Natural Resources Conservation and Development Level III

Based on March 2018, Version 3 Occupational standards

Module Title: Participating in Design and Implementation of Soil &Water Conservation Measures

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LG #61	LO #1- Identify and select appropriate measures to be designed

Instruction sheet

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

- Reviewing plan or strategy
- Confirming adherence to OHS requirements
- Identifying and selecting technology
- Identifying and accessing sources information
- Applying erosion control and design criteria/principles
- Principles of native topsoil conservation and protection

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Review plan or strategy for technical accuracy and environmental impacts.
- Confirm and note adherence to OHS requirements regulations and legislation on works plans.
- Identify and select appropriate technology according to work requirement
- Identify and access relevant information sources
- Apply design criteria in line with industry standards.
- Apply principles of native topsoil conservation and protection

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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Reviewing plan or strategy

1.1. Introduction

This learning guide covers the process of the construction/installation and maintenance of soil and water conservation measures specified on plans. It requires the ability to prepare for implementation and construction, carry out implementation and construction works, and carry out repairs and maintenance procedures. Implementing indigenous soil and water conservation measures requires a knowledge of Indigenous soil/water management practices, cultural customs and heritage, application of protocols, relevant land legislation, interaction between natural and cultural processes, and cultural knowledge on plants, animals and relationship to country, materials cartage, pollution control, sequence of working and timing, occupational health and safety issues relating to the site, equipment used, construction techniques and specifications and standards. It ranges from exploration to implement and maintain of contemporary indigenous soil and water conservation practices for a specified area.

Soil erosion is a major environmental threat to the sustainability and productive capacity of agriculture. During the last 40 years, nearly one-third of the worlds arable land has been lost by erosion and continues to be lost at a rate of more than 10 million hectares per year. With the addition of a quarter of a million people each day, the world population's food demand is increasing at a time when per capital food productivity is beginning to decline. (Pimentel et al,1995).

1.2 Review types conservations

Since erosion is a natural process, it cannot be prevented but it can be reduced to an acceptable limit. The soil conservation techniques used to combat and control erosion must be designed to do their job efficiently. Their design, layout and construction must be carried out even more accurately. More damage can be caused by improperly surveyed and constructed structure than when there was no any protection measure at all.

Their ultimate success depends on how well the nature of the erosion problem has been identified and on the suitability of the conservation measures selected to deal with the

problem and relate to as part of integration for the whole area or land use rather than working for individual piece of arable land. In addition, maintenance of organic matter and soil physical properties should be incorporated in soil conservation practices to increase infiltration capacity of the soil; reduction of runoff; improving the aggregate stability of soil.

Soil conservation measures can be grouped as follows:

- Biological/agronomic
- Physical/mechanical

Biological /Agronomic SWC techniques

Biological soil conservation can be defined as a set of conservation practices, which by the adequate cover of the soil surface, the recirculation of organic matter and nutrient, as well as the establishment of vegetative barrier across the slope, prevent soil moisture loss, improve soil properties and maintain (restore) the productivity and stability of the agro ecosystem. Wherever possible, biological conservation measures must be interacted with physical structures and mutually benefit one from the other. In general it can be called as conservation farming which can improve the stability, productivity, sustainability and equitability of cropping systems in dry lands. It includes several practices aimed at improved vegetation cover and improved soil structure for erosion control.

1.3. Principles

1. Reducing rain drop impact: - first and above all biological soil and water conservation prevents soil erosion by protecting the soil surface from the direct impact of rain drop. Organic matter from vegetation helps the formation of elastic soil aggregates which absorbs the kinetic energy of rain drops with out being smashed and soils which are rich in organic matter have higher pores that in hence infiltration.

2. Increasing the time of concentration: - Vegetation provides resistance to the flow.
3. Reducing both the velocity and the volume of over land flow.

1.3. Technical accuracy and environmental impacts.

(a) Data.—In recognition of the importance of and need for obtaining and maintaining information on the current status of soil, water, and related resources, the Secretary is authorized and directed to carry out a continuing appraisal of the soil, water, and related resources of the Nation. The appraisal shall include, but not be limited to -

(1) data on the quality and quantity of soil, water, and related resources, including fish and wildlife habitats;

(2) data on the capability and limitations of those resources for meeting current and projected demands on the resource base;

(3) **data on the changes that have** occurred in the status and condition of those resources resulting from various past uses, including the impact of farming technologies, techniques, and practices;

(4) **data on current Federal and State laws**, policies, programs, rights, regulations, ownerships, and their trends and other considerations relating to the use, development, and conservation of soil, water, and related resources;

(5) **Data on the costs and benefits** of alternative soil and water conservation practices;

(6) **Data on alternative irrigation techniques** regarding their costs, benefits, and impact on soil and water conservation, crop production, and environmental factors; and

(7) **Data on conservation plans**, conservation practices planned or implemented, environmental outcomes, economic costs, and related matters under conservation programs administered by the Secretary.

(b) **Collection of data**.—The appraisal shall utilize data collected under this chapter and pertinent data and information collected by the Department of Agriculture and other Federal, State, and local agencies and organizations. The Secretary shall establish an integrated system capable of using combinations of resource data to determine the quality and capabilities for alternative uses of the resource base and to identify areas of

local, State, and National concerns and related roles pertaining to soil and water conservation, resource use and development, and environmental improvement.

(c) **Public participation**.—The appraisal shall be made in cooperation with conservation districts, State soil and water conservation agencies, and other appropriate citizen groups, and local and State agencies under such procedures as the Secretary may prescribe to insure public participation.

(d) **Evaluation of Appraisal**.—In conducting the appraisal described in subsection (a), the Secretary shall concurrently solicit and evaluate recommendations for improving the appraisal, including the content, scope, process, participation in, and other elements of the appraisal, as determined by the Secretary.

(e) **Completion dates**.—The Secretary shall conduct comprehensive appraisals under this section, to be completed

1.4 Apply procedures relating to erosion and sediment control

(a) Program development.—The Secretary is hereby authorized and directed to develop in cooperation with and participation by the public through conservation districts, State and national organizations and agencies, and other appropriate means, a national soil and water conservation program (hereinafter called the "program") to be used as a guide in carrying out the activities of the Secretary which assist landowners and land users, at their request, in furthering soil and water conservation on the private and non-Federal lands of the Nation. The program shall also include but not be limited to -

(1) analysis of the Nation's soil, water, and related resource problems;

(2) analysis of existing Federal, State, and local government authorities and adjustments needed;

(3) an evaluation of the effectiveness of the soil and water conservation ongoing programs and the overall progress being achieved by Federal, State, and local programs and the landowners and land users in meeting the soil and water conservation objectives of this chapter;

(4) identification and evaluation of alternative methods for the conservation, protection, environmental improvement, and enhancement of soil and water resources, in the context of alternative time frames, and a recommendation of the preferred alternatives and the extent to which they are being implemented;

(5) investigation and analysis of the practicability, desirability, and feasibility of collecting organic waste materials, including manure, crop and food wastes, industrial organic waste, municipal sewage sludge, logging and wood-manufacturing residues, and any other organic refuse, composting, or similarly treating such materials, transporting and placing such materials onto the land to improve soil tilt and fertility.

(6) analysis of the Federal and non-Federal inputs required to implement the program;

(7) analysis of costs and benefits of alternative soil and water conservation practices; and

(8) investigation and analysis of alternative irrigation techniques regarding their costs, benefits, and impact on soil and water conservation, crop production, and environmental factors.

(b) Evaluation of Existing Conservation Programs.—In evaluating existing conservation programs, the Secretary shall emphasize demonstration, innovation, and monitoring of specific program components in order to encourage further development and adoption of practices and performance-based standards.

(c) Improvement to Program.—In developing a national soil and water conservation program under subsection (a), the Secretary shall solicit and evaluate recommendations for improving the

program, including the content, scope, process, participation in, and other elements of the program, as determined by the Secretary.

(d) Completion dates.—The initial program shall be completed

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. What are principles of soil erosion controls?

   _____

   _____

2. What stratagem we use to improve the aggregate stability of soil?

   _____

   _____

3. Define biological conservation. _____

   _____

   ____

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

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

Answer Sheet

Score = _____

Rating: _____

Operation Sheet -1 Assessing Erosion Hot Spot Areas

Objectives

- ✓ To assess erosion hot spot areas

Procedures:

1. Make necessary arrangements
2. Prepare simple data collection sheet and checklist
3. Collect basic information about specific site
4. Contact with the people and organizations to be affected by erosion
5. Make preliminary observation of the area
6. Record relevant evidences of erosion
7. Identify following OHS procedures
8. Delineate the area to be assessed & measured in consultation with the community
9. Identify the extent & severity of erosion in a delineated area (Erosion Hot Spot Areas) using, first, visual indicators of erosion
10. Apply Erosion Assessment and Measurement standard Techniques particularly USLE
11. Analyze the gathered data
12. Present your outcome in appropriate reporting format

2.1. Occupational Health and Safety

Occupational Health and Safety (OHS): Any occurrence which results in personal injury, disease or death, or property damage

A hazard: *A hazard is anything that has the potential* to harm the health or Safety of a person.

Risk: Risk is the significance of the hazard in terms of likelihood and severity of any possible injury.

Safety: The provision and control of work environment systems and human behaviour which together give relative freedom from those conditions and circumstances which can cause personal injury, disease or death, or property damage.

2.2. OHS policies, procedures and legislations

A safe workplace is no accident! In a safe workplace, everyone knows the potential hazards and what actions must be taken to eliminate them or control them. Some ways in which this can happen include:

- documenting OHS policies and procedures to cover work activities and hazards
- making sure everyone understands the OHS policies and procedures, especially what is to be done in the event of one of the hazards occurring
- Putting up safety signs in the workplace.
- making sure you have the Material Safety Data Sheet for every chemical you have in your workplace
- making sure all chemicals and other substances that could cause ill health or injury are labeled properly and listed on a register kept at your workplace
- inspecting the workplace, including the buildings, equipment and vehicles to make sure they are all correctly maintained and in good working order
- making sure everyone knows how to use safety equipment, such as machinery guards, eye wash facilities

- practicing emergency procedures, for example evacuation in the case of a fire

OHS policies

An OHS policy is a broad statement that says who is responsible for managing and monitoring OHS and lists any particular objectives for OHS, such as reducing vehicle accidents or days off work due to work-related illness or injury.

It is supported by a set of OHS procedures and work instructions that together should cover what must be done to eliminate or minimize risks in the work-place

OHS procedures

These may also be described as safe work procedures. These need to cover what needs to be done when carrying out tasks that may have risks or when working in a hazardous environment. For example, when cleaning an extracting room floor, an OHS procedure would explain:

- the purpose of the task and associated possible hazards
- who is to carry out the task and any special training or other requirements that they must meet
- the equipment needed to carry out the task and how it should be used
- what chemicals can be used and any safety precautions that need to be followed for those chemicals
- how to safely deal with excess water, for example by using a squeegee or mop or 'sweep' the excess water towards the drainage point in the floor
- requirement to place hazard warning signs to alert others to the hazard of excess water
- Emergency procedures to be followed (e.g. washing out chemicals on skin or eyes).

The term ''hazardous'' refers to any chemical which can affect an employees health. Effects can range from mildly irritating to potentially highly carcinogenic. If employees may be potentially exposed to hazardous chemicals, the employer is required to develop a written hazard communication program that includes the following:

1. A MSDS (Material Safety Data Sheets) for each known hazardous chemicals used in the farm or business, along with container labeling or other forms of warning.
2. A written plan which outline the method that will be used inform employees, workers, and outside contractors of hazardous chemical to which they may be exposed while working on the site.
3. A program which explain the dangers of hazardous chemicals in the work area at initial work assignment and provides information about any new hazard introduced work area.

Employers are required to make the written hazard communication program available upon request to employees or their designated representatives or official of OSHA.

Emergency procedures

When an accident occurs resulting in an employee poison injuring involving pesticides:

1. Promptly make transportation available to an appropriate medical facility.
2. Promptly provide to the victim and to medical personnel product name, EPM registration number, and active ingredient all first aid and medical information from label description how the pesticide was used information about of victims exposure.

2.3. Protective devices or equipment

The proper use of protective equipment in the process requires training, monitoring and encouragement and the following precautions should be followed.

- Garment closures must be kept closed.
- Sleeves must be kept rolled down.
- Goggles and faces shields must be kept in position, not pushed up on the head or hung around the neck.
- Pant legs must be kept on the outside of the boots.
- Aprons must be kept tied and in place.
- Once closing has been used for handling pesticide, it should never be used for any other activity.

Self-Check – 2	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. _____policy is a broad statement that says who is responsible for managing and monitoring OHS and lists any particular objectives for OHS, such as reducing vehicle accidents or days off work due to work-related illness or injury. (2pts)
2. _____ is anything that has the potential to harm the health or Safety of a person. (2pts)
3. What is OHS procedure would explain about? (2pts)

   _____

   _____

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

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

Answer Sheet

Score = _____

Rating: _____

3.1. Technology

Technology is not always a product of scientific institutions. Human beings are inherently capable of modifying their environment in the process of adaptation, whereby technology is created and subsequently utilized. The struggle between the environment and people never stops, though under some circumstances, a long time may pass before intended changes are realized. For various reasons, some societies adhere to certain technology for centuries whereas others pass a comparable level of technology in a relatively shorter period of time.

For instance indigenous knowledge from Konso People in Ethiopia (SNNP) on natural resources management-soil and water conservation is nowadays a center for technology experiments in scientific communities.

3.2. Components of Biological Soil and Water conservation Measures

Depending on the nature of application, materials used and management Practices: Biological measures are classified in to the following three components.

A. Crop management measures

Soil erosion either by the splashing effect of rain fall and/or run off becomes a basic problem under the following two cases;

- ✓ When the existing vegetation does not provide complete ground cover
- ✓ When the ground is devoid of vegetation during critical periods of the year; particularly at the beginning of the rainy season.

In crop management practices we conserve or minimize the soil loss by adjusting the cropping system and cropping pattern.

- ➢ **Cropping system** is the way and manner in which crops are grown in given area over a period of time and includes technical and managerial resources that are utilized.
- ➢ **Cropping pattern** refers to the sequence of crops, their arrangement and sowing sates. In cropping pattern the selection of crops and varieties is important.

1. Selecting crops and its population density

The best selected crops are:

- Crops able to sufficiently and rapidly cover the soil surface (fast growing crops) and thus protect the soil against soil erosion.
    - Crops able to produce satisfactory yields with limited moisture available (Drought resistant).
    - Tap rooted (vertical root system) E.g. Broad leave plants
    - Close growing crops rather than wide spaced crops

2. Early plantation

Cultivated crops should cover the soil around the time just be for the most effective rains occurs.

3. Crop rotation: - is a practice of growing different crops one at a time in a definite sequence on the same piece of land. It is a system of farming in which the same piece of land is kept under cultivation for years, but the crops grown are changed on a rotational basis with a definite sequence.

Several **advantages** are associated with crop rotation:-

1. Improves soil structure with consequent reduction in soil erosion

2. Different plant species are able to extract nutrient at different soil depth. This is a result of differences in the development of their root systems. It is advantageous to rotate deep rooted feeders with those having shallow root systems to ensure uniform removal of nutrient and moisture from different depth year after year.

3 Allows a balanced nutrient removal from the soil Eg. Some crops have heavy nutrient demand and cause soil exhaustion (yam, cassava, sun flower,..) , Some crops have relatively less nutrient demand (Tomato, ground nuts, pump kin,)

N:B legume crops and/or a fallow period may be included in the rotation to improve soil fertility. Introduction of grass will improve soil structure.

4. Inter Cropping It is the practice of growing two or more crops simultaneously on the same piece of land. It has a number of technical and economical advantages that make the system efficient.

- Better use of the environment in terms of space, water, and nutrient. It permits higher plant population than would a single crop makes, effective use of available plants nutrients.
- The more extensive root system produced by two crops tends to hold the soil particles together, thereby giving the soil good structure which in turn minimizes erosion.
- If legumes are added the inter crop leaves residual nitrogen in the soil which may benefit the subsequent crop.
- Economically the return per unit of labour is higher
- Reduced risk of crop failure & controls the spread of pest and disease.

Inter cropping is divided in to the following three group

1. **Row inter cropping**- is growing of two or more crops simultaneously on the same field in a definite sequence of rows.
2. **Patch inter cropping-** crops grown in patches in the same field simultaneously.
3. **Mixed (inter) cropping-** is growing of two or more crops simultaneously with out a definite pattern.
4. **Relay Cropping:- i**s the practice of growing two/ more crops during the same growing season with certain over lap between plating of the second and harvesting of the first crop (the second crop is planted inside a stand of an existing sole crop).Usually, relay cropping is practiced to take advantages of the residual moisture left in the soil and the open space between matured plants. The intention is to leave the soil in better conditions for the next season crops. E.g. Before sorghum is harvested some legume crops may be sown between rows and then grow on the residual moisture. This technique is suitable when the first crop is planted at an early stage benefiting from early rains. Then the second crop would have better chance to grow and produce sufficient biomass.

6. Ley Cropping

Is a cropping system in which legume based pastures are rotated with purely grown crops. Legume based pastures are grown on fallow lands for a few years to improve fertility of the soil and thus the yields of subsequent crops. The establishment of dense productive forage crop during the fallow period provides thick ground covers which prevent soil erosion, restores soil fertility quicker than bare fallow and increase the water holding capacity of the soil. Substantial biomass produced may be incorporated in to the soil to raise the soil fertility.

7. Strip cropping

Rows of crops and protection effective crops are growing in alternating strips aligned on the contour or perpendicular to the wind direction in case of wind erosion. The soil which is removed from crop strips is trapped in the next strip down slope which is generally planted grass or grass + legumes strip. The practice is good measure on permeable soil preferably not exceeding 15-20% slope. If wide strips of perennial grass + legumes cannot be alternated with a strip of annual crops, or grass cannot be rotated for normal strip cropping narrow strips of grass or grass + legumes can be used. Grass strips are widely used practice on slops 5-15% usually with the width of 1 or 2m but not exceeding 4m.

B. Soil management

In soil and water conservation, soil management practices refer to those practices done on the soil which reduce soil erosion to a safe amount. These are practices which increase infiltration rate, increase amount of organic matter, help safe disposal of run off water from the field.

Soil management practices can be grouped in to two-

1. **Cultivation practices: -** These practices include farm operations that would improve yields. Most of these measures are integrated with physical structure for soil and water conservation.
2. **Fertility improvement practices: -** include all practices aimed to increase the amount and quality of organic matter content in to soil by improving the transformation of plant and animal residues.

Soil management practices

1. Contour cultivation: - is a practice of ploughing, sowing and planting along a contour line as opposed to along the slope. It increases the contact time between the runoff and the soil, due to the contour cultivation and/or vegetative barriers that checks the flow of water. Contouring gives a better result in the field of relatively uniform and gentle land slopes. It is impracticable on fields with irregular topographies, higher slope and longer slopes. It is simple and cheap, except additional drought power, time and labour required to cultivate along the contour.

2. Conservation tillage:- Tillage is mechanical manipulation of soil to provide favourable environment for good germination of seeds and crop growth; to control the weeds; to maintain infiltration capacity and accretion. The effect of tillage is the function of its several effect on soil such as aggregation, surface sealing, infiltration and resistant to erosion. Conservation tillage is any tillage system which has its primary objective of reducing soil and water loss (relative to conventional or excessive tillage). It can be achieved by minimum or zero tillage practices which are done in association with mulching or stable mulching.

Conservation tillage provides a good environment for the seed to germinate and for seedlings. It also increases the water in take capacity of the soil and thus to control the erosion & discourage weed growth. However excessive tillage is a practice that leaves the soil bare and unprotected from the ravages of erosion: It destructs soil structure and increases the soil erodibility causing significant soil loss.

3. Application of organic manure and mineral fertilizers.

Farmyard manure: - is a decomposed mixture of cattle dung and urine, straw and litter used as bedding and any remnants of straw and plant stalks fed to cattle.

Compost: - crop residues, vegetable residues and litter usually mixed with animal dung and some soil. Compost is used for fertilizing and conditioning the soil. Green manuring: - is the practice of ploughing or turning into the soil un-decomposed green plant for the purpose of improving physical structure as well as fertility of the soil. Fertilization: - is

the application of organic matter or synthetic origin in to the soil supply elements essential to the growth of plants.

Applying organic manure and mineral fertilizer in to the soil reduces soil erosion by:-

- Increasing the permeability of the soil to water, thus decreasing
- Increasing the density of the vegetative cover which in turn decreases rate of surface run off and increases water penetration.
- If organic manures are used as a top dressing, protects the soil from beating rains and decreases evaporation loss of water.
- Decreases soil readability by improving soil physical properties E.g. by improving the water holding capacity of the soil, promoting granulation, and improving porosity.

4. Mulching is the practice of covering soil surface with grass, straw plant residue, litter, plastic film or stone, to protect the soil and plant roots from the effect of rain drops (soil detachment and crusting) evaporation and freezing. Mulching reduces soil erosion by:-

- Intercepting the falling rain drops over the land surface and thus dissipating their kinetic energy.
- Increasing the infiltration capacity of the soil by maintaining the upper soil surface more permeable.
- Controlling sheet erosion:- mulching reduces the velocity of surface run off by the obstacles e.g. Leaves stems. Roots,…
- Maintaining the soil cool and moist which fevers good vegetation cover
- Conserving the soil moisture by reducing evaporation in dry seasons.

5. Contour farming practices

Grass barrier strips and Contour ridging

Trash lines: - are formed by building up of crop residues perhaps with the addition of a few shovels of soil and stones collected from the space between the lines. Trash lines consisting only of lines of weeds and crop residues with out being earthed over is less effective on very steep slopes where they may be washed by heavy runoff.

3.3. Mechanical soil and water conservation measures

Mechanical works may not be necessary to the solution of an erosion protection or they may be one solution, but not necessarily the best. Physical methods are normally employed in conjunction with cultural measures which are equally important for maintenance of physical, chemical, biological properties, including nutrient status which leads to soil fertility. Before considering the detailed design of mechanical protection works, some general principles will be discussed as the method is expensive and time consuming, and so deserves careful thought and planning.

Some of mechanical soil and water conservation measures are:

- Bunds
- Terraces
- Trenches
- Diversion Ditches /Cut-off drain
- Fana juu
- Check dam
- Gabion
- Water ways

Self-Check – 3	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: choice the best answer

1. _____Is a cropping system in which legume based pastures are rotated with purely grown crops.

A Relay cropping B. Ley Cropping C. Alley Cropping D. inter cropping

2. The best selected crops are:
   A. Crops able to sufficiently and rapidly cover the soil surface
   B. Crops able to produce satisfactory yields with limited moisture available
   C. Tap rooted (vertical root system)
   D. All

Test II: Short Answer Questions

1. _____refers to the sequence of crops, their arrangement and sowing sates. In cropping pattern the selection of crops and varieties is important.
2. List some structural soil and water conservation

_____

_____

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

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

Answer Sheet

Score = _____

Rating: _____

4.1. Source of information

Information can come from virtually anywhere — media, blogs, personal experiences, books, journal and magazine articles, expert opinions, encyclopedias, and web pages — and the type of **information** you need will change depending on the question you are trying to answer. Look at the following sources of information. There are two source of information.

Primary and secondary information sources. A primary **source of information** is one that provides data from an original source document.

4.1. The nature and purpose of assessment

Formal and non-formal assessment

(i) *Formal* assessments, involving systematic data collection and analysis, usually across one or more 'sectors' (e.g.health), and using a pre-defined methodology;

(ii) *Non-formal* assessment, involving a user-specific and usually unstructured process of information gathering and analysis in relation to a given situation.

An assessment process may include elements of both, and involves considering the facts of the situation in relation to organizational mandate, policy, strategy and capacity. Formal assessments themselves vary in the extent to which they are systematic, follow standard methodologies, or produce results that are reliable and can be generalized from; compare, for example, a rapid environmental health assessment with a full health survey (see below). Non-formal assessment is, by definition, a more subjective process. Most management decisions about humanitarian response are made primarily on the basis of non-formal assessment, with the results of formal assessments forming only a part of the process.

Formal assessments are looked to for *objective* results that derive their validity from the methods used and the way they are applied, rather than from the judgment of the individual. Information on agro ecological condition should be collected from the area where soil and water conservation implemented.

Agro ecological condition includes: climate, soil, physiography, and biotic factors to be assessed. The species selection first must be adapted to the site condition. The climate, soil, and biotic factors affect the growth and performance of trees shrubs and other forms of vegetation directly while the physiographic factors affect the climate and the soil thus affect the vegetation. From the point of view of selecting species for rehabilitation systems, several climatic parameters should be considered, such as annual rain fall, humidity, number of rainy days, mean minimum and mean maximum with extreme range of temperature.

Self-Check – 4	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: choice the best answer

3. All are secondary source of information except one

A Books B. journal C. personal experiences D. web pages

4. Agro ecological condition includes:

E. Climate B. soil C. physiography D biotic factors E. All

Test II: Short Answer Questions

1. What are the source of information?

_____

_____

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

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

Answer Sheet

Score = _____

Rating: _____

Different kinds of soil treatments may reduce or increase soil erosion. For example, mulching prevents the direct impact of raindrops on soil aggregate and maintains pore space (i.e. increasing infiltration), thus decreases soil erosion.

5.1. Forms/Types of Soil Erosion.

1-**Geological erosion**: it is a normal process, under natural condition; landscapes are formed and subsequently molded and reshaped by the processes like weathering and erosion. Since under natural undisturbed conditions the landscape is nearly always covered by vegetation erosion is very slow process. Soil loss by erosion is in balance with soil formation by weathering, so, there is no net soil loss and no degradation of land.

2-**Man made or accelerated erosion**: since man started practicing agriculture he had to clear natural vegetation in order to obtain arable land. He also needed land for cattle grazing. Much higher erosion rates and degradation of land were the consequences. In the last century, however, accelerated erosion has become a serious problem in many developing countries, since population and consequently the need for agriculture land have shown virtually exponential growth.

Accelerated erosion and land degradation, have become worldwide major threats to the possibility of nourishing future population properly. In addition, Ethiopian agriculture and forestry are confronted with negative consequences of land degradation.

Soil Erosion is the removal of soil particles from the place where it belongs by water, wind and / or gravity: water and wind are the main agents for erosion.

Mechanisms of Soil Erosion

For a soil erosion to occur, three processes are obligatory,

1. Detachment of soil particles from the soil mass
2. Transportation of the detached material by gravity, overland flow - - -
3. Deposition of the transported materials

5.2. Factors Affecting Soil Erosion

1. **Climate**

Rainfall is the most important factor affecting soil erosion. Water erosion is dependant on the intensity, duration, distribution and frequency of rainfall.

Moreover, climate indirectly affects soil erosion through affecting the vegetation cover of the area. Lack of organic matter in dry land makes the soil more susceptible to erosion by wind and water. In wind erosion, wind speed is the main factor that affects wind erosion.

2. **Soil Properties**

Soil erodibility is the soil's vulnerability to detachment and transportation. Soil erodibility is largely dependant up on the texture, structure and organic matter content of the soil.

3. **Topography**

- Steepness of slope and length of slope are the main characteristics that affect run off in erosion by water.
- Slope accelerates erosion: it increases the velocity of runoff and makes the water a better transporting agent.

4. **Vegetation Cover**

Vegetation intercepts the beating action of falling raindrops, retards the velocity of surface runoff, permits more water flow into the soil and decreases the erosive power of the wind.

Plant roots and other residues of vegetation help to improve soil aggregation and porosity and there by enhance infiltration and reduce run off.

5. **Land Management practices**.

Different kinds of soil treatments may reduce or increase soil erosion. For example, mulching prevents the direct impact of raindrops on soil aggregate and maintains pore space (i.e. increasing infiltration), thus decreases soil erosion

5.3. Effects of Soil erosion

- Loss of soil /Reduced soil depth
- Textural change: The finer topsoil is removed, which is desirable for its structure, plant nutrients and water retention
- Soil structure damage

- Loss of plant nutrient. The topsoil, which is the most fertile and rich in nutrient, is removed.
- Silting up of reservoirs
- Frequent floods: Silting up of streams and reservoirs reduces the capacity of these water bodies to carry large volumes of water, as they occur during the rainy season. This way the streams are prone to flooding.
- Loss of crops (due to crop damage by runoff water)
- Engineering structural damage Channels and other conservation and irrigation structures are blocked due to erosion of soil materials.

5.4. Forms of water erosion

Common types of erosion

- **Rain-splash erosion** Occurs when raindrops fall on unprotected ground. The impact on the soil splashes away soil particles and digs a crater. *Rain-splash erosion*
- **Sheet erosion** Occurs when thin layers of the topsoil are moved by the force of the runoff water, leaving the surface uniformly eroded.
- **Rill erosion** Caused by runoff water when it creates small, linear depressions in the soil surface. These are easily removed during land tillage.
- **Gully erosion** Unlike rill erosion, gullies are too deep to be removed during normal cultivation with ordinary farm implements. They are formed from small depressions, which concentrate water and enlarge until several join to form a channel. The deepening channel undermines the head wall, which retreats upslope. The gully then widens as the side-walls are worn back.

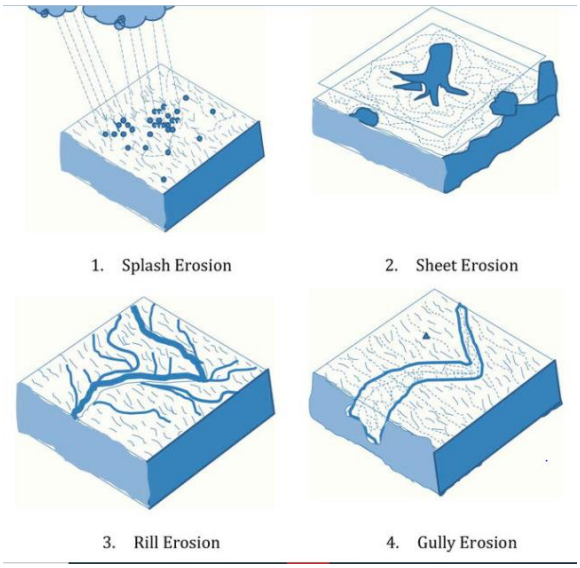


Figure 5.4: Types of water erosion

5.5. Visual indicators of water erosion

- Rills and gullies
- Pedestals: -Are columns of soil standing out from the general eroded surface protected by resistant material such as stone or root.
- Armour layer: - is the concentration at the soil surface of coarser soil particles randomly distributed thought the topsoil. That indicates the finer soil particles have been selectively removed by erosion
- Plant root exposure
- Exposure of below ground portion of posts, fence and other structure
- Rock exposure and exposure of parent material
- Tree mounds describe the situation where the soil under a tree canopy is at a higher level than the soil in the surrounding area. The presence of tree mound indicates that there has been more erosion away from the tree than near it, since the surface of the mound represents an earlier soil level.
- Building of sediments against barriers (in the upslope side)
- Sediment in drains
- Change in soil texture and color
- Muddy water and mudflows: - during and shortly after the rain

Self-Check – 5	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: choice the best answer

1. Man made or accelerated erosion is

A normal process B. under natural conditions C. result of land degradation D All

2. Mechanisms of Soil Erosion

A. Detachment Transportation Deposition

B. Transportation Detachment Deposition

C. Deposition Detachment Transportation

D. Detachment Deposition Transportation

3. Soil erodibility is largely dependant up on

A. the texture of soil B structure of the soil C organic matter content of the soil D. All

4. Occurs when thin layers of the topsoil are moved by the force of the runoff water, leaving the surface uniformly eroded.

A. Rain-splash erosion B. Sheet erosion C. Rill erosion D. Gully erosion

Test II: Short Answer Questions

1. What are factors affecting soil erosion?

_____

_____

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

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

Answer Sheet

Score = _____

Rating: _____

Operation Sheet -2 Measurement of gully and ravine erosion

Objectives

- To measure gully erosion

Procedures:

For an area where the average dimensions of many measured gullies or ravines estimate soil loss in ton/ha/yr using the following steps:

1. Measure the average cross-sectional area (width at lip = ____ m, width at base = _____ m, depth = _____m of the gully/rill in a study area, assuming a trapezoidal cross-section
2. Measure the gully length in the study area, and then compute the volume of soil lost from an average gully or ravine.
3. Delineate and determine the catchment area of the gully
4. Convert volume of soil lost in step 2 to a volume per catchment area (square meter).
5. Estimate soil bulk density value of the area using oven dry method in your local soil laboratory or use secondary data of the area available.
6. Convert the volume per square meter soil lost in step 4 to tonnes per hectare
7. Interview the indigenous people about the age of the gully in year(s).
8. Convert tonnes per hectare by dividing by the age of the gully to tonnes per hectare per year (t/ha/yr)

Hint: Using the average measurements of width at lip and width at base, and depth, calculate the average cross-sectional area of the gully or ravine (considering the cross-sectional shape is trapezoid); using the formula:

(width at lip (m) + width at base (m) / 2) * depth (m)

6.1. Principles of controlling water erosion

A. Reduce raindrop impact on the soil;

The soil surface can be protected from the raindrops either by growing close growing crops or by covering with straw, farmyard manure or leaf mulch.

B. Reduce run off volume and velocity: controlling the length and angle of the slope can regulate the concentration and velocity of run-off water.

C. Increase the soils resistance to erosion: - The structure of the soil can be maintained by covering it with bush, green cover (crops, grass and vegetation) and mulching. Beside other soil properties soil structure has a direct effect on crop yield.

Control Measures

1. **Contouring /contour farming or contour ploughing**:- is the method of applying agricultural practices (tillage, seeding - - -) along the contour (across the slope) rather than up and down slopes.
2. **Strip cropping**:- is a cropping practice where strip of forage and food crops are alternately established or it is a system of establishing more than one crop in alternate strips(E.g. Row crops: erosion permitting crops, are alternately planted with close growing crops : erosion permitting crops) following certain pattern for definite purpose.
3. **Tillage Practice /Zero tillage**
4. **Mechanical soil and water conservation measures**

- ✓ Bunds
- ✓ Terraces
- ✓ Trenches
- ✓ Ditches

6.2. Principles and Control Measures of Wind Erosion

Wind erosion starts when force of lift and drag exerted by wind against the surface of the ground overcomes the force of gravity of individual soil particles. Therefore the basic principles of wind erosion control lies, in preventing movement of the soil. This can be achieved in one of the following ways:

A. **Reducing wind velocity at the ground surface** sufficiently to prevent its capacity to remove soil particles away. The method reducing wind velocity needs the practice of growing plants or vegetative residues that will protect the land from wind erosion better than any other practice. Such covers acts as a barrier between the soil and wind and effectively reduce the force of the wind on he soil surface.

Bunding and planting trees on the bund, forming a barrier is an example of reducing wind Velocity on agricultural lands.

B. **Increasing the size of soil aggregates** or covering the soil with non-erodible surface. One of the principles, there for in wind erosion control is the creation of larger aggregates, which are less susceptible to wind erosion. Organic matter plays important role in forming stable aggregates that are less likely to be eroded. High organic matter content in soil is often associated with high fertility soil.

C. **Trapping saltating soil particles**- Trapping of erodible soil particles would be most effective in reducing further soil loss. Trapping may be accomplished by roughening the surface by placing barriers in the path of the wind, or by burying the erodible particles by tillage. A vegetative cover can trap saltating particles most effectively.

D. **Keeping the soil moist**: - Soil particles moving by saltation looses their energy by the momentum at the surface of the soil. The land can be kept moist by growing some economic crops, which may keep the soil covered and moist, thus making it less vulnerable to wind erosion.

Control Measures

A. Cultivation of erosion - resistant (close growing) crops to cover the ground rapidly.

B. Contour cropping

C. Strip cropping does not require change in cropping practices, and it does not remove any land out of cultivation. The field is simply sub - divided into alternate strips of erosion resistant crops and erosion susceptible crops.

D. Tillage should leave the soil as rough as possible. Excessive tillage leads to severe wind erosion.

E. Windbreaks and shelterbelts:- are important soil conservation practices improving the microclimate for production; and protection of crops and range lands against distractive wind energy.

Self-check- 6	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. What are the principles of wind erosion controls

   _____

   _____

2. List control measure for both water and wind erosion.

   _____

   _____

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

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

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

Answer Sheet

Score = _____

Rating: _____

LAP TEST 1	Performance Test

Name……. ID……..
Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour for each task. The project is expected from each student to do it.

Task-1 Assessing Erosion Hot Spot Areas

Task-2 Measurement of gully and ravine erosion

LG #62	LO #2- Apply design procedures

Instruction sheet

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

- Calculating catchments characteristics
- Determining methods to design specifications
- Managing peak water flows
- Modifying measures or design procedures

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Calculated catchments characteristics to required accuracy in line with industry standards.
- Determine methods to design specifications in accordance with industry standards.
- Manage peak water flows to conserve soil conservations
- Modify measures in response to applying design procedures and followed in line with accepted industry practices.

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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Calculating catchments characteristics

.1. Catchments characteristics

Catchment characteristics obtained from maps and the Data Base of the Water Resources Management Department were: Catchment Area (AREA), Main Stream Length (MSL),Slope as (S1085) Stream frequency (STRFQ), Mean Annual Rainfall (MAR) and Potential Evaporation (PE) (Ruks ***et al,*** (1970)). A **catchment** is an area where water is collected by the natural landscape. Gravity causes all rain and run-off in the **catchment** to run downhill where it naturally collects in creeks, rivers, lakes or oceans.

Catchment characteristics interact with variable patterns of rainfall and determine the character and size of runoff volumes and peak flows. Local slopes are often relatively high and they may direct runoff either into basins where it can infiltrate or to channels by which it can easily leave the **catchment**. A **hydrograph** is a graph showing stage, discharge, velocity, or other properties of water flow with respect to time. When the stage is plotted against time, the graph is a stage **hydrograph** (which is the form of a stream gage record). When the discharge is shown against time, the graph is a discharge **hydrograph**.

Catchment area means:

- An **area** from which surface runoff is carried away by a single drainage system.
- The **area** of land bounded by watersheds draining into a river, basin or reservoir.

The amount and/or rate of runoff generated by a catchment are influenced by a range of physical characteristics. Some of these characteristics vary with the season and the nature of land use and management. For example, paddocks containing soils with high infiltration rates with consistently high levels of surface cover will have lower rates of runoff than paddocks containing soils with low infiltration rates and with low levels of surface cover. The impact of an individual characteristic depends on the size and shape of the catchment. These characteristics should be taken into account when designing a waterway to accommodate the runoff from a paddock. However, when preparing a design for a larger catchment containing a variety of soils and land uses, the effects of

different characteristics will be averaged out and some representative parameter values for the whole catchment may be selected when calculating a runoff estimate.

.1.1. Size and shape

In general, the volume and peak flow rate of runoff increases with catchment size. However, they may also vary with shape. For instance, for the same rainfall event, a long narrow catchment would be expected to have a lower peak rate of runoff than a more compact or circular one of the same size. This is because in the longer catchment, it takes more time for the runoff from the most remote part of the catchment to reach the outlet and so the flow is spread over a longer time period. Contour bays represent an unnatural shape for a catchment. They feature a relatively short length of overland flow between banks that act as long detention basins, especially when the channel flow is restricted by a crop or standing stubble. This shape needs to be taken into account when determining the peak discharge from a contour bay

.1.2. Topography

Catchments with relatively flat terrain generally have a lower peak rate of runoff than those with steep terrain. This is because runoff flows slower and takes longer to travel over lower sloping surfaces, resulting in the peak discharge being both reduced in height and delayed. However, steep watercourses will often have a higher roughness of the ground surface which may offset any increase in flow velocity due to the higher slope.

.1.3. Soil conditions

The rate that rainfall infiltrates into the soil affects the amount and rate of runoff. Infiltration rates vary with soil type. Deep sands and friable red soils (ferrosols) have high infiltration rates whilst hard-packed grey clays generally have low infiltration rates. Cracking clay soils have a variable infiltration rate—high when cracks are open and low when cracks are closed. Texture contrast soils often have subsoil layers with low infiltration rates whilst the surface soil can be quite porous. The term soil permeability is also used to express the rate at which water moves through a soil profile. The least permeable layer in the soil controls the rate of water transmission through the soil overall. The Australian Soil and Land Survey Field Handbook (known as the ‘Yellow’

book) (National Committee on Soil and Terrain 2009) classifies permeability into four levels:

- very slowly permeable—less than 5 mm per day
- slowly permeable—5 mm to 50 mm per day
- moderately permeable—50 mm to 500 mm per day
- highly permeable—greater than 500 mm per day.

Soils with abundant biological life generally have high rates of infiltration. Earthworms and termites improve soil aeration and drainage by constructing burrows and termite galleries. Tillage destroys these structures and can reduce permeability. Infiltration rates are also reduced by soil compaction and the formation of surface seals. The amount of infiltration also depends on the moisture content of the soil. Catchments will absorb more rainfall before runoff commences if they start in a dry condition. Major floods (and severe soil erosion) can occur when heavy rain falls on a catchment that has already been saturated.

.1.4. Storage

Localised depressions in the land surface can retard surface flows and reduce the amount of runoff. Examples of such features include roughly ploughed paddocks, hoof prints, melon holes (or gilgais), sediment traps, dams, and wetlands. Some cultivation implements, such as tied-ridging implements, are designed to create such storage in an attempt to better utilise rainfall.

Contour banks can provide significant temporary storage. Contour banks of the same height will have much greater capacity on lower slopes than higher slopes because of the greater amounts of runoff stored behind the bank. Contour banks on lower slopes will also have lower gradients, which further increases the period of temporary pondage. Constructed surface storages can be designed to empty over an extended period of time in order to reduce the flood peak downstream. These are termed detention storage structures.

.1.5. Land use and management

Generally, forested land will produce less runoff than cultivated or pasture land. As an example, Lawrence and Thorburn (1989) found that clearing brigalow forest at Theodore and converting the land to pasture or annual crops more than doubled the

mean annual runoff depths. For one catchment, the mean annual runoff increased from 26 mm while under forest, to 56 mm when cultivated, for the time period studied. For another, it increased from 23 mm to 47 mm when the land use changed from forest to pasture. Management of the soil surface can have an important effect. Higher rates of runoff will usually result from paddocks with low levels of surface cover compared to those with a crop or stubble from the previous crop. Surface vegetation helps increase infiltration rates by reducing soil aggregate breakdown and surface sealing caused by raindrop impact and by impeding overland flows. The effect of soil surface management on runoff is illustrated in Figure 3.5 which shows peak runoff rates measured from two treatments in a paddock at Greenmount on the Darling Downs between 1976 and 1991. The peak runoff rates from areas where high levels of surface cover remained were significantly lower than the rates from areas with bare fallows in most years. There was a smaller difference in treatment effects when the storm event occurred late in the fallow (e.g. events 6, 9, 12 and 13). Differences in surface cover levels are much higher at the beginning of a fallow than at the end when much of the stubble will have decomposed.

Catchments provide people, stock and flora and fauna with drinking water. They provide people with water for domestic and industrial use, including irrigation, and they cater for recreation and tourism. They may also include **important** cultural sites.

.2. Difference between catchment area and drainage basin

There are subtle differences between them. River Basin: All the area drained by a river and its tributaries. Catchment area: It refers to all the area of land over which rain falls and is caught to serve a river basin. ... There are many smaller watersheds within a river basin.

.3. Peak discharge estimation

As discussed in the previous sections, the peak rate of runoff produced by a catchment is dependent on many variables. If peak runoff rates from a catchment have been measured over a long period of time, it would be possible to get a reasonable indication of the magnitude of the peak rates that could be expected for different ARIs from that catchment. However, such records don't exist for the small agricultural catchments that are the subject of most soil conservation designs. For this reason it is necessary to use

a method that provides an estimate of the peak rate of flow taking selected catchment characteristics into account. Methods of estimating runoff vary in complexity depending on the hydraulic processes they attempt to simulate. To fully simulate all runoff generation processes and relationships requires a high degree of expertise as well as sophisticated software and large amounts of data. Such resources are rarely available when designing soil conservation works so the methods used are generally greatly simplified. Ideally, the method used should be developed using data from the catchment for which the design is required or from similar catchments. If this is not possible, the next best approach is to use methods developed elsewhere but incorporating parameter values derived using local data.

There are a number of different methods that can be used to estimate runoff based on local hydrologic data. These include:

• Flood frequency analysis: the flood peak discharge record of a catchment is analysed to provide a direct estimate of the desired design flood for that catchment.

Regional flood frequency models: these models use relationships developed between runoff data and characteristics of catchments in the region. This approach was used to develop a version of the Rational Method for use in small catchments in the Darling Downs

Runoff routing techniques: runoff is followed from its point of origin to the design point using models which represent the runoff processes using storage routing concepts with a series of conceptual storages. The output represents the direct runoff hydrograph at the design point (a hydrograph being a graph showing discharge plotted against time.

Design of cut-off-drains

- Before calculating the dimensions of the channel which is going to be constructed. We need to determine how much runoff is going to be discharged by the channel.
- There are two methods to determine the discharge
  a) Rational formula
  b) Cook's method

Cook's method

- this is a method of determining the peak run off discharge in areas where data is not available .
- it is based on the catchments area and the catchments characteristics (soil, slope & vegetation cover)
- the peak run off is found from a table

Rational formula.

- this by using empirical formulas to calculate the peak discharge.

$$Q = \frac{CIA}{360}$$

Q= peak run off rate (M^3.sec)

C= Run off coefficient

I= rainfall intensity (mm/hr)

A= Catchments area (ha)

.4. Universal Soil Loss Equation (USLE) model:

Soil erosion is influenced by many different variables. The essence of USLE is to isolate each variable and reduce its effect to **a number** so that when the numbers are multiplied together the answer is **amount of soil loss**. The equation is used to **predict soil loss** and helps to choose agricultural or soil conservation practices.

Erosion processes do not normally affect all areas of a landscape equally. It is also not technically possible, socially sounding and economically feasible to conserve all soil erosion areas at once. Predicting the location of excessive erosion hazard is therefore relevant to make successful erosion control, properly manage degraded lands, and improve the wellbeing and development of people. Soil erosion models are commonly used to achieve these goals. The absence of appropriate erosion assessment model for tropical and subtropical countries forced many researchers to rely on USLE or other soil loss assessment models developed for temperate countries. These models, however, can be adapted to the existing local condition and erosion hazard assessment of tropical and sub tropical countries (Hurni, 1985a). In the developing countries, shortage

of data limits the application of data intensive research models. However, the compatibility of the USLE model help in estimating soil loss rate, identify hotspots of soil degradation and priority of land management in a wide range of areas enables researchers to apply the model. The model can be used to calculate the soil loss rate of the catchments based on the product of six different data sets: rainfall intensity (R), soil erodibility (K), slope length and angle (LS), land use/cover (C) and land management (P) factors. Once the data of these erosion factors are available, the average annual soil loss rates (A), based on USLE, can be calculated as shown in Equation:

The equation is presented in the form:

A=R*K*L*S*C*P

- A=soil loss in tons/ha/year.
- R=the rain fall erosivity index; number indicating erosivity of rain.
  - ✓ Measures the erosive forces of rainfall to detach and transport soil particles in a given.
- K=soil erodibility factor: a number, which reflects the liability of a soil to erosion.
  - ✓ Refers to the inherent soil susceptibility to the forces of erosion by rainfall.
- L=the slop length factor: gives the ratio of soil loss from the length of the field for which erosion is to be predicted.
- S=slope (gradient) factor: the soil loss on the site concerned with its specified slope gradient.
- C= Land cover/crop management factor; the soil loss on the site concerned with various crops.
  - ✓ Different land use/cover patterns have various degree of soil protection against soil erosion. Land use/land cover pattern with better vegetation cover has lower C value and low degree of soil erosion hazard and vice versa. By intercepting rainfall drops and reducing velocity of runoff, plant cover protects the soil against erosion.

- P= Management/conservation practice factor; it is the relation of soil on the site concerned, to the soil loss on a standard plot under fallow.

Despite the simplicity and usefulness of the equation, its application for Ethiopian condition for the time being is limited. Since the equation is developed in USA and even it was adapted to Ethiopian conditions which differs enormously from USA that the values are not directly transferable.

Table 1.1: USLE

Equation: **A= R*K*L*S*C*P** (tons per ha yr.)

1. R: Rainfall erosivity

Annual rainfall (mm)	100	200	400	890	1200	1600	2000	2400
Annual factor R	48	104	217	441	666	890	1115	1340

2. K: Soil erodibility

Soil color	Black	Brown	Red	yellow
Factor K	0.15	0.20	0.25	0.30

3. L: Slope length

Length (m)	5	10	20	40	80	160	240	320
Factor L	0.5	0.7	1.0	1.4	2.1	2.7	3.2	3.8

4. S: Slope gradient

Slope (%)	5	10	15	20	30	40	50	60
Factor S	0.4	1.0	1.6	2.2	3.0	3.8	4.3	4.8

5. C: Land cover	6**. P: Management/conservation factor**
Dense forest = 0.001 Dense grass = 0.01 Other forest: see grass Degraded grass = 0.05 Badlands hard = 0.05 Fallow hard = 0.05 Badlands soft = 0.04 Fallow ploughed = 0.60 Sorghum, maize = 0.10 *Teff* = 0.25 Cereals, pulses = 0.19 Continuous fallow = 1.0	Ploughing up and down = 1.0 Ploughing on contour = 0.90 Strip cropping = 0.80 Intercropping = 0.80 Applying mulch = 0.60 Dense intercropping = 0.70 Stone cover 80% = 0.50 Stone cover 40% = 0.80

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Match column "A" With Column B based catchment characteristics

" A"	**"B"**
1. Management of the soil surface can have an important effect	A. Size and shape
2. An attempt to better utilize rainfall	B. Topography
3. Infiltration rates vary with soil type	C. Soil conditions
4. Peak discharge based on sloping surfaces	D. Storage
5. The volume and peak flow rate of runoff	E. Land use and management

Test II: Short Answer Questions

1. **Why are catchments important**?

   _____

   _____

2. What are two methods to determine the discharge?

   _____

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

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

Answer Sheet

Score = _____

Rating: _____

2.1. Design specifications

Soil and water conservation structures include all mechanical or structural measures that control the velocity of surface runoff and thus minimize soil erosion and retain water where it is needed. SWC structures can be designed to either conserve water or to safely discharge it away. The main physical SWC structures constructed in the watershed include soil bund, water way, cut off drain, fanya juu terraces and check dams. Each structural measurement has their own design specification.

A **design specification** is a detailed document providing a list of points regarding a product or process. For example, the **design specification** could include required dimensions, environmental factors, ergonomic factors, aesthetic factors, maintenance that will be needed, etc.

The design specification should provide a clear and unambiguous definition of the outcomes to be achieved. Design requirements are formally defined; often in terms of constraints that must be met for the solution to be feasible, and objectives by which the performance of a feasible design is ranked.

Design rules and specifications are proposed in different countries to define standards and methods of analysis of physical soil and water conservation.

Cut-off Drain (Cod)/Diversion Ditch.

This is a ditch/channel placed up slope of areas where protection is required to intercept flood water/runoff from top of hillside to prevent large flows down the slope. It is built across slope at slight grade so as to convey the intercepted runoff to a suitable outlet. Cutoff drains, which are only a part of the mechanical methods of erosion control. They should be combined with other measures. They are vital protection system since all the structures lower down will be designed on the assumption that it will effectively control all the runoff outside the arable land.

Principles and design procedures: cutoff drains are needed where protection from water flow coming from areas outside a farm. They can also be used for gully control. They should be constructed only where the need is quite evident with great care.

Survey of site: As the aim is to collect water flow before it flows out over a cultivated land, locate them at break point of the slope; where long slope changes into flatter land, if no break points, in the middle of the slope and not on the lower section of the slope. If the slope is very long, it may be convenient to dig more than one cutoff drain on the same slope.

Suitable disposal point: The water diverted by CoD up slope can be discharged into a river, or

- In to non erodible rocky ground, or
- In to well established grass land, or
- In to an artificial waterway, or
- In to a natural waterway.

If water is discharged onto grassland widen the outlet of CoD to dissipate the energy of the water. Frequently there is no suitable natural watercourse and one must be artificially made. This should be regarded as a continuation of the CoD. Do not discharge the water to farms and other sensitive areas. If you cannot discharge the water safely, do not construct CoD.

Determine the catchment's area of the CoD & **Catchment's characteristics** based on the vegetation, soil type, and slope condition to find out runoff generating characteristics.

Dimensions: Decide the top width or top and bottom width. The dimension must provide sufficient capacity to confine a the peak runoff from a storm with a certain return period (ten-year)

Grading: Cutoff drains must always be graded in the longitudinal direction of the slope. It is preferable if the same gradient is used along the whole length of the line. To

minimize the risk of flooding CoD should be as short as possible especially on erodible soils.

Table1.2: Recommended Length

Length	Clay soils	other soils
Normal length	400m	200m
Max. Length	450m	450m

The digging of CoD should start from the outlet point because rock or boulders can hinder further digging.

Terraces

A terrace, cutoff drain and a waterway system must be designed to give the most efficient layout possible in terms of farming practice. Terraces are earth embankments constructed along the contour for controlling the flow of surface runoff down slope and to shorten slope length. Terraces are needed on slopes with erodible soils, where contour farming, crop rotation, and/or strip cropping are not sufficient measures to protect an undesirable loss of soil. Depending on the particular site conditions and objectives, terraces may be on slight gradient (graded terrace) with the intention that the surplus runoff will flow gently off the farmland at non-erosive velocities to a place where it can be safely discharged. Or they may be on a true contour, i.e., flat along their length with the intention of holding the water so that it infiltrates into the soil (retention terrace.) If the gradient of the terraces is too steep it will scour, if too flat it will flow sluggishly and there will be a danger of silting. The choice of a grade, which will result in non-scouring velocities of flow under all conditions, is not easy.

Spacing: The distance between terraces may be measured either as the difference in elevation between two terraces VI or as the distance between them on the ground HI, but for convenience it is measured not horizontally but down the slope.

Similarly, where the slope of the land is described as a percentage S, it is the fall in meters over a horizontal distance of 100m.

HI= VI * 100 where S is % slope

S

Note that: although the VI increases with slope, the HI decreases more so that the terraces are closer together on steeper slope.

Length: After spacing has been decided, the next step to consider is the maximum length. Care should be taken that damage and failure were closely correlated with long terraces.

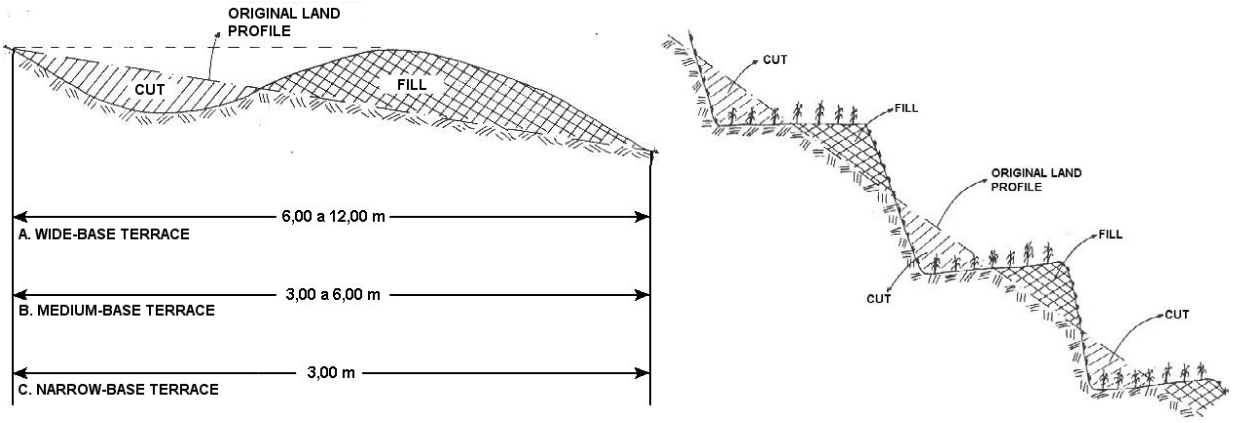


Figure1.1: common terrace form explaining the classification according to different base sizes (FAO, 2000).

The design aspect of terraces generally should consider factors such as of slope of land, rainfall and runoff rates, soil characteristics, vegetative or crop cover, tillage, and cropping practices. Moreover, the layout and design characteristics of SWC technologies are affected by local, environmental and socio-economic factors of the area. As much as possible, most important factors of erosion should be taken into account for improving the design and layout of SWC. However, the assumed guideline for SWC implementation in Ethiopia have only suggested to use slope gradient and soil depth in order to design SWC structures or measures (Hurni, 1986). The guideline was based on the dominant limiting factors on two slope categories. For slopes greater than

15 % however, the layout of SWC is irrespective of the gradient factor which probably assumed a linear effect of slope on soil depth given other factors constant (Gizaw, 2010).

Name of structure : Level soil bund

Land use: Applied on slopes above 3% and below 15% Grazing lands (up to 5%)

Minimum technical standards: Height: min. 60 cm after compaction. Base width: 1-1.2m in stable soils (1H:2V) and 1.2-1.5m in unstable soils (1H:1V) Top width: 30 cm (stable soil) - 50 cm (unstable soil). Channel: shape, depth and width vary with soil, climate and farming system. Ties (if appropriate): tie width dimension as required, placed every 3-6 m interval along channel. Length of bund: 30-60m in most cases, higher (max 80m) on slopes 3-5% Need to be spaced staggered for animals to cross

Layout and Vertical interval (VI) :-VI: follow a flexible and quality oriented approach: Slope 3-8% VI = 1-1.5m. Slope 8-15% VI = 1-2m. Slope 15-20% VI = 1.5-2.5m (only exceptional cases). (Note that: soil bunds > 15% to max 20% only if space reduced and with trench, short bunds - above 15% better apply stone faced or stone bunds. Layout along the coutours using line level - discuss spacing with farmers Make bund length max 50-80m (the > the slope the < the length)

Name of structure : Stone Bund

Land use: Applicable in a broad range of land uses in all agro-climatic areas, particularly in cultivated lands with some level of stoniness

Minimum technical standards: Height: 60-70cm up to 100 cm (lower side). Total Base width: (height/2) + (0.3-0.5 m). Top width: 30-40 cm. Foundation: 0.3 m width x 0.3 m depth. Grade of stone face downside: 1h: 3v Grade of stone face upper side: 1h: 4v. Grade of soil bank (seal) on upper side: 1h: 1.5-2v. Bunds need to be spaced staggered for animals to cross. Max bund length 60-80 meters

Layout and Vertical interval (VI) :- Caution: (stone bunds up to 50% slope they should not be constructed above 35% slope under Ethiopian conditions)

Ground slope %	Height of bund (m)	Vertical interval (m)	Distance apart (m)
5	0,50	1,00	20
10	0,50	1,50	15
15	0,75	2,20	12
20	0,75	2,40	10
25	1,00	2,50	8
30	1,00	2,60	8
35	1,00	2,80	6
40	1,00	2,80	5
50	1,15	2,80	4

Name of structure : Stone Faced Soil Bunds

Land use: Applicable in a broad range of land uses, particularly in cultivated lands with some level of stoniness.

Minimum technical standards: Grade of lower stone face: 1 horiz. to 3 vertical; Grade of upper stone face (if any): based on soil embankment grade. Grade of soil: 1 horiz. to 1.5 vertical on stable soils and 1 horiz. to 2 vertical on unstable soil; Lower stone face riser foundation: 0.3 depth x 0.2-0.3 width; Upper stone face riser foundation: 0.2 x 0.2 m; Stone size: 20 cm x 20 cm stones (small and round shape stones not suitable); Top width: 0.4-0.5m; Height: min. 0.7 and max. 1 m (lower stone face); Channel or trench along bund; Ties required every 3-6 m along trench/channel.

Layout and Vertical interval (VI) :- a) Slope range: 3-35% max b) Follow VI from soil bunds. Between slopes 5-15% add 10% to distance between bunds as stability of stone faced bunds is higher than soil bunds. Slope 3-8% VI = 1-1.5 m. Slope 8-15% VI = 1-2 m. Slope 15- 30% VI = 1.5-2.5 m Above 30% slope only in very stable soils or shift to stone bunds. c) Soil depth 50-100 cm d) Use line levels and follows contours. In gentle slopes (< 8%) avoid sharp curving along depression points and fill by plowing.

Name of structure : Level Fanya Juu (FJ)

Land use:Applied generally on cultivated lands with slopes above 3% and below 15% gradient. It can be applied on grazing lands with gentle slopes at wider intervals (up to 5%).

Minimum technical standards:

Height: min. 60 cm after compaction. . Base width: 1-1.2m in stable soils (1 horiz: 2 vertical) and 1.2-1.5m in unstable soils (1 horiz: 1 vertical). Top width: 30 cm (stable soil) - 50 cm (unstable soil). Collection ditch: 60cm W x 50cm D. Ties: placed every 3-6 m interval along channel. Length of bund: up to 60 m in most cases, max 80 m. FJ need to be staggered to allow animals to cross fields as required.

Layout and Vertical interval (VI) :- VI: follow a flexible and quality oriented approach: Slope 3-8% VI = 1-1,5 m Slope 8-15% VI = 1-2 m Layout along the coutours using line level - discuss spacing with farmers and in case of lateral slopes shift to soil bunds for higher water accumulation and apply reinforcements and keys. Note: Shift to soil bunds in areas with slight traverse slopes and apply stone keys and reinforcements.

Name of structure : Bench Terrace (BT)

Land use: Applied generally on cultivated lands and unused steep hillsides of slopes of average 12 to 58% considering the various land use types (cereal, fruits,etc.).

Minimum technical standards: Width: For areas of cultivation by hand: 2-5m is suitable. For animal driven cultivation: more than this is desirable. The more the depth of soil and the less the slope, the wider the bench terrace. Height: The height of the riser(terrace) is the vertical interval (for a reverse slope the change in elevation across the terrace is subtracted). A Riser has a slope expressed as a ratio of horizontal distance to vertical rise.

Layout and Vertical interval (VI) :- Vertical interval is calculated as follows: VI (meters) = S x W / 100-SU Where S is the land slope (%) W is the bench width(meters) U is the slope of the riser, expressed as the ratio of horizontal distance to vertical rise

Name of structure : Hillsid Terrac (HTs)

Land use: Applicable in steep hillsides - community closures with steep slopes (max 50%). In dry areas and shallow soils need to be combined with other measures (eyebrow basins, etc).

Minimum technical standards: Slope range: 20-50%. (VI): 2-3m. Height or stone riser:(range 0.5-0.75 m) Width of terrace:(range 1.5-2m)· Foundation: 0.3m depth x 0.3

m width foundation· Grade of stone riser: well placed stone wall (grade 1:3horiz to vert.)· In lower rainfall areas (most cases) hillside terrace have 5-10% gradient back slope

Layout and Vertical interval (VI) :- Cut and fill of the terrace area, · Collection of stones from working site, light shaping (if necessary) of side of stones with sledgehammer for better stability & merging, · Excavation of foundation, · Placement and building of stone riser, · Small stone ties every 5 m (optional), · Leveling of top of terrace with an A-frame.

Name of structure : Grade Fanya Juu (GFJ)

Land use: Applied generally on cultivated lands with slopes above 3% and below 15% gradient. Like level fanya juus graded Fanya juus are best constructed in uniform terrains with deep soils that do not have traverse slopes (depressions), but in high rainfall areas.

Minimum technical standards: Height: min. 60 cm after compaction. Base width: 1-1.2m in stable soils (1 horiz: 2 vertical) and 1.2- 1.5m in unstable soils (1 horiz: 1 vertical).Top width: 30 cm (stable soil) - 50 cm (unstable soil). Drainage ditch: 60cm W x 50 cm D. Ties: placed every 3-6 m interval along channel. Length of bund: up to 60 m in most cases, or max 80m on gentle slopes (3-5%). Channel cross section increases towards the end because of more water concentration e.g. from 25cm depth and 50cm width to 50 and 100cm, respectively.

Layout and Vertical interval (VI):- Vertical intervals: flexible and quality oriented approach. Slope 3-8% VI = 1-1.5 m. Slope 8-15% VI = 1-2 m Layout along the coutours but with 1% gradient using line level - discuss spacing with farmers and in case of lateral slopes shift to graded soil bunds

Self-Check – 2	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: choice the best answer (2pts each)

1. _____ is needed where protection from water flow coming from areas outside a farm. A. Soil Bund B. water Ways C. Cut-off drain D. Terraces E. All
2. The main physical SWC structures constructed in the watershed include
   A. Soil Bund B. water Ways C. Cut-off drain D. Terraces E. All

3. The design specification should

A. detailed document providing a list of points regarding a product or process

B. Provide a clear and unambiguous definition of the outcomes to be achieved

C Design rules and specifications are proposed in different countries

D. All

4. The **design specification** could include

A. Dimensions B. Environmental factors C. ergonomic factors D. All

5. Which one of the following is not true about Level soil bund

A. Applied on slopes above 3% and below 15% B. Base width is 1-1.2m in stable soils

C. Applicable in steep hillsides

D. Channel shape, depth and width vary with soil, climate and farming system

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

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

Answer Sheet

Score = _____

Rating: _____

Operation Sheet 1 -Marking contour lines

Objective

To mark contours Using a line level

Procedures

1. Always starts laying out contours at the top of the slope (not the middle or bottom), or immediately below the cutoff drain (if you have dug one). Drive a peg in to the ground where you want the first contour to begin.
2. One person holds the first pole upright at this first peg. The other person walks roughly level with the other pole until the string is tight. The third person checks the sprit level in the middle of the string, and directs the second person to move the pole up or down the slop until the bubble is in the middle of its run. Drive a peg in to the ground next to the second pole.
3. The two people holding the poles then both move forward until the first pole is at the second peg. Keeping the string tight, the second person again moves his or her pole up or down the slope until the line is again level. Drive a third peg in to the ground here. Repeat the process until the whole contour line is marked out.
4. To start a second contour line further down the slope, find a starting point by measuring the vertical interval you want. Then repeat the process for the new contour line.

In difficult topography, it might be inconvenient to measure 10 m at a time. Try to use half of the string (5 m).

Operation Sheet 2 Method of Marking graded lines

Objective

To drain excess water from farm land

Using a line level to mark graded lines

For a 2% gradient, tie the string at 120 cm on the first pole, and the other end at 100 cm.

For a 0.5% gradient, tie the string at 105 cm on the first pole.

procedures

1. Start marking graded lines at their lower end, for example, where you want a graded drainage line to meet a natural stream. Mark this place with a peg, and stand the pole with the string tied higher up (e.g., at 110cm) here.
2. Move the other pole (tied at 100 cm height) roughly level and slightly upslope until the string is tight (10 m away).
3. Check whether the bubble is in the center of the sprit level. Move the second pole up or down the slope until the bubble shows the string is exactly level. Mark this point with another peg.
4. Move both poles forward until the first pole is at the second peg (this pole must always be lower down, nearer the start of the line). Move the second pole until the string is tight, then move it up and down the slope until the string is level. Mark this point with a third peg. Repeat this process until you have marked out the whole graded line.
5. To start a second graded line, find a starting point by measuring the vertical interval you want. Then repeat the process for the new line.

Operation Sheet 3 Measuring vertical intervals and slope gradients

Objective

To measure slope of land

To determine distance between bunds

Procedures

1. To measure a vertical interval of 1 m, fix the string on one pole of the line level at 100 cm. you can unite the string from the other pole; you will not need it.
2. Have the person with the free end of the string hold it on the ground at the top of the slope.
3. A second person with the pole and string attached moves straight down the slope. The first person pays out enough string to keep the string taut. The third person watches the bubble in the sprit level.

4. When the bubble is in the center of its run, the string is level. The pole is exactly 1 m below the free end of the string. Mark these two places with pegs or stones. On gentle slopes, the string may be too short. Try measuring the vertical interval in two steps of 50 cm each.

To mark a larger vertical interval of, say, 1.5 m, you can measure a 1 m vertical interval, then one of 0.5 m.

A rule of thumb for spacing structures such as check dams and bench terraces:

- On slopes less than 15%, use a vertical interval of 1 m.
- On slopes steeper than 15%, use a vertical interval 2.5 times the depth of the soil. For example, if the soil is 50 cm deep, space check dams at a vertical interval of 125 cm.

Information Sheet 3- Managing peak water flows

3.1. Peak flow

One of the key parameters in the design and analysis of soil and water conservation structures is the resulting **peak runoff** or the variations of **runoff** with time (hydrograph) at the watershed outlet. The maximum flow at outlet thus attained is called **peak** flow of **runoff**.

The maximum rate of discharge during the period of runoff caused by a storm is called a "**peak flow**". The information about **peak flows** and associated volume of runoff during various floods that have been observed in the past can be complied by the analysis of the observed discharge data and runoff hydrographs.

Peak flow **measurement** is a quick test to **measure** air flowing out of the lungs. The **measurement** is also called the peak expiratory flow rate (PEFR) or the peak expiratory flow (**PEF**). Peak flow **measurement** is mostly done by people who have asthma. In the technical literature the maximum **water** demand is usually related to the hour of the maximum demand. The **peak** coefficient is obtained as the volume of the **water** required at the **peak** hour over the average, hourly **flow** demand volume.

Simple, straightforward methods of **calculating runoff** can tell you the amount of water that storms bring to the earth. For a given surface area such as a roof or yard, multiply the area by the inches of rainfall and divide by 231 to obtain the **runoff** in gallons.

The factor 231 comes from the fact that the volume of 1 gallon equals 231 cubic inches. When calculating roof runoff volume, you can use a **direct runoff formula** (in in^3) which calls for multiplying the area that covers the roof by the inches of rainfall.

More nuanced, complicated equations take into account factors such as variations in how much rain a storm creates over time. One method, known as the **Rational Method** uses the **Rational Equation*:***

$$C = \frac{Q}{iA}$$

for runoff coefficient *C*, peak runoff rate *Q*, rainfall intensity *i* (in in/hour) and size of the area *A* (usually in acres).

Other runoff coefficients use different units of measurement for the other variables such as area in m^2 and intensity in mm/hr

The Rational **Formula** is expressed as Q = CiA where: Q =**Peak** rate of runoff in cubic feet per second C =Runoff coefficient, an empirical coefficient representing a relationship between rainfall and runoff.

To calculate the runoff from any given rainfall:

1. Take the dimensions of the footprint of your roof and convert them to inches. (So, a 50' x 20' roof is 600" x 240".)
2. Multiply the roof dimensions by the number of inches of rainfall. (In this example, 600" x 240" x 1" = 144,000 cubic inches of water.)

3.2. Meteorological factors affecting runoff:

- Type of precipitation (rain, snow, sleet, etc.)
- Rainfall intensity.
- Rainfall amount.
- Rainfall duration.
- Distribution of rainfall over the drainage basin.
- Direction of storm movement.
- Precipitation that occurred earlier and resulting soil moisture.

Self-Check – 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. The maximum rate of discharge during the period of runoff caused by a storm is called a _____
2. List same **meteorological factors affecting runoff.**

   _____

   _____

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

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

Answer Sheet

Score = _____

Rating: _____

4.1. **Design modification**

A **design change** is the **modification** conducted to the product. It can happen at any stage in the product development process. The **design changes** that happen early in the **design** process are less expensive when compared to those that take place after it is introduced into full-scale production.

Design Modification Process during the Lifetime of a structural construction when Challenges and Good Practices occurred.

A well-understood **measurement-design** process can become an organizational norm that allows for dynamic change, which in a rapidly changing business environment is **important** for survival because it creates the opportunity for generative learning.

The steps in the product design process include:

- Brainstorming. The first **step to design a product** is brainstorming, which appeared in 1953 in the United States
- Defining the **Product**
- Conducting the User Research
- Sketching.
- Prototyping
- Compiling Specifications
- Producing the Factory Samples
- Sample Testing.

4.1. **Methods for measuring design**

There are many methods for **measuring design**, but in this article we'll talk about analytics, surveys, tree testing, and usability testing, which are particularly helpful when comparing before and after a change.

Performance **measurement** and **improvement** are systematic processes by which an organization continuously and consistently tracks and applies important program and

operations data for the purpose of optimizing its ability to efficiently and effectively advance its desired social impact.

Precision is a metric that quantifies the number of correct positive predictions made. **Precision**, therefore, calculates the accuracy for the minority class. It is calculated as the ratio of correctly predicted positive examples divided by the total number of positive examples that were predicted.

Self-Check –4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. Define Precision (**3 points)**
2. _____Process during the Lifetime of a structural construction when Challenges and Good Practices occurred (**3 point)**.

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

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

Answer Sheet

Score = _____

Rating: _____

LAP TEST 1	Performance Test

Name……. ID……..
Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour for each task. The project is expected from each student to do it.

Task 1- Mark contour lines

Task 2- identify Method of Marking graded lines

Task 3- Measure vertical intervals and slope gradients

LG #63	LO #3- Prepare & Interpret plans and specifications

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics: • Establishing earthworks specifications • Confirming suitability of design specifications • Determining overall plan • Verifying plan accurately • Aligning documentation provided This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**: • Establish earthworks specifications in consideration of desired outcome and prevailing hazard conditions • Confirm suitability of design specifications to comply with the category of work. • Determine overall plan in consultation with landholder and surveyor • Verify plan accurately in line with job requirements. • Provide documentation aligned with the plan and followed in line with industry standards
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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

1.1. Earthworks specification

An **earthworks specification** must address the provision of a well constructed excavation or placement site forming a reliable platform for the subsequent fill operations.

Excavation exceeding 1.5m in width as well as 10sqm. on plan (excluding trenches for pipes, cables etc.) and exceeding 30cm in depth shall be described as **excavation** over areas. **Excavation** exceeding 1.5m in width as well as 10sqm.

In this method Sections are drawn for Each Line of Value. Area of Cutting and **Filling** is found out for each Section with Trapezoidal Method or Nett Area **Calculation** Method. Then volume is determined by multiplying Average Area with Distance between Sections.

Before the **earthwork** is started, the whole area where the work is to be done shall be cleared of grass, roots of trees and other organic matter. Site preparation shall consist of clearing grubbing and removal of any and all inappropriate materials.

The determination of **earthwork** quantities is based upon field cross- sections taken in a specified manner before and after **excavation**. Cross- sections are vertical profiles taken at right angles to the survey centerline. Every section is an area formed by the subgrade, the sideslopes, and the original ground surface.

1.2. Types of Excavation

- Earth **excavation** is removal of the layer of soil immediately under the topsoil and on top of rock.
- Muck **excavation** is removal of material that contains an excessive amount of water and undesirable soil. ...
- Unclassified **excavation** is removal of any combination of topsoil, earth, rock, and muck.

Others types of excavation

- Cut and fill excavation.
- Trench excavation.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I Give short answer

1. _____must address the provision of a well constructed excavation or placement site forming a reliable platform for the subsequent fill operations.
2. Write types of Excavation

_____

_____

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

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

Answer Sheet

Score = _____

Rating: _____

Information sheet 2- Confirming suitability of design specifications

2.1. Design verification

Design verification provides evidence (test results) that the **design** outputs (actual product) meet the **design** inputs (product **requirements** and **design specifications**). Depending on the item being verified, a test case or test suite would be run, or an inspection or analysis done to provide the required evidence.

Cut – off - drains

- These are channels used to collect runoff coming from up hill and divert it safely to a waterway or stream.
- Cut – off - drains protect a crop land, road, house or other property from damage by runoff.

Design of cut-off-drains

- Before calculating the dimensions of the channel which is going to be constructed. We need to determine how much runoff is going to be discharged by the channel.
- There are two methods to determine the discharge
  c) Rational formula
  d) Cook's method

Cook's method

- this is a method of determining the peak run off discharge in areas where data is not available .
- it is based on the catchments area and the catchments characteristics (soil, slope & vegetation cover)
- the peak run off is found from a table

Rational formula.

- this by using empirical formulas to calculate the peak discharge.

$Q = \frac{CIA}{360}$

Q= peak run off rate (M^3 sec)
C= Run off coefficient
I= rainfall intensity (mm/hr)
A= Catchments area (ha)

*. Channel gradient
- channel gradient is determined using the manning formula

$V = \frac{1}{n} R^{2/3} S^{1/2}$

V=mean velocity of flow (m/sc)
n = manning roughness coefficient
R= Hydraulic radios (m)

S= Hydraulic slope (m/m)

$R = \frac{A}{p}$

R= Hydraulic radios (m)

A= Cross-sectional area of the water in the channel (m^2)

P= Wetted perimeter (m)

$Q = AV$ → Q= peak runoff rate (m^3 /Sec)

A= Cross-sectional area (m^2)

V= velocity of flow (m/sec)

The maximum safe velocity is choose from a table depending on soil material of the channel and vegetation cover of the channel.

Self-Check – 2	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I Give short answer

1. _____ is a method of determining the peak run off discharge in areas where data is not available (**3 points .)**
2. _____ are channels used to collect runoff coming from uphill and divert it safely to a waterway or stream (**3 points)**

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

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

Answer Sheet

Score = _____

Rating: _____

3.1. Planning

There are no universal conservation practices that work everywhere. Planning soil conservation is like having a large array of techniques and practices set out each in a separate pigeonhole/compartment. The object of planning soil conservation is to make up a system by selecting a set of individual items which are each relevant to the conditions, and which can be combined into a workable system.

Looking at the large choice of mechanical works, the main factor in deciding which to select must be to define the objective. The way that different terraces will help meet different objectives.

The main objective may be:

- to modify the soil slope
- to influence the surface run-off
- to allow the agricultural use of steep slopes

Preparation for SWC System development planning

Having identified the SWC System for development, the next stage is collecting the above mentioned basic information of the SWC area. Some of the required information may be obtained from maps and aerial photographs if available. However, much of the information will have to be collected from the map, report, interview and field reconnaissance.SWC development planning should refer to **multi-disciplinary approaches**. It is not only conservationist interest but also other sectors of economic development. Mainly agronomist, extension promotes, forester, soil scientist, range land manager, sociologist may be required. But in many situations all these disciplines may not be available. So that the core disciplines can be sufficient.

Information required about SWC area include:

- Assessment of bio-physical particularly climatic conditions

- ✓ Knowledge of **climatic conditions** likely to occur in SWS area is basic requirement. The amount distribution and intensity of rainfall is a particular importance. This is useful for the design of many soil and water conservation structures. In addition the knowledge of rainfall and temperature is essential for selected a suited vegetation erosion control species. This information may be obtained from metrology stations, National Atlas of Ethiopia supplemented by local people information.
- ✓ Information about **topography, slope and vegetation condition** of the area are also required.

- Socio-economic survey
  - ✓ The socio-economic survey must reflect the conditions and important characteristics of SWC area. Socio-economic survey of the SWC area is a fundamental requirement and are useful to identify farmers problems, requirements priorities and also helps to identify where development potentials exist to improve living standard of the farmers.

The format of the development plan consists:

a) **The development map**: The location of the development measures are shown on this map. The extension worker therefore can easily locate on the ground where various soil and water conservation measures to be built. In addition any development work that has been previously implemented (which has been indicated on the present land use map) should be also recorded on this map

b) **A table of inputs**: After completing the development map the next step is preparing the table of inputs to determine the appropriate inputs required for implementing the plan. The volume of inputs required can be estimated from the extent of the work, specification, availability of tools, materials, labor and others.

c) **The time table**: A time table for the development measure should be prepared. The time table is used when to implement the various development measure and quantity of labor and other material required.

Self-Check -3	**Written Test**

Name: _____ Date: _____

Short Answer Questions

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

1. SWC development planning should refer to **multi-disciplinary approaches**. What does a multi-disciplinary approach mean? (5points)

   _____

   _____

2. What are the two Information's required about SWC areas (5points)?

   _____

3. List the format of the development plan consists (5points).

   _____

   _____

Note: **Satisfactory rating >7.5 points** **Unsatisfactory - below 7.5 points**

Answer Sheet

Score = _____

Rating: _____

4.1. Verification

The verification plan identifies the procedures and methods to be used for verification, including the development of test benches and automation. The verification plan is usually distinct from the Verification Tests themselves.

The soil and water conservation plan is very much analogous to the development of a good facility design. The planner must weigh the costs and reliability of different options while at the same time insuring technical feasibility. Construction planning is more difficult in some ways since the structure process is dynamic as the site and the physical facility change over time as agro ecology vary. On the other hand, construction operations tend to be fairly standard from one project to another, whereas structural or foundation details might differ considerably from one facility to another.

4.2. Verification Types

The four fundamental methods of **verification** are Inspection, Demonstration, Test, and Analysis. The four methods are somewhat hierarchical in nature, as each verifies requirements of a product or system with increasing rigor.

The **Verification Process** confirms that Design Synthesis has resulted in a physical structure that satisfies the system requirements. Throughout a system's life cycle, design solutions at all levels of the physical structure are **verified** to meet specifications. **Requirement Verification**: the process of ensuring the **requirement** meets the rules and characteristics defined for writing a good **requirement**. The focus is on the wording and structure of the **requirement**.

The purpose of the verification and validation (**V&V) Plan** is to identify the activities that will establish compliance with the requirements (**verification**) and to establish that the system will meet the customers' expectations (**validation**). Identity **verification** ensures that there is a real person behind a process and proves that the one is who he or she claims to be, preventing both a person from carrying out a process on our behalf without authorization, and creating false identities or commit fraud.

Self-Check – 4	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I Give short answer

1. What are the four fundamental methods of verification? **(4 points)**

   _____

   _____

2. What is the purpose of the verification and validation in SWC plan? **(4points)**

   _____

   _____

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

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

Answer Sheet

Score = _____

Rating: _____

Operation sheet 1 Making physical contour barriers with trash/stone

Objective: To construct physical contour barriers with trash/stone

Materials :Fork , Spade, Shovel

Procedure

Having marked out your contour line using an A-Frame, water leve:

Trash barriers

1. Collect all dry cut grass, twigs, crop residue etc. From around the farm

2. Lay this trash along the contour lines in 1m or 2m wide strips

NB: Trash lines can be very effective in low-rainfall areas where the slope gradient is low and the land is almost flat. One big advantage is that trash lines can easily be moved if you need to change the lay-out of fields or if pegging was not done properly. Compared to the conservation works (which require digging) this is a big advantage.

There is nothing in the whole of nature which is more important than or deserves as much attention as the soil. Truly it is the soil that makes the world a friendly environment for man-kind. It is the soil which nourishes and provides for the whole of nature; the whole of creation depends on the soil which is the ultimate foundation of our existence.

Alignment should be done considering the following:

a) Bunds should be constructed in straight line if possible sharp curves should be avoided.
b) If there are depressions, the bund should be constructed at right angle to them.
c) Longer length of graded bund should be avoided. The maximum length should be 350m.
d) There should be a passage for movement of carts & cattle's.

The plan must include the following items: A conservation plan map. This may consist of several map documents to account for the entire planning area.

Matching indigenous and introduced soil and water conservation plan and schedule of works with site conditions helps us for successful implementation of the plan. Here is the development plan format as described below.

Self-Check – 5	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I Give short answer

1. In SWC measurement what is Alignment should be considered?

_____

_____

_____

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

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

Answer Sheet

Score = _____

Rating: _____

LAP TEST 1	Performance Test

Name……. ID……..
Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour for each task. The project is expected from each student to do it.

Task-1 Make physical contour barriers with trash/stone

Task-2

LG #64	LO #4- Relate plan to site

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics: • Locating key plan points on site • Identifying additional features • Identifying and recording site issues This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**: • Key plan points are located on site. • Additional features are identified on site plan as per work requirements • Site issues which affect survey and pegging are identified and recorded as requirement of the organization.
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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them. 4. Accomplish the “Self-checks” which are placed following all information sheets. 5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks). 6. If you earned a satisfactory evaluation proceed to “Operation sheets

Information sheet 1- Locating key plan points on site

1.1. site plan

The **site plan** shows how your plans relate to the **features** of the land and surrounding area. Pay special attention to precautions to prevent **soil** erosion and **water** pollution. **Conservation** planning, **soils**, erosion control, wetlands; MN Department of Natural . Outline of existing and proposed biological structures soil and water conservation. Distance between physical structures, distance between cut-off drain and bund properly marked. The **site plan** is a detail of a plot area under the boundary of water shade. It is a **plan** of the owner and used for the construction of owners structures. The **layout plan** is a **plan** of a **layout** which include the **site plan**, channel plan, cut-off drain, water ways, community drainage etc.

Before the delineation of degraded lands, it is critically important to closely work with and empower the community for decision making. The community should be given the right orientation and sensitized about the danger of land degradation and erosion hazards based on the concrete facts on the ground and the actual problems they are facing as a result of the degradation. This requires a strong community orientation and awareness creation to convince them and develop sense of ownership before closing the area. The community should be the major actor in problem identification, selection of technical (development options), in reviewing and designing strategies for improvement, in developing management and administration strategies and utilization of the products. In order to minimize the problem of feed shortage for stall feeding after the closure of the land to free grazing; it is necessary to optimize forage production from other sources. This can be achieved by integrating improved forage production into farming system through the establishment of fodder banks on selected plots, intensification of forage production on conservation structures, farm boundaries, in gullies, adopting backyard forage development strategies, ley farming, increasing the productivity of grazing lands by introducing improved forage species and management practices.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I Give short answer

1. What is the role of community in Locating key plan points on site?

_____

_____

_____

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

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

Answer Sheet

Score = _____

Rating: _____

Information sheet 2. Identifying additional features

2.1. Key features of site plan

A site plan is a large scale drawing that shows the full extent of the site for an existing or proposed development. Site plans, along with location plans, may be necessary for planning applications. In most cases, site plans will be drawn up following a series of desk studies and site investigations.

- **Key features of site plan may include:**
  - ✓ Access and outlet.
  - ✓ Contours and slopes.
  - ✓ Drainage lines.
  - ✓ Easements.
  - ✓ Environmental and heritage overlays.
  - ✓ Existing dwellings, buildings or other structures.
  - ✓ **Location** and situation.
  - ✓ Major geological and topographical **features**.

Structural **aspects** includes foundation **plan**, Structural Elevation, Building Sections, Beam, Column, and Slab Specifications. Architectural **aspects** include the isometric view of the structure, Floor **plan**, Elevations which include front view elevation, rear view elevation, and left and right side view elevation.

2.2 Community Features

The **community** has **five functions**: production-distribution-consumption, socialization, social control, social participation, and mutual support.

What are the features of community any three

- **Boundaries**: Great online communities have boundaries. They split the insiders from the outsiders.
- **Purpose**: Great communities have a purpose members strongly believe in.
- **Communication**: Great communities communicate, a lot.

Self-Check – 2	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I Give short answer

1. List Key features of site plan

_____

_____

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

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

Answer Sheet

Score = _____

Rating: _____

3.1. Recording

Any **sites** found will be **recorded** in the first instance to **Site** Avoidance level. The low cost of **electronic** storage does not encourage individuals to **manage** their **records** by disposing of **records** who's lives have expired. There is a greater risk for potential security breaches and damage via virus attacks. There are significant risks of **records** loss or damage due to instability of storage media.

A **record** is any document (paper or electronic) created or received by offices or employees that allows them to conduct business. This definition includes, but is not limited to correspondence.
A **recording format** is a **format** for encoding data for storage on a storage medium. Record information on the diagram topic is an important one.

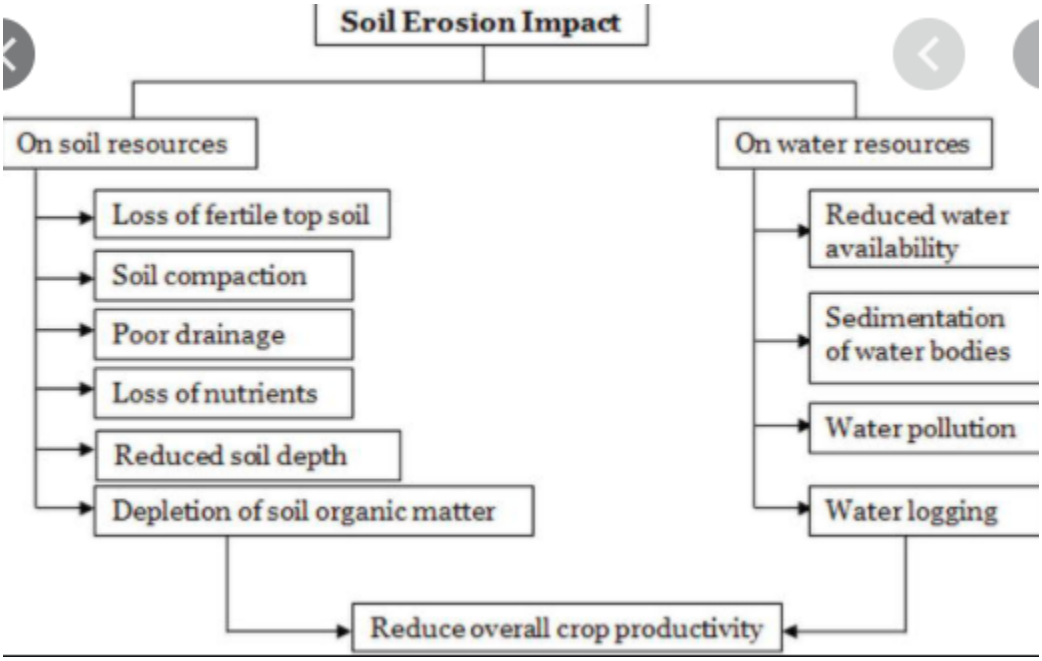


Figure 3.2 soil erosion impact

Self-Check – 3	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I Give short answer

1. Why recording is important? 4 pts

_____

_____

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

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

Answer Sheet

Score = _____

Rating: _____

LG #65	LO #5: Peg project Carry out pegging and construction

Instruction sheet

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

- Establishing pegging sequence
- Measuring site dimensions
- Establishing peg locations
- Selecting materials, tools and equipment
- Advising all construction personnel
- Pegging and constructing earthworks
- Applying site works maintenance inspection schedule

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Establish pegging sequence in consultation with the site surveyor.
- Measure site dimensions in compliance with job specification.
- Establish peg locations using prescribed methods.
- Select materials, tools and equipment are to complete proposed works in line with construction schedule.
- Advise all construction personnel of pegging and the need for site integrity.
- Peg and construct earthworks are in line with in accordance with details specified in project specification and to industry standards.
- Apply site works maintenance inspection schedule to reinstate operating effectiveness of erosion and sediment control measures on site.

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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Before construction of Structural soil and water conservation layout and pegging is first activities after measurement of slope of land.

Bunds are constructed to create stability of existing sub-soils, slope angles and water levels to ensure the integrity of the reclamation area.

It consists of **building** earthen embankments across the slope of the land, following the **contour** as closely as possible. A series of such **bunds** divide the area into strips and act as barriers to the flow of water, thus reducing the amount and velocity of the runoff.

Pegging start next to cut-off drain from the top of farm and from water ways for graded bund. The first peg marked at water ways and follow a head to the farm land up to end of farm. For Level soil bund the sequence started either of the corner. Ways is not mandatory.

Terrace

- Terraces are embankments constructed across the slope
- Land which has a slope in excess of about 2% will usually required some form of physical measures such as terracing to control soil erosion.

Design of bench Terrace

- It include
  1. Type of bench terrace
  2. Spacing bench terrace
  3. width bench terrace

All structural measurements have their own pegging sequences to construct. For each structure pegging sequence should be followed rule and regulations according to structure based.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I Give short answer

2. What is the difference between graded and level soil bund in pegging sequences? (5 pts.)

_____

_____

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

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

Answer Sheet

Score = _____

Rating: _____

2.1. **structural measures**

The Graphics' industry standard is width by height (width x height). Meaning that when you write your measurements, it is better to write them from your point of view, beginning with the width.

Length is describing how long something is while width is describing how wide an object is. In geometry, length pertains to the longest side of the rectangle while width is the shorter side.

General principles of structural measures

- Structural measures refer to those conservation measures which are put on the land physically and are of non living organism.
- Mechanical protection is expensive and time consuming; they deserve careful thought and planning.
- Some of the risks related to physical conservation measures are
  - ✓ short term benefits are not existing
  - ✓ physical measures take more space ultimately reducing the crop land.
  - ✓ We are investing our ,money for future benefit so things related to land tenure must be considered.
  - ✓ The structures may become the hiding place for rodents and other insects which destroy our crops.
  - ✓ If there are mistakes on the designing there might be a great loss of money and other resources.

Bunds

- In high and low rainfall areas the water should not be allowed to attain an erosive velocity.
- On the other hand some of the water can be saved and made available in dry areas for good production of crops.
- The most obvious remedy to control runoff and the soil erosion is to place embankment across the slope.

Types of bundling: Graded and Contour

Graded bunds

- as the name indicate these structures have some gradient which helps to drain water safely.
- Mostly practiced in areas where the rainfall is high > 700 mm/year.
- also practiced in areas where the soil heavy textured

The main functions of graded bund are:-

- reduces the length of slope as a result the soil erosion gets reduced
- It also disposes the excess water very safely to a suitable point.

Limitations

- Require establishment of grassed water way as an outlet
- Not recommended on land slope less than 2% and greater than 8% common up to 35%
- Grassed water way need an extra care.

The bund can be constructed by stone or soil or both.

The choice of these bunds depend on

1. resource available
    - Rock, Money, Man power and Equipment
2. the run-off amount

Design criteria for bund construction

a. Land submergence
b. Water conservation
c. Economy of construction
d. Critical length
e. Seepage condition

} these points should be considered while thinking to construct bund.

Design specification of bund

The following parameters are included in designing of bunds

1. Choice of bund
2. Spacing
3. size
4. side slope
5. Alignment of the bund

contour bunding

- The formation of bunds passing through the points of equal elevation (i.e on contour) of the land, is defined as contour bunding.

- This work can be practiced in all type of permeable soils but it is not recommended for clays and deep black soils as these soils have a problem of cracking . In addition clay soils have a problem of water logging.

Functions of contour bund.

- Reduce the slope length
- Impound the water at upstream portion and permits more water to recharge the soil.
- Trap the sediment eroded form u/s areas.

limitations

- Suitable for areas with rainfall up to 600mm /yr
- It is not used in clay soils
- It is not technically feasible on slope with greater than 6%

1) Choice of bund

- depend on the rainfall, soil condition & type of outlets used.
- in low rainfall areas contour bunds are recommended in high rainfall areas graded bunds are preferable

2) Other parameter differed based on the construction material

a) Soil bund

Design specification

Height; 60cm after compaction

Bottom width : 1-1,2m (stable soils)

1,2 – 1.5m (unstable soils)

Top width : 30 cm (stable soils)

50 cm (unstable soils)

Side slope : 1:1 (H.V) for stable soils

Spacing : 2:1 (H:V) for unstable soils

Slope (%)	V.I(m)	H.D (m)
3-8	1-1.5	
8-15	1-2	H.D = V.I / slope
15-20	1.5-2.5	Exptional cases

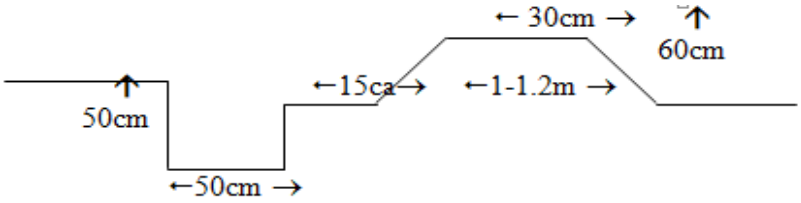


Fig Design of soil bond (stable soil)

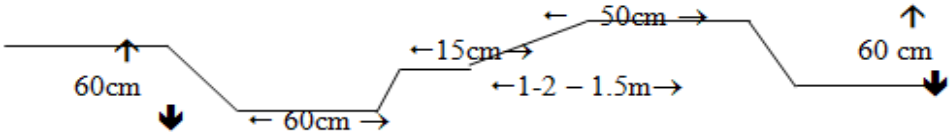


Figure: design specification of soil bund

Design specification

Height: 60-70 cm 100cm on lower side

Bottom width: h /2 + (0.3 – 0.5m) Top width: 30-40cm

Foundation: 0.3m x 0.3m (width x depth).

Table: Spacing

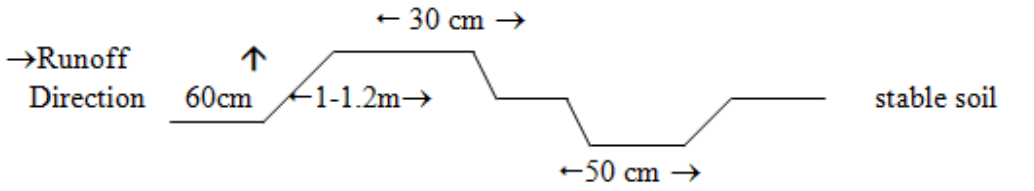
Slope (%)	Height of bund (m)	V.I (m)	H.D (m)
5	0.5	1	20
10	0.5	1.5	15
15	0.75	2.2	12
20	0.75	2.4	10
25	1	2.5	8
30	1	2.6	8
35	1	2.8	6
40	1	2.8	5
50	1.5	2.8	4

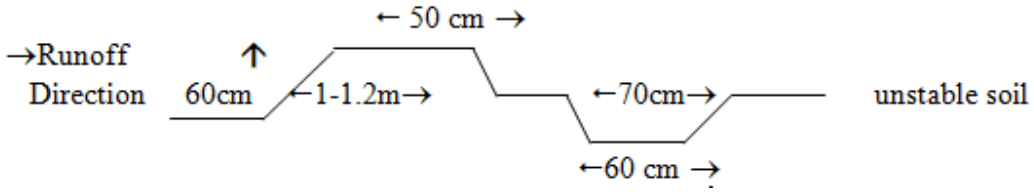
should be the maximum slope

Fanya juu Bund

- suitable mostly in moist wouna dega, medium to high rainfall areas with deep and well drained soils.
- it helps to reduce and stop the velocity of runoff and consequently reduce soil erosion. In high rainfall areas it helps to reduce the erosion. That is caused by overtopping of bunds.

Design





- on the embankment vegetation must grow for stability

  Eg. - Susbania susban
  - Vetirer grass
  - Phalaris grass
  - Elephant grass
  - Enset.

Self-Check – 2	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I choice best answer (2 pts each)

1. One of the following parameters are included in designing of bunds
   A. Choice of bund B. Spacing C. size D. side slope E. All
2. Points should be considered while thinking to construct bund.
   A. Economy of construction C. Land submergence
   B. Water conservation D. All
3. Which vegetation grow on the embankment for stability of structure?
   A. Susbania susban B. Vetirer grass C. Phalaris grass D. All

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

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

Answer Sheet

Score = _____

Rating: _____

Information sheet 3- Establishing peg locations

3.1. Setting Out Survey

Surveying is the process of **determining** the relative position of natural and man-**building sites**, then the two **peg** test should be regularly carried out. Construction **surveying** (also known as “lay-out” or “setting-out”) is the process of indicating or marking precise location and **positions** in a site, this is usually done by expert of soil and water conservation. We can put a peg in right on that mark so the trick is measure out your distance. Drive that peg.

Methods of Setting Out Survey

- **Setting out** structure by meter.
- **Setting out** with clinometer and water level.
- Checking verticality.
- **Setting out** and alignment in structure.
- Alignment and verticality in form work.
- Control and calculation for route surveying.

Self-Check – 3	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I give short answer (5 pts)

1. List Methods of Setting Out Survey

_____

_____

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

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

Answer Sheet

Score = _____

Rating: _____

2.1. Materials tools and equipment

An expert should prepare materials, tools and equipment needed for soil and water conservation. Marking-out tools are used to indicate points or positions, while setting-out tools are used to set surfaces and edges at angles.

Materials tools and equipment should include:

- Meter
- Rope
- water level
- clinometer
- GPS
- pick axe
- Shovel
- Peg
- range pole

Self-Check – 4	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I give short answer (5 pts)

1. List Materials tools and equipment for SWC

   _____

   _____

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

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

Answer Sheet

Score = _____

Rating: _____

5.1. Advise and assist

In implementation of structural soil and water conservation, advise and assist in overall planning is crucial. Building People is bringing together the huge amount of resource that exists across the Built Environment industry, with a focus on diversity and inclusion, skills and careers, and social value. The site manager's role is the supervision and management of all site-based staff employed by the company to ensure that the project is delivered within their contractual obligations. The major responsibilities of the role are to:

- Advise and assist in overall planning.
- Plan and coordinate resources.
- Monitor and control progress and quality.
- Communicate with the consultant team.
- Provide feedback and reports to the client.
- Ensure that all aspects of the project are carried out in accordance with statutory requirements.
- Ensure that all aspects of the project are carried out in accordance with company policy.

Each community has its own knowledge which needs to be transferred and implemented. Thus, **accessing those knowledge requires** identification and consultation of authorized person (relevant and appropriate people) or individuals to whom certain information or knowledge can be disclosed without disregarding cultural code of conduct (rules of correct or appropriate behavior of a community) and rights to that knowledge according to community guidelines and cultural protocols.

Therefore, a better understanding of the **farming system** in the area and the farmers' opinion on tackling **agricultural constraints** should be considered. Moreover, further evaluations and improvement work need to be done. Thus, integrating the traditional with modern developments may lead towards **a sustainable management** of the ever-increasing problem leading to a **comprehensive advancement of the production** system.

Self-Check – 5	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I give short answer (5 pts)

1. What is the major responsibilities manager in implementation of SWC

_____

_____

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

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

Answer Sheet

Score = _____

Rating: _____

6.1. Constructing earthworks

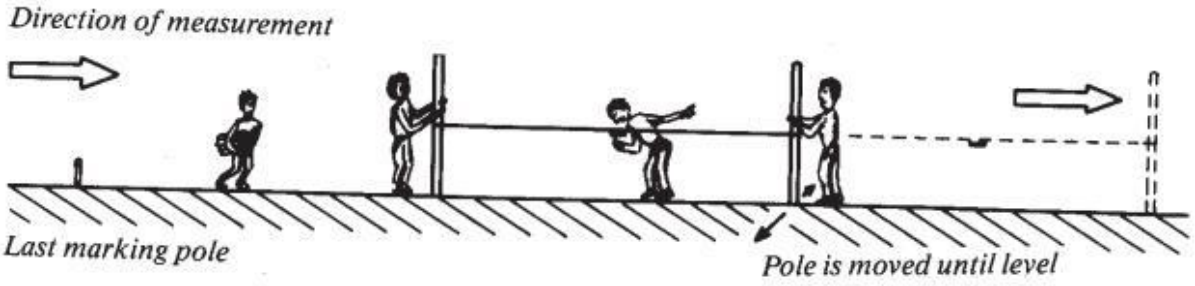
Graded are lines of constant gradient (usually 1% or 2%), going across a slope. They are used to plan conservation structures, such as cut-off drains and graded terraces that need to slope gently so they allow water to drain away.

Contour lines are horizontal lines across a slope, linking up points at the same elevation. It is important to mark contour lines as preciously as possible when building barriers such as level bunds and bench terraces that protect the soil from erosion. A simple way of marking contour is line level.

The line level

A line level consists of two wooden poles of the same height (usually 2 m) with a string 10 m long joining them. The poles have marks every 10 cm. a sprit level is tied exactly in the middle of the string.

Proceed across the slope as shown in the drawing below. Survey 10 m at a time, in difficult topography only 5 m (half the rope).



Several physical conservation measures with the purpose of reducing surface runoff thereby increasing infiltration should be implemented through community participation.

a) Definition:

Slope gradient is the steepness of a slope. It is given as height in percentage of length (%) or in degree.

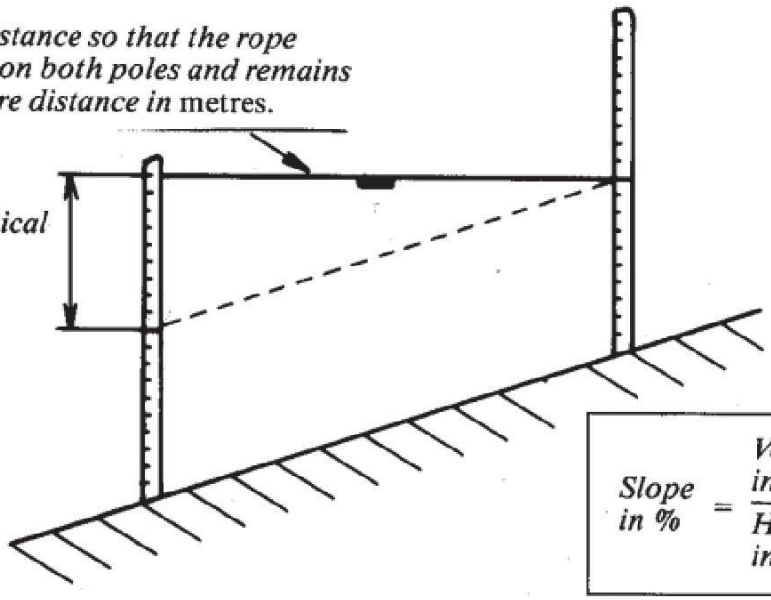
b) Materials:

The following items are needed:
- Waterlevel or this page of the book (see c) below)
- Thin plastic rope, 11 m long, meter band or meter stick
- 2 wooden poles, 2 m long, marked every 10 cm
- Small poles for marking on the ground

d) Measuring slope gradients with the line level:

Follow the steps given below and use the formula to calculate the slope percer tage. Take care that you use the correct units (1 metre = 100 centimetres, cm)

1. *Select any distance so that the rope can be fixed on both poles and remains level. Measure distance in* metres.
2. *Measure vertical interval in* centimetres.



$$\text{Slope in \%} = \frac{\text{Vertical interval in centimetres}}{\text{Horizontal distance in metres}}$$

Figure: 5.6.1 Soil and water conservation structure under construction.

Source: Yericho Berhanu.

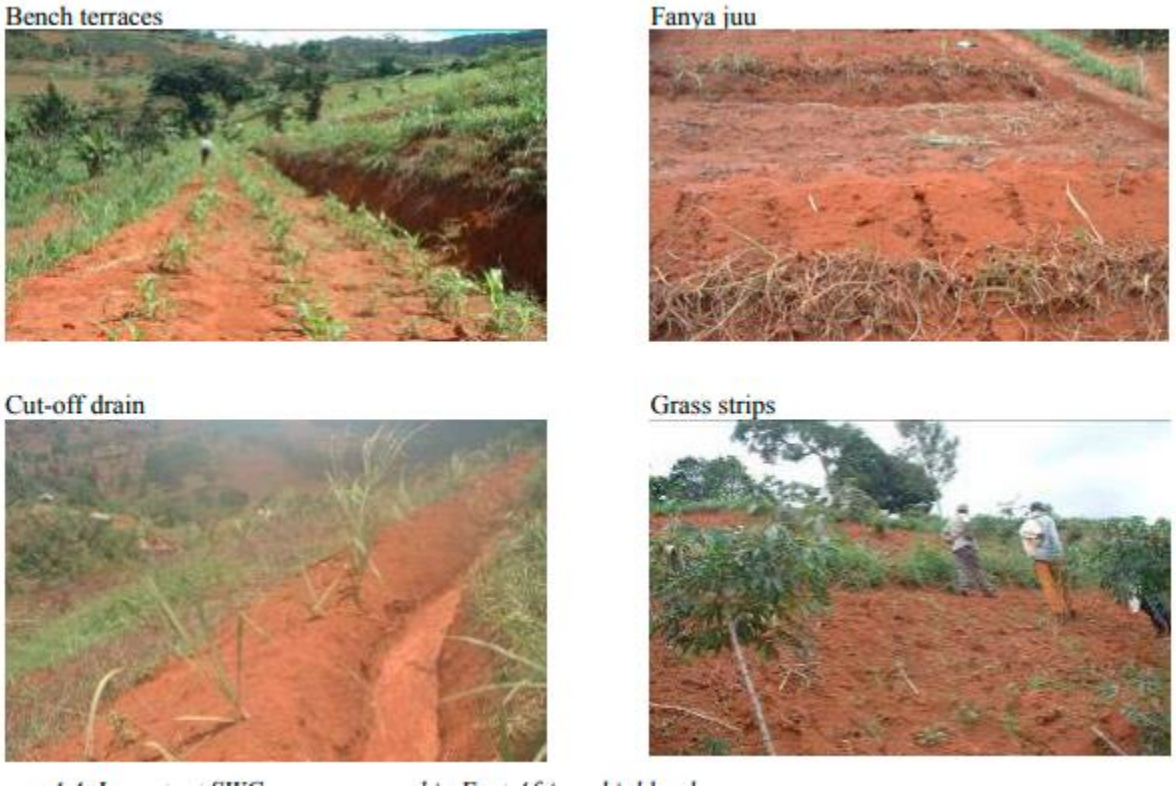


Figure 5.6.2 some physical structures

Self-Check – 6	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I give short answer (5 pts)

1. What is the maximum gradient of slop channel on graded bund of SWC?

   _____

   _____

2. What is the formula of slope?

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

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

Answer Sheet

Score = _____

Rating: _____

Operation sheet 1 Construct bunds

Objectives: To reduce soil erosion

Materials: Two Range pole, Hoe , water level, rope 11m long meter , pegs, pickaxe

Procedures:

1. Wear safety cloths
2. Collect all tools, materials and equipment.
3. Fix the thin rope with each end to one wooden pole (10m between two pole)
4. Mark the middle of the rope at 5m with knot.
5. Hang the small water level in middle of the rope.
6. Three to four people are needed to survey a level line and to mark it on ground
7. Measure the slope of land
8. Proceed across the slope and lay out the structure (10 m at time)

7.1. Maintenance program

As a key component of a **maintenance** program, **inspections include** tasks that check the condition of equipment and determine what tools, materials, and labor are required to service them. A **maintenance inspection is the** process of evaluation the condition of equipment or machines. Repair works to take appropriate safety measures for inspection, maintenance and repair work staff.

A **maintenance schedule** represents the routine services and or inspections that are to be performed on a plant item. Each **maintenance schedule** consists of multiple intervals which are assigned a service or inspection procedure. **Soil and water** are fundamental natural resources for the agricultural practices. This practice reduces the runoff velocity and **checks** erosion processes and structures. These **structures** are cheap, having a long life, and fewer **maintenance requirements**.

Maintenance schedule will be set based on the kind of SWC measures and season of the year. Maintenance activities are very important in keeping each conservation practice identified on the easement area in good condition. Maintenance begins after successful development of the conservation practice and continues for the duration of the practice. Maintenance activities are the responsibility of the landowner.

The *owner* must ensure that all erosion and sediment control practices and all post-construction storm water management practices identified in the SWCD are maintained in effective operating condition at all times.

For construction sites where soil disturbance activities have been temporarily suspended (e.g. winter shutdown) and temporary stabilization measures have been applied to all disturbed areas. Watershed management, particularly **Soil and Water Conservation** (SWC), supports sustainable livelihoods through reducing environmental degradation and increasing crop production (as it increases infiltration and reduces erosion as well as maintains **soil** fertility). After every rain fall season maintenance should be conducted by responsive group.

Self-Check – 7	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I give short answer (5 pts)

1. Why maintenance of SWC structure is importanr?

_____

_____

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

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

Answer Sheet

Score = _____

Rating: _____

Operation sheet 2 Carry out repairs and Maintenance procedures

Objectives

To apply site works inspection, maintenance, and schedule to re-establish operating effectiveness of indigenous soil and water conservation measures on site

Procedures

1. Wear safety cloths
2. Collect all tools, materials and equipment.
3. Identify the destroyed structure
4. Plan for maintenance schedule
5. Conduct maintenances

LAP TEST 1	Performance Test

Name……. ID……..
Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour for each task. The project is expected from each student to do it.

Task-1 Construct bunds

Task 2- Carry out repairs and Maintenance procedures

LG #66	LO6: Finalize work and report

Instruction sheet

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

- Recording and reporting soil and water conservation measures
- Reporting problems or difficulties in completing work
- Documenting and reporting work completion and work outcomes

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, **upon completion of this learning guide, you will be able to**:

- Record and report design, layout and implementation of soil and water conservation measures to the appropriate personnel in accordance with workplace procedures
- Report problems or difficulties in completing work to required standards or timelines to supervisor.
- Document and report work completion and work outcomes in standard format to the supervisor.

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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets

1.1. Documenting result of information

- Information which is extracted from different sources should be documented for future use.
- Documentation of extracted information would help in collecting all relevant information together as evidence or as reference material for required purposes which would further help in providing written details or information about land situation.
- Extracted information may be documented based on but not limited to:
  - ✓ date of extraction
  - ✓ sources of extraction
  - ✓ purpose of extraction
  - ✓ Relationship of information

1.2. **Preparing report/correspondence**

Developing a report/correspondence format, plan and structure

Report is needed to give information about the situation in logical order or to inform relevant personnel in authority about the situation that has happened

Format of the report

To meet the needs of these different users of the report, it has frequently been found useful to divide the plan into the following sections:

- ❖ ***Executive summary***: a summary of the land situation, its problems, the opportunities and the recommendations for action, i.e. the focal point. Reasons for decisions taken are given, but only briefly. Clear, concise writing is of the highest importance. This section should include at least one key map, the (master) land-use plan and possibly other maps at small scales.
- ❖ ***Main report***: Explains the methods, findings and factual basis of the plan. Written for technical and planning staff who wants to know details, including reasons for decisions taken. Often five to ten times as long as the executive summary.

- ***Maps volume***: An integral part of the main report, presented separately for convenience of binding with Appendixes. Give the technical data that support the main report. These may run to several volumes. They include the results from original surveys conducted as part of the plan, e.g. soil surveys, forest inventories, records of river flow.

Example of headings for a report

- *Highlight problems, recommendations and the main reasons for these recommendations.*

Introduction

- *The long-term goals for the planning area and the purpose of the plan*
- *Relationship with other documents. Briefly describe legislation and any higher-level plans as well as local plans that are related to this plan.*
- *Description of the planning area. A brief overview of location, area, population, land resources, current land use and production*

Management problems and opportunities

- *Statement of land-use problems and opportunities.*
- *Rationale for the selected option.*
- *Summary of the changes the plan will bring about, by subject area or geographic area.*

Direction

- *List land-use types and standards that apply to the whole planning area and to individual planning units.*
- *Identify projects. Illustrate with maps and diagrams.*

Monitoring and revision

- *Time scale for action*
- *Describe the procedure for reviewing progress and revising the plan.*

Work plan for implementation

- *List individual projects with details of location, time, resources required and responsibility for implementation.*

Appendixes

- *Supporting information:.*
    - ✓ physical environment, planning units, agroclimate and soil data;
    - ✓ population, settlement, infrastructure, tenure;
    - ✓ present land use;
    - ✓ land-use types and land requirements;
    - ✓ land suitability;
    - ✓ economic projections.

Public relations material

Relatively few people will read the full planning document, a larger number will read the executive summary, but a lot of people need to be informed about the plan. Equally important is a range of public information documents, posters and press releases which are needed to inform the people about the plan, its relevance, the benefits to the community as a whole and the participation needed from different sections of the community. This additional material will draw on the main report but should be specially prepared and well illustrated to secure the most effective participation of all parties.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I give short answer

1. List the contents of a format of the report.(3points)

   _____

2. How does extracted information may be documented ?(2points)

   _____

   _____

3. How does finalizing report/correspondence?(5points)

   _____

   _____

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

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

Answer Sheet

Score = _____

Rating: _____

Information sheet 2- Reporting problems or difficulties in completing work

2.1. **Completing work**

There are many **problems or difficulties in completing work** such as non-routine process and quality **problems**, equipment selection, availability and failure of doing tasks, teamwork and **work** allocation **problem**, safety and emergency situations and such incidents.

2.2. **Reporting a workplace issue**

1. describe the specific behaviour or circumstances that is causing concern.
2. describe the effect the behaviour or circumstance is having on you or your **work**.
3. give your colleague the opportunity to ask questions and respond.
4. state your desired outcome.

- Writing a report/correspondence
  - ✓ After deciding the format of the report the next step is to write a report or account of something from notes made earlier and making communication by means of exchanged written messages such as letters
- Formatting a report/correspondence according to enterprise policies and procedures.
  - ✓ Revising and updating of the report up to date by writing additional entries according to enterprise policies and procedures.
- Checking report/correspondence for accuracy
  - ✓ Regularly check the report for updates and correctness with the tangible situation as of comparing with the changes of the local situation.

Finalizing report/correspondence

- Arranging review and sign off of report/correspondence
- Forwarding report/correspondence to client

Self-Check – 2	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I give short answer

1. Why recording and documenting information? (3points)

   _____

   _____

2. What does the format of documentation purpose consists of?(5points)

   _____

   _____

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

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

Answer Sheet

Score = _____

Rating: _____

3.1. Why Recording and documenting?

Different request would be coming in to you through various means. Those requests may have also different purposes. Therefore, documenting the request accordingly would help you to properly react to request with referring to it. This would further avoid complication and promote keeping evidence for future use. Moreover, identification of request is important to process information and document those information for physical planning, land development and environmental control in the planning area. Some of the requested/ required information may be obtained from documented report, maps and aerial photographs if available. However, much of the information will have to be collected from field reconnaissance. Thus, documenting information would help in obtaining information with saving time and resources with limited core disciplines.

The format of soil erosion assessment and measurement for documentation:

a) **The development map**: The location of the development measures are shown on this map. The extension worker therefore can easily locate on the ground where various soil and water conservation measures to be built. In addition any development work that has been previously implemented (which has been indicated on the present land use map) should be also recorded on this map

b) **A table of inputs:** After completing the development map the next step is preparing the table of inputs to determine the appropriate inputs required for implementing the plan. The volume of inputs required can be estimated from the extent of the work, specification, availability of tools, materials, labour and others.

c) **The time table:** A time table for the development measure should be prepared. The time table is used when to implement the various development measure and quantity of labour and other material required.

3.2. Recording and documenting system

- Manual/hard copy
- Digital and soft copy

Self-Check – 3	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I give short answer

3. List the two Recording and documenting system .(5points)

_____

_____

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

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

Answer Sheet

Score = _____

Rating: _____

Reference Materials

Book:

FAO (Food and Agriculture Organization of the United Nations) (1992). *Protect and Produce—Putting the Pieces Together.* 35 pp. Rome, Italy: FAO. [This is a booklet that outlines the problems of soil erosion and what can be done about it.]

Hallsworthy E. G. (1987). *Anatomy, Physiology and Psychology of Erosion.* 176 pp. New York: John Wiley & Sons. [This book presents a good background to the effects of erosion and farmers' fight against it over the centuries.]

Hudson N. (1995). *Soil Conservation.* 391 pp. London: B. T. Batsford Limited. [This is a classical textbook on the technology of soil conservation.]

Sambatpanit S., Zobisch M., Sanders D. W., and Cook M. (eds.) (1997). *Soil Conservation Extension: From Concepts to Adoption.* 487 pp. New Delhi, India: Oxford & IBH Publishing Co. [This is a book based on the proceedings of a conference held in Chiang Mai, Thailand, which explored the concepts, strategies, implementation and adoption of soil conservation.]

Shaxson T. F., Hudson N. W., Sanders D. W., Roose E., and Moldenhauer W. C. (1989). *Land Husbandry—A Framework for Soil and Water Conservation*. 64 pp. Published in cooperation with the World Association of Soil and Water Conservation by the Soil and Water Conservation Society. Ankeney, IA: Soil and Water Conservation Society. [This is a booklet describing many of the approaches now used in soil-conservation programs.]

Taffa Tulu, 1983. Manual on soil and water conservation

Taffa Tulu, 1998. Perimeter and area of gully cross section

Tato K. and Hurni H. (eds.) (1992). *Soil Conservation for Survival.* 419 pp. Ankeney, IA: Soil and Water Conservation Society. [This book consists of a number of papers which were presented at the 6th International Soil Conservation Conference, Addis Ababa,

Ethiopia, in 1989. They provide an insight into a large range of soil-conservation issues in different parts of the world.]

LAND DEGRADATION ASSESSMENT IN DRYLANDS (LADA) PROJECT.____. Manual for local level assessment of land degradation, sustainable land management and Livelihoods: part2 – Field methodology and tools.

Liniger, H.P., R. Mekdaschi Studer, C. Hauert and M. Gurtner. 2011. Sustainable Land Management in Practice – Guidelines and best Practices for Sub-Saharan Africa. TerrAfrica, World Overview of Conservation Approaches and Technologies (WOCAT) and Food and Agriculture Organization of the United Nations (FAO).

Humberto Blanco and Rattan Lal.2008. Principles of Soil Conservation and Management. Current address:Kansas State University Western Agricultural Research Center-Hays 1232 240th Avenue Hays, KS 67 601 USA; The Ohio State University 2021 Coffey Road Columbus OH 43210 422B Kottman Hall USA.

R. P. C. Morgan. 2005. *SOIL EROSION AND CONSERVATION* .3rd ed. published by Blackwell Publishing Ltd. ISBN 1-4051-1781-8 (pbk. : alk. paper): A catalogue record 2004009787.

WEB ADDRESSES

1. **https://academicjournals.org/journal/JSSEM/article-full-text-pdf/BA1571261038**
2. **https://www.cifor.org/publications/pdf_files/Books/BKassa1102.pdf**

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