NQF Level: 4  US No: 116317

Learner Guide
Primary Agriculture

Installation and management of Irrigation systems

My name: ..............................................

Company: ...........................................

Commodity: ......................... Date: .................

The availability of this product is due to the financial support of the National Department of Agriculture and the AgriSETA. Terms and conditions apply.
Before we start...

Dear Learner - This Learner Guide contains all the information to acquire all the knowledge and skills leading to the unit standard:

**Title:** Installation and management of Irrigation systems  
**US No:** 116317  
**NQF Level:** 4  
**Credits:** ??

The full unit standard will be handed to you by your facilitator. Please read the unit standard at your own time. Whilst reading the unit standard, make a note of your questions and aspects that you do not understand, and discuss it with your facilitator.

This unit standard is one of the building blocks in the qualifications listed below. Please mark the qualification you are currently doing:

<table>
<thead>
<tr>
<th>Title</th>
<th>ID Number</th>
<th>NQF Level</th>
<th>Credits</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Certificate in Animal Production</td>
<td>48979</td>
<td>4</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>National Certificate in Plant Production</td>
<td>49009</td>
<td>4</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

Please mark the learning program you are enrolled in:

Are you enrolled in a: Y N  
Learnership?  
Skills Program?  
Short Course?  

Your facilitator should explain the above concepts to you.

This Learner Guide contains all the information, and more, as well as the activities that you will be expected to do during the course of your study. Please keep the activities that you have completed and include it in your Portfolio of Evidence. Your PoE will be required during your final assessment.

What is assessment all about?

You will be assessed during the course of your study. This is called *formative assessment*. You will also be assessed on completion of this unit standard. This is called *summative assessment*. Before your assessment, your assessor will discuss the unit standard with you.

Assessment takes place at different intervals of the learning process and includes various activities. Some activities will be done before the commencement of the program whilst others will be done during programme delivery and other after completion of the program.

The assessment experience should be user friendly, transparent and fair. Should you feel that you have been treated unfairly, you have the right to appeal. Please ask your facilitator about the appeals process and make your own notes.
Your activities must be handed in from time to time on request of the facilitator for the following purposes:

♦ The activities that follow are designed to help you gain the skills, knowledge and attitudes that you need in order to become competent in this learning module.

♦ It is important that you complete all the activities, as directed in the learner guide and at the time indicated by the facilitator.

♦ It is important that you ask questions and participate as much as possible in order to play an active role in reaching competence.

♦ When you have completed all the activities hand this in to the assessor who will mark it and guide you in areas where additional learning might be required.

♦ You should not move on to the next step in the assessment process until this step is completed, marked and you have received feedback from the assessor.

♦ Sources of information to complete these activities should be identified by your facilitator.

♦ **Please note** that all completed activities, tasks and other items on which you were assessed must be kept in good order as it becomes part of your **Portfolio of Evidence** for final assessment.

Enjoy this learning experience!
How to use this guide …

Throughout this guide, you will come across certain re-occurring “boxes”. These boxes each represent a certain aspect of the learning process, containing information, which would help you with the identification and understanding of these aspects. The following is a list of these boxes and what they represent:

What does it mean? Each learning field is characterized by unique terms and definitions – it is important to know and use these terms and definitions correctly. These terms and definitions are highlighted throughout the guide in this manner.

You will be requested to complete activities, which could be group activities, or individual activities. Please remember to complete the activities, as the facilitator will assess it and these will become part of your portfolio of evidence. Activities, whether group or individual activities, will be described in this box.

Examples of certain concepts or principles to help you contextualise them easier, will be shown in this box.

The following box indicates a summary of concepts that we have covered, and offers you an opportunity to ask questions to your facilitator if you are still feeling unsure of the concepts listed.

My Notes …

You can use this box to jot down questions you might have, words that you do not understand, instructions given by the facilitator or explanations given by the facilitator or any other remarks that will help you to understand the work better.
What are we going to learn?

What will I be able to do? ................................................................. 6
What do I need to know? ........................................................................ 6
Revision of Level 3 .................................................................................. 7
Session 1 Install an Irrigation System...................................................... 12
Session 2 Maintenance and evaluation of an Irrigation System............. 30
Session 3 Operating an Irrigation System.............................................. 38
Session 4 Collating data for Management of an Irrigation System...... 43
Am I ready for my test? ................................................................. 51
Checklist for Practical assessment ....................................................... 52
Paperwork to be done ....................................................................... 53
Bibliography ....................................................................................... 54
Terms and Conditions ....................................................................... 54
Acknowledgements ........................................................................... 55
SAQA Unit Standards
What will I be able to do?

When you have achieved this unit standard, you will be able to:

♦ Effectively supervise the installation, operation and maintenance of irrigation systems of agricultural crops.

♦ Learners will gain specific knowledge and skills in irrigation and will be able to operate in a plant production environment implementing sustainable and economically viable production principles.

♦ They will be capacitated to gain access to the mainstream agricultural sector in plant production, impacting directly on the sustainability of the sub-sector. The improvement in production technology will also have a direct impact on the improvement of agricultural productivity of the sector.

What do I need to know?

It is expected of the learner attempting this unit standard to demonstrate competence against the unit standard:

♦ NQF 3: Literacy and Numeracy

♦ NQF 3: 116266, Monitor the operation and maintenance of irrigation systems

♦ NQF 4: 116290, Establish a plan for the monitoring, safe use and maintenance of equipment, implements, technology and infrastructure
Revision of Level 3

Modifying and Implementing Irrigation Schedules

- Irrigation scheduling refers to timetables that are used to determine when crop should be irrigated because all the orchards cannot be irrigated at the same time.

- A well-developed irrigation schedule ensures that all plants receive an equal and sufficient amount of water, that the pump system is not overtaxed, that no more than the necessary amount of electricity is used, and that the pump system operates at optimum efficiency.

- The irrigation cycle refers to the number of times in a week that blocks are irrigated, while stand-time is the number of hours that a block is irrigated for at a time.

- The soil-water balance is determined to ensure that plants are receiving enough water and to ensure that the irrigation schedule is effective.

- Soil absorbs water much like a sponge. When soil is saturated, it is at field water capacity (FWC), measured in mm/m.

- Permanent wilting point (PWP) is the water content level of the soil, measured in mm/m, at which most plants will wilt permanently.

- Plant available water (PAW) is the difference between the FWC and PWP.

- Precipitation is the increase in the water content of the soil, measured in mm, as a result of irrigation or rain.

- Effective root depth (ERD) means the depth to which roots can extract water from soil. The ERD for Fruit trees is about 600mm.

- Easily available water (EAW) is the amount of water that is easily available to the plant, which is 50% of the PAW in the ERD.

- The operations table, pressure table and irrigation schedule is required to implement a schedule.

- The operations table shows which irrigation blocks are irrigated at the same time.

- The pressure table indicates the pressure at which in-field valves should be set.

- The irrigation schedule indicates the cycle and stand-time for the different operations.

- The irrigation schedule must be adapted to ambient weather conditions to ensure that plants are not over-irrigated or under-irrigated.
Various problems can be caused by incorrect scheduling. When symptoms of such problems are detected, the irrigation schedule must be changed to ensure that irrigation remains effective.

**Collecting and Recording Data**

- The scheduling equipment that is used most commonly in irrigation scheduling is evaporation pans, rain gauges, tensiometers and probes.
- An evaporation pan measures the daily evaporation due to climatic factors, and is installed 200mm above ground level.
- A rain gauge measures daily rainfall in mm, and is installed in an open space about 1m above ground level.
- A tensiometer measures the amount of free water in the soil and is inserted at depth of the root-zone and below the root-zone.
- Probes are specialised equipment that measures the amount of water in the soil.
- Evaporation pan data is recorded in a log in which the daily evaporation is calculated.
- Rainfall as recorded by the rain gauge is recorded in the rain calendar and evaporation pan log.
- Tensiometer readings are taken from a special dial gauge mounted on the tensiometer.
- Readings from probes are recorded with a data logger and processed on special software.
- The daily evaporation and crop factor is used to calculate the crop evapotranspiration and from that the daily soil-water balance, or ground water reservoir, is calculated, which is used to assist with scheduling.
- From the soil-water balance, the weekly water requirement is calculated, which is divided into the number of times per week that the orchard is irrigated. The stand-time is calculated by taking the system application rate into account.
- Tensiometer and probe readings are used to determine the EAW. Irrigation can either be applied when the EAW is depleted, or the readings can be used to determine the stand-time.
- The areas around the evaporation pan must be kept clear, it should be cleaned regularly and checked for damage.
- Rain gauges must be in a clear area and should be replaced when cracked or broken.
- Tensiometers must be reset if the ground has dried out and checked for cracks.
- The accuracy of readings from scheduling equipment can be determined by comparing readings from different equipment and applying reasonability tests.
Supervising Irrigation Activities

- Supervising the implementation of an irrigation schedule is easiest done by compiling a work program for the field workers and monitoring them.
- The irrigation schedule is adapted to ambient weather conditions by using information from scheduling equipment.
- The operation of the irrigation system is monitored through keeping records of readings when the pump system is started up.
- Workers must all be aware of safety regulations.
- Irregular problems must be reported to the irrigation manager immediately.

Efficient Operation of Irrigation System

- Major irrigation system checks and repairs are performed on an annual basis, normally during the winter when irrigation is required less often.
- The following checks are made on the pump system:
  - Pressure readings
  - Pipe work
  - Pump and motor coupling
  - Mounting bolts
  - Electrical panels
- Be attentive to noise and vibration from the pump whenever it is working.
- The following checks are made on filters:
  - Filtering material (sand, discs, screens, etc.)
  - Hydraulic valves
  - Lid seals and rubber tubing
- In the infield irrigation system, the valves, emitters and pipes must be checked regularly.
- Pre-start-up inspections must be performed every time before the pump is started, and start-up and shut-down procedures must be strictly followed.
- The pump installation is equipped with an amp meter, volt meter, pressure gauge and flow meter. Readings from these meters are used to determine the working characteristics of the pump and pump-motor.
- The normal pump-motor working characteristics are determined by the irrigation manager and based on the irrigation design.

Irrigation System Maintenance

- The lifespan of irrigation equipment is determined by the quality of the equipment that was originally installed and the ongoing maintenance of the irrigation system.
Pump systems, sub-mainlines and filters should only need to be replaced at the end of the lifespan of the orchard, while mainlines should have a life-expectancy of twice the lifespan of the orchard.

Good quality and well-maintained lateral lines should have a life-expectancy of around seven years, at which time drippers should also be replaced. Micro-jets should last for the lifespan of the orchard, but may deteriorate sooner if water quality is poor.

A long-term maintenance plan describes the tasks that should be performed on a monthly, yearly, 5 yearly and 5-7 yearly bases.

Contingency plans should be in place to deal with emergency situations such as floods, fire, pump breakdowns, pipe bursts, and chemical spills.

In case of floods, pumps must be removed from vulnerable positions as soon as possible. The electricity must be shut down and not be switched on again before the system has been inspected by a qualified electrician.

The risk of fire must be limited as far as possible, and a fire fighting unit must be kept at hand and in good working condition.

When pump breakdown occurs, high-value crops must receive priority for the available water and the pump must be repaired as soon as possible.

Equipment must be kept on hand to repair pipe burst as soon as possible.

If the irrigation water has been contaminated as a result of a chemical spill, all irrigation must be halted immediately and the irrigation manager must be informed.

A monthly budget can be developed from the list of irrigation equipment requirements.

Irrigation equipment should be bought from dependable suppliers that provide good quality equipment.
**Cavitation**: Cavitations’ is caused when there are air bubbles in the water. When air bubbles hit the impeller, (the part of the pump that rotates and moves the water) and implode on the impeller and breaking off little pieces of the metal of the impeller.

**Water Hammer**: Water hammer occurs when water flow is stopped abruptly, e.g. the column of pumped water stops and flows backwards towards the pump. This can cause major pipe damage.

**Irrigation cycle**: The irrigation cycle refers to the number of days before a block is irrigated again. For example, if the cycle for a block is three days, it will be irrigated for instance on Mondays and Thursdays.

**Stand-time**: Stand-time is the period (in hours) that a block is irrigated.

**Field Water Capacity (FWC)**: Field water capacity (FWC) is the volume of water, measured in millimetres, that is required per meter of soil to saturate the soil and all free water has drained. This is regarded as the full point of the water reserve in the soil.

**Permanent Wilting Point (PWP)**: The Permanent Wilting Point (PWP) is the volume of water, measured in millimetres per meter soil, where most plants will wilt permanently, i.e. where plants will not recover in twelve hours after being watered again. This is regarded as the empty point of the water reserve in the soil.

**Plant Available Water (PAW)**: Plant Available Water (PAW) is defined as the difference between Field Water Capacity and Permanent Wilting Point, i.e. $\text{PAW} = \text{FWC} - \text{PWP}$

**Precipitation**: Precipitation refers to the increase in the water content of the soil as a result of irrigation or rain, and is measured in millimetres (mm). Precipitation is calculated as follows:
- Precipitation (mm) = Volume of water (m$^3$) / Area of land (m$^2$) : $P = \frac{V}{A}$
- or
- Precipitation (mm) = Volume of water (m$^3$) x 1,000 / Area of land (m$^2$)

**Effective Root Depth (ERD)**: Effective Root Depth (ERD) refers to the depth to which roots can extract water from the soil. The ERD for most fruit trees is usually 600mm.

**Easily Available Water (EAW)**: Easily Available Water (EAW) refers to the amount of water that is easily available to the plant, being 50% of the Plant Available Water. The easily available water in the soil is determined as follows:
- Easily Available Water (mm) = Plant Available Water (mm/m) x Effective Root Depth (m) x 50%  
  or  
- $\text{EAW} = \text{PAW} \times \text{ERD} \times 50\%$

**Transpiration**: Transpiration reverses to the loss of water by means of evaporation from a plant’s surface through minute pores on the leaf surface, called stomata.

**Osmotic Pressure**: Osmotic Pressure refers to the pressure required by plant roots to draw water from the soil.
1. Install an Irrigation System

After completing this session, you should be able to:

SO 1: Install an Irrigation System

1.1 Interpreting an irrigation Design Plan

The foundation of a high quality irrigation system is a good irrigation design plan. The irrigation system should be designed by a qualified irrigation designer. The SA Irrigation Institute (SABI) has a specific designer membership which is attainable by passing an exam. Below is an example of an irrigation design plan for three adjacent blocks of a micro sprayer irrigation system for a fruit orchard.
## Orientation

When reading an irrigation design plan, the first step is to get the orientation right. The plan must be turned so that landmarks on the plan agree with the actual landmarks, such as dams, canals, koppies (hillock), or any other distinguishable features that is shown on the map. Familiarise yourself with the block and pipe layout on the plan and compare it with the actual block and pipe layout (if it is an existing system).

## Symbols

On an irrigation design plan symbols or different colours are used to depict the various pipes, valves and other features. Usually, a key is provided with the symbols and their meaning. In the table below, the symbols and keys that are shown on the irrigation design plan above are explained further.
Installation and management of Irrigation systems

Primary Agriculture
NQF Level 4
Unit Standard No: 116317

Version: 01
Version Date: July 2006

Symbol Description Example of Use Details

Pump

The best place to start on an irrigation plan is at the pump station or the beginning of the mainline. The pump station is marked on the plan with a dot and the pump duty point is noted (63m³/h at 30m in this case).

Mainline

The mainline can be traced from the pump station. On some plans there may also be sub-mainlines, which are pipes that branches off from the mainline to take water to blocks that are further off the mainline.

Valve

Every block has a valve on the mainline and sub-mainlines that feeds directly into the mother line.

Sub main Line

There is a sub main line for each block. The lateral lines branches off from the sub main lines.

Lateral line

Lateral lines run from the mother line along the tree rows. The emitters are located on the laterals.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Example of Use</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pump</td>
<td><img src="image1" alt="Image" /></td>
<td>The best place to start on an irrigation plan is at the pump station or the beginning of the mainline. The pump station is marked on the plan with a dot and the pump duty point is noted (63m³/h at 30m in this case).</td>
</tr>
<tr>
<td></td>
<td>Mainline</td>
<td><img src="image2" alt="Image" /></td>
<td>The mainline can be traced from the pump station. On some plans there may also be sub-mainlines, which are pipes that branches off from the mainline to take water to blocks that are further off the mainline.</td>
</tr>
<tr>
<td></td>
<td>Valve</td>
<td><img src="image3" alt="Image" /></td>
<td>Every block has a valve on the mainline and sub-mainlines that feeds directly into the mother line.</td>
</tr>
<tr>
<td></td>
<td>Sub main Line</td>
<td><img src="image4" alt="Image" /></td>
<td>There is a sub main line for each block. The lateral lines branches off from the sub main lines.</td>
</tr>
<tr>
<td></td>
<td>Lateral line</td>
<td><img src="image5" alt="Image" /></td>
<td>Lateral lines run from the mother line along the tree rows. The emitters are located on the laterals.</td>
</tr>
</tbody>
</table>

**Pipe Notations**

The notations next to the different sections of pipes indicate the pipe size and class for that particular section of pipe, and the length of the pipe.

Using the notation of 110/6-175 for the mainline in the table above as an example, the 110/6 indicates the pipe size and class, meaning the pipe will have a nominal diameter of 110mm and will be uPVC class 6 pipes. The second part of the notation indicates the length of the pipe in meters, meaning that this pipe will be 175m long. Note that this is the total length and includes the bends in the pipe.

Pipe sections are indicated by a short line (/ or -). In the example above, the different sections of the lateral lines are marked in this way. The first lateral for block 1.3 has the numbers 25-63, 20-60 and 15-55. This means that in the first section, 25mm poly pipe is laid for 63m. In the second section, 60m of 20mm poly pipe is laid and 15mm poly pipe is laid for 55m in the third section.

Classes are usually not specified for the laterals as class 3 poly pipe is used as a rule. If drippers are used, the drip line would be specified.

The class of the pipe (PVC and poly pipe) indicates the pressure (in Bar) a pipe can withstand. The class notations for asbestos and cement pipes are more complicated and have to be verified with the supplier.

Information on the pipe sizes and classes commonly used is as follows:
## Popular Pipe Sizes and Classes for Irrigation Pipes

<table>
<thead>
<tr>
<th>Pipe</th>
<th>Number</th>
<th>Nominal Diameter (mm)</th>
<th>Class</th>
<th>Working Pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poly pipe</td>
<td>15/3</td>
<td>15</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Poly pipe</td>
<td>20/3</td>
<td>20</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Poly pipe</td>
<td>25/3</td>
<td>25</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Poly pipe</td>
<td>32/3</td>
<td>32</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Poly pipe</td>
<td>40/3</td>
<td>40</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Poly pipe</td>
<td>50/3</td>
<td>50</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Poly pipe</td>
<td>32/6</td>
<td>32</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Poly pipe</td>
<td>40/6</td>
<td>40</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Poly pipe</td>
<td>50/6</td>
<td>50</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Poly pipe is also available in sizes 65mm, 80mm, 100mm and in classes 3, 6, 9 – but is not that commonly used because of cost. Note that for all these pipes above the material specification is LDPE (low density polyethylene).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uPVC</td>
<td>50/4</td>
<td>50</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>uPVC</td>
<td>50/6</td>
<td>50</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>uPVC</td>
<td>63/4</td>
<td>63</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>uPVC</td>
<td>63/6</td>
<td>63</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>uPVC</td>
<td>75/4</td>
<td>75</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>uPVC</td>
<td>75/6</td>
<td>75</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>uPVC</td>
<td>90/4</td>
<td>90</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>uPVC</td>
<td>90/6</td>
<td>90</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>uPVC</td>
<td>110/4</td>
<td>110</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>uPVC</td>
<td>110/6</td>
<td>110</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>uPVC</td>
<td>140/4</td>
<td>140</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>uPVC</td>
<td>140/6</td>
<td>140</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>uPVC</td>
<td>160/4</td>
<td>160</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>uPVC</td>
<td>160/6</td>
<td>160</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>uPVC</td>
<td>200/4</td>
<td>200</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>uPVC</td>
<td>200/6</td>
<td>200</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>uPVC pipes are available in sizes 16mm up to 500mm and from class 4 up to class 20. The commonly used sizes are from 50mm upwards. The material specification for this type of pipe is non plasticised polyvinyl chloride.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asbestos Cement</td>
<td>150/6</td>
<td>150</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>
Asbestos Cement pipes are not manufactured anymore because of the health risk of asbestos.

**Irrigation Block Information**

On the irrigation design plan information with regard to each block is given in a table that shows the block number, area, spacing, emitter delivery and application rate.

<table>
<thead>
<tr>
<th>Block Information on Irrigation Design Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block#</td>
</tr>
<tr>
<td>1.1</td>
</tr>
<tr>
<td>1.2</td>
</tr>
<tr>
<td>1.3</td>
</tr>
</tbody>
</table>

The area of each block is indicated in hectares (ha). In the **Space** column, the plant spacing is indicated. In the example the spacing is 6m x 2m, meaning that the plant rows are 6m apart and the trees are planted 2m apart in the rows. Remember that plant spacing varies according to the specific crop and variety, as well to the production area.

The plant spacing is used to calculate the number of plants per hectare, and therefore the number of emitters that are required.

The plant spacing is multiplied to calculate the area per plant, and area in hectare is divided by the area per plant, which will give the plant population per hectare. Remember that 1 hectare equals 10,000m².
Calculating Plant Population per Hectare

Plant spacing: 6m x 2m

Calculating Area per Plant
6m x 2m
=12m² per plant

Calculating Plant Population per Hectare
Area of a hectare / Area per plant
10,000m² / 12m²
=833 plants per hectare

Calculating Plants per Block
Plants per hectare x Block Area
833 plants x 1.7ha
=1,416 plants in block number 1.1

This is useful when plants are ordered or when the plants are allocated per block.

The emitter delivery in the table is used to calculate the precipitation and to check the emitters. The precipitation is used in the scheduling of the irrigation.

The irrigation design plan also contains a table with the pressure and flow per block. This information is used in the irrigation scheduling.

**Bill of Quantities**

When a system is designed from scratch or if new blocks are designed, a bill of quantities is supplied along with the irrigation design plan.

If the company that designed the system is delivering the materials as well, the bill of quantities is used to check and verify all the materials that are delivered. If the designer is not delivering the materials, the bill of quantities is used to obtain quotations for the materials and for budgeting.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poly pipe 15/3</td>
<td>m</td>
<td>1 200</td>
</tr>
<tr>
<td>Poly pipe 20/3</td>
<td>m</td>
<td>1 300</td>
</tr>
<tr>
<td>Poly pipe 25/3</td>
<td>m</td>
<td>900</td>
</tr>
<tr>
<td>25 mm nylon couplings</td>
<td>Each</td>
<td>90</td>
</tr>
<tr>
<td>20 mm nylon couplings</td>
<td>Each</td>
<td>130</td>
</tr>
<tr>
<td>15 mm nylon couplings</td>
<td>Each</td>
<td>120</td>
</tr>
</tbody>
</table>
### Installation and management of Irrigation systems

**Primary Agriculture**

**NQF Level 4**

**Unit Standard No: 116317**

**Version: 01**

**Version Date: July 2006**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducer 25x20 mm</td>
<td>Each</td>
<td>80</td>
</tr>
<tr>
<td>Reducer 20x15</td>
<td>Each</td>
<td>85</td>
</tr>
<tr>
<td>Grommet fitting and rubber</td>
<td>Each</td>
<td>85</td>
</tr>
<tr>
<td>Micro 40 l/h, spreader, peg, tube, barb</td>
<td>Each</td>
<td>8250</td>
</tr>
<tr>
<td>uPVC 50/4</td>
<td>m</td>
<td>300</td>
</tr>
<tr>
<td>uPVC 63/4</td>
<td>m</td>
<td>200</td>
</tr>
<tr>
<td>uPVC 75/4</td>
<td>m</td>
<td>180</td>
</tr>
<tr>
<td>uPVC 90/4</td>
<td>m</td>
<td>150</td>
</tr>
<tr>
<td>Reducer 63x50</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Reducer 75x63</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Reducer 90x75</td>
<td>Each</td>
<td>5</td>
</tr>
<tr>
<td>Bend 80x90</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Valve cluster 80mm hydraulic valve, pilot</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Saddle 110x50</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Reducing socket 50x80</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Nipple 50 mm nylon</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Glue on bend 50mm</td>
<td>Each</td>
<td>12</td>
</tr>
<tr>
<td>Glue on ball valve</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>End cap 110</td>
<td>Each</td>
<td>1</td>
</tr>
<tr>
<td>Air valves 25 mm</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Risermatic short 25 mm</td>
<td>Each</td>
<td>6</td>
</tr>
<tr>
<td>Bend 110mm</td>
<td>Each</td>
<td>2</td>
</tr>
<tr>
<td>uPVC 110/6</td>
<td>m</td>
<td>800</td>
</tr>
<tr>
<td>Pipet</td>
<td>Each</td>
<td>1</td>
</tr>
<tr>
<td>Pressure gauge 0 – 4 bar</td>
<td>Each</td>
<td>1</td>
</tr>
<tr>
<td>Pipe punch</td>
<td>Each</td>
<td>2</td>
</tr>
<tr>
<td>Hole saw</td>
<td>Each</td>
<td>1</td>
</tr>
<tr>
<td>Pipe lubricant</td>
<td>Bucket</td>
<td>1</td>
</tr>
</tbody>
</table>
Activity 1 – Action Plan:

Study the irrigation design plan below.

Draft an action plan with specific duties, timeframes and deliverables according to your interpretation of the design plan.
## Installation and management of Irrigation systems

### Primary Agriculture

**NQF Level 4**

**Unit Standard No:** 116317

**Version:** 01  **Version Date:** July 2006

<table>
<thead>
<tr>
<th>Actions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duties:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Timeframes:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deliverables:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
1.2 Laying Out the Irrigation System

Now that we have developed an understanding of the irrigation design plan, the blocks can be demarcated (lay out) in the field. The assumption is made that the land has been cleared and soil preparation has been done, and that other infrastructure items, such as roads and waterways, has already been demarcated.

Care must be taken when laying out the irrigation blocks that it is done correctly and precisely, even if it may take a day or two longer to obtain an accurate lay out. Remember, the result will determine the lifespan of the orchard. The same principles are used for demarcation of other types of irrigation systems.

The following tools and equipment are required for demarcating of blocks:

- Pegs (one per tree in the block)
- Hammer
- Dumpy level or other surveying instrument
- Measuring tape
- Wire or rope

Blocks are laid out as follows:

- Marking the corners of the blocks
- Marking the rows
- Marking the plant positions

Marking the Corners of the Blocks

The corners of the blocks are first pegged out roughly to see the relation of the blocks to one another.

The lengths of the sides of the blocks are now measured on the irrigation design plan, and the scale of the plan is used to calculate the actual length.

The scale is a ratio that shows the relation between the measurement on the plan and the actual distance on the ground. The scale of the plan in the example in section 1 is 1:1500, meaning that for every centimetre on the plan, the distance on the ground would be 1,500cm or 15m. If the side of a block measures 10cm on the plan, it equals a distance of 15,000cm or 150m on the ground.

The corners of the blocks can now be marked precisely. Make sure the corners are in the right spot and that the pegs are driven in well. These corner-markers will be the used to lay out the rest of the block, so if they are wrong, the rest of the layout will also be wrong.

Marking the Rows

Start by measuring the rows on the side of the block with the mother line, using a measuring tape. Remember that poor-quality measuring tapes can stretch and expand. Use a good quality measuring tape made of fibre.
If the plant spacing on the irrigation design plan is for example 6x2, it means that there must be a 6m space between rows, and a 2m space between the plants in the rows. The row spacing is the bigger number.

Set up the dumpy level at one of the corners of the block. To set up the dumpy, the legs of the tripod is extended and secured. The base of the dumpy is fastened to the tripod by means of the attachment screw on the base the tripod.

On the dumpy is a spirit level, located on the eye-piece or the base of the dumpy. By moving one leg of the tripod at a time, in- or outwards, will adjust the level of the dumpy until it is almost centred. On each corner of the base of the dumpy is an adjusting screw. Adjust these screws until the bubble in the spirit level is dead centre. In the case of the spirit level being located on the eye-piece, the dumpy has to be turned to face the leg that is being adjusted. Rotate the dumpy trough all three legs after it is centred to check the levelling.

When you look into the dumpy level you will note crossed hair lines (the same as a rifle’s telescope) on the inside. Turn the dumpy towards the other corner of the block. (If the other corner is out of sight due to elevation, have an assistant hold a long pole at the other corner.) Plant pegs between the corners at about 20m to 30m intervals. Make sure the pegs are in the vertical hair line and therefore in line with the other corner. These preliminary pegs give a straight line along the side of the block for the measuring of the rows.

Use a tape measure to mark the end of each row with a peg. Make sure the straight line is followed. Check the pegs with the dumpy. They should all be in one straight line from the dumpy to the other corner. Move the pegs perfectly into line, and check the row spacing again with the measuring tape.

Keep the dumpy at the one corner and swivel it to mark a line perpendicular to the one on which the rows have been marked. Apply the same method as above, and put down two marking pegs at about 50m to 100m intervals on this line. Move the dumpy to the first peg and follow the same levelling method as above. Turn the dumpy back to the first corner and zero the degree scale by adjusting the degree plate on the dumpy so that 0 degrees shows to the first corner. Now swivel the dumpy trough 90° and lock.

Peg out a line to the opposite end of the block and use the same method as above to mark the rows at six meter intervals on this line as well. Repeat the procedure for the remaining pegs that run parallel to the rows. When the rows are marked, the pegs in the rows must be checked to see that they are in line.

Orchards are ridged in many cases. This means that the ground is cropped up into the row to improve the soil depth and drainage.

Once the rows are marked, the ridges must be made. Once the rows have been ridged, the rest of the land can be pegged (demarcated). Check the rows by using the same method that was used to lay them out.
Marking the Plant Positions

Set up the dumpy at the end of a row and look at the other end. Use the tape measure to measure the inter-plant spaces. If the plant spacing is 6x2m, this would be 2m. Plant pegs at every spot where a tree must be planted. Check the pegs visually to see that they are in line and also check them at an angle, meaning from one corner to the corner diagonally opposite, to see if they are aligned.

1.3 Conveyance System Trenches

Conveyance system trenches are the trenches into which the pipelines are buried. Before the trenches are dug, they must be pegged out at first. The centre of the trench can be pegged with pegs about 50m to 100m apart. Tie a wire or a rope to the pegs to mark out the line between them and use ordinary lime to mark out the line of the trench. When the trenches are dug, the chalk line must be in the centre of the trench.

The measurements of trenches vary from 400mm to 600mm in width, depending on the size of the pipe, and are usually about 600mm deep. Trenches for pipes that go through lands and roads, such as mainlines and sub-mainlines, should be 1,000mm deep. Trenches for mother lines can be a bit shallower, at about 400mm. Trenches must be free of protruding rocks on the bed since these rocks can break the pipes.

Trenches can be dug by either using manual labour or a back-end loader, also called an excavator. Manual labour may be cheaper, but will take longer, while using a back-end loader will be faster but more expensive. Keep in mind that back-end loaders are also more suited for rocky terrain. The choice will depend on the budget.

1.4 Installing Irrigation Equipment

In the table below several irrigation equipment items is discussed in depth.

<table>
<thead>
<tr>
<th>Pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos cement pipes are not manufactured any longer due to health concerns regarding the manufacturing process. It is however not uncommon for these pipes to be used second-hand. Many older systems also use these pipes for mainlines and sub-mainlines.</td>
</tr>
<tr>
<td>AC pipes are hard but very brittle, so care must be taken when they are handled and transported. The trench must be free of protruding stones and the pipe must be laid on a bed of clean sand. AC pipes are joined by collars. Triplex couplings are made out of asbestos cement and have three seal rings. The pipe slides into this socket shaped joint. The other method of joining AC pipes is with the short collar, which is a coupling with two iron rings that are tightened around an iron collar. Each ring contains a rubber ring that is compressed around the pipe when the</td>
</tr>
</tbody>
</table>
### Installation and management of Irrigation systems

**Primary Agriculture**

**NQF Level 4**

**Unit Standard No: 116317**

**Version: 01**

**Version Date: July 2006**

<table>
<thead>
<tr>
<th><strong>IRrigation</strong></th>
<th><strong>AC</strong> pipes were manufactured in COD (constant outside diameter) and CID (constant inside diameter).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>uPVC Pipes</strong></td>
<td>This is the most commonly used pipe for irrigation. PVC is a plastic material and these pipes are more flexible and tolerant to movement. It is available as uPVC or mPVC. The latter is more pliable than uPVC, but not widely used yet. (Normal garden hoses are made of PVC and are plasticised i.e. soft and bendable.) The one end of the pipe is chamfered and the other end is socket shaped with an integral rubber ring. The chamfered end slides into the socket shaped end. Trenches must be free of stones but need not to be lined with sand for smaller pipe sizes of 200mm and smaller. Fittings are either metal or uPVC and are also socket shaped. Inside the sockets are lip-seals that seal the pipe.</td>
</tr>
<tr>
<td><strong>Steel Pipes</strong></td>
<td>Steel pipes are very expensive but very reliable and durable and are therefore used more often as suction pipes, delivery pipes, risers and filter manifolds where the line must go through or over unsuitable terrain. Steel pipes can be threaded at the end (up to 150mm) or flanged (from 50mm and bigger). Threaded pipes are connected using screwed sockets. Flanged pipes are bolted together with a packing in the middle. Steel pipes rust, so they must be coated with a rust-proof coating such as paint, coupon, galvanizing or powder coating.</td>
</tr>
<tr>
<td><strong>Poly pipe</strong></td>
<td>Poly pipe (or polyethylene or PE) class 3 LDPE (low density PE) pipe is most often used for the lateral lines. Although HDPE (high density PE) is also available, it is normally used in boreholes, shade houses and for stock water supply.</td>
</tr>
</tbody>
</table>

### General Fittings

| **Reducers** | A reducer is used to connect pipes of different sizes. |
| **Bend** | A bend is used to allow a pipe to change direction. Bends are commonly available in 90° and 45°. |
| **End Cap** | An end cap is used to plug the end of a pipe. |
| **Air Valve** | An air valve expels air from the system, preventing air locks. Some air valves have a vacuum function (see below). |
| **Vacuum Valve** | A vacuum valve prevents the formation of a vacuum when the pump system is switched off. |
| **Non-return Valve** | A non-return valve prevents the back-flow of water. |
| **Gate and Butterfly Valve** | Gate and butterfly valves open and close the pipeline, thereby decreasing and increasing the water flow. They are used to regulate the water pressure manually in a block. |
| **Hydraulic Valves** | Hydraulic valves are also used to decrease or increase the water-flow, thereby regulating the water pressure in a block. |

### Infield Fittings

| **Grommets** | A grommet is a fitting that is used to connect lateral lines to the sub main line. |
Nylon Couplings | Nylon couplings and reducers are used to connect poly pipes.
---|---
Micro-jets and Drippers | Micro-jets or sprayers and drippers are the emitters that supply water to each individual tree. They are installed on the lateral lines.
Sprinklers | Sprinklers are larger emitters commonly used for field crops. They are mostly impact sprinklers but can also be gear driven.

### Installing Pipes

Pipes are installed in trenches as follows:

- Before installing pipes in trenches, ensure that the trenches are free of stones and sharp edges.
- Asbestos cement pipes and large uPVC pipes must be bedded in sand.
- Place the first pipe into the trench and secure it by backfilling the trench near the ends of the pipe.
- Place a collar over the end of the pipe. Make sure the collar and the end of the next pipe is clean.
- Lubricate the inside of the collar and the end of the next pipe with pipe lubricant. Do not use oil because this will cause the rubbers to perish.
- Insert the end of the second pipe into the collar.
- Place a wooden block over the tail end of the second pipe and tap the block with a hammer to force the pipe into the collar. The force that is required depends on the size of the pipe.
- Drive the one pipe into the next one as far as the depth mark on the pipe. Take care not to pinch the rubbers.
- If the pipe refuses to go into the collar, remove the pipe and inspect the collar as the rubbers may have shifted.
- Ensure that there are no foreign objects inside the pipes that can cause blockages in the irrigation system.
- As the pipes are fitted and positioned they can be backfilled in between joints, but the joints must be left open to check for leaks when the system is operated.

Where bends, reducers or end caps are fitted, there is always the possibility that the joints can kick out, except in the case of steel joints. Bends and end caps must be anchored by concrete thrust blocks. Thrust blocks should be done according to specifications.

It is a good practice to flush the pipes as the work continues. First flush the mainline before the valves are fitted. Then flush the sub main lines before the laterals are fitted. Next, the laterals can be flushed before emitters are fitted.

After the system has been tested (see section Error! Reference source not found.) the trenches can be backfilled. The backfilling around and above the pipe for about 100mm must be stone free and compacted. The rest of the backfill also need to be compacted to prevent subsidence of the backfilled soil.
Installing Filters and Valve Clusters

Pump and filter bank installation is a specialised job that should be carried out by a competent contractor.

Inline filters can however be installed very easily. The filter is attached to risers so that it is above ground. The bottom end of the risers is fitted with riser outlet bends which are spigot to slide over the pipe. At the back of each riser leg, a Y-standard is hammered in and tied down to the riser to keep the leg from popping out. The valve clusters are installed in the same way.

Installing Infield Fittings

Grommets are installed by drilling a hole in the mother line and inserting a rubber ring into the hole which has a groove that fits into the sides of the pipe. The coupling is inserted into the lateral and then pushed into the rubber ring. There is also another type of grommet that is pushed into the hole and the retaining nut on the grommet is tightened.

Nylon couplings and reducers are pushed into the poly pipe with no clamps needed as long as the working pressure is within limits.

Micros have a tube that is fitted with a barb and drippers have the barb moulded onto them. A hole is punched in to the poly pipe and the barb inserted into the hole.

1.5 Testing the Irrigation System

The various components of the irrigation system are tested as they are installed and the performance of the entire system is tested once the installation is complete.

As the pipes are laid and flushed, joints are inspected for leaks. Once the pipes are partially backfilled with the joints exposed, the system is brought up to working pressure. The blocks that are grouped in operations are opened. Pressure readings are taken in front of and after the valves. These are compared with the values noted on the irrigation design plan in the Pressure and Flow at Nodes table. If the readings are not correct, it may be an indication of wrong pipe size, incorrect hydraulic valve settings, or pump or filter malfunction.

Hydraulic valves are calibrated at this time. The pressure gauge is inserted downstream, after the valve, and the valve is opened. Note the pressure reading.
Once the block is filled, the valve is switched to automatic. If the pressure reading drops, the screw on the pilot is turned slowly in a clockwise direction. If the pressure rises, the screw on the pilot is turned anticlockwise. The process is repeated by adjusting the pilot, checking the pressure again after a while, and adjusting the pilot again if necessary.

Once the hydraulic valves have been calibrated, the pressures in the lateral lines can be checked. Check the pressure at the end of each lateral which should be close to the pressure that the valve is set at. Alternatively, each lateral can be assessed visually and the pressure of the laterals measured that appears to have a different distribution pattern than the other lines.

Emitter delivery can also be checked to see if it corresponds with the irrigation plan. Place the emitter in a suitable container. After a specific time (this may be 1 minute up to 30 minutes), remove the container and measure the amount of water. Calculate the emitter delivery per hour. When this test is done with a representative sample for the whole block, the CU (Coefficient of Uniformity) could be calculated. At least 30 measurements, spread out over the block, need to be done for this test. A Cu of 90% or more is good. A qualified irrigation technician should carry out CU tests as it needs good judgement and statistical calculations.

After this test is done and the system has been operating for a couple of days, the joints must be inspected for leaks. If no leaks are found, the trenches can be backfilled completely.

Please complete Activity 2

Practical duties

Complete the practical duties listed and include naturally occurring evidence in the form of reports, job cards, pictures, meeting minutes and performance management assessments.

1. Peg out (demarcate) a block according to an irrigation design plan.
2. Dig conveyance system trenches according to specifications.
3. Install irrigation pipes, valves, and filters.
4. Back-fill the trenches according to specifications.
5. Test the irrigation system.

Write key-notes for yourself about what you did and attach signatures from your mentor, coach or superior proving that you have successfully completed the tasks.

Key Notes:


Learner’s Signature | Date: 
Assessor’s Signature | Date:
Please complete Activity 3

Compete the worksheet below

Describe how you would orientate the plan to the field?

Describe in your own words how colours and symbols are used on irrigation design plans?

What does the following notations mean:
110/6-80
25/3-150

Describe how you would demarcate a trench and discuss the requirements for a trench in terms of dimensions.

Describe how to install different types of pipes, bends and end caps.

Describe the testing of the irrigation system.
The foundation of a good quality irrigation system is a good irrigation design plan.

The first step in reading an irrigation design plan is to orientate the plan according to landmarks.

Symbols are used on the irrigation design plan to indicate positions of pipes and other components of the irrigation system.

Notations next to pipes indicate their size, class and length.

A table on the irrigation design plan provides information on the individual irrigation blocks, including the size, tree spacing, emitter delivery and the application rate.

A bill of quantities indicates the equipment that is required to install the irrigation system.

Blocks are laid out by first marking out the corners of the blocks, then marking the rows, and lastly marking the position of each tree.

The lengths of the blocks on the irrigation design plan are used in conjunction with the scale of the plan to determine the position of the corners of the blocks.

A dumpy level is used to ensure that rows are straight, starting at the row closest to the mother line of the block.

A measuring tape is used to determine the positions of trees in each row.

Conveyance system trenches are dug for all pipelines. The width and depth of the trenches depend on the size of the pipe.

The manner in which irrigation equipment is installed depends on the type of equipment.

Components of the irrigation system, such as pipes, are tested while being installed, and the entire system is tested once the installation has been completed.

<table>
<thead>
<tr>
<th>Concept (SO 1)</th>
<th>I understand this concept</th>
<th>Questions that I still would like to ask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation design plan is interpreted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation system is pegged out according to specification.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conveyance system trenches are dug according to specifications.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation pipes, valves, filters, etc. are installed according to specifications.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation system is tested and evaluated according to standard procedures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trenches are back-filled according to specification.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Session 2 Maintenance and evaluation of an irrigation system

After completing this session, you should be able to:
SO 2: Maintain and evaluate an irrigation system

2.1 Introduction

Well designed irrigation systems that have been installed correctly and that are operated within the set parameters never requires major maintenance under normal circumstances, meaning circumstances that do not include for instance a flood or a fire.

A sound preventative maintenance plan ensures that minor problems do not turn into major problems, and constant evaluation and monitoring of the system ensures that the system operates within the required parameters, and that problems are identified and dealt with when they occur.

2.2 Maintenance Planning

Crops have a continuous or seasonal irrigation cycle, depending on various factors. During winter, the water demand is low or zero, and this is the ideal time to perform maintenance and repair operations that require a system shutdown for a few days. It is with this in mind that a continuous preventative maintenance plan is implemented and carried out. A good maintenance plan focuses on daily, weekly, monthly and yearly actions.

Water quality is a very important factor in planning preventative maintenance. Water quality differs widely from farm to farm and it is essential to keep records of lateral flushing, filter flushing and water quality. This data is used to determine whether flushing should be done more often or whether water treatments are required.

In general terms, physical water quality is worse during the summer than in winter. In summer rainfall areas, the higher rainfall in summer means that water sources are muddy with an increased content of silt and sand. Algae are also more prevailing during the warmer months which increases the biomass that has to be filtered out of the water. In many cases the chemical water quality is lower during dry periods as rain does not dilute compounds such as salts in the water sources.
Water quality usually suffers because of the lower water level as pumps tend to suck more dirt and there is little time for the silt and sand to settle out of the water. When water quality is poor, filters must be flushed more often.

Below is an example of a fairly comprehensive maintenance plan, which also includes essential monitoring actions:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Item</th>
<th>Task and Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>Pressures</td>
<td>Check that pump and block pressures are within prescribed limits.</td>
</tr>
<tr>
<td></td>
<td>Emitter operation</td>
<td>Check for clogged, broken or misplaced emitters. Repair, replace, unclog or reposition emitters.</td>
</tr>
<tr>
<td></td>
<td>Leaks</td>
<td>Check for water wastage and leaks in pipes and other equipment and repair immediately.</td>
</tr>
<tr>
<td></td>
<td>Primary filter</td>
<td>Flush primary filters as prescribed.</td>
</tr>
<tr>
<td></td>
<td>Fertigation application</td>
<td>Check that fertigation applications are within specifications.</td>
</tr>
<tr>
<td>Weekly</td>
<td>Lateral lines</td>
<td>Flush lateral lines as prescribed.</td>
</tr>
<tr>
<td></td>
<td>Exposed joints</td>
<td>Check and repair if needed, e.g. quick coupling rubbers</td>
</tr>
<tr>
<td></td>
<td>Secondary filters</td>
<td>Flush secondary filters as prescribed.</td>
</tr>
<tr>
<td></td>
<td>System pressure and flow</td>
<td>Check that system pressure and flow are as per irrigation design plan.</td>
</tr>
<tr>
<td></td>
<td>Pump operation</td>
<td>Check that pump operation is within prescribed parameters.</td>
</tr>
<tr>
<td></td>
<td>Block pressures for automated valves</td>
<td>Check that block pressures are as prescribed where automated valves are used.</td>
</tr>
<tr>
<td></td>
<td>Pump oil levels</td>
<td>Check pump oil levels as prescribed.</td>
</tr>
<tr>
<td></td>
<td>Fertigation plant</td>
<td>Inspect fertigation plant.</td>
</tr>
<tr>
<td></td>
<td>Pipes (above and below ground)</td>
<td>Check for leaks and repair</td>
</tr>
<tr>
<td>Monthly</td>
<td>Valves, water meters, and gauges</td>
<td>Visually check valves, water meters and gauges and look for damage and / or vandalism.</td>
</tr>
<tr>
<td></td>
<td>Filters</td>
<td>Open and inspect filters as prescribed.</td>
</tr>
<tr>
<td></td>
<td>Pump pipe work</td>
<td>Check for leaks at pump station that causes water losses and air locks.</td>
</tr>
<tr>
<td></td>
<td>Pump motor</td>
<td>Pump motor must be greased as prescribed.</td>
</tr>
<tr>
<td>Annually</td>
<td>Valves</td>
<td>Service valves and physically check correct operation.</td>
</tr>
<tr>
<td></td>
<td>Filters</td>
<td>Clean filters thoroughly and replace sand in sand filters annually or biennially.</td>
</tr>
<tr>
<td></td>
<td>Pump</td>
<td>Change oil in pump.</td>
</tr>
<tr>
<td></td>
<td>Water sampling</td>
<td>Take a water sample at the end of lateral lines and send it in for analysis.</td>
</tr>
</tbody>
</table>
Installation and management of Irrigation systems

Primary Agriculture
NQF Level 4
Unit Standard No: 116317

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Item</th>
<th>Task and Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emitter delivery tests</td>
<td>Test specific emitters for discharge and pressure.</td>
<td></td>
</tr>
<tr>
<td>Sprinkler parts</td>
<td>Replace nozzles annually and other parts when needed.</td>
<td></td>
</tr>
<tr>
<td>2-10 years</td>
<td>Pump</td>
<td>Replace bearings and other wearing parts on pump and motor every five years.</td>
</tr>
<tr>
<td></td>
<td>Hydraulic valves</td>
<td>Replace diaphragms on hydraulic valves every three years.</td>
</tr>
<tr>
<td></td>
<td>Poly pipe and emitters</td>
<td>Replace poly pipe and emitters every seven to ten years.</td>
</tr>
</tbody>
</table>

Note that the physical water quality, which relates to the suspended solids in the water, plays a role in how frequently filters are flushed and cleaned.

The above plan is merely an indication of the tasks that has to be performed. The objective should be to use this plan as a base to develop your tailored made maintenance plan. Use the following as a guideline:

- If the physical water quality is poor, increase the frequency of flushing and cleaning for laterals, mother lines, filters and filter rings.
- Discharge tests can be performed less often if critical points are checked more often.
- The frequency of the inspection for air leaks can be decreased on new suction pipe work.
- Replace bearings and wearing parts as soon as the pump does not deliver the original capacity.
- Replace diaphragms when valves do not close properly.
- Replace poly pipe when the pipes become brittle and burst easily.
- Replace emitters as soon as the discharge test shows a deviation form the design specifications and the flow rate per block increase.

2.3 Evaluating the Functioning of Irrigation System

Evaluating the functioning of the irrigation system is important in that it ensures that the system operates within the set parameters which protect the components of the system. This is essential for ensuring that the correct amount of water is delivered to the crop.

All the data required to monitor and evaluate the operation of the irrigation system is provided on the irrigation design plan, including the list of operations, a table with pressures and flows at valves and at nodes, and a table with the plant spacing and precipitation for each block.
Uniformity (CU) Tests

The CU uniformity test is used to determine the deviation relative to the average in the performance of equipment, meaning the uniformity in the delivery rate of the emitters across an irrigation block. For sprinkler irrigation the uniformity needs to be determined by catching up water in cans while the sprinklers are operating. These tests must be performed by a qualified technician after installation or when there is a specific problem.

In order to ensure that the system is working within specification a simple emitter discharge test can be done. To perform a discharge test on the delivery and pressure of emitters, select five evenly-spaced lateral lines in the most critical block i.e. the block with the lowest pressure. Use (for example) the 1st, 5th, 9th, 13th and 17th line in the block. Select five evenly-spaced emitters on each lateral line. Use an emitter at the beginning of the line, an emitter about one quarter of the way along the line, one about half-way along the line, one about three-quarters of the way along, and the one on the end.

The delivery of each sample emitter is measured by allowing the emitter to drip or spray into a measuring tube for 5 minutes. Measure the volume of water as well as the pressure and record in such a way that future tests can be compared with this one. The delivery of each emitter in litres per hour is calculated from the data that has been gathered. The average delivery is calculated and the difference between the highest and the lowest emitter delivery is expressed as a percentage higher or lower than the average. This tolerance level for the variance is 10% either side of the average. If the difference is more than 10%, the system must be examined and the fault repaired. The real use of this test would be to compare a test with the previous tests. For this reason the same emitters need to be tested. Dropping in pressure or increased variations will be picked up immediately and the fault could then be identified and rectified.

### Uniformity Test Data Table (with 25 points)

<table>
<thead>
<tr>
<th>Emitter Delivery in liter/5min</th>
<th>Position on Lateral</th>
<th>Lateral</th>
<th>Beginning</th>
<th>¼</th>
<th>½</th>
<th>¾</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>3.30</td>
<td>3.30</td>
<td>3.16</td>
<td>3.16</td>
<td>3.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>3.30</td>
<td>3.30</td>
<td>3.30</td>
<td>3.25</td>
<td>3.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>3.40</td>
<td>3.30</td>
<td>3.30</td>
<td>3.30</td>
<td>3.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13</td>
<td>3.30</td>
<td>3.25</td>
<td>3.25</td>
<td>3.25</td>
<td>3.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td>3.30</td>
<td>3.30</td>
<td>3.30</td>
<td>3.25</td>
<td>3.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emitter Delivery in l/h</th>
<th>Position on Lateral</th>
<th>Lateral</th>
<th>Beginning</th>
<th>¼</th>
<th>½</th>
<th>¾</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The average emitter delivery is 39.48l/h. The emitter with the largest delivery is 40.8l/h (or 3.3% higher than average) and the emitter with lowest delivery is 37.9l/h (or 4.0% lower than average). This is a deviation is well within the tolerance level of 10%, the system can be considered to be in order.

### Evaluation Irrigation System Performance

The installed irrigation system is evaluated as follows:

- Open the blocks as per the list of operations
- Check and correct, if necessary, the block pressures
- Note the pump operating parameters
- Note the pressures at nodes
- Perform a discharge test
- Repeat the procedure for all the operations
- Evaluate the data

The following is indicative of the system flow being higher than specified:

- **Pump:** Amp reading is higher than expected
- **Pump:** Pressure reading is the same or lower than expected
- **Pump:** Flow meter reading higher than expected
- **Pressure at Nodes:** Lower than expected
- **Pressure at Blocks:** Lower than expected
- **CU/ Discharge Test:** CU might be good, but the flow per emitter can be higher

The most probable cause is worn nozzles on the emitters, especially if the water has a high silt and sand content. The system pressure is lower due to the higher flow in each block. The pump is trying to compensate by pumping more, which is why the amp reading will be higher. The uniformity should be acceptable, since wear and tear will occur on all the nozzles.

The following is indicative of the system flow being lower than specified:

- **Pump:** Amp reading is lower or higher than expected
- **Pump:** Pressure reading is higher or lower than expected
- **Pump:** Flow meter reading is lower than expected
- **Pressure at Nodes:** Higher or lower than expected
- **Pressure at Blocks:** Lower or higher than expected
CU/ Discharge Test: Uneven and/or low emitter delivery

Lower flow can be caused by a worn pump or by blockages. When the pump impeller is worn, the symptoms will be low pressure and flow but a high amp meter reading. In this case, the pump must be serviced and repaired, or replaced. Blockage can occur at various places with differing symptoms. The pressure reading before the blockage will be abnormally high, but pressure readings after the blockage will be very low. Amp meter readings will also be lower. Consider the following examples:

- Blocked Impeller: Low pressure reading at pump and in the rest of the system
- Blocked Filter: High pressure at pump, but low pressure after filter bank
- Blocked Pipeline: High pressure up to the filter and some nodes, but at other nodes the pressure is low

A preventative maintenance plan ensures that minor problems do not turn into major problems.
Constant evaluation and monitoring of the system ensures that the system operates within the required parameters and that problems are picked up and dealt with when they occur.
In fruit production irrigation is used all year round, but during the winter the water requirement is lower and therefore major maintenance is done during the winter.
Physical water quality impacts on the frequency with which certain maintenance actions will be performed.
A maintenance plan include actions that has to be performed on a daily, weekly, monthly, annual and two- to ten-yearly basis.
The coefficient of uniformity (CU) and/or the discharge test is used to determine the variance in the performance of equipment.
The irrigation system is evaluated by opening the blocks as per the list of operations, checking and correcting, if necessary, the block pressures, noting the pump operating parameters and the pressures at nodes, performing a delivery test, repeating the procedure for all the operations, and evaluating the data.

<table>
<thead>
<tr>
<th>Concept (SO 2)</th>
<th>I understand this concept</th>
<th>Questions that I still would like to ask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-season maintenance is carried out.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-season maintenance is carried out.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-season maintenance is carried out.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular evaluation of the functioning of an irrigation system as per design specifications.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please complete Activity 4

Duty list
Draft duty lists for the team on the daily, weekly, monthly, seasonal and yearly maintenance of the irrigation system.

Daily:

Weekly:

Monthly:

Yearly:
Please complete Activity 5

Worksheet
Complete the worksheet below

Use the maintenance plan in section 2 and rewrite it in order to relate to the farm you work on. Mention how and why the intervals of certain tasks will be lengthened or shortened.

What symptoms can be indicative of a higher system flow?

What symptoms can be indicative of a lower system flow?

Describe the symptoms for a blocked impeller, filter and pipe.
3 Operating an Irrigation System

After completing this session, you should be able to:

SO 3: Efficiently operate an irrigation system

3.1 Irrigation Scheduling

In this section, we will look at how the irrigation schedule can help you to manage and operate the irrigation system more efficiently.

The aim of scheduling is to maintain the soil water balance at the optimum level. In other words, the soil must not be too wet, in which case the plants drown, or too dry, in which case the plants will suffer from water stress. The correct stand time and irrigation frequency, or cycle, must be determined and maintained.

An irrigation schedule consists of:

- The table of operations lists the different operations and the blocks involved in each operation.
- The irrigation schedule lists the date and stand time for each operation. The longer the stand time the more water is applied, which would apply during hot periods.
- List of pressures and flows, which is used to set the pressure for each block.

For the irrigation system to operate effectively, these three components must all be managed properly.
3.2 Monitoring the Irrigation Schedule

Various aids are available to monitor the implementation of the irrigation schedule. These aids include E-pans, rain meters, tensiometers and probes. This equipment provides information that assist with the calculation of the soil-water balance, thereby enabling one to determine the effectiveness of the irrigation.

**Irrigation Scheduling**

Farmer Brown has an apple farm. The irrigation system has an application rate of 2mm/h. With the current schedule, each block is irrigated for 4 hours every second day. There is no irrigation on day 7. This means that farmer Brown applies 8mm of water during every operation, irrigating a total of 24mm a week.

According to the E-pan, the average evaporation (ETC) is 3.4 mm/day, being 23.8 mm/week. The stand time is therefore adequate for the moment. He would also observe an adequate water balance according to the readings from the tensiometers and the probes. These instruments will show that the soil-water balance is kept between FWC and the lower end of EAW.

Should the climate become warmer, the daily ETC will rise. The probe and the tensiometer readings will also start to indicate the soil-water balance is nearing the lower end of EAW. The stand time now needs to be increased until the tensiometer and probe readings show the soil-water balance to be in the correct range. The same principle would also apply for cooler seasons, when the scheduling equipment would indicate a lower evapotranspiration rate and the stand times need to be decreased accordingly.
3.3 Determining the Effectiveness of Irrigation

The effectiveness of irrigation can be assessed by means of a holistic approach that considers factors such as:

- The discharge test (see chapter 2, section 3.1)
- Discharge test
- Scheduling equipment data
- Visual inspection of profile holes
- Tree health
- Crop yield data

Not one of the factors to determine the irrigation effectiveness should be viewed in isolation. For instance, if the CU and profile holes show a high effectiveness, but the yield is low, other factors influencing yield must be investigated. On the other hand, if tree health is poor in certain areas and the profile holes data vary greatly, the cause of poor irrigation effectiveness must be investigated.

### Scheduling Equipment Data

Data obtained from scheduling equipment, especially equipment such as probes and tensiometers, also indicates the volume of water being put down in the soil as well as the depth of the wetted profile.

This data can be compared to the actual water meter readings for the specific block. In this manner, the effectiveness can be determined as it indicates losses due to evaporation and misting during irrigation.

### Profile Holes

Digging and inspection of profile holes helps to determine irrigation effectiveness. Although no readings can be taken, it offers the opportunity to determine the depth and width of the wetted profile as well as in situ inspection of root growth and health. Good root growth and health indicate that the profile is wetted correctly and consistently, while bad root health can be attributed to poor irrigation.

Profile holes are also useful to determine if water logging occurs, especially at sub-levels. Profile holes evaluate the effectiveness of the stand time and irrigation cycle. Too long stand times generally causes water logging and wetting of lower profiles below the root-zone. Short stand times will show as shallow wetting of the upper crust.

Too long cycle times are more difficult to detect, but can manifest as dryer profile with deep roots and wetting beyond the root-zone. Short cycle times are not necessarily bad, provided the stand times are in proportion.
Crop Health

General crop health is a subjective method of determining irrigation effectiveness. Although some skills are required in assessing tree health and the general condition of the trees, it is none the less a method where the whole orchard can be assessed for over- or under-irrigation. It must however be kept in mind that three health is influenced by a wide range of production factors.

It is also possible to identify problem areas in a specific orchard. Symptoms such as wilting, colouring and turning of the leaves can be indicative of poor irrigation.

Crop Yield Data

Yield data can indicate if irrigation effectiveness is poor or good, but is also influenced by a wide range of production factors making it difficult to isolate the effect of irrigation. Yield is influenced by other factors such as fertilising, pruning and pest control, but can also be indicative of irrigation effectiveness over a longer period of time.

- Irrigation scheduling should ensure that the soil-water balance is maintained at an optimum level.
- An irrigation schedule consists of a table of operations, the irrigation schedule and a list of pressures and flows.
- Various types of equipment are used to monitor the effectiveness of the irrigation schedule by monitoring the soil-water balance.
- The effectiveness of irrigation is assessed by taking a holistic approach and taking into account uniformity tests, scheduling equipment data, visual inspection of profile holes, crop health and crop yield.
- The discharge test indicates the performance of the irrigation system and measures the actual delivery of the emitters.
- Scheduling equipment data indicates the soil water balance.
- Profile holes are used to assess the water balance throughout the profile, especially in the sub-levels.
- Crop health and crop yield data is subjective methods to measure the effectiveness of irrigation, as it can be influenced by many other production factors.

<table>
<thead>
<tr>
<th>Concept (SO 3)</th>
<th>I understand this concept</th>
<th>Questions that I still would like to ask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule is given to and discussed with the field/orchard operator.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation is monitored according to irrigation schedule.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation effectiveness is determined.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please complete Activity 7

Report writing
Obtain an irrigation schedule of the farm where you are performing your practical work. Draft an additional report explaining in detail how the following influenced the irrigation schedule and how it would influence adjustments to the schedule:

1. The use of tensiometers and tensiometer readings
2. The taking of soil samples and analyses of soil sample reports
3. The use of a probe
4. The considerations of the previous week’s and month’s scheduling programmes
5. Current flow rates and flow rate readings
6. Weather station information and data
7. 7-day weather forecasts

Please complete Activity 8

Pictogram
Draft a pictogram and make a brief presentation to the class explaining the process of irrigation effectiveness. Be sure to include considerations for discharge tests, water balance determination and depth of irrigation.
After completing this session, you should be able to:
SO 4: Collate data pertaining to the long-term efficient management of an irrigation system

4.1 Irrigation data Records

Collecting and recording data is extremely important as it helps to establish a history of events thereby assisting with the management of the irrigation. There is a saying: “there is no management without measurement”. It is equally important to record measurements.

The soil-water content is measured to determine if the stand time is adequate. By recording the soil water content over a period of time, the soil characteristics can be determined and the irrigation schedule can be tuned accordingly.

Here is a list of possible records:

- **Daily records** are the records of block pressures, flow-rates, amp meter readings, hour meter readings, start-up and shut-down inspections and readings, fertiliser levels, readings linked to fertigation like pH and EC and system performance checks such as CU tests. Records like these are contained in a logbook for the irrigation system. The recorded data is useful to identify trends, for instance, water use per week and an increase in flushing cycles which can help to make decisions proactively.

- **Weather station and scheduling equipment data** is recorded to assist with irrigation scheduling. It is essential that these records at the very least are kept on every farm.

- **Yield data** is used to determine if the irrigation was effective or not during the season.

- **Labour records** include labour used for irrigation, clock-in and -out times, job descriptions, and records of work done by each worker. The recording of this data helps to manage workers effectively as the man-hours spent on a task can be determined.

Most data is initially captured by hand, for which a logbook, or a form that has been designed for that specific purpose, is used. Other data is captured electronically, such as from weather stations and probes which must be downloaded onto a computer.
Below are some examples of forms that can be adapted. When adapting the examples for use on a farm, keep the following in mind:

- One sheet can be used to record all the labour working in your section. The description of the day's work can be more abbreviated or in more detail.
- The daily record must preferably include the daily checks. This will vary between farms. Again the record can be more detailed or more abbreviated.
- The weather details and scheduling equipment record depend on the equipment on the farm. Obviously you can only record readings from the equipment that you have.
- The irrigation manager or supervisor would prescribe the fields required in the various records.

**Labour Record**

<table>
<thead>
<tr>
<th>Date</th>
<th>Clock-In Time</th>
<th>Clock-Out Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>07h00</td>
<td>17h00</td>
<td>Irrigate operation 1</td>
</tr>
<tr>
<td>2</td>
<td>07h00</td>
<td>17h00</td>
<td>Irrigate operation 2</td>
</tr>
<tr>
<td>3</td>
<td>07h00</td>
<td>17h00</td>
<td>Irrigate operation 1</td>
</tr>
<tr>
<td>4</td>
<td>07h00</td>
<td>17h00</td>
<td>Irrigate operation 2</td>
</tr>
<tr>
<td>5</td>
<td>07h00</td>
<td>17h00</td>
<td>Irrigate operation 1</td>
</tr>
<tr>
<td>6</td>
<td>07h00</td>
<td>17h00</td>
<td>Irrigate operation 2</td>
</tr>
</tbody>
</table>

**My Notes ...**
**Daily Report**

<table>
<thead>
<tr>
<th>Block</th>
<th>Pressure</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>1.8</td>
<td></td>
</tr>
</tbody>
</table>

**Readings**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Meter</td>
<td>15,008</td>
</tr>
<tr>
<td>Amp Meter</td>
<td>120</td>
</tr>
<tr>
<td>Volt Meter</td>
<td>400</td>
</tr>
<tr>
<td>Pump Pressure</td>
<td>7</td>
</tr>
<tr>
<td>EC</td>
<td>1.2</td>
</tr>
<tr>
<td>pH</td>
<td>6.5</td>
</tr>
</tbody>
</table>

**Action**

<table>
<thead>
<tr>
<th>Action</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre start-up Inspection</td>
<td>Y</td>
</tr>
<tr>
<td>Start-up Inspection</td>
<td>Y</td>
</tr>
<tr>
<td>Shut-down Inspection</td>
<td>Y</td>
</tr>
<tr>
<td>Filter Flushing</td>
<td>5</td>
</tr>
</tbody>
</table>

**Weekly Activities**

<table>
<thead>
<tr>
<th>Weekly Activities</th>
<th>Date: 09/08/2005</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly Inspection</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Filter Flushing</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Filled in By</td>
<td>John</td>
<td></td>
</tr>
</tbody>
</table>
4.2 Recording Data in Electronic Form

Once data has been recorded on paper it can be transferred and captured in electronic format. With the advancement in computer technology, computers have become cheaper and more powerful, with the added benefit that data can be transferred electronically to anywhere in the world through the internet. Computers also help to convert data to useful information.

Data is captured in either a database or in spreadsheets. The use of a database has advantages because they can store masses of data and are very powerful in converting data into information. Operating databases however requires skilled personnel and they are used mostly by large farms and estates. The use of
spreadsheets finds a wider application as they are easy to use, more assessable, and adequate for most tasks.

In the simplest form, the hand-written document is simply recorded on computer in an identical spreadsheet with the same fields as the paper format. Alternatively, the spreadsheet can be altered to sort and filter some of the data. Once the data is keyed into the spreadsheet it can be linked to other spreadsheets that sort and filter the data, thereby converting it into information, including the calculation of averages, averages over time, and so on.

The data from equipment with electronic loggers, such as probes and automated systems, is downloaded from the logger to a computer. Usually an interface and program is supplied to download the data to the computer. This program has an option that converts the data to formats that are commonly used.

Software and hardware are improved continuously and new versions of software are released from time to time. As older programs are replaced by new programs, it is necessary to save the data in a format that is supported by the new program. New hardware also becomes available from time to time and it is wise to save data on the most recent storage media.

### 4.3 Evaluating Data

Even the most sophisticated equipment can fail and therefore instruments must be recalibrated from time to time and reasonable checks done on the data to verify the accuracy and precision. Electronically collected data is sensitive to instrument drift and even failure. The principle is the same as a clock that needs to be corrected when it loses time. We will however only discover that it is losing time when we compare it to another clock.

In the simplest form, reasonable checks can be done by taking readings in set conditions. This applies especially to EC and pH meters where readings can be taken with the use of stock solutions. If the value is different from the test value for a stock solution, the instrument must be recalibrated or serviced. It is recommended that one refers to the owners manuals of such equipment.

Some probes can also be tested in the same manner. It is however best to correlate data with other scheduling equipment, if available, or even the general condition of the trees and observations from profile holes. Even if different types of scheduling equipment are used, they should all point to the same tendencies. If one set of data contradicts another set or sets of data, this set’s readings must be taken again and verified.

The importance of checking and verifying data cannot be overstated. It is always better to rather believe the tree conditions than a set of data. It would make no sense at all to stop irrigating when a probe for instance shows that the soil water content is sufficient, but the trees shows signs of wilting.
4.4 Preparation of Reports

Reports are developed from records, and in some cases, such as daily records, the records itself is sufficient for reporting purpose. In other cases it is however necessary to develop reports based on recorded data. A report is a summary of the relevant information reflecting the information that is relevant to the issue under review. In the example below, a weekly report has been prepared based on daily reports.

### Weekly Reports

<table>
<thead>
<tr>
<th>Date and Day</th>
<th>Daily Report</th>
<th>Comment on Daily Checks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>All workers present, workers irrigated and did discharge test on blocks in operation 1 and 2, results within limits</td>
<td>All checks OK. Water level at pump suction reaching minimal level.</td>
</tr>
<tr>
<td>Tuesday</td>
<td>All workers present, continue to perform discharge test on rest of operations (3 and 4). Shifted pump suction down into water.</td>
<td>All checks OK. ETC more.</td>
</tr>
<tr>
<td>Wednesday</td>
<td>All workers present, repaired leak on sub-mainline. Schedule affected, pump operation extended</td>
<td>All checks OK. ETC rising</td>
</tr>
<tr>
<td>Thursday</td>
<td>All workers present. Took reading with the probe, data downloaded.</td>
<td>All checks OK. ETC rising</td>
</tr>
<tr>
<td>Friday</td>
<td>All workers present, probe readings processed, increased stand time from 3 hours to 3½ hours. Clean filter elements.</td>
<td>All checks OK. ETC constant</td>
</tr>
<tr>
<td>Saturday</td>
<td>Team A present (weekend off for team B), irrigated</td>
<td>All OK</td>
</tr>
</tbody>
</table>

When preparing a report, keep the following in mind:

- Keep the report short and to the point, but not too abbreviated.
- Give the details as required by the supervisor.
- Write the report in neat hand-writing or type it out.
Data collection and recording is essential for proper management. Records that are kept for irrigation management include daily records, weather station and scheduling equipment data, yield data and labour records. Data is mostly first recorded by hand and then transferred to a computerised record keeping system. Databases or spreadsheets are used to collect data and convert it into information. Data must be evaluated as equipment can be incorrect or measurements can be taken incorrectly. The best way to evaluate data is through reasonability tests. Reports are developed for specific purposes from data that has been collected.

<table>
<thead>
<tr>
<th>Concept (SO 4)</th>
<th>I understand this concept</th>
<th>Questions that I still would like to ask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record all relevant water use/crop yield/climatic data for later evaluation and adaptation (of, for instance, scheduling practices, if required).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recording of all relevant data in a recognised electronic format.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular updating of all records to comply with new generation electronic hardware/software.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-going, low-key, checking/evaluation of all data to ensure validity of, especially, electronically collated data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparation of reports for supervisor evaluation.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Please complete Activity 9**

**Flow diagram**

Draw a flow diagram with attached notes, details and training schedules for the preparation of reports regarding management of the irrigation system.
Please complete Activity 10

Worksheet

Use the examples of records in section 1 and adapt it to suit your specific conditions.
Prepare a form that captures the yield per block.

My Notes ...

..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
Am I ready for my test?

- Check your plan carefully to make sure that you **prepare in good time**.
- You have to be found **competent** by a qualified **assessor** to be declared competent.
- Inform the assessor if you have any **special needs** or requirements **before** the agreed date for the test to be completed. You might, for example, require an interpreter to translate the questions to your mother tongue, or you might need to take this test orally.
- Use this worksheet to help you prepare for the test. These are **examples** of **possible questions** that might appear in the test. All the information you need was taught in the classroom and can be found in the learner guide that you received.

1. **I am sure** of this and understand it well
2. **I am unsure** of this and need to ask the Facilitator or Assessor to explain what it means

<table>
<thead>
<tr>
<th>Questions</th>
<th>1. I am sure</th>
<th>2. I am unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. You are now ready for step six of the assessment process, during which you will be asked to write a report for the farm on which you are completing your practical duties comparing the current management of the irrigation system versus the ideal long-term efficient management of the same irrigation system. Make constructive observations and suggestions for possible improvements. Include information regarding the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• General record keeping of all irrigation practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Periodic scientific appraisal and improvement of irrigation practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Compare records pertaining to water use versus crop yield versus climatic data and make recommendations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Assess the format in which format records are kept, being hand written, electronic, manual, computerised, etc. and make recommendations on how these can be improved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Discuss the first line maintenance and checking an evaluation of all instruments, i.e. calibrated to assure validity and avoid instrument drift or calibration drift</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Checklist for practical assessment...

Use the **checklist** below to help you prepare for the part of the practical assessment when you are observed on the **attitudes** and **attributes** that you need to have to be found competent for this learning module.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Answer Yes or No</th>
<th>Motivate your Answer (Give examples, reasons, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can you identify problems and deficiencies correctly?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are you able to work well in a team?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you work in an organised and systematic way while performing all tasks and tests?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are you able to collect the correct and appropriate information and / or samples as per the instructions and procedures that you were taught?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are you able to communicate your knowledge orally and in writing, in such a way that you show what knowledge you have gained?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can you base your tasks and answers on scientific knowledge that you have learnt?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are you able to show and perform the tasks required correctly?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are you able to link the knowledge, skills and attitudes that you have learnt in this module of learning to specific duties in your job or in the community where you live?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The assessor will complete a checklist that gives details of the points that are checked and assessed by the assessor.
- The assessor will write commentary and feedback on that checklist. They will discuss all commentary and feedback with you.
- You will be asked to give your own feedback and to sign this document.
- **It will be placed together with this completed guide in a file as part of you portfolio of evidence.**
- The assessor will give you feedback on the test and guide you if there are areas in which you still need further development.
Paperwork to be done ...

Please assist the assessor by filling in this form and then sign as instructed.

<table>
<thead>
<tr>
<th>Learner Information Form</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit Standard</strong></td>
</tr>
<tr>
<td><strong>Program Date(s)</strong></td>
</tr>
<tr>
<td><strong>Assessment Date(s)</strong></td>
</tr>
<tr>
<td><strong>Surname</strong></td>
</tr>
<tr>
<td><strong>First Name</strong></td>
</tr>
<tr>
<td><strong>Learner ID / SETA Registration Number</strong></td>
</tr>
<tr>
<td><strong>Job / Role Title</strong></td>
</tr>
<tr>
<td><strong>Home Language</strong></td>
</tr>
<tr>
<td><strong>Gender:</strong> Male:</td>
</tr>
<tr>
<td><strong>Race:</strong> African:</td>
</tr>
<tr>
<td><strong>Employment:</strong> Permanent:</td>
</tr>
<tr>
<td><strong>Disabled</strong> Yes:</td>
</tr>
<tr>
<td><strong>Date of Birth</strong></td>
</tr>
<tr>
<td><strong>ID Number</strong></td>
</tr>
<tr>
<td><strong>Contact Telephone Numbers</strong></td>
</tr>
<tr>
<td><strong>Email Address</strong></td>
</tr>
<tr>
<td><strong>Postal Address</strong></td>
</tr>
</tbody>
</table>
Bibliography

Books:

Besproeiings Bedryfshandleiding, ARC Institute for Agricultural Engineering, LNR-ILI 2003, F.H. Koegelenbergh

Irrigation Design Manual, ARC Institute for Agricultural Engineering, ARC-ILI 2003, J.H. Burger et al

Terms & Conditions

This material was developed with public funding and for that reason this material is available at no charge from the AgriSETA website (www.agriseta.co.za).

Users are free to produce and adapt this material to the maximum benefit of the learner.

No user is allowed to sell this material whatsoever.
Installation and management of Irrigation systems

Primary Agriculture  NQF Level 4  Unit Standard No: 116317

Acknowledgements

■ Project Management:
♦ M H Chalken Consulting
♦ IMPETUS Consulting and Skills Development

■ Donors:
♦ Citrus Academy
♦ Boland College
♦ Weskus College

■ Developer:
♦ Dr M Roets
♦ Mr J H P van der Merwe
♦ Cabeton Consulting

■ Authenticator:
♦ Rural Integrated Engineering
♦ Prof P J Robbertse
♦ Ms D Naidoo
♦ Le Toit Management Consultants cc
♦ Mr M M Ratsaka
♦ Mr D N Cronje

■ Technical Editing:
♦ Mr R H Meinhardt

■ OBE Formatting:
♦ Ms P Prinsloo
♦ Ms B Enslin
Design:
♦ Didacs Design SA (Pty) Ltd

Layout:
♦ Ms N Matloa
SOUTH AFRICAN QUALIFICATIONS AUTHORITY
REGISTERED UNIT STANDARD:

Schedule the operation and maintenance of irrigation systems

<table>
<thead>
<tr>
<th>SAQA US ID</th>
<th>UNIT STANDARD TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>116317</td>
<td>Schedule the operation and maintenance of irrigation systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SGB NAME</th>
<th>PROVIDER NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGB Primary</td>
<td>NSB 01-Agriculture and Nature</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Conservation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIELD</th>
<th>SUBFIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and Nature Conservation</td>
<td>Primary Agriculture</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ABET BAND</th>
<th>UNIT STANDARD TYPE</th>
<th>NQF LEVEL</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undefined</td>
<td>Regular</td>
<td>Level 4</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REGISTRATION STATUS</th>
<th>REGISTRATION START DATE</th>
<th>REGISTRATION END DATE</th>
<th>SAQA DECISION NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered</td>
<td>2004-10-13</td>
<td>2007-10-13</td>
<td>SAQA 0156/04</td>
</tr>
</tbody>
</table>

PURPOSE OF THE UNIT STANDARD

A learner achieving this unit standard will be able to effectively supervise the installation, operation and maintenance of irrigation systems of agricultural crops.

Learners will gain specific knowledge and skills in irrigation and will be able to operate in a plant production environment implementing sustainable and economically viable production principles.

They will be capacitated to gain access to the mainstream agricultural sector, in plant production, impacting directly on the sustainability of the sub-sector. The improvement in production technology will also have a direct impact on the improvement of agricultural productivity of the sector.

LEARNING ASSUMED TO BE IN PLACE AND RECOGNITION OF PRIOR LEARNING

It is assumed that a learner attempting this unit standard will show competence against the following unit standards or equivalent:

- NQF 3: Monitor The Operation And Maintenance Of Irrigation Systems.
- NQF 4: Establish a plan for the monitoring, safe use and maintenance of equipment, implements, technology and infrastructure.

UNIT STANDARD RANGE

Whilst range statements have been defined generically to include as wide a set of alternatives as possible, all range statements should be interpreted within the specific context of application.

Range statements are neither comprehensive nor necessarily appropriate to all contexts. Alternatives must however be comparable in scope and complexity. These are only as a general guide to scope and complexity of what is required.
UNIT STANDARD OUTCOME HEADER
N/A

Specific Outcomes and Assessment Criteria:

SPECIFIC OUTCOME 1
Install an irrigation system.

OUTCOME RANGE
Includes but is not limited to plan interpretation, site preparation, survey, pipe/valve/filter requirements, etc.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
Irrigation design plan is interpreted.

ASSESSMENT CRITERION 2
Irrigation system is pegged out according to specification.

ASSESSMENT CRITERION 3
Conveyance system trenches are dug according to specifications.

ASSESSMENT CRITERION 4
Irrigation pipes, valves, filters, etc. are installed according to specifications.

ASSESSMENT CRITERION 5
Irrigation system is tested and evaluated according to standard procedures.

ASSESSMENT CRITERION 6
Trenches are back-filled according to specification.

SPECIFIC OUTCOME 2
Maintain and evaluate an irrigation system.

OUTCOME RANGE
Includes but is not limited to regular maintenance and evaluation of the functioning of an irrigation system.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
Pre-season maintenance is carried out.

ASSESSMENT CRITERION RANGE
Flush system, repairing/replacing worn/broken pipes/valves/sprinklers, etc.
ASSESSMENT CRITERION 2
In-season maintenance is carried out.

ASSESSMENT CRITERION RANGE
Daily, weekly, monthly according to standard procedures such as CU tests, pressure tests, etc.

ASSESSMENT CRITERION 3
Post-season maintenance is carried out.

ASSESSMENT CRITERION RANGE
Pumps, filters, flushing, etc.

ASSESSMENT CRITERION 4
Regular evaluation of the functioning of an irrigation system as per design specifications.

ASSESSMENT CRITERION RANGE
Functioning of pumps, motors, pressure, delivery rate, water distribution efficiency, etc. evaluated against design specifications.

SPECIFIC OUTCOME 3
Efficiently operate an irrigation system.

OUTCOME RANGE
Includes but is not limited to irrigating according to schedule, regular in-field operational checks, etc.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
Schedule is given to and discussed with the field/orchard operator.

ASSESSMENT CRITERION 2
Irrigation is monitored according to irrigation schedule.

ASSESSMENT CRITERION RANGE
Tensiometers, soil samples, Neutron probe, scheduling programmes, stand time, flow rate, etc.

ASSESSMENT CRITERION 3
Irrigation effectiveness is determined.

ASSESSMENT CRITERION RANGE
CU tests, water balance determination, depth of irrigation, etc.

SPECIFIC OUTCOME 4
Collate data pertaining to the long-term efficient management of an irrigation system.
OUTCOME RANGE
Includes but is not limited to general record keeping of all irrigation practices in order to be able to, in time, allow for scientific appraisal of and improvement of all relevant practices.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
Record all relevant water use/crop yield/climatic data for later evaluation and adaptation (of, for instance, scheduling practices, if required).

ASSESSMENT CRITERION 2
Recording of all relevant data in a recognised electronic format.

ASSESSMENT CRITERION RANGE
Linked spread sheets, tables, etc.

ASSESSMENT CRITERION 3
Regular updating of all records to comply with new generation electronic hardware/software.

ASSESSMENT CRITERION 4
On-going, low-key, checking/evaluation of all data to ensure validity of, especially, electronically collated data.

ASSESSMENT CRITERION RANGE
Instrument drift, calibration drift, etc.

ASSESSMENT CRITERION 5
Preparation of reports for supervisor evaluation.

ASSESSMENT CRITERION RANGE
Regular overview reports, reports pertaining to deviations in data (i.e. water quality), recorder problems, etc.

UNIT STANDARD ACCREDITATION AND MODERATION OPTIONS
The assessment of qualifying learners against this standard should meet the requirements of established assessment principles.

It will be necessary to develop assessment activities and tools, which are appropriate to the contexts in which the qualifying learners are working. These activities and tools may include an appropriate combination of self-assessment and peer assessment, formative and summative assessment, portfolios and observations etc.

The assessment should ensure that all the specific outcomes, critical cross-field outcomes and essential embedded knowledge are assessed.

The specific outcomes must be assessed through observation of performance. Supporting evidence should be used to prove competence of specific outcomes only when they are not clearly seen in the actual performance.
Essential embedded knowledge must be assessed in its own right, through oral or written evidence and cannot be assessed only by being observed.

The specific outcomes and essential embedded knowledge must be assessed in relation to each other. If a qualifying learner is able to explain the essential embedded knowledge but is unable to perform the specific outcomes, they should not be assessed as competent. Similarly, if a qualifying learner is able to perform the specific outcomes but is unable to explain or justify their performance in terms of the essential embedded knowledge, then they should not be assessed as competent.

Evidence of the specified critical cross-field outcomes should be found both in performance and in the essential embedded knowledge.

Performance of specific outcomes must actively affirm target groups of qualifying learners, not unfairly discriminate against them. Qualifying learners should be able to justify their performance in terms of these values.

- Anyone assessing a learner against this unit standard must be registered as an assessor with the relevant ETQA.
- Any institution offering learning that will enable achievement of this unit standard or assessing this unit standard must be accredited as a provider with the relevant ETQA.
- Moderation of assessment will be overseen by the relevant ETQA according to the moderation guidelines in the relevant qualification and the agreed ETQA procedures.

**UNIT STANDARD ESSENTIAL EMBEDDED KNOWLEDGE**

The person is able to demonstrate a basic knowledge of:

- Appropriate Laws and Regulation pertaining to agricultural water use, environmental safety, etc.
- Elementary hydraulics.
- Principles of irrigation, crop water requirements, soil water holding capacity, etc.
- Principles of irrigation system design.
- Principles of irrigation scheduling.
- Use of computer based irrigation scheduling programmes.
- Principles of human and resource management.

**UNIT STANDARD DEVELOPMENTAL OUTCOME**

N/A

**UNIT STANDARD LINKAGES**

N/A

**Critical Cross-field Outcomes (CCFO):**

**UNIT STANDARD CCFO IDENTIFYING**

Problem solving relates to all specific outcomes.

**UNIT STANDARD CCFO WORKING**

Teamwork relates to all specific outcomes.

**UNIT STANDARD CCFO ORGANIZING**
Self-organisation and management relates to all specific outcomes.

**UNIT STANDARD CCFO COLLECTING**  
Information evaluation relates to all specific outcomes.

**UNIT STANDARD CCFO COMMUNICATING**  
Communication relates to all specific outcomes.

**UNIT STANDARD CCFO SCIENCE**  
Use science and technology relates to all specific outcomes.

**UNIT STANDARD CCFO DEMONSTRATING**  
Inter-relatedness of systems relates to all specific outcomes.

**UNIT STANDARD CCFO CONTRIBUTING**  
Self-development relates to all specific outcomes.

**UNIT STANDARD ASSESSOR CRITERIA**  
N/A

**UNIT STANDARD NOTES**  
N/A

All qualifications and unit standards registered on the National Qualifications Framework are public property. Thus the only payment that can be made for them is for service and reproduction. It is illegal to sell this material for profit. If the material is reproduced or quoted, the South African Qualifications Authority (SAQA) should be acknowledged as the source.