Basic infrastructure operation

NTQF Level I

Learning Guide # 41

Unit of Competence: **Carry-out Basic Leveling**

Module Title **Carrying-out Basic Leveling**

LG Code: **CON BIO1M11LO2LG41**

TTLM Code: **CON BIO1 TTLM1019V1**

LO 1: Plan and prepare work

Instruction Sheet	Learning Guide #41

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

- Analyze compliance documentation
- Basic concept of leveling terminology
- Safety for equipment , OHS regulation requirements and application
- implementing signage requirement
- selecting tools and equipment for leveling task
- Types and function of leveling equipment
- Concept of environmental protection

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

- Access, interpret and apply compliance documentation relevant to the work activity
- Obtain and confirm safety requirements from the site safety plan and organizational policies and procedures, and apply to the allotted task
- Identify, obtain and implement signage requirements From the project traffic management plan,
- Select plant, tools and equipment to carry out leveling tasks consistent with the requirements of the job, check for serviceability and rectify or report any faults
- Check leveling equipment for serviceability within specified tolerances, and report any faults
- Identify environmental protection requirements from the project environmental management plan, and confirm and apply to the allotted task

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information Sheet 1- 7
4. Accomplish the “Self-check 1- 7
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet
6. Do the “LAP test” (if you are ready).

Information Sheet-1	Analyze compliance documentation

1.General Obligations

You are obliged to act responsibly and perform work safely. You are also expected to take reasonable care to protect the health and safety of yourself and others by:

- reporting to a supervisor or safety representative any unsafe conditions, activities, dangerous occurrences or injuries
- using correct Personal Protective Equipment (PPE)
- using your work site's lock and tag system (if applicable)
- reporting damaged or defective equipment for repair
- not attempting any task unless you are qualified, authorised, competent and confident to perform the task in a safe manner.

1.2.Legislation and Site Policies

You must access and understand government legislation and site guidelines to perform your work within the regulations. Compliance documentation may include:

- legislative acts and regulations
- employment and workplace health and safety procedures
- organisational and site requirements and procedures
- manufacturer guidelines and specifications
- national standards
- codes of practice.

1.3.Comply with Legislation and Site Procedures

During your general and site specific inductions you would have been familiarized with organizational and site policies and procedures. These have been developed in accordance with legislation and are designed to ensure that work is undertaken safely.

Gather and read all relevant documents and procedures for the task that you are doing. Ensure that you understand the documents and how they apply to your work.

1.4.Equipment Inspections

Do not use any equipment that is in an unsafe condition. You should aim to improve the general appearance, mechanical standard and operating efficiency by:

- carrying out inspections and pre-start checks
- completing detailed and accurate defect reports
- ensuring that all servicing is carried out as scheduled
- using the equipment according to manufacturer instructions

- keeping the equipment clean (dirt can hide defects).

Regular inspections will identify defects at an early stage, before they become a significant problem that may cause injury and equipment or environmental damage. You should inspect the equipment before using it and again after use before storage.

Isolate any defective equipment and attach an Out of Service tag to the item. Report all damaged or defective equipment according to site procedures.

Self-Check 1	Written Test

1.Which one of the following is Equipment Inspections

A. national standards
B. site requirements and procedures
C. codes of practice.
D. keeping the equipment clean

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Basic concept of leveling terminology

2. Leveling

Introduction

Leveling is type of surveying which is carried out for measuring the elevation of ground points or near to it and to establish the elevation or heights of ground points which are vital for engineering design. The elevation of points or heights of points is defined as its vertical distance above or below a given reference, Level Surface, Datum.
The elevation or height of point has been defined as its vertical distance above or below a given reference. Generally leveling is a vital operation producing necessary data for mapping, engineering design and construction.
Leveling results are used to:

- ♣ Design high ways, railways & canals having grade lines that best conform to the existing topography.
- ♣ Layout construction works or projects according to planned elevations.
- ♣ Calculate volumes of earth work.
- ♣ Investigate drainage characteristics of an area.
- ♣ Develop maps showing general ground configuration.
- ♣ Determine the height (altitude) of the ground at a number of points along any desired lines so that sections may be drown.
- ♣ To set out level or horizontal surface such as floor slabs, foundation trenches and machine bases etc.

Level Surface

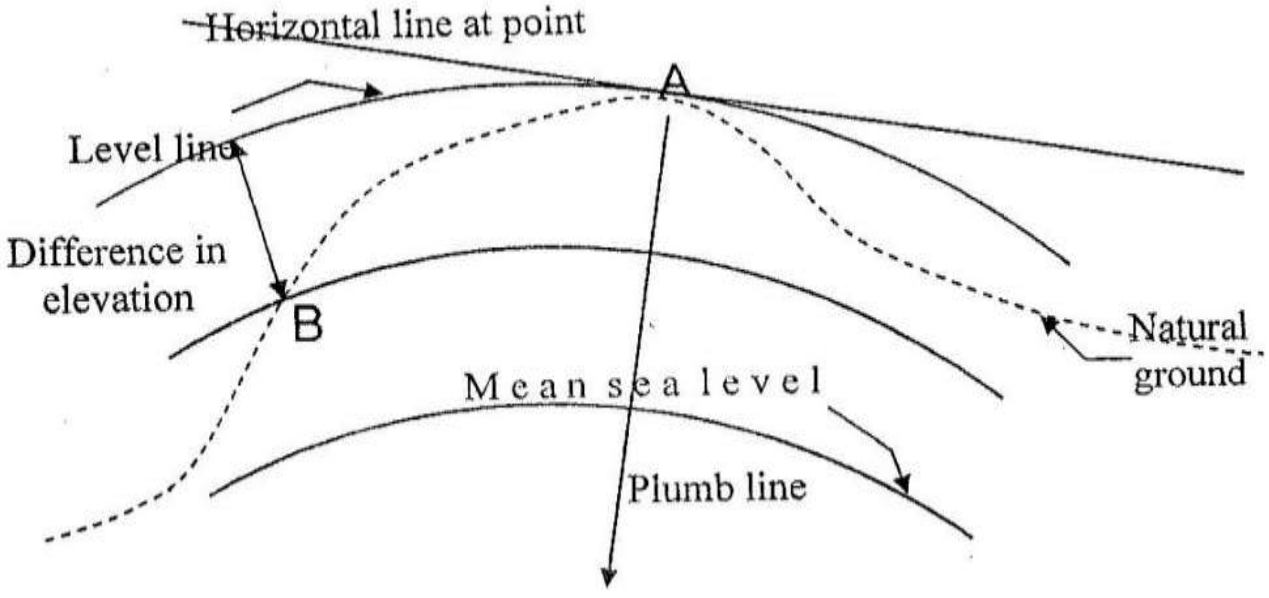


Figure 2. Level Surface

2.1.Definitions & Terminologies

1. **Datum:-** is the point with reference to which levels of other points are calculated.
2. **Reduced level(R.L):-** it is the height of points stated with reference to the selected datum for the work in hand.
3. **Instrument station:-** is the place where the instrument is set up for observation.
4. **Staff station:**- is the place where the leveling is held vertically.
5. **Height of collimation:**- is defined as the vertical distance from the datum to the line of sight.

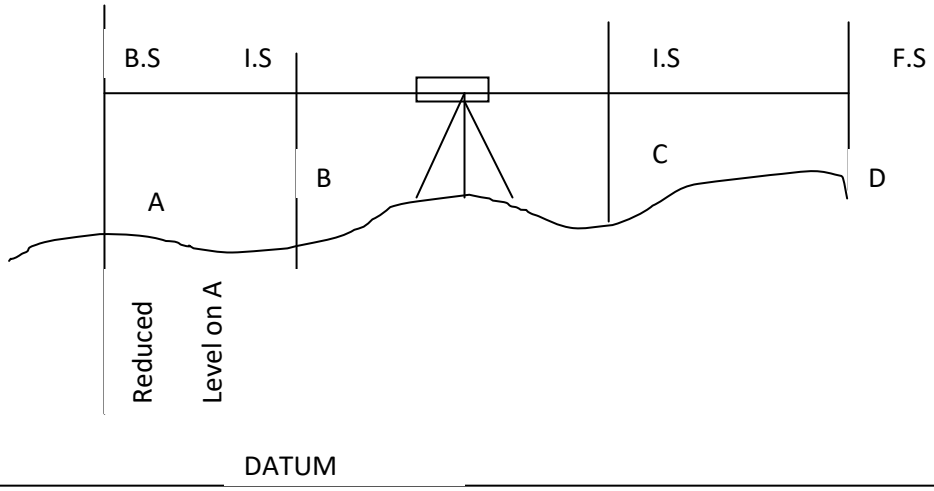


Figure 2.1. Original ground level

6. **Back sight (B.S):-** is a staff reading taken on a point after the instrument is immediately set up.
7. **Fore sight (F.S):-** is the last staff reading taken during taken during leveling before the instrument is moved.
8. **Intermediate sight(I.S):-** it is any staff reading taken other than backs sight & fore sight.

Note: a single set up of leveling instrument there is only one B.S & only one F.S but in the case of "I.S" the Number is not limited.

9. **Turning point.(T.P):-** is the station where a back sight and Foresight readings are taken. It indicates the shifting of Instrument.
10. **Bench-Mark (B.M)**- is a relatively permanent and fixed reference point of known elevation.
11. **Tripod stand** :- is a portable three-legged frame, used as a platform for supporting the weight and maintaining the stability of some other object.
12. **Level**- is an instrument used to take readings on a staff.
13. **Leveling**- is the process of determining the elevations of Points.

Self-Check 2	Written Test

1. Leveling may be defined as the process of determining_____.

A. horizontal distance between points C. distance the spreader and roller

B. vertical distance between points D. distance between the stake and hub

2. An elevation is the _____ above a reference plane, or datum.

A. horizontal distance B. vertical distance

C. corrected point D. staking party

3. A benchmark is the reference normally used to establish_____ control on highway construction projects.

A. horizontal C. vertical

B. Instrument D. Turning point

Part II: - Match column 'B' with column 'A '

A	B
1. ___Datum	A. Known elevation
2. ___Turning point	B. Reference plane
3. ___Bench-Mark	C. Back sight and fore sight are taken
4. ___Level	E. The process
	F. Instrument

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Safety for equipment , OHS regulation requirements and application

Safety means – a relative level of risk reduction. It also knows the correct safe things to do then acting accordingly.

Safety requirement

- safety requirement are obtained from the site
- safety plan
- other regulatory specification
- legal obligation
- task are performed in a safe manner and in accordance with:
- legislative requirement
- Enterprise policies
- Enterprise procedure
- Always the equipment must be carried in its case (box)
- When transported the equipment make sure it is protected from vibration.
- Selecting equipment for job
- Selecting equipment for serviceability

Objectives: After completing the learning elements the trainee will be able to wear safety working clothes and shoes, in the working place.

1. **Overall clothes: -** protects the normal clothes from dusts, grease, bitumen and the other spilling materials.
2. **Helmet/hard hat: -** protect head of the worker from any falling objects dropping from high level during construction

3. **Safety shoes/boots: -** Protects the worker from nails, sharp objects and heavy falling objects by hard rolled leather shoes with metal toe caps.
4. **Rubber boot: -** Protects the workers feet from colds; chemicals and mud or mortar in the work area.
5. **Gloves: -** Protects the workers from oils, chemicals, dust and other dangerous material that affect the skin and hand fingers.

6. **Google: -** protects eyes of the workers during welding of metal works and when placing reinforcement in the formwork. Google with safety glass or plastic lenses.

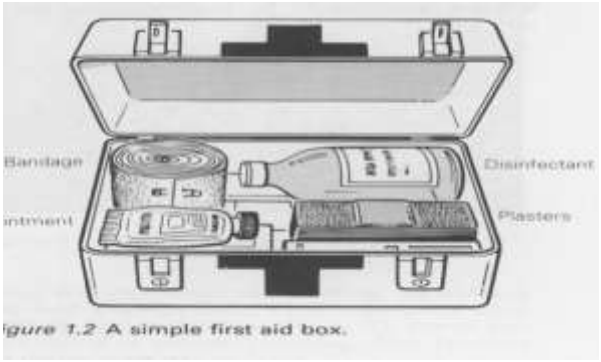
First aid

First aid is an immediate care given to a person who has been injured or suddenly ill. It includes self-care & home care if medical assistance is not available.

☞ It's the process of giving the first care for the victim workers before him/her arriving hospital.

A building site should have a first aid box which as minimum contents: -

- Plasters;
- Bandages;
- Ointments;
- Disinfectant.



igure 1.2 A simple first aid box.

Self-Check 3	Written Test

1. Which one of the following to protect head at the worker from falling object?
   A. Helmet C. Mask
   B. Google D. Gloves
2. _____is to protect the workers from oils, chemical etc.
   A. Google C. Safety shoes
   B. Bandages D. Gloves

3. ----------is Protect the eyes of the workers.

   A. Overall clothes C. Rubber boot

   B. Mask D Google

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	implementing signage requirement

4.Signage requirement

4.1.Traffic sign

principles to be applied In selecting and positioning temporary road signs

i. Only standard signs should be used,

ii. The signs must be clean and in good condition,

iii. The standard signs should be displayed in a standard layout,

iv. The layout used must give drivers time to understand and respond to the information which the signs convey.

What things has to be done to keep the principles

1. Each maintenance gang should be provided with signs appropriate to the work
2. All foremen and supervisors should be trained in the use and layout of signs
3. All temporary signs must be removed as soon as the work they relate to is complete.

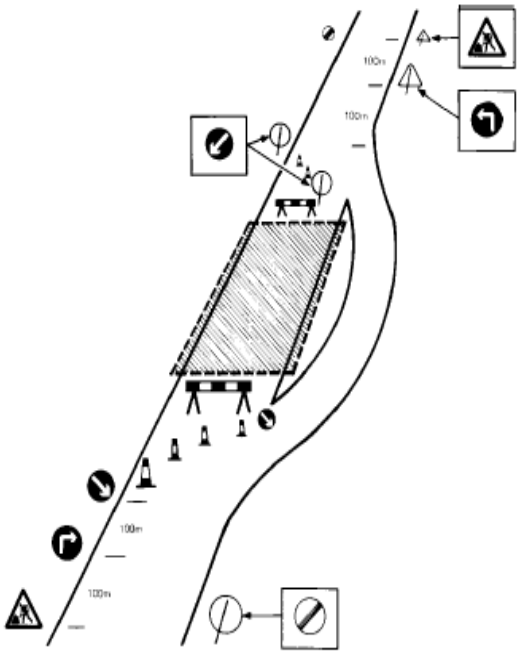


Figure 4. Traffic sign

☞ Before work starts the following things must be placed around work area to confirm safety:

- warning sign
- barriers
- cones

Sign must be placed in the following order.

1. Men working sign- this sign should be placed 200m in front the work area.
2. Road narrow sign- this sign should be placed 200m in front the work area.
3. Keep left/right arrows – should be placed at the start of the work area.
4. Barriers - should be placed at the end of the work area.
5. Cone – should be placed at 5m gap around work area.

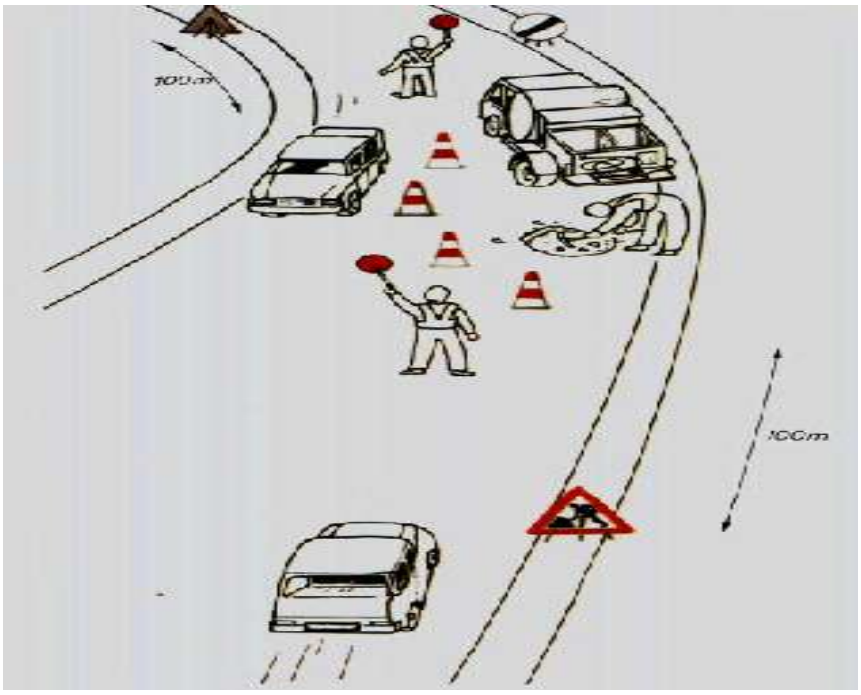


Figure 4.1. partial closure of the carriageway

What type of signs are provided for the above works classes

Edge working - not affect the carriageway

- *'Men working' signs should be placed at the approaches to the work area.*
- *'Road clear' signs should be placed at the ends of the work area.*

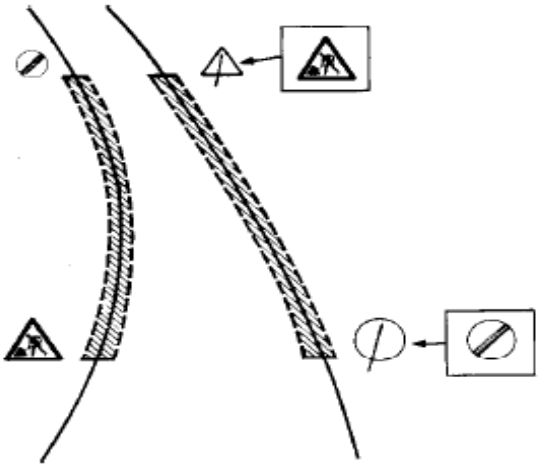


Figure 4.2. Edge working

partial closure of the carriageway

a. 'Men working' signs should be placed 200 meters in front of the work area.

b. 'Road narrows' signs should be placed 100 meters in front of the work area.

c. 'Keep left/right' arrows should be placed at the start of the work area.

d. Barriers should be placed at each end of the work area.

e. 'Keep left/right' arrows should be placed next to the barriers.

g. Cones should be placed in a taper at the approaches to the work area and at a spacing of 10 meters along the middle of the road next to the work area.

h. 'Road clear' signs should be placed 200 meters beyond the work area.

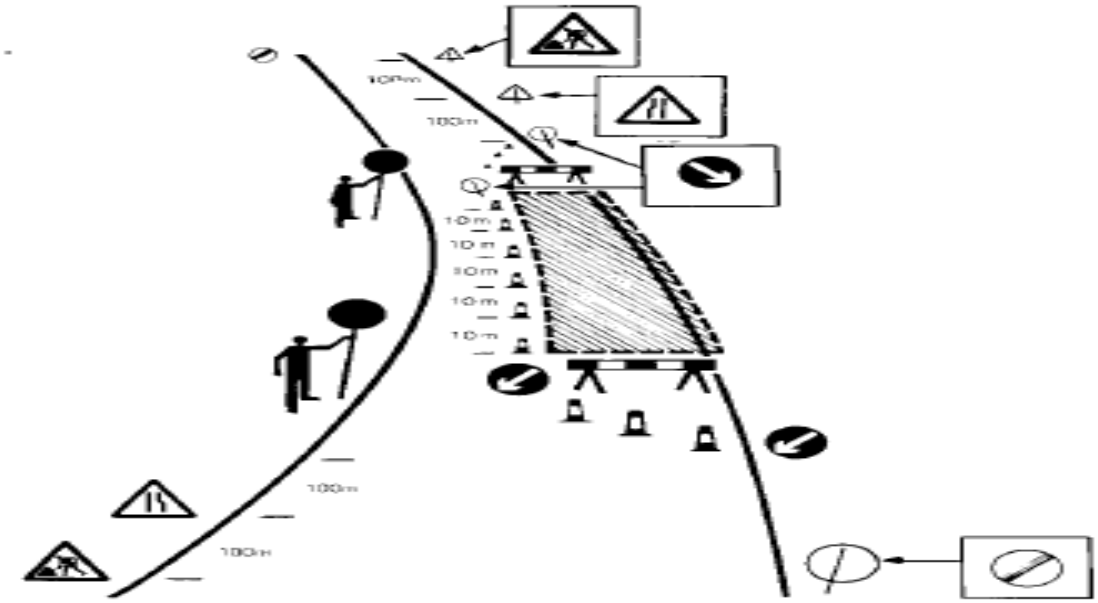


Figure 4.3.on the centre line working

on the centre line working

a. 'Men working' signs should be placed 200 meters in front of the work area at the side of the road.

b. 'Road narrows' signs should be placed 100 meters in front of the work area at the side of the road.

c. 'Keep left' arrows* should be placed in the centre of the road at the start of the work area.

d. Barriers should be placed behind the 'keep left' signs.

e. Cones should be placed at a spacing of 10 meters on either side of the work area.

f. * Assumes driving on the left.

g. 'Road clear' signs should be placed 200 meters beyond the ends of the work area at the side of the road.

- Center line working

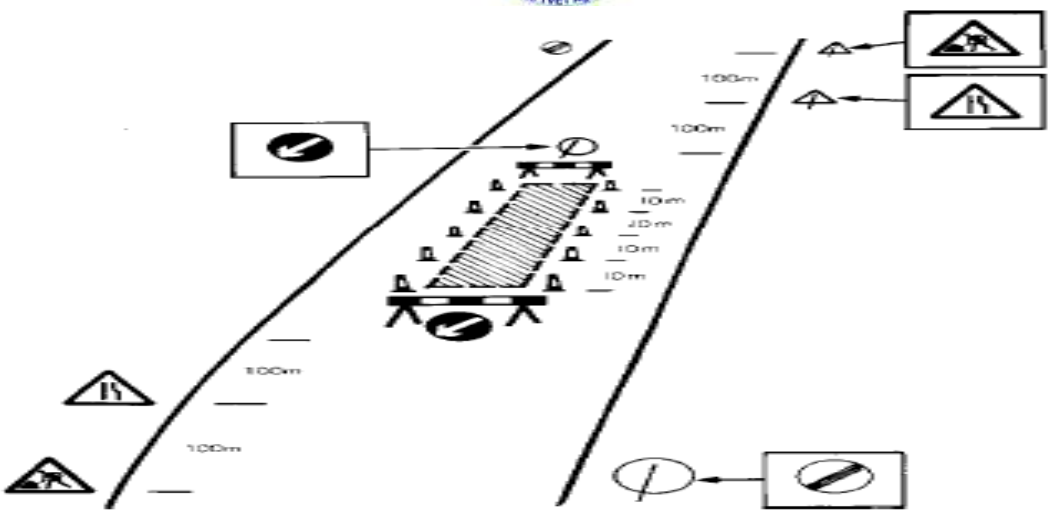


Figure 4.4.Center line working

Diversions

a. 'Men working' signs should be placed 200 meters in front of the work area.

b. 'Turn left/right ahead' arrows should be placed 100 meters in front of the work area.

c. Cones should be placed diagonally across the road to lead into the diversion.

d. 'Keep left/right' arrows should be placed at both ends of the lines of cones.

e. Barriers should be placed behind the lines of cones.

f. 'Road clear' signs should be placed 200 meters beyond the ends of the diversion.

Diversions

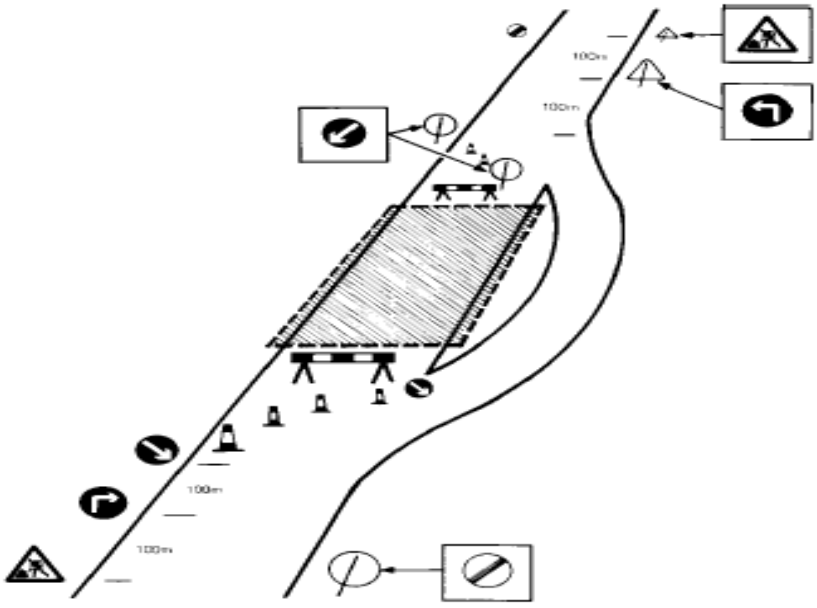


Figure 4.5. *Diversions*

Temporary Signposting

❖ Traffic signs **conforming to the regulations** must be correctly placed before starting any work. Why?

This is to ensure the safety:

- of the road users,
- of the personnel working on the site,
- of the vehicles and equipment to be used on the site.

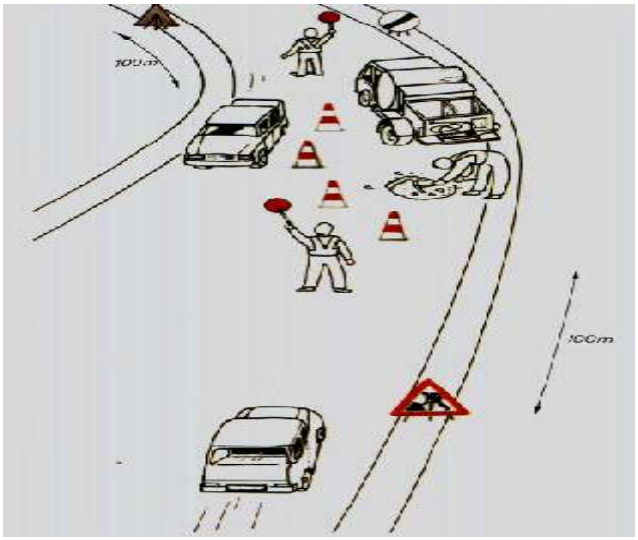


Figure 4.6. Traffic signs location

Where are Traffic signs can be located?

➢ On the shoulder on the side of the approaching traffic, 100 m ahead of each end of the road works:

- 1 "Men Working" sign,

➢ Along the length of the road works:

- to 10 traffic cones, as required to clearly separate the traffic from the road works.

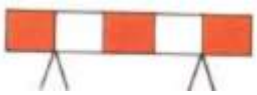
➢ On the shoulder on the side of the departing traffic, at each end of the site:

- 1 "End of Restriction" sign.

N.B In busy traffic 2 men must be assigned to direct the traffic in alternate directions past the road works.

Self-Check 4	Written Test

1. The type of safety tool used to inform road users that people are working ahead.

A.  B.  C.  D. 

2. _____ this sign should be placed 200m in front the work area.

A. Barriers
B. Keep left/right arrows
C. Cone
D. Men working sign

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-5	selecting tools and equipment for leveling task

5.Leveling tasks

5.1.Selection of tools and equipment

- ☞ Selection of tools and equipment is depends on the which is performed
- ☞ Tools – is small material which we use to do something.

1. Chain:-The chain is usually made of steel wire, and consists of long links joined by shorter links. It is designed for hard usage, and is sufficiently accurate for measuring the chain lines and offsets of small surveys.

Figure.5. **Chain**

Chains are made up of links which measure 200mm from centre to centre of each middle connecting ring and surveying brass handless are fitted at each end. Tally markers made of plastic or brass are attached at every whole metre position or at each tenth link. To avoid confusion in reading, chains are marked similarly form both end (E.g. Tally for 2m and 18m is the same) so that measurements may be commenced with either end of the chain

2. **Arrows**- they are used to mark the position of survey station or the point of the tape on ground. Helps for temporary.

Figure.5.1 Arrows

3. Peg

Pegs are used for survey purposes and for setting out all the activities. On labor based sites usually wooden sticks are used of approximately 50 cm length and strings. On one end they are pointed so that they can easily be hammered into the ground. Survey pegs, for example chain age pegs, are cut at the edge so that a clear marking can be made.

Figure 5.2.peg

4. **Profile Boards**

Profile Boards are used to determine the vertical alignment of a road section. The profile board is designed in such a way that it can be attached to a ranging rod. It has a screw mechanism that enables the profile board to slide up and down the ranging rod and be fixed at any desired level by tightening the screw. A long-lasting profile board is made from thin steel plate welded to a short length of metal tubing that can slide up and down and be clamped to the ranging rod. A useful size for the metal profile board has been found to be40cm by 12cm. It is painted red to make it easy to see.

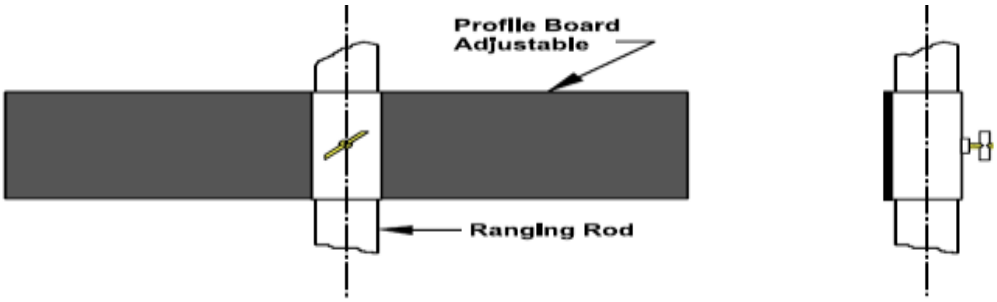


Figure.5.3.Profile board

5. staff

Staff is Used for measuring distance vertically above or below points on which is held relatively to a line of collimation as defined by the level. Many types of staff are in current used and making can take different forms, but the E type staff face is the most common Example sees the figure E. type of staff

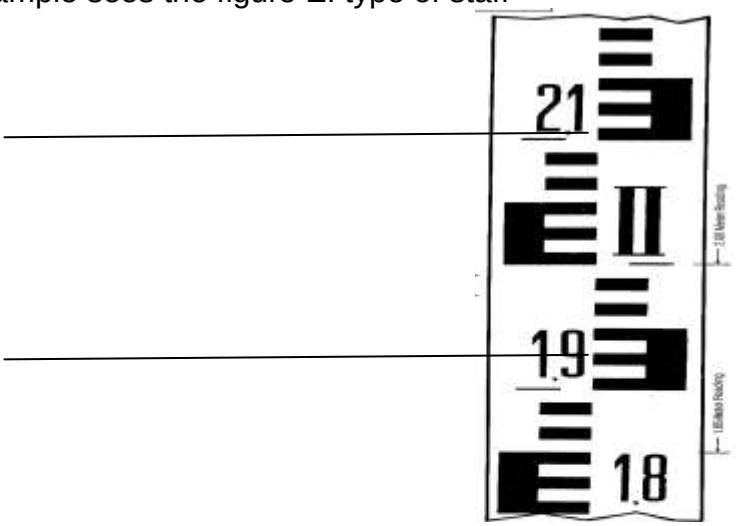


Figure.5.4.Staff

6. **A tripod** is a three- legged stand used to support a level or other surveying instrument during field measurements.

There are two models of tripods. (1) The extension leg tripod and

(2) The fixed leg tripod

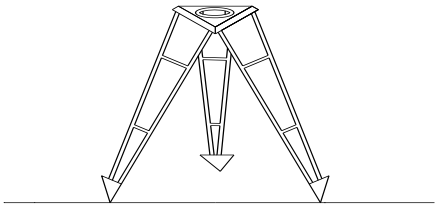


Figure.5.5.Tripod

7. Tapes: Tapes are used where greater accuracy of measurements are required, such as the setting out of buildings and roads. They are 15m or 30m long marked in metres, centimeter and millimeters. Tapes are classified into three types;

Figure.5.6.Tapes

- Note: The location of the 'zero point' may differ from tape measure to tape measure.

8. Ranging Rod:

Figure.5.7.Ranging Rod

These are poles of circular section 2m, 2.5m or 3m long, painted with characteristic red and white bands which are usually 0.5m long and tipped with a pointed steel shoe to enable them to be driven into the ground. They are used in the measurement of lines with the tape, and for marking any points which need to be seen.

9. **Level-** is an instrument used to take readings on a staff.

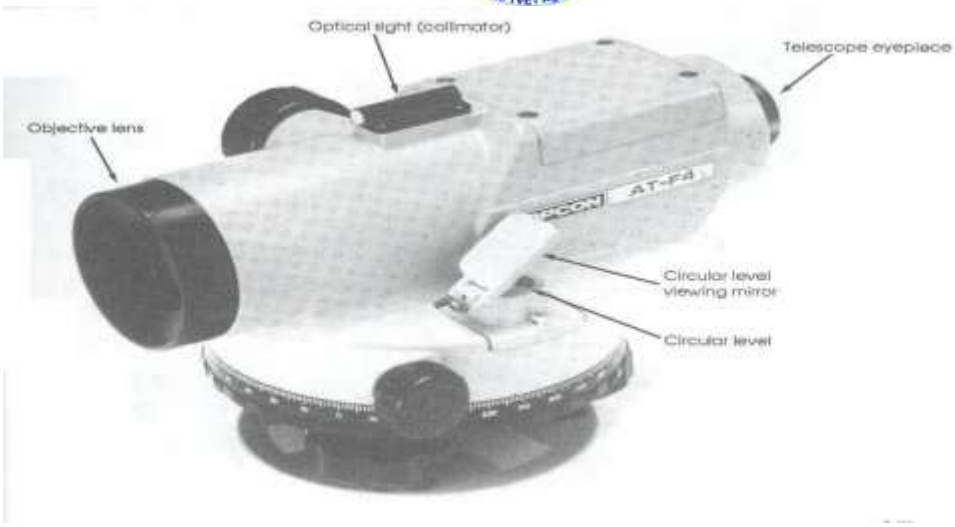


Figure.5.8.Level

10. Optical Square:

This instrument is used for setting out lines at right angle to main chain line. It is used where greater accuracy is required. There are two types of optical square, one using two mirrors and the other a prism.

Figure.5.9.Optical Square

11. **Plumb Bob**:-it is used to find the center point of the tripod or instrument set up place.

Figure.5.10.Plumb Bob

12. Clinometer

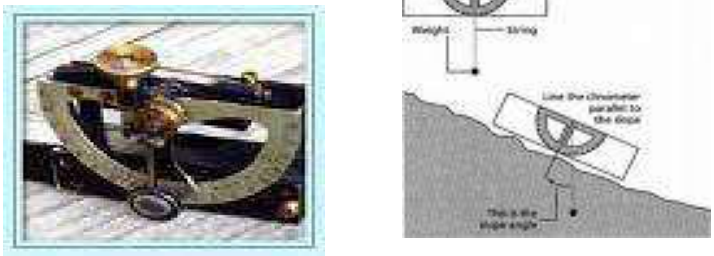


Figure.5.11.Clinometer

This instrument is used for measuring angles of ground slopes (slope angle). They are of several form, the common form is the WATKING'S CLINOMETER**,** which consist of a small disc of about 60mm diameter. A weighted ring inside the disc can be made to hang free and by sighting across this graduated ring angle of slopes can be read off. It is less accurate than abney level.

13. Laser levels

Laser levels contain a rotating laser which defines a visible horizontal plane from which distance to the ground can be made and then the height can be determined

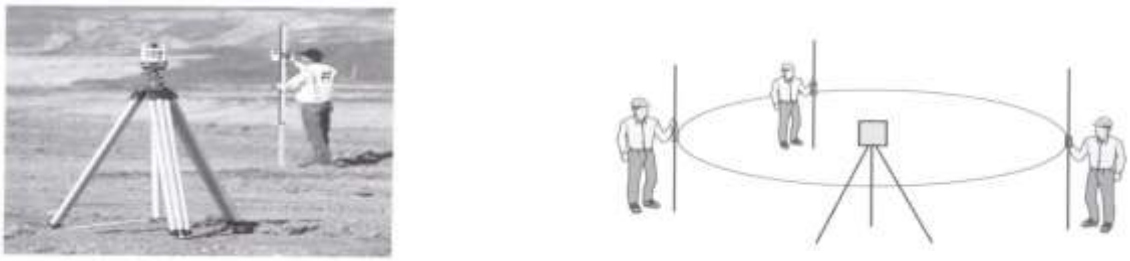


Figure.5.12.Laser levels

14. Staff bubbles

These are generally a small circular bubble on an angle plate which is held against one corner
of the staff to ensure that the staff is held in a vertical position. If the staff is not held vertical, the reading will be too large and may be significantly in error.

Figure.5.13.Staff bubbles

Self-Check 5	Written Test

1. Which one the following hand tool is used for to check only vertical alignment.
   A. plumb bob C. Sprit Level
   B. Manson Squire D. Trowel
2. _____are used for survey purposes and for setting out all the activities.
   A. Peg C. Profile board
   B. Spirit level D. shovel
3. _____is the one made from thin steel plate (40 cm x 10 cm) welded to a short length of metal tubing that can slide up and down and can be clamped to the metal rod.

   A . shovel C. hammer
   B. range pole D. profile board

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-6	Types and function of leveling equipment

6.Operating Leveling instruments

6.1.Types of leveling instruments

Leveling is the term used for determines the height or difference in height. Above the ground form a horizontal reference surface.
The instrument used for leveling is called a' level. Leveling instruments can be classified under the following categories, i.e.

- ♣ Dumpy level,
- ♣ Tilting level
- ♣ Automatic level.
- ♣ Digital Level

Dumpy Level
In dumpy level the line of sight is perpendicular to the vertical axes. Once the instrument is leveled the line of sight becomes horizontal and the vertical axes become truly vertical provided the instrument is in adjustment.
Tilting Level
The telescope is not rigidly attached with the tri-branch as the dumpy level. These types of instruments can be tilted a small amount in the vertical plane between the telescope and the pivot. The amount of title can be controlled or adjusted with the help of tilting screw
Automatic level
This type of instrument leveled automatically by means of a compositor which ensures that the line of sight viewed, through the telescope is horizontal. The advantage of instrument are it can be leveled within assort period of time and shows an erect image through the telescope.
Digital Level
Electronic image processing for determining height and distance Electronic mode with rod face graduated in barcode Compare image with the whole rod image. – Auto determination of height & dist and recorded

6.2.Parts of a level

- ♣ Objective lens
- ♣ Eye piece
- ♣ Foot screws
- ♣ Focusing knob

1. Objective lens- it is used for gathering the incoming light rays.
2. e ye piece- it is a microscope used for viewing the image focused by the objective lense.
3. Foot screws- are used to see the telescope in a horizontal plan.
4. Focusing knob- it is used to show the image clearly by adjusting the distance b/n the instrument and the target by focusing.
5. horizontal motion screw Endless drive (both sides)
6. circular level Bubble (to check horizontal plane)

7. Mirror to view bubble level
8. Base plate (sits on tripod)
9. Sight

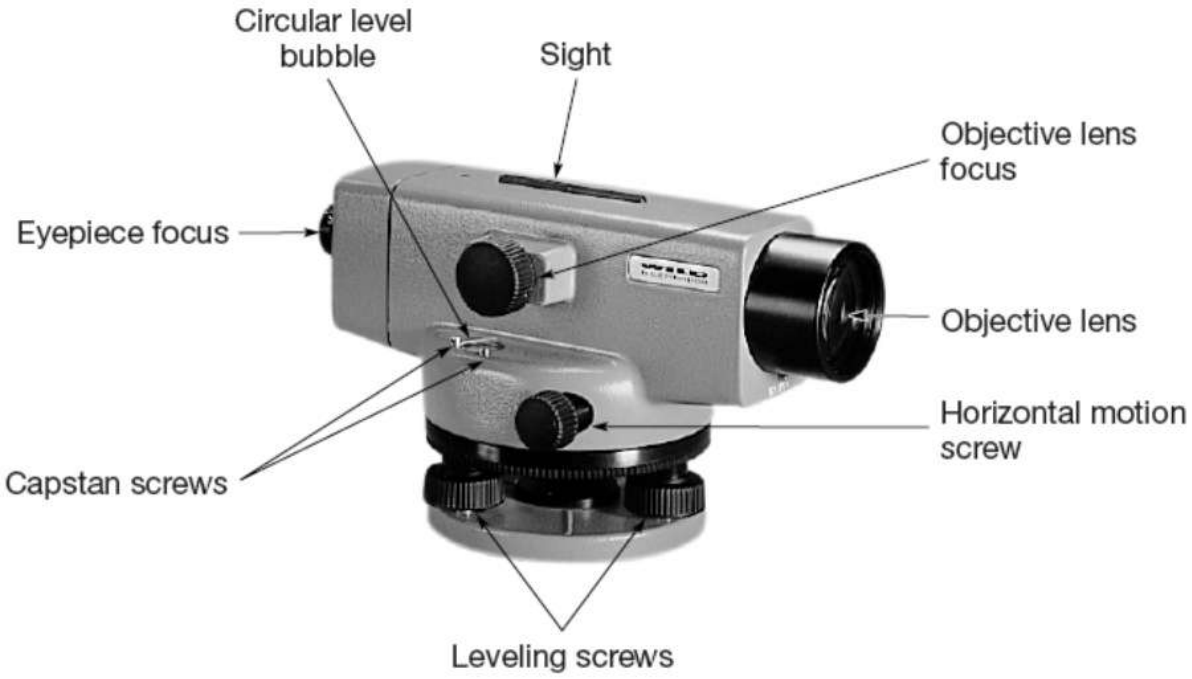


Figure 6. Part of Level

Self-Check 6	Written Test

1. Which one of the following is gathering the incoming light rays?
   A. eye piece C. objective lens
   B. base plate D. foot screw
2. ___is type of instrument leveled automatically by means of a compositor which ensures that the line of sight viewed, through the telescope is horizontal.
   A. Tilting Level C. Automatic level
   B. Dumpy Level D. Digital level

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-7	Concept of environmental protection

7.Construction

Construction activities, or actions which could impact negatively on the environment and therefore be a transgression of the above acts, include:

- ✓ Pollution of water source
- ✓ Soil pollution

7.1.Pollution of water sources

- ✓ At water points – by destroying the river banks, vegetation and contamination by workers.
- ✓ When disposing of left-over bituminous binders, cement, oil/lubricants and other construction products, spillage or inappropriate and clumsy usage or handling of these materials.
- ✓ When washing and cleaning of equipment.
- ✓ Contamination by workers.
- ✓ Contamination due to construction activities e.g. gravel and spoil in water courses.

7.2.Soil pollution

- ✓ When disposing of left-over bituminous binders, cement, oil/lubricants and other construction products, spillage or inappropriate and clumsy usage or handling of these materials.
- ✓ When washing and cleaning of equipment.
- ✓ Contamination by workers.

7.3.Environmental protection requirements

Relevant principles of this act, which could impact on the contract, include:

- ✓ That pollution and degradation of the environment must be avoided or, where they cannot be altogether avoided, are kept to a minimum and corrected.
- ✓ That waste is avoided, or where it cannot be altogether avoided, minimized.
- ✓ That negative impacts of the contract, on the environment and the people in the environment, are prevented and where they cannot be altogether prevented, are kept to a minimum and corrected.

The following construction and operations activities as having potential, in the absence of mitigation, to result in the introduction of deleterious substances (contaminated runoff) into the River:

- ✓ Hazardous materials spill in the vicinity of the river/marsh during the course of roadway construction.
- ✓ Release of re-suspended, contaminated bottom sediments during the course of construction of roadway embankment over Riel Pond.
- ✓ During operation, introduction of contaminants (deleterious substances) into the River Marsh as a result of discharge of roadway/bridge runoff from storm water management facilities.

- ✓ During operation, release of hazardous materials as result of a spill associated with a vehicular accident on the roadway, bridge deck or approaches.
- ✓ During operation, introduction of contaminants (deleterious substances) into the Sturgeon River/Riel Marsh as a result of roadway/bridge maintenance procedures.

The above-described environmental protection measures will achieve the following:

- ✓ Minimization of the potential for hazardous materials spills to occur during construction
- ✓ Minimization of the potential for any spill occurring during construction or operation to reach the Sturgeon River or Riel Marsh.
- ✓ Minimization of the volume of spilled material that could reach the Sturgeon River or Riel Marsh during construction.
- ✓ Minimization of the risk that spilled material could pose to water quality or aquatic organisms.
- ✓ Minimization of the volume of hazardous materials that could reach the Sturgeon River or Riel Marsh in the event of a spill resulting from a vehicular accident during roadway operation.
- ✓ Establishment of clear emergency response plans that ensure speedy and effective clean-up of any spills that do occur during construction or operation and full compliance with all spill reporting guidelines and regulations.
- ✓ Minimization of potential for the introduction of deleterious substances as a result of roadway/bridge maintenance procedures. The measures discussed above adhere to existing best management practices for roadway/bridge maintenance.

The following are guidelines for fulfilling the responsibility for protecting and preserving various environmental resources during construction as required by law:

7.4.Archeological and Historical Resources

Mitigating a project's impact on historical and archaeological sites during construction may require the recovery of artifacts. Mitigation may also require Native Americans, archeologists, architects, and historians to monitor and coordinate the recovery process. Normally, archaeological work is done in advance of construction, but occasionally, finds are made during construction. If human remains or previously unknown historic and archaeological artifacts are unearthed, suspend work in the vicinity until the find can be evaluated and properly treated.

7.5.Endangered Species

Both state and federal laws are designed to protect designated plant and animal species along with their respective habitats. As a result, often very strict prohibitions exist on certain types of work, work during certain times of the year, or work at specific locations. Even inadvertently impacting protected species can result in fines or jail sentences. The contract will specify the necessary measures and restrictions and the plans will show environmentally sensitive areas. However, during construction, project crews may discover protected species that were not anticipated in the contract. If such a discovery occurs, suspend work in the area and immediately notify the district environmental unit.

7.6.Migratory Bird Act

The Migratory Bird Act makes it illegal to interfere with migratory birds. Breeding and nesting seasons for these species can result in strict prohibitions or require working around nesting areas. The act may require avoidance or prohibit disturbance of many species of birds, such as swallows that roost or nest under highway structures. Should occupied nests be found, suspend work in the nests' vicinity until the birds abandon the nests.

7.7.Erosion

The rehabilitated drainage system should be sufficient to minimize the risk of erosion. The principle of "little and often" should guide the arrangements for discharge of rainwater from the road margins. Any new earthworks will have a potential to create unstable slope situations. Quarries should be developed and reinstated so that erosion risks are minimized.

7.8.Siltation

Siltation often occurs at drainage outlets, particularly where culverts have been incorrectly installed. This can cause ongoing siltation problems on adjacent productive agricultural land. The rehabilitation works should include the rebuilding of culverts previously causing siltation so that this problem is removed.

7.9.Tree Removal

Where trees are removed for the road rehabilitation or bridgeworks, arrangements should be made to plant replacement trees and also for any future timber requirements for replacement of bridge decking etc. Care must be taken to ensure that tree or vegetation removal will not lead to erosion or slope stability problems.

7.10.Gravel Reserves

Gravel surfacing is worn away by the effects of traffic and weather. Natural gravel reserves are a finite resource. They can only be used once. Depletion of resources will deprive future generations of their availability and will result in future increasing haul distances. The choice of surfacing should consider the consequences of present resource use and any policy directives on use and depletion of local mineral resources.

7.11.Dust

The further environmental (and social) issue with regard to unpaved roads is that of the dust pollution for the people who are living adjacent to the road (and their property). This can lead to cleanliness and health problems.

Dust generation also causes a further social and economic concern. Dust can cause a severe safety hazard for road users, particularly for overtaking movements and in villages.

Self-Check 7	Written Test

1. _____often occurs at drainage outlets, particularly where culverts have been incorrectly installed.

   A. Dust C. Siltation

   B. Tree Removal D. Erosion

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

List of Reference Materials

Basic Civil Engineering (S.S BHAVIKATTI) New Age International Publisher

Bangash - Structural Details in Concrete [Blackwell Scientific 1992]

Advanced concrete technology edited by John Newman Ban Seng Choo.

Ethiopian Building Code Of Standard (EBCS 2/1995)

Fundamentals of land surveying

Surveying - Bannister & Raymond 6th Edn.

Engineering surveying, W. SCHOFIELD AND M. BREACH, SIXTH EDITION.

Surveying (Edn5) - Kavanagh & Bird

Teaching methodology learning material

Basic infrastructure operation

NTQF Level I

Learning Guide # 42

Unit of Competence: Carry-out Basic Leveling

Module Title Carrying-out Basic Leveling

LG Code: CON BIO1M11LO2LG42

TTLM Code: CON BIO1 TTLM1019V1

LO2 Set up and use leveling device

Instruction Sheet	Learning Guide #2

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

- basic concept of leveling task and calculation
- leveling instrument set up
- carrying out basic leveling
- identifying heights from project plan
- leveling procedures

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

- Identify heights to be transferred/established from project plans or instructions
- Set up and use leveling instruments correctly in accordance with standard operating procedures and manufacturer's guidelines
- Transfer heights from the known to the required
- Document results of leveling procedure and close them

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1- 4.
4. Accomplish the “Self-check 1 - Self-check t 4.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet .
6. Do the “LAP test” (if you are ready).

Information Sheet-1	Basic concept of leveling task and calculation

Leveling is type of surveying which is carried out for measuring the elevation of ground points or near to it and to establish the elevation or heights of ground points which are vital for engineering design. The elevation of points or heights of points is defined as its vertical distance above or below a given reference, Level Surface, Datum.
The elevation or height of point has been defined as its vertical distance above or below a given reference. Generally leveling is a vital operation producing necessary data for mapping, engineering design and construction.
Leveling results are used to:

- ♣ Design high ways, railways & canals having grade lines that best conform to the existing topography.
- ♣ Layout construction works or projects according to planned elevations.
- ♣ Calculate volumes of earth work.
- ♣ Investigate drainage characteristics of an area.
- ♣ Develop maps showing general ground configuration.
- ♣ Determine the height (altitude) of the ground at a number of points along any desired lines so that sections may be drown.
- ♣ To set out level or horizontal surface such as floor slabs, foundation trenches and machine bases etc.

The basic cycle of differential leveling can be summarized as follows:

Height of Instrument = Known elevation + back sight
HI = Elev A + BS
New elevation = height of instrument – foresight
Elev B = HI - FS

Example

Elv of B = elv of A ± (HA-HB)
= 1235.53 – 0.59
= **1234.940m**

- ► Check
- ☞ BS – FS = Last Rl –first Rl
- ☞ 1.26 – 1.85 =1234.94 -1235.53
- ☞ **0.59** = **0.59**

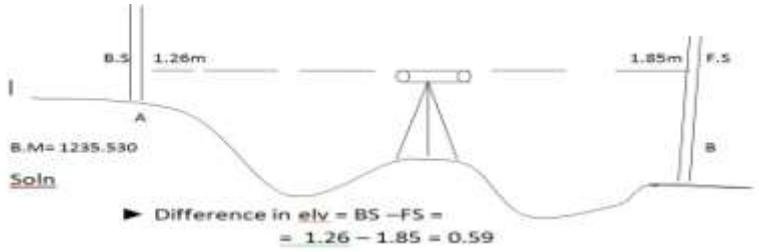


Figure.1.Original Ground level

Self-Check 1	Written Test

_____1. Surveyor take the following reading of leveling on the field, which one of the staff readings shows lower point?

A. 3.75m C.0.85m

B. 2.75m D. 0.05m

_____2.Surveyor take the following reading of measurement in leveling work with field book as shown in the table below calculate “A and B”

Station	BS	FS	Raise	Fall	Elevation
A	A				1000m
B		2.56		1.05	B

A.1.51m,998.95m B. 2.52m,1001.05m C.0.85m,999.05m D.3.61m,1001.05m

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	leveling instrument set up

2.1.Setting the leveling instruments.

2.2.Leveling Instrument Set- Up

The first step in leveling is to spread the tripod leg, used to support the head part, so that the tripod head is approximately horizontal, the legs should be far enough and they should be pushed to the ground to make the level sable.

The next step is to center the bubble by the help of foot screws, lastly targeting & Focusing.

Spread the tripod ⟶ Center the ⟶ Targeting⟶ Focusing.

2.3.Precision of leveling

As with all techniques used in engineering surveying it is important to estimate how accuracy of the measurements taken.
An assessment of the quality of leveling can be made by calculating the misclosure for a line of levels. This is determined by comparing the reduced level of the closing bench mark with the level obtained for it by calculation from the staff readings.
On construction sites and other engineering projects, leveling is usually carried out over short distances and it can involve a lot of instrument positions. The allowable misclosure for a line of levels is given by:

Allowable misclosure = $\pm m\sqrt{n}$

Where, *m* is a constant and *n* is the number of instrument positions used.
The value most often used for *m* is 5mm

However, most levels are not in perfect adjustment and when leveled their line of sight is never exactly horizontal. If the line of sight is not horizontal when the instrument has been leveled, the level has a collimation error.

As most levels will have some level of collimation error, a method is required to check if the error is within acceptable limits. This is known as a two-peg test. This needs to be conducted when using a new or different level for the first time and at regular intervals thereafter.

Two peg test

Stage 1

On fairly level ground, two points A and B are marked a distance of *L*m apart. In soft ground, two pegs are used, on hard surfaces nails or paint may be used.

The level is set up midway between the points at C and carefully leveled. A leveling staff is placed at A and B and staff readings *S*1 (at B) and *S*2 (at A) are taken.

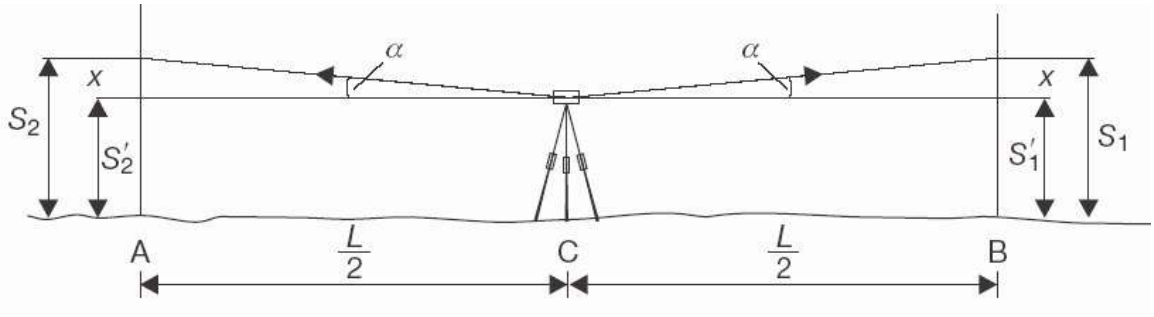


Figure.2. Two peg test

The two readings are:

*S*1 = (S_1‘ + x) and *S2* = (S_2‘ + x)

S_1‘ and S_2‘ are the staff readings that would have been obtained if the line of collimation was horizontal, x is the error in each reading due to the collimation error, the effect of which is to tilt the line of sight by angle α.

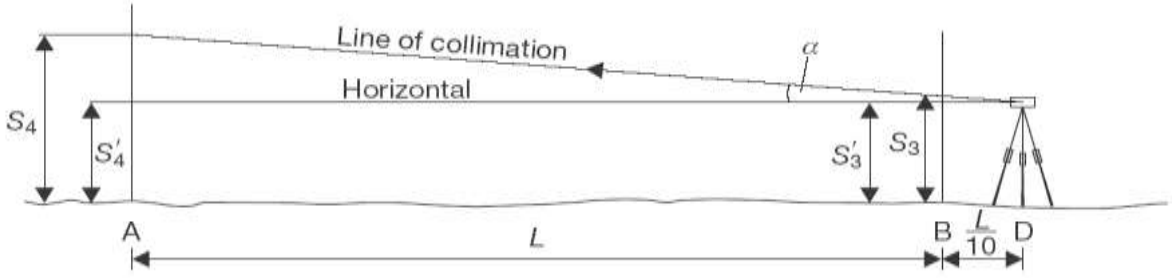
Since AC = CB, the error x in the readings S_1 and S_2 will be the same. The difference between readings S_1 and S_2 gives:

$S_1 - S_2 = (S_1‘ + x) – (S_2‘ + x) = S_1‘ - S_2‘$

This gives the true difference in height between A and B. This demonstrates that if a collimation error is present in a level, the effect of this cancels out when height differences are computed provided readings are taken over equal sighting distances.

Stage 2

The level is then moved so that it is L/10m from point B at D and readings S_3 and S_4 are taken.



The difference between readings S_3 and S_4 gives the apparent difference in height between A and B. If the level is in perfect adjustment then: $S_1 - S_2 = S_3 - S_4$

However this is not always the case and that an error term (e) needs to be estimates

$e = (S1 - S2) - (S3 - S4)$ per Lm

If the results of these tests show that the collimation error is less than 1mm per 20m (or some specified value). If the collimation error is greater than this specified value then the level has to be adjusted. This is normally done by the manufacturer or a trained technician.

Self-Check 2	Written Test

1. Readings obtained from a two peg test carried out on an automatic level with a staff placed on two pegs A and B 50m apart are: Staff reading at A = 1.283m Staff reading at B = 0.860m With the level position 5m from peg B (L/10): Staff reading at A = 1.612m Staff reading at B =1.219m

   A. -0.030M per 50M
   B. 0.030M per 50M
   C. 0.20M per 50M
   D. 0.01M per 50M

2. The rod person must hold the level rod _____ when it is being read.

   A. diagonally
   B. vertically
   C. as best they can
   D. horizontally

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	identifying heights from project plan

3.1.Reading Vertical Distances

The method of determining the elevation difference between points is that, after the instrument is set up, the readings are taken on the staff that is vertically held on the point & then shifting the staff to the next point that is going to be determined. Hence the elevation difference can be calculated as First staff reading minus second, second minus third staff reading at a single set up.

If you need to transfer any elevation/height first take reading of one point and then find reading of next point.

For example:- construct any structure may be has formwork that height are transfer for one point to another point.

Self-Check 3	Written Test

1. The rod reading is_____ from the height of the instrument to find the elevation of the second benchmark.

A. add C. subtract

B. multiply D. divide

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	leveling procedures

4.1.Leveling Methods

There are different methods of Leveling like

1. Differential Leveling
2. profile Leveling
3. Cross- Sectional Leveling

1. **Differential Leveling**

It is the method of direct leveling, the objective of which is solely to determine the difference in elevation of two points regardless of the horizontal position of the points with respect of each other. When the points are apart, it may be necessary to set up the instruments several times.

The operation of leveling to determine the elevation of points at some distance apart is called differential leveling and is usually a accomplished by direct leveling. The difference in elevation may not found by single setting but the distance b/n the points is divided in to two or three steps or stages by forming or establishing temporary points as turning points on which the staff is held and the difference of elevation of each of succeeding points.

4.2.Leveling Field books

There are tow methods of booking and reducing the elevation of points from the observed staff readings.

4.2.1. Rise & Fall method
4.2.2.Height of collimation method.

Rise and Fall Method

Each reading is entered on a different line in the applicable column, except at change points where a fore-sight and a back-sight occupy the same line. This is to connect the line of sight of one setup of the instrument with the line of sight of the second setup of the instrument. From the above figure it can be seen that they are not at the same level. R.L. of change point *D* is obtained from the first line of sight by comparing intermediate sight 1.645 with foresight 1.515, i.e. a rise of 0.130m. For the R.L. of next point *E*, back sight 1.815 is compared with intermediate sight 1.715, i.e. a rise of 0.100m. At the end of the table arithmetic checks are shown.

If a positive result is obtained there is a <u>rise</u> on the ground b/n the points, similarly of a negative result id obtained a <u>fall</u> on the ground can be conclude.

The checks are:

$\sum$ Back sights - $\sum$ Foresights = $\sum$ (Rises) - $\sum$ (Falls) = Last R.L. – First R.L.

<u>Checking levels (Arithmetic check)-</u> The difference b/n the sum of the B.S & sum of rise & the sum of fall & should also be equal to the difference b/n the R.L of Last & first point. Thus

$\sum$B.S - $\sum$ F.S = $\sum$ Rise- $\sum$Fall = Last R.L – First R.L

It is advisable that on each page, the rise & fall calculations shall be completed & checked by comparing with the difference of the back & fore sight column summations, before the R.L calculations are commenced.

Start	B.S	I.S	F.S	Rise	Fall	R.L	Remark
BMA	2.462					165.265	B.M
1	2.660		2.048	0.414		165.679	T.P
2		2.381		0.279		165.958	
3		2.042		0.339		166.297	
4		1.984		0.058		166.355	
5	2.990		2.656		0.672	169.683	T.P
6		3.220			0.230	165.453	
7		3.123		0.097		165.550	
8			2.885	0.238		165.788	
∑ 8.112		7.589	1.425	0.902			

∑ B.S- ∑F.s = ∑Fall =∑Rise= Last R.L – First R.L

8.112 – 7.589 = 1.425- 0.902= 165.788-165.265

0.523= 0.523 0.523

The Reduced level of the points is calculated by adding the rise to the previous reduced level or by subtracting the Fall to the previous Reduced level of a point.

Height of Collimation Method

In this methods, the height of collimation i.e, the distance from datum to the line of sight, is calculated for each setting of the instrument by adding back sight to the elevation of the B.M. The reduced level of the turning point is then calculated by subtracting from H.C of the Foresight. For the next setting of the instrument, the H.C is obtained by adding the B.S. taken on T.P to its R.L (reduced level). The process continues until the R.L of the last point (Fore sight) is obtained by subtracting the staff reading from height of collimation of the last setting of the instrument.

Arithmetic level (checking of Level) – The difference b/n the sum of B.S & the sum of F.S should be equal to the difference b/n the last R.L & the first R.L.

∑ B.S. - ∑ F.S. = Last R.L. – First R.L.

Exercise- The following staff readings were observed successively with a level, the instrument having been moved after third, sixth and eighth readings:

2.228; 1.606; 0.988;2.090;2.864;1.262;0.602; 1.982;1.044;2.684 meters.

Soln- Since the instrument was shifted after third, sixth & eigth readings, these readings will be entered in the F.S column & there fore, the Forth, seventh and ninth readings will be entered in the B.S column & the last reading in the F.S. Column. All other readings will be entered in the I.S. column.

Station	B.S	I.S	F.S	H.C	R.L	Remark
1	2.228			1010.693	1008.465	B.M
2		1.606		1010.693	1009.087	
3	2.090		0.988	1011.795	1009.705	T.P
4		2.864		1011.135	1018.931	
5	0.602		1.262	1011.135	1010.533	TP
6	1.044		1.982	1010.197	1009.153	TP
7			2.684		1007.513	
Check	5.964		6.916			

∑ B.s- ∑ F.s = Last R.L – First R.L.

5. 964-6.916 = 1007.513 – 1008.465

- 0.952 = - 0.952

Station	B.S	I.S	F.S	Rise	Fall	R.L	Remark
1	2.228					1008.465	B.M
2		1.606		0.622		1009.087	
3	2.090		0.988	0.618		1009.705	T.P
4		2.864			0.774	1008.931	
5	0.602		1.262	1.602		1010.533	TP
6	1.044		1.982		1.380	1009.153	TP
7			2.684		1.640	1007.513	
∑	5.964		6.916	2.842	3.794		

∑ B.S- ∑ F.S = ∑ Rise - ∑ Fall = Last R.L – First R.L

s.964-6.916 = 2.842-3.794 = 1007.513-1008.465

- 0.952 = - 0.952 = -0.952

2. Profile- Leveling

Profile leveling or longitudinal section is a type of leveling it is used to determine the elevations of the ground surface along some definite line or along a particular line that is the center line of existing or proposed work. Before designed a profile of the existing grand is necessary.

The route along which the profile is run may be a single straight line; as in the case of a short side walk; a broken line as in the case of a transmission line or sewer; or a series of straight line connected by curves as in the case of a railroad, highway, or canal.

In general profile leveling is a longitudinal sectional view showing the undulation (ups & downs) of the ground surface along a given line.

When the profile is plotted the profile is used for many purposes like:-

- ❖ Determining depths of cut & fill on the proposed center line. (Earth work, volumes)
- ❖ For studying gradient or grade lines
- ❖ Investigating and selecting the most economical grade, location & depth for sewer, pipe lines etc.

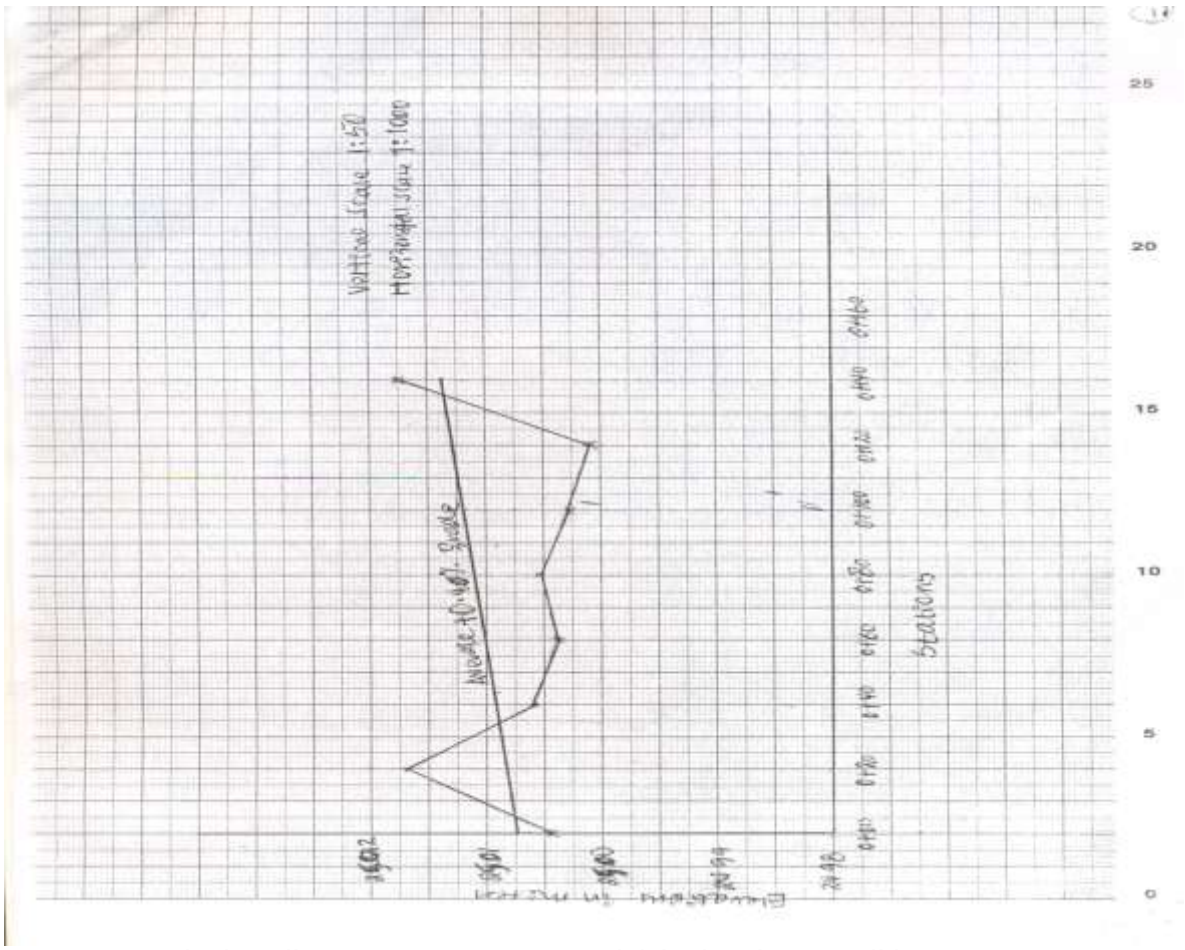
The general procedure of field work in profile leveling is

a) The center line of the prorated alignment is marked ground; points at equal generals say 20 or 30m are marked. In addition to these required points, other representative points.
b) The instrument is set up at some suitable position so as to command the maximum number of point.
c) A back sight is taken on the B.M.
d) The staff is then kept on the points previously marked and all these points or observations are entered as the intermediate sights.
e) When changing the instrument station for further observations a foresight is taken on the turning point.

In plotting the profile, Horizontal distance is marked on a horizontal line, A datum line is selected, the height of points are written against the points. Then the points laying on the profile is plotted against with respect to the horizontal scale. Normally the horizontal scale is kept in 1:1000 to 1:2000 & the vertical scale is exaggerated when compared with horizontal scale & 1:100 to 1:200

Station	Chainage	B.S	I.S	F.S	H.C	R.L	Remark
B.M		3.56			2503.56	2500	BM
1	0+00		3.08			2500.48	
2	0+20		2.85			2501.71	
3	0+40		2.98			2500.58	
4	0+60		3.17			2500.58	
5	0+80	2.64		3.01	2503.19	2500.55	T.P
6	0+100		2.92			2500.27	
7	0+120		2.98			2500.11	
8	0+140			1.45		2501.74	

When the above data is plotted the profile of the ground at each station is as follows:-



The rate of grade (gradient or percentage grade) is the rise or fall in meters per 100m. For example the aviaries gradient for the above Formation level is + 0.40% i.e the elevation

difference b/n the station 0+00 & 0+100 is 0.40m. Generally ascending grades are plus (+) sign & descending grades or down ward grades are minus (-).

Calculation of Formation level

		0.86						0.39
Depth of fill	0.27		0.32	0.61	0.71	0.93	1.19	
Design/Formation) Level	2500.75	2500.85	2500.90	2501.00	2501.10	2501.20	2501.30	2501.35
Original ground level	2500-48	2501-71	2500-58	2500-39	2500-55	2500.27	2500.11	2501.74
Cumulative distance	0+00	0+20	0+40	0+60	0+80	0+100	0+120	0+140
Station	1	2	3	4	5	6	7	8

If the ground level is higher than the proposed level or formation level there must be cutting & where the proposed level exceeds the surface level, filling will be required.

Example:- at station 0+00- the proposed level is higher than the ground level then it will be fill.- at station 0+20- the proposed level is lower than the ground level, then there will be cutting.

3. **Cross-Sectional Leveling**

Cross – sectional leveling is a type of leveling which is run at right angles to the longitudinal profile and on either side of it for the pupate of lateral out line of the ground surface. They provide the data for estimating quantities of earth work and for other purposes. The cross-sections are numbered consecutively from the commencement of the center line and are set out at right angle to the main line of section. The length of cross-section depends up on the nature of the work

Note:- The above figure illustrates the cross-section is taken at interval of 20m which is at right angle to the center that is the longitudinal section.

Plotting – Cross section

Cross- sections are plotted in a very similar way to that of profile leveling section. One essential difference how ever, is that the cross-section is plotted to a natural scale that is the horizontal & vertical scales are the same. The points to the left of center point are plotted to the left and those to the right are plotted to right.

Self-Check 4	Written Test

I. Choose the Best Answer

_____1.The reading you take to complete your leveling work is

A. Back sight (BS) C. Intermediate sight (IS)
B. Fore sight (FS) D. All

_____3. is the method of direct leveling work, the objective of which is solely to determine the difference in elevation of two points regardless of the horizontal position.

A. Profile leveling C. Cross-section leveling
B. Differential leveling D. None

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1.

operation sheet # 1	Setting up leveling instrument

Objective:

To setting up leveling instrument

Equipments:

Level , Tripod, Leveling staff, staff bubble.

General procedure for setting up leveling instrument:

Step 1.Setting up the tripod

1.1.Loosen screws of tripod legs, pull out to required length and tighten screws.

Step 2.Push legs firmly into the ground

2.2. In order to guarantee a firm foothold sufficiently press the tripod legs into the ground.

When pressing the legs into the ground notes that the force must be applied along the legs.

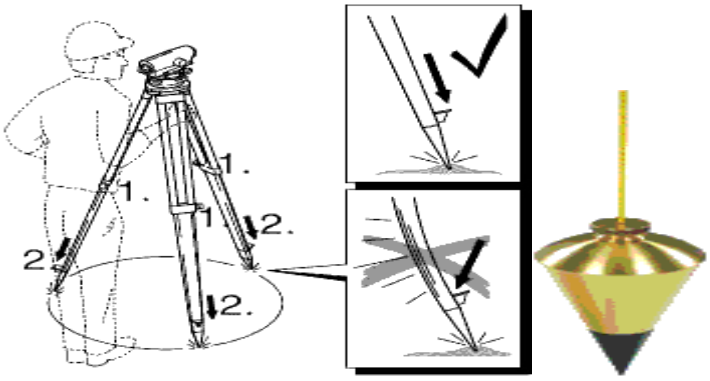
Step 3.Ensure the top is level

3.1. Check all screws and bolts for correct fit.

When setting up the tripod pay attention to a horizontal position of the tripod plate. Minor inclinations of the tripod can be corrected with the foot screws of the tri branch.

Step 4.Attach level

4.1. Place level onto tripod head. Tighten central fixing screw of tripod. So that the tripod head is approximately horizontal.



Set up the tripod where you have a clear sight of the benchmark, at a similar height to but preferably higher, than the benchmark. If possible, set up in the centre of the area that you intend to survey, or somewhere that you can see all of the site as well as the back sight/Bench Mark, with the top plate relatively level.

Note: Bear in mind that if at some point you have to move the level (higher or lower, or to a new location) you will need to re-level it and retake the back sight reading.

If you want to centre an instrument over a ground point:

4.2. Attach plumb bob and arrange the tripod in such way that the drop is over the point.

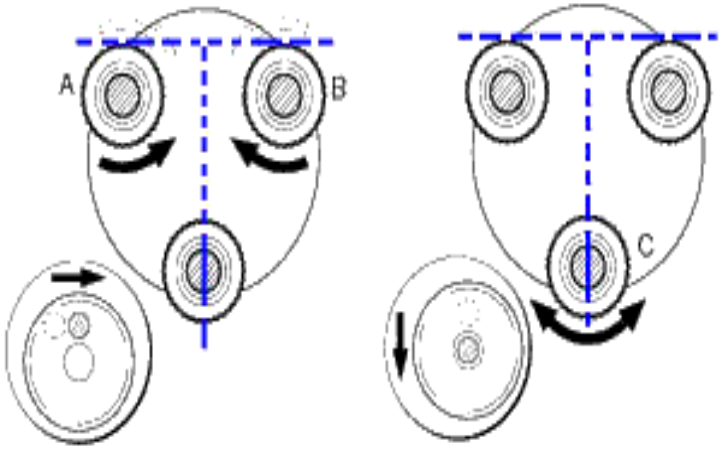
4.3. For fine adjustment loosen central fixing screw slightly and shift instrument

parallel on tripod until the plummet is exactly over the point.

4.4.. Tighten central fixing screw.

Step 5.Use foot screws to centralise the circular bubble

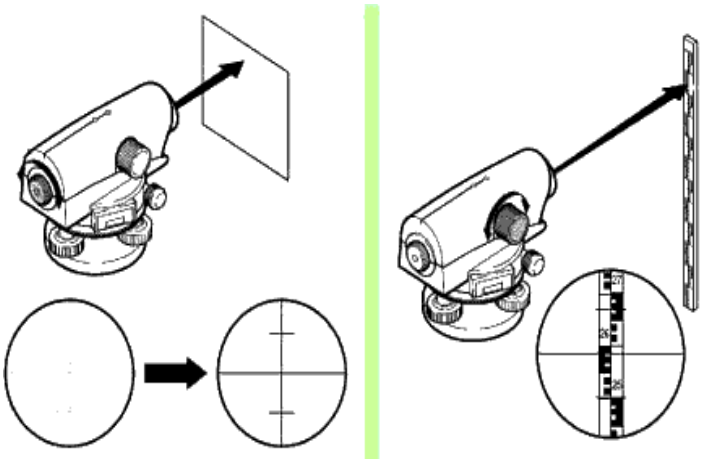
b. Center the bubble



c. Targeting d. Focusing

I. Turn foot screws A and B simultaneously in opposite directions until bubble is in the centre (on the imaginary "**T**").

II. Turn the instrument 90° and then turn the foot screw C until bubble is centered



- Aim telescope against a bright background
- Turn eyepiece until reticule is sharp-focused and deep black. Now the eyepiece is adapted to your eye.

Step 6.Test to see if the compensator is working

- Turn focusing knob until image of staff is sharply focused.

Step 7.Remove parallax

operation sheet #2	Calculate elevation difference and Reduce levels by rise and fall method

Objective:

To find the difference in elevation and to calculate the reduced level of various points by Rise and Fall method.

Equipments:

Level, Leveling staff. Tap

Procedure:

The field procedure and booking of staff reading is done in the same way as explained in the height of instrument method (each reading is entered on a different line in the appropriate column, except at a change point, where a FS and BS occupy the same line). However the data booking is performed as shown in the Table below.

Tabulation:

STATION	READINGS			RISE	FALL	REDUCED LEVEL	REMARKS
	B.S	I.S	F.S				

Calculations:

1. The difference in elevation between any two successive points (say A and B) can be calculated as:

Elevation difference between A and B = first reading at A – second reading at B

2. NOTE, for any two successive staff readings:

Second reading smaller than first reading represents a Rise (The sign of elevation difference is positive).

Second reading greater than first reading represents a Fall (The sign of elevation difference is negative).

3. If the elevation of the first point is known, then the elevation of the second point can be calculated as:

Height of B = height of A + rise (in rise case)

or

Height of B = Height of A – fall (in fall case)

4. **Checks:** The following checks on the booking and arithmetic calculations are performed:

A) Number of BS readings = Number of FS readings

B) ∑BS - ∑FS = ∑Rise - ∑Fall = RL of last point – RL of first point

operation sheet #3	Calculate elevation difference and Reduce levels by h.i method

Objective:

To find the difference in elevation and calculate the reduced levels of various points by H.I method.

Equipments:

Level, Tripod, Leveling staff, staff bubble.

General procedure for measuring elevations using a level:

Suppose that B, C and D are points whose reduced level is to be determined as in Figure 1:

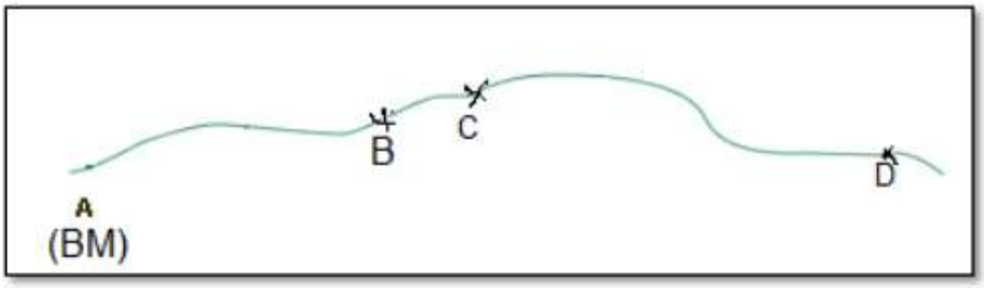


Figure 1: points whose reduced level is to be determined

1. Place the staff over a bench mark (BM), whose reduced level is known, and set up the instrument in convenient and safe location where the BM (point A) is visible. Take a sight on the staff, that reading is called backsight (B.S). See Figure 2
2. Place staff over B. Take a sight on the staff, that reading is called Intermediate sight (I.S). See figure 2
3. Place staff over C. Since the distance between the level and D is long, so it is not possible to read the staff over D from the current level position (pos 1). So take the last reading over C for this position, this will be a foresight (F.S). See figure 2
4. Now, move the instrument to a new position (position 2) and take the reading on the previous position of the staff (over C). This position of staff is known as Turning Point (T.P) and this reading will be backsight (BS). See figure 2
5. Now, shift the staff to the point D and take reading, this reading will be foresight (F.S). See figure 2

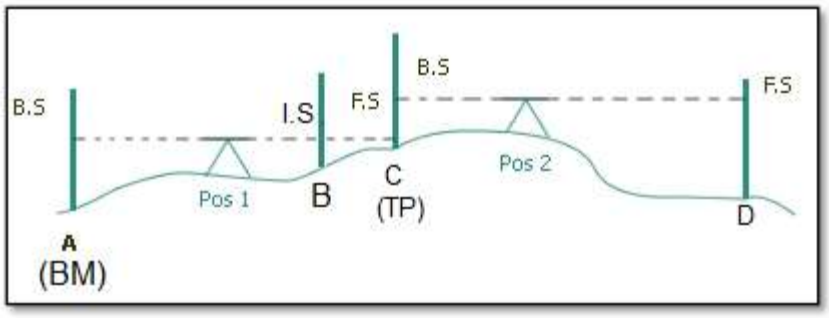


Figure 2: Leveling procedure

- **Tabulation:**

STATION	READINGS			HEIGHT OF INSTRUMENT	REDUCED LEVEL	REMARKS
	B.S	I.S	F.S			

Calculations

1. The height of instrument position(1) can be calculated as:
HI of position 1 = Elevation of BM + BS at BM
2. The reduced level of any point (i) taken from position 1, can be calculated as:
R.L of point i = HI of position 1 – staff reading at point i
3. The height of instrument position(2) can be calculated as:
HI of position 2 = Reduced level of TP1 + BS at TP1
4. The reduced level of any point (i) taken from position 2, can be calculated as:
R.L of point i = HI of position 2 – staff reading at point i
5. And so on….
6. **Checks:** The following checks on the booking and arithmetic calculations are performed:
A) Number of BS readings = Number of FS readings
B) ∑BS - ∑FS = RL of last point – RL of first point

LAP Test # 1	Set up leveling instrument

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 30 minute.

Task 1: - set up the leveling instrument properly.

LAP Test # 2	Calculate elevation difference and reduce level by rise and fall method

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 1 hours.

Task 1**: -** set up the leveling instrument properly.

Task 2:- observe the data and record on sheet

Task 3:- calculate

LAP Test # 3	Calculate elevation difference and reduce level by h.i method

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 1 hours.

Task 1: **-** set up the leveling instrument properly.

Task 2:- observe the data and record on sheet

Task 3:- calculate

List of Reference Materials

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Ramsay J. P. Wilson, Mac Donald and Evans Ltd. 1983
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WATER TECHNICAL PAPER NO. 7
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Assistance to irrigated agriculture in Turkana/Pokot

SURVEYING MANUAL

Associate Prof. Dr. Eng. Ibrahim Mahamid
Civil Engineering Department, Engineering Faculty, University of Hail, KSA

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Basic infrastructure operations
NTQF Level I

Learning Guide # 43

Unit of Competence: Carry-out Basic Leveling
Module Title: Carrying-out Basic Leveling

LG Code: CON BIO1M11LO3LG-43
TTLM Code: CON BIO1 TTLM1019V1

LO3 Establish offsets for civil works

Instruction Sheet	Learning Guide #43

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

- Establishing recovery and offset pegs
- Re-establishing recovery and offset pegs based on specification
- Establishing drainage offset

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

- Establish offset and recovery pegs from survey controls to specified plans and drawings to meet project requirements
- Re-establish earthwork and pavement control lines from offsets and/or recovery pegs in accordance with plans, drawings and specifications
- Establish drainage offsets from survey

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1 & Sheet 2 ”.
4. Accomplish the “Self-check 1 & Self-check 2 .
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1**.**
6. Do the “LAP test” (if you are ready).

Information Sheet-1	Establishing recovery and offset pegs

1.1.Setting out the road construction stakes

Once the position and level of the centre line has been established, the next step is to set out guiding stakes for the entire road formation including its drainage system. This work is normally carried out in two stages. A preliminary survey is done when preparing the detailed design drawings, which form part of the bidding document s. This survey exercise is essential for estimating the exact quantities of work.

A second surveying exercise is carried out at the time when civil works commence.

At this stage, the setting out of the road cross section provides the detailed directions for civil works activities such as clearing, excavation and fills works, and drainage construction. A similar exercise is carried out when works on a road section have been completed, for the purpose of reporting and payment of the actual quantities of work carried out.

Using the established centre line for the road, this setting out exercise will result in details relating to:

- The exact location and amount of excavation works,
- Detailed measurements of fills and embankments,
- All road levels including shape of road camber,
- Location and shapes of the drainage system, including side and miter drains, cut-off drains, drifts and culverts, and
- Exact location and dimensions of any other structures.

As with the surveying of the road alignment, the setting out of the road cross-section can effectively be carried out using the same surveying tools and methods. The results are marked with pegs, indicating the key locations such as extent and depths of fills and excavations, location and depth of drains, etc.

Figure.1 Setting out of road cross section

1.2.Setting construction guiding Slotting

The slotting method is adequate for most sections of road where a reasonable vertical alignment exists. It usually allows earthworks to be balanced laterally and is suitable for the majority of situations on unpaved rural roads. The following work methods are used:

A. Set out a slot every ten meters in a right angle to the centre line. Each slot is 50cm wide. The length depends on the chosen cross-section and should extend from back of ditch to back of ditch.

B. If the slot is more than 0.5 meters high at any point, the sides of the slot excavation should be backslapped instead of vertical.

C. Compact the fill side of the slope using hand hammer.

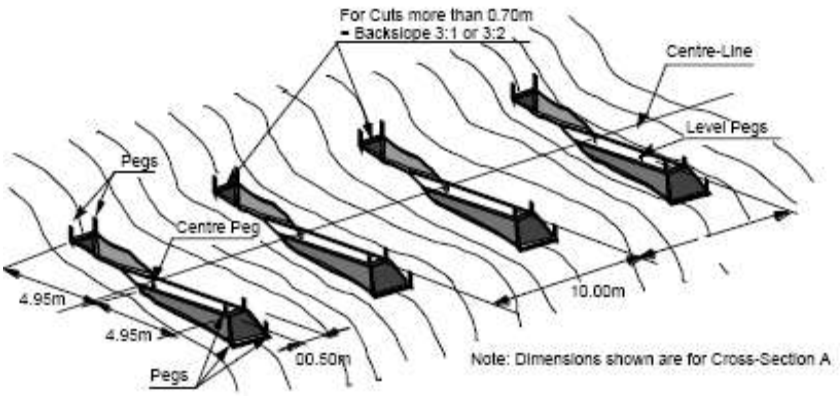


Figure 1.2.Slotting setting out

1.3.Setting out the Road Camber

With the position and levels of the centre line already established, it is possible to set out the camber and side drains. The road camber is usually constructed at the same time as the side drains. The cross section is set out at a right angle to the centre line.

When designing the camber and side drains, it is important once again to keep the excavation works to a minimum by following the existing level of the terrain along the road line. By carefully assessing the road levels along the centre line, the resulting quantities of earthworks can be kept at a minimum.

1.4.Set out on flooded flood prone land and earthwork volume calculations

The height of the embankment at any point on the centre line can be established with the use of profile boards. The high water level is marked on trees or solid pegs at convenient locations along the route. The actual flood levels can be obtained through consultations with local residents. The centre line is then set out with ranging rods every 20m. Profile boards are fixed on these ranging rods at one meter above the nearest high water level mark. The centre line profiles are then sighted to check that they line up and are horizontally aligned. Adjustments to the profile levels are made as necessary. The full height of the embankment is established at each 20m section by measuring down from the profiles to the ground and subtracting 0.5m. The measurement is rounded off to the nearest 10cm.

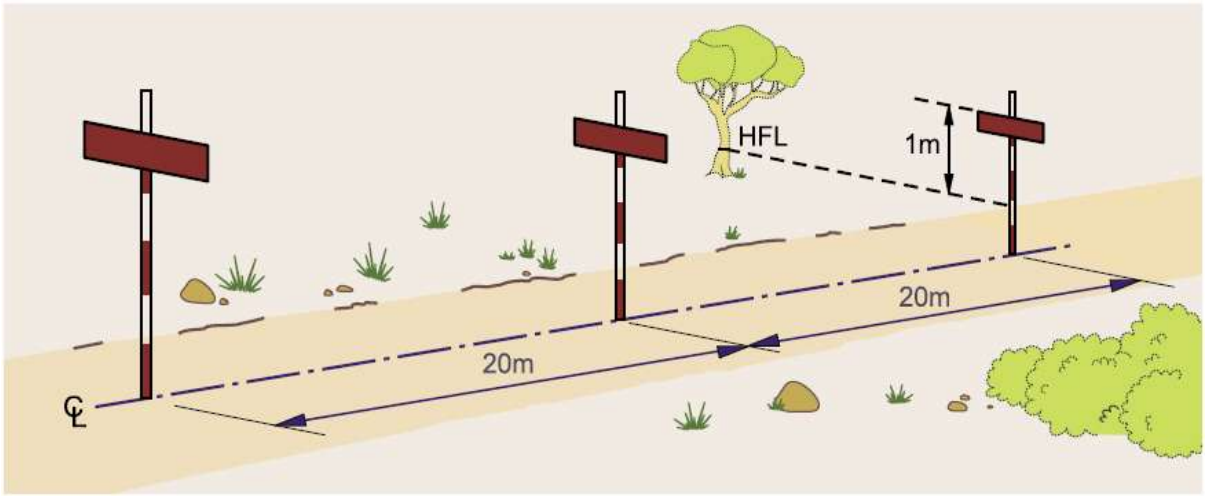


Figure.1.3.Flood setting out

The surveyor establishes the high water levels along the route, and adds 0.5m to allow for sufficient embankment height. The height of the embankment may vary along the road line. Therefore, it is practical to use the average height over a section of 20 meters when calculating the volumes. Once the centre line has been established, it is possible, using profiles, to get a fast and accurate estimate of the volume of earthworks.

Calculation of earthwork quantities is especially important for the planning and control of embankment construction activities. It is necessary to apply a simple and accurate method of estimating embankment quantities at the site. The cross-section dimensions are fixed by national standards or project specific designs. In this example, we will assume some dimensions commonly used for rural roads, i.e. a road width of 5.5m, side slopes of 1:2 and a clearance above highest flood levels of 0.5m. The height of the embankment, H, is determined on the basis of the expected flood levels.

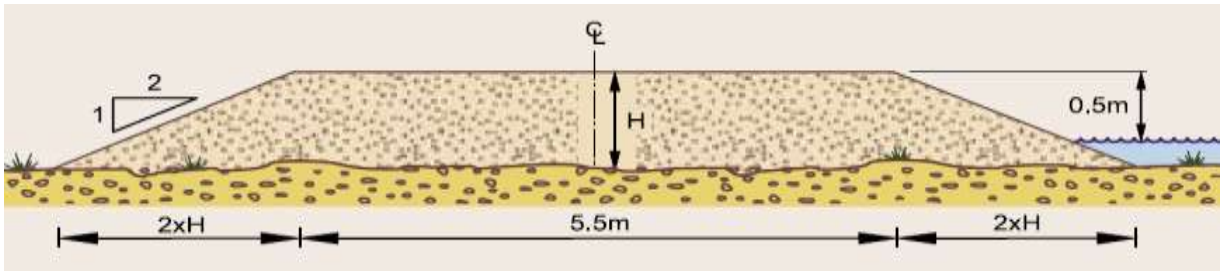


Figure.1.4.Road cross section

It is common practice to raise the embankment another 0.5m above the flood level. The area of the standard cross-section is then:

2 x (2xH x H)/2 + 5.5 x H = (5.5 + 2H) x H [m²] which is equivalent to m³ per meter length when calculating volumes. Embankments are only necessary on flood prone land where there are only slight variations in ground levels. In these conditions, it is quite safe to take the height at the centre line profile as the average height of the cross-section.

Self-Check 1	Written Test

1.Set out a slot every ____ meters in a right angle to the centre line.

A. 25 C.5

B.50 D.10

2._____is set out at a right angle to the centre line.

A. Profile C. Plan

B. Cross section D. Bridge

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

Answer Sheet

Score = _____

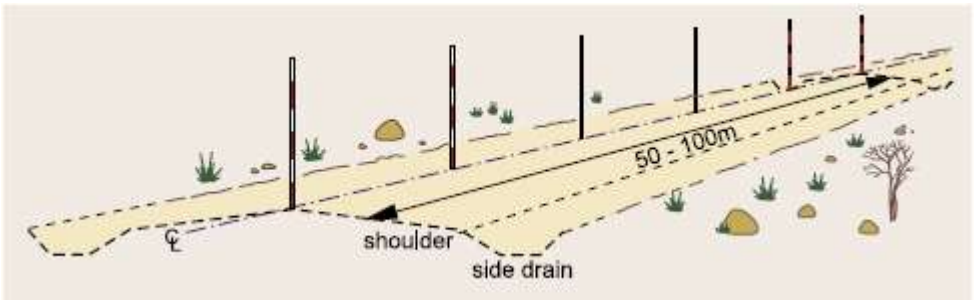
Rating: _____

Name: _____ Date: _____

operation sheet # 1	Setting out road levels & drainage

The procedure described below is an efficient way of setting out the road levels, achieving a well-placed road with good drainage and which does not involve extensive excavation or fill works.

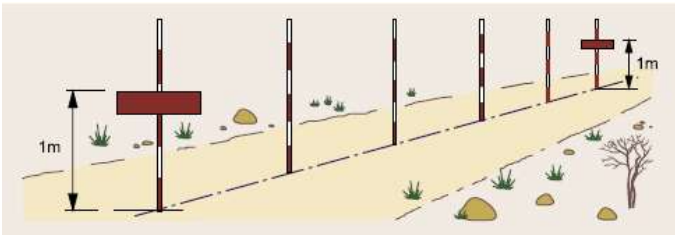
Step 1



Using the previously established centre line, set out ranging rods at 10m intervals along the centre line for a section of 50 to 100 meters

By placing ranging rods at the start and end of the road section, intermediate ranging rods are sighted in along the centre line. The distance between the ranging rods is measured out using a tape or a piece of string with a fixed length.

Place a wooden peg next to each of the intermediate ranging rods.



Step 2

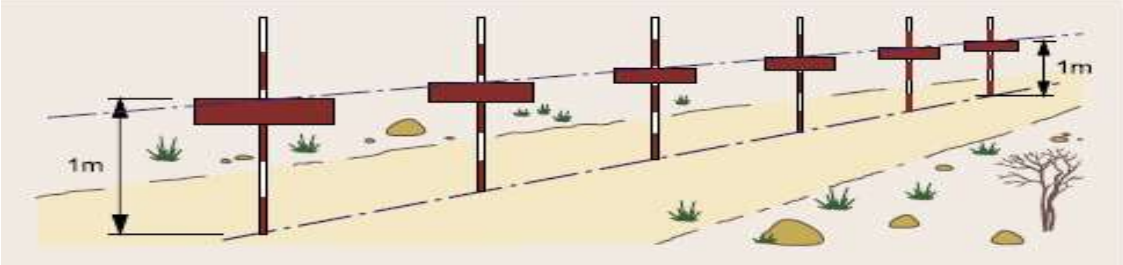
On the centre line of the road, fix the first profile board. This profile may already be in position as the last profile from the previous set out section. If not, measure one meter up from the existing ground level, and mark this level by fixing a profile board so that the top edge of the profile board measures one meter above the ground

Step 3

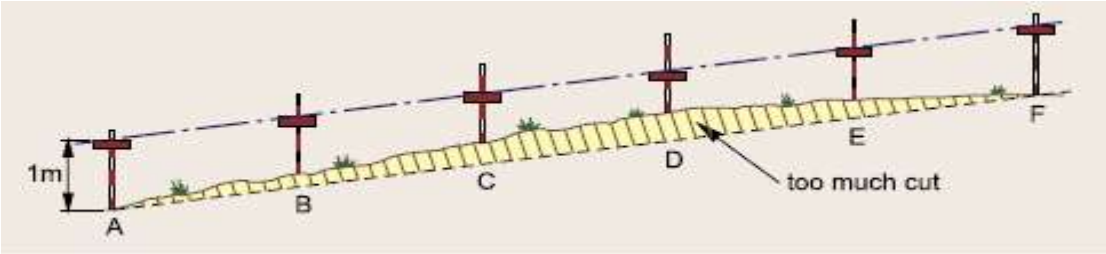
Go to the centre line ranging rod at the other end of the road section and repeat the procedure, measuring up one meter from the ground level.

Step 4

By sighting in the intermediate profiles from one end, fix profile boards on the intermediate ranging rods along the centre line so that they are all at the same level.

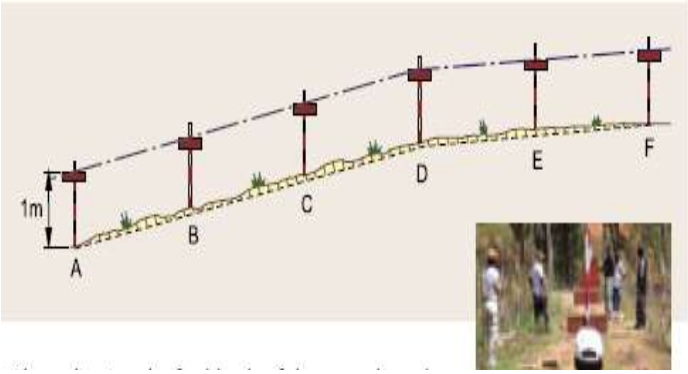


STEP: 5



Check the height of each profile board above the ground level. If the height is approximately one meter, there is no need to adjust the levels. On the other hand, if the height of the profile boards is significantly greater or less than one meter (by more than 10cm), the levels may need to be adjusted. There are normally humps or depressions along the line and in most cases, the set out line will smooth out such minor variations. However, it may be that the centre line passes a hill or a dip in the terrain. In such cases, it is necessary to adjust the profiles to avoid excessive excavation works. If this is the case, raise the profile at position D so that it is one meter above the ground and then lift the profiles at B, C and E so they are in line with the levels of the profiles at A to D and D to F. This measure will reduce the amount of excavation works.

Step 6



When adjusting the final levels of the centre line, there are some general rules, which are useful to follow:

(i) Try to match the road levels to the existing terrain.

(ii) It is better to lift the profiles than to drop them. Getting the final level of the road, up and above the surrounding terrain improves its drainage features.

(iii) Try to keep lifts and drops less than 10cm.

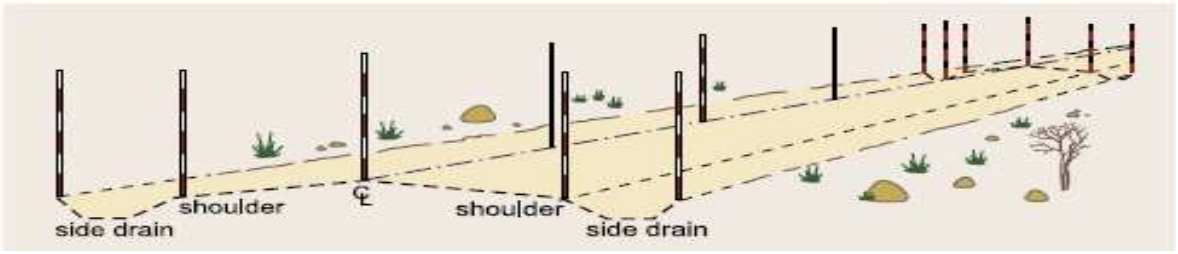
Larger variations may result in an uneven or bumpy vertical alignment.

(iv) Use the profiles in a conscious manner to get a good picture of the vertical alignment.

As a final control measure, make sure that the chosen gradient still allows for the side drains to be emptied. It is important to spend time on this aspect before continuing the next steps, because all other levels will be set out based on the profiles along the centre line of the road.

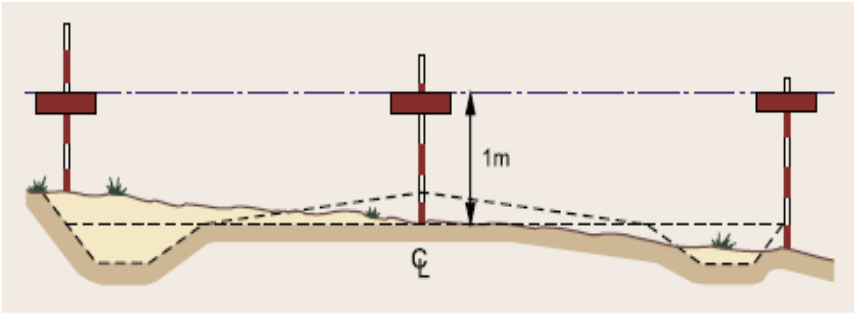
Step 7

At the start of the section, measure out the position of the road shoulders and the outer end of the side drains from the centre line. Mark the road shoulders and side drains with ranging rods. Repeat this exercise at the other end of the section. Once the key positions of the cross section have been set out at the start and the end of the road section, sight in intermediate ranging rods at every 10m along the road shoulders and side drains. Place a wooden peg next to each of the intermediate ranging rods.



Step 8

Transfer the levels to the ranging rods at the outer end of the side drains. Start with the beginning of the road section. Using a string and a line level, transfer the level of the profile board at the centre line to the ditches on both sides of the road. Once the levels are set out with profile boards, mark the levels on pegs next to each ranging rod.

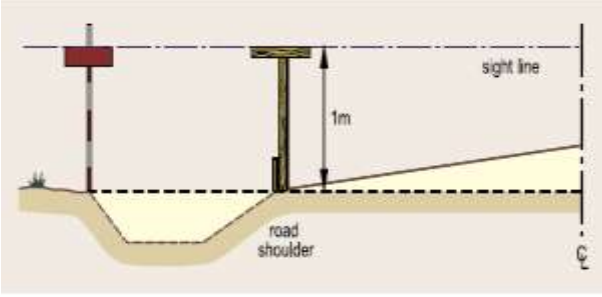


Repeat this procedure for the same two ranging rods at the other end of the road section and for any intermediate profile along the centre line that was lifted or lowered to reduce excavation works. Then, sight in the intermediate side drain levels

As can been seen in the figure above, the height of the profile on the low side of the centre line is more than one meter when the road is passing through terrain with a cross-slope. If there is good natural drainage on the lower side of the road, it may not be necessary to install a drain on this side.

Step 9

Mark the levels for the centre line on pegs placed next to the ranging rods along the centre line. Now, use the centre line profile boards to set out intermediate pegs, placed at every 5 m along the centre line. This is easily carried out with a one meter tall traveler. Mark these pegs at the point where the bottom of the traveler



touches the peg, when lined up with the profiles. On all the centre line pegs, mark the level of the crest of the camber.

Levels are usually indicated as three-digit numbers, showing the required cut or fill in meters (e.g. +0.20 means that a fill of 20 centimeters is required). When the level is indicated, always measure from the top of the peg.

Step 10

Place the levels of the shoulders along the road. For this, it is one again useful to have a traveler. Line up the traveler along the line between two side drain profiles, and the bottom of the traveler will show the correct level of the shoulder.

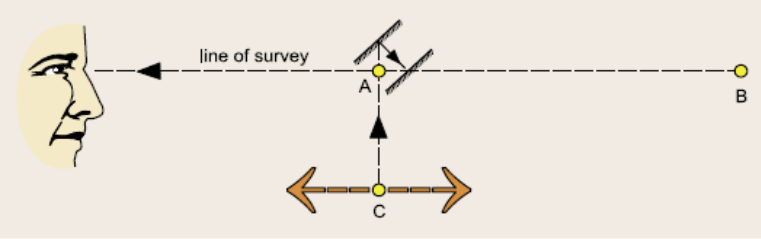
Place pegs every 5m along the edge of the shoulder. Using a traveler, mark these pegs at the point where the bottom of the traveler ends when it lines up

Step 11

Locate and set out the miter drains. Make sure that the miter drains are set out before commencing the excavation works for the side drains and camber.

Step 12

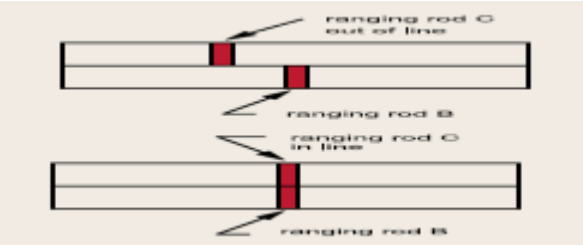
Set out with string line the side drains that need to be excavated. Remember to leave out the miter drain block-offs with the profiles



2. Prism method/Optical Square

The optical square is a small instrument using either mirrors or a prism to establish a right angel, as illustrated in the figure below. Whilst holding the optical square, the observer can see both point B, through a narrow opening in the optical square, and point C through a mirror or prism.

When ranging rods are placed at positions B and C, the observer will see ranging rod B directly and ranging rod C reflected as illustrated in the figure above.

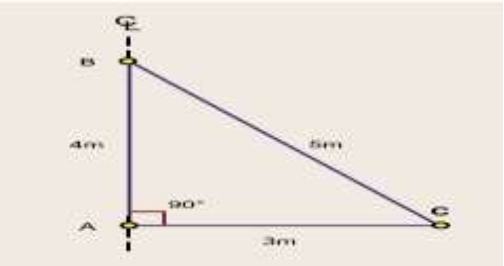


When points A and B on the survey line are known and point C has to be found, as shown in the figure below, the person holding ranging rod C moves forwards or backwards until the observer sees the reflection of rod C in one line with the direct view of rod B. At this point, the angle AB, is at a right angle.

2. Setting out offset stakes and reference points

A).Off-set Pegs

As the pegs along the centre line of the road may be lost during construction, it is common practice to establish permanent references away from the area covered by the road. These off-set pegs are the permanent markers for setting out works, and provide an efficient reference from which all future works are

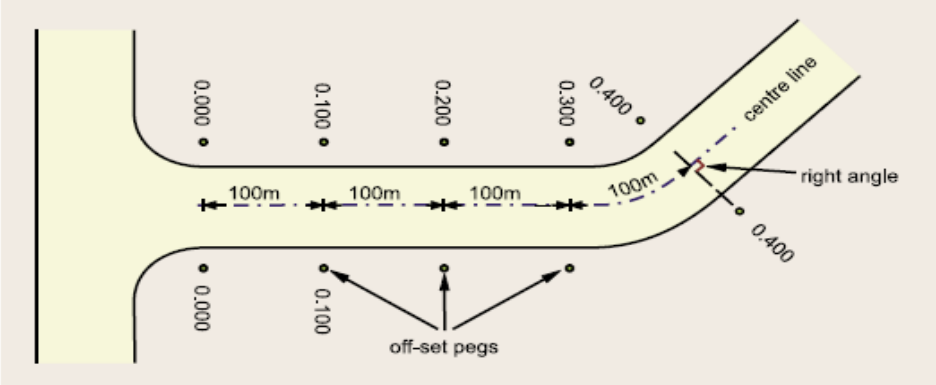


set out. Equally, these off-set pegs are useful for checking completed works.

After the road works have been completed, those pegs should be retained to serve as references when planning and supervising maintenance works. The off-set pegs are located at right angles to the centre line.

To determine the location of the off-set pegs, first construct a 90 degree angle from the centre line. The quickest way of doing this is by using a measuring tape, creating a right-angled triangle with sides measuring 3, 4 and 5 meters. Alternatively, a string line can be used on which the same lengths are marked on the string.

Place a ranging rod at the point on the centre line from which an off-set peg is required (A). Measure 4 meters along the centre line and place a peg at this position (B). Fix the 4m mark on the tape to this point. Then measure 5 more meters along the tape/string to find position (C). By measuring another 3 meters along the tape and placing this point on the tape back in point (A), and stretching out the tape, position (C) can be located. The line between points A and C will be 90 degrees to the centre line. Repeat the exercise on the opposite side of the centre line and then check that the ranging rods on both sides are on line. The position of the off-set pegs can now be located by measuring the desired distance from the centre line following the direction of the ranging rods. The chain age and the location of the off-set peg relative to the centre line is marked on the peg. In flat and rolling terrain, the off-set distance is usually half the width of the formation plus the width of the side drains. This would apply to the offset distance on both sides of the road alignment. Where the road passes through sloping ground, and side cuts and f ills are therefore required, it is useful to locate a toe and a back slope peg in order to fully define the road cross section. The toe peg normally defines the outside edge on the low side at the base of the fill, and the back-slope peg defines the top of the back slope.



LAP Test # 1	Setting out road levels & drainage

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 1 hours.

Task 1: **-** set out road level and drainage.

Information Sheet-2	establishing drainage offset

2.1.Off Road Drainage

The main problems for the side drains are erosion and silting. Erosion is caused by a large quantity of water travelling at high speeds. It is possible to reduce the speed by widening the side drain, but the best way to control erosion is by reducing the amount of water flowing through the drain. This is done by using *mitre drains* to empty the side drain at regular intervals before the volume of water builds up and causes erosion.

Another method to control erosion is to place *scour checks*. These are only used in hilly terrain with steep road gradients where it may not be possible to remove water using mitre drains. Their function is to slow down the water flow by reducing the natural gradient of the drain by allowing the drain to silt up behind the scour check.

Silting is caused by sand and silt settling out of the water. This only occurs with slow flowing, or stationary water. It takes time for the particles to settle, so the further the water has to travel in the drain, the more time there is for the silting to take place. The solution is to empty the side drains frequently by means of installing mitre drains at regular intervals.

In some cases, it is wise to construct cut-off or interception drains which prevents surface water from reaching the road. These are particularly useful in the surrounding areas to drift approaches, culverts and bridges. They are also effective in channeling away water from the high side of the road in side sloping terrain.

2.2.Mitre Drains

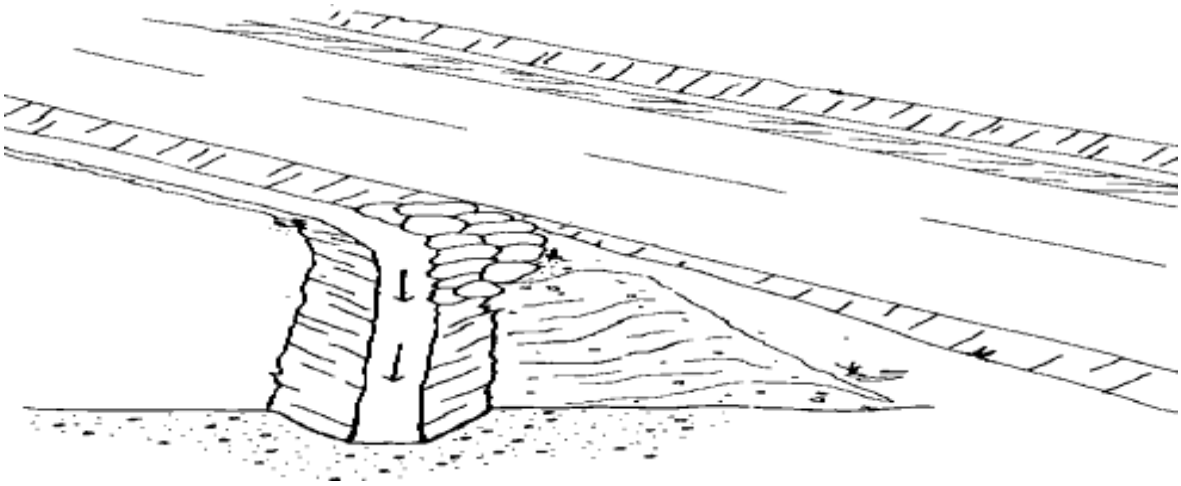


Figure 2.MitreDrain

The location of mitre drains should be determined during the initial stages when setting out the road alignment, thereby ensuring that the road receives a good off road drainage. Make sure that sufficient numbers of mitre drains have been located before side drain excavation starts.

Calculating the correct space between the mitre drains can be quite complicated, in principle the more mitre drains provided, the better.

A general rule is to:

- wherever possible, provide a mitre drain for every 100m or less,and

• when the road gradient is very small, provide mitre drains at every 50m along the side drain.

There are some important items to bear in mind when designing mitre drains:

! Make a strong block off in the side drain, and make it easy for the water to flow along and out of the mitre drain.

Water will always flow the easiest way. The water will try to continue to flow down the side of the road because it is usually steeper and in a straight line. If you want to divert the water into the mitre drain you must make it easier for it to flow where you want it to go.

The best way to provide a strong block-off is to leave 3 - 8m of natural ground on the drain line not excavated. Forming the block-off with excavated material is not as strong. Block-offs act as useful turning points for trucks and other equipment during the gravelling operation. They are also a natural point to off-load and store gravel for future routine maintenance works.

! The amount of water entering the mitre drain cannot be greater than the amount flowing out. Otherwise, the drain will fill up and over flow, often damaging the block off and causing even greater problems at the next mitre drain. In most cases, the standard mitre drain should be big enough to carry water coming from the standard side drain, except when:

• the side drains carry more water than usual,
• the side drain slope is much greater than the mitre drain slope

In such cases, the mitre drain should be made wider than the side drain so that it can carry more water.

! The length of the drain depends on the terrain ground levels and the slope of the drain. Mitre drains should be as short as possible. Long mitre drains are expensive, more likely to silt up or get blocked off, and in general more difficult to maintain.

A good slope for a mitre drain is 2%. The gradient should not exceed 5%, otherwise there may be erosion in the drain or to the land where the water is discharged. In mountainous terrain, it may be necessary to accept steeper gradients. In such cases, appropriate soil erosion measures should be considered. In flat terrain, a small gradient of 1% or even 0.5% may be necessary to discharge water, or to avoid very long drains. These low gradients should only be used when absolutely necessary. The slope should be continuous with no high or low spots.

! Try to select a line for the mitre drains which will connect with natural run-off channels that take the water well clear of the road. If this is not possible, make sure that the next mitre is set out to catch this water before it enters back into the side drains.! Finally, it is important that the discharged water does not disturb farming activities in the surrounding areas. By discussing the location where to discharge water from the road with the local farmers, it may be possible to achieve solutions which may assist the farmers rather than destroying the water management of their farm lands.

2.3.Angle of Mitre Drains

The angle between the mitre drain and the side drain should never be greater than 45 degrees. An angle of 30 degrees is ideal.

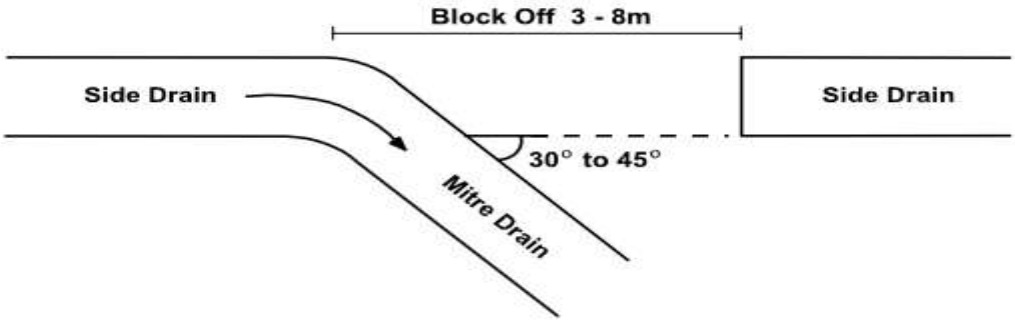


Figure 2.1Angle mitre drain

For checking, the angle between the mitre and side drain, first construct a 90 degree angle and then use the measurement of the below triangles:

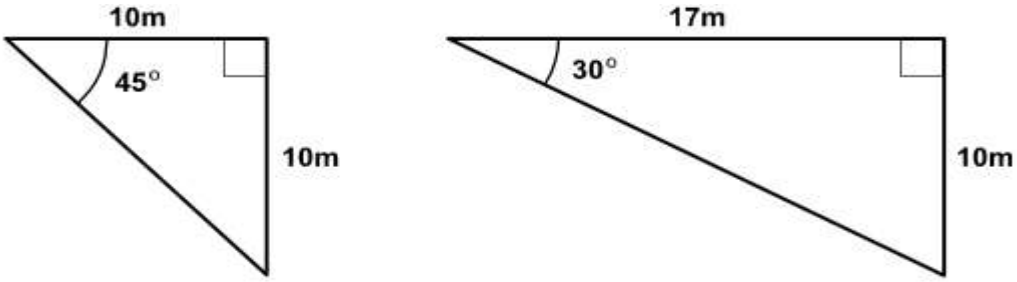
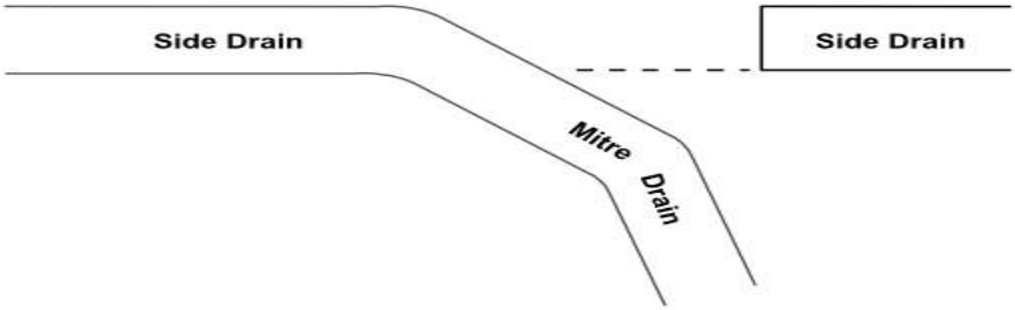


Figure 2.2 Angle mitre drain

If it is necessary to take water off at an angle greater than 45o, it should be done in two or more bends so that each bend is less than 45o



2.4.Scour Checks

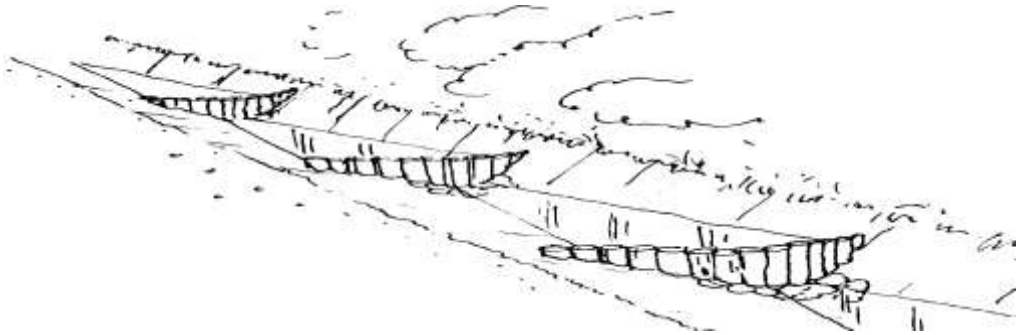


Figure 2.4 Scour check

When road gradients are steeper than 4%, the drainage water will gain high speed which may cause erosion of the side drains. Apart from leading the water off in mitre drains, scour checks may reduce the speed of water and prevent the water from eroding the road structure. Scour checks are usually constructed in natural stone or with wooden or bamboo stakes. By using natural building materials available along the road side, they can easily be maintained after the road has been completed. The distance between scour checks depend on the road gradient. This relation is shown in the following table.

Road Gradient [%]	Scour Check Interval [m]
4	not required
5	20
6	15
7	10
8	8
9	7
10	6

The basic measurements for constructing a drift is illustrated in the figure below:

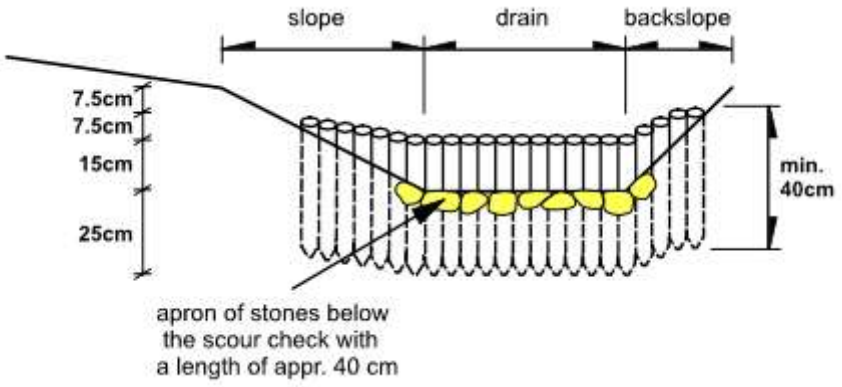


Figure 2.5 Drift

After the basic scour check has been constructed, an apron should be built immediately downstream using stones. The apron will help resist the forces of the waterfall created by the scour check. Sods of grass should be placed against the upstream face of the scour check wall to prevent water seeping through it and to encourage silting to commence on the upstream side. The long term goal is to establish complete grass covering over the silted scour checks to stabilise them.

2.5.Cut-off Drains

The purpose of cut-off or interception drains is to prevent water from reaching the road, or to direct water to where it can cross the road safely at constructed water crossings such as culverts, bridges, drifts, etc.

These drains, when properly thought out, properly set out and properly built, can be very useful in reducing damage to the road and reducing maintenance costs.

In most cases, it is cheaper and safer to direct water away from the road, using these drains, rather than providing erosion control measures in the side drains.

However, there are certain dangers with cut-off drains that must be considered:

- the water usually carries a lot of silt and if not properly built can silt up quickly,
- as they are off the road they will probably receive less maintenance – especially when they are difficult to maintain,
- when they fail, water will break through in a concentrated flow causing damage, and
- they may be ploughed up or blocked off by people using the land.

These dangers can only be avoided if careful planning goes into the drains before construction and if they are built properly.

The following precautions should be taken:

- reduce the danger of silting by making sure there is a continuous down hill gradient and that there is a clear outlet at the end,
- make sure they are easy to maintain and that erosion damage is reduced so that maintenance needs are small (wide with sloped sides),
- make the drain strong - anticipate the possible weak points of the drain where water could break through and strengthen the drain there,
- locate drains carefully after discussion with local people - where people have to cross the drain, provide easy side slopes so that people will not fill the drain.

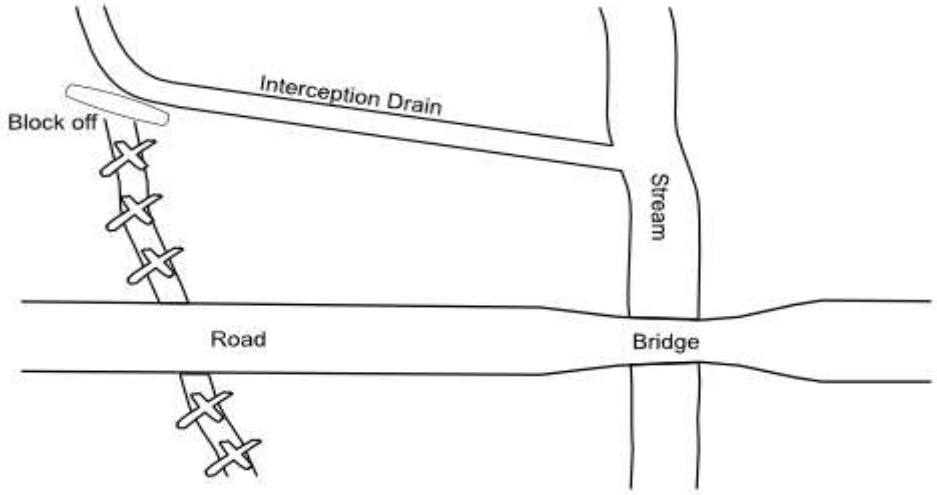


Figure 2.6 Cross drain

Self-Check 2	Written Test

1. Which one of the following is caused by a large quantity of water travelling at high speeds.
   A. Erosion C. Cut-off Drains
   B. Silting D. Scour Checks
2. The purpose of _____ is to prevent water from reaching the road.

   A. Scour Checks C. Mitre Drains
   B. Cut-off Drains D. Off Road Drainage

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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BASIC INFRASTRUCTURE OPERATIONS
NTQF Level I

Learning Guide # 44

Unit of Competence: Carry-out Basic Leveling
Module Title: Carrying-out Basic Leveling

LG Code: CON BIO1M11LO4LG-44
TTLM Code: CON BIO1 TTLM1019V1

LO4 Cleaning up

Instruction Sheet	Learning Guide #44

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

- cleaning work area
- cleaning and handling of tools and equipment

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

- Clear work area and dispose of or recycle materials in accordance with project environmental management plan
- Clean, check, maintain and store tools and equipment

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information Sheet 1- 2
4. Accomplish the “Self-check 1- 2
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet
6. Do the “LAP test” (if you are ready).

Information Sheet-1	cleaning work area

1.1. Disposing, reusing and recycling waste materials Introduction

Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, paint, or the like.
Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations
Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction
Diversion: Avoidance of demolition and construction waste sent to landfill or incineration. Diversion does not include using materials for landfill,
alternate daily cover on landfills, or materials used as fuel in waste-to energy processes.
Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse
Recycling: The process of sorting, cleansing, treating, and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
Salvage: Recovery of demolition or construction waste and subsequent reuse or sale in another facility
Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.
Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste
Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.1.2.PERFORMANCE REQUIREMENTS

A. The Owner has established that this Project shall generate the least amount of waste possible and that processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors shall be employed.

B. Of the waste that is generated, as many of the waste materials as economically feasible shall be reused, salvaged, or recycled. Waste disposal in landfills or incinerators shall be minimized, thereby reducing disposal costs.

C. Develop a construction waste management plan that results in end of Project rates for salvage/recycling of 95 percent by weight of construction and demolition waste.

D. Salvage/Recycle Requirements: Salvage and recycle as much non hazardous demolition and construction waste as possible, including the following materials:

a. Asphaltic concrete paving

b. Concrete

c. Concrete reinforcing steel

d. Brick

e. Concrete masonry units

Construction Waste Management Plan (CWMP): It is the intent of this specification to maximize the diversion of demolition and construction waste from landfill disposal. Accordingly, not more than 30 days after receipt of Notice to Proceed and prior to the generation of any waste, prepare and submit a draft Construction Waste Management Plan including, but not limited to, the following:

1. Procedures for Recycling/Reuse Program to divert a minimum of 95% (by weight) of construction and demolition waste from landfill disposal, including waste resulting from demolition of any existing building and site paving scheduled for demolition; any site paving is required to be ground on site and reused as granulated fill on site.

2. Approval of the Contractor's CWMP shall not relieve the Contractor of responsibility for adequate and continuing control of pollutants and other environmental protection measures.

1.1.3. construction waste management plan

Develop and implement a CWMP consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Include separate sections in plan for demolition and construction waste. Indicate quantities by weight or volume, but use the same units of measure throughout the CWMP.

Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, reused, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. **Salvaged Materials for Reuse**: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
2. **Salvaged Materials for Sale**: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. **Salvaged Materials for Donation**: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. **Recycled Materials**: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. **Disposed Materials**: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. **Handling and Transportation Procedures**: Describe method that will be used for separating recyclable waste, including sizes of containers, container labeling, and designated location on Project Site where materials separation will be located.

Materials Handling Procedures: Provide a description of the means by which any waste materials identified will be protected from contamination, and a description of the means to be employed in recycling the above materials consistent with requirements for acceptance by designated facilities.

Self-Check 1	Written Test

1. Recovery of demolition or construction waste and subsequent incorporation into the Work.

A. Source Separation C. Reuse

B. Clean D. Trash

2. Which one of the following is correct ?

A. Trash: Untreated and unpainted; not contaminated with oils, solvents, caulk, paint, or the like.

B. Demolition Waste: Any product or material unable to be reused, returned, recycled, or salvaged.

C. Clean: Building and site improvement materials resulting from demolition or selective demolition operations

D. Salvage: Recovery of demolition or construction waste and subsequent reuse or sale in another facility

Information Sheet-2	cleaning and handling of tools and equipment

2.1. Maintaining plants, tools and equipments

Introduction to maintenance

Maintenance can be defined as working on something to keep it in a functioning and safe state and preserving it from failure or decline. The “something” could be a workplace, work equipment, or means of transport (e.g. a ship).

1, Preventive – or proactive – maintenance is carried out to keep something functional. This type of activity is usually planned and scheduled.

2, Corrective – or reactive – maintenance is repairing something to get it working again. This is an unscheduled, unplanned task, usually associated with greater hazards and higher risk levels.

Maintenance is not the exclusive domain of fitters and mechanics. It is the responsibility of almost all workers in every sector and is carried out in almost every working environment. Workers’ health and safety can be affected during the maintenance process, but also by lack of maintenance or inadequate maintenance. Design of equipment and the work area also has a significant impact on the health and safety of workers performing maintenance.

For the purpose of this e-fact, portable tools are defined as tools which can be carried by hand. These tools can be divided into non-powered portable (hand) tools and powered portable tools.

Non-powered portable (hand) tools include saws, hammers, screwdrivers, pliers, axes and spanners. The greatest hazards posed by these tools result from misuse and improper maintenance. Blunt tools, for example, can make the work more difficult and result in more injuries.

Hand tools:

- Mechanical failure or loss of control when using a tool with defective parts. Examples o funsafe tools are hammers with loose or damaged heads, screwdrivers with broken handles or blunt edges, chisels with mushroomed heads, and blunt saws.

Power tools:

- Malfunctioning of safety devices such as emergency button (red button), protective covers, guards, etc. In case of emergency these devices will not work properly or will provide limited protection to the worker, which in some cases can be worse than no protection at all because it gives a false sense of security.

- Risks of electrocution, shock or burns due to electrical malfunctions, torn cables and lack of proper insulation or proper earthling.
- Cracked or broken grinding wheels or cracked blades can cause injuries. E.g. cracked abrasive wheels could fly apart in operation, which could lead to serious injury or death.
- Emissions of chemical substances such as toxic fumes or dust, etc.
- Noise and vibration emitted by almost all portable tools that can lead to hearing loss and hand–arm vibration syndrome respectively. Vibration can cause “white-finger” disease, which arises from damage to the muscles and nerves that control the blood flow. Poorly maintained tools can cause a significant increase in noise and vibration emissions (e.g. a cutting tool that is not sharp emits higher levels of vibration). Also, damaged anti-vibration mountings in a tool can increase transmission of vibration to the worker.

2.1.2 OSH management and maintenance

The Framework directive obliges the employers to take the necessary measures to ensure the health, safety and welfare of all their workers including those involved in maintenance. Employers have to carry out a workplace risk assessment to identify hazards related to the use and maintenance of portable tools and take preventive measures to eliminate or minimize the risks. Companies contracting out maintenance work have to make sure that the contractor is managing occupational health and safety according to the legal requirements.

2.1.3. Maintenance and inspection programmed

The key to safe maintenance is putting in place a maintenance programmed, integrating safety and health aspects of maintenance and including inspection, reporting and record keeping procedures. Records must be kept to provide information for planning maintenance and replacement activities so that they occur at the proper time. Proper maintenance management of equipment requires a detailed inventory of all major items, including among other things information on manufacturer, model, year and number, and a list of the parts required for normal service and major repairs respectively.

An important part of the maintenance program is the inspection program setting out the frequency of formal inspections to be carried out by competent and trained maintenance technicians
Portable tools must be checked:

- Before the tool is put into use for the first time
- After servicing and changing parts
- At regular intervals appropriate for each tool.

Factors to consider when making the maintenance plan

- Type of tool and power source

- Manufacturer's instructions and recommendations
- Age of the tool
- Frequency of use and the work cycle of the tool
- Working environment in which the tool is used (e.g. wet or dusty), or likelihood of mechanical damage
- Foreseeable misuse of the tool
- Effects of any modifications or repairs to the tool
- Analysis of previous records of maintenance.

Tool design

Design for good maintainability helps to facilitate the maintenance of portable tools and reduces safety risks.

All components and interfaces should be designed and located so that they are directly and easily accessible for maintenance. Maintenance tasks should be designed to eliminate or minimize the need for special tools.

Good design can significantly contribute to eliminating or reducing the opportunity for human error during maintenance.

Self-Check 4	Written Test

1. Portable tools must be checked:

A Before the tool is put into use for the first time

B .After servicing and changing parts

C. At regular intervals appropriate for each tool.

D. All

2.what is the purpose of maintain tools and equipment

A. reduce accident B. increase life cycle

C. reduces safety risks **D.** all

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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Answer key lo 1

Self-Check 1	Written Test Answer key

1. B, Hard hat
2. A. mask

Self-Check 2	Written Test Answer key

1. C, Land tenure and approval for use
2. B, Geotechnical site investigation
3. A, true

Self-Check 3	Written Test Answer key

1. D, Bulldozer
2. C, Leveling
3. B, Excavator
4. A, Sieve and Pan

Self-Check 4	Written Test Answer key

1. C, Wastage material place
2. B, 200m
3. B, false
1. B, false

Self-Check 5	Written Test Answer key

1. B, Governmental taxation
2. A, True

Self-Check 6	Written Test Answer key

1. B, true
2. C. Quarry managers
3. A. False

Self-Check 7	Written Test Answer key

1. b, Water
2. a), Noise
3. d), Erosion

Answer key lo 2

Self-Check 1	Written Test Answer key

1. A, true
2. C, Geological information in population growth

Self-Check 2	Written Test Answer key

1. A, true
2. D, The quarry should contain sufficient

Self-Check 3	Written Test Answer key

1. A, false true
2. B, travelling speed over 80 km/h

Self-Check 4	Written Test Answer key

1. A, false
2. B, Determine manpower history

Self-Check 5	Written Test Answer key

1. A, true
2. B, false

Self-Check 6	Written Test Answer key

1. A, Unsuitability
2. B, false

Answer key lo 3

Self-Check 1	Written Test Answer key

1. B, false
2. E, all

Self-Check 2	Written Test Answer key

1. a. true
2. b. false

Self-Check 3	Written Test Answer key

1. C, Budget planning and control
2. B, Derived from the list of resources

Self-Check 4	Written Test Answer key

1. B, False
2. A, True

Self-Check 5	Written Test Answer key

1. C, Advise supervisor on labor allocation in the quarries
2. B, To give budget on the work to be done

Self-Check 6	Written Test Answer key

1. A, True
2. B, False
3. A, True