Ethiopian TVET-System

Irrigation & Drainage Construction

Level II

Based on, March 2017G.C. Occupational Standard

Module Title: Constructing Open Earthen Channels or Drains

TTLM Code: EIS IDC2 TTLM 0920v2

This module includes the following Learning Guides

LG 62: Plan and prepare for construction work

LG Code : EIS IDC2 M15 0920LO1-62

LG 63: Construct channels or drain

LG Code: EIS IDC2 M15 0920LO2-63

LG 64: Restore work site and equipment

LG Code: EIS IDC2 M15 0920LO3-64

Instruction Sheet-1	Learning Guide 57: Plan and prepare for construction work

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

- Determining work requirements
- Checking sites and identifying hazards
- Identifying legislative and organizational requirement
- Arranging drainage and diversion systems
- Checking equipments and open cut excavation methods
- Preparing construction site

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 –**

- Determine Work requirements from design plans, specifications, instructions and work orders according to the organizational standard.
- Check site and identify hazards according to legislative and organizational requirements.
- Made appropriate drainage and diversion arrangements without damage to environment.
- Check equipment and open cut excavation methods to ensure that safety requirements of task and to site are met.
- Prepare site according to specifications and organizational requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets "1- 6”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks 1,2,3,4,5 & 6" in each information sheets on pages 10, 15, 24,31, 42 & 45.

5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work.
6. If you earned a satisfactory evaluation proceed to “Operation sheets 1- 4 on pages 53, 54, 55 & 56 and do the LAP Test on page 57”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and the LAP Test, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next LG.

Information Sheet-1	Determine Work Requirements from Design Plans, Specification, Instructions and Work Orders

1.1 Introduction to work requirement

Determining work requirement is a process of identifying and arranging all necessary things by reading and interpreting the given design plans, drawings, specifications and instructions that can be used to accomplish the specific construction works.

1.2 Common work requirements

A. **Confirmation of site availability**: This is for ensuring availability of suitable construction site to implement the specific project according to its design plan, the given specifications and standards.

B. **Confirmation of legal approvals**

I. **Vegetation clearing approval**: -The Ethiopian government's main environmental legislation, which regulates matters of national environmental significance (e.g. threatened species, ecological communities). You may need to obtain approval under the Act if your proposed clearing could have a significant impact on matters of national environmental significance.

II. **Riverine protection permits**: - is provision of the permission to excavate or place fill in water course, lake or spring. Riverine protection permit exemption is the permission to allow excavation, place fill in water course, lake or spring without need of riverine protection permit stated under the water law. Minimum requirements are set out to ensure permitted activities to minimize impacts on water quality, water flow and the physical integrity of a watercourse, lake or spring. The exemption requirements only apply to the excavation or placement of fill in a watercourse, lake or spring for the purposes of:

- the construction, installation, removal, maintenance or protection of in stream infrastructure

- the establishment and maintenance of flow efficiency around in stream infrastructure
- riverine restoration or rehabilitation, flood mitigation, erosion protection or weed control.

The minimum requirements outlined below must be achieved to be qualified for an exemption from having to apply for and obtain a riverine protection permit:

- Sediment and erosion controls must be used.
- All areas of disturbed bed and banks must be stabilized to protect against erosion.
- All fill placed must be free from contamination (e.g. weeds seeds, oils, chemicals and other contaminants).
- Disturbed banks must be returned to a profile similar to the pre disturbance condition.
- All culverts placed within the watercourse must be aligned with the stream channel and placed as close to the center of the watercourse channel as practical.
- Constructed access tracks (e.g. culverts or splash through crossings) must be

III. Borrow approvals: -This consist of the getting of borrow, topsoil, sub base and base materials, mineral aggregates for concrete structures, surfacing, and landscape plating, from sources either designated on the project plans or in the Special Provisions or from other sources.

IV. Preparations for conditions included in statutory approvals for work:- This indicates facilitating pre conditions to get statutory approvals for the specific works. Statutory requirements are regulations and general directions for construction of irrigations and drainage works. Getting the signed approval for accomplishment of the work is mandatory for any work area.

C. Site boundaries:

Owners/operators of construction activity must complete several steps before beginning construction. Identifying the construction site boundaries, the latitude and longitude for the centroid of the site, and the project's major phases.

D. Borrow and spoil areas

Borrow pit:- In construction and civil engineering, a borrow pit is an area where material (usually soil, gravel or sand) has been dug for use at another location. Borrow pits can be found close to many major construction projects.

Location of spoil disposal areas: - It is the area where disposal materials are accumulated. Spoil disposal areas shall be located:

(a) Above the 100-year flood level.

(b) Where the final slope after disposal will be no steeper than 1.5:1.

(c) Where the risk of sediment delivery from soil erosion and/or mass soil movement is minimal.

(d) All spoils shall be placed to allow drainage without additional water Ponding.

(e) All spoils shall be located outside of Wetlands and their wetland management zones. Spoils shall not be located within the boundaries of forested wetlands without written approval of the department and unless a less environmentally damaging location is unavailable.

E. Boundary protection:

Boundary protection is structure constructed in order to keep the area behind the structure like irrigation canal, drainage structures, highway roads etc.

Figure 1: Boundary protection

F. Location, timing and type of work activity:

- The entire works of the project first of all should be arranged in sequential order then it will divide into small pieces of work (work break down) so that it could be easily achieved.
- Each piece of the work should have specified time in which it will be accomplished. This is termed as work scheduling. A schedule can be looked at as a time management tool which outlines the specific times at which certain tasks/activities need to be undertaken.
- Most of the schedules are organized in a given chronological order, and this sequence will dictate the achievement of certain goals. Scheduling refers to the process of coming up with a given schedule, it will involve coming up with an elaborate order of achieving certain tasks and allocating the necessary resources to facilitate their execution.

G. Extent of the work

This shows that to the extent that the scope of work involves in the construction of irrigation and drainage works. Determining the extent of the work before starting of it and is useful for managing safe time and resources.

Purpose of Understanding extent of work:

- to choice technology for accomplishment of specific work,
- to define of work tasks,
- to estimate required resources for each task
- to estimate durations for individual tasks,
- to identify any interactions among the different work tasks.

H. Access roads:

- Site access roads will be required to provide all weather access to channel all the traffic generated by the construction activities for the safe transport of personnel, materials and equipment both during construction and operation
- Ideally, these access roads should be located to minimize vegetation disturbance, while giving appropriate consideration to the intended purpose of the road.

I. Specifications for depth, width and gradient: -

- Specification for depth, width and gradient is determination of measurement of canal depth, h (in meter) and its width, B (in meter) where as determining bed slope, so of the canal for the purpose of flow of water.

Figure 2: a) Rectangular canal b) Trapezoidal canal

J. Utility location and Safe work methods:

- Safe work place and methods must be prepared by the persons conducting activities for any identified high risk construction work in relation to all construction works.
- A worker must eliminate or, where it is not reasonably practicable, control the risks associated with 'construction work' in line with the 'hierarchy of controls'.
- The one must monitor and, where required, review these risk control measures, especially when workplace specific circumstances change.

Review risk controls regularly:

- before a change occurs to the work itself, the system of work or the work location
- if a new hazard associated with the work is identified
- when new or additional information about the hazard becomes available
- when a modifiable incident occurs in relation to the work
- when risk controls are inadequate or the SWMS is not being followed

In all of the above situations, stop the work, review the SWM adjust as required and re-brief the team and retain all versions of the SWMS in a readily available location for the duration of the HRCW and for at least two years after modifiable incident occurs.

1.3 Statutory approvals and conditions

Drainage and diversion arrangements should meet requirements of Environmental Assessment Procedures and Guidelines of Ethiopia according to environmental impact assessment (EIA) Guideline document (EPA 2002). This guideline follows the conventional pattern adopted in many other parts of the world, and makes provision for screening, scoping, identification and evaluation of impacts, the development of environmental management and monitoring plans, consideration of alternatives etc. At the project identification phase, based on EPA's guideline projects are categorized in one of the following three categories:

Schedule 1: Projects which may have adverse and significant environmental impacts, and may, therefore, require full EIA.

Schedule 2: Projects whose type, scale or other relevant characteristics have potential to cause some significant environmental impacts but not likely to warrant an environmental impact study.

Schedule 3: Projects which would have no impact and does not require environmental impact assessment.

1.4 Environmental protection

According to the guideline, all projects in environmentally sensitive areas are treated as equivalent to Schedule 1 activities irrespective of the nature of the project. Before diversion and drainage work implementation there should be environmental protection agency approval. The environmental impact of construction contributes to global warming. Construction projects emit large amounts of carbon dioxide and methane. Infrastructure developments cause pollution and produce waste. As the output of the construction industry multiplies, so can its damaging effects.

Self-Check 1	Written Test

Ddirection I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. One of the following is included during determination of work requirement.
   A. Confirmation of site availability
   B. Confirmation of legal approvals
   C. site boundaries
   D. Borrow and spoil areas E. All of the above
2. For what purpose Federal democratic republic of Ethiopia, ministry of water resources formulates and adopt national standards and criteria in water resources management?
   A. Design
   B. installation
   C. construction
   D. inspection, operation & maintenance E. all of the above
3. One of the following is not included in Legislative and organizational requirements
   A. Relevant federal water legislation and regulations
   B. Local authority by-laws
   C. Organizational procedures
   D. Environmental & Cultural heritage E. All of the above
4. One of the following is objective of specifications **[4 points]**
   A. ensuring adherence to laws and regulations
   B. prevent conflicts between the specifications and other contract requirements
   C. prevent omission of essential elements
   D. prevent inclusion of extraneous materials E. All of the above

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

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

Score = _____

Rating: _____

1. _____ **3.** _____

2. _____ **4.**_____

Information Sheet-2	Checking site and Identifying hazards

2.1 Introduction to hazard identification

Hazard is any condition associated with construction works that can cause harm to life, properties and environment. Identifying hazards is the process of examining each work area and work task for the purpose of identifying all the hazards which are “inherent in the job”.

Examples of hazards associated with construction are:

- the construction workplace itself, including its location, layout, condition and accessibility
- the use of ladders, incorrectly erected equipment, unguarded holes, penetrations and voids, unguarded excavations, trenches, unstable structures such as incomplete scaffolding or mobile platforms, fragile and brittle surfaces such as cement sheet roofs, fiberglass, roofs, skylights and unprotected formwork decks
    - ✓ falling objects, for example tools, debris and equipment
    - ✓ collapse of trenches
    - ✓ structural collapse
- the handling, use, storage, and transport or disposal of hazardous chemicals the presence of asbestos and asbestos-containing materials
    - ✓ welding fumes, gases and arcs
    - ✓ hazardous manual task
    - ✓ the interface with other works or trade activities

2.2 Risk assessment

Assessing the risks: - Assessing the risk includes considering:

- Isolating the severity of any injury or illness that could occur, isolating small hazard that cause minor injury or significant hazards that cause severe affects.
- The likelihood or chance that someone will suffer an illness or injury, for example consider the number of people exposed to the hazard.

Assessing the risks will help to:

- identify which workers are at risk of exposure
- determine what sources and processes are causing that risk
- identify if and what kind of control measures should be implemented
- Check the effectiveness of existing control measures.

Eliminating risk

This means removing the hazard or hazardous work practice from the workplace. This is the most effective control measure and must always be considered before anything else. If elimination of the risk is not reasonably practicable, you must consider using substitution, isolation or engineering controls, or a combination of these control measures, to minimize the risk.

2.3 Hazardous materials handling

Hazardous material is an any solid, liquid, or gas that can harm people, other living organisms, property, or the environment.

Rules for safe handling of hazardous materials

These 11 rules are presented in no particular order. They are all top priorities for chemical handlers. However, feel free to rearrange them in whatever order you think is best for your workplace, your workers, and your material hazards.

The followings are rules for handling hazardous materials:

- Follow all established procedures and perform job duties as you have been trained.
- Be cautious and plan ahead. Think about what could go wrong and pay close attention to what you're doing while you work.
- Always use required personal protective equipment(PPE) and inspect it carefully before each use to make sure it's safe to use. Replace worn out or damage PPE; it won't provide adequate protection.
- Make sure all containers are properly labeled and that the material is contained in an appropriate container. Don't use any material not contained or labeled properly. Report any damaged containers or illegible labels to your supervisor right away.
- Read labels and the material safety data sheet (MSDS) before using any material to

make sure you understand hazards and precautions.

- Use all materials solely for their intended purpose. Don't, for example, use solvents to clean your hands, or gasoline to wipe down equipment.
- Never eat or drink while handling any materials, and if your hands are contaminated, don't use cosmetics or handle contact lenses.
- Read the labels and refer to MSDSs to identify properties and hazards of chemical products and materials.
- Store all materials properly, separate incompatibles, and store in ventilated, dry, cool areas.
- Keep you and your work area clean. After handling any material, wash thoroughly with soap and water. Clean work surfaces at least once a shift so that contamination risks are minimized.
- Learn about emergency procedures and equipment. Understanding emergency procedures means knowing evacuation procedures, emergency reporting procedures, and procedures for dealing with fires and spills. It also means knowing what to do in a medical emergency if a co-worker is injured or overcome by chemicals.

2.4 Risk factors and potential hazards of construction processes

- Construction work is a hazardous land based job. Some construction site jobs include: building houses, roads, dams, weirs, channels, tree forts, workplaces and repair and maintain infrastructures.
- This work includes many hazardous task and conditions such as working with height, excavation, noise, dust, power tools and equipment.
- The most common fatalities are caused by the fatal four: falls, being struck by an object, electrocutions, and being caught in between two objects.

2.4.1. Construction hazards and their prevention

The top four causes of construction fatalities are:

- Falls,
- Struck-by,

- Caught-In/Between and
- Electrocutions.

Prevention of fall

- Wear and use personal fall arrest equipment.
- Install and maintain perimeter protection.
- Cover and secure floor openings and label floor opening covers.
- Use ladders and scaffolds safely.

Prevention of Struck-By

- Never position yourself between moving and fixed objects.
- Wear high-visibility clothes near equipment/vehicles.

Prevention of caught-in/Between

- Never enter an unprotected trench or excavation 1.6 meter or deeper without an adequate protective system in place.
- Make sure the trench or excavation is protected either by sloping, shoring, and benching or trench shield systems.

Figure 3: Prevention of caught-in/Between

Self Check 2	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. The causes of construction fatalities are:
   A. Falls C. Struck-by
   B. Caught-In/Between D. Electrocutions E. All
2. Removing the hazard or hazardous work practice from the workplace is:
   A. Eliminating hazards
   B. Assessing hazards
   C. Evaluating hazards
   D. Identifying hazards
3. Examples of hazards associated with construction are:
   A. unguarded holes
   B. unstable structures
   C. unguarded excavations,
   D. Incomplete scaffolding or mobile platforms
   E. All
4. Rules for handling hazardous materials include:
   A. Be cautious and plan ahead.
   B. Always use required personal protective equipment(PPE)
   C. Use all materials solely for their intended purpose
   D. Never eat or drink while handling any materials
   E. All

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

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

Score = _____

Rating: _____

1. _____ **3.** _____

2. _____ **4.**_____

Information Sheet-3	Identifying legislative and organizational requirement

3.1 Introduction to organizational standard

The term standard refers specifically to a specification that has been approved by a standards setting organization. The standards most frequently encountered in construction work will now be described under two headings; 'general-purpose standards' and 'nuclear standards'. Both standards specify systems which will maintain and assure quality; the difference is that whereas the first category is oriented to the requirements of the market place, the second is aimed more at satisfying the statutory requirements imposed by regulatory authorities particularly in respect of safety.

Federal democratic republic of Ethiopia, ministry of water resources formulate and adopt national standards and criteria for the design, installation, construction, operation, maintenance, inspection and other activities in all water resources management undertakings.

Any water work activities should be agreed with the standards and full fill with the following conditions.

- Adopt the water sector as the responsible authority for issuance of the necessary professional certification, professional permits and licenses for consultancy, contracting, as well as manufacturing and importing related to water resources development.
- Provide the necessary legal framework for penalties commensurate with the violation of legal provisions relating to water resources.

3.2 Legislative and organizational requirements

Legislative and organizational requirements are indicators of actual or potential risk of abuse, neglect or harm. You need to work within the parameters of accepted standards, such as:

- protocols defined in legislation

- Organizational procedures.

Legislative and organizational requirements may include:

- Relevant federal water legislation and regulations
- Local authority by-laws
- Organizational procedures
- Environmental
- Cultural heritage
- OHS procedures
- Dangerous goods and chemicals

3.2.1. Relevant federal water legislation and regulations

3.2.1.1. Relevant federal water legislation

Relevant federal water legislation and regulations is legislative framework created for the implementation of the water proclamation and the operational of the Ethiopian Water Resources Management policy.

Development of the water policy, formulation of the national water sector strategy, the issuance of water resources management proclamation and the preparation of the 15-year Water Sector Development Programme (WSDP) beginning 2002 and in addition Ethiopia's effective involvement in the Nile Basin Initiative among others, are signs of effective governance by way of creating the ground for sustainable water resources development and management.

Focus will be given in this section for the Water Resources Management Proclamation issued in 2000(FDRE, 197/2000) and the Water Resources Management Regulations, which is due to be approved soon by the Council of Ministers before the end of 2004.

3.2.1.2. Water Resources Management Proclamation

The proclamation was issued with clear objectives and purpose to implement the,

fundamental principles objectives, goal and the stipulated sectoral and cross cutting policy issues articulated in the water policy for Ethiopia.

- The proclamation has Nine Parts and 33 Articles and several sub- articles.
- The social, legal, environment, institutional and many more other related legislative provisions are treated here as appropriate and required.
- The proclamation declares, "All water resources of the country are the common property of the Ethiopian people and the state". (Federal Democratic Republic of Ethiopia (FDRE),197/2000 Article 5)
- Regarding water use priority, the proclamation states, "Domestic water use shall have priority over and above any other water uses". (FDRE, 197/2000 Article 7sub-article 1).

3.2.1.2. Relevant federal water Regulations

Relevant federal water regulations are those covered in the proclamation, but detailing the procedures as to how the various legal materials contained in the proclamation are to be achieved on the ground. The Regulation has TEN parts and 44 relevant Chapters (Articles).

3.2.2. Local authority by-laws

Planning and implementing of water resources development and management, which are within the legal competence of the Regional States are further transferring down to the local administrative units at Woreda levels known as water desk. These desks are responsible for planning, budgeting, implementing and monitoring and follow-up of water projects and programmes, in their respective localities.

3.2.3. Organizational procedures

Procedure is the fundamentals of the policy, outlining what has to be done to implement the policy. A policy is a course of action or guidelines to be followed whereas a procedure outlines what has to be done to implement the policy. For example, a staff recruitment policy could involve the following procedures:

- All vacant paid positions will be advertised in local and state-wide papers.
- The advertisements will have details of duties, salary range, closing date and contact details.
- All interested people will be mailed job descriptions and information about the organization

The following strategies will support you to increase your knowledge and understanding of your responsibilities:

I. Current legislation

Obtain a copy of the legislation that informs your role and what some of your agency's policies are based on. Discuss how the legislation underpins the work of your agency with your supervisor.

II. Agency procedures

Read the Policies and Procedures Manual of your agency which details work practice guidelines in line with relevant legislation and regulations.

III. Consultation

Use all opportunities offered to you to consult with others (including involvement in formal supervision sessions with your supervisor and/or mentor) about your legal and workplace responsibilities and obligations.

3.2.4. Environmental requirements

Depending on the regulation, a violation can result in both civil and criminal penalties. Ethiopia has established 16 the fundamental general policy principles that guide the equitable, sustainable and efficient development, utilization, conservation and protection of water resources in Ethiopia as it is stated in the document of Ethiopian Water Resources Management Policy.

The **policy's stated goal** is to "improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound

management and use of natural, human-made and cultural resources and the environment as a whole". This is done through several sectoral policies as well as some cross-sectoral policies. One sectoral policy specifically addresses climate change and atmospheric pollution, through:

- promoting a climate monitoring programme
- acknowledging a commitment to mitigate emissions, even at low or even insignificant levels of contribution to global emissions
- actively participating in protecting the ozone layer, as a means to reduce vulnerability of the highlands of Ethiopia
- encouraging re-vegetation, monitoring grazing and rehabilitating degraded land to compensate for high biomass-fuel consumption

Other sectoral policies include:

- soil husbandry and sustainable agriculture
- forest, woodland and tree resources
- genetic, species and ecosystem biodiversity
- energy resource
- water resources
- mineral resources
- human settlement, urban environment and environmental health
- control of hazardous materials and pollution from industrial waste
- cultural and natural heritage

Thus, any water resources development construction should obey federal water legislation and regulations.

3.2.5. Cultural heritage

Cultural heritage is the legacy of *tangible* and *intangible* attributes of a group or society that are inherited from past generations, maintained in the present and bestow for the benefit of future generations.

Tangible culture:-Tangible cultures are those of features such as buildings, monuments,

landscapes, books, works of art, and artifacts.

Intangible culture: - Intangible cultures are those of attributes such as folklore, traditions, language, and knowledge, and natural heritage (including culturally significant landscapes, and biodiversity.

Ethiopia is rich in linguistic and cultural diversity. This diversity includes tangible and intangible heritage with both traditional and modern cultural expressions, languages, and centuries old know how in handicraft production. The intangible heritage of Ethiopia is also rich with an exceptional variety including ceremonies, festivals, celebrations, rituals, and other living expressions.

3.2.5.1. Factors affecting natural and cultural heritages

Population pressure, environmental degradation, poverty and global warming endanger Ethiopia's natural and cultural heritages. In addition, the creative industries are not well developed due to numerous reasons including inadequate legal framework, ineffective implementation of laws, weak operational capacity, and inadequate entrepreneurial capacity and age-long traditional marginalization of artisans.

3.2.6. OHS procedures

- Some kinds of accidents commonly caused by lack of Observing OH& S policies and procedures are:
- Poor Interpretation of work instructions according to job requirements
- Well organized and selected tools are not available
- Sub standard and unsafe installation
- Control devices remain unchecked

3.2.7. Dangerous goods and chemicals

Dangerous goods or hazardous goods are solids, liquids, or gases that can harm people,

other living organisms, property, or the environment. Dangerous goods are substances, mixtures or articles that, because of their physical, chemical (physicochemical) or acute toxicity properties, present an immediate hazard to people, property or the environment. Hazardous chemicals are any substance, mixture or article that satisfies the criteria for a hazard class in the Globally Harmonised System of Classification and Labeling of Chemicals (GHS) that are used in the workplace. These can be classified according to their health and physicochemical hazards.

Regulatory requirements

The World Harmonised System of Classification and Labeling of Chemicals (WHS) Regulation 2011 covers workplace hazardous chemicals and dangerous goods under a single framework for hazardous chemicals and introduces a new hazard classification and hazard communication system based on the United Nations' Globally Harmonised System of Classification and Labeling of Chemicals (GHS).

The following rules should be followed.

- All containers holding dangerous goods or hazardous chemicals used in the work place need to be appropriately labeled and labels must not be removed, defaced, modified or altered in any way.
- Employees must be trained in relation to the storage and use of dangerous chemicals and hazardous chemicals.

3.3. Specifications and organizational requirements

a. National Standard Construction Specifications:

Is State the technical and workmanship requirements for the various operations required in the construction of the works, the methods of measurement, and the basis of payment.

b. National Standard Material Specifications

- State the quality of materials to be incorporated in the permanent works.

c. Interim Specifications

- Specifications prepared by States for use in contracts that include construction items

or materials not covered by national standard specifications.

d. Standard Specifications

- National standard and interim specifications.

e. Unique or One-Time-Use Specifications

Specifications for construction or material items that are unique to the contract and are not covered by national standard specifications or State interim specifications. The specifications are prepared within the State and intended for one-time-use only in a specific contract.

f. Construction Details

- Prepared by the design office and state the special requirements peculiar to a specific work of construction.
- They may take the form of written addenda to the standard construction specifications or notes on the drawings.

g. Contract specifications

- The complete specifications prepared for a specific contract and consist of an assembly of appropriate standard and one-time-use specifications supplemented by lists and descriptions of items of work and construction details.

Objectives of specifications:

The national standard specifications are used to:

- ensure adherence to laws and regulations, prevent conflicts within the specifications and between the specifications and other contract requirements,
- prevent omission of essential elements and inclusion of extraneous materials,
- provide a uniform basis for interpretation, and ensure uniform quality

3.3.1. Rules for use of construction Specification 1-Clearing

1. Applicability

Construction specification 1 is applicable to the clearing of vegetation at construction sites where grubbing is not required.

2. Material specifications

No material specifications complement Construction Specification 1.

3. Included items

Items to be included in contract specifications and drawings follow:

A. When the area(s) to be cleared is definable on the project layout map or other construction plan view drawing, the limits of each class (A, B, or C) of clearing must be shown and clearly defined.

B. When the area(s) to be cleared is not definable on the drawings, the extent of each class of clearing required must be described by notes and by designation of right of way boundaries and station limits. The full extent of work to be performed must be clearly defined.

C. When replacement plants are required because of damage caused by the contractor, the specific size, number, and species needs to be specified.

D. Areas in which disposal of refuse/waste material is not allowed or areas where disposal is restricted or limited must be clearly defined or shown on the drawings

E. Required minimum depth of earth cover over buried materials, if applicable.

F. Required surface grading over buried materials, if applicable. Existing natural flow patterns onto or from the construction site onto other properties must be a consideration in the final grading.

G. Restrictions on the use of explosives, if any.

H. Restrictions on the burning of combustible materials as a disposal procedure

I. Special requirements to control erosion, water pollution, and air pollution, if applicable.

Self Check 3	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. What is a standard?
   A. It is a specification that has been approved by a standards setting organization.
   B. Is indicators of actual or potential risk of abuse, neglect or harm.
   C. Is a course of action or guidelines to be followed whereas a procedure is the 'nitty gritty' of the policy
   D. All

2. Items to be included in contract specifications and drawings are:
   A. Restrictions on the use of explosives, if any.
   B. Restrictions on the burning of combustible materials as a disposal procedure
   C. Required minimum depth of earth cover over buried materials, if applicable.
   D. When replacement plants are required because of damage caused by the contractor, the specific size, number, and species needs to be specified.
   E. All

3. The national standard specifications are used to:
   A. ensure adherence to laws and regulations, prevent conflicts within the specifications and between the specifications and other contract requirements,
   B. prevent omission of essential elements and inclusion of extraneous materials,
   C. provide a uniform basis for interpretation, and ensure uniform quality of a project works. D. All

4. ---------is solids, liquids, or gases that can harm people, other living organisms, property, or the environment.

A. Dangerous goods C. Inflammable goods

B. Poisonous goods D. Harmless goods

Note: **Satisfactory rating – 8 points** **Unsatisfactory - below 8 points**

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

Score = _____

Rating: _____

1. _____ **3.** _____

2. _____ **4.**_____

Information sheet # 4	Arranging Drainage and Diversion Systems

4. 1 Drainage Systems

Drainage is the natural or artificial removal of excess surface and sub-surface water from an area. Natural drainage is drainage channel formed by naturally by moving water whereas artificial drainage is drainage channel constructed by human being. Many agricultural soils need drainage to improve production or to manage water supplies.

Drainage System: a system of watercourses or drains used for carrying off excess water. A **drainage system**, the pattern formed by the streams, rivers, and lakes in a particular **drainage** basin. A **drainage system,** an intervention to control water logging aiming at soil improvement for agricultural production.

4.1.1. Function of drainage system

Drainage system is constructed for the purpose of removing excess water from crop lands so that there would no water logging.

- Another purpose of drainage is to make safe removal floods
- It also used to remove salt accumulation from soil

4.1.2. Types of drainage

Drainage can be either natural or artificial. Many areas have some natural drainage; this means that excess water flows from the farmers' fields to swamps or to lakes and rivers. Natural drainage, however, is often inadequate and artificial or man-made drainage is required. Poor drainage can be a result of construction damage. When topsoil is removed for building, all that is left is subsoil. Heavy equipment compacts the soil, reducing air space. Improper grading of the site can lead to Ponding in low areas, as well as runoff water from roofs or downspouts.

There are two types of artificial drainage:

- Surface drainage

- Sub-surface drainage.

4.1.2.1. Surface drainage

Surface drainage is the removal of excess water from the surface of the land.This is accomplished by shallow ditches, also called open drains. The shallow ditches discharge into larger and deeper collector drains.

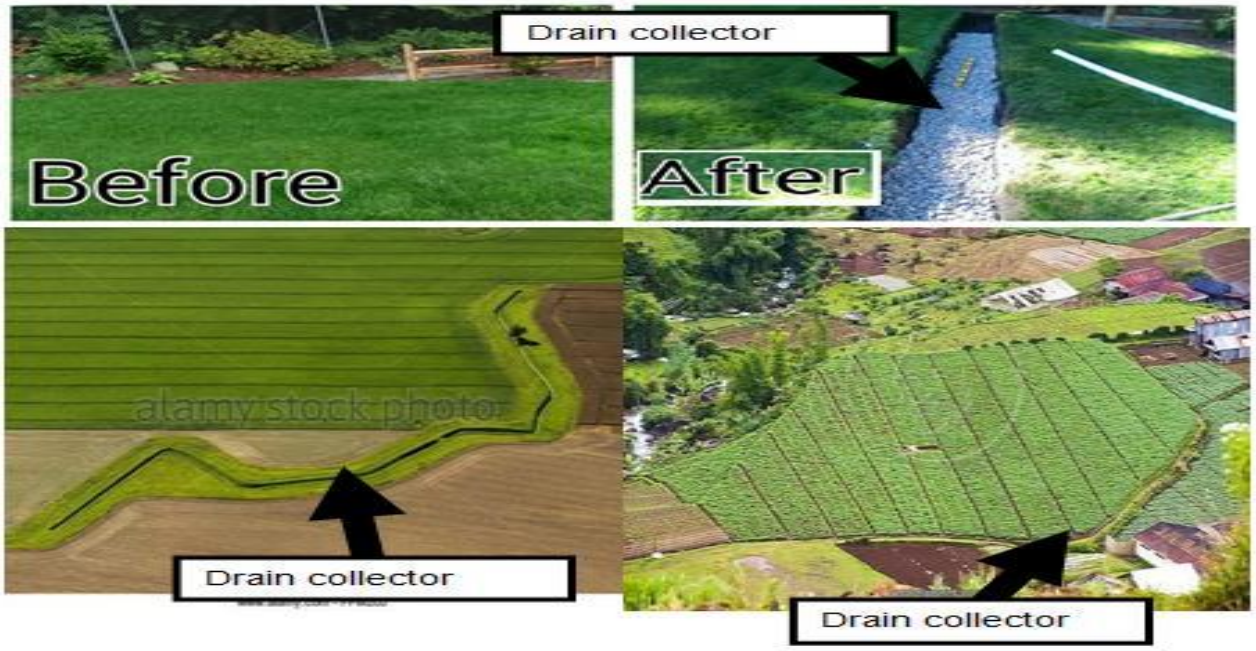


Figure 4: Surface drainage

4.1.2.2. Sub-surface drainage

Subsurface drainage is the removal of water from the root zone. It is accomplished by deep open drains or buried pipe drains.

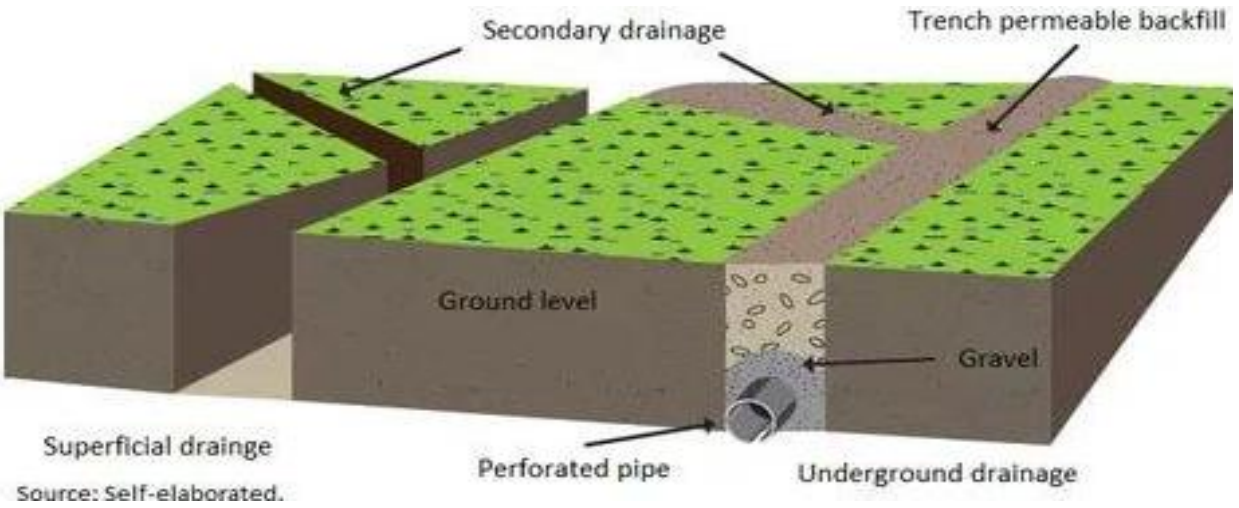


Figure 5: Sub surface drainage

4. 2 Diversion Structures

Is the process of diverting natural flow direction of stream or river to another artificially constructed channel for the purposes of different water uses like irrigation, water supply etc.

Diversion head work:-Diversion headwork is a structure constructed across a river for the purpose of raising the water level in the river so that it can be diverted into the off taking canal. It is also known as canal headwork's.

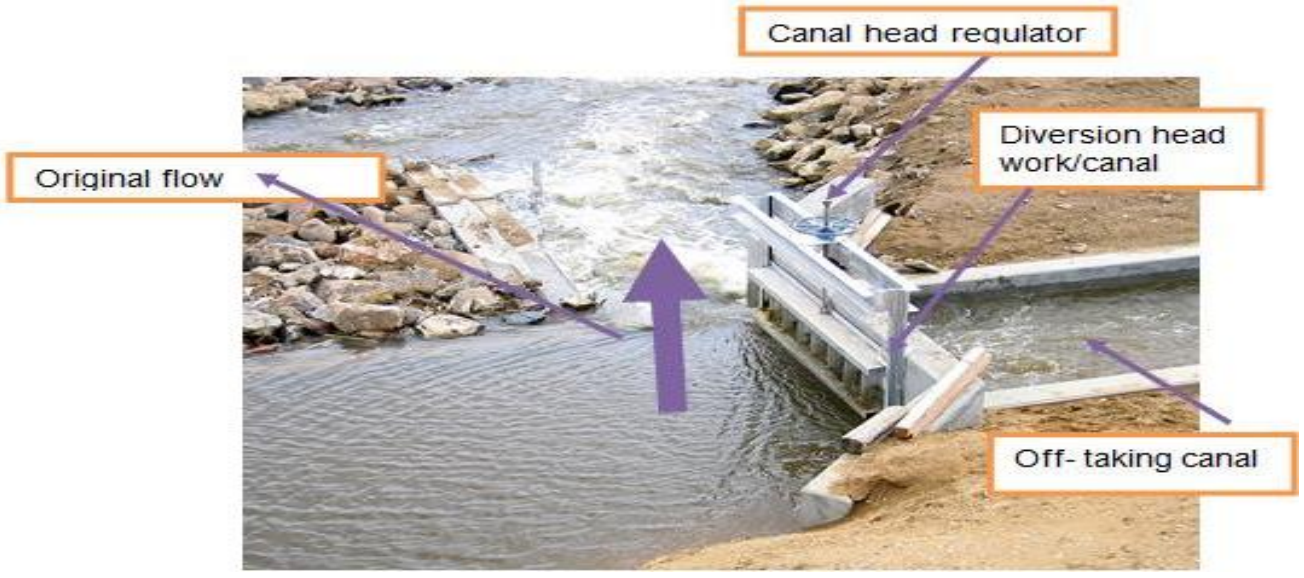


Figure 6: Diversion of river or stream

4.2.1. Objectives of diversion head works

- It raises the water level in upstream side
- It regulates the supply of water into canals
- It controls the entry of silt into canals
- It provides some poundage creating small pond
- It helps in controlling the vagaries of water
- To reduce the fluctuation in the water level of the river

Some of the structures commonly used for diversions are weir and barrages. **Weir** is common river regulatory structures constructed across a river at the canal entrance or at the take-off point. It has the following components.

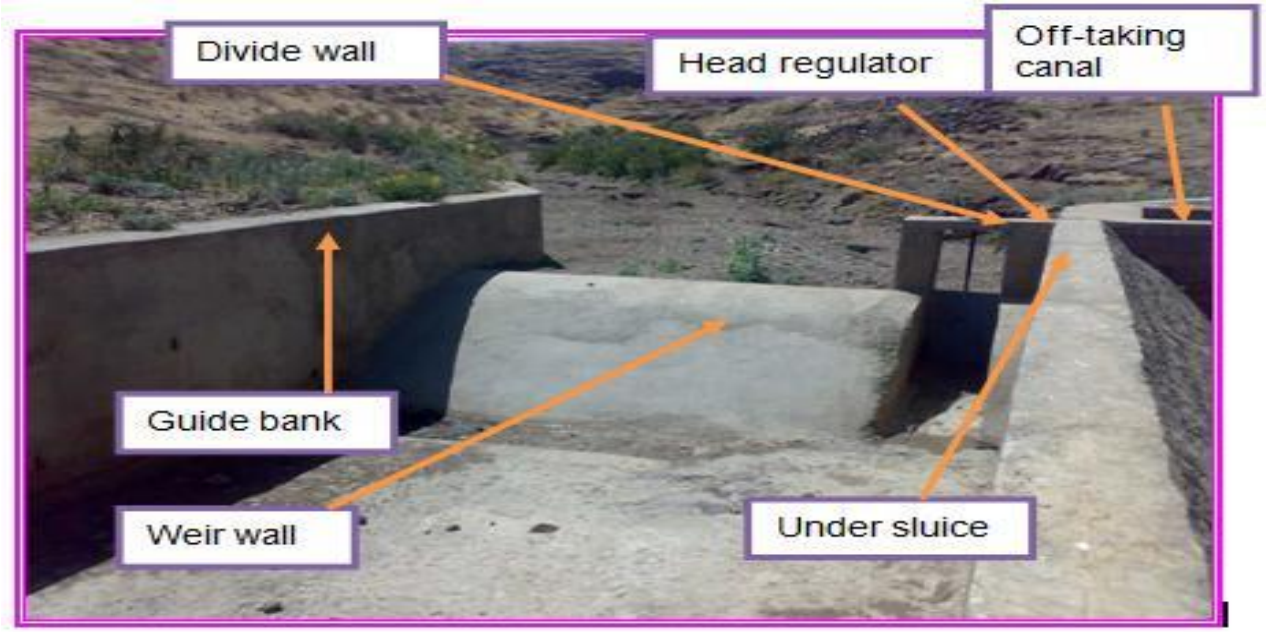


Figure 7: Diversion weir &its components

4.2.2. Components of the weir and their functions

- **Guide bank: is** a structure used to guide weir body from external pressure of earth.
- **Canal Head Regulator is** a structure constructed at the entrance of the canal take off and used to regulate water flow in to off-taking canal.
- **Weir body wall:** a solid wall which divides the river water into two portions – the weir

and the under sluice portion.

- **Off-taking canal:** a canal with head regulator constructed to convey water to field.
- **Under sluice portion**: a portion from which the main canal takes off water and helps to reduce turbulence of flow near the canal head regulator**.**

4. 3 Basic surveying principles

4.3.1. Principle of working from whole to part

- It is a fundamental rule to always work from the whole to the part. This implies a precise control surveying as the first consideration followed by subsidiary detail surveying.
- This surveying principle involves laying down an overall system of stations whose positions are fixed to a fairly high degree of accuracy as control, and then the survey of details between the control points may be added on the frame by less elaborate methods.
- Once the overall size has been determined, the smaller areas can be surveyed in the knowledge that they must (and will if care is taken) put into the confines of the main overall frame.
- Errors which may inevitably arise are then contained within the framework of the control points and can be adjusted to it. Thus they have no chance of building up on accumulating throughout the whole survey.

4.3.2. Importance of scientific honesty

- Honesty is essential in booking notes in the field and when plotting and computations in the office. There is nothing to be gained from cooking the survey or altering dimensions so that points will tie-in on the drawing. It is utterly unprofessional to betray such trust at each stage of the survey.
- This applies to the assistants equally as it does to the surveyor in charge. Assistants must also listen carefully to all instructions and carry them out to the later without questions.

4.3.3. Check on measurements

- The second principle is that; all survey work must be checked in such away that an error will be apparent before the survey is completed.
- Concentration and care are necessary in order to ensure that all necessary measures are taken to the required standard of accuracy and that nothing is omitted. Hence they must be maintained in the field at all times.
- Surveyor on site should be checking the correctness of his own work and that of others which is based on his information.
- Check should be constantly arranged on all measurements wherever possible. Check measurements should be conducted to supplement errors on field. Pegs can be moved, sight rails altered etc.
- Survey records and computations such as field notes, level books, field books, setting out record books etc must be kept clean and complete with clear notes and diagrams so that the survey data can be clearly understood by others. Untidy and anonymous figures in the field books should be avoided.
- Like field work, computations should be carefully planned and carried out in a systemic manner and all field data should be properly prepared before calculations start. Where possible, standardized tables and forms should be used to simplify calculations. If the result of a computation has not been checked, it is considered unreliable and for this reason, frequent checks should be applied to every calculation procedure.
- As a check, the distances between stations are measured as they are plotted, to see that there is correspondence with the measured horizontal distance. Failure to match indicates an error in plotting or during the survey.
- If checks are not done on observations, expensive mistake may occur. It is always preferable to take a few more dimensions on site to ensure that the survey will resolve itself at the plotting stage, rather than to retire to site for taking more measurements when things do not be in on the drawing board which can often be expensive besides the frustration and time loss.

4.3.4. Accuracy and precision

These terms are used frequently in engineering surveying both by manufacturers when quoting specifications for their equipments and on site by surveyors to describe results obtained from field work.

- Accuracy allows a certain amount of tolerance (either plus or minus) in a measurement, while;
- Precision demands exact measurement. Since there is no such things as an absolutely exact measurement, a set of observations that are closely grouped together having small deviations from the sample mean will have a small standard error and are said to be precise.

Self Check 4	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. Which of the following demands exact measurement?

A. Precision C. Accuracy

B. Surveying D. Tape measurement

2. One of the following is not included in basic surveying principles

A. Precision in measurement C. Principle of working from whole to part

B. Check on measurements D. Importance of scientific honesty

3. A component of a weir which is a used to guide weir body from external pressure of earth is:

A. Canal Head Regulator C. Guide bank

B. Weir body wall D. Off-taking canal

4. A type of drainage system used for the removal of excess water from the surface of the land is:

A. Surface drainage C. Subsurface drainage

B. Artificial drainage D. Natural drainage

5. A structure used to change the direction of natural flow direction of stream or river to another artificially constructed channel for the purposes of different water uses like irrigation, water supply etc is:

A. Diversion structure C. Drainage Structures

B. Soil conservation Structure D. Hydraulic Structure

Note: Satisfactory rating – 10 and above points Unsatisfactory - below 10 points

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

Score = _____

Rating: _____

1. _____ **4.** _____

2. _____ **5.**_____

3. _____

Information Sheet 5	Checking equipments and Open cut excavation methods

5.1 Introduction

Open cut trench excavation method is the traditional and most popular method for irrigation, sewer lateral construction, repair, or replacement. Open cut trench excavation consists of excavating a trench for the manual installation of each “stick” or piece of pipe. The open cut trench method involves excavating down to and exposing the existing pipe so that it can be repaired or replaced and then backfilled.

Figure 8: Open excavation

Checking equipment is reviewing hazards associated with hand and power tools during annual shop inspections. The tools will be reviewed to make sure they are in good working order, suitable for the jobs they are used for, and do not pose a hazard to the operator.

5.2 Types of excavation equipments

- Hand and power tools

- On and off-road vehicles
- Off-road plant
- Lifting and winching equipment
- Compressors
- Rotating lasers
- Profiles
- Automatic level
- Pneumatic spaders and attachments
- Motorized cutting equipment
- Portable pumps
- Communication equipment
- Breathing apparatus
- Gas detection equipment
- Rescue equipment
- Appropriate personal protective equipment

5.2.1. Hand and power tools

5.2.1.1. Power tools

A power tool is a tool that is actuated by an additional power source and mechanism other than the solely manual labour used with hand tools. The most common types of power tools use electric motors.

Figure 9: Electric motor

A. Compressors

A compressor is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of a gas. Liquids are relatively incompressible; while some can be compressed, the main action of a pump is to pressurize and transport liquids.

Figure 10: Compressor

B. Rotating Lasers

Rotating Lasers are equipments used to provide a desired slope or elevation and are used on various projects typically performed by General Contractors, Highway Construction contractors, Municipalities, and Utility Contractors.

Figure 11: Rotating laser

C. Automatic level

An Auto Level is a Professional Leveling Tool used by Contractors, Builders, Land Surveying Professionals, or the Engineer who demands accurate leveling every time. Auto Levels set up fast, are easy to use, and save time and money on every job.

Figure 12: Automatic levels

D. Pneumatic spaders and attachments

- Pneumatic spaders and attachments are Hydraulic powered spaders operate on maximum recommended working pressure

E. Motorized cutting equipment

- Motorized cutting equipment is equipment utilized to cut timbres, woods steels and others powered by electricity. Variety of fixed and portable motorized cutting equipments is available for straight and curved cutting.

5.2.2. Hand tools

A hand tool is any tool that is powered by hand rather than a motor. Categories of hand tools include wrenches, pliers, cutters, striking tools, struck or hammered tools, screwdrivers, vises, clamps, snips, saws, drills and knives.

Figure 13: Some of Hand tools of construction

5.2.3. On and off-road vehicles

On and off-road vehicles are considered to be any type of vehicle which is capable of driving on and off paved or gravel surface. It is general characterized by having large tires with deep, open treads, a flexible suspension, or even caterpillar tracks. Off-roading is the activity of driving or riding a vehicle on un surfaced roads or tracks, made of materials such as sand, gravel, riverbeds, mud, snow, rocks, and other natural terrain.

Figure 14: Off- road

5.4.3. Lifting and winching equipment

Lifting and winching equipment is a general term for any equipment that can be used to lift loads. This includes jacks, rotating screws, gantries, A frames, gin poles, shear legs, sheer leg, windlasses, lifting harnesses, forklifts, hydraulic lifting pads, and cranes.

5.4.4. Safety equipments

Breathing apparatus

Breathing apparatus is an apparatus, usually consisting of tanks of air or oxygen and a mouthpiece, that enables the wearer to breath in difficult conditions such as a smoke filled building or it is a device that facilitates breathing in cases of respiratory failure. Devices worn by rescue workers, firefighters, and others to provide breathable air in an immediately dangerous to life or health atmosphere.

Gas detection equipment

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. This type of equipment is used to detect a gas leak or other emissions and can interface with a control system so a process can be automatically shut down. A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This type of device is important because there are many gases that can be harmful to organic life, such as humans or animals.

Gas leak detection

Gas detection is the process of identifying potentially hazardous gas leaks by sensors. These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Exposure to toxic gases can also occur in operations such as painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, entering confined spaces, etc.

Table 1: Summary of hand and power excavation tools and equipments

Hand tools	
 **Spade**	 **shovel**
 **Trowel**	 **Pick axe**
 **Mattock**	 **Hoe**

Machinery Tools used for Soil Excavation	
 **Tracked Excavator**	 **Wheeled Excavator**
 **Backhoe Excavator**	 **bulldozer**
 **roller**	 **trencher**

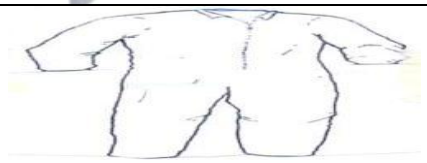
Rescue equipment

In a high-hazard industry like construction, safety is an investment that provides real benefits for workplace illness and injury. Having measures in place to reduce risk and increase wellbeing are worthwhile investment because they will lower the number of days lost due to workplace illness/injury, increasing your overall productivity. Equipments that are designed for purpose of safety in construction industries are called rescue equipment.

5.4.5. Rules for fitting and using personal protective equipment

- All PPE clothing and equipment should be of safe design and construction, and should be maintained in a clean and reliable fashion.
- Any employers should take the fit and comfort of PPE into consideration when selecting appropriate items for their workplace.
- Most protective devices are available in multiple sizes and care should be taken to select the proper size for each employee.
- If several different types of PPE are worn together, make sure they are compatible.
- If PPE does not fit properly, it can make the difference between being safely covered or dangerously exposed.
- It may not provide the level of protection desired and may discourage employee use.

Table 1: Selecting and checking of safety equipment and tools

1. Helmet/hard hat: - protect head of the worker from any falling objects from high level during construction.	
Over all cloths:-Protects the normal clothes from dust, grease and other spilling materials.	
Safety shoe (boot):-Protects the worker form nail, sharp objects and heavy falling objects by hard-rolled leather shoes with metal toe caps.	
Goggle: - Protects eyes of the workers during welding of metal works and when placing reinforcement in the form work. **Goggles** or **safety glasses** are forms of protective eyewear that usually enclose or protect the area	

Gloves:-Protects the workers from oils, chemicals, and dust and other dangerous material that affect the skin.	

5.5. Equipment operation, capacity and limitation

the volume of output (work) produced per unit of time by a given piece of equipment in accor dance with the equipment'sdesign properties and technical characteristics and the productio n skills of the operators. Equipment is a component of fixedproduction assets; it acts directly on the article that is being produced, moves the article through the production process,andi mplements the control of production flow.

The capacity of power equipment is determined by its power output, that is, by the quantity of work produced per unit time; this capacity is measured in kilowatts. The capacity of operating equipment is determined by the output per unit time; this capacity is measured in units that vary by type of equipment.

For instance, the capacity of metalcutting machine tools ismeasured by the number of parts produced per hour, the capacity of rolling mills is measured by the number of tons of rolled stock produced per hour, and the capacity of computer equipment is measured by the volume of data processed per unit time. Capacity of equipment is a necessary component in estimating the productive capacity of an enterprise.

Self-Check 6	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. One of the following is **NOT** construction equipment.

A. Hand and power tools B. On and off-road vehicles

C. Air plane D. Motorized equipment

2. Any type of vehicle which is capable of driving on and off paved or gravel surface.

A. On and off-road vehicles B. Space vehicles

C. Wing vehicles D. Romantic vehicles

3. The most common types of power tools is:

A. Electric motors B. Shovels

C. Water D. Solar energy

4. A tool that is actuated by an additional power source and mechanism other than the solely manual labour used with hand tools is:

A. Hand tool C. Power tool

B. Communication tool D. Excavation tool

5. Protect head from any falling objects from high level during construction.

A. Helmet

B. Goggle

C. Face mask

D. Ear muff

Note: Satisfactory rating – 10 and above points Unsatisfactory - below 10 points

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

1. _____ **4.** _____

2. _____ **5.**_____

3. _____

Score = _____

Rating: _____

Information Sheet -6	Preparing Construction Site

6.1 Introduction to site preparation

Preparing site is one of the preliminary works to be done for starting construction works. The selected construction site preparation needs to be completed properly before the start of construction process.

Site assessment may involve determining the present and installation of underground services specify suitable foundation depend on recommendation of geotechnical report, anticipate the level of ground water, grading amount needed for proper drainage to push water away from the structure, whether the site is difficult to excavate or not, frost penetration depth.

The construction site is usually prepared in two steps: first the vegetation is cleared, and then the surface soil layer is removed. These operations can be done either by hand or by machine.

The followings are included in site preparation

- Installation of temporary erosion control structures
- Cultural heritage monitors
- Safety barricades
- Removal of vegetation, debris, silt and soil

6.1.1. Installation of temporary erosion control structures

During installation of temporary erosion control structures:

- The contractor shall protect the project and adjoining properties from soil erosion and siltation by effective and continuous erosion control methods.
- The contractor shall install and maintain temporary erosion control to prevent sediment from escaping from the right-of-way.
- The intent of erosion control is to prevent sediment pollution of streams,

- lakes, tidal waters, reservoirs, canals, and other impoundments as a result of construction operations.

6.1.2. Cultural heritage site monitoring

Land is fundamental to the cultural heritage and wellbeing of indigenous people. It is the core of all spirituality and this relationship and the spirit of 'country' is what needs to be protected during Cultural Heritage Management activities.

Indigenous cultural heritages include:

- artifacts, objects and skeletal remains
- sites, landscapes or areas of significance
- cultural knowledge, lore, language, stories, song, dance and identity

6.1.3. Safety barricades

Safety barricade is any object or structure that creates a barrier or obstacle to control, block passage or force the flow of traffic in the desired direction. Barricades are critical tools for diverting traffic away from active construction areas, excavation.

Fig 15: Safety Barricade

6.1. 4. Cleaning the site (Removal of vegetation, debris, silt and soil)

Land clearing is the removal of any existing material from a site, in preparing it for

development. Land clearing can include the removal of trees and other vegetation, and grubbing, which is the excavation of stumps and roots and fine, dense soils (such as silt or clay).

Self-Check 6	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. ---------- is the removal of any existing material from a site, in preparing it for development.
   A. Land clearing
   B. Excavation
   C. Material selection
   D. Setting out

2. Indigenous cultural heritages include:
   A. artifacts, objects and skeletal remains
   B. sites, landscapes or areas of significance
   C. cultural knowledge, lore, language, stories, song, dance and identity
   D. All

3. Any object or structure that creates a barrier or obstacle to control, block passage or force the flow of traffic in the desired direction is----------.
   A. PPE
   B. Safety barricades
   C. Excavation tools
   D. Communication tools

4. When site preparation is conducted?
   A. Prior the construction process
   B. During construction
   C. After construction
   D. Any time during construction process

Note: Satisfactory rating – 8 and above points Unsatisfactory - below 8 points

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

1. _____	**3.** _____
2. _____	**4.**_____

Score = _____

Rating: _____

Operation Sheet- 1	Techniques of identifying and eliminating hazards

Activity 1:- Basic steps for identifying hazards

Step 1: Select the job.

Step 2: Breakdown the job into successive steps.

Step 3: Identify hazards and potential accidents in each step.

Step 4: Develop safety measures to eliminate above hazards and consequential accidents.

Activity 2: - **procedures for eliminating hazards**

Step 1: Remove items from the area or select different area for employees and volunteers to utilize.

Step 2: Isolate People from the Hazard:

Step 3: Guards on entry points

Step 4: Use effective barriers and edge protection.

Step 5: Change Work Practices

Step 6: Provide Personal Protective Equipment

Operation Sheet -2	Techniques of preparing construction site

Steps used for preparation of construction site are:

Step 1: Obtaining site soil properties from Geotechnical report

Step 2: Clearing and excavation of construction site

Step 3: Grading of project site

Step 4: Compaction of project site

Operation Sheet-3	Techniques of Installing temporary erosion controlling structure

Activity 1: Install temporary surface drainage erosion control structure

Procedures:

Step 1: Position the structure a minimum of 50cm above street level.

Step 2: Divert storm water runoff away from the structure by grading the lawn to provide at least 15cm of vertical fall in the first 25cm of horizontal distance.

Step 3: Construct side and rear storage area sales to take surface water away from the structure.

Step 4: Avoid filling in existing drainage channels and roadside ditches, since that could result in wetness problems on someone else's property and/or damage to adjacent road surfaces.

Activity 2: Install temporary sub-surface drainage erosion control

Procedures:

Step 1: Evaluate the site.

Step 2: Identify Vegetation to Be Saved.

Step 3: Protect Trees and Sensitive Areas.

Step 4: Install Perimeter Erosion and Sediment Controls.

Step 5: Prepare The Site for Construction.

Step 6: Salvage and Stockpile the Topsoil/subsoil.

Step 7: Build the Structure(S) and Install the Utilities.

Step 8: Maintain the Control Practices.

Operation Sheet -4	Techniques of completing safe work

Recommended steps for completing a safe work

Step 1: Consult with relevant workers, contractors and health and safety representatives (HSRs) about the tasks, the high risk construction work (HRCW) involved and the associated hazards, risks and controls.

Step 2: In the 'task' column, list in sequence what basic steps will be undertaken for the work.

Step 3: Under 'What high risk construction work does this task involve?' detail the relevant hazard number(s) relating to the HRCW involved with that task.

Step 4: Brief each team member on safe work methods (SWM) before commencing work. Ensure the team knows work is to stop if the SWM is not followed.

Step 5: Observe the work being carried out and monitor compliance with the SWM

LAP Test	Practical Demonstration

Name:_____

Date:_____

Time started: _____

Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within **8 hours.**

Task 1: Identify hazards associated with construction site

Task 2: Eliminate or minimize the hazards

Task 3: Install temporary erosion controlling structure

Task 4: Prepare site for construction

Task 5: Complete safe work

Instruction Sheet	Learning Guide #-58

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

- Constructing earthen channels, batters and drains
- Width, depth and gradient of earthen channels, batters and drains
- Applying soil additives and compacting earthen samples
- Soil types, mechanics and compaction rates
- Checking constructed works
- Environmental aspect of construction
- Effects of weather and conditions on construction site or plant

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 –

- Construct Earthen channels, drains and batters (ponds) according to planned width, depth and gradient.
- Apply Soil additives if necessary and compacting earth samples to meet organizational requirements.
- Check Construction works to ensure that specifications are met.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1- 3”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks 1,2 & 3" in each information sheets on pages 13,23 & 31.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work.
6. If you earned a satisfactory evaluation proceed to “Operation sheets 1 & 2 on pages 26-32 and do the LAP Test on page 33”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.

7. After You accomplish Operation sheets and the LAP Test, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next LG.

Information Sheet-1	Construct earthen channel, drains and batters

1.1 Introduction

Drainage is the natural or artificial removal of surface and sub-surface water from an area. Many agricultural soils need drainage to improve production or to manage water supplies. The excess water from the root zone flows into the open drains.

Objectives of channel design are to transport water between two points in a safe and cost-effective manner. It includes:

- economical,
- safety, and
- esthetics aspects.

Here, mainly hydraulic aspects are considered. General observations:

- Conveyance of a channel increases with the hydraulic radius (wetted perimeter deceases).

From Manning's formula,

- The best hydraulic section is a semicircle (for a given area it has the minimum wetted perimeter).
- For a specific cross section, the proportion that produce the best hydraulic section (maximum flow) might be derived.
- The best hydraulic section might not be the best from an economical point of view.

1.2 Definition of open earthen channel

Open earthen channel is channel constructed by earthen material/ soil and it has a free open surface exposed to atmosphere. Open-channel flow is a type of liquid flow within a conduit with a free surface.

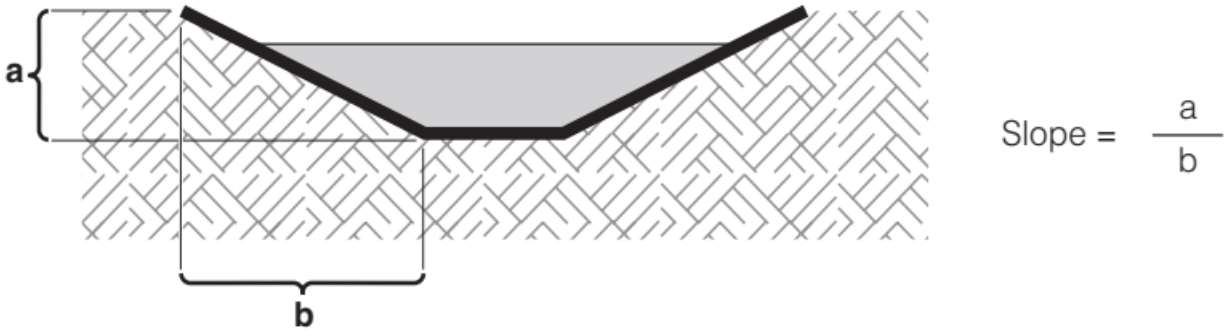


Figure 16: Section of an unlined drain in les stable soil

1.3 Classifications of open channel flow

Open-channel flow can be classified and described in various ways based on the change in flow depth with respect to time and space.

The fundamental types of flow dealt with in open-channel hydraulics are:

1) **Time as the criterion**
   a) Steady flow
   b) Unsteady flow
2) **Space as the criterion**
   a) Uniform flow
   b) Non uniform (Varied flow

Steady flow: The depth of flow does not change over time, or if it can be assumed to be constant during the time interval under consideration.

Unsteady flow: The depth of flow does change with time.

Uniform flow:

- The depth of flow is the same at every section of the channel.
- Uniform flow can be steady or unsteady, depending on whether or not the depth changes with time, (although unsteady uniform flow is rare).

Varied flow:

- The depth of flow changes along the length of the channel. Varied flow technically may be either steady or unsteady.
- This Varied flow also can be further classified as either rapidly or gradually varied.

Rapidly varied flow:

- The depth changes abruptly over a comparatively short distance. Rapidly varied flow is known as a local phenomenon. Examples are the hydraulic jump and the hydraulic drop.

Gradually varied flow: The depth changes over a long distance.

Continuous flow:

- The discharge is constant throughout the reach of the channel under consideration.
- This is often the case with a steady flow.
- This flow is considered continuous and therefore can be described using the continuity equation for continuous steady flow.

Spatially varied or discontinuous flow:

- The discharge of a steady flow is non-uniform along a channel.
- This happens when water enters and/or leaves the channel along the course of flow.
- Example, flow entering a channel would be a road side while flow leaving a channel would be an irrigation channel.

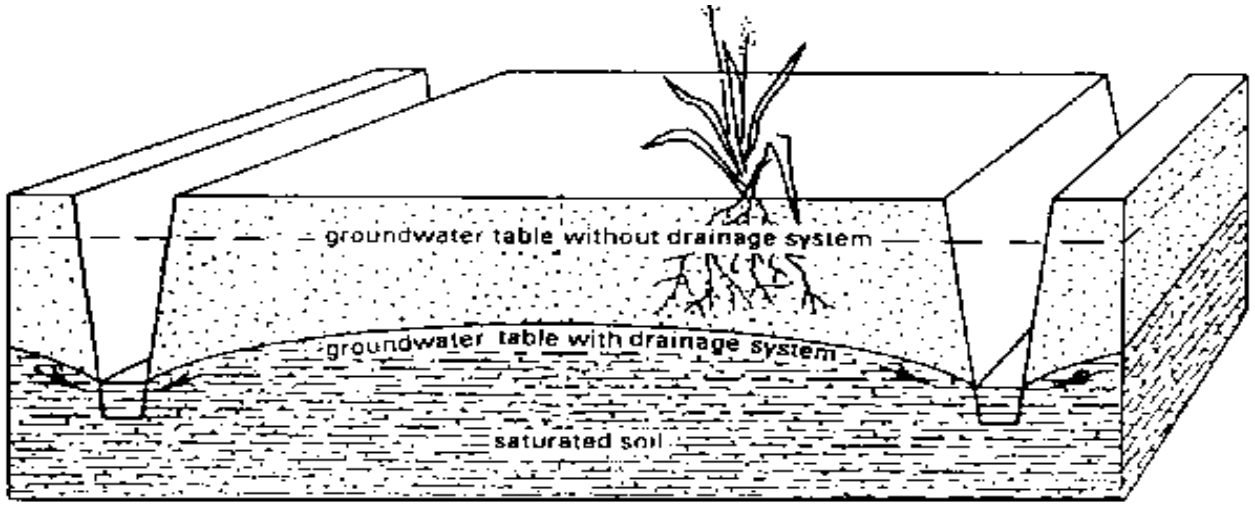


Figure 17: Deep open drains

Open channel as well as drains is used to provide discharge capacity required for irrigation, flood prevention, drainage, and other authorized water management purposes or any combination of these purposes.

1.4 The basics of irrigation canals design

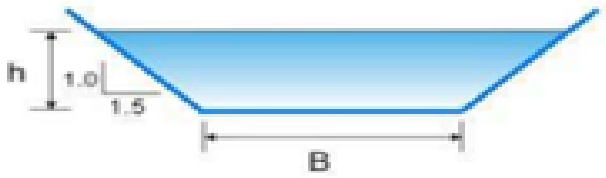
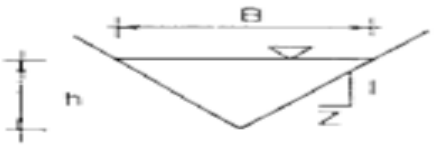
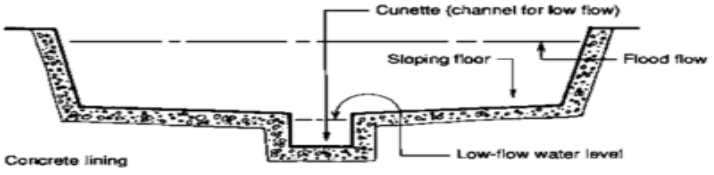
The entire water conveyance system for irrigation, comprising of the main canal, branch canals, major and minor distributaries, field channels and water courses have to be properly designed. The design process comprises of finding out the longitudinal slope of the channels and fixing the cross sections. The channels themselves may be made up of different construction materials. For example, the main and branch canals may be lined and the smaller ones unlined.

1.5 Types of open Irrigation Canal

1.5.1. Open Irrigation Canal based on their shape

Canals can be divided in to different based on their shape.

Table 1: Classification of canal based on their shape

1	Trapezoidal	
2	Rectangular	
3	Triangular	
4	Semi –circular	
5	compound	

1.5.2. Based on construction materials

Canals can be classified in to two.

a. Lined canal

b. Unlined canal

Lined canal is canal in which its bed is lined by either concrete or clay soil whereas un lined canal is a canal not lined by those materials unlined.

1.5.3. Design of Stable, Unlined, Earthen Channels

For the stable cross section, there should neither scour nor deposition problems.

Three types of unstable sections:

A. Scouring occur but no deposition
B. Deposition occur but no scouring
C. Both scour and deposition occurring

- The area needed to excavate the best hydraulic section might be larger than the area required to achieve the flow area
- It may not be possible to construct a stable best hydraulic section in the natural material
- The cost of excavation depends on other things than the amount of material removed (e.g., access to the site, cost of disposing material)
- The slope of the channel must also be considered.

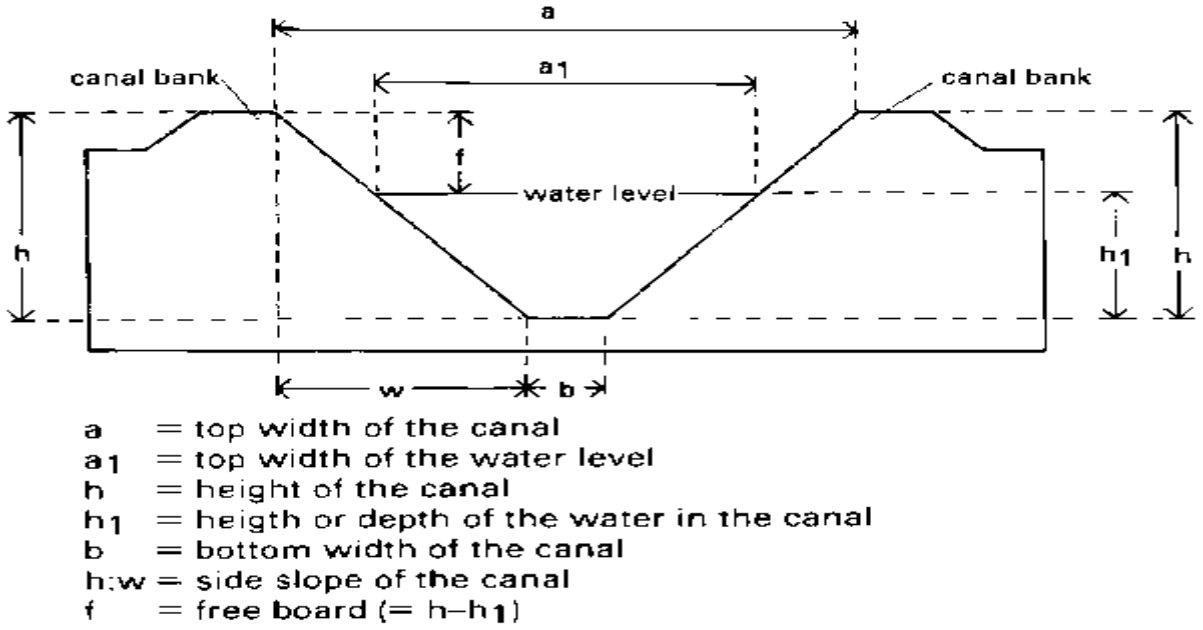


Figure 18: A trapezoidal canal cross-section

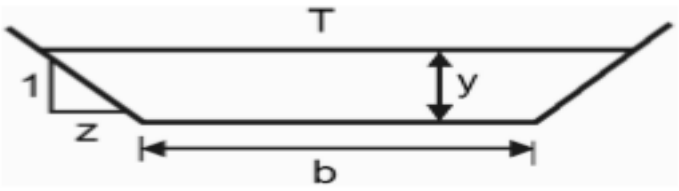
Channel geometry characteristics of open irrigation canal

- Depth, y
- Area, A
- Wetted perimeter, P
- Top width, T

Hydraulic Radius, Rh = Area / Wetted perimeter

Hydraulic Depth, Dh = Area / Top width

Trapezoidal Channel



$$A = (b + zy)y \quad ; \quad P = b + 2y\sqrt{1+z^2} \quad ; \quad T = b + 2zy$$

1.6 Constructing Open earthen channel

1.6.1. Canal alignment

A. Layout

The main canal of a system will be laid along the high edge of the irrigable area in order for the largest possible area to be commended for irrigation. In most cases, the canal will closely follow the land contours, losing only enough elevation to maintain the slope needed for suitable flow velocity. The land commanded by the main canal will be subdivided into irrigation units of about 10 ha each.

From the main canal, secondary canals will be laid out to each irrigation unit, following the line of highest elevation in each unit so as to maximize the area served by each secondary canal. Tertiary canals, or field channels, will then be laid out from the secondary to deliver water throughout the unit.

B. Bed slope

On flat sloping, non-undulating lands, canals will generally have the same slope as the terrain. In steeply sloping lands, canals will be given a slope which is less than the terrain to avoid high flow velocities. In such cases, drop structures will have to be installed to connect the canal sections. When a canal crosses a depression or a gully, it cannot follow the terrain and should be constructed in fill, and if a ridge in the terrain has to be crossed the canal will have to be constructed in cut. Whatever the slope of the canal, abrupt changes in the slope should be avoided. If the bed slope changes suddenly the flow velocity in the canal will also change, and such a change in flow velocity can cause erosion or may lead to siltation in the canal bed.

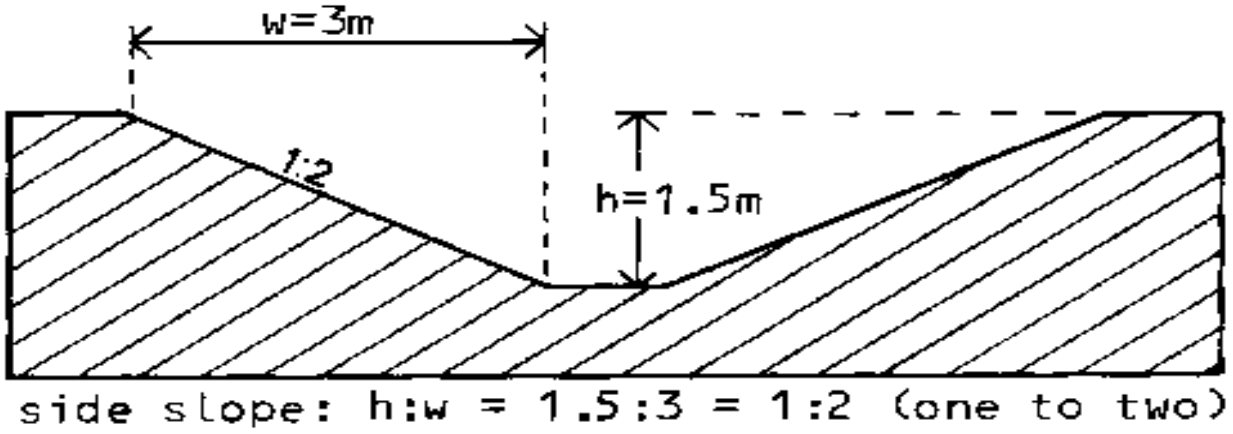


Figure 19: A side slope of 1:2 (one to two)

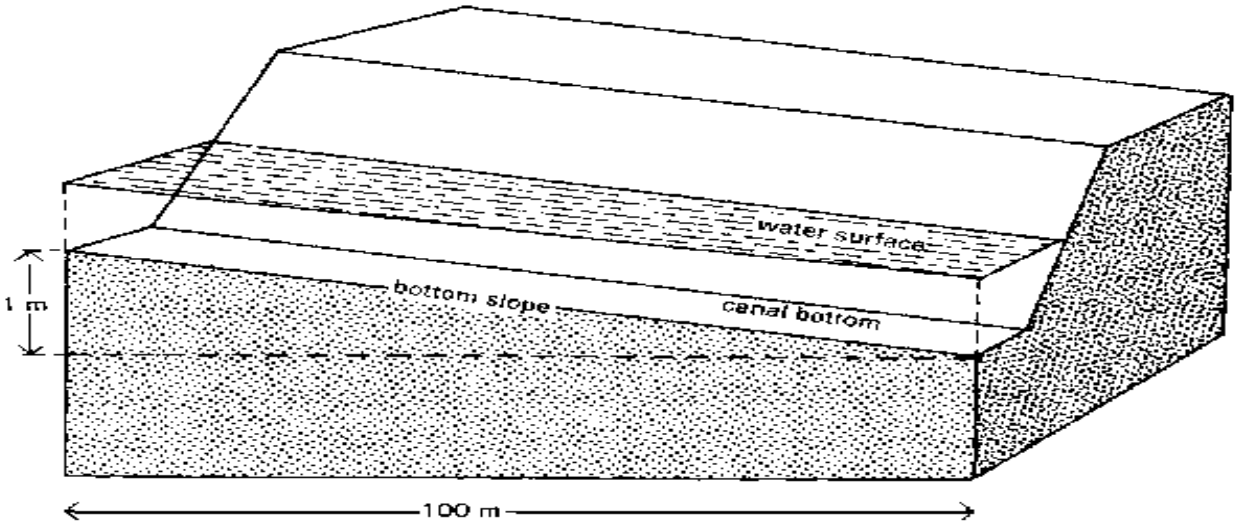


Figure 20: A bottom slope of a canal

C. Bed elevation

Depending on local circumstances, canals can be built in fill or in cut.

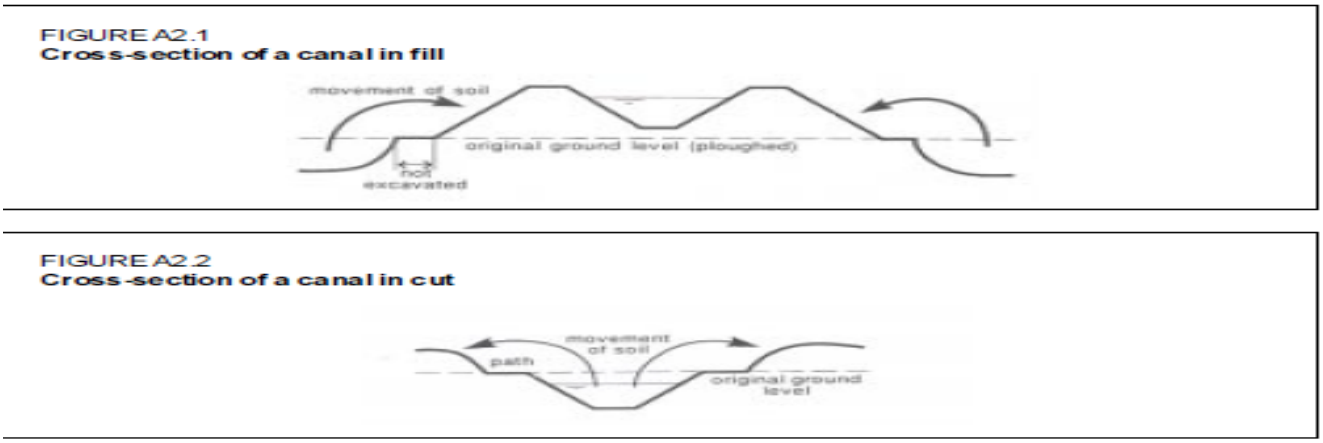


Figure 21: Cross Section of a canal in cut and in fill

There are three factors that play a role in deciding the level of the canal bed.
The first factor is that the slope of a canal should be as constant as possible. Abrupt changes in slope should be avoided. This may result in canal sections having to be constructed in cut or in fill, depending on topography. Another factor is that the volume of cut should preferably equal the volume of fill when constructing the canal.

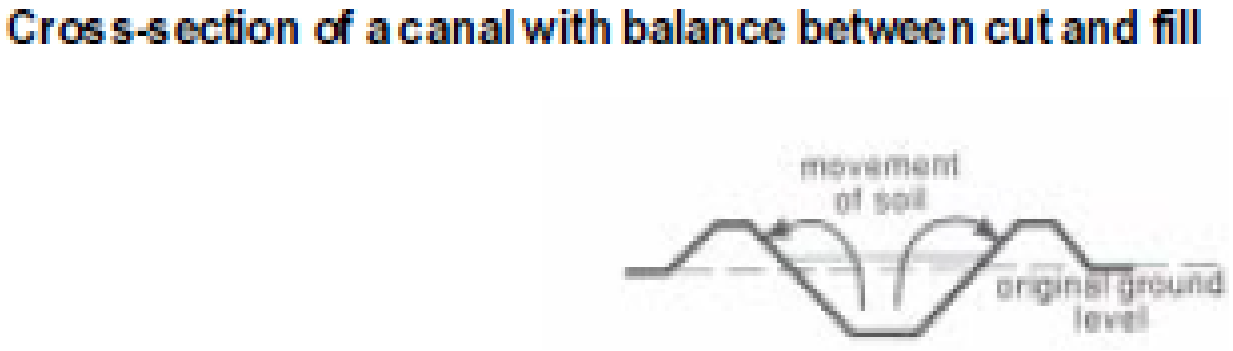


Figure 22: Cross Section of a canal with balance in cut and fill

Volume of cut, soil has to be brought from elsewhere. This may result in high construction cost. Also, if a canal is to be constructed in cut, the excavated soil is to be spread out over the fields or it should be used elsewhere, which also increases the cost of canal construction. Construction costs are usually at a minimum when there is a balance between the volumes of cut and fill.

The third factor to take into account when determining the bed level of a canal is the water level in the canal. The water level in field channels should be about 0.10 m higher than the level of the fields to be irrigated from those canals, and the water level in a secondary canal which supplies a field channel should be about 0.05 m higher than the design level in the field channel. This is because of the loss in water level at the canal off take. The bed elevation and water level at the downstream end of a tertiary canal is determined as the first step, assuring at least 0.10 m difference between the water level in the canal and the field level. Going upstream, it should be checked that the water level in the field channel all along the channel is at least 0.10 m higher than the fields. Further upstream, the water level in the secondary canal can also be determined, taking into account the 0.05 m loss at the canal off takes.

Self-Check 1	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer. **(4 points each)**

1. ----------is channel constructed by earthen material/ soil and it has a free open surface exposed to atmosphere
   A. Open earthen channel
   B. Lined channel
   C. closed earthen channel
   D. Conduit channel
2. Channel geometry characteristics of open irrigation canal include:
   A. Depth, y
   B. Area, A
   C. Wetted perimeter, P
   D. Top width, T E. All
3. Canal alignment is characterized by its:
   A. Bed elevation
   B. Layout
   C. Bed slope
   D. All
4. the type of flow in which the depth of flow is the same at every section of the channel is :
   A. Uniform flow
   B. Varied flow
   C. Rapidly varied flow
   D. Continuous flow
5. The natural or artificial removal of surface and sub-surface water from an area is:
   A. Drainage C. Irrigation
   B. Pumping D. Excavatio

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

Score = _____

Rating: _____

1. _____ **4.** _____

2. _____ **5.**_____

3. _____

Information Sheet 2	Applying soil additives and compacting earthen samples

2.1 Introduction to soil compaction

Soil is formed in place or deposited by various forces of nature such as glaciers, wind, lakes and rivers residually or organically. Following are important elements in soil compaction:

- Soil type
- Soil moisture content
- Compaction effort required

Compaction is a process that brings about an increase in soil density or unit weight, accompanied by a decrease in air volume. There is usually no change in water content.

Soil compaction occurs when soil particles are pressed together, reducing pore space between them. Heavily compacted soils contain few large pores, less total pore volume and, consequently, a greater density. A compacted soil has a reduced rate of both water infiltration and drainage. This happens because large pores more effectively move water downward through the soil than smaller pores.

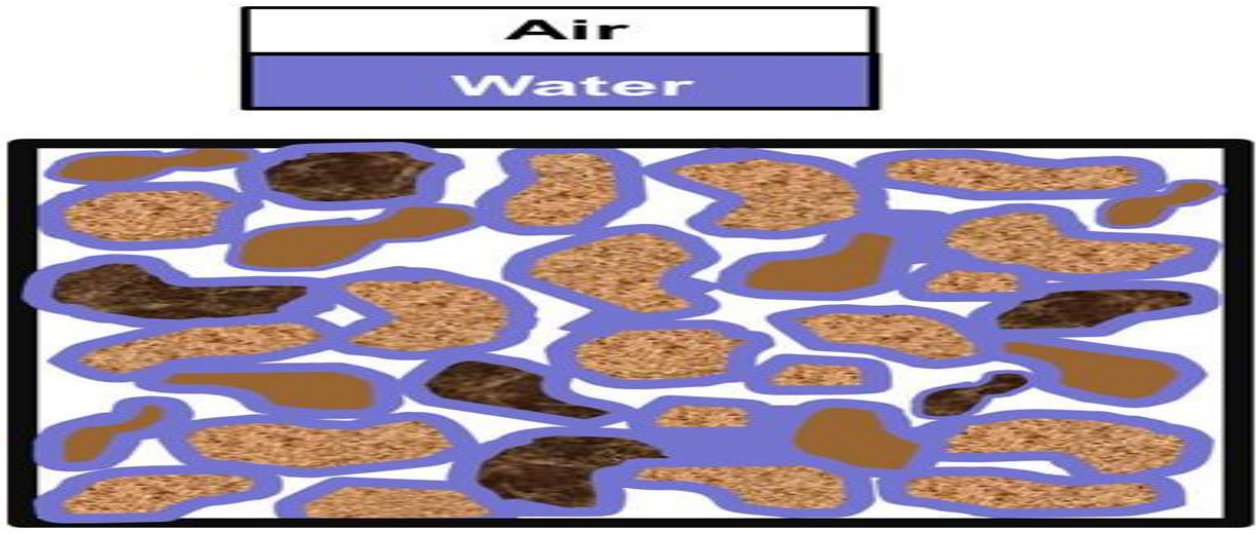


Figure 23: Effects of compaction on pore space.

Compaction is the process of mechanically identifying a soil, normally by the application of a moving (or dynamic) load. This is in contrast to consolidation, which is the gradual densification of a soil under a static load.

When controlled properly, compaction increases a soil's load-bearing capacity (shear resistance), minimizes settlement (consolidation), changes the soil's volume, and reduces the water-flow rate (permeability) through the soil. Compaction does not affect all soils to the same degree. However, the advantages gained by compaction make it an essential component of the horizontal construction process.

2.2 Principle of soil Compaction

There are five principle reasons to compact soil:

- Increases load-bearing capacity
- Prevents soil settlement and frost damage
- Provides stability
- Reduces water seepage, swelling and contraction
- Reduces settling of soil

2.3 Types of compaction

There are four types of compaction effort on soil:

- Vibration
- Impact
- Kneading
- Pressure

2.4 Effect of soil compaction in reducing seepage

One of the ways to control water seepage for irrigation canals is to reduce soil permeability; this can be made by compacting the soil. Soil compaction is carried out by means of special compactors, rammers and vibration machines. Compaction allows

reducing seepage by 70-75%, but it can be implemented only on cohesive soils. Seepage losses are also reduced considerably with changing seepage characteristics of canal bed soil by soil compaction and mud fill. Canal bed soil can be compacted by different methods: rolling; impact, and shooting.

- Rolling is carried out by special compactors: tamping/sheep foot; sectional/harrow; and smooth-wheeled rollers.
- Use of tamping rollers gives the highest efficiency; these machines allow compacting soil down to a layer of 60-70 cm.
- Impact compaction is carried out by impact compactors (rammers) or excavator plates; in this case, the maximal layer of compacted soil comes to 1 m.
- Effect of the compaction lasts for several years, after which the compaction needs to be renovated. When compacting the soil, its optimum water content should be provided.
- Mud filling implies washing out of soil silt particles that come along with irrigation water to the upper layer of the canal bed soil.
- Installation of concrete and reinforced concrete lining reduces seepage losses by 85-95%; installation of asphalt lining, by 80-90%; screens (made from clay), by 60-80%. With canal bed soil compaction and mud filling these losses reduce by 50-70%.

2.5 Soil types and compaction

Horizontal construction projects such as roads and airfields are constructed using a variety of soil types. The suitability of these materials for construction applications depends on their gradation, physical characteristics, and load-bearing capacity. While some soil types are suitable for structural purposes in their natural state, others require processing such as adjusting the moisture content by mixing and blending. Because there is a direct relationship between increased density and increased strength and bearing capacity, the engineering properties of most soils can be improved simply by compaction.

Table 1: Properties of soil and compaction

Fill materials	Permeability	Foundation Support	Pavement Sub grade	Expansive	Compaction Difficulty
Gravel	Very High	Excellent	Excellent	No	Very Easy
Sand	Medium	Good	Good	No	Easy
Silt	Medium Low	Poor	Poor	Some	Some
Clay	None	Moderate	Poor	Difficult	Very difficult
Organic	Low	Very Poor	Not Acceptable	Some	Very difficult

Compaction equipment ranges from handheld vibratory tampers (suitable for small or confined areas) to large, self-propelled rollers and high speed compactors (ideally suited for large, horizontal construction projects). Consider the following factors when selecting compaction equipment:

- Type and properties of the soil.
- Density desired.
- Placement lifts thickness.
- Size of the job.
- Compaction equipment available.

Soil-compacting equipment normally available to military engineers includes tamping-foot rollers, pneumatic-tired (rubber tired) rollers, dual drum vibratory rollers, and smooth-drum vibratory rollers. To select the most appropriate type of compaction equipment, a project officer must know the characteristics, capabilities, and limitations of the different types of rollers. Generally, tamping-foot compactors that produce high unit pressures are best for predominantly fine-grained cohesive materials such as clays and sandy clays. Large, steel-drum rollers are best for larger particle materials such as gravel or cobble. Vibratory rollers are ideal for well-

graded or gap-graded materials because the shaking action causes the smaller particles to fill voids around the larger grains.

2.6 Soil types and compaction rates

Every soil type behaves differently with respect to maximum density and optimum moisture. Therefore, each soil type has its own unique requirements and controls both in the field and for testing purposes. Soil types are commonly classified by grain size, determined by passing the soil through a series of sieves to screen or separate the different grain sizes.

Soil classification is categorized into 15 groups, a system set up by AASHTO (American Association of State Highway and Transportation Officials). Soils found in nature are almost always a combination of soil types. A well-graded soil consists of a wide range of particle sizes with the smaller particles filling voids between larger particles. The result is a dense structure that lends itself well to compaction. A soil's makeup determines the best compaction method to use. There are three basic soil groups:

- Cohesive
- Granular
- Organic

Cohesive soils have the smallest particles. Clay has a particle size range of .00004" to .002". Silt ranges from .0002" to .003". Clay is used in embankment fills and retaining pond beds.

Soils at construction sites are generally compacted as a result of excavation, mixing, stockpiling, equipment storage, and equipment traffic. In addition, exposed subsoil is susceptible to compaction. Clay soils and wet soils are more susceptible to compaction. Even at sites where selective grading is employed, compaction occurs as a result of construction equipment, stockpiling and vehicle traffic.

When soil is compacted, porosity decreases and bulk density increases. Typical increases in bulk density are shown below, with other compacting activities included for comparison.

Table 2: Soil Classification

Major Soil Categories		Symbol and Description	Value as a Base, Sub base, or Sub grade	Potential Frost
Coarse-grained soils (50% or more larger than a	Gravel and/ or gravelly	GW Well-graded gravels or gravel-sand mixture	Fair to good for base; good to excellent for	None to very slight
		GP Poorly graded gravels or gravel-sand	Fair to good for all	None to very slight
		GM Silty gravel and poorly graded gravel-sand-silt mixtures	Not suitable for base (15% or less of fines with PI of 5 or less); fair to	Slight to medium
		GC Clayey gravel and poorly graded gravel-sand-clay	Not suitable for base (15% or less of fines with PI of 5 or less); poor to	Slight to medium
	Sand and/or sandy soils	SW Well-graded sands or gravelly sand mixture with 5% or less of	Poor for base; fair to good for subbase and subgrade	None to very slight
		SP Poorly graded sands or gravelly sand	Poor to not suitable for base; poor to fair for	None to very slight
		SM Silty sands, sand-silt mixture	Not suitable for base; poor to good for subbase	Slight to high
		SC Clayey sands, sand-clay mixture	Not suitable for base; poor to fair for subbase	Slight to high
	Silt and clays with	ML Inorganic silt of low plasticity, silty fine	Not suitable for base or subbase;	Medium to very
		CL Inorganic clay of low to medium plasticity,	Not suitable for base or subbase;	Medium to high
		OL Organic silt and organic silt- clay of	Not suitable for base or subbase; poor to very	Medium to high

Fine-grained soils (more than 50% smaller	Silt and clays with liquid	MH Inorganic silt micaceous or	Not suitable for base or subbase;	Medium to very
		CH Inorganic clay of high plasticity, fatty clays	Not suitable for base or subbase; poor to fair for	Medium
		OH Organic clay of medium to high	Not suitable for base or subbase; poor to very	Medium
Highly organic		Highly organic soils (peat) are not defined by numerical criteria; these soils are identified by visual and manual inspection		

Table 3: Soil types and compaction rates

What to look for	Appearance/feel	Water movement	When moist...	When dry...
Granular soils, fine sands and silts.	Coarse grains can be seen. Feels gritty when rubbed between fingers.	When water and soil are shaken in palm of hand, they mix. When shaking is stopped, they separate.	Very little or no plasticity.	Little or no cohesive strength when dry. Soil sample will crumble easily.
Cohesive soils, mixes and clays.	Grains cannot be seen by naked eye. Feels smooth and greasy when rubbed between fingers.	When water and soil are shaken in palm of hand, they will not mix.	Plastic and sticky. Can be rolled.	Has high strength when dry. Crumbles with difficulty. Slow saturation in water.

2.7 Compaction equipments

The desired level of compaction is best achieved by matching the soil type with its proper compaction method. Other factors must be considered as well, such as compaction specs and job site conditions.

- Cohesive soils—clay is cohesive; its particles stick together. Therefore, a machine with a high impact force is required to ram the soil and force the air out, arranging the particles. A rammer is the best choice, or a pad-foot vibratory roller if higher production is needed.
- Granular soils—since granular soils are not cohesive and the particles require a shaking or vibratory action to move them, vibratory plates (forward travel) are the best choice.

Figure 24: Compaction equipments

Reversible plates and smooth drum vibratory rollers are appropriate for production work. Granular soil particles respond to different frequencies (vibrations) depending on particle size. The smaller the particle, the higher the frequency necessary to move it. As you compact soils with larger particles, move up to larger equipment to obtain lower frequencies and higher compaction forces.

Fig 25: Roller

2.8 Soil compaction additives

The strength of soil-lime or soil-fly ash mixtures depends on many variables such as the soil type, the lime and fly ash content, the additive type, the time and method of curing (temperature and humidity), the water content, the unit weight and the time interval between mixing and compaction.

Additives are categorized into:

(a) cementitious: lime and fly ash

(b) non-cementitious: stone dust, and

(c) chemical additives: $CaCl_2$ and Na_2SiO_3

If the moisture content of a soil is below its optimum moisture range, add water to the soil before compaction. When it is **necessary** to add water, the project officer must consider the following:

- The amount of water required.
- The rate of water application.
- The method of application.
- The effects of the weather.

2.9 Proctor soil compaction test

Compaction test of soil is carried out using Proctor's test to understand compaction characteristics of different soils with change in moisture content. Compaction of soil

is the optimal moisture content at which a given soil type becomes most dense and achieve its maximum dry density by removal of air voids.

Compaction is the process of densification of soil by reducing air voids. The degree of compaction of a given soil is measured in terms of its dry density. The dry density is maximum at the optimum water content. A curve is drawn between the water content and the dry density to obtain the maximum dry density and the optimum water content.

Dry density of soil: $= \frac{M \ / V}{1 + w}$

Where M = total mass of the soil, V= volume of soil, w= water content.

Self-Check 2	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer. **(4 points each)**

1. The best compaction equipment used to cohesive soils is:
   A. rammer
   B. reversible plates
   C. Vibratory plates
   D. all
2. What factors are considered when it is necessary to add water, during compaction?
   A. The amount of water required.
   B. The rate of water application.
   C. The method of application.
   D. The effects of the weather E. All
3. The basic soil groups affecting soil compaction are:
   A. Cohesive
   B. Granular
   C. Organic E. All
4. types of compaction effort on soil :
   A. Vibration C. Impact
   B. Kneading D. Pressure E. All
5. There are five principle reasons to compact soil:
   A. Increases load-bearing capacity
   B. Prevents soil settlement and frost damage
   C. Provides stability
   D. Reduces water seepage, swelling and contraction
   E. All

Note: Satisfactory rating – 10 and above Unsatisfactory - below 10 points points

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

Score = _____

Rating: _____

1. _____ **4.** _____

2. _____ **5.**_____

3. _____

Information Sheet 3	Checking construction works

3.1 Introduction

Quality in construction is defined as 'meeting or exceeding the requirement of client/owners. In construction industry, quality is used in different every than the product industry. The common way of controlling quality is the inspection of finished parts of a product.

Quality control in construction means making sure that things are done according to the plans, specifications and permit requirements. The quality assurance process checks the quality plan and quality control process to confirm that quality standards are implemented on the project site.

3.2 Quality assurance in construction industry

It is the planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled. Hence, quality assurance acts are done during the construction and not at the end of it. Excellent quality monitoring will not only let you avoid expensive delays but also ensures that the method followed to complete the project is going through a planned procedure. Specific procedures and inspections become part of the construction process.

Quality assurance makes sure that you are doing the right things in the appropriate way while quality control is making sure that the results of what is done to meet the set standards. Quality assurance is connected to a working interaction between each contractor on site while quality control deals with the inspection of the outcome of this work. The two operations are closely linked because monitoring your quality levels through the project guarantee high quality results at the end.

3.3 Specification of constructed works

Construction specifications, also called specs, are the details for the work that needs to be completed in a construction project. These details include information such as materials, the scope of work, installation process, and quality of work.

3.3.1. Purposes of Specifications

Purpose of specification is to highlight the necessary information which cannot be obtained from drawing. In addition, it is used to show the strength of construction material or construction work. During construction, specifics are everything and failure to communicate specifically could create massive change orders, cost overruns and schedule delays, which can negatively impact your bottom line. In fact, specifics are such a key element of construction that there is an entire formal process dedicated to them; enter construction specifications.

Although blueprints and certain documents can illustrate what a building should look like visually, an in-depth written explanation is needed to describe the construction process. Simply put, construction specifications are documents prepared ahead of construction to describe how building should be carried out by contractors and subcontractors.

3.3.2. Main types of construction specifications

Each project is unique and will need a different set of specifications and most likely corresponding packages. However, there are three main types of construction specifications commonly used on projects.

Prescriptive: Provides details on the types of materials and installations needed to complete a project. Additionally, prescriptive specifications also describe how to measure installations to ensure that they were up to project quality and standards.
Performance: Describes the operational requirements. Fundamentally, the performance specifications should describe to the contractor what is needed for the final product and how it should essentially function once completed.

Proprietary: Although not as common as prescriptive and performance, proprietary specifications are used if only one specific product can be used for an installation.

3.4 Quality control of construction works

The common way of controlling quality of construction works is the inspection of finished parts of a product. The quality control engineers' main purpose is to minimize the chance of defects before the project delivery to the owner. Controlling quality means monitoring if the work practices are going as planned or not, examining the quality of the current construction tasks, and provides reports daily for any unsatisfactory work output.

Self-Check 3	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer. **(4 points each)**

1. The elements of quality control to be included in a firm's quality control system is:
   A. leadership responsibilities for quality within the firm
   B. relevant ethical requirements
   C. acceptance and continuance of client relationships and specific D. All
2. What is quality construction industry?
   A. meeting or exceeding the requirement of client/owners.
   B. the details for the work that needs to be completed in a construction project.
   C. inspection of finished parts of a product
   D. The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled.
3. ----------is a type of specification which describes how to measure installations to ensure that they were up to project quality and standards.
   A. Prescriptive C. Performance
   B. Proprietary D. Detail
4. Which of the following is correct about quality assurance?
   A. it makes sure that you are doing the right things in the appropriate way
   B. it makes sure that the results of what is done to meet the set standards
   C. used to inspect of finished parts of a product
   D. defines meeting or exceeding the requirement of client/owners.

Note: **Satisfactory rating – 8 points and above pts Unsatisfactory - below 8pts**

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

Score = _____

Rating: _____

1. _____ **3.** _____

2. _____ **4.**_____

Operation Sheet 1	Constructing earthen channels, batters and drains

Activity 1: Collect data for open channel design

Procedures

Step 1: Wear appropriate PPE and select and use appropriate tools and equipments

Step 2: Obtain a long section survey of the channel bed.

Step 3: Locate pools and riffles.

Step 4: Conduct soil tests to determine if the soil is dispersive(Emerson Aggregate Test) and determine what type of soil it is. e.g. sandy, sandy loam, or clay.

Step 5: Collect the necessary data by taking measurements

Step 6: Calculate the width, height and width of the drain

Step 7: Document the findings

Step 8: Maintain and store tools and equipments appropriately

Activity 2: Constructing earthen channel

Basic steps

Step 1: Wear appropriate PPE and select appropriate tools and equipments

Step 2: Clear the site

Step 3: set out the site

Step 4: Mark the length of the canal with centre, slope and bottom stakes

Step 5: Stretch a length of strong cord along the bottom stakes to mark the first cut. Dig out a vertical trench as wide as the canal bottom (See the figure 1 below).

Step 6: Move the lengths of cord out to the slope stakes to mark the next cut. Remove the centre and bottom stakes and the sections of earth that you left to hold these stakes in place.

Step 7: Dig out the remaining 10 cm of earth in the bottom of the canal (See the figure 2 below).

Step 8: Cut out the sides of the canal from the side stakes obliquely to the edges of the canal bottom (See the figure 3 below).

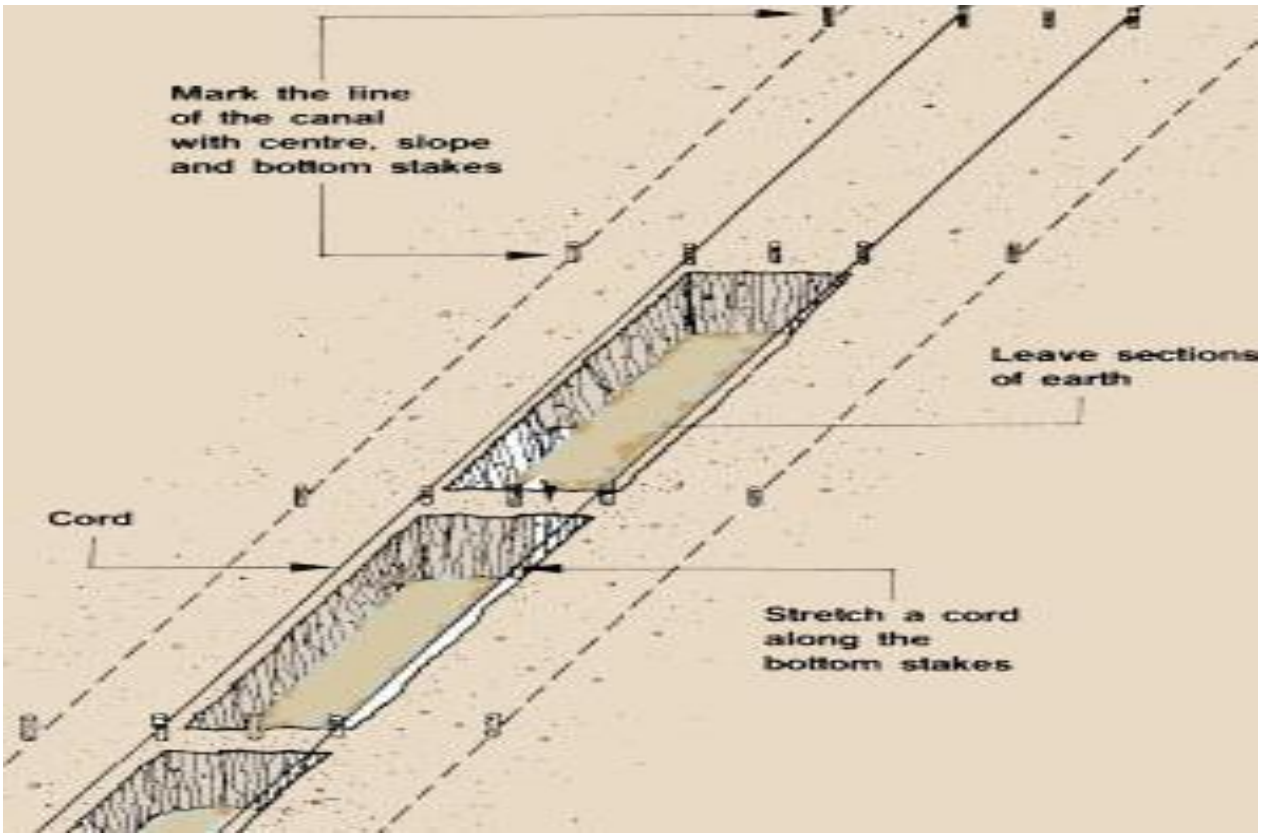


Figure 26

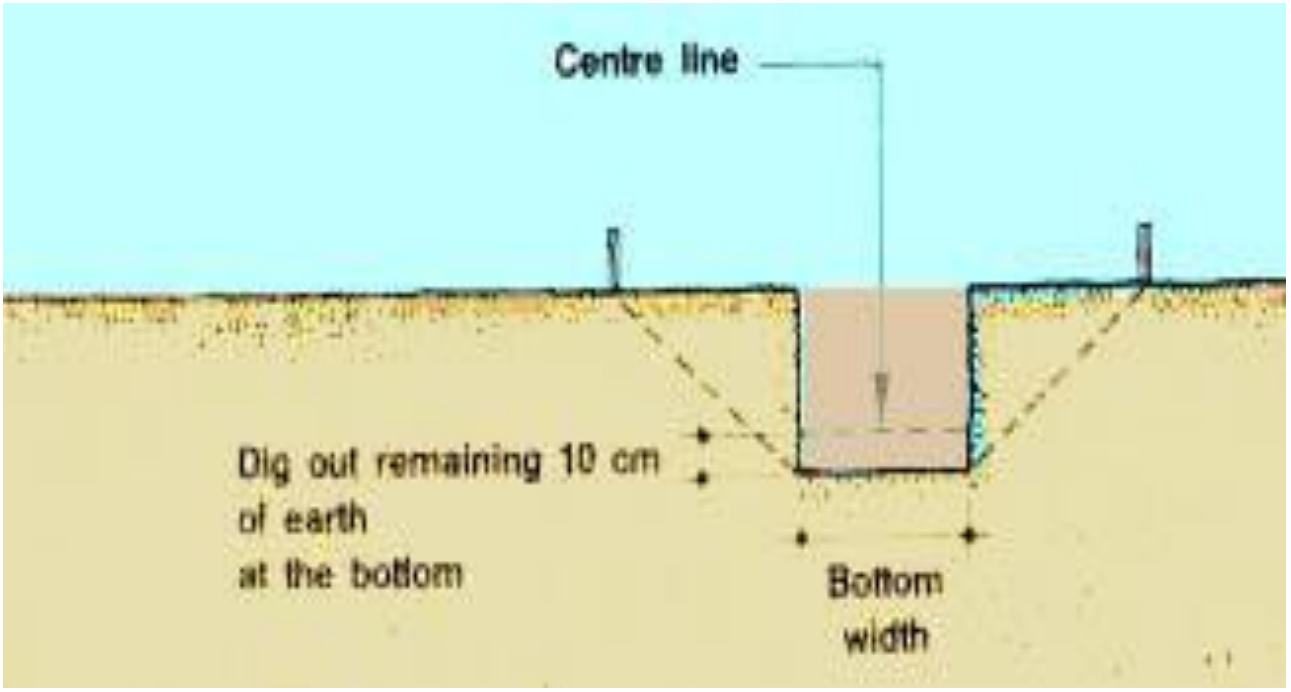


Figure 27

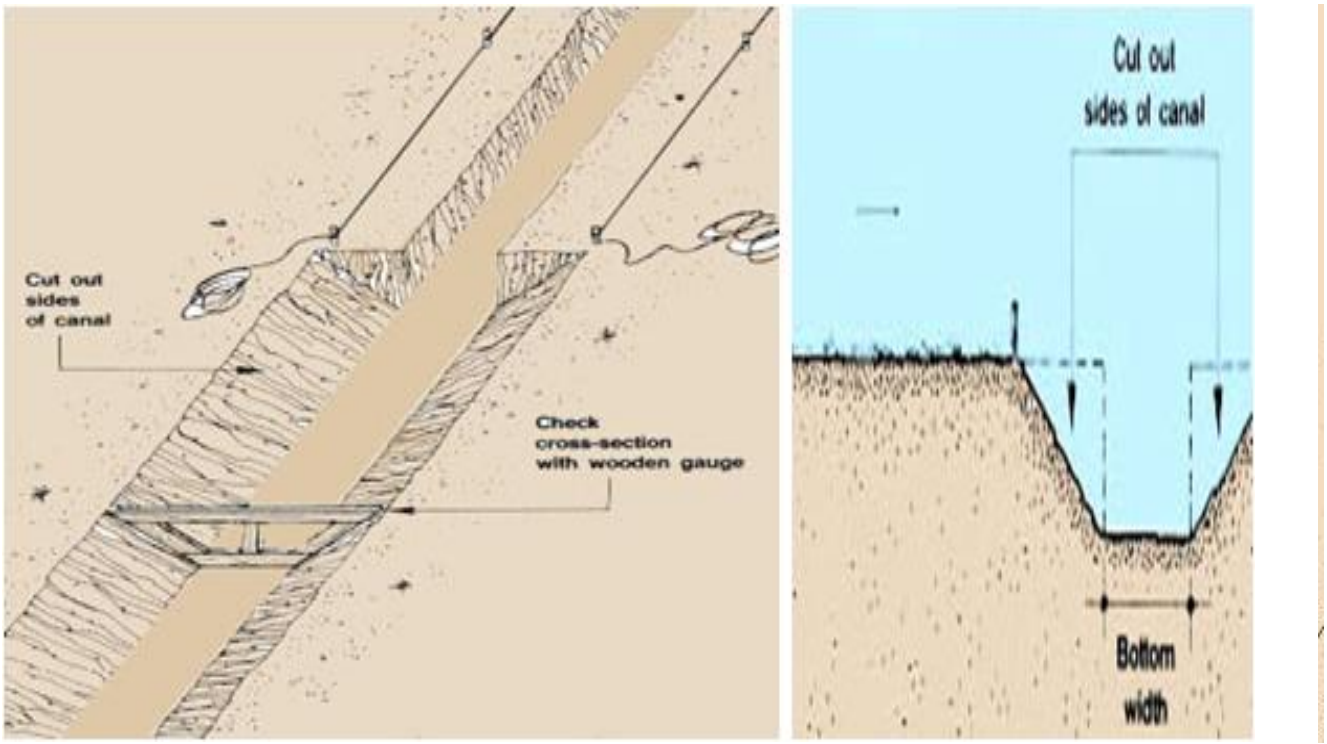


Figure 28

Step 9: Complete the construction of the banks if necessary, leveling the top and forming the external side slopes.

Step 10: Build the water control structures before letting any water flow through the canal

Step 11: After you have finished check that the canal functions as designed by letting in some water before starting the construction of the diversion ponds.

Step 12: Maintain and store tools and equipments appropriately

Activity 3: Construct embankment for earthen channel

Steps:

Step 1: Wear appropriate PPE and select appropriate tools and equipments

Step 2: Plough a strip in the terrain where the embankment is planned based on the canal layout, locate the alignment of the canal (Figure 1).

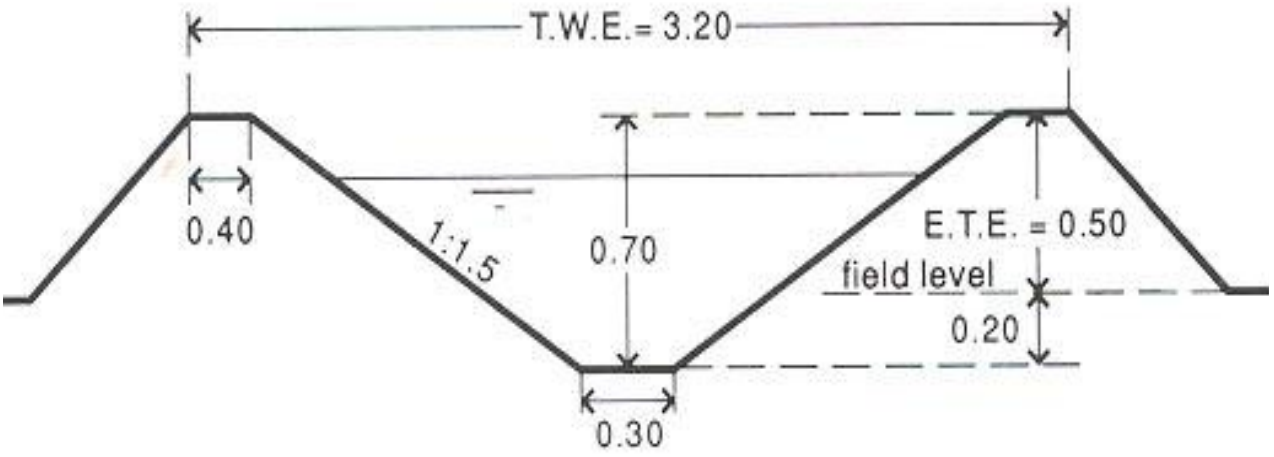


Figure 29

Step 3: Determine elevation and width of an embankment

Step 4: Plough the field as preparation of embankment construction

Step 5: Hammer pegs in the soil every 1m in a line to mark the center line of the embankment and its final level (Fig 3).

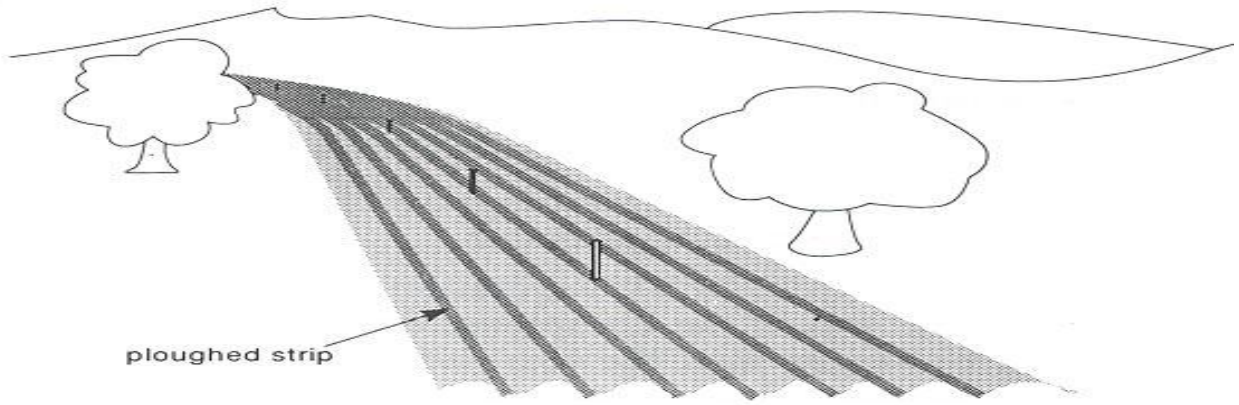


Figure 30

Step 6: Stake out the center of the embankment

Step 7: Mark the outer line of the body of the embankment to be constructed. Every 1m, The top level of the embankment has been marked in Step 2. The outside slope of the embankment must be stable and depends on the material which is used. As a rule of thumb, a slope of 1:2 [1 vertical to 2 horizontal] may be taken (Figure 4).

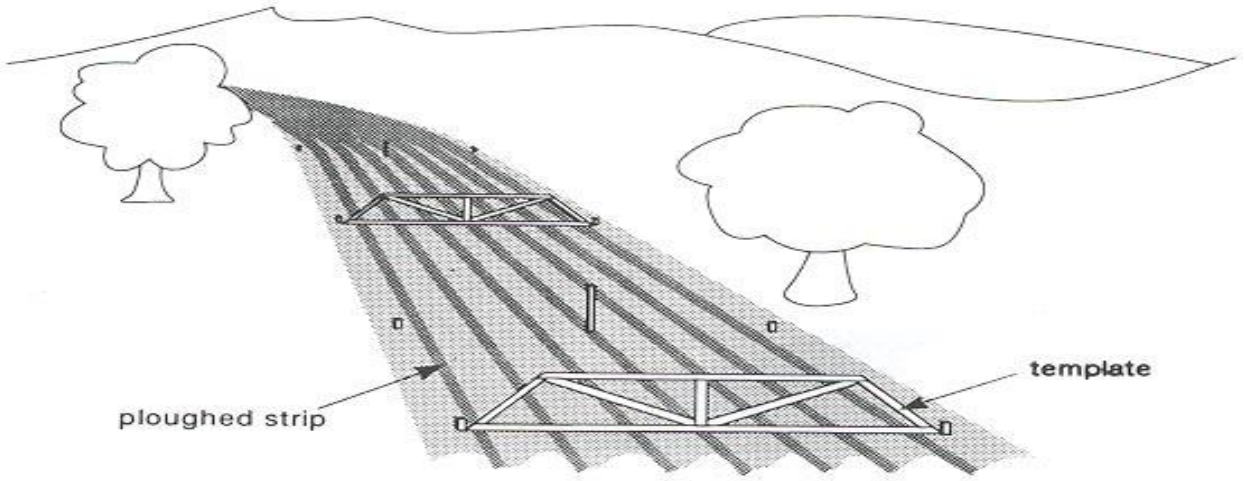


Figure 31

Step 8: Marking of the embankment to fill

Step 9: Construct the embankment. The embankment is constructed by adding soil in 5 cm thick layers, with each layer compacted moist.

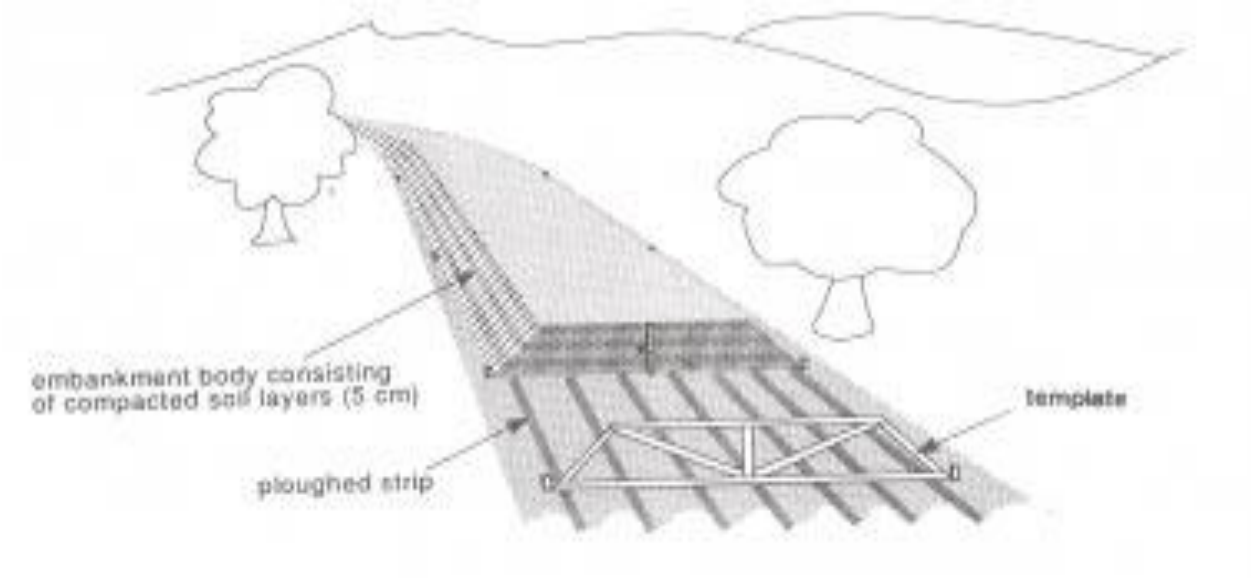
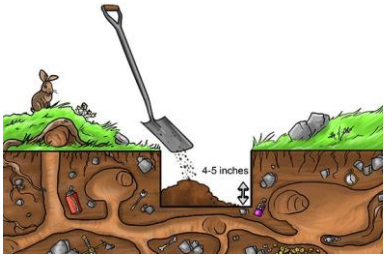


Figure 32

Step 10: Maintain and store tools and equipments appropriately

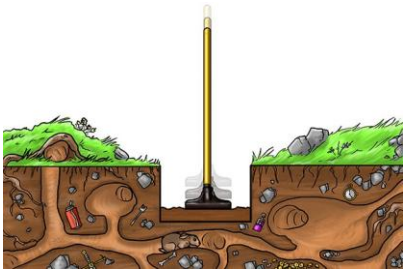
Operation Sheet 2	Applying soil additives and compacting earthen samples

Steps



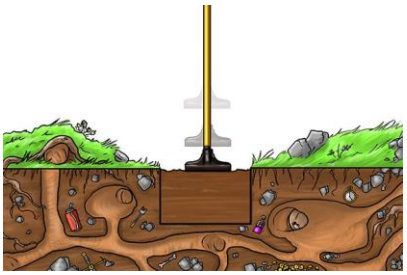
Step 1 - Refill trench

- Begin by moving the soil you removed from your trench back into it. If you do not have the soil you removed, use a soil that is native to your area.
- Use a shovel to refill your trench and spread it in an even layer until it's about 10-12cm (4-5") high.



Step 2 - Use trench tamper

- Use your trench tamper to compact the soil in the trench. Use a firm pressure to pack down the soil, but be more careful when directly tamping over pipes or cables so as not to damage them.
- This is why a manual trench tamper is preferable over a mechanical one when backfilling a trench.



Step 3 - Repeat the above steps

- Repeat the process, adding more soil and compacting until the trench is completely filled to ground level.
- A mechanical tamper can be useful for larger trenching projects to finish off the leveling, once the trench has been filled.

Step 4: Clean, check, maintain tools

LAP Test	Practical Demonstration

Name: _____ Allotted Time: **10 hrs**

Date: _____

Time started: _____

Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 10 hours.

Task 1: Collect data for canal design

Task 2: Construct earthen canal

Task 3: Construct trapezoidal earthen channel

Task 4: Construct embankment for earthen channel

Instruction Sheet	Learning Guide #59

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

- Checking, maintaining and storing equipment, tools and materials
- Manufacturer guidelines and organizational procedures.
- Environmental improvements or controls
- Measuring to reduce channel deterioration, infestation of weeds, pests and seepage

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

- Check, maintain and store Equipment, tools and materials according to manufacturer guidelines and organizational procedures.
- Restore work site and environmental improvements or controls to complete work according to plans and organizational requirements.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets "1- 4”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks 1,2,3 & 4" in each information sheets on pages 11, 15, 20 & 23.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work.
6. If you earned a satisfactory evaluation proceed to “Operation sheets 1 & 2 on pages 24 & 25 and do the LAP Test on page 26”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.

7. After You accomplish Operation sheets and the LAP Test, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next LG.

Information Sheet 1	Checking , Maintaining and Storing Equipment, Tools and Materials

1.1 Introduction

Any piece of plant, machinery, instrument etc., which is used for carrying out a specific activity or operation of construction are properly checked, maintained and stored properly after and before task.

1.2 Construction Tools

- Construction tools can vary widely depending on the material and supplies necessary to the particular job.
- Carpentry tools are definitely going to be used throughout most construction jobs and you will want to begin by collecting those tools necessary for measuring, cutting, mixing and laying out foundation material and digging.
- As the construction job evolves, specialized tools make more sense, to meet the tasks that come up as the building goes up.

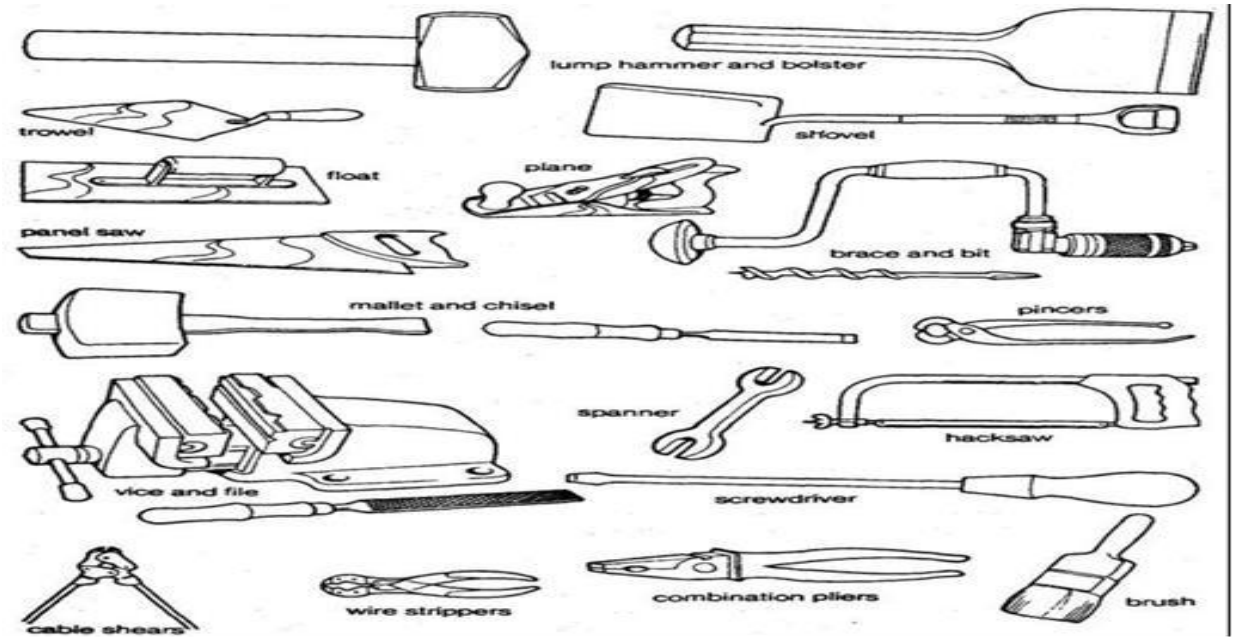


Figure 34: Construction Tools

1.3 Construction materials

Are materials which are commonly used for construction purpose and which is consumable. They include:

Cement: Is a material with adhesive and cohesive properties. It is material capable of uniting or bonding solid particles together.

Sand and aggregate: Sand, aggregates are a mixture of sand, gravel, crushed rock or other aggregates held together by a hardened paste of cement and water to form concrete.

Figure 35: Concrete material

Reinforcement bar: Reinforcement bar is collectively known as reinforcement steel ranging from 6 to 24 mm in diameter. It is a steel bar or mesh of steel wires used as a tension device in reinforced concrete and reinforced masonry structures to strengthen and hold the concrete in compression.

Timber

- the words ‘lumber’ and ‘timber’ are often used to refer to wood used specifically in construction work, however there is debate as to which terms should apply to different scenarios.
- Wood is generally classified as hardwood and softwood
- Hardwood is typically heavier and denser than softwood and is usually utilized for construction of walls, ceilings and floors

Eucalyptus poles

- Eucalyptus poles can be used a variety of applications
- Larger poles can be utilized for construction support structures
- Poles with a smaller diameter are perfect for fences, decorative trim, trellises and much more
- It is a very versatile and durable product, offering a great alternative to many traditional and less sustainable products

Nail (fastener)

- In wood working and construction, a nail is a pin-shaped object of metal (or wood, called a tree nail or "tunnel") which is used as a fastener, as a peg to hang something, or sometimes as a decoration
- Generally, nails have a sharp point on one
- end and a flattened head on the other, but headless nails are available
- Nails are made in a great variety of forms for specialized purposes

Black wire

Black wire used in building construction with good quality and good price for tying the different reinforcement bars and others.

Figure 36: Black wire

Bitumen

Bitumen is defined as an amorphous, black or dark-colored, (solid, semi-solid, or viscous) cementitious substance, composed principally of high molecular weight hydrocarbons, and soluble. This article presents the basic principles and practices of the usage of bituminous materials and mixtures in pavement construction

Contraction joint

- A contraction joint or control joint is a joint that is put in the concrete to control cracking. For example, when they saw cut joints into the concrete pavement, these are control joints. These are necessary, because we know the concrete will crack. We just need to try to control where it cracks. These are called contraction joints, because concrete tends contract when it is curing.
- Some people refer to these as expansion joints, but that is not technically correct.
- A construction joint occurs when there are multiple concrete placements. It can occur between different days of concrete placements.

Water stops

A water stop is an element of a concrete structure, intended to prevent the passages of fluids (such as water) when embedded in and running continuously through concrete joints. Water stops are grouped in two distinct categories.

- Water stops for joints without any movement of the adjoin concrete sections (construction cold joints) and
- Water stops for joints with movement of the adjoin concrete sections (dilation joints).

Water stops are being manufactured from a variety of materials depending on the functionality and their intended use.

The most common types are:

1. Water stops made from extruded plastics such as flexible polyvinyl chloride PVC, polyethylene (PE) or thermo plastic vulcanizate rubber (TPV); formed metal such as stainless steel, copper, or carbon steel - with or without polymeric coatings; extruded thermosets such as natural rubber, styrene-butadiene rubber, or neoprene rubber.
2. Hydrophobic Polymer water stops such as PVC, PE, TPV, or rubber are supplied to the construction site in coils (usually 25 m long), and are generally anywhere from 120 mm to 320 mm wide in a variety of profiles that are designed to simultaneously provide an interlock with the concrete they are installed in and to provide for a limited amount of movement within the joint.
3. Metal water stops are delivered in coils of up to 50 m with a typical dimension of 1.0 to 1.5 mm thickness and width of 250 to 300 mm. Splices can be welded, overlapped or joined with a sealant.
4. Hydrophilic or "water-loving" water stops are strips of rubber, modified with a hydrophilic agent (such as betonies) so they swell in the presence of moisture to effectively seal concrete construction joints. Hydrophilic strip applied water stops should not be used in contraction or expansion joints per the instructions of most commercial manufacturers.

1.4 Preparing Tools and Equipment for maintenance and Storing

- This practice deals with the confinement of the maintenance, cleaning, and storage of construction machinery, vehicles, and equipment, to areas specifically designed and designated for those purposes.
- It is applicable to both temporary and permanent sites and facilities, whether open or covered.

Pollutants controlled

- Equipment maintenance and storage areas which properly control runoff will prevent oil, grease, solvents, hydraulic fluids, sediment, wash water, and other pollutants from being carried off the areas and into surface waters.

Location

- Where possible, locate maintenance and storage areas on flat ground, to prevent surface runoff from entering or leaving the areas.
- Implement this practice at all existing or planned equipment maintenance and storage areas, including construction sites at which equipment will be stored, serviced, maintained, or repaired.
- Prior to construction, identify appropriate locations for equipment maintenance and storage
- Keeping tools properly storing, cleaning, and maintaining will save time and money. In order to keep tools in good working condition during storage, there are some basic preparatory steps that should be taken. It is important to follow the cleaning and storage instructions, especially for larger power tools.

1.5 Maintenance of equipments

- Engine maintenance
  - ✓ Changing engine oil
  - ✓ Changing fuel filters regularly and always use clean fuel.

- ✓ Tighten all hardware, including ramming shoe hardware, engine cylinder screws, and any external hardware.
- ✓ Clean air cleaner cover.
- ✓ Clean out engine cooling fins with an air compressor.
- ✓ Clean and check spark plug gap.
- ✓ Clean all filters.
- ✓ Replace the spark plugs.
- ✓ Replace fuel and oil lines every two years regardless of visible wear.

- Maintenance of Grinder
  - ✓ lubricating with cleaned oil
  - ✓ Replacing of worn parts of grinding machine.
  - ✓ Cleaning dusts and other materials
  - ✓ Changing worn blade
- Maintenance rolling compactors: The most common components need of daily maintenance service are:
  - ✓ lubrication oil levels
  - ✓ radiator water levels
  - ✓ hydraulic oil levels
  - ✓ hydraulic hoses and couplings
  - ✓ grease nipples/tracks
  - ✓ battery terminals and battery water
  - ✓ connections from the alternator
  - ✓ V-belts and their tension
  - ✓ tire pressure
  - ✓ transmission oil level
  - ✓ brake and clutch fluid levels
  - ✓ nuts and bolts of buckets and tracks

1.6 Storing tools and equipments

- Storing of Block/Brick/Tile Saw
  - ✓ Store the saw in preferably in mounting brackets or its metal box.

- ✓ Storing the saw in dry place

- Storing of Grinder
  - ✓ Store the saw in preferably in mounting brackets or its metal box.
  - ✓ Storing the saw in dry place
- Storage of plate compactor
  - ✓ Store the plate compactor on dry places

3.6.2. Rules to store tools

- To keep tools tidy, it should be cleaned after use and wiped down with a rag or towel to be sure that they are free of dirt, grease and debris.
- After cleaning, damage or defects should be checked. If the tool cannot be repaired, it should be thrown to away.
- Any soil and dirt should be scraped away from the metal surfaces with an approved solution.
- Before placing in storage it should be dried with a towel or rag.
- The metal parts of the tools should be coated with a lubricant protector spray.
- Tools do not directly store on the ground both small hand and power tools should be placed on shelving.
- Short-handled tools should be stored in a plastic bin or box. All surfaces of power tools should be cleaned and completely dry before storage and spraying lubricants

Store tools properly after every use:

- Keeping your tools properly stored,
- Cleaned, and maintained
- Use hinged rolling pegboard, or portable pegboard storage
- Use portable Toolboxes

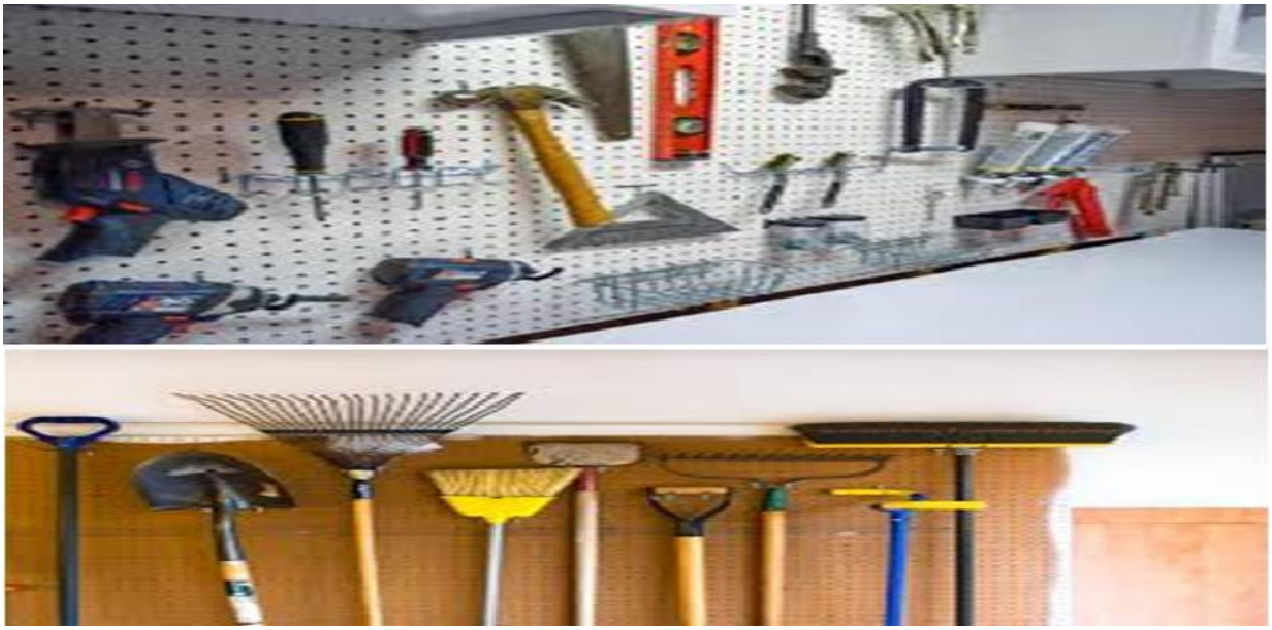


Figure 37: Tools storing board

Cleaning your tools may be the last thing you want to do after a day of work, but it's essential for keeping your tools in good shape.

- Clean most hand tools by simply wiping them down with a rag. If they are dirty, don't be afraid to give them a good wash with soap and water.
- Power tools are a little trickier to clean. First, make sure the tool is unplugged before you clean it. Next, get all the dust off.

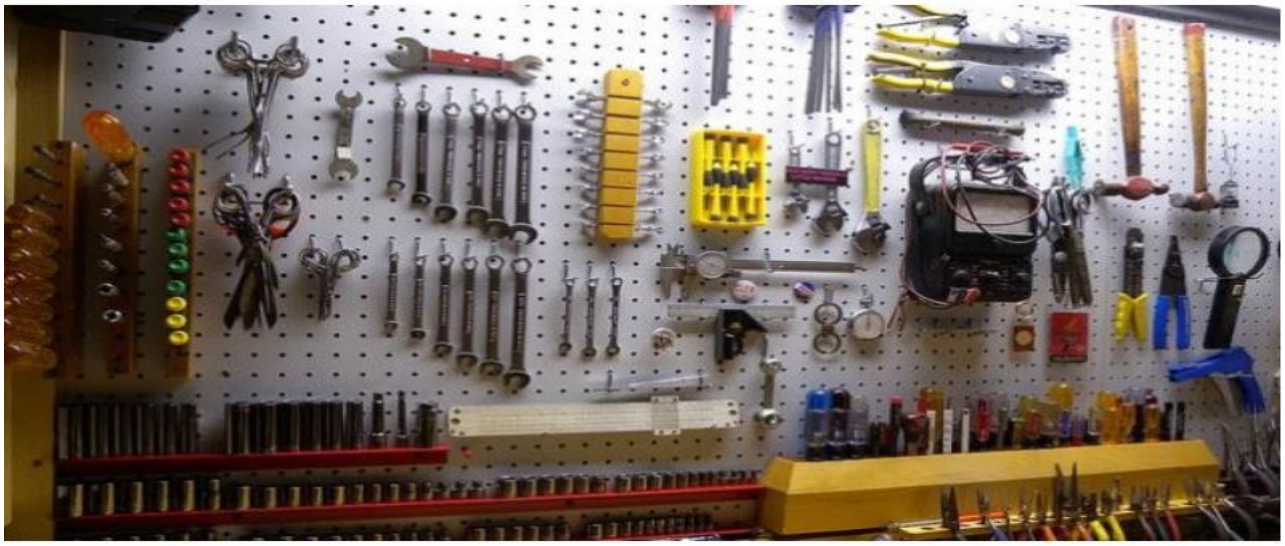


Figure 38: Storing tools

General requirement of storing of construction materials

- Bricks or other masonry building materials are not piled more than 2 m high, unless the pile is tapered back to one-half block per tier above the two meter level,
- Structural steel material, including poles, pipe, or bar stock, are stacked in racks or frames, or otherwise suitably restrained to prevent movement, and
- Bagged or loose materials are supported to prevent movement; and if materials are stored outdoors, the effect of wind, wind gusts and other environmental conditions are considered when determining the manner of stacking and storing the material.

Self-Check 1	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer. **(4 points each)**

1. One of the following is not correct concerning storing of tools
   A. Before placing in storage it should be dried with a towel or rag.
   B. Any soil and dirt should be scraped away from the metal surfaces with water
   C. To keep tools tidy, it should be cleaned after use and wiped down with a rag
   D. Tools do not directly store on the ground both small hand and power tools
2. All are hand tools except;
   A. hack saw C. hammer
   B. shovel D. jig saw
3. The most common components compactor need of daily maintenance service are:
   A. connections from the alternator C. V-belts and their tension E. All
   B. tire pressure D. transmission oil level
4. Amorphous, black or dark-colored and soluble (solid, semi-solid, or viscous) Cementitious substance, composed principally of high molecular weight hydrocarbons is:
   A. Bitumen C. Cement
   B. Gypsum D. Additive
5. The diameter of re enforcement bar ranges from:
   A. 6-18mm C. 6-30mm
   B. 6-24mm D. 6-32mm
6. A type of water stop which can be welded, overlapped or joined with a sealant.
   A. Metal water stops
   B. Hydrophobic water stops
   C. Polymer water stops
   D. Hydrophilic or "water-loving" water stops

Note: **Satisfactory rating - 12 and above points Unsatisfactory - below 12 points**

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

Score = _____

Rating: _____

1. _____ **4.** _____

2. _____ **5.** _____

3. _____ **6.** _____

Information Sheet 2	Manufacturer Guidelines and Organizational Procedures

2.1 Introduction

Organization is a social unit of people that is structured and managed to meet a need or to pursue collective goals. All organizations have a management structure that determines relationships between the different activities and the members, and subdivides and assigns roles, responsibilities, and authority to carry out different tasks. Organizations are open systems they affect and are affected by their environment.

A guideline is a statement by which to determine a course of action. A guideline aims to streamline particular processes according to a set routine or sound practice.[1] Guidelines may be issued by and used by any organization (governmental or private) to make the actions of its employees or divisions more predictable, and presumably of higher quality. A guideline is similar to a rule.

Procedures are designed to influence and determine all major decisions and actions, and all activities take place within the boundaries set by them. Procedures are the specific methods employed to express policies in action in day-to-day operations of the organization. Together, policies and procedures ensure that a point of view held by the governing body of an organization is translated into steps that result in an outcome compatible with that view.

2.2 Manufacturer guidelines

Standards and baselines describe specific products, configurations, or other mechanisms to secure the systems. Sometimes security cannot be described as a standard or set as a baseline, but some guidance is necessary.

Good manufacturing practice guidelines provide guidance for manufacturing, testing, and

quality assurance in order to ensure that a manufactured product is safe for human consumption or use.

2.3 Basic principles and guidelines

- Manufacturing facilities must maintain a clean and hygienic manufacturing area.
- Manufacturing facilities must maintain controlled environmental conditions in order to prevent cross contamination from adulterants and allergens that may render the product unsafe for human consumption or use.
- Manufacturing processes must be clearly defined and controlled. All critical processes are validated to ensure consistency and compliance with specifications.
- Manufacturing processes must be controlled, and any changes to the process must be evaluated. Changes that affect the quality of the drug are validated as necessary.
- Instructions and procedures must be written in clear and unambiguous language using good documentation practices.
- Operators must be trained to carry out and document procedures.
- Records of manufacture (including distribution) that enable the complete history of a batch to be traced must be retained in a comprehensible and accessible form.
- Any distribution of products must minimize any risk to their quality.
- A system must be in place for recalling any batch from sale or supply.
- Complaints about marketed products must be examined, the causes of quality defects must be investigated, and appropriate measures must be taken with respect to the defective products and to prevent recurrence.

2.4 Procedure

The ultimate goal of every 'Procedure' is to provide the reader with a clear and easily understood plan of action required to carry out or implement a guideline. A well-written procedure will also help eliminate common misunderstandings by identifying job responsibilities and establishing boundaries for the jobholders. Good procedures actually allow managers to control events in advance and prevent the organization (and employees) from making costly mistakes.

Procedures objectives are:

- Identify specific actions
- Explain when to take actions
- Describe alternatives
- Shows emergency procedures
- Includes warning and cautions
- Gives examples
- Shows how to complete forms
- Are normally written using and outline format

Self-Check 2	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer. **(4 points each)**

1. Objectives of procedure does not include:
   A. Describing alternatives
   B. Identifying general actions
   C. Giving examples
   D. Showing emergency procedures
2. One is not correct concerning organizations
   A. Is a social unit of people that is structured and managed to meet a need or to pursue collective goals.
   B. Are specific methods employed to express policies in action in day-to-day operations of the organization
   C. All organizations have a management structure that determine**s** relationships between the different activities and the members,
   D. Are open systems, i.e., they affect and are affected by their environment.
3. A procedure is:
   A. specific methods employed to express policies in action in day-to-day operations of the organization
   B. provide the reader with a clear and easily understood plan of action required to carry out or implement a guideline
   C. adopted by an organization to reach its long-term goals and typically published in a booklet or other form that is widely accessible D. All

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

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

1. _____ **3.** _____

2. _____

Score = _____

Rating: _____

Information Sheet 3	Restore worksite and the environment

3.1 Restoring work Sites

Restoration of work site is very important after any work because the work may have a certain effect on the environment directly or indirectly so after the dams or the water storage reservoirs been maintained be careful to look for any damage to the environment and restore it as it was before.

At the completion of any drainage system work site should be restored and environmental management should be practiced. All things which disturb the environment as the result of drainage system maintenance should be cleared off site. On completion of backfill operations and other work, the entire site shall be cleared of all debris, and ground surface shall be finished to a neat workman like appearance. All damages done to the environment during the course of the drainage system maintenance should be restored as its regional position.

3.1.1. Re-vegetation processes

Re-vegetation is the process of replanting and rebuilding the soil of disturbed land. This may be a natural process produced by plant colonization and succession, manmade rewinding projects, accelerated process designed to repair damage to a landscape due to wildfire, mining, flood, or other cause.

Re-vegetation helps prevent soil erosion, enhances the ability of the soil to absorb more water in significant rain events, and in conjunction reduces turbidity dramatically in adjoining bodies of water. Re-vegetation also aids protection of engineered grades and other earthworks.

- Originally the process was simply one of applying seed and fertilizer to disturbed lands, usually grasses or clover.
- The fibrous root network of grasses is useful for short-term erosion control, particularly on sloping ground.

- Establishing long-term plant communities requires forethought as to appropriate species for the climate, size of stock required, and impact of replanted vegetation on local fauna.
- The motivations behind re-vegetation are diverse, answering needs that are both technical and aesthetic, but it is usually erosion prevention that is the primary reason.

3.2 Drainage measures

Drain Protection is a critical part of any storm water management or spill out prevention plan. Whether you need to filter silt, sediment, oil, or heavy metals, we have a drain protector that can meet your needs. The following are the common drainage measures in restoring work site.

1. **Under Grate Filter:** Catches sediment, trash, and debris before pollutants enter storm drain systems. Long term field life provides overall cost savings.
2. **Storm water Drain Inserts:** Often referred to as the witch's hat, these inserts are placed directly into drains to collect and filter out pollutants as they flow into a storm water system. **Gutter Guards:** For curb, inlet, or gutters, contractors often go to drain guards that are easy to use and fast to install. Options include inlet inserts, gutter logs, plastic curb guards, and more.
3. **Drain Protection Covers:** For some locations, the only drain protection that is required are models that can quickly be placed on top of a drain grate. Drain grate covers will often include fabrics that can effectively continue water flows, while preventing unwanted sediment or debris from entering the drain.
4. **Drain Seals**: Sealing off the drain is an essential action for sites dealing with hydrocarbon spills. Drain seals are temporary blockers that attach quickly to the top of a drain to prevent anything from entering. Seals can be used on their own or in conjunction with spill response kits.
5. **Combination Drains:** Dealing with a combination drain? We also offer many options that are able to accommodate both the street and curb portion of the drain.

3.3 Sedimentation and Erosion Control Systems

3.3.1. Erosion Impacts

Construction activities, such as grading and filling, drastically reduce soil quality on construction sites. Left unprotected, sites will be further degraded by erosion and begin to adversely affect the surrounding environment. The goal of soil quality management on construction sites is to revegetate for protection against off site damage and increase soil organic matter levels to remedy the onsite damage caused by site preparation.

On-site impacts: The loss of topsoil, either by actual removal with heavy equipment or erosion by wind and water, is the worst on-site damage in urban areas. This layer of soil has the highest biological activity, organic matter, and plant nutrients—all key components of healthy soil. The onsite loss of this upper layer of soil nearly eliminates the soil's natural ability to provide nutrients, regulate water flow, and combat pests and disease.

Off-site impacts: Erosion from construction sites has off-site environmental and economic impacts. Erosion creates two major water quality problems in surface waters and drainage ways: excess nutrients and excess sediment. These problems adversely impact the health and biological diversity of water bodies.

3.3.2. Principles of Construction Erosion Control

- Here are some basic principles of erosion control on construction sites:
- Divide the project into smaller phases clearing smaller areas of vegetation.
- Schedule excavation during low-rainfall periods, when possible.
- Fit development to the terrain.
- Excavate immediately before construction instead of leaving soils exposed for months or years.
- Cover disturbed soils as soon as possible with vegetation or other materials (mulch) to reduce erosion potential.
- Divert water from disturbed areas.

- Control concentrated flow and runoff to reduce the volume and velocity of water from work sites to prevent formation of rills and gullies.
- Minimize length and steepness of slopes (e.g. use bench terraces).
- Prevent sediment movement off-site.
- Inspect and maintain any structural control measures.
- Where wind erosion is a concern, plan and install windbreaks.
- Avoid soil compaction by restricting the use of trucks and heavy equipment to limited areas.
- Soils compacted by grading need to be broken up or tilled prior to vegetating or placing sod.

3.4 Sediment control techniques

Sediment control techniques are used on construction sites to prevent sand, soil, cement and other construction materials from reaching waterways. Even a small amount of pollution from a site can cause significant environmental damage by killing aquatic life, silting up streams and blocking storm water pipes.

The objectives of sediment control are to:

- divert uncontaminated water away from the work area
- minimize erosion by minimizing site disturbance and stabilizing disturbed surfaces
- Prevent material supplies from collecting or discharging sediment.

Successful control measures on construction sites trap and retain sediment displaced by up slope erosion and results in:

- cleaner channels and healthier aquatic life
- reduced clean-up costs to the community
- improved site conditions
- improved wet weather working conditions
- reduced wet weather construction delays
- reduced losses from material supply
- fewer mud and dust problems
- fewer public complaints and less chance of fines.

3.3.1. Sediment control devices

1. **Woven sediment fences**: Woven sediment fences trap sediment but allow water through. These are generally the most efficient barriers for construction sites.
2. **Vegetated filter strips:** Vegetated filter strips are useful as a secondary measure but generally are not a substitute for sediment barriers. The nature strip is often used for this purpose.
3. **Storm water inlet traps:** Construct a temporary sediment fence around on-site storm water inlet grates.
4. **Off-site sediment traps:** For safety and efficiency, do not locate sediment barriers outside property boundaries, particularly on roads.

Self-Check 3	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer. **(4 points each)**

1. Sediment control devices which are used to trap sediment but allow water through are:
   A. Off-site sediment traps C. Vegetated filter strips
   B. Woven sediment fences D. Storm water inlet traps
2. Drainage measures which are placed directly into drains to collect and filter out pollutants as they flow into a storm water system are:
   A. Drain Protection Covers C. Storm water Drain Inserts
   B. Gutter Guards D. Under Grate Filter
3. The objectives of sediment control are to:
   A. divert uncontaminated water away from the work area
   B. minimize erosion by minimizing site disturbance and stabilizing disturbed surfaces
   C. Prevent material supplies from collecting or discharging sediment. D. All
4. Replanting and rebuilding the soil of disturbed land. This may be a natural process produced by plant colonization and succession, manmade rewinding projects, accelerated process designed to repair damage to a landscape due to wildfire, mining, flood, or other cause is:
   A. Revegetation C. Sediment control
   B. Restoring the site D. Backfilling

Note: **Satisfactory rating - 8 and above points Unsatisfactory - below 8 points**

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

1. _____ **3.** _____

2. _____ **4.**_____

Score = _____

Rating: _____

Information Sheet 4	Measures to reduce channel deterioration, infestation of weeds and seepage

4. 1 Measures to reduce channel deterioration

The channel improvement / renovation consists of complete demolishing of community channel and its rebuilding/re-aligning according to the engineering design to increase conveyance and efficiency by reducing seepage, evaporation, and operational losses. Parts of reconstructed channel are lined and necessary water control structures are installed to improve conveyance of the channels and tube well water. Measures are lining carried out under:

- using double-brick masonry walls - proved to be durable
- Other types of lining
- Pre-fabricated concrete (pre-cast parabolic lining)
  - ✓ Pipe
  - ✓ plastic etc

4. 2 Selection Criteria

The following criteria are adopted to improve channel:

- Channel that have not been previously improved
- Sections of channel to be lined should have:
  - ✓ Head reaches having maximum usage and flows
  - ✓ Elevated sections susceptible to leakage, over topping, and spillage
  - ✓ Portion of channel crossing / passing through / along villages/roads
  - ✓ Sections having sandy/porous soils

A. Measures to reduce channel infestation of weeds

Weeds are defined in many ways, but most definitions emphasize behavior that affects structures. Weeds are the plants, which grow where they are not wanted or a plant out of place or growing where it is not wanted.

Weed control is the process of limiting weed infestations. The main aim of weed control is to manage the vegetation on land and water bodies in such a way as will encourage the long life of the channel. Weed eradication is the complete removal of all live plant parts and seeds from an area.

B. Measures to reduce channel seepage

The two most common solutions for reducing seepage are lining canals or replacing them with pipes. These options bring along with them additional benefits, such as stabilization of banks (canal lining) or reduced need for access and fewer drowning (pipelines). However, these solutions are expensive. Compaction of canal banks and canal bottoms is another low cost solution. Compaction increases the impermeability of soils in the existing channels to acceptable levels.

Self-Check 4	Written Test

Direction I: Multiple choice item

Instruction: Choose the best answer for the following questions and write the letter of your answer on the answer. **(4 points each)**

1. Major criteria which should be adopted to improve channel is:
   A. Head reaches having maximum usage and flows
   B. Elevated sections susceptible to leakage, over topping, and spillage
   C. Portion of channel crossing / passing through / along villages/roads
   D. Sections having sandy/porous soils
   E. All
2. All are used as measures to reduce channel deterioration, EXCEPT,
   A. using double-brick masonry walls - proved to be durable
   B. Other types of lining
   C. Using unlined earthen channel
   D. Pre-fabricated concrete (pre-cast parabolic lining)
3. How channel seepage is reduced?
   A. canal lining and Compaction
   B. vegetating the inside of the channel
   C. constructing the channel manually
   D. Limiting weed infestations
4. How do you limit weed infestation in open earthen channel?
   A. By using biological control
   B. By using pesticide
   C. By using herbicide
   D. By using insecticide

Note: Satisfactory rating – 8 and above points Unsatisfactory - below 8 points

Answer Sheet-1

Name: _____ Date: _____

Multiple Choice Questions

1. _____ **3.** _____

2. _____ **4.**_____

Score = _____

Rating: _____

Operation sheet 1	Techniques for Maintaining and Storing Tools and Equipments

Steps for the operation:

Step 1: Wear appropriate PPE.

Step 2: Identify tools and equipments depends on their type.

Step 3: Set in order by placing the tools and equipments in proper places.

Step 4: Clean each tools and equipment.

Step 5: Store tools and equipments in their proper position.

Operation Sheet 2	Techniques of Restoring Work Site and Equipment

Steps for restoring work site and equipments:

Step 1: Wear PPE.

Step 2: Identifies the damaged work site depends on activity/-task type. Step 3: Clean the site.

Step 4: Use the right tools and equipments for the specific task/activity

Step 5: Use the appropriate site improving measures

Step 6: Store tools and equipments in their proper position

LAP Test	Practical Demonstration

Name: _____

Date: _____

Time started: _____

Time finished: _____

Instructions: Suppose you are site foreman for irrigation and drainage project currently, so you are required to prepare construction tools and equipments that you have been used for the next two weeks in 4 hours

Task1: Prepare construction tools and equipments for the next works.

Task 2: Maintain and store tools and equipment's

Task 3: Restore work site and equipment

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