	**Agricultural TVET College**	

Small Scale Irrigation Development

Level IV

Learning Guide#08

Unit of Competence

Manage Construction of Irrigation Schemes

Module Title:

Managing Construction of Irrigation Schemes

LG Code: AGR SSI4M08 L01-L03

TTLM Code: AGR SSI4 TTLM08 1218V1

Instruction Sheet	Learning Guide 08

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

- Conduct Land Surveying
- Prepare quantity Surveying bill of quantity and interpret specifications
- Manage construction site activities

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- ✓ Conduct land surveying
- ✓ Prepare quantity surveying bill of quantity and interpreted specifications
- ✓ Check availability and workability of all machinery and equipment throughout construction period.
- ✓ Manage construction site

Learning Activities

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the “Information Sheet”
3. Accomplish the “Self-check”.
4. If you earned a satisfactory evaluation proceed to the next “Information Sheet”. However, if your rating is unsatisfactory, see your facilitator for further instructions or go back to Learning Activity.
5. Submit your accomplished Self-check. This will form part of your training portfolio.
6. Read and Practice “Operation Sheets”.
7. If you think you are ready proceed to “Job Sheet”.
8. Request you facilitator to observe your demonstration of the exercises and give you feedback.

INFORMATION SHEET#1	Conduct Land Surveying

1.1 Introduction:

Surveying or **land surveying** is the technique, profession, and science of determining the terrestrial or three-dimensional positions of points and the distances and angles between them.

These points are usually on the surface of the Earth, and they are often used to establish:

- Maps and boundaries for ownership,
- Locations, such as building corners or the surface location of subsurface features, or other purposes required by government or civil law, such as property sales.

☞ A land surveying professional is called a **land surveyor**.

Surveyors work with elements of geometry, trigonometry, regression analysis, physics, engineering, metrology, programming languages, and the law.

1.2: Selecting required surveying *tools and equipment*

Surveyors use equipment, such as total stations, theodolites, GPS receivers, retro-reflectors, radios, digital levels, GIS, and surveying software.

Note:

☞ Selection of surveying tools and equipments is based on their purpose and sophistication of utilization for the operator

Common land surveying equipment can be categorized as;

Equipment	Purpose	Picture
1. Total stations	☞ It is an electronic/optical instrument composed of electronic transit theodolite integrated with electronic distance measurement (EDM) used to measure both vertical and horizontal angles and the slope distance from the instrument to a particular point.	

2. Theodolite	☞ It is a precision optical instrument for measuring angles between designated visible points in the horizontal and vertical planes.	
3. GPS receivers	☞ It is a device that is capable of receiving information from GPS satellites and then to calculate the device's geographical position.	
4. Retro-reflectors	☞ Is a device or surface that reflects light back to its source with a minimum of scattering.	
5. Digital levels	☞ Are precise instruments used for precise leveling	

1.3: Locating Bench Mark (#BM)

In surveying term bench mark is generally applied to any item used to mark a point as an elevation reference. Bench mark is to be located using standard geo positioning tool (GPS) this is due to its easiness to locate.

Based on its function BM may be classified as temporary and permanent

Geographic positions are specified relative to a fixed reference. Positions on the globe, for instance, may be specified in terms of angles relative to the center of the Earth, the equator, and the prime meridian. Positions in plane coordinate grids are specified as distances from the origin of the coordinate system. Elevations are expressed as distances above or below a vertical datum such as mean sea level.

Figure_6: Bench marks

1.4: Interpretation of lay out drawings

1.4.1 Concept of Layout drawing

A drawing is one of the most effective tools we use to communicate with. It holds no barriers between peoples who don't understand each other's language. It is a method used to communicate and share ideas with people of different cultures and nationalities. The ability to read and interpret construction drawing is of greater value to any construction worker. He will be able to accurately construct an architect's architectural concepts and design in to realistic ground structure.

Construction drawing uses lines, words, symbols, abbreviations and specifications to indicate to the construction team what the ground structure will look like and the purpose and use thereof.

1.4.2: Identifying drawings and symbols used on a construction drawing

1. The different types of drawing and their applications

It would not be possible to give a builder a written description how to construct any construction structure. The construction of any ground structure would require a complete set of drawing drawings that would show all the aspects and outlay of a proposed building. These drawings are commonly referred to as the construction drawings, structural plan or plan.

A construction drawing for a single-story structural scheme would consist of the following drawings:

- A site plan
- A plan view of the floor layout
- Sectional view
- Elevations
- Schematic layout of the ancillary structures
- Details

Each of these drawings would be accompanied with all dimensions, notes and labels. The construction worker must be provided with all the required information to construct the structure.

2. The key functions of the drawing in terms of the finished product

The key function of the drawing is that it must be clear, easy to read. The drawings must consist of sufficient plan layouts, sections and elevations, to gather with detail for special parts of the construction. The drawing must be neatly drawn; with all dimensions, notes, and specifications clearly stated. It must have a clear indication what the finished structural scheme will look like.

The construction team must be able to understand the purpose of the building. Changes to the original design can only be the owner's interest and consultation of the architect or design drawing provider.

3. Key users of the drawing

Before and during the construction the plans will be used by various peoples who are either directly or indirectly involved with the construction of the structural scheme. The reason for this is that the plan will go through many stages before final approval is granted for the structure to be progressed. This approval starts with the client or owner approving the design and cost of construction and then there are the many divisions within the local authorities approving the construction methods.

4. Abbreviations and symbols

The use of symbols and abbreviations is used to prevent ''overcrowding'' the drawing with too many words. Symbols are simple line drawings or graphs that would represent either the various types of materials or fixtures and fittings or services. Symbols are also accompanied by abbreviations. The lines that makes up the drawing are also symbols; with each line representing a feature of a structure. Abbreviations normally takes the form of the shortened version of full words, examples of these are:

- The letter ''B'' on a plan would include the position of the bath in the bathroom.
- ''CONC'' would be the abbreviation for concrete.

Table_1: below shows some of the abbreviations that are commonly used on construction structural plan.

Components/Materials	Symbol		Components/Materials	Symbol
Aluminum	AL		North	N
Concrete	CONC		Not to Scale	NTS
Drawing	DRG		Poltethylene	PE
Hard Core	HC		Soil Pipe	SP
Hard Wood	HWD		Top	T

Table_2: Below shows how material are represented

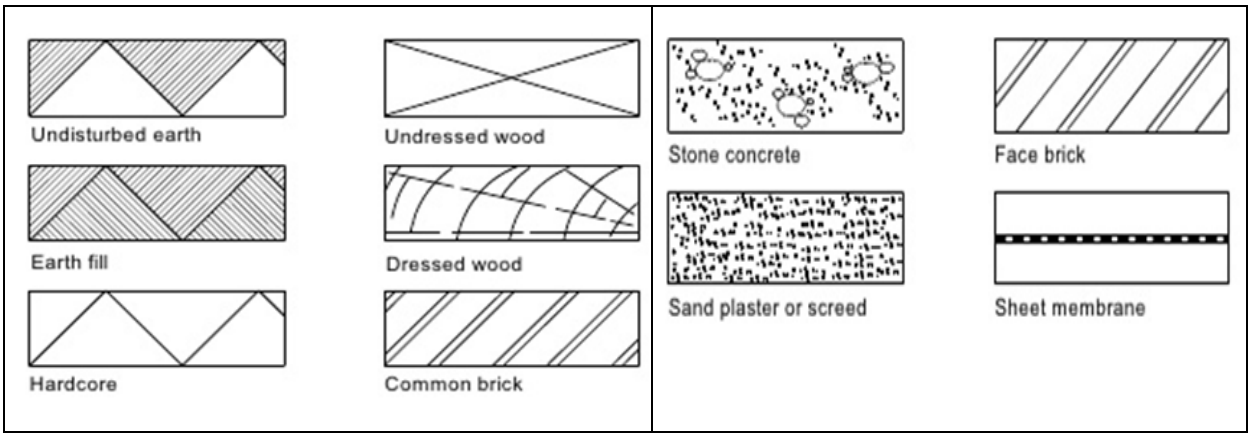


Table_3: Symbols which are known as general graphical symbols that are used to show specific parts on construction drawings.

GENERAL SYMBOLS	
Description	Symbol
Centre line	
Datum line	D
Diameter	
Finished floor level	0,000
North point	
Ramp	1:2
Staircase	

SERVICES	
Description	Symbol
Drain	
Gully	
Hot water cylinder	WW
Storm water drain	
Water meter	

FIXTURES AND FITTINGS	
Description	Symbol
Bath	
Wash-basin	
Water-closet pan (toilet)	
Shower	
Kitchen sink	

5. The layout is interpreted of the different views shown the purpose of each view

Designer must supply the construction worker with the all the information required to successfully progress and complete a construction work. This is done by representing a proposed structure in the form of graphical layout which will consists of various types of drawings.

The layout drawings are also commonly referred to as the construction drawing or structural plan. A builder uses the layout drawings to interpret the designer's idea into reality. All drawings must be fully dimensioned and labeled with all notes and specifications.

The title panel

Each drawing must consist of a little panel. This panel is suited at the bottom of right hand corner of the drawing page and contains a summary of the information the drawings on the page. A typical title panel for a normal structure will read as follows and assuming it is a new structure.

Table_4: A typical title panel of normal structure drawings

NOTES: 	
Title of the project:	New diversion headwork for irrigation water supply Site name, Kebelle, Woreda, Region, Signed by: ……Date:…….. Address:……
Drawn by:	Name:…….. Sign:…… Date:……

Self check # 1	Knowledge questions

Name: __________________________ Date: ________________

Directions: Answer the following questions in the space provided

1. Describe the function/purpose of the following equipments *(10 points)*
   a) Total stations____
   b) GPS ____
   c) Theodolite ____
   d) Retro-reflector____
   e) Digital level____
2. What is the difference between the terms abbreviations and symbols *(5 points)* ____
3. Write the name of the components/Materials which are symbolized below*(5 points)*

   CONC: ____________________

   DRG: ____________________

Note: satisfactory Rating-5 and above pts. Unsatisfactory Rating-below 5 pts.

You can ask your teacher for the copy of the correct answers

Operation Sheet # 1	Establishing Benchmark

Project Title: **Establishing and Locating Benchmark**

Objective: To establish and locate temporary and permanent benchmark

Tools, equipment required

- Surveyors pegs (40-50 cm height, 5x5cm thickness, strong and well sharpened at its bit)
- Hammer
- Marker
- Handheld GPS

Procedures:

- Identify the site to be surveyed
- Decide the accessible and suitable place for benchmarking
- Put and hammering the survey peg as required
- Turn on and read the location point using GPS
- Label the point using marker up on the GPS information's

Precaution:

- Be careful when hammering the pegs

Quality Criteria:

- ✓ Care of the failures of the equipment
- ✓ Take the GPS reading at better satellite strength and accuracy
- ✓ Reading accuracy of GPS would be in a range less than ± 3m

INFORMATION SHEET#2	Prepare quantity surveying, BoQ and interpret specifications

Introduction

Before starting any construction one has to have a thorough knowledge about the volume of the work and the probable cost that may be required for the completion of the project. Otherwise, the construction will be stopped before its completion due to shortage of money or materials.

Types of estimates

1. Approximate/Rough estimate
   - ☞ To get an idea for the probable expenditure in a short time
   - ☞ To prepare a preliminary estimate before drawing up a detailed estimate for a project

   This is made after knowing the costs of similar projects.
2. A detailed estimate

   This is the best method and includes the quantities and cost of everything required for the work.

   Requirements
   - ☞ Drawings
   - ☞ Specification

Therefore, quantity surveying may be defined as the process of calculating the quantities and cost of various works required in connection with the project.

Purposes of quantity surveying

- To know the amount of money required
- To know the quantities of materials required
- To know the tools and equipment required for the construction
- To know the different workers to be employed
- To draw up the construction schedule and program
- To fix up the completion period
- To invite tenders
- To Obtain sanction of necessary funds from the concerned authority
- For valuation of an existing structure

2.1: Identifying type of construction material and equipment

2.1.1: Construction materials

Materials used in construction include asbestos, asphalt, brick and stone, cement, concrete, flooring, foil sealing agents, glass, glue, mineral wool and synthetic mineral fibers for insulation, paints and primers, plastic and rubber, steel and other metals, wallboard, gypsum and wood.

Construction materials can be generally categorized into two sources, natural and synthetic. Natural materials are those that are unprocessed or minimally processed by industry, such as lumber or glass.

Synthetic materials are made in industrial settings after much human manipulations, such as plastics and petroleum based paints.

Types of common construction materials

a) Cement

Cement is a hydraulic bonding agent used in building construction and civil engineering. It is a fine powder obtained by grinding the clinker of a clay and limestone mixture calcined at high temperatures.

When water is added to cement it becomes slurry that gradually hardens to a stone-like consistency. It can be mixed with sand and gravel (coarse aggregates) to form mortar and concrete.

b) Asphalt

Asphalts can generally be defined as complex mixtures of chemical compounds of high molecular weight, predominantly asphaltenes, cyclic hydrocarbons (aromatic or naphthenic) and a lesser quantity of saturated components of low chemical reactivity.

The chemical composition of asphalts depends both on the original crude oil and on the process used during refining.

c) Gravel

Gravel is a loose conglomerate of stones that have been mined from a surface deposit, dredged from a river bottom or obtained from a quarry and crushed into desired sizes.

Gravels can be categorized as finer size (Sand) and coarser size (aggregate).

d) Stones

Stones are the rock material used for construction works; the most commonly utilized construction stones are such as; Alabaster, Basalt, Granite, Limestone, Marble, and Quartzite e.t.c.

e) Cement products

Concrete:

Concrete is a prescribed mixture of cement, sand, pebbles or crushed rock and water, which, when placed in the skeleton of forms and allowed to cure, becomes hard like a stone.

There are three basic ingredients in the concrete mix:

- **Cement:** The cement and water form a paste that coats the aggregate and sand in the mix. The paste hardens and binds the aggregates and sand together.
- **Water**: Water is needed to chemically react with the cement (hydration) and too provide workability with the concrete. The amount of water in the mix compared with the amount of cement is called the water/cement ratio. ***The lower the w/c ratio, the stronger the concrete. (higher strength, less permeability)***
- **Aggregates (Crashed rock and sand):** Sand is the fine aggregate. Gravel or crushed stone is the coarse aggregate in most mixes.

Mortar:

Mortar is a workable paste (prescribed mixture of water, cement and sand sometimes with a little lime) used to bind building blocks such as stones, bricks, and concrete masonry units, fill and seal the irregular gaps between them, and sometimes add decorative colors or patterns in masonry walls.

Cement-mortar ratio for wall plastering, jointing and flooring is performed depending on the quality and types of works and economic consideration.

These mixtures of cement, lime and sand can be generalized as;

- ☞ Mix cement and sand in the ratio of 1:6 – 1:8 (1 cement: 6-8 sand) for jointing
- ☞ Mix cement and sand in the ratio of 1:6 for pointing and inner plastering of bricks.
- ☞ Mix cement and sand in the ratio of 1:3-4 for outer plastering and flooring.
- ☞ And Mix cement, lime and sand in the ratio of 1:0.5:3 for outer plastering.

CURING:

For the cement to be strong, curing is very essential. You must do the curing for at least 14 days, continuously.

The more curing you do, the better it is.

- Slow setting cement is always the best.
- The color of cement has nothing to do with the strength of the cement.
- If too much water is used, concrete loses its strength.

2.1.2: Construction equipment

There are several equipment that is been used in the Construction Industry. These are used for both large and small scale purposes. There are various operations that are involved in construction projects, whether it's a large scale or a small scale such as

- Excavation and digging of large
- Excavation and digging of large quantities of earth,
- Placement of construction materials (eg:-Bricks, concrete)
- Compacting and leveling, Dozing, Grading, Hauling etc…

Construction equipment can be categorized in to 4 main sections based on purpose and use, They are:

1. Earth Moving equipment
2. Construction vehicle
3. Material Handling Equipment
4. Construction Equipment

Categories of equipment	Equipment	Picture
Earth Moving equipment	Excavators	
	Graders	
	Loaders	
	Bulldozers	

Construction vehicle	Dumbers	
	Tankers	
	Trailers	
Material Handling Equipment	Crane	
	Conveyors	
Construction Equipment	Mixers	
	Compactor	
	Pavers	

2.1.3: Selection of construction materials and equipments

The most important decisive factor for the selection of construction materials and equipment are the availability, economic and applicability factors. The following questions shall be made during the planning and site visit of construction works.

- What are the construction materials available in the area?
- Is there a shortage of required construction material in the local market?
- Is it possible to hire construction machinery in the area?
- What is the availability of skilled labor in the area and the rates?

2.2. Interpreting Construction Specification

"Specifications" is a general term applying to all directions, provisions, and requirements pertaining to the performance of the work and payment for the work.

The purpose of construction specifications is to delineate the requirements regarding the materials, products, installation procedures and quality aspects involved with execution of the work and fulfillment of the contract.

Standards of specifications

Construction projects are controlled by the Standard Specifications. These standard specifications contain General Provisions dealing with contracting procedures, general and legal responsibilities of the Contractor, prosecution of the work, control of work and materials, and measurement and payment for the work.

Each section of the construction details, standards of specifications is organized into the following five parts, in the following order:

i. **Description:-** This part consists of short, succinct statements summarizing the work covered by this Section of the Standard Specifications. The Description should not contain details, materials or construction requirements, or explanations of measurement and payment.

ii. **Materials:-** This part specifies the materials requirements the work of this section must meet or refers to subsections in the materials details sections that contain those requirements.

iii. **Construction Requirements:-** This part consists of the required construction procedures or end results of the work to be performed. Specific construction details are specified in this part.

iv. **Method of Measurement:-** This part describes the methods and the units by which the work will be measured for payment to the contractor.

v. **Basis of Payment:-** This part establishes the pay items for work accomplished and, when necessary, explains what is included in the payment for those pay items.

2.3. Determining Man power requirements

Determination of right number and right skills of human force to suit present and future needs is vital to achieve any planed activities. Manpower determination is defined by stainer "strategy for the requisition, utilization, improvement and preservation of an enterprise's human resource. It relates to establishing job specifications or the quantitative requirements of jobs determining the number of personnel with necessary qualification required and developing sources of manpower.

Man power requirements determination is also needed for identifying surplus or shortage manpower areas and there by balancing manpower. In short manpower planning provides right size and structure of human resources which provides the basic infrastructure for smooth

functioning of a project work. It minimizes the cost of employment and nullifies the effects of disruptions in developing and utilizing the human resources.

In any construction work, the needed of skilled and unskilled manpower's or equipment daily and hourly output must be determined to accomplished the planned activity regarding with the given time schedule and estimated budget.

Any construction works are output of a collection of one working crew output or one skilled or unskilled person per day or an hour.

A man power requirement is determined depending on the different factors such as;

- Type of work
- Type of equipment used,
- Persons efficiency

Type of manpower system to be used may depend on:

- ☞ Training
- ☞ Skilled or unskilled availability
- ☞ Sub contract labour

2.4. Determining all service and running cost

Establishment of efficient irrigation practices is influenced by the knowledge the irrigator has concerning both the economic and technological aspects of irrigation. It is of critical importance for irrigators to know how to estimate costs of irrigation under various operating conditions in order to evaluate efficient water use-techniques.

The eventual goal of water conservation research is to have water users establish conservation techniques as part of their continuing operating procedure.

The overall service and running cost for the irrigation project life time may include.

- Fuel cost for operation.
- Oil cost for an internal combustion engine.
- Annual electric connect charge.
- Oil cost for an electric motor and oil cost for a gear drive.
- Maintenance costs for pumping plant.
- Repair and maintenance costs for the distribution system.
- Labor costs for maintaining the pumping plant.

- Labor costs for setup and takedown and operating the distribution system.
- Cost of operating a reuse system for gated pipe systems.
- Cost of driving the center pivot for center pivot systems.

In addition to calculating the annual operating costs, It is necessary to calculate net returns to crop irrigation for the current system and also has six options that can be used to economically evaluate improvements in the pumping plant or the way the irrigation system is used for crop production. The options are:

- ☞ Evaluation of pump repair or replacement.
- ☞ Evaluation of switching power units from one power source to another.
- ☞ Estimates of operating cost changes caused by a falling water table and/or a pump efficiency decline.
- ☞ Estimates of operating costs for different levels of water application.
- ☞ Estimates of operating costs under selected fuel inflation rates.
- ☞ Estimates of changes in operating costs when switching distribution systems and net present value analysis of returns from switching distribution systems.

2.5. Preparing b*ill of quantity*

Bill of quantity is essentially prepared following standard procedure. There are three processes in the preparation of the completed bill of quantities.

- Taking-off quantities
- Abstracting or 'working-up'
- Billing

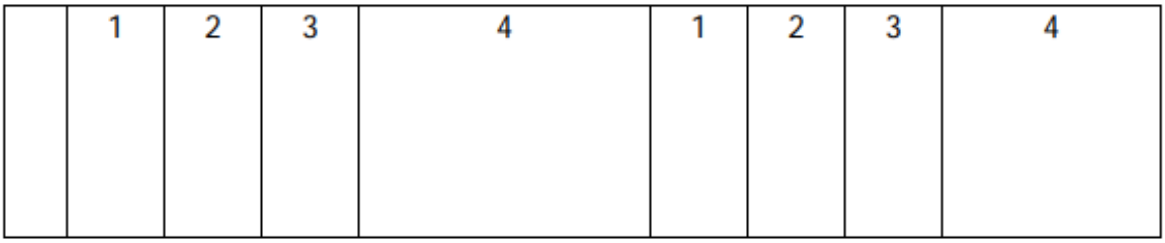
2.5.1 Taking-off quantities

In the first instance quantities need to be extracted from drawings, together with an appropriate description. This process - known as booking dimensions or taking-off quantities - involves the measurer in either reading or scaling dimensions from the drawings. There are two distinct parts to this.

- ☞ The first involves the recording of quantities,
- ☞ Whilst the second required a written description to accompany the quantity.

The sequence adopted by measurers in this initial stage bears little relation to the eventual order of the finished bill of quantities. This is because 'taking-off' has been devised in order to assist the measurer with both the speed and accuracy of recording dimensions.

Dimensions are taken from a drawing and recorded on specially lined paper known as dimension paper.



The format of standard dimension paper

The A_4 page is divided vertically into two identical halves each comprising a set of four columns. These are labeled for the purpose of identifications. The extra column on the extreme left is called the binding margin and would not normally be used for recording dimensions.

The purpose of each column

Column_1 is called the 'timesing column' in which multiplying figures are entered when there is more than one of the particular items being measured.

Column_2 is called the 'dimension column' in which the actual dimensions, as scaled or taken direct from the drawings, are entered. There may be one, two or three lines of dimensions in an item depending on whether it is linear, square or cubic.

Column_3 is called the 'squaring column' in which the length, area or volume obtained by multiplying together the figures in columns 1 and 2 is recorded, ready for transfer to the abstract or bill.

Column_4 is called the 'description column' in which the written description of each item is entered. This column is frequently used to accommodate preliminary calculations and other basic information.

General principles of taking-off

1. Entering dimensions

Dimensions are entered in the dimension column in meters to two places of decimals.

The four principal units of measurement are:

- Enumeration (nr. or pcs.)
- Length (m)
- Area (m^2)
- Volume (m^3)

For enumerated items whole numbers are entered in the dimension column, with a line drawn horizontally beneath each single entry.

The order of recording dimensions is:

- Length
- Width/breadth
- Vertical height/depth

2. Abbreviations

Many of the words entered in the description column are abbreviated in order to save space and time in entering the item by highly skilled technical staff. Many abbreviations have become almost standard and are of general application; for this reason there is a list of the more common abbreviations.

3. Grouping of dimensions

Where more than one set of dimensions relate to the same description, the dimensions should be suitably bracketed so that this shall be made clear.

Where the same dimensions apply to more than one item, the best procedure is to separate each of the descriptions by an ampersand '&' sign and to bracket the descriptions.

4. Adjustment of openings and voids

When measuring areas with openings or voids, the most convenient practice is usually to measure the full area in the first instance, and to subsequently adjust for any voids or openings.

5. Order of taking off

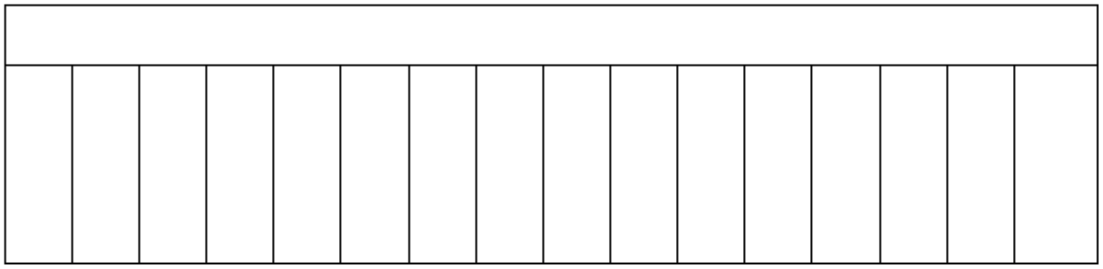
The order of taking off largely follows the order of construction to simplify the work and to reduce the risk of items being missed.

2.5.2 Abstracting or 'Working up' bill of quantities

The sequence adopted by measurers follows construction operations as they occur on site. However, once the take-off is complete, these measured items need to be collated, like items must be merged and deduction adjustments made. This process, known as abstracting or working-up quantities, is carried out on specially lined A3 size paper.

At the head of each abstract a work section heading is recorded. Each measured item is copied from the dimension column and transferred to the abstract. In an effect to avoid double transfer, or the omission of an item, each description is lined through on the dimension sheet as it is transferred.

Descriptions are copied spanning two columns on the abstract and a horizontal line is drawn below each transferred description. The squared quantity is entered below this line, additions on the left and deductions on the right. To provide a cross-reference to the dimension page, each squared quantity is labeled with its source (i.e., the dimension page number) Related work section items from different parts of the take-off will appear on the same abstract. The abstracted items should be well spaced apart, allowing the later insertion of omitted items. Once all measured items have been transferred to the abstract, the quantities are totaled and rounded to the nearest whole unit.



Layout and spacing of a completed abstract

2.5.3 Billing

This is the final stage in the preparation of the completed bill of quantities. The effort of assembling and ordering was completed at the abstracting stage and all that remains is for the descriptions and quantities to be presented in a structured and consistent fashion.

There are three levels of heading and they have the following titles:

Level 1: Group (eg. Substructure)

Level 2: Sub-group (eg. Earthwork)

Level 3: work section (eg. Site clearance)

Table_1: Draft of bill of quantity with level of heading

Item	Description	Unit	Qty	Rate	Amount
	A. SUB-STRUCTURE **1. Earthworks**				
1.1	Site clearance				
1.2	Backfilling				
Sub-total carried to summary					
	2. Concrete works				
2.1					
2.2					
Sub-total carried to summary					
Total carried to summary					
	B. SUPPER STRUCTURE **1. Masonry work**				
1.1					
1.2					
Sub-total carried to summary					
	2. Concert work				
2.1					
2.2					
Sub-total carried to summary					
Total carried to summary					

2.6 Mensuration in Quantities

Mensuration is the term used by mathematicians to describe the measurement of lengths, areas and volumes of different figures. It is necessary to understand the principles of mensuration before dimensions can be correctly presented and recorded on dimension paper.

2.6.1 Girths

One of the most frequently used techniques when booking dimensions is 'girthing'. Most building structures are based on a square or rectangular plan shape and it is often necessary to establish the perimeter of individual rooms or whole structures either internally or externally.

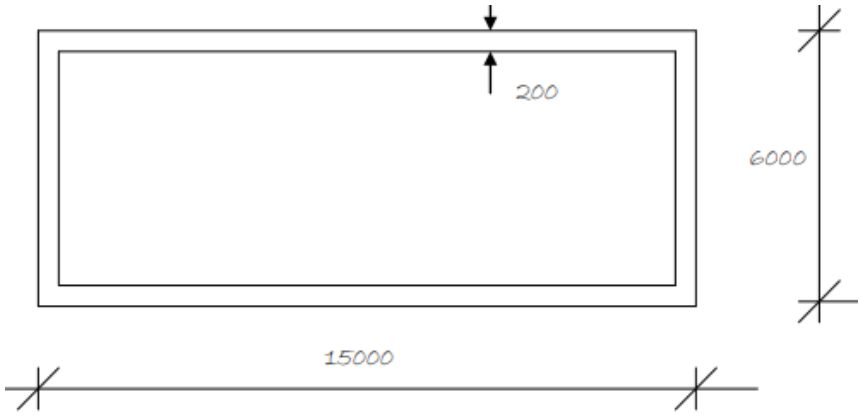
Whilst the drawings will show plan dimensions, before these can be set down and recorded on dimension paper it will be necessary to build up perimeter lengths as waste calculations. This length is required for foundations, walls and associated items.

The length can be calculated by determining:

- The total internal length of the wall
- The total external length of the wall
- The center line length of the wall

Example:

Determine the internal, external and centerline girths for the room plan shown below.



Plan of a structural layout

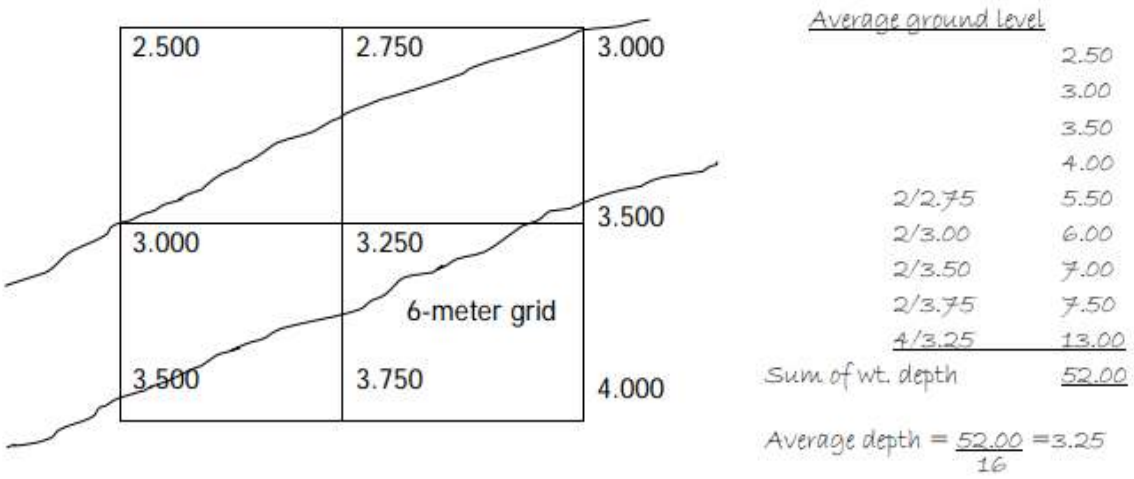
Answer;

External girth	Internal girth	Centerline girth
Length = 2*15000=30000	Ext.gth. =42000 - 8*200 = 1600	Ext.gth.= 42000 – 8*(½)*200 = 800
Width = 2*6000 =12000	Int.gth. = 40400	Centerline gth. = 41200
Ext.gth. = 4200		

2.6.2 Excavation and Earthworks

It is about determining the average ground level of a sloping site.

Example: Determine the average ground level for the sloping site shown below.



What types of works are included in excavation and earthworks?

a) Site clearance

Carbonatious elements are not good in concrete, steel and timber works. In soils under structures even 5% of these elements will damage the structure. Therefore, these materials (including trees, bushes and the top 20 to 30 cm soil), termite hills, any other obstruction, too, have to be cleared.

b) Excavation (bulk excavation)

Excavation to get reduced levels of every structural element below the ground level is called bulk excavation. They are subdivided as follows depending on the subsurface condition.

- Ordinary soil – with boulders and without boulders and can easily be removed by shovel.
- Weathered rock –it can be divided easily without blasting.
- Rock- bedded rocks that cannot be dug without blasting (requires using explosives);
  Note: - Working space for bulk excavation is 25 cm (not used for shallow masonry)
- Depth of excavation less than 30 cm – measured per m^2 ,depth > 30 cm per m^3.

c) Fill / Embankment

Shall be measured in m^3 of net volume to be filled. Fill is required because the reduced level of every structural element above the structure has to be covered. Excavation and embankment should not be added at a time in computing their volume, because their costs are different.

The major consideration under embankment is compaction. Compaction is done usually at 20 cm lift thickness. The subdivisions under fill are:

- *Back fill*: - filling by using the excavated soil but by removing coarse particles.
- *Borrow fill*:- filling by using fill material from another place whe n there is shortage of fill or when better quality material is required.

d) **Disposal** - cleaning the building area including cart away.

e) **Sundry items** – application of termite proof solution, providing hard coring, dust blinding, expansion joints, etc are itemized as sundry items; measured in m^2.

2.6.3 Concrete and masonry works

a) Concrete work

Concrete works comprises of both plain concrete (PC) and reinforced concrete (RC).

Plain concrete (PC):

- Measured inm2 (area) if thickness <20 cm.
- Measuredinm3 (volume) if thickness≥20 cm.
- Average thickness should be mentioned when measurement is done by area.

Reinforced concrete (RC):

- All RC elements measured by volume (m3) except hollow block slabs measured by area (m2).
- Domes, cylindrical roofs and shells measured by area in the horizontal projection.

➢ **Grades of plain Concrete:**

- C5 – lean concrete, to protect the structural concrete from damage
- C15 – for totally supported structural elements
- C20 – used for slabs; mix proportion is 1:2:4 (cement, finer, coarser aggregate)
- C25 – Commonly used grade of structural Concrete; mix proportion is 1:2:3
- C30 – Used for chemical stores and nuclear plants

b) Formwork – measured in m^2

A temporary structural element, which supports slabs, beams in casting concrete. It shall be desig ned and erected to safely support, vertical and lateral loads that might be applied until such load can be supported by the concrete structure.

Period of removal (minimum):

- Vertical formwork to columns, walls and beams: 16 hrs
- Soffits formwork to slab: 21 days

c) Reinforcement:

The different sizes of reinforcement bars are tied by ø6 mm mild steel wire and measured in kg.

Masonry Works

Masonry works are works that are executed by laying building material units of specified dimension through a binding material such as mortar. Stone massonary works is a constituent of (75-85% stone) and (15-25 % mortar). Stone obtained from quarries shall be hard and sound, free from vents, cracks, fishers, discoloration or other defects that will adversely affect strength or appearance. Stone chips to be produced shall not be less than 450 mm average and 380 mm in individual length. Stone for various masonry works shall be selected and shaped as follows:

a) Stone for facing works shall generally be selected for consistency in grain, color and texture, throughout the work
b) Stone for below ground work shall be chiseled from natural stone. Stone wall is measured by volume, whereas stone pavement is measured by area, specifying thickness.

Note:

Important units used as reference to estimate quantities of construction material

- Density of water = 1000kg/m^3
- Density of cement = 1440 kg/m^3
- Acceleration due to gravity (g) = 9.81m/s^2
- Density of river sand (1520 - 1680 kg/m^3)
- Aggregates and crushed stones (1120 - 2080 Kg/m^3)

Concrete mix quantities calculation

Let us consider M20 concrete mix - 1:1.5:3

- Total Volume = 1+1.5+3 = 5.5
- Consider, Wet volume = 1m^3, Dry Volume =1.54x1 =1.54 m^3 (54% increases)

Cement:	**Sand:**
➢ Quantity of cement in m^3 = 1x1.54/5.5 = 0.28m^3	➢ Quantity of sand in m^3 = 1.5x1.54/5.5 = 0.42 m^3
➢ Quantity of cement in kg = 1x1.54/5.5x1440 = 403.2 kg (Density of cement = 1440 kg/m^3)	➢ Quantity of sand in kg = 1.5x1.54/5.5x1500 = 630 kg (Density of sand = 1500 kg/m^3)
➢ Total no. of cement bags required = 403.2/50 = 8.064 bags	

Self check # 2	Knowledge questions

Name: __________________________ Date: _______________

Directions: Answer the following questions in the space provided

1. Define what quantity surveying mean (*4 points*) ____
2. Describe the main purposes of quantity surveying *(8 points)* ____
3. Determine the three basic processes in the preparation of the completed bill of quantities *(3 points)* ____
4. Write down the four main categories of construction equipment based on purpose and use *(8 points)*____
5. Describe at least two types of concrete work products *(2 points*) ____
6. Narrate at least three grades of Concrete *(3 points*) ____

Note: satisfactory Rating- 13 and above pts.   Unsatisfactory Rating-below 13 pts.

You can ask your teacher for the copy of the correct answers

Operation Sheet # 2	Bill of Quantity Preparation

Project Title: **Preparing Bill of Quantity**

Objective: To improve candidate's practical skill, and critical knowledge in drawing interpretation and bill of quantity preparation

Tools, equipment required

- Calculator
- Note book
- A-4 paper
- Pen
- Pencil
- Drawing layout (Plan)

Procedures:

- Interpret and understand the drawing design of the suggested structure
- Identify and estimate the necessary materials required
- Estimate the quantity of the works using the menustration
- Prepare the draft of bill of quantity with level of heading
- Calculate the amount of work and prepare budge summary.

Precaution:

- Be careful when hammering the pegs

Quality Criteria:

- ✓ Follow your trainer's instruction
- ✓ Care of the failures of the equipment
- ✓ Take the GPS reading at better satellite strength and accuracy
- ✓ Reading accuracy of GPS would be in a range less than ± 3m

Note: A complete drawing design of any irrigation structure would be provided by the instructor

INFORMATION SHEET # 3	Manage construction Site Activities

3.1. Checking availability and workability of all machinery and equipment

3.1.1 Checking the availability of all machinery and equipment

During implementation of any construction project the availability of all machinery and equipment used to perform the entitled tasks must be checked throughout construction period.
The availability of all necessary machinery and equipment can be checked based on the division of four sub categories of large scale construction works.

These are based on their functionality. These are as follows:

- Construction Vehicles
- Material Handling Equipment
- Construction Equipment
- Earth Moving Equipment

3.1.2: Checking workability of all machinery and equipment

In construction sector keeping construction equipment and machinery in good operation is mandatory. To attain the good operations construction equipment and machinery needs inspections and checking for servicing and maintenance. Therefore the maintenance of these heavy machineries becomes important.

When the construction equipment are regularly checked and maintained, they last longer in comparison to those that have not been serviced often. Regular maintenance of heavy machinery reduces the repair costs, increases the longevity of the machinery and adds resale value if you intend to sell it.

Operating cost is also important while running these machines. Construction machinery requires fuel or electricity to run. Heavy duty equipment runs on fuel of some kind. When equipments are not up-to-date, these will use more fuel and energy than usual. This increases the operating cost. So, in order to reduce the cost of operation, regular maintenance and servicing of these constructions equipment is required.

Performing maintenance and checking activities

1. **Preventative maintenance**

   Preventative maintenance prevents breakdowns and ensures that equipment is operational and safe to use. Preventative maintenance uses schedules which provide simple guidelines for all types of equipment, covering the tasks to be undertaken in the following areas:

   - Care and cleaning
   - Safety checks
   - Functional and performance checks
   - Maintenance tasks (changing bulbs, lubricating moving parts, etc.)

The best source of this information is usually the manufacturer's user and/or service manual.

2. Repair

Repair means responding to the breakdown of equipment and undertaking work to correct the problem in order to return the equipment to a working condition.

Before equipment can be repaired, you need to be aware that there is a problem! Therefore, there should be a clearly understood system for reporting faults and breakdowns and equipment users should be encouraged to report faults and breakdowns as soon as possible. If there is no back-up equipment, a breakdown will mean that the service the equipment was providing will come to a halt.

- ☞ **Simple repairs** can be done by the in-house or external maintenance and repair team**.** If the equipment is repaired where it is used, it is important that the team is trained to work safely and that they don't create hazards for patients or staff.
- ☞ **More complex repairs** will be carried out by specialized maintenance personnel; they might come to the eye care unit or you may have to send the equipment to them for repairs.

3.2. Allocating and budgeting resources

During execution of construction project resources are allocated and budgeted considering the;

- Time schedule
- Work load and
- Quality requirements.

There are five important aspects used in monitoring and controlling of the allocated and budgeted resources of construction works;

- ❖ Actual schedule progress must be compared against the project program to determine whether the project is on schedule; if it is not, actions must be undertaken to try to bring the program back into conformance.
- ❖ the cost status must be checked to establish how actual performance compares with the budget
- ❖ Quality management, to assure that the work complies with the technical requirements set forth in the contract processes and documents.
- ❖ Safety of equipment, machinery and the manpower has an important role to play in executing the work safely and
- ❖ Managing adverse environmental impacts

3.3. Solving practical challenges and difficulties

Everyone has what they need to complete the tasks necessary to deliver a construction project. It is a big task for anyone to take on and comes with challenges.

Some of the several challenges and difficulties in construction site work and their possible solutions are summarized below;

Challenges/Problems	Possible solutions
☞ Lack of communication - Fragmentation - Unreliable Subcontractors	➢ Performing periodic supervision and management practices
☞ Lack of risk management - **Mechanical hazards** (due to the action of machinery and equipment moving parts) - **Non-mechanical hazards:** such as harmful emissions, contained fluids or gas under pressure, chemicals products, electricity and noise - **Access hazards:** safe access that is not suitable for the work they perform in, on and around machinery and equipment.	➢ Providing workplace health and safety laws required for the highest order control are applied. ➢ Apply 5S (KAIZEN-practices)
☞ Human-resource problems - Lack of Skilled Workers - Absenteeism of labour - Productivity problems - Poor quality / workmanship - Inexperienced management and supervision	➢ Conducting training ➢ Using routine attendance ➢ Routine supervision ➢ Performing experience sharing practices
☞ Time management problems - Time constraints and/or accelerated completion - Late completion of entitled tasks according to schedule - Time Constraints and Excessive Overtime	➢ Motivating manpower ➢ Proper operation and servicing machinery and equipments.
☞ Financial related problems - Late payment - Cost overruns and design changes - Changes of design during construction	➢ Performing payments up on the execution of the item works and the insured agreements

3.4. Creating smooth working environment

The working environment at construction sites must be stipulated in the working environment act to enhance productivity by maintaining safety and health issues.

3.4.1 Preparing safety and health plan (SHP)

The safety and health plan, or SHP, is a description of how the construction site is to be established and fitted out and how work is to take place on site. The purpose of this plan is to ensure that everyone enjoys a good working environment – but at the same time it is a handy steering tool for the construction management team. A written safety and health plan must be prepared if there is more than one employer on the construction site and if more than 10 people are working at the same time.

Contents of the safety and health plan

There are detailed rules on how a SHP is to be prepared and what it should include. Safety and health plan should mainly include;

- An organization plan,
- A construction site drawing, a description of locations on the site where work will be done by several employers, and
- A description of the safety measures to be established.

The plan also has to state who is responsible for checking compliance with the plan and that the plan is updated regularly over the construction period.

Safe work procedures

- Make sure that work on the construction site is carefully planned and arranged, and that everyone has received detailed instruction. This will reduce the risk of accidents and injuries at work.
- There must be instructions for use on all machinery, tools and work tools – and staff must comply with these instructions.
- Keep the construction site clean and tidy so that you can access machinery and equipment and to make sure nobody falls over materials or waste.

Special rules for other construction sites

Small construction sites: There is no requirement for a written SHP on construction sites with several employers but no more than 10 people working. Instead, the individual employers have to agree amongst themselves how to perform work safely and correctly at the construction site.

3.4.2 Enhancing Workplace Productivity

Maintaining and enhancing productivity in the workplace is not always very easy to accomplish. And the need to ensure and enhance employee productivity is essential to achieve a particular aim. The first thing to do is identify these factors, so you can consciously prevent them from emerging or aggravating. You should also be able to suppress them if they already exist.

Some of these preferable ways of maintaining and enhancing employee productivity are;

1. Get rid of motivation killers

As mentioned earlier, there is a need to identify motivation killers in the workplace. A good manager will find ways to carefully observe the work environment in search of problem areas that adversely affect employee motivation.

Typical motivation killers include toxic people, abrasive personalities, lack of organizational vision, and absence of opportunities for professional development, poor communication systems, autocratic management styles, and the feeling of lack of appreciation. Addressing each of these requires a variety of approaches but there are ways to kill these motivation-killers.

2. Motivate through Gamification

Motivation is a very important factor in ensuring productivity. Unmotivated employees get bored especially when they are dealing with monotonous routines. Likewise, employees who lack motivation may not have the enthusiasm to complete challenging tasks.

One effective way of motivating employees is through the use of gamification techniques. Tasks like completing reports or contributing ideas for projects and policy changes can be gamified to make them more appealing, exciting, or interesting.

Gamification involves the use of badges, rewards, leader boards or rankings, points, challenges, and other game elements to make repetitive and quantifiable tasks more engaging.

3. Set Clear Goals and Provide Feedback

Employees or personnel will be more motivated if they know what they are expected to achieve. Clearly stating goals or having a company vision provides guidance for everyone. Short-term goals, in particular, are effective in encouraging employees to properly manage their speed in

doing tasks to meet targets. Additionally, it is important to provide feedback or show that employees are being supervised.

Accomplishments should be acknowledged, while errors or failures in meeting targets should be promptly addressed. Good management practices can enhance and help maintain employee productivity.

4. Use of technology responsibly

Refusing to leverage technology could be considered a grave mistake for any business. There are many technologies that significantly increase productivity in a workplace. To emphasize, using technology is not just about having computers and an Internet connection in the office. It's also important to study and utilize different hardware and software solutions that can improve employee productivity.

5. Set standards and provide skills development

In every business, it is important to establish standards. Employees should be familiar with what the company expects from them. They need to know what they should be doing as well as their assigned roles. Without clear or explicit expectations, people tend to find excuses when they fail to achieve targets. Be clear at the outset: define what you expect of everyone, and how you expect people to perform their assigned tasks and responsibilities.

6. Communicate effectively and efficiently

Communication, without a doubt, is a crucial aspect of business operations. Without an effective system of communication in place, you will have difficulty in achieving goals and even in functioning properly. Communication here, by the way, is not just the simple use of devices, such as phones or verbal and written exchanges of information. Effective and efficient communication means that employees should know the hierarchy and expertise within the construction project or any company.

Self check # 3	Knowledge questions

Name: _________________________ Date: _______________

Directions: Answer the following questions in the space provided

1. Describe the basic contents of the safety and health plan *(3 points)* _

2. Write down the six preferable ways of maintaining and enhancing employee productivity *(12 points)* _

Note: satisfactory Rating-8 and above pts. Unsatisfactory Rating-below 8 pts.
You can ask your teacher for the copy of the correct answers

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions:

1. You are required to perform any of the following:
    - interpreting lay out drawing •
    - Operating surveying materials
    - Preparing bill of quantity and budget of any irrigation project scheme
    - Allocating irrigation project resources
2. Report work out come to the teacher
3. Request your teacher for evaluation

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