and equipment as identified

**Step 6:** Tidy work site

**Step 7:** Dispose of waste

**Step 8:** Return tools and equipment to operational condition

**Step 9:** Clean, check and store cleaning equipment and chemicals

Operation Sheet 2	<b>Maintaining and storing construction tools and equipment</b>
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Techniques of maintaining and storing construction tools and equipment utilize the following steps.

- Step 1:** Wear appropriate personal protective equipment
- Step 2:** Identify maintenance tasks to be undertaken
- Step 3:** Select appropriate maintaining tools and equipment
- Step 4:** Prepare the tools and equipment for maintaining
- Step 5:** Perform maintenance tasks, as required
- Step 6:** Report problems and faults that require additional attention
- Step 7:** Store maintenance tools and equipment
- Step 8:** Perform required administrative tasks
- Step 9:** Assist in special projects, where required

<b>LAP Test</b>	<b>Practical demonstration</b>
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Name: \_\_\_\_\_ Date: \_\_\_\_\_

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 8hr

**Task 1:** Clean and store all construction tools and equipment's properly

**Task 2:** Maintain all construction tools and equipment's properly

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