AGRICULTURAL TVET COLLEGE

SMALL SCALE IRRIGATION DEVELOPMENT

LEVEL-III

MODEL TTLM

Learning Guide- 03

Unit of competency: Install drainage systems

Module Title: Installing drainage systems

LG code: AGR SSI1M 19 LO1-LO5

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Nominal duration: 55Hr

Instruction sheet	Learning guide- 03

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

- Prepare for drainage system installation activities
- Co-ordinate installation work
- Prepare the site for installation of drainage system
- Undertake installation of drainage system
- Complete installation of drainage system

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 –

- Identify the construction site
- Understand the drainage system plan
- Select construction method
- Select Materials, tools, equipment and machinery
- Carry out pre-operational and safety checks
- Identify OHS hazards
- Assess and controlling risks
- Implement and reporting risks
- Select, use and maintain suitable safety and Personal Protective Equipment
- Identify enterprise work team
- Identify contractors and design consultants
- Coordination work tasks
- Undertake installation of the drainage system
- Maintain a clean and safe work area (environment & gender)
- Interpret symbols and terminology

- Identify layout of services, checking depths and reporting discrepancies
- Complete survey & checking soil characteristics
- Measure and mark out of the site
- Confirm soil characteristics
- Complete excavations (environment & gender)
- Install the drainage system
- Test the drainage system
- Test configuration
- Test flow rates
- Test capacity
- Consult the supervisor& taking remedial action
- Finish earthworks (environment & gender)
- Restore the site and remove waste material
- Clean, maintain and store tools, equipment and machinery
- Record or report work outcomes

Learning Activities

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets.
3. Accomplish the "Self-check" at the end of each learning outcomes.
4. Ifyouearnedasatisfactoryevaluationproceedtothenext"InformationSheet".However, if youacting is unsatisfactory, see your teacher for further instructions or go back to the Learning Activity.
5. Submit your accomplished Self-check. This will form part of your training portfolio
6. Follow the steps and procedure list on the operation sheet
7. Do the "LAP test" and Request your teacher to evaluate your performance

Information Sheet-1	Prepare for drainage system installation activities

Introduction:

Drainage is the removal of excess surface and subsurface water and soluble salts from the land/soil to enhance crop growth, most of the time using gravity system.

Causes of poor drainage

Poor drainage can occur in arid and humid areas and can be caused by natural or human reasons, including:

- The presence of semi-permeable or impermeable layers of soil
- Over-irrigation
- Proximity to reservoirs or coastal areas
- Canal seepage

Why artificial drainage is needed?

Land drainage, as a tool to manage groundwater levels, plays an important role in maintaining and improving crop yields:

- It prevents a decrease in the productivity of arable land due to rising water tables
- A large portion of the land that is currently not being cultivated has problems of the accumulation of salts in the root zone; water logging and salinity. Drainage is the only way to reclaim such land.

Types of drainage systems

The main types of drains are surface and subsurface.

Surface drains

Also referred to as open drains are typically ditches from which low-gravity conditions remove excess surface water from agricultural land. When deep enough, the ditches can also provide relief to adjacent areas. Surface drainage also can be used as an outlet for collection and disposal of water from subsurface drainage systems.

Surface drainage can be achieved by;

- Building ditches,

- Improving natural channels, or shaping the land.

Open ditches have a low initial cost and are easy to inspect.

Disadvantages to these systems include that they reduce the cropping area, require a right-of-way, and have high maintenance costs.

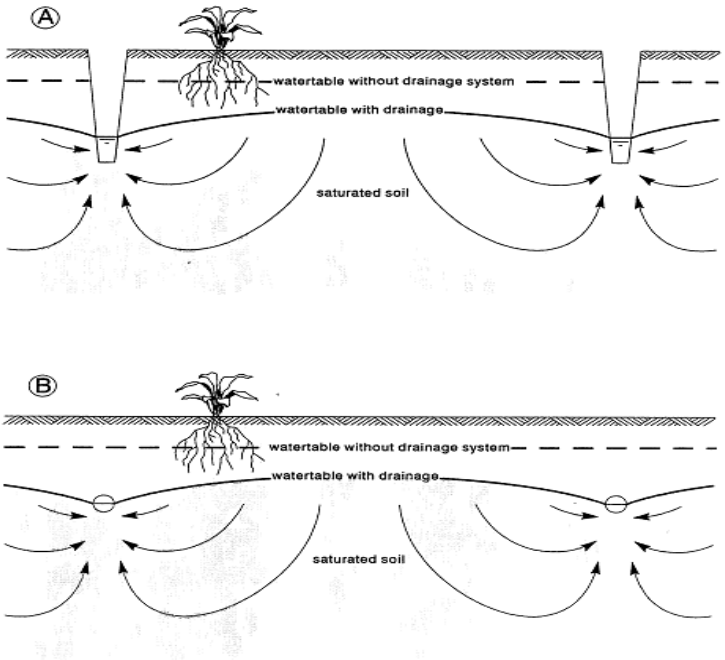
Subsurface drains

This type is closed drains installed underground to remove excess groundwater below the ground surface. These systems are often perforated clay tile, PVC and concrete pipe sections (laterals) were used to help drain agricultural land.

To keep silt and sand from clogging the system and to increase water flow through the pipe, the laterals are surrounded by a nylon envelope or "sock"

Components of agricultural drainage system

An agricultural drainage system is composed of the following basic components



- Field drains
- Collector drains
- Drain outlets
- Water way

1.1: Identifying the construction site for the *drainage system* and construction method

1.1.1 Understanding and identifying the Site to be installed a Drainage System

When planning a drainage system, it should consider factors such as;

- The types and functions of such systems,
- Methods to detect drainage problems,
- Design options, and
- The environmental effects of drainage installation.

Before implementing the drainage system the following important conditions must be determined;

- The desired depth to which the water table should be lowered
- The amount of rainfall received and the amount of irrigation to be applied
- The proper depth and spacing of the relief and collector lines
- The maximum length of laterals
- The material and diameter of the pipe
- The slope grade at which the lines should be installed

1.1.2: Construction method

Generally, installation and construction of drainage can utilize manual system to sophisticated equipment and machinery.

Construction method of drainage system is decided based on the following conditions

- Availability of tools, equipment and machinery
- Type of material to be installed
- Suitability and accessibility of the land (accessibility, soil wetness during installation, trench backfilling and
- The general quality of the work.

1.2: Selecting materials, tools, equipment and machinery

The selection of adequate materials, **tools, equipment and machinery** and their proper installation and maintenance are essential for the effective and lasting performance of land

drainage systems. The appropriate materials, tools, equipment and machinery which are required during installation of drainage work may include:

Surveying and leveling equipment such as

- Automatic level
- Dumpy level
- Staff
- Boning rods
- Pegs
- Notebook
- Pencil and
- Calculator

Hand tools such as

- Rakes
- Shovels
- Spades
- Rollers
- Wheelbarrows
- Hoses and hose fittings

Machinery such as

- Bobcats
- Ditch witches
- Backhoes
- Front-end loaders
- Graders
- Mechanical rollers
- Trucks
- Hydraulic trailers and
- Tractors and

3-point linkage equipment;

- Pumps and pump fittings and
- Fitting and welding tools appropriate to the drainage system.

1.2.1: Drainage materials

Materials for drainage systems include drainpipes and their accessories, envelope materials and auxiliary structures.

Drainpipes and Their Accessories: -PVC and PE are generally used as pipe materials for corrugated plastic lateral drains. Concrete pipes are used for larger collector drains. Specifications and standards for clay, concrete and corrugated plastic pipes are required. Pipe accessories, such as end caps, couplers, pipe fittings and reducers, and rigid pipes for drain bridges and lateral outlets are also mandatory.

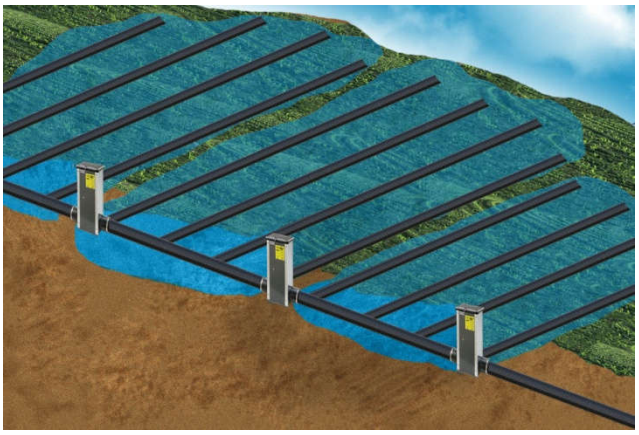


Figure_1. Drainpipes and Their Accessories

Envelopes: - Drain envelopes restrict the entrance of soil particle into the drain, improve the hydraulic conductivity at the soil-drain interface and provide structural stability around the drain. Mineral granular envelopes and pre-wrapped fibrous organic and synthetic envelopes have been used. Specifications and standards for envelope materials must be also provided, as well as rules and recommendations to predict the need of an envelope and design criteria for the selected material. However:

- Methods validated by field experience to assess the need for drain envelopes;

- Selection criteria for the most appropriate envelope material, depending on local soil conditions, need verification;
- Case studies on the evaluation of the performance of drain envelopes in the field, especially for synthetic envelopes are important.

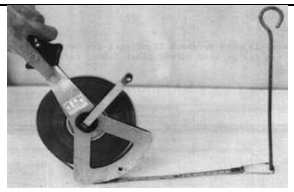
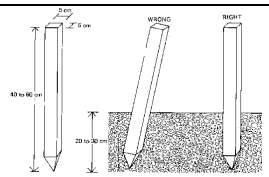
Fig_2. Envelope materials

Auxiliary Drain Structures: - Connection structures, inlets and outlets of water and special structures, such as cleaning facilities and structures for controlled drainage and sub-irrigation, are common auxiliary structures of drainage systems. In this order the following issues can be covered:

- Quality control and maintenance of outlet structures.
- In composite drainage systems, junction boxes and manholes are sometimes hardly used or not used at all and may be unnecessary with GPS availability.
- Designs for special structures for controlled drainage in the lateral and collector outlets must be available, but examples of construction and operation of such structures are not frequent.

Equipment: -

Drainage equipment include land survey equipment and accessories involve in locating and measuring both man-made and natural features in the field. Some of these accessories and equipment are;

Equipment/ accessories	Purpose
Chain and Tape 	- Chains or tapes are used to measure distances on the field.
Plumb Bob 	- A plumb bob is used to check if objects are vertical. A plumb bob consists of a piece of metal (called a bob) pointing downwards, which is attached to a cord
Pegs 	- Pegs (see Fig. 8) are used when certain points on the field require more permanent marking.
Auto level 	- Useful during site surveys and building construction to gather, transfer or set horizontal levels and grade applications.

Drainage Machinery

Some special machines are used for construction, installation and maintenance of subsurface drains.

Installation Machinery: - Trenchers of various types have been used in the past and still are used with success to install subsurface drains, especially for clay and concrete pipes and for granular mineral envelopes.

Fig_3. Installing machine

Maintenance Equipment: -Drainage systems adequately installed with appropriate drainage materials should have low maintenance requirements. Dry rodding is sufficient to remove slight clogging, fresh ochre and roots proliferating inside the drainpipe, especially near the lateral outlet.

To remove sediments and serious ochre deposits and to clean clogged perforations jet flushing is necessary. Medium pressure equipment is also most recommended and flushing should be used only in case of dissatisfaction with or deterioration of drainage system performance.

Fig_4. Maintenance machine

1.3. Carrying out pre-operational and safety checks

During installing and constructions safety checks on tools, equipment and machinery must be carried out. These safety check tasks are carrying out according to;

- Manufacturer's specifications which are provided as manuals and tags.
- Enterprise work procedures which are provided as instructions and supervisory service.

Safety equipment may include signage and barriers

- Signage:- Gives as instructions and instruction to keep us from hazards
- Barriers:- Are physical matters which protects us from hazards

1.4: Identifying OHS hazards, risks assessed controls

1.4.1 Hazard Identification

There are a number of quite simple methods used to identify workplace hazards. For example:

- Workplace inspections, using a formal checklist or spot checks
- Referring to information recorded in incident/injury report of previous occurrences
- Communication with employees and through OH& consultations
- Observing work areas, work tasks, work processes or work methods
- Sharing information with other internal workgroups
- Information supplied by the HR Manager or General Manager Operations, Work Cover Authority or other safety organizations

1.4.2 Hazard Control

Workplace hazards arise as a result of the activities performed, equipment used and the physical and environmental conditions of the workplace.

The factors that create hazards can best be controlled by managers and employees at the workplace. Therefore managers and employees must be equipped with adequate knowledge, skills and an understanding of the application of simple hazard management techniques in relation to their own work environment.

Hazard: a condition or situation that has the potential to cause harm to people at work

Risk: the likelihood that exposure to the hazard will cause harm to people at work and the seriousness of that harm

1.4.3 Risk Assessment

The authority shall carry out risk assessment for its sites. The assessment will involve the identification of hazards present (whether arising from work activities or from other factors, e.g. the layout of the premises) and then evaluating the extent of the risk. These assessments will be carried out on an annual basis in conjunction with the staff representatives

In addition, risk assessments can be called by staff or management side representatives for issues which require urgent consideration

The risk assessments shall:

- ensure that all significant risks or hazards are addressed;
- address what actually happens in the workplace or during work activity
- ensure that all groups of employees and others who might be affected are considered;
- identify groups of workers who might particularly be at risk
- take account of existing preventative or precautionary measures
- be carried out on a regular basis and the significant findings recorded

Risk Control

The rated value of the risk (high, medium or low) will determine the most suitable and practicable method of risk control. The most suitable method of risk control must be selected in relation to the work environment following the hierarchy of control process described below.

The order of preference of selecting risk control is as follows:

- Elimination /substitution
- Engineering control /Isolation

- Administrative controls
- Personal Protective Equipment's (PPE)

1.5 Selecting Suitable safety and personal protective equipment(PPE)

Personal protective equipment (PPE): the appropriate PPE's may includes

- Hat
- Boots
- Overalls,
- Gloves
- Goggles
- Respirator or face mask
- Face guard
- Hearing protection
- Sunscreen lotion and
- Hard hat.

Before you begin, use this checklist to confirm you have followed good safety procedures and have all the right resources.

SAFETY CHECKLIST ACTIVITY		✓
Long trousers, shirt and boots		
Hat (hard hat if necessary) and gloves		
Sunscreen, insect repellant and sunglasses		
Water		
First aid kit		

Self-Check 1	**Written Test**

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. What is drainage, list and explain the types of drainage systems. (5 pts)
2. Describe the basic components of any drainage system? (8 pts)
3. Define what an envelope is and describe its function? (4pts)
4. What are the disadvantages of subsurface drainage system? (3pts)

Note: satisfactory Rating-10 and above pts. Unsatisfactory Rating-below 10 pts.

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

InformationSheet-2	Coordinate installation work

2.1 Identify contractor and design consultant

- **Identification of drainage area**

In thispartyou needtorecorddetailedinformationaboutyour site layout includingwherematerialsarestoredandwhere emergencyresponseequipmentislocated.Site storm water andwastewater drainagemustbeclearlyidentified.Youwill developwhichisanessentialcomponentofyourPlan.

2.1.1 Irrigation Contractor

Irrigation contractors install new irrigation systems and retrofit older systems as standalone projects or as part of larger landscaping jobs. Whether working from designs developed by the contractor or by an irrigation consulting company, contractors develop a formal cost estimate for materials and installation. Contractors prepare the job site, lay out piping and other components, and install the irrigation system. Most contractors offer after-sale service, maintaining and repairing irrigation systems after their initial installation. Contractors troubleshoot and repair malfunctioning components and systems. They also perform regular system maintenance, such as spring startup, controller programming and winterization. Contractors vary widely in size, from a few employees at one location to a company that has multiple branches that service a metropolitan area, a state or multiple states. Irrigation professionals who work for smaller contractors will typically have responsibilities that would be performed by multiple specialists at a larger company. **Irrigation contractor jobs include the following:**

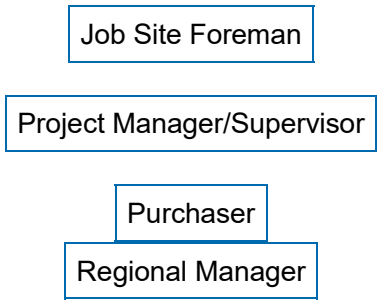
Bidder/Estimator

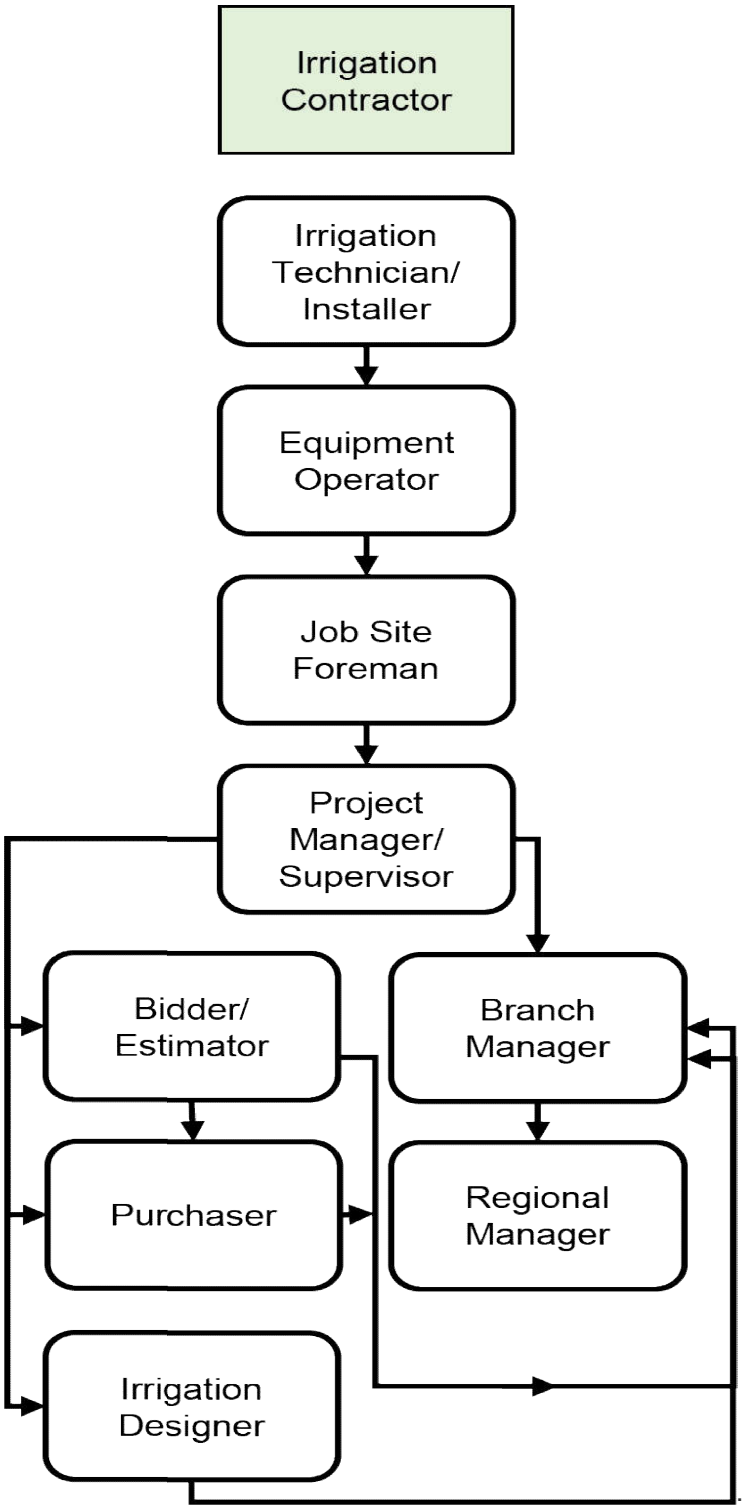
Branch Manager

Equipment Operator

Irrigation Designer

Irrigation Technician/Installer


Job Site Foreman
Project Manager/Supervisor
Purchaser
Regional Manager


Irrigation Contractor
Irrigation Technician/ Installer
Equipment Operator
Job Site Foreman
Project Manager/ Supervisor
Bidder/ Estimator
Branch Manager
Purchaser
Regional Manager
Irrigation Designer

2.1.2 Irrigation Designer

Irrigation designers evaluate site conditions and water availability, then design a landscape irrigation system that meets the client's requirements and budget. Designers create detailed drawings that specify which types and brands of products should be used and how they should be installed. Irrigation designers also develop detailed lists of materials and cost estimates for their projects.

- ✓ **Responsibilities**

- Meet with clients to discuss project objectives, budget and other requirements.
- Evaluate site conditions — including planting areas, soil conditions, sun exposure and elevation changes — and determine water availability and use requirements.
- Select the most effective irrigation equipment, methods and materials for the project.
- Develop efficient and cost-effective irrigation designs that meet plant watering requirements.
- Prepare comprehensive plans and specifications that include construction details, equipment and materials.
- Work with contractor and irrigation managers to ensure the installation and any change orders match the design intent.
- Provide direction to clients on system use, scheduling and maintenance.

2.1.3 Project Manager/Supervisor

Project managers/supervisors are responsible for multiple crews that install, maintain and service irrigation systems. Project managers/supervisors meet with clients, develop bids and cost estimates, schedule and assign projects, and ensure that crews follow all required procedures and safety regulations. Project managers also develop budgets and financial forecasts, as well as implement plans to increase sales, profitability, market share and customer satisfaction.

Responsibilities

- Develop and implement plans to add accounts, introduce new services, grow market share and improve profitability.
- Meet with prospective clients and develop detailed lists of materials, estimated costs and project bids.
- Work with the branch manager to identify staffing needs and hire crew members.
- Schedule projects, assign employees, coordinate subcontractors, order materials, assign equipment and schedule deliveries to the job site.
- Conduct weekly job site inspections and monitor crews' production rates, quality control and safety performance.
- Communicate with clients and job site foremen throughout each project, and resolve customer service issues.
- Ensure compliance with all regulations, reporting requirements, equal employment opportunity laws and company policies.
- Monitor changing market conditions, business opportunities and competitors.

2.2 installation of drainage system according to OHS requirement

2.2.1. Hazard Identification

There are a number of quite simple methods used to identify workplace hazards. For example:

- Workplace inspections, using a formal checklist or spot checks
- Referring to information recorded in incident/injury report of previous occurrences
- Communication with employees and through OH& consultations
- Observing work areas, work tasks, work processes or work methods
- Sharing information with other internal workgroups
- Information supplied by the HR Manager or General Manager Operations, Work Cover Authority or other safety organizations

2.2.2 Hazard Control

Workplace hazards arise as a result of the activities performed, equipment used and the physical and environmental conditions of the workplace.

The factors that create hazards can best be controlled by managers and employees at the workplace. Therefore managers and employees must be equipped with adequate knowledge, skills and an understanding of the application of simple hazard management techniques in relation to their own work environment.

Hazard: a condition or situation that has the potential to cause harm to people at work

Risk: the likelihood that exposure to the hazard will cause harm to people at work and the seriousness of that harm

2.2.3 Environmental considerations

Wherever possible the design and alignment of underground and surface drainage should avoid or minimize the impact on existing environmental values. This includes direct impacts such as tree removal and habitat disturbance as well as ecological process issues, such as changes in water regimes for wetlands or grasslands. The following issues should be considered:

- impact on remnant indigenous trees and shrubs
- impact on remnant native grasslands or wetlands
- impact on native fauna, including local and migratory species
- impact on listed threatened species
- potential to encourage weed invasion

2.2.4. Setting out alignments and levels

The location and alignment of the drain lines must be set out before the actual digging can begin, (Figure1). First, the downstream location of the drain is marked off by placing a row of pegs along the collector drain at the design drain spacing. Next, the center line of each drain is set out by placing another row of pegs at the upstream end. Stakes are placed in the soil at both ends of the drain line with the top of the stakes at a fixed height above the future trench bed using a leveling instrument. This very clearly indicates the drain line. The direction of the field drains is assessed standing at the starting point at the collector line, thereafter marking off the location of the field drains with pegs.

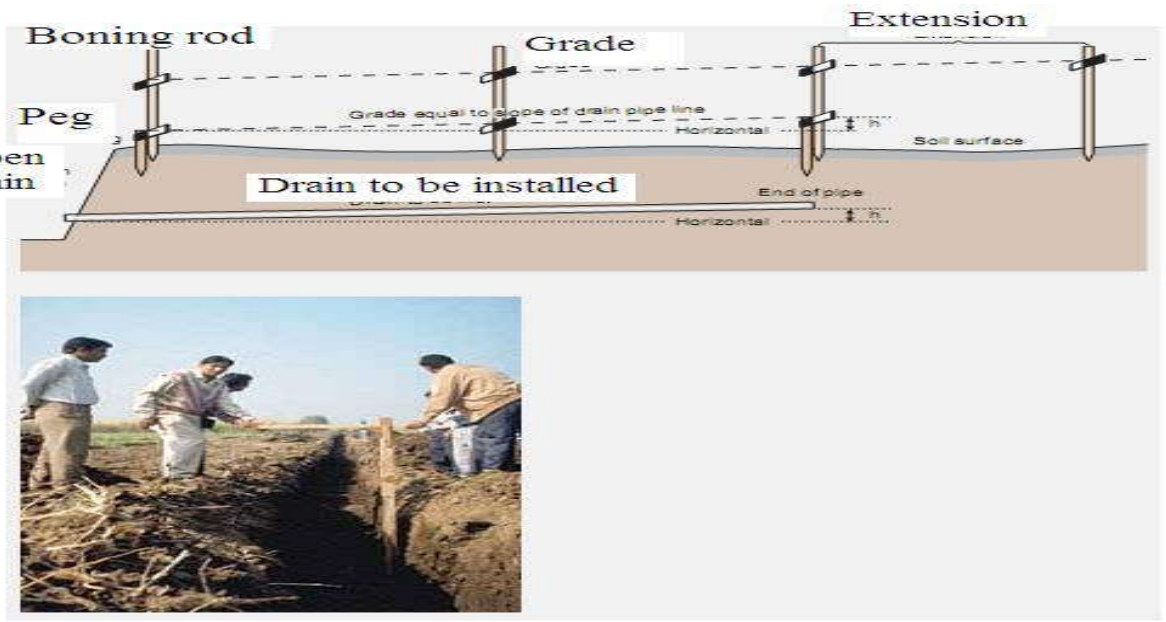


Figure_2.1: Setting out alignments and levels

Setting out trench location

- ✓ Setting out the drainage system (with pegs in the field indicating where the drainage system will come, where the manholes are to come etc.);
- ✓ Giving reference levels for the installation of the drainage system (for adjustment of the laser);
- ✓ Managing the laser: transporting, charging and setting up the emitter and adjusting the slope;
- ✓ Giving levels for installation of manholes and checking the levels during installation.

Excavating the trenches

Excavation work generallymeans work involving the removal of soil or rock from a site to form an open face, hole or cavity using tools, machinery or explosives.

Specific duties apply in relation to the higher-risk excavations such as trenches, shafts and tunnels. However, these requirements do not apply to a mine, a bore to which a relevant water law applies or a trench used as a place of interment.

There are three methods of mechanical installation:

- ✓ Excavator. All steps in the implementation process are separate steps, implemented one after the other. The trench is dug by the excavator to about 5 cm above the required drain depth and up to the last few centimeters, when the leveling and placing the drain pipes is done by manual labor;

- ✓ Trencher. Digging the trench, placing the drain pipes and (if applicable) the envelope, is done in a one-time operation. The pit from where the laying of the pipe will start is either dug by the trencher itself or an excavator;
- ✓ Trenchless. Just like the trencher method, it is a one-time operation, but instead of digging a trench the pipe is directly ploughed into the soil.

Figure_2.2: Excavating the trench

2.2.5. Laying bedding materials

Porous material placed around a subsurface drain, to protect the drain from sedimentation and improve its hydraulic performance, should be referred to as a drain envelope. It is worthwhile to distinguish between the definition and function of an envelope and that of a filter.

Envelopes have the task to improve the permeability around the pipe, and act as permeable constraints to impede entry of damaging quantities of soil particles and soil aggregates into drainpipes. Yet the majority of small particles of soil material and organic matter, suspended in water moving toward a drain, will actually pass through a properly selected and installed drain envelope without causing clogging. The relatively coarse envelope material placed around the drain should stabilize the soil mechanically and hydraulically, but should not act as a filter.

In addition to the functions described above, drain envelopes can improve the bedding conditions. This bedding function is primarily associated with gravel envelopes in unstable soils. Gravel provides a mechanical improvement in the drain-envelope-soil system, serving as bedding and side support for large diameter plastic pipes.

Envelope materials used to protect subsurface drains have included almost all permeable porous materials that are economically available in large quantities. Based on the composition of the substances used, they can be divided into three general categories: mineral, organic, and synthetic envelopes.

Figure_2.3: Envelopes can be made of wrapped polypropylene fibers (a, f & g), polystyrene granules (b) and coconut fibers (c), non-woven nylon (d) and woven type (e)

2.2.6. Lowering and positioning pipes

Placing the pipes

Several methods can be used to place the drain pipes, depending on the type of pipe (Figure4):

- Concrete/clay drainpipe. The drain pipes are loaded to a platform on the machine and then put along the chute in the trench box to the bottom of the trench. This requires one lab our on the platform to put the pipe in the chute and one lab our in the trench box to put cloth or other sealing around the joints;
- Flexible corrugated drain pipe. The field drain pipes are delivered in coils and the coils are put on reels attached to the machine. The drain pipe is guided over rollers into the trench box. A press pulley puts the pipe at the bottom of the trench;
- Plastic collector pipes are larger in diameter and cannot be coiled. The pipes are delivered in sections of 6-12 m. These larger diameter pipes are usually laid out on the field beforehand. The pipesections need to be connected in the field over the full length of the collector drain before the pipe laying starts and then guided through the machine.

Figure_2.4: placing the pipes: (a) concrete/clay pipes (b) flexible corrugated pipes and (c) large diameter plastic pipes

Back filling Pipes to specifications.

Backfill of the drain trench is a three-step operation (Figure5&6):

Blinding. Careful placing of an initial backfill of 0.15 to 0.30 m of soil around and over the drain is referred to as blinding. This is done to ensure that the drain will remain in line when the

remaining excavated material is placed in the trench. Blinding the drain may be done by shaving off the topsoil at the top of the trench with a spade or with an attachment (scraping knife) to the trench box. Care should be taken that the alignment of the drain is not changed;

Backfill. The fill should be firm but not compacted too much so that it prevents the passage of water to the pipe. All trenches should be filled to a sufficient level above the surface of the ground to allow for settlement. Trenches are preferably backfilled the same day they are dug to avoid a possible destabilization of soil under wet conditions, such as irrigation, rain or high water table. Only in unripe soil is it advisable to leave the trenches opens for some time to initiate ripening;

Compaction. Compacting is required to avoid serious problems arising in irrigated areas when water moves rapidly through the unconsolidated trench fill causing severe erosion (piping).

Trench backfilling is done by the following methods:

- ✓ Hand with shovels;
- ✓ Bulldozer;
- ✓ Grader;
- ✓ Tractor equipped with a dozer blade;
- ✓ Screw augers mounted on the trenching machine.

Figure_2.5: Backfilling of the drain: using a dozer and grader

Figure_10: Backfill equipment: tractor with dozer blade (a) and V-shaped disc-blade mounted at the rear end of a subsoil type trenchless drainage machine (b)

2.3 establish clean and safe area

- **establish clean area**

✓ Municipalstaffshouldregularly inspect facilitiestoensure thefollowing:

- Immediaterepairofanydeteriorationthreatening structuralintegrity.
- Cleaningbeforethesumpis40%full.Catchbasins shouldbecleanedasfrequentlyasneededtomeetthis standard.
- Stencilingof catchbasinsandinlets

✓ Cleancatchbasins,stormdraininlets,andotherconveyance structuresinhighpollutantloadareasjustbeforethewet seasontoremovesedimentsanddebrisaccumulatedduring thesummer.

✓ Conductinspectionsmorefrequentlyduringthewetseasonforproblemareaswhere sedimentortrashaccumulatesmoreoften.Cleanandrepairasneeded.

✓ Keepaccuratelogsofthenumberofcatchbasinscleaned.

✓ Recordtheamountofwastecollected.

✓ Storewastescollectedfromcleaningactivitiesofthedrainagesystemin appropriate containersortemporarystoragesitesin amannerthatpreventsdischargetothestorm drain.

- ✓ Dewaterthewasteswithoutflowintothesanitarysewerifpermitted. Watershouldbe treatedwithanappropriatefilteringdevicepriortodischargetothesanitarysewer.If dischargetothesanitarysewerisnotallowed,watershouldbepumpedorvacuumedtoa tankandproperlydisposedof.Donotdewaterneara stormdrainorstream.
- ✓ Exceptforsmallcommunitieswithrelativelyfewcatchbasinsthatmaybecleanedmanually, mostmunicipalitieswillrequiremechanicalcleanerssuchaseducators,vacuums,orbucket loaders.

Establish safe area

During installing and constructions safety checks on tools, equipment and machinery must be carried out. These safety check tasks are carrying out according to;

- Manufacturer's specifications which are provided as manuals and tags.
- Enterprise work procedures which are provided as instructions and supervisory service.

Safety equipment may include signage and barriers

- Signage:- Gives as instructions and instruction to keep us from hazards
- Barriers:- Are physical matters which protects us from hazards
-

Self-check-2	Written test

Name: _____ **Date:** _____

Directions: Answer all the questions listed below.

1. Define what an envelope is and describe its function? (5pts)
2. How can we establish clean and safe area? (10 pts)

Note: satisfactory Rating-7.5 and above pts. ***Unsatisfactory Rating-below 7.5 pts.***

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

Information- 3	**Assess efficiency of irrigation and repeat cycles of irrigation**

3.1. Measuring effectiveness of irrigation application

Irrigation systems should be evaluated in order to limit the following common water losses:

- Evaporation from the soil and plant surfaces, runoff from the target site, and deep percolation below the root zone.
- Irrigation systems should be periodically inspected and properly maintained for best performance.
- Managementpracticessuchasirrigationschedulingandconservationtillagecanhelptoimprovetheoverallwateruseefficiency on the farm

Water application efficiency is a measurement of how effective the irrigation system is in storing water in the crop root zone. It is expressed as

The percentage of the total volume of water delivered to the field that isstored in the root zone to meet crop evapo transpiration (ET) needs

Irrigation System Performance Testing

Accurate measurement or estimation of water inputs and use/outputs is required in order to assess overall farm water use. In-field irrigation performance is most commonly defined in terms of how efficiently and uniformly a known volume of water is applied; these themes are discussed below.

Metering Irrigation Water: All sites where water is extracted for irrigation must have a water meter installed according to the Natural Resources Management Act 2004. Water meters are important tools and provide information that is fundamental to good irrigation management. Examples of different meters used in the South East and tips on how to read and use your meter can be found in the "Irrigation Systems" section of the "Water and Coast" tab on the "Natural Resources South East" website.

Irrigation Efficiency: Field Application Efficiency = crop water use □ water delivered to irrigated field

Irrigation efficiency is defined as the ratio of water used by (or available to) the plant to the water input (i.e. the volume pumped). That is, application efficiency of 85 % indicates that 85 % of the water pumped was stored in the root zone for use by the crop and 15 % was 'lost'.

The goal of irrigation design and management is optimum efficiency, not necessarily maximum efficiency, to deliver irrigation water in the target range.

Efficient water use at the whole farm scale may be found by considering efficiency of the following sub-systems:

- supply systems (i.e. pumping from groundwater bores and on-farm storage dams or tanks)
- storage systems (i.e. dams, tanks and ponds)
- distribution systems (i.e. earthen channels and enclosed, pressurized pipes)
- application systems (i.e. surface, spray and drip)
- recycling systems (i.e. run-off / tail water dams and wastewater reuse schemes)

Both the input and output water volume can be defined at a range of locations and over a range of time scales within the overall irrigation system. Where and how the manager chooses to measure these will vary according to system design and site characteristics.

Tip Scheduling irrigating to replace crop water use requires that efficiency of the irrigation system be considered in calculations. If distribution efficiency is poor (leaks, atmospheric losses etc.), the volume of water pumped may need to be substantially more than that required by the crop. If this is not accounted for, there is a risk of under-irrigation throughout the season with resultant productivity losses

Considerations for Improving Efficiency

Routine Maintenance: Irrigation systems should be periodically inspected and properly maintained for best performance. The uniformity of water application is also important to check periodically as irregularities in application patterns can lead to yield losses. For example, a

detached normal functioning sprinkler nozzle could lead to leaching of nutrients from over irrigation or dry patches in the field

Irrigation Scheduling: The overall efficiency of water use can be improved when irrigation events are scheduled based on soil moisture estimates or measurements. Soil moisture can be tracked with soil sensors and/or weather-based crop ET estimates to determine when and how much irrigation is needed. This can help to avoid over-watering and crop water stress.

Reduce the Frequency of Irrigations: With certain types of spray irrigation equipment, application efficiency can be reduced as application frequency increases. With every application, a percentage of the water applied will evaporate from the wet soil and plant surfaces. The rate of evaporation from the crop canopy will depend on climate demand, time available for evaporation to occur, and the surface area of the droplets. Evaporation from crop surfaces is considered the greatest evaporative loss from most sprinkler or spray irrigation systems.

Water Measurement: An irrigation flow meter can be
used to monitor the total volume of water pumped. Water measurement data can be helpful with determining overall irrigation system efficiency, monitoring system performance, detecting well problems, monitoring pumping plant performance, and simplifying completion of annual water use reports.

Residue Management: Conservation tillage practices such as no-till and strip tillage have been shown to improve soil water holding capacity, water infiltration rates, soil moisture retention, and reduce runoff compared to conventional tillage.

3.2. The estimated soil moisture level in scheduling system is adjusted to match that measured.

Monitoring soil moisture for irrigation need to:-

- Provide efficient and timely applications of water to crops
- To Provide growers with water management tools to Test equipment in conjunction with growers
- Obtain grower feedback

Before starting this scheduling three major items should be known:

- Water holding capacity (WHC) of soil in the root depth
- Estimated Etc of the crop to be grown
- Soil moisture balance at the beginning of the scheduling period

By entering all these in the appropriate column of the worksheet the moisture balance at the end of the week is determined

Gravitational Water: The water in the large pores that moves downward freely under the influence of gravity is known as the. Gravitational water. This is the water between the saturated point and FC. .

Field Capacity (FC): Yield capacity is the moisture content of the soil when rapid drainage has essentially ceased and any farther drainage occurs at a very slow rate. The FC corresponds to a soil moisture tension of about 1/10 to 1/3 atmosphere.

Permanent Wilting Point (PWP): The Soil moisture content at which the plant wilts permanently or dies is known as permanent wilting point. The soil still contains some water but it is too difficult for the roots to extract it from the soil as it is held with a suction force of about 15 atm. typically for medium soils the moisture content at PWP is about one-half the FC.

Available Water

The water contained in the, soil between FC and PWP is known as the available water.

Total Available Water (TAW)

The amount of water, which will be available for plants in the root zone, is known as the total available water. It is the difference in volumetric moisture content at FC and at PWP; multiplied-by root zone depth.

Management Allowable Depletion (MAD)

MAD is the degree, to which the water in the soil is allowed to be depleted by management decision.

Reference Crop Evapotransporation (ETo)

The rate of evapotranspiration from an extensive surface of 8 to 15 cm tall green grass cover of uniform height, actively growing, completely shading the ground and of not short of water is known as the reference crop evapotranspiration.

Crop Evapotranspiration (ETc): The depth of water needed to meet the water loss through evapotranspiration of a disease-free crop, growing in large fields under non-restricting soil conditions including water and fertility and achieving full production potential under-the given growing environment.

Crop Coefficient (Kc): The ratio of ETc / ETo is termed as crop coefficient.

Effective Rainfall (Re): Rain that is retained in the root zone and used by plants is considered as effective rainfall.

Effective Rainfall (Re) =Total rainfall(R)-Runoff (R0)-Evaporation (E)-Deep Percolation (P)The amount of water, which will be available for plants in the root zone, is known as the total available water. It is the difference in volumetric moisture content at FC and at PWP; multiplied-by root zone depth.

Available Water Capacity (AWC): is the portion of water in a soil that can be readily absorbed by plant roots of most crops.Soil Moisture Deficit (SMD) or Depletion is theamount of water required to raise the soil-water content of the crop root zone to field capacity.

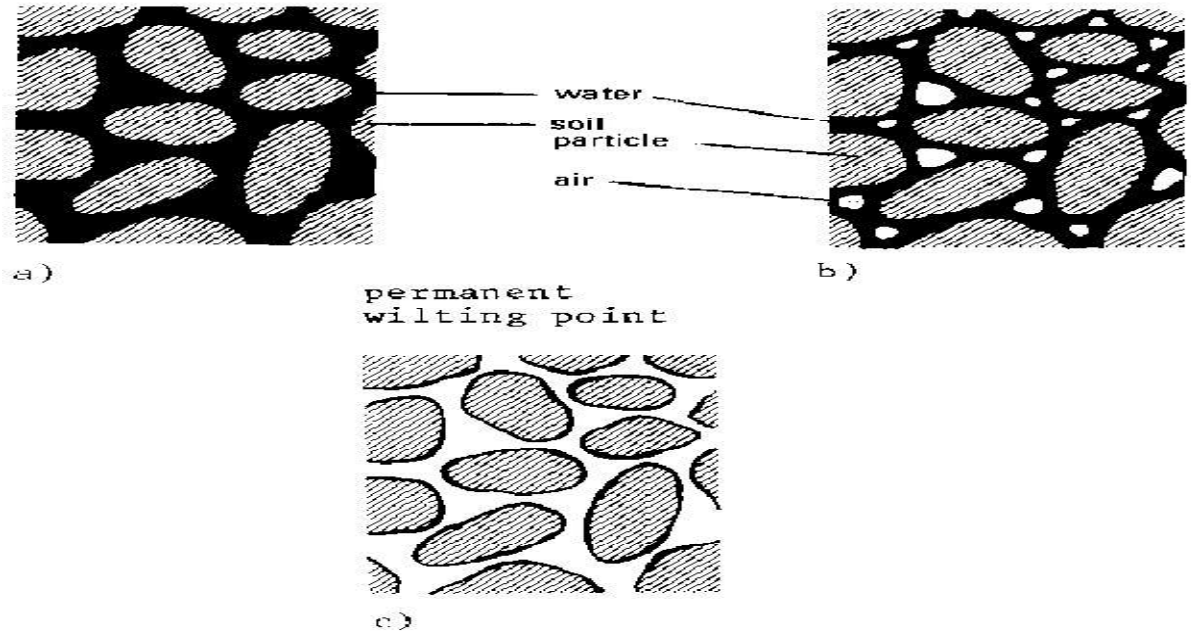


Fig 3.1 Available soil moisture

Monitoring equipment for soil moisture for irrigation

- Soil Moisture Sensor
- Field scout TDR
- Portable instrument
- Capacitance probe
- TDR: time-domain reflector metry determines soil volumetric water content. The principal of measurement is based on measuring the travel time of an electromagnetic wave along a waveguide between the two probes. A built in GPS system is able to pin-point the measured sites which is helpful for re-sampling
- Tensiometers: are installed permanently at the depth of the root zone. They provide a reading of the soil water suction, or tension, caused by the soil water moving away from the ceramic cup (in a drying soil), or moving towards the ceramic cup (in a wetted soil). The water tension is related to the soil water that is available to plants.

Fig.3.2.tensio meter

Watermarks (gypsum blocks):Watermarks: installed permanently in the soil, and determines volumetric water content which is displayed. It works on the same principal as the tensiometer, it measures the electrical resistance to current flow between electrodes embedded in gypsum; as the gypsum dries the electrical resistance increases between the rods.

Fig 3.3. Watermarks

3.3. Recalibrating the scheduling system

Irrigation scheduling is planning when and how much water to apply in order to maintain healthy plant growth during the growing season. It is an essential daily management practice for a farm manager growing irrigated crops. Proper timing of irrigation water applications is a crucial decision for a farm manager to:

- meet the water needs of the crop to prevent yield loss due to water stress;
- maximize the irrigation water use efficiency resulting in beneficial use and conservation of the local water resources
- Minimize the leaching potential of nitrates and certain pesticides that may impact the quality of the groundwater.

Effective irrigation is possible only with regular monitoring of soil water and crop development conditions in the field, and with the forecasting of future crop water needs. Delaying irrigation until crop stress is evident, or applying too little water, can result in substantial yield loss. Applying too much water will result in extra pumping costs, wasted water, and increased risk for leaching valuable agrichemicals below the rooting zone and possibly into the groundwater. Several scheduling tools are available to assist a farm manager in irrigation scheduling: soil probes, soil moisture sensors, in-field weather stations, crop water use estimators, daily soil water balance checkbook worksheets, computerized daily soil water balance accounting programs, and private consultants. The purpose of this bulletin is to describe the set-up and operating procedure for a manual soil water balance accounting method, commonly referred to as the CHECKBOOK method.Calibrating an irrigation system has been found to be one of the most effective ways managing water guzzling plants without spending a fortune on water biils. There are several reasons why calibrating an irrigation system is important. Not only is frequent watering is expansive it can also cause lawn problems:

- Fungal disease
- Poor growth
- Bacterial disease

- Insect proliferation

Monitoring exactly how much water is being used help your lawn reaches the ultimate level of growth and long term health. in some areas of the country watering restriction may be imposed to limit water consumption. The time at which watering can be done could also be constrained. This need taken into consideration and worked around when calibrating an irrigation system for your lawn. Oftentimes people will use a simple lawn sprinkler as a way of irrigating their lawns .but they may not deliver the proper amount of water to each area of the lawn. They may also consume more water than is necessary. However they can still be adjusted to become an effective irrigation system for your lawn.

3.4. Repeating and establishing cycles of irrigation

To apply water without creating runoff the cycling and repeating of irrigation is more important because runoff carry fertilizers, pesticides and unfiltered soils into the nearest rivers leaks and seas which cause for

- ✓ For pollution of ground water
- ✓ Water deficit in the soil
- ✓ Erosion of top fertile soils
- ✓ Loss of irrigation water etc.

The cycle and soak method is used to eliminate thus problems by applying water in a multiple cycles with 30 to 60 minutes in between cycles so water has time to soak deeper into the soil. The first cycle breaks the compacted surface tension of the soil which compacted by storm and irrigation activity and saturates the top layer of the soil. With time the water soaks deeper allowing the second cycle to infiltrate to the soil more efficiently. A third and even a fourth cycle will be beneficial if a slop is involved or if runoff occurs after the sprinklers run for just a few minutes. A new irrigation controller will have a cycle and soak settings. For these controllers you set the maximum runtime and the number of cycles. The controller automatically divides the runtime into the number of cycles you set. if you find your existing controller doesn't have the ability to schedule multiple start times with multiple programs. The cost to upgrade a controller

will pay for itself by saving water preventing runoff and effective using every drop of water on your lawn and landscape.

Just remember that lawns only need about 1 inch of water per a week to sustain healthy growth. Also a turnoff irrigation system when rain is in the forecast and leaves it off for a few days or until water is needed. The cycle soak method minimizes runoff and allow for better water filtration into the soil. Also it will assists in the development of extensive root systems which results in drought tolerance .Irrigation scheduling is planning when and how much water to apply in order to maintain healthy plant growth during the growing season. It is an essential daily management practice for a farm manager growing irrigated crops. Proper timing of irrigation water applications is a crucial decision for a farm manager to:meet the water needs of the crop to prevent yield loss due to water stress; maximize the irrigation water use efficiency resulting in beneficial use and conservation of the local water resources Minimize the leaching potential of nitrates and certain pesticides that may impact the quality of the groundwater. Effective irrigation is possible only with regular monitoring of soil water and crop development conditions in the field, and with the forecasting of future crop water needs. Delaying irrigation until crop stress is evident, or applying too little water, can result in substantial yield loss. Applying too much water will result in extra pumping costs, wasted water, and increased risk for leaching valuable agrichemicals below the rooting zone and possibly into the groundwater. Several scheduling tools are available to assist a farm manager in irrigation scheduling: soil probes, soil moisture sensors, in-field weather stations, crop water use estimators, daily soil water balance checkbook worksheets, computerized daily soil water balance accounting programs, and private consultants. The purpose of this bulletin is to describe the set-up and operating procedure for a manual soil water balance accounting method, commonly referred to as the CHECKBOOK method.Calibrating an irrigation system has been found to be one of the most effective ways managing water guzzling plants without spending a fortune on water biils. There are several reasons why calibrating an irrigation system is important. Not only is frequent watering is expansive it can also cause lawn problems:

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Self-Check 3	**Written Test**

Name: _____ **Date:** _____

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

1. How to Improving irrigation Efficiency?(5pt)
2. list common water losses of Irrigation systems to evaluated the irrigation system(5pt)
3. define Irrigation efficiency?(5pt)
4. List Monitoring equipment for soil moisture for irrigation(5pt)
5. What is the difference between saturation and field capacity(5pt)

Note: satisfactory Rating: 12.5 and above pts. Unsatisfactory rating: below 12.5pts.

InformationSheet-4	**Undertake installation of drainage system**

4.1. Completing excavation of drainage system and plant plants

Excavations are the process of removing drainage systems from the ground. This needs to be done in a safe manner with minimal damage to the surrounding area or piping systems. Whatever the size, in the home or commercial premises we can assist with all types of drain excavations.

We have experience in:

- Trench Excavation
- Drain Health and Safety Inspections
- Pipes and Sewer Equipment

Drain excavation must be precise and done correctly to ensure your drain remains unblocked and running freely. This is why we conduct an onsite inspection. This includes a CCTV drain survey. We are experienced in managing drain excavation projects and make sure everything is done without causing damage to your property.

Excavation services Sometimes we need to do trench excavation work before we install or repair drains and pipes. We have experienced specialist excavation teams capable of working in both domestic, commercial and public locations. We meet health and safety regulations being trained to work within confined spaces and the public highway.

What is Drainage Excavation and why would you need it? Drain excavation involves digging a hole or trench to the drainage in need of attention. Often a drainage issue is so severe that it really can't be fixed without digging right down to it. The drain might be old and in poor condition, with multiple leaks, or may have collapsed altogether. If it isn't old, it may be severely damaged or suffered from subsidence or flooding. Tree roots can often cause serious issues.

Safety

At an excavation, safety is paramount. That's why our engineers are trained to follow strict drainage guidelines which help prevent flooding, waste water contamination and trench collapses. In addition our engineers have access to local drain schematics though their laptop at all times and are trained to identify underground service lines such as gas and electric.

4.1.1 Planting on the ridge of drainage system

Ridge planting reduces erosion by leaving the soil covered with residue until planting. After planting, 30% to 50% residue may be left, but it is not uniformly distributed. Residue-covered areas between the rows alternate with residue-free strips in the row area. For erosion control, NRCS specifies that ridges must be 3 to 5 inches higher than the furrows after planting and that ridges be shaped to shed water to the furrow. For the most effective erosion control, orient ridges approximately on the contour.YourPlanwillhelpyoucomplywithrelevantlegislation and thereforemanageyouroperation'slandandwaterpollution risks.

4.2 installing drainage system according to system plan and enterprise work procedure

- ✓ **Refer Installing drainage system were discussed on 2.2**

Inthissectionyou will istothe authorizations, consentsandpermitsthatimpactonyourpollutionpreventiongoals.

Thesemaybeonesthatyou alreadycomplywithoronesthatyouare workingtowardscomplianceora consent/permit application.Youonlyneedtolistthoseconsentsthatrelateto environmentalperformanceoreffects.Discharge consents,storm water dischargeconsents,and tradewaste permits. Youdo notneedtolistthoserelatingtonon-environmentalfactorssuchashealthandsafetyor buildings.

YourPlancanincludethefollowinginformation:

- Consent/permittypeandpurpose (andnumberandexpiry ifalreadygranted).
- Status(e.g.applied,granted,investigationfor requirement).
- Iftheconsent/permitisforaspecificareaand/orspecific volumeofdischarge.
- Issuing agency (e.g.BOPRC,TCC).
- Keyconditionsandmonitoringrequired.

4.3 Testing the configuration, flow rate and capacity of drainage system

- **Drainage testing method's**

There are various methods of drain testing available depending on the circumstances and the nature of the particular problem to resolve.

- ✓ **CCTV drain survey** is the most commonly used method of drain testing and involves inspecting a drain with a camera and reporting any defects.

Figure 4.1 CCTV survey

- ✓ A **hydraulic water test** is used when testing for water-tightness, this test involves stopping up the down-stream pipe in the manhole and filling the drain with water until it can be visually observed at the top end of the pipe. If the water level goes down it means the drain is leaking.
- ✓ **Dye testing** can be used in conjunction with hydraulic water testing which involves adding a color dye to the water, if the pipe is leaking into a basement area this type of test can highlight the drainage which is causing the problem.
- ✓ **Air testing** is used when testing a pipe for air tightness and this involves stopping up both ends of the pipe and then putting the pipe under air pressure using a testing device. If the pressure drops then the pipe has failed the test.

Figure4.2. Drain testing specialists Scanseal

4.3.1. Flow rate measurement of drainage system

- ✓ Locatethesite'sdischargepipe.

  Ifdischargeoccursviaachannel,thenatemporarydammayneedtobeplacedacrossthechannelwiththedischargedirectedthrough hasingleoutletpipe.
- ✓ Placethecontainerofaknownvolume(e.g., a 1 or5 gallonbucket) directlyunderpipe. Allofthedischargeshouldflowintothecontainer.Note: The5-gallonlineonthebucketmayneed tobemeasuredandmarkedaheadoftime.
- ✓ Usingastopwatch,timehowlongittakestofill thecontainer.
- ✓ Repeatthisprocessthreetimestoobtainanaverage.

CalculatingtheDischarge-ExampleCalculation

A5galloncleanpaintbucketwasplacedunderthespoutofadischargepipe.

Thebucketfilledupin15seconds,18secondsand14seconds.

Calculateaveragetime:

Addthethreerecordedtimestogetheranddividebythreetoobtaintheaverage time.

Averagetime=15+18+14=15.7seconds

3

Convertaveragetimeinsecondstominutes:

Divideaveragetimeby60secondsper minutetoobtainminutes.

Averagetime=15.7sec/60=0.26minutes

Calculatethesitedischarge:

Dividethevolumeofthecontainer(gallons)bytheaveragetimeneededtofill thecontainer (minutes).

Discharge= 5gal /0.26=19.2gallonsperminute(gpm)

4.3.2 Configuration of drainage system

An arrangement of drainage pattern in a particular area meets to the standard of drainage depending on the method of drainage system. "The unrepeatable configuration of drainage structure must be done.

Most efficient drainage system design for a particular property includes soil type, land configuration, amount and pattern of rainfall, and types of crops to be grown. Soils of high sand or silt content are generally suited to subsurface drainage, while soils of high clay content generally require surface systems.

4.3.4 Capacity of drainage system

Any drainage installation is sized according to the probability of occurrence of an expected peak discharge during the design life of the installation. This, of course, is related to the intensity and duration of rainfall events occurring not only in the direct vicinity of the structure, but also upstream of the structure. In snow zones, peak discharge may be the result of an intense warming period causing rapid melting of the snowpack.

In addition to considering intensity and duration of a peak rainfall event, the frequency, or how often the design maximum may be expected to occur, is also a consideration and is most often based on the life of the road, traffic, and consequences of failure. Primary highways often incorporate frequency periods of 50 to 100 years, secondary roads 25 years, and low volume forest roads 10 to 25 years.

Of the water that reaches the ground in the form of rain, some will percolate into the soil to be stored until it is taken up by plants or transported through pores as subsurface flow, some will evaporate back into the atmosphere, and the rest will contribute to overland flow or runoff. Streamflow consists of stored soil moisture which is supplied to the stream at a more or less constant rate throughout the year in the form of subsurface or groundwater flow plus water which is contributed to the channel more rapidly as the drainage net expands into ephemeral channels to incorporate excess rainfall during a major storm event.

The capacity of drainage system design depends:

1. `The size of the drainage area`. The larger the area, the greater the volume of runoff. An estimate of basin area is needed in order to use runoff formulas and charts.
2. `Topography`. Runoff volume generally increases with steepness of slope. Average slope, basin elevation, and aspect, although not often called for in most runoff formulas and charts, may provide helpful clues in refining a design.
3. `Soil`. Runoff varies with soil characteristics, particularly permeability and infiltration capacity. The infiltration rate of a dry soil, by nature of its intrinsic permeability, will steadily decrease with time as it becomes wetted, given a constant rainfall rate. If the rainfall rate is greater than the final infiltration rate of the soil (infiltration capacity), that quantity of water which cannot be absorbed is stored in depressions in the ground or runs off the surface. Any condition which adversely affects the infiltration characteristics of the soil will increase the amount of runoff. Such conditions may include hydrophobicity, compaction, and frozen earth.

4.4 Remedying measure of drainage system

Supervisors are responsible for multiple crews that install, maintain and service irrigation systems. Project managers/supervisors meet with clients, develop bids and cost estimates, schedule and assign projects, and ensure that crews follow all required procedures and safety regulations. Project managers also develop budgets and financial forecasts, as well as implement plans to increase sales, profitability, and market share and customer satisfaction.

- **Drainage System Types, Problems, and Solutions!**

Lawn drainage is an issue that homeowners can face in Texas. Due to soil composition, land grading, and other pertinent factors, drainage systems are often needed to keep lawns and landscaping from becoming over-saturated or flooded. Where poor drainage is a problem, drainage system companies can resolve the issue with the right drainage system plan that will move water away from homes and yards, so flooding is less of a problem. Various

techniques can accomplish this, so knowing which best one for a particular section of lawn is or landscaping requires experienced drainage system services.

Drainage Problems

Water is essential to life, for both plants and all living creatures; however, it can be very invasive when it flows. When residential property experiences drainage issues, water can be a nuisance and actually cause a great deal of damage. Different drainage problems, including puddling, pooling, and saturated soil, and even undirected downspout water, can destroy landscaping and turn a backyard into a swamp. It creates moisture and mold problems and can damage home foundations; drainage is a serious concern when there is a problem. Drainage systems must be improved or installed by drainage system companies or a homeowner will end up dealing with worsening problems as time goes on.

Different Solutions to Drainage Problems

Not every drainage solution will work for every situation. There are a number of successful ways that water can be diverted away from houses and properties. With the help of experienced drainage system services, problems with drainage can be controlled so it is controlled or eliminated.

- **French Drain** – This is a popular drainage method consisting of trenches that hold perforated pipes, filled with gravel, and buried. Water seeps into the ground through the gravel and into the pipes, which divert it elsewhere, usually to public sewers. This is the most commonly used type of drainage system in residential applications.

- **Dry Well** – Similar to a French drain, the main difference is that instead of being diverted to a sewer, water is diverted to an underground well where it can be dispersed back to the soil. Companies who offer drainage system services say this is a very environmentally friendly answer to drainage concerns, as it conserves water by putting it directly back into the soil.

- **Corrugated Tubes** – These above-ground or buried tubes are used to direct downspout water away from buildings. When using tubing, the diversion is usually to a landscaped area that requires frequent watering or some other place where excess water will not be harmful.

- **Grassy Swale** – Drainage system companies say this is another natural means of diverting water away from buildings, either alone or in conjunction with other methods. It involves building a slight hill or grade that diverts water away from one side to roll down the other side and disperse in more absorbent soil or to create a bog area for collection.

- **Planned Bog** – This method is used in conjunction with some of the other methods above to divert water away from buildings and allow it to pool in one, dedicated area that is planted with water-loving species. It is another environmentally friendly way to deal with poor drainage.

The right approach to drainage must be taken into consideration for each circumstance, since there are many factors that determine which drainage system is best for each property. What works and is allowed in one area may not work or be allowed in another. Homeowners who experience drainage problems can work with experienced drainage system companies to diagnose the problem and remedy it with the right drainage system!

Self-check-4	**Written test**

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Define the word excavation? (5pts)
2. List the techniques of drainage system? (10 pts)
3. How can we control drainage system? (5pts)

Note: satisfactory Rating-7.5 and above pts. Unsatisfactory Rating-below 7.5 pts.

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

InformationSheet-5	**Complete installation of drainage system**

5.1 Finishing earthworks

After completion of the installation work in drainage system we are expected to undertake finishing activities. The finishing activities may include:

- **Blinding/ Bedding**

Since the risk of sedimentation is largest during installation and in the immediate subsequent period as long as the backfill has not settled and stabilized, drains are normally covered with friable topsoil to create a stable and highly permeable soil surround, and to preserve the alignment. Therefore trenching machines are equipped with cutters to bring a layer of topsoil or soil from another suitable layer from the sides of the trench on top of the drain. Its thickness

should be at least 100 to 250 mm, depending on the drain diameter. Granular envelope material (like gravel) can also be used to achieve a highly permeable drain surround and to prevent vertical and horizontal displacement once the pipe is installed. Any envelope material to be used must be in place around the pipe before blinding is done.

- **Soil conditions**

Since soil cohesion is strongly correlated with its water content, installation of the drainage system should preferably be done in unsaturated soil conditions with the water table below installation depth and outside periods of general wetness. In addition, the backfill should have settled before heavy rain or irrigation. In some situations, however, these conditions are not, or cannot be fulfilled. Drainage installation in wet conditions is discouraged, yet it is not always possible to drain under favorable or ideal circumstances.

- **Backfilling**

Backfilling and finishing of trenches should ensure a minimum of later land subsidence and preclude the occurrence of piping. The piping phenomenon may occur as a result of internal erosion of trench backfill by water flowing from the soil surface directly to the drains through the loose backfill material. This is crucial in irrigated lands, where irrigation water that can flow freely through the trench or drain plough fissures into the drainpipe, will dramatically lower the irrigation efficiency. Furthermore, soil piping may cause soil material to be carried by the flowing water into the drain, creating sinkholes at the soil surface and/or mineral clogging of drains and envelopes, if present. Proper backfilling of the trench or plough fissures is therefore essential. It is easier to backfill and compact V-plough fissures than trenches. Fissures, created by vertical ploughs cause the most problems.

5.2. Restoring and removing waste material

After completion of the installation work are expected to clean and maintain our work area by collecting, restoring and removing waste materials like:

- Unused construction and excavated materials
- Plant debris
- Litter and
- Broken components.

Plant-based material may be mulched or composted,plastic, metal, paper-based materials may be recycled, reused,returned to the manufacturer or disposed of accordingto enterprise work procedures.Waste may be removed to designated areas for recycling,reuse and return to the manufacturer or disposal.

After completing the installation works, make sure;

- All the trenches are filled in and the site is cleaned up properly.
- The site must be restored and **waste material** removed from the site and disposed of in an environmentally aware and safe manner according to work procedures.

Disposal of waste materials

After installing irrigation and landscaping there is often range of unwanted waste material left behind that needs to be dealt with. Things such as matting, old pipe, envelopes, pots/tubes, soils, fertilizer, plastic wrapping, stakes, mulch, and plant debris. It is best practice when finished to leave a completely clean site free of rubbish.

Methods of waste disposal could include:

- Organic waste: mulch and composting.
- In organic wastes: plastic/ metal/paper based material may be recycled, reused or returned to manufacturer.

5.3. Cleaning, maintaining, storing tools, equipment and machinery

Cleaning and maintenance is obvious when there is severe clogging. If done regularly it may extend the service life of the system and enhance its performance. In case of light obstructions in pipes dry rodding may be helpful: a long series of coupled rods, with a scratcher at the end, is pushed into the drain and removed later. If done during a period of considerable discharge, the loosened materials will be discharged. For more serious forms of clogging, jet flushing has to be used. Jet flushing is a technique used to remove clogging and precipitating agents (e.g. soil particles and microbiological deposits) from drainpipes through the impact of water jets. More particularly, the functions of jet flushing are:

- Lifting of blockages inside the pipe drain
- Removal of deposits from the inner wall surface of the drain
- Cleaning of clogged perforations

- Removal of loose smaller roots of agricultural crops and weeds and
- Supply of sufficient water to carry the loosened agents, including sand and clay particles towards the drain outlet.

To make the next job easy and to prevent personal injury it is very important to keep tools in good condition. Follow the steps below each time the tool are used:

- Wash the mud and dirty off and oil any metal parts to prevent rusting. Steel wool and light oil will remove any surface rust.
- Keep tools, machinery sharp and in good working order. Bevel the back edge of a spade off with a bench grinder or a course sharpening stone.
- Replace any broken handles and parts. Never use bush sticks as handles as they often break causing injury.
- Sand and oil all wooden handles to avoid getting nasty splinters.
- Machines repair and services must be under taken according to the manufacturer and enterprises standards.

Figure_28: Cleaning tools

5.4. Maintaining a clean and safe work area.

A regular maintenance program in conjunction with inspections can prevent big problems. Typical problems found in open channels and pipe drains may include clogging, weed growth, trash, shopping carts, tires, plastic containers, branches, and logjams. Typical storage basin problems include clogged inlets and outlets, basin sedimentation, and broken pumps. When

found early, they can often be removed or corrected with minimal equipment and expense.In the installation of drainage systems it is must to the tools, equipment and machineries and maintain a clean and safe work area throughout and on completion of work, these tasks may include:

- Removing all excess and scrap materials and making the site neat and clean
- Backfilling trenches and excavations for different purposes
- Disabling unused tools, equipment and machinery
- Storing neatly out of the way of installation and construction activities;
- Safely storing materials on site

Using signage and safety barriers during construction and removing them after activities are completed, and swiftly and efficiently removing and processing debris and waste from the work area.When human-made or natural debris is allowed to accumulate, it can create a dam in a channel or fill needed storage areas. Although a properly maintained channel can carry runoff from most small storms, a blocked or dammed channel can cause more frequent overbank flooding, unexpected erosion, and sedimentation. Similarly, a lack of maintenance can result in detention or retention basins being filled with sediment or debris. If these basins are already full of sediment or debris, they cannot store water and flooding can result because the drainage system cannot do its job.

5.5. Recording and reporting work outcomes

Work outcomes are recorded or reported to the supervisor according to enterprise work procedures. A maintenance program needs records. Typically, these include

- Complaint or inquiry forms for recording reports of problems
- Inspection forms that show everything that was checked
- Work orders that task an office to clear debris or correct a problem and
- Maintenance records that show the work that was done.

Self-Check -5	**Written Test**

Name: _____ Date: _____

***Directions**:* Answer all the questions listed below.

1.What are the main activities that we are expected to do the end of installation work systems, explain. (5 pts)

2. Write at least five tasks that would be under taken after completion of installing drainage system? (8pts)

3. What is the function of field drain? (4pts)

4. List and explain the ways of ways of disposing waste materials? (3pts)

Note: satisfactory Rating-10 and above pts. Unsatisfactory Rating-below 10 pts.

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

Operation sheet-1	**Installing drainage system**

Objective: install sub surface drainage system

Procedure

1. Mark out

Before undertaking any work you should identify that you have the correct site and orientate your plan to the site. Mark out the location of all the lines with either lime or spray paint. At this time you should be able to establish the location of the point of connection (POC) or the discharge point.The POC is the usual point from which to start, main lines will rise from this point. Mark out any laterals in the same way with their point of connection being the main pipe.

2. Locate services

Check for any service lines that may intercept your drainage line.Remember the cost of having these service lines located by the service provider is nothing but the cost of damaging or cutting these lines could be many thousands of dollars and even your life. Ring 1100 - Dial Before You Dig.

3. Establish levels

Determine the gradient that is required for each section of the project, this should be indicated in the plan or in the manufacturers specifications. Establish the level at the POC and then the subsequent levels at the end of each line. If you are using stringlines to get an even grade you will need to set up profiles so the string will run over each point.

4. Excavation

Cut a trench into the subsoil below the topsoil being drained, making sure the sides of the trench are clean and vertical.

The bottom of the trench should be cleaned with a trenching shovel to remove any heavy clay or material fallen in from the trench sides. At the same time the gradient can be checked and adjustments made as necessary to the trench depth.

Small undulations in the bottom of the trench are difficult to eliminate, but they can be smoothed out when the bedding material is placed in the trench.

Any clay subsoil brought to the surface should be removed and not be used to later backfill the trench. The trench needs to be wide enough to allow for the width of the pipe plus 50 mm of sand either side of the pipe. A 100 mm diameter drainage pipe will therefore need a minimum trench width of 200 mm.

5. Install components

Place the bedding material in the trench to a depth of approximately 50 mm. This then needs to be firmed down. This can be done by walking up and down the trench. Smooth out any undulations to give a final even gradient. The top of this bedding layer must be at the correct gradient.

If using rigid slotted unplasticized polyvinyl chloride (uPVC) pipe, then one end of each six meter length will be belled to allow the smaller end of the next length to push into it. These joins should be glued in the same way as uPVC irrigation pipes using primer and the correct solvent cement.

If using "Corrugated Ag pipe", it should be unrolled and straightened well in advance to reduce the likelihood of it twisting when laid in the trench.

Start laying the pipe from the discharge end and if it needs to be connected into a pit then this can be done as you commence laying the pipe. The top end of the drainage pipe should not be left open but closed off with a small sheet of black plastic or similar.

The pipe must be placed in the center of the trench with one line of holes or slots at the bottom of the trench. Hold the pipe in the center with a shovel at points along the trench while covering it with enough backfill material to hold it in place.

With the pipe now cantered, the rest of the sand or aggregate can be shoveled in more quickly and firmed down.

6. Backfill and consolidate

Backfill the trench with the topsoil originally removed. Do not place any clay back in the trench, as it will greatly impede the movement of water into the drain.

Additional topsoil should not normally be needed as the sand and pipe occupy additional space in the trench. Firm this soil in place. The finished level over the drain should be left a little higher than the surrounds to allow for subsidence after the next rain.

7. Finish

Ensure that on finish off according to the plans and specifications. Check the site to make sure no tools or other items have been left behind. You should also make sure all trenches and pits have been filled or covered. It is your responsibility to leave the site in a clean and safe state.

Lap Test	**Practical Demonstration**

Name: _____Date: _____

Time started: _____ Time finished: ____

Instructions:

☞ You are required to perform the following activity:

- Task_1:Selecting the necessary tools and equipment's:
- Task_2: Setting out trench location
- Task_3: Setting out alignments and levels
- ✓ Task_4:Excavating the trenches
- ✓ Task_5:Check for any service lines that may intercept your drainage line.

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