Ethiopian TVET-System

Irrigation & Drainage Construction

Level II

Based on, March 2017G.C. Occupational Standard

Module Title: Practices Work Effectively in Water Industry

TTLM Code: EIS IDC2 TTLM 0920v2

This module includes the following Learning Guides

LG25: Assess the importance of water services to the community

LG Code: EIS IDC2 M07 LO1-LG-25

LG26: Assess the factors affecting water quality

LG Code: EIS IDC2 M07 LO2-LG-26

LG26: Apply knowledge and understanding of the organization's systems and structure to work

LG Code: EIS IDC2 M07 LO3-LG-27

Instruction Sheet	Learning Guide -25: Assess the importance of water services to the community

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

- Exploring and explaining structure of water industry
  - ✓ Identifying system and infrastructure components
  - ✓ work effectively as part of a team
- Explaining ranges of water and waste systems service delivery system
- Explaining and exploring community's use of wastewater services
- Reviewing and assessing of strategies to ensure long term water sustainability

This guide will also assist you to attain the learning outcome stated in the cover page. Specificity, upon completion of this Learning Guide, you will be able to understand &work:-

- Explore and explain structure of water industry
  - ✓ identify system and infrastructure components
  - ✓ work effectively as part of a team
- explain ranges of water and waste systems service delivery system
- explain and exploring community's use of wastewater services
- review and assess of strategies to ensure long term water sustainability

Learning Activities

1. Read the objectives of this Learning Guide#1
2. Read the information written in the "Information Sheet 1"2,3&4. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
3. Accomplish the "Self-check 1".2,3&4
4. Submit your accomplished Self-check. This will form part of your training portfolio.
5. Your output will be evaluated and will form part of your training portfolio.

Information Sheet-1	Exploring and explaining structure of water industry

1.1. Introduction to water industry

The water industry provides drinking water and wastewater services (including sewage treatment) to residential, commercial and industrial sectors of the economy. Typically public utilities operate water supply networks. The water industry does not include manufacturers and suppliers of bottled water which is part of the beverage production and belongs to the food sector.

1.2 Overview water industry

The water industry includes the water engineering, operations, water and waste water plant construction, and equipment supply and specialist water treatment chemicals among others.

The water industry is at the service of other industries e.g of the food sector which produces beverages such as bottled water.

1.2.1. Organizational structure

There are a variety of organizational structures for the water industry, with countries usually having one dominant traditional structure, which usually changes only gradually one time.

1.2.2 Ownership of water infrastructure

A. Local government –the most usual structure worldwide , public utility
B. National government-in many developing countries ,especially smaller ones
C. Private ownership- relatively few
D. Co-operative ownership and related NGO structure , public utility

1.3. Identifying system and Infrastructure components

The water infrastructure systems in any society provide the foundations for development and prosperity, the infrastructures that fall under the umbrella of civil engineering, i.e., water and transportation systems are lifelines for smooth functioning of day to day activities.

Maintaining the integrity of water and other infrastructure systems at all times is essential for the society to have a strong economy. In the past, infrastructure systems were self-contained and operated independently of each other. In today‘s world, the infrastructures are increasingly interconnected by various degrees of complexity. While these interconnections ease their operations, they also bring about increased complexity for analyzing the infrastructures.

The commission identified eight critical infrastructures, namely power systems, transportation, water systems, government systems, telecommunications, banking and finance and emergency services. The commission noted that in capacity or destruction of them will have a debilitating impact on the defense and economic security of the country. Furthermore, the interconnected nature between these critical infrastructures magnifies the consequences of service disruptions.

The integrity of the water systems depends on

A. Power infrastructure for operating pumps, valves, and other mechanical components, as well as to power computer, and telecommunications systems;
B. On transportation infrastructure for transporting the required chemicals, personnel and equipment to the treatment plants;
C. On storage infrastructure for storing these chemicals.
D. On agricultural development (irrigation development)
E. Environmental protection

Water infrastructure systems broadly consists of

a. surface and ground water sources
b. channels and pipes that convey untreated water
c. water treatment plants
d. water distribution systems which convey treated water
e. storage tanks, that store treated water and
f. Wastewater collection, treatment and disposal systems.

The water system can be visualized as four subsystems:

1. water storage,
2. water treatment,
3. water use and
4. Wastewater treatment,

The functionalities associated with these subsystems are:

1. **Water storage subsystems**: comprise of dams, reservoirs, tanks and other facilities, man-made or natural, used to store water for eventual use. This subsystem includes tanks that store treated water.
2. **Water treatment subsystems** consist of facilities necessary to treat raw water. Treatment involves adding and/or removing substances from water so as to protect the health of the consumers.
3. **Water use subsystem** which consists of the water users as well as the network of pipes, valves and hydrants, water meters, and backflow preventers which deliver water to the end-user. The system is responsible for conveyance, as well as the regulation and operation of water for all.
4. **Wastewater treatment subsystems** consist of facilities designed to treat used water to a quality at which it would have a minimum harmful impact when re-introduced into the environment.

1.4. Work effectively as part of a team

Working in groups is almost unavoidable today. Often you will be asked to work in groups in school, at work or sometimes when participating in a volunteer activity. Specific and clear communication is the key to successfully working in groups, whether for short term or long term projects.

Figure 1: Team discussion as part of effective work in industry

1.5. Instructions

A. Get to know each other. If you're going to be working in a group with other people for any extended period of time, spend a few minutes talking at the outset of the first meeting. Introduce yourselves if you do not already know one another.

B. Assign roles if the project requires working together in a group for an extended period of time to reach a specific goal. For instance you might designate one person the group leader or facilitator and another scribe or note taker.
C. Exchange contact information to enable group members to communicate effectively outside of scheduled meetings if the project is long term.
D. Identify the group's goal. For instance, perhaps a manager/contractor asked you to accomplish a specific task within your group, or your company asked you to research specific information and report back. Discuss and document the group's goal to make sure you all agree on the primary goal of the group's work.
E. Divide tasks into steps and assign each member a specific task to attack long term projects. Often this will go easier if people volunteer for tasks they like to do.
F. Listen to each other and encourage each other. Make sure everyone in the group is heard and offer encouragement when others contribute a good idea or perform a task effectively.

Deal immediately with conflict if it arises. Although difficult to deal with, conflict or discord in a group can undermine the group's objectives. As quickly as possible, address any conflicts to keep the group members focused on the ultimate goal.

Self-Check -1	Written Test

Directions: Choose the best Answer for the questions listed below.

1. The integrity of the water systems depends on
   A. Power infrastructure
   B. On transportation infrastructure
   C. On storage infrastructure for storing these chemicals.
   D. All
2. Water infrastructure systems broadly consists of
   A. surface and ground water sources
   B. water treatment plants
   C. water distribution systems which convey treated water
   D. storage tanks, that store treated water E .All
3. Which one is not the factors that affect the flow of water in pipes are :
   A. Cross sectional area
   B. Roughness of the pipe's inner surface
   C. . Condition and type of flow D. none

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

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

Score = ___________

Rating: ____________

Answer sheet

Name: _________________________ Date: _______________

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2_______________

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Information Sheet -2	Explaining ranges of water and waste systems

2.1 Range of water and waste systems

Range of water and waste systems may include, but not limited to:

1. Water catchment systems
2. Storm water drainage systems
3. Irrigation and Drainage System
4. Water storage systems
5. Water treatment systems
6. Water distribution systems
7. Sewerage systems and sewerage treatment systems
8. Trade waste treatment systems

2.2. Water catchment systems

Definition of catchment and Watershed

A catchment: is an area where water is collected by the natural landscape. ... Rain falling outside the edge of one catchment is falling on a different catchment, and will flow into other creeks and rivers. Some water also seeps below ground where it is stored in the soil or in the space between rocks.

Watershed: The topography of any region may be subdivided into several ecological units, each of which drains to a common point. Each such ecological unit is referred to as watershed. Strictly speaking, the higher land that separates each such unit is called a watershed, and the unit itself being termed as the catchment area. However, it has become fairly common now to speak of catchment area and watershed in identical terms. The size of a watershed may vary from a few hectares to thousands of square kilometers.

- Watershed management: is the rational utilization of land and water resources for gaining optimum production and with minimum hazards to natural resources. It essentially relates to the practice of soil and water conservation in the watershed, which means proper land use, protecting land against all forms of deterioration, building and maintaining soil fertility, conserving water for farm use, proper management of local water for drainage, flood protection and sediment reduction and increasing productivity from all prevailing land uses.

- Causes of watershed deterioration: Watershed deterioration takes place due to the uncontrolled, unplanned, and unscientific land and natural resource use, and added to by the human interventions.

2.3 Storm water drainage systems

It is a network of structures, channels and underground pipes that carry storm water (rain water) to ponds, lakes, streams and rivers. The network consists of both public and private systems. It's an integral part of the storm water management system in the county that is designed to control the quantity, quality, timing and distribution of storm runoff. It's not part of the wastewater (sanitary sewer) system, which carries water and waste from drains (sinks, bathtubs, showers, etc.) and toilets to a treatment plant to be treated and filtered. Storm water does not flow to a treatment plant.

A. Excess water in the crop root zone soil is injurious to plant growth. Crop yields are drastically reduced on poorly drained soils, and, in cases of prolonged water logging, plants eventually die due to a lack of oxygen in the root zone.
B. Sources of excess soil water that result in high water tables include:
C. high precipitation in humid regions;
D. Surplus irrigation water and canal seepage in the irrigated lands; and artesian pressure.

Water logging in irrigated regions may result in excess soil salinity, i.e. the accumulation of salts in the plant root zone.

- Artificial drainage is essential on poorly drained agricultural fields to provide optimum air and salt environments in the root zone.
- Drainage is regarded as an important water management practice, and as a component of efficient crop production systems.
- Drainage (both surface and subsurface) is not simply the conversion of wetlands, but the improvement of naturally inadequately drained cropland. It is complementary to irrigation and is viewed as an essential component of irrigated agriculture.
- The objective is to increase production efficiency, crop yields and profitability on naturally poorly drained agricultural lands.

2.4. Irrigation and Drainage System

Irrigation is a science of artificial application of water to the land, in accordance with the crop water requirement throughout the cropping period.Irrigation can also be defined as a systematically developed knowledge based on long-term observation and experiments of handling available sources of water for economic growth of bumper crops. It includes:

- Training and tapping of source of water
- Storing of water
- Conveying that water efficiently to the field (it includes also draining of surplus water)

When rainfall is not sufficient, the plants must receive additional water from irrigation. Various methods can be used to supply irrigation water to the plants.

The most common methods are

- Surface irrigation:
    1. basin irrigation,
    2. furrow irrigation and
    3. border irrigation
- Sprinkler irrigation and
- Drip irrigation

The irrigation system consists of a (main) intake structure or (main) pumping station, a conveyance system, a distribution system, a field application system, and a drainage system.

1. The (main) intake structure, or (main) pumping station, directs water from the source of supply, such as a reservoir or a river, into the irrigation system.
2. The conveyance system assures the transport of water from the main intake structure or main pumping station up to the field ditches.
3. The distribution system assures the transport of water through field ditches to the irrigated fields.
4. The field application system assures the transport of water within the fields.
5. The drainage system removes the excess water (caused by rainfall and/or irrigation) from the fields.

Drainage: a complementary component at any level of an irrigation system and is the removal of excess water and dissolved salts from the surface and subsurface of the land in order to enhance crop growth.

Drainage can be either natural or artificial. Most areas have some natural drainage; this means that excess water flows from the farmers' fields to swamps or to lakes and rivers. Sometimes, however, the natural drainage is inadequate to remove the extra water or salts brought in by irrigation. In such a case, an artificial or man-made drainage system is required.

A man-made drainage system is an artificial system of surface drains and/or subsurface drains, related structures, and pumps (if any) to remove excess water from an area.

Surface drainage is the removal of excess water from the surface of the land by diverting it into improved natural or constructed drains, supplemented, when necessary, by the shaping and grading of the land surface towards such drains.

To remove excess water from the root zone, subsurface drainage is used. This is done by digging open drains or installing pipes, at depths varying from 1 to 3 m. The excess water then flows down through the soil into these drains or pipes. In this way, the water table can be controlled.

Subsurface drainage is the removal of excess water and dissolved salts from soils via groundwater flow to the drains, so that the water table and root-zone salinity are controlled.To remove salts from the soil, more irrigation water is applied to the field than the crops require. This extra water infiltrates into the soil and percolates through the root zone. While the water is percolating, it dissolves the salts in the soil and removes them through the subsurface drains. This process, in which the water washes the salts out of the root zone, is called leaching.

Leaching is the removal of soluble salts by water percolating through the soil. The extra water required for leaching must be removed from the root zone by drainage, otherwise the water table will rise and this will bring the salts back into the root zone. Therefore salinity is controlled by a combination of irrigation and drainage.

Benefits of Drainage

One of the benefits of installing a drainage system to remove excess water is that the soil is better aerated. This leads to a higher productivity of crop land or grassland because:

- The crops can root more deeply.

- The choice of crops is greater.
- There will be fewer weeds.
- Fertilizers will be used more efficiently.
- There will be less gentrification.
- The grass swards will be better.
- Other benefits of well-drained soils are:
- The land is more easily accessible.
- The land has a greater bearing capacity.
- .The soil has a better workability and tilth.

When drainage makes it possible to control the water table, the benefits that follow are:

1. The root zone cannot become salinized by the capillary rise of saline groundwater.
2. Leaching is made possible.

In its turn, the benefits of leaching are:

3. It prevents increases in soil salinity in the root zone, thus making irrigated land use sustainable in the long term.
4. By removing salts, it allows salt-sensitive crops, or a wider range of crops, to be grown.
5. It makes it possible to reclaim salt-affected soils, thus bringing new land into cultivation.

A drainage system has three components:

6. A field drainage system: This prevents ponding water on the field and/or controls the water table.
7. A main drainage system: This conveys the water away from the farm.
8. An outlet: which is the point where the drainage water is led out of the area.

2.5. Water storage systems

An irrigation water storage structure made by constructing a dam, embankment, or pit. The purpose of water storage is to conserve water by holding it in storage until it is used to meet crop irrigation requirements. conditions where practice applies This practice applies to irrigation water storage structures that meet all the following criteria:

a. The water supply available to the irrigated area is insufficient to meet conservation irrigation requirements during part or all of the irrigation season.

b. Water is available for storage from surface runoff, stream flow, or a subsurface source.
c. A suitable site is available for the construction of a storage reservoir.

Storage

Irrigation storage reservoirs shall be designed to satisfy irrigation requirements in the design area, unless limited by reservoir site characteristics, available watershed yield, or limitations imposed by water rights. Additional capacity shall be provided as needed for sediment storage.

2.6.Water treatment systems

Water treatment is any process that improves the quality of water to make it more acceptable for a specific end-use. The end use may be drinking, industrial water supply, irrigation, river flow maintenance, water recreation or many other uses, including being safely returned to the environment.

They typically consist of several steps in the treatment process.

These include:

(1) Collection
(2) Screening and Straining
(3) Chemical Addition
(4) Coagulation and Flocculation
(5) Sedimentation and Clarification
(6) Filtration
(7) Disinfection
(8) Storage
(9) and finally Distribution.

2.8. Water distribution systems:-

A water distribution system consists of three major components: pumps, distribution storage, and distribution piping network. Most systems require pumps to supply lift to overcome elevation differences and energy losses due to friction. Storage tanks are included in systems for emergency supply or for balancing storage to reduce energy costs. Pipes may contain flow-control devices, such as regulating or pressure-reducing valves. The purpose of a distribution system is to supply the system's users with the amount of water demanded under adequate pressure for various loading conditions. A loading condition is a spatial pattern of demands that defines the users' flow requirements. The flow rate in individual pipes results from the loading condition and is one variable that describes the networks hydraulic condition. The piezometric and pressure heads are other descriptive variables.

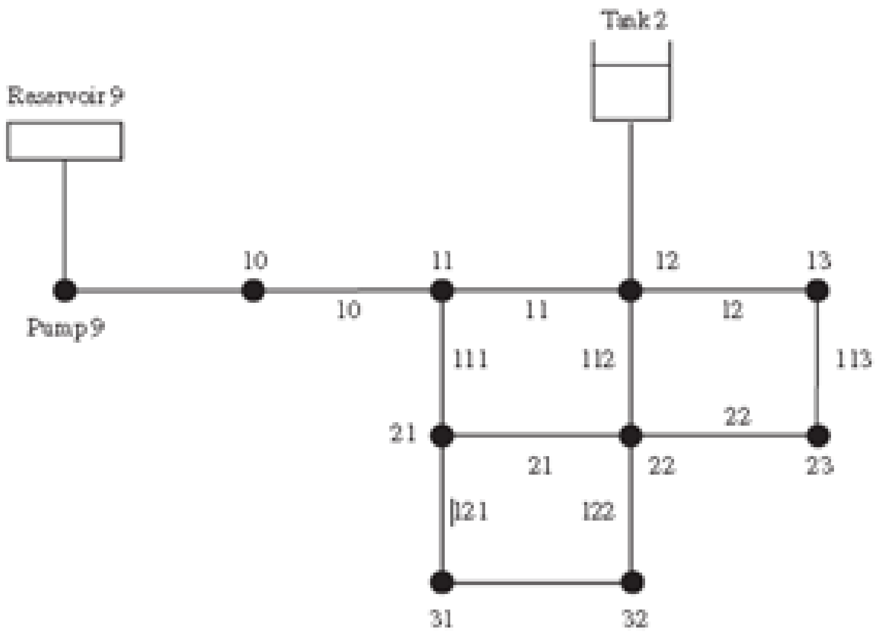

Figure -2 Network scheme

2.9 Sewerage systems and sewerage treatment systems

Sewerage system, network of pipes, pumps, and force mains for the collection of wastewater, or sewage, from a community. Modern sewerage systems fall under two categories: domestic and industrial sewers and storm sewers.

The difference between sewage and sewerage

- Sewage is the waste matter carried off by sewer drains and pipes. Sewerage refers to the physical facilities (e.g., pipes, lift stations, and treatment and disposal facilities) through which sewage flows.

Self-Check -2	Written Test

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

1. List and disuse the major types of water pollution?
2. Disuse the use of water in home?
3. What is the range of water and waste water systems?

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

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

Score = ___________

Rating: ____________

Answer sheet

Name: _________________________ Date: _______________

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Information Sheet-3	Explaining and exploring Community's use of water deliver services

3.1 community’s Water resources and use

Ethiopia has 12 river basins with an annual runoff volume of 122 billion m3 of water and an estimated 2.6 - 6.5 billion m3 of ground water potential. This corresponds to an average of 1,575 m3 of physically available water per person per year, a relatively large volume. However, due to large spatial and temporal variations in rainfall and lack of storage, water is often not available where and when needed. Only about 3% of water resources are used, of which only about 11% (0.3% of the total) is used for domestic water supply.

The capital Addis Ababa's main source of drinking water is the Gafsara dam built during the Italian occupation and rehabilitated in 2009. Wells and another dam complement the supply.The great majority of the rural community water supply relies on groundwater through shallow wells, deep wells and springs. People who have no access to improved supply usually obtain water from rivers, unprotected springs and hand-dug wells. Well, rivers and springs can be contaminated and can cause waterborne diseases. Rainwater harvesting is also common.

3.2. Access

The number of people lacking access to "improved" water in 2015 was 42 million. Regarding sanitation, progress has been slower and there were still 71 million people without access to "improved" sanitation, in 2015. According to data from the Joint Monitoring Programme for Water Supply and Sanitation of WHO and UNICEF, which are in turn based on data from various national surveys including the 2005 Ethiopia Demographic and Health Survey (DHS), access to an improved water source and improved sanitation was estimated as follows in 2008:

- 38% for improved water supply (98% for urban areas and 26% for rural areas)
- 12% for improved sanitation (29% in urban areas, 8% in rural areas)
- According to figures used by the Ministry of Finance and Economic Development for planning purposes, however, access was much higher.
- In 2010, access to drinking water was estimated at 68.5%: 91.5% in urban areas (within 0.5 km) and 65.8% in rural areas (within 1.5 km). The higher figure for rural areas may be because the distance to an improved water source used in

this definition is higher than the distance used by the Demographic and Health Survey.

- In communities that lack access to an improved water source, women bear the brunt of the burden of collecting water.

3.2. Policy and regulation

There is strong national water supply and sanitation policies and key agencies have clear roles and strategies. National policies are set by the Ministry of Water and Energy (MWE), formerly the Ministry of Water Resources (MWR), for water supply, and by the Ministry of Health for sanitation.

In 2006 the government adopted a Universal Access Plan (UAP) to achieve 98% access for rural water supply and 100% access for urban water supply and sanitation by 2012. Its cost was estimated at US$2.5bn. During the first phase until 2012 the focus is on affordable and appropriate technologies, with the following service standards:

Table 1 service standards

Setting	Per capita consumption	Service radius
Rural	15 liter/capita/day	1.5 km
Urban	20 liter/capita/day	0.5 km

Self-Check 3	Written Test

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

1. Mention the access to drinking water at rural and urban in 2010(5pt)
2. List the rural community water supply sources.(5pt)

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

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

Score = ___________

Rating: ____________

Answer sheet

Name: _________________________ Date: _______________

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Information Sheet-4	Reviewing and assessing of strategies to ensure long term water sustainability

4.1 Introduction to sustainability

Definition: sustainability can be defined as forms of progress that meet the needs of the present without compromising the ability of future generations to meet their needs. Sustainability is the ability to maintain a certain status or process in existing systems. It generally refers to the property of being sustainable.

4.2. Strategies

Strategies may include water conservation, including:

1. Water saver fittings and fixtures
2. Behavioral change
3. Water rationing strategies
4. Water recycling and re-use
5. Water treatment and re-use
6. Third pipe systems
7. Improved catchment and storage
8. Effective and efficient use of irrigation water
9. Appropriate drainage provision
10. Control and monitor drain runoff

4.3. Water Usage Reduction Strategies

Some of the more common ways to control residential water usage is through plumbing codes, public policy, and consumer awareness.

Amendments in an effort to make sure that water wise conservation measures will be implemented that will reduce demands on the water resources available to the city in an effort to help the economy and residents prosper. Some of the techniques mentioned in the amendments include: proof of compliance with minimum water conservation measures, compliance with major renovation or improvement, transfer of title conservation inspection, and the replacement of all high volume flow fixtures with low flow fixture.

Atlanta posted 9 water-saving tips. These public awareness tips include:-

- take short showers
- collect shower water to use on outdoor plants

- turn off the water while you brush your teeth
- don't use the toilet as a trash receptacle
- upgrade water fixtures to low flow
- hand wash your dishes
- upgrade water using appliance and
- Use the disposal sparingly.

4.4. Grey water

Grey water is household wastewater that has not come into contact with toilet waste. It comes from the bath, shower, bathroom wash basins, washing machines, and laundry trough. Wastewater from the kitchen sink and dishwasher should not be reused, as these can contain heavy loads of organic material, fats and caustic additives. Western Australia is experiencing water restrictions due to current drought conditions and the critically low levels of surface water storage. It is recognized that in times such as these many householders like to conserve water by reusing their grey water. This site will hopefully provide some guidance on how grey water can be reused for watering gardens, trees and lawns.

Grey water reuse:-Grey water from the bath, laundry trough and hand basin is the most readily available sources of grey water that can be reused. By using a bucket, grey water can be collected and supplied to the garden and or lawn areas. Alternatively, a number of systems are now available which permit grey water to be spread through an interconnecting subsurface trench system to water your trees. If the house is serviced by reticulated sewerage, it is important not to reuse all the grey water from the household. Some grey water is needed to help flush sewer pipes to prevent blockages.

4.5. Installation of domestic grey water treatment

Several devices are available commercially that dispense appropriate amounts of iodine or chlorine (in solid or liquid form) to a water system. In a settling tank, solids and large particles will settle to the bottom, while grease, oils, and small particles will float. The remaining liquid will be reused. A settling tank also allows hot water to cool before reuse.

NOTE: In general ,Grey water recycling system includes process of collecting Grey water, removing the large suspended particles / debris, aeration or freshening, filtration and 'polishing' to get it to Class A standard, which is required for indoor home usage.

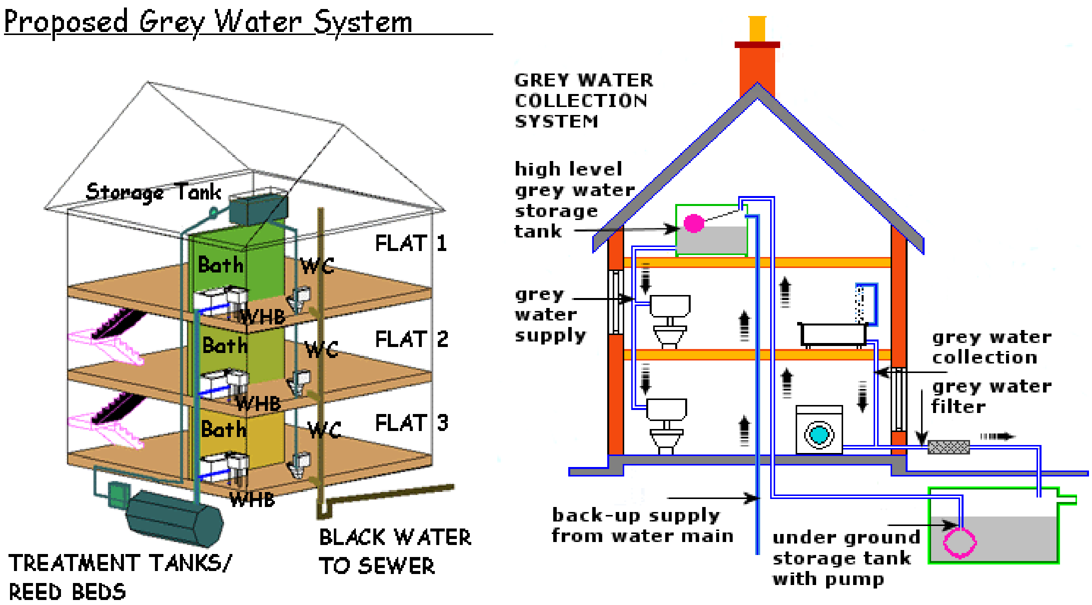

Figure-3: Proposed grey water system

4.6 Harvesting and reuse of storm water and roof water

Harvesting roof water and urban storm water for safe reuse has many potential benefits. It can help to reduce the impact of urban development on water quality and stream flow, and can also help to meet water conservation objectives. These potential benefits are important to the economic and environmental viability of many roof water and storm water reuse projects. Roof water and storm water reuse schemes are commonly used in water sensitive design strategies for new urban developments.

Roof water harvesting generally involves installing rainwater tanks to collect roof water from residential dwellings for uses such as garden watering and toilet flushing. Storm water Harvesting and Reuse demand for harvesting roof water from larger buildings, such as community halls, schools and commercial premises. Storm water harvesting involves collecting runoff from drains or creeks, and represents a relatively new form of water reuse compared to rainwater tanks and the reuse of effluent from sewage treatment plants. Roof water and storm water should be harvested in a way that minimizes health and environmental risks, or at least reduces such risks to acceptable levels. Storm water may contain chemicals and disease-causing microorganisms (pathogens).

Self-Check -4	Written Test

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

1. Define the term sustainability of water usage? (1 points)

2, Write down the common ways used to control residential water usage?(3 points)

3, why we use grey water? (2 points)

4, what is the benefit of roof water harvesting & urban storm water?(2 points)

5, what is the difference between roof water & urban storm water? (2 points)

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

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

Score = ___________

Rating: ____________

Answer sheet

Name: _________________________ Date: _______________

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5_______________

Instruction Sheet	Learning Guide -26: Assess the factors affecting water quality

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

- Reviewing and understanding of legislative, regulatory and licensing requirements
- Identifying required standards and characteristics for drinking water
- Assessing Quantity and quality of Irrigation water
- Conducting of simple tests for assessment of water quality
- Identifying and assessment of environmental risks and impacts to water services
- Identifying organizational procedures for maintenance of water quality
- Water quality performance indicators

This guide will also assist you to attain the learning outcome stated in the cover page. Specificity, upon completion of this Learning Guide, you will be able to understand &work:-

- Review and understand of legislative, regulatory and licensing requirements
- Identify required standards and characteristics for drinking water
- Assessing Quantity and quality of Irrigation water
- Conduct for simple tests assessing water quality.
- Environmental risks and impacts to water services are identified and assessed.
- Organizational procedures are identified for maintaining water quality.

Learning Instructions:

1. Read the objectives of this Learning Guide.
2. Read the information written in the "Information Sheet 1".2,3,4&5 Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
3. Accomplish the "Self-check 1".2,4,&5
4. Submit your accomplished Self-check. This will form part of your training portfolio.

1.1 legislative, regulatory and licensing requirements

The federal government will be responsible for establishing over all guiding policy and legislative frame works for the drinking water sector at the national level and be responsible for special initiatives and allocation of special fund to ensure coverage in underserved and disadvantaged areas. To focus on the role of the state as both a service provider and regulator to ensure that water quality standards are properly articulated, maintained and enforced.

The provincial and area government will be responsible for establishing policy guidelines and legislation for the drinking water sector at the provincial level. The provincial government will be also responsible for determining the institutional responsibility at the provincial level for the water sector. The institutional roles and responsibilities for water supply will be clearly stated and assigned in keeping with the human, finical and technical capacity of those institutions.

Ministry of water resources is responsible for formulating policies for the water sectors at national level, for long term planning strategies, the setting of generic standards and for the coordination of projects and their funding together with liaising with foreign donor agencies. It is also responsible for legislation with regard to utilization and protection of water resources as well as the allocation of water between regional governments. It takes an active role in the sector planning in a generic term. It also provides technical assistance and advice up on request to the regional governments of the country.

Ministry of water Resources prepared water resources management policy of Ethiopia. The overall goal of the policy is to enable and promote all national efforts towards the efficient, equitable and optimum utilization of the available water resources of Ethiopia for significant socioeconomic development on sustainable basis.

1.2. Legislative, regulatory and licensing requirements

Legislative, regulatory and licensing requirements will include:

- Relevant federal and state or territory legislation and regulations
- Codes of practice, associated standards and guidance material
- Documented organizational policies, manuals and induction programs

- Relevant community planning and development agreements, such as land care agreements

Self-Check -1	Written Test

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

1. Disuse who is responsible for formulating policies for the water sectors at national level
2. Disuse who prepared water resources management policy of Ethiopia

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

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

Score = ___________

Rating: ____________

Answer sheet

Name: _________________________ Date: _______________

1_______________

2_______________

Information Sheet-2	Identification of required standards and characteristics for drinking water

2.1 standards and characteristics for drinking water

The quality of the drinking water that enters your home is affected by several things. When you understand the various elements that lead to unhealthy and unsafe drinking water, then you can start to take measures to improve your family's health. In some cases, it requires more than just a filter to clean tap water. Some issues may force people to boil water before they can drink it. Becoming familiar with the various issues that surround water quality will help you to take the appropriate actions.

2.2. Water quality characteristics

Water quality characteristics divided into three main classes:

- Physical characteristics
- Chemical characteristics
- Biological characteristics

I. Physical characteristics: are

- Temperature- temperature of drinking water is best in the range 7-11OC.
- Turbidity- is the amount of suspended particles in water. It is given by the unit called Nephelometric Turbidity Units (NTU). according to WHO guideline turbidity of drinking water should not be more than 5NTU
- Color- indicates the presence of organic matter from natural and manmade sources.
- Taste- drinking water should not have bad taste. Pleasant taste of water is due to dissolved oxygen.
- Odor- drinking water should be odorless.

II. Chemical characteristics:

- TDS and Conductivity: indicate the extent of dissolved ionic and non-ionic species in water. Conductivity is expresses in S/cm.
- pH- is the measure of acidity and alkalinity of water. pH of drinking water should be from 6.5 to 8.5.
- Hardness- is due to dissolved calcium and magnesium ions. Two types of hardness are there- temporary hardness and permanent hardness. Hardness in water causes scale formation in pipes and house utensils. It is given in mg/L as CaCO3.

- Major cations- are Na^+, K^+, Ca^{2+}, Mg^{2+}.
- Major anions- are F^-, Cl^-, SO_4^{2-} , HCO_3^-. High fluoride (F^-) in drinking water causes health effect called tooth fluoresis and bone fluoresis. According to WHO guideline fluoride in drinking water should not be more than 1.5mg/L.
- Heavy metals- cadmium (Cd), lead(Pb), zinc(Zn), copper(Cu), iron(Fe), manganese (Mn). These have different health effects if they exist in high amount in drinking water.

III. Biological characteristics: also called bacteriological characteristics. These include bacteria, virus, protozoa and worms. They cause waterborne diseases. Generally microorganisms in water are classified as coli forms. Two types of coli forms are there in water- total coli form and fecal coli form. Total coli forms are collection of all microorganisms (both harmful and harmless). Fecal coliforms are harmful ones. They are measured in water by the method called membrane filtration.

Sample of water is filtered by a membrane (filter paper) with pore sixe 0.45µm and put in a dish with growth media and incubated for 14-16 hours. For total coliform temperature of incubator is set at 37°C and for fecal coliform at 44°C.

2.3. Standards

In the setting of standards, agencies make political and technical/scientific decisions about how the water will be used. In the case of natural water bodies, they also make some reasonable estimate of pristine conditions. Different uses raise different concerns and therefore different standards are considered. Natural water bodies will vary in response to environmental conditions.

Environmental scientists work to understand how these systems function, which in turn helps to identify the sources and fates of contaminants. Environmental lawyers and policymakers work to define legislation with the intention that water is maintained at an appropriate quality for its identified use. The vast majority of surface water on the planet is neither potable nor toxic. This remains true even if seawater in the oceans (which is too salty to drink) is not counted. Another general perception of water quality is that of a simple property that tells whether water is polluted or not. In fact, water quality is a complex subject, in part because water is a complex medium intrinsically tied to the ecology of the Earth.

Industrial and commercial activities (e.g. manufacturing, mining, construction, transport) are a major cause of water pollution as are runoff from agricultural areas, urban runoff and discharge of treated and untreated sewage.

Table 1 major cause of water pollution

Element/ substance	Symbol/ formula	Normally found in fresh water/surface water/ground water	Health based guideline by the WHO
Aluminum	Al		0,2 mg/l
Ammonia	NH4	< 0,2 mg/l (up to 0,3	No guideline
Antimony	Sb	< 4 μg/l	0.005 mg/l
Arsenic	As		0,01 mg/l
Asbestos			No guideline
Barium	Ba		0,3 mg/l
Berillium	Be	< 1 μg/l	No guideline
Boron	B	< 1 mg/l	0,3 mg/l
Cadmium	Cd	< 1 μg/l	0,003 mg/l
Chloride	Cl		250 mg/l
Chromium	Cr+3, Cr+6	< 2 μg/l	0,05 mg/l
Colour			Not mentioned
Copper	Cu		2 mg/l
Cyanide	CN-		0,07 mg/l
Dissolved oxygen	O2		No guideline
Fluoride	F	< 1,5 mg/l (up to 10)	1,5 mg/l
Hardness	mg/l CaCO3		No guideline
Hydrogen sulfide	H2S		No guideline
Iron	Fe	0,5 - 50 mg/l	No guideline
Lead	Pb		0,01 mg/l
Manganese	Mn		0,5 mg/l
Mercury	Hg	< 0,5 μg/l	0,001 mg/l
Molybdenum	Mb	< 0,01 mg/l	0,07 mg/l
Nickel	Ni	< 0,02 mg/l	0,02 mg/l

Nitrate and nitrite	NO3, NO2		50 mg/l total nitrogen
Turbidity			Not mentioned
pH			No guideline
Selenium	Se	< < 0,01 mg/l	0,01 mg/l
Silver	Ag	5 – 50 µg/l	No guideline
Sodium	Na	< 20 mg/l	200 mg/l
Sulfate	SO4		500 mg/l
Inorganic tin	Sn		No guideline
TDS			No guideline
Uranium	U		1,4 mg/l
Zinc	Zn		3 mg/l

Table. 2 DRINKING WATER STANDARDS (REQUIREMENT)

s.no.	characteristics	Normally acceptable value	Max. permissible limit
1.	Temperature	10°C – 15°C	-
2.	Turbidity (N.T.U)	2.5	10
3	Colour (platinum cobalt scale)	5.0	25
4	Taste and odour	Unobjectionable	
5.	PH	7.0-8.5	6.5-9.2
6.	Total dissolved solids(mg/litre)	500	1500
7.	Total hardness mg/l (as caco3)	200	600
8.	Chlorides (as Cl) mg/l	200	1000
9.	Sulphate (as So4) mg/l	200	400
10.	Nitrates (as No3) mg/l	45	45
11	Fluorides (as F) mg/l	1.0	1.5
12	Calcium (as Ca) mg/l	75	200
13	Magnesium (as mg) mg/	l 30-120	150
14	Iron (as Fe) mg/l	0.1	1.0
15	Manganese (As Mn) mg/l	0.05	0.5
16	Phenolic compounds(as phenol) mg/l	0.001	0.002
17	Arsenic (as mg) mg/l	0.05	0.05
18	Chromium (as cr+6) mg/l	0.05	0.05
19	Cynamides (as CN) mg/l	0.05	0.05
20	Coliform count per 100ml of water sample	Zero	-

Self-Check 2	Written Test

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

- why drinking water to be odorless?(2 points)
- Define the term Turbidity? (2 points)
- What is the reason to create waterborne diseases? (2 points)
- Indicate the extent of dissolved ionic and non-ionic species in water? (1 points)
- What are the major causes of water pollution? (3 points)

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

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

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

1.____

2.____

3.____

4.____

5.____

Information Sheet -3	Assessing Quantity and quality of Irrigation water

3.1. Introduction

Water quality influences its suitability for a particular use, i.e. how well the quality fulfills the requirement of the user. Water quality deals with the physical, chemical and biological characteristics of water in relation to all other hydrological properties. For example, river water having good quality with sediment load can be applied for irrigation successfully but may be objectionable for municipal use without treatment. Similarly, snowmelt water is acceptable for municipal purpose and may not be applicable for industrial due to its corrosion potential.

The characteristics of water quality have become important in water resources planning and development for drinking, industrial and irrigation purposes . Water quality is the basic to judge the fitness of water for its proposed application for existing conditions. The current information is required, provided by water quality monitor for optimum development and management of water for its proficient uses.

- The evaluation of quality of water resulted to find out the causes, relationship and effects among water constituents and level of acceptability.
- Certain constituents emerge as indicators of quality-related problems with sufficient reported experiences and measured responses (FAO, 2013).

3.2. Major Concern of irrigation

The major concerns in terms of water quality and quantity are due to its inadequate distribution on the surface of earth and the rapid declining of fresh useable water . The possible contamination in water included organic matter, nutrients, suspended solids, heavy metals, pesticides and industrial chemicals. Anthropogenic activities within river basins, erosion, and atmospheric depositions were also the main negative impacts on the water quality of most the reservoirs .

The salinity of soil is also important factor for the determination of water quality. Soil salinity is developed when soil becomes more salty as a result of water movement in the soil especially due to irrigation. Water quality is critical for the survival of humans, animals, industry and agriculture. Furthermore, the proper management is requisite to meet water quality standards and for ecosystem health. The agriculture success is highly dependable on the quality of water applied in an agriculture area. Due to the application of poor or hazardous quality water the agriculture land/soil is affected and damages the crop yield in several ways. The accumulation of salts in root zone, limited the availability of water and plant can take up lesser water which resulted in high plant stress and decreased crop yields . The presence of metals in irrigation water also has adverse effects on crop production. Also, high concentration of salts can change the plant nutrients balance in the soil meanwhile some salts are toxic to certain plants . It is also notable that most of the normal plants tolerate wide range of salt but pasture plants are not highly salt-tolerant and would finally die out under saline conditions.

The physical and chemical properties of soil are also affected by salinity that leads in soil loss in term of surface soil compaction and erosion. Salinity also dehydrates the soil bacteria and fungi and reduces soil health. These microorganisms are useful for the formation of organic matter and nutrient recycling. Irrigation water quality is described by different parameters such as Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Residual Sodium Carbonate (RSC)

Self-Check 3	Written Test

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

1.------is deals with the physical, chemical and biological characteristics of water in relation to all other hydrological properties

A. water quantity   B. water quality   C. water pollution   D.None

2. The physical and chemical properties of soil are also affected by

A. salinity   B. Water quality   C. water quantity   D. None

3. Irrigation water quality is described by

A. Electrical conductivity (EC),   B. Total Dissolved Solids (TDS)

C. Residual Sodium Carbonate (RSC)   D.All

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

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

Score = ___________

Rating: ____________

Name: _________________________ Date: ________________

Short Answer Questions

1.____

2.____

3.____

Information Sheet -4	Conducting of simple tests for assessment of water quality

4.1 Conducting water Sampling

Two water samples were collected for analyzing the irrigation water to determine its quality; one from the bore-hole water and another from the adjacent River which is a surface source of irrigation water. The water samples were collected on the 12th of July 2012 to coincide with peak periods of irrigation in the scheme. For the borehole sample, two litres of water were collected from the main irrigation line from the borehole in the fields to represent the water that is actually used for irrigation. The water samples were sent for analysis at the Soils and Chemistry Research Institute in Harare. The water samples were analyzed for pH, EC, Ca2+, Mg2+, Na+, 3HCO− and Cl−.

The quality of the water and the soil were assessed using SAR and ESP, calculated from ionic concentrations of Na+, Ca2+, Mg2+ and CEC.

Steps and Procedures for check up and ensure of water quality testing results

4.2. Hydrostatic Testing

General:

- Conduct tests on each line or valued section of line.
- Tapping sleeves are to be tested at 150 psi for a minimum of 15 minutes prior to making tap. No leakage is allowed.
- Clean and flush line of dirt and foreign material. The Contractor shall be responsible for the cost of the water used for flushing if it is obtained from District sources. In lieu of metering, the Contractor may pay an amount equal to normal District rates using ten (10) times the volume of the entire new water system.
- Do not perform hydrostatic tests until at least five days after installation of concrete thrust blocking.
- Test pressures shall be 150 psi based on the elevation of the lowest point of the section under test and corrected to the elevation of the test gauge.
- Tests are to be conducted in the presence of a representative of the District.

4.3. Pressure tests:

After the pipe is laid, the joints completed, fire hydrants permanently installed and the trench backfilled, subject the newly laid pipe and valved sections to a hydrostatic pressure of 150 psi.Open and close each valve within the section being tested several times during the test period. Replace cracked pipe, defective pipe, and cracked or defective joints, fittings and valves with new material and repeat the test until results are satisfactory.

4.4. Leakage test:

a. Conduct leakage test after the pressure test has been satisfactorily completed.

b. Duration of each leakage test: at least two hours.

c. Pressure and leakage tests must be conducted in accordance with the rules and regulations. The pressure must be at least 1.5 times the maximum working pressure and the duration of this test must be at least two (2) hours.

1) All visible leaks shall be repaired regardless of the amount of leakage.

2) Should any test of pipe disclose leakage greater than that specified above, locate and repair the defective joint or joints until the leakage is within the specified allowance.

4.5.Disinfection

General:

a. Upon completion of testing, disinfect all water lines.

b. Newly laid valves or other appurtenances shall be operated several times while line is filled with chlorinating agent.

c. Should initial treatment fail to meet results specified, repeat procedures until satisfactory results are obtained?

Procedure:

- Flush line to extent possible with available pressure and outlets, prior to disinfection.

Hydrant openings required to produce proper flushing velocity at 40 psi are:

Pipe Size (Inches) Hydrant Openings

4 through 12 one 2½”

14 through 18 two 2½”

20 one 4½”

- Apply chlorine as liquid chlorine and chlorine compound such as calcium hypochlorite with known chlorine content.
- Apply through corporation cock in top of main, at beginning of section being sterilized.
- Use proper feeder and flow regulator to introduce chlorinating agent.
- Application rate shall be not less than 50 ppm.

- Retain chlorinated water in main not less than 24 hours.
- At end of retention period, at least 10 ppm of chlorine shall remain in the
- Water at the extreme end of section.
- De-chlorinate and flush line thoroughly.

Acceptance:

A. Provide two separate samples for each sample location, taken at 24- hour intervals, free of coliform bacteria.

1) Contractor to take first and second samples delivers to the concerned authority laboratory for testing.

2) The first and second sample results shall include the free chlorine residual at the time the samples were collected.

3) Notify concerned technician/chemist to take a third sample.

B. At a minimum, sample locations shall be as required by the authority and the following:

1) The tie-in location of new and existing water lines.

2) The end of all dead end lines.

3) At intervals of no more than 1,200 feet for all new lines longer than 1,200 feet in length.

c. All sample locations are to be given an identifying label and a corresponding identification label is to be included on the record drawings indicting each sample location.

d. Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non-detectable in those systems not chlorinating.

e. If the membrane filter method of analysis is used for the coliform analysis, non-coliform growth must also be reported.

f. If the non-coliform growth is greater than eighty (80) colonies per one hundred (100) milliliters, the sample result is invalid and must be repeated.

R. De-chlorination of Chlorinated Disinfection Water

1. De-chlorinate the chlorinated water used for disinfected water lines to meet requirements of the authority.

S. Notice of Construction Activity

1. Immediately prior to the beginning of construction the “Notice of Construction Activity” form should be prepared and mailed to the District Representative with a copy mailed to the District’s Engineering Representative.

T. Cross Connection Control (Backflow Prevention Devices):

1. There shall be no connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby unsafe water or other contamination materials may be discharged or drawn into the system.

2. No by-passes shall be allowed, unless the bypass is also equipped with an equal, approved back-flow prevention device.

3. High hazard category cross connections shall require an air gap separation or an approved reduced pressure backflow preventer.

4. Reduced pressure principal backflow prevention assemblies shall not be installed in any area location subject to possible flooding. This includes pits or vaults which are not provided with a gravity drain to the ground's surface that is capable of exceeding the discharge rate of the relief valve. Generally, if installed in a pit, the drain line shall be 2 times the size of the line entering the backflow prevention device. The drain cannot empty into any type of ditch, storm drain, or sewer, which could flood water back into the pit.

5. All piping up to the inlet of the backflow prevention device must be suitable for potable water. The pipe must be approved by the concerned authority. Black steel pipe cannot be used on the inlet side of the device.

6. Fire line sprinkler systems and dedicated fire lines, except those in the high hazard category shall be protected by an approved double check valve assembly

4.6. Sampling for Quality of Water

The agency operating the water supply system is charged with the primary responsibility of ensuring that the water supplied to the consumer is of an appropriate quality. To achieve this objective it is necessary that the physical, chemical and bacteriological tests are carried out at frequent intervals. Samples should be taken at different points on each occasion to enable overall assessment. In the event of epidemic or danger of pollution more frequent sampling may be required, especially for bacteriological quality.

For each distribution system a monitoring programme has to be prepared showing the location of sampling points. Based on historic records of a system it will be possible for the manager of the system to decide locations for bacteriological sampling and residual chlorine testing. Possible water quality problems and causes and remedies are given in Table below. Table on Water Quality Problems, Causes and Remedies

Table-4: Water quality parameters cause and remedies

S. No.	Problem	Possible Cause	Suggested remedies
1.	Taste and Odour	High chlorine residual.	Lower chlorine dosage
		Biological growth or microorganisms in dead ends and reservoir.	Chlorinate, flush mains and clean the reservoir
2.	Turbidity	Silt or clay in suspension.	Flushing or proper operation of WTP
		Microorganisms	Same as above
		Floc carryover	Same as above
3.	Colour	Decay of vegetable matter	Chlorination
		Microscopic organisms	Chlorination
4.	Positive coliform results	Contamination in distribution system	Locate and remove source of contamination
		Cross connection	Install backflow prevention such as double reflex valves
		Negative pressure	Maintain positive pressure after disinfection
		Improper disinfection	Improve chlorination process

Self-Check 4	Written Test

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

1, why drinking water to be odorless?(2 points)

2, Define the term Turbidity? (2 points)

3, what is the reason to create waterborne diseases? (2 points)

4, Indicate the extent of dissolved ionic and non-ionic species in water? (1 points)

5, What are the major causes of water pollution? (3 points

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

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

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

1.____

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Information Sheet -5	Identification and assessment of environmental risks and impacts to water services

5.1 Environmental impacts of irrigation

The Environmental impacts of irrigation relate to the changes in quantity and quality of soil and water as a result of irrigation and the effects on natural and social conditions in the river basin and downstream of an irrigation scheme. The impacts stem from the altered hydrological conditions caused by the installation and operation of the irrigation scheme.

5.2. Enviromental risk and impacts

Environmental risks and impacts may include:

1. Impact of mismanagement of chemicals
2. Impact of mismanagement of biological agents
3. Detrimental impact on limited water resource
4. Spillage
5. Waste disposal
6. Detrimental impact on urban and non-urban water catchment areas
7. Detrimental impact on rivers, waterways and channels
8. Unsatisfactory water and wastewater treatment processes
9. Unsatisfactory trade waste treatment and disposal processes
10. Poor construction processes

5.2.1 Direct Effects

An irrigation scheme draws water from groundwater, river or lake and distributes it over an irrigated area. Hydrological, or direct, effects of doing this include reduction in downstream river flow, increased evaporation in the irrigated area, increased level in the water table as groundwater recharge in the area is increased and flow increased in the irrigated area.

5.2.2 Indirect Effects

Indirect effects are those that have consequences that take longer to develop and may also be longer-lasting. The indirect effects of irrigation include the following:

- Water logging
- Soil Stalinization
- Ecological damage
- Socioeconomic impacts

The indirect effects of water logging and soil Stalinization occur directly on the land being irrigated. The ecological and socioeconomic consequences take longer to happen but can be more far-reaching.Some irrigation schemes use water wells for irrigation. As a result, the overall water level decreases. This may cause water mining, land/soil subsidence, and, along the coast, saltwater intrusion.

Irrigated land area worldwide occupies about 16% of the total agricultural area and the crop yield of irrigated land is roughly 40% of the total yield. In other words, irrigated land produces 2.5 times more product than non-irrigated land. This article will discuss some of the environmental and socioeconomic impacts of irrigation.

5.2.3. Adverse impacts

Reduced river flow

The reduced downstream river flow may cause:

- Reduced downstream flooding
- Disappearance of ecologically and economically important wetlands or flood forests
- Reduced availability of industrial, municipal, household, and drinking water
- Reduced shipping routes. Water withdrawal poses a serious threat to the Ganges. In India, barrages control all of the tributaries to the Ganges and divert roughly 60 percent of river flow to irrigation

5.3. Reduced fishing opportunities.

Reduced discharge into the sea, which may have various consequences like coastal erosion. This illustrates an environmental impact of upstream irrigation developments causing an increased flow of groundwater to this lower lying area leading to the adverse conditions. The increased groundwater recharge stems from the unavoidable deep percolation losses occurring in the irrigation scheme.

The lower the irrigation efficiency, the higher the losses Although fairly high irrigation efficiencies of 70% or more (i.e. losses of 30% or less) can be obtained with sophisticated techniques like sprinkler irrigation and drip irrigation, or by precision land leveling for surface irrigation, in practice the losses are commonly in the order of 40 to 60%. This may cause:

5.3.1. Rising water tables,

Increased storage of groundwater that may be used for irrigation, municipal, household and drinking water by pumping from wells,

1. Water logging and drainage problems in villages, agricultural lands, and along roads with mostly negative consequences. The increased level of the water table can lead to reduced agricultural production.
2. shallow water tables are a sign that the aquifer is unable to cope with the groundwater recharge stemming from the deep percolation losses,
3. Where water tables are shallow, the irrigation applications are reduced. As a result, the soil is no longer leached and soil salinity problems develop,
4. Stagnant water tables at the soil surface are known to increase the incidence of water borne diseases like malaria, , yellow fever, dengue, and schistosomiasis (Bilharzia) in many areas. Health costs, appraisals of health impacts and mitigation measures are rarely part of irrigation projects, if at all.
5. to mitigate the adverse effects of shallow water tables and soil Stalinization, some form of water table control, soil salinity control, drainage and drainage system is needed.

As drainage water moves through the soil profile it may dissolve nutrients (either fertilizer-based or naturally occurring) such as nitrates, leading to a built up of those nutrients in the ground water aquifer. High nitrate levels in drinking water can be harmful to humans particularly for infants under 6 months where it is linked to 'blue-baby syndrome.

5.3.2.Reduced downstream river water quality

Owing to drainage of surface and groundwater in the project area, which waters may be Stalinized and polluted by agricultural chemicals like biocides and fertilizers, the quality of the river water below the project area can deteriorate, which makes it less fit for industrial, municipal and household use. It may lead to reduced public health.

1. Polluted river water entering the sea may adversely affect the ecology along the sea shore. Water becomes scarce for nomadic pastoralist in Baluchistan due to new irrigation developments
2. Downstream water users often have no legal water rights and may fall victim of the development of irrigation.
3. Pastoralists and nomadic tribes may find their land and water resources blocked by new irrigation developments without having a legal recourse.
4. Flood-recession cropping may be seriously affected by the upstream interception of river water for irrigation purposes.

5.3.3. Lost land use opportunities

Irrigation projects may reduce the fishing opportunities of the original population and the grazing opportunities for cattle. The livestock pressure on the remaining lands may increase considerably, because the ousted traditional pastoralist tribes will have to find their subsistence and existence elsewhere, overgrazing may increase, followed by serious soil erosion and the loss of natural resources.

5.3.4. Flooding as a consequence of land subsidence

When more groundwater is pumped from wells than replenished, storage of water in the aquifer is being mined. Irrigation from groundwater is no longer sustainable then. The result can be abandoning of irrigated agriculture.

5.3.5. Simulation and prediction

The effects of irrigation on water table, soil salinity and salinity of drainage and groundwater, and the effects of mitigation measures can be simulated and predicted using agro-hydro-salinity reduced downstream drainage and groundwater quality

- The downstream drainage water quality may deteriorate owing to leaching of salts, nutrients, herbicides and pesticides with high salinity and alkalinity. There is threat of soils converting into saline or alkali soils. This may negatively affect the health of the population at the tail-end of the river basin and downstream of the irrigation scheme, as well as the ecological balance. The Aral Sea, for example, is seriously polluted by drainage water.
- The downstream quality of the groundwater may deteriorate in a similar way as the downstream drainage water and have similar consequences

5.4. Mitigation of adverse effects

Irrigation can have variety negative impacts on ecology and socio economy, which may be mitigated in a number of ways. These include siting the irrigation project on a site which minimizes negative impacts. The efficiency of existing projects can be improved and existing degraded croplands can be improved rather than establishing a new irrigation project

Developing small-scale, individually owned irrigation systems as an alternative to large scale publicly owned and managed schemes. The use of sprinkler irrigation and micro-irrigation systems decrease the risk of water logging and erosion Where practicable, using treated wastewater makes more water available to other users Maintaining flood flows downstream of the dams can ensure that an adequate area is flooded each year, supporting, amongst other objectives, fishery activities.

5.5. Delayed environmental impacts

It takes time for the prediction of how current irrigation schemes will impact the ecology and socio economy of a region. By the time predictions have come out, a considerable amount of time and resources may have already been expended in the carrying out of the current project. When that is the case, the project managers will often only change the project if the impact would be considerably more than they had originally expected.

There are different agents that affect the water quality, some of those are mentioned below:-

- Natural contaminants:-When it comes to discussing what factors affect water quality, natural contaminants are the ones which are completely outside our control. This includes contamination caused due to dried leaves, dead insects, bird droppings, animal feces reaching the natural sources of water.
- Agricultural contaminants:-These are the factors like agricultural runoffs, fertilizers, cleansers which reach the natural source of water and pollute it. Pesticides used on the crops also eventually seep down and contaminate the ground water.

5.6. Industrial contaminants

The list of what factors affect water quality will be incomplete without mentioning about industrial wastes being dumped directly in rivers. There are various hazardous chemicals which also pollute the ground water by seeping in along with rain water.

5.7. Microbial contaminants

These are the contaminants like bacteria, viruses, cysts which comfortably dwell in the old and rusty industrial pipes and when water travels through these pipes to reach your home, they get added to it. There are other contaminants like algae and traces of rust which also get added in similar manner.

5.8. Human added contaminants

Though this may sound strange but yes we too knowingly/unknowingly pollute the water. One way is what water companies do – add chlorine in water to prevent microbes but this is how knowingly chlorine gets added to the water. Later chlorine reacts with other organic contaminants to produce toxic by-product

- **Pollution**:-Air pollution and the act of dumping waste into the water supply can have devastating effects on the quality of your water. Air pollution mixes with the water in the atmosphere and can come down in the form of polluted rain. When this gets into the water supply, it can create a dangerous situation. Waste dumped into the water directly has obvious negative effects. Commercial filtration systems work hard to clean up polluted water, but it is not a perfect system.
- **Pipes**:- Over the last several years, municipalities spent billions of dollars replacing copper and iron pipes with safer conduits made of more durable materials.
- If your city or town still uses iron or copper pipes to move water underground, then that can create problems. Older iron and copper pipes begin to corrode and introduce potential toxins into your water.
- In many cases, iron or copper pollution in drinking water makes the water a brownish color, or you will see flakes in the water as it comes out of your faucet. Contact your local health authority for the proper advice on how to deal with this kind of situation.

Figure.2. Rural communities fetching unsafe water for their consumptions

5.9.How to Prevent Water Pollution

The best way to prevent water pollution is to not throw trash and other harmful chemicals into our water supplies. Here are a few more ways you can prevent water pollution:

- Wash your car far away from any storm water drains
- Don’t throw trash, chemicals or solvents into sewer drains
- Inspect your septic tank system every 3-5 years
- Avoid using pesticides and fertilizers that can run off into water systems
- Sweep your driveway instead of hosing it down
- Always pump your waste-holding tanks on your boat
- Use non-toxic cleaning materials
- Clean up oil and other liquid spills with kitty litter and sweet them up
- Don’t wash paint brushes in the sink

Self-Check 5	Written Test

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

1. How can agriculture affects water quality?(3 points)
2. Mention some of the natural contaminants which affect the quality of water? (2 points)
3. Which types of conduit pipes are recommended for water distribution system to minimize contamination of water? (2 point)
4. If you are one of water user (consumer) in your town or village, how can you prevent the contamination of your water source? (3 points)

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

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

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

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Information Sheet -6	Identification of organizational procedures for maintenance of water quality

6.1. procedures for maintenance of water quality

There are four fundamental strategies to combat water quality problems that can form the basis of policy solutions for improving water quality

- Prevention of pollution;
- Treatment of polluted water;
- Safe use of wastewater ;
- Restoration and protection of ecosystems.

6.2.Prevention of pollution: -

Pollution prevention strategies focus on the reduction or elimination of waste at the source. Prevention is widely regarded as the cheapest, easiest and most effective way to protect water quality. Furthermore, not only are there environmental benefits to preventing or reducing pollution, there may also be tremendous financial benefits, as generation of waste, especially from industrial and agricultural processes, is a demonstration of inefficient use of material and resources.

In industry, solution includes reformulating products so that they produce less pollution and require fewer resources (including water) during their manufacture. In agriculture, reducing the use of toxic material for pest control, nutrient application and overall water usage can reduce pollution. Examples of implementation of good agricultural practices include crop rotation, cover cropping, conservation agriculture, improved irrigation management and integrated pest management techniques. In human settlements, design (such as the type of materials used for construction), the location of industry and the handling of storm water, as well as reducing wastewater production.

6.3. Treatment of polluted water

In case where contaminants result from domestic, industrial or agricultural activities, wastewater must be treated before discharging. Treatment strategies for contaminated water range along a continuum from high-technology, energy-intensive approaches to low-technology, low-energy, biologically and ecologically focused approaches. Where good water distribution and treatment system are already in place, constant effort is needed to maintain and expand their effective operation. Nevertheless, many wastewater treatment facilities are not working due to deficient human, technical and financial resources for operation and maintenance. Poorly maintained or operated system can lead to degradation of even high-quality water before it reaches its point of use.

The appropriate treatment options depend on the circumstances and intended after use. For example, to supply drinking – water for larger settlements, modern multiple-stage water treatment plant are typically required. At the community level solutions may include solar stills, and smaller-scale filtration or disinfection plant. at the household level options include boiling , solar water disinfection mentioned may also be appropriate for treatment of water for industrial use, agricultural source water can, in some cases, be of much lower quality, especially where harmful contaminants that can accrue in soil and crops are absent.

Safe use of wastewater

Wastewater is usually disposed of into water bodies, ideally following treatment to render it environmentally safe. however, it can be safely used, sometimes even untreated, in circumstances where impacts on human health and the environment are well understood and all possible action is taken to eliminate risks .If well regulated, safe use of wastewater, for example in agriculture, can reduce the pressure exerted by human activities on existing freshwater resources and augment water supply in water-scarce and semi-arid zone and in rapidly growing per-urban settings.

Furthermore, wastewater can be a source of nutrients and, when properly managed, is potentially valuable for certain agricultural use, reducing the need for expensive chemical fertilizers. Additionally, agriculture may act as a form of biological treatment, removing nutrients from water that, otherwise, may pollute watercourses.

In peri-urban and rural areas, treated human wastewater can be a viable source of water for reuse. Ecological sanitation, for example, is a low –cost method of dealing with human waste promoted by many development agencies. it involves the separation of urine and faecal matter- sterile urine may be applied directly to plants, while faecal matter is composted until it is safe for land application . this approach has been implemented in several countries and regions , including China, India, Burkina Faso, Kenya, Niger, Sweden and part of eastern Europe , by recycling water and using dry pre-stored human wastes, jobs are created for local pollutions as well as market opportunities for provision of indigenous fertilizer and soil conditioners for agriculture.

Some industries, such as the food and processing industry, utilize large volume of water, and often also discharge considerable quantities of wastewater. In such instance, safe reuse of wastewater, as a component of cleaner production application, can improve water and energy efficiency and generate environmental benefits.

For example, industry can reuse wastewater from certain process in other application that do not require high-quality water, or apply appropriate technologies to process wastewater for procedures requiring water to higher quality. Example can be derived from Namibia and Singapore, where freshwater resources for both industrial and human consumption are supplemented with treated wastewater.

6.4.Restoration and protection of ecosystems

Healthy ecosystems provide water quality benefits in the form of water purification, often at far lower cost than subsequent engineered efforts to clean contaminated water .when water system, including watersheds, are adversely impacted by poor water quality, strategies to remediated pollution and restore systemic health and function s are important .Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. Strategies for freshwater restoration can be as straightforward as removing upstream dams and the restoration of rivers and wetland. One of the well-established approaches that can be used to deal

An eco-hydrological approach is based on the understanding of the interrelationships between ecological processes and the water cycle in a given catchment, and supports the role of ecosystem processes in water quality improvement. Linking this approach with social and economic capacities in a region by involving all users through a water shed management council is a foundation for system solution that incorporates environmental and social elements. Eco-hydrology can address water-related threats, such as reducing flood risk by increasing the retention capacity of the landscape , or by creating wetland that prevent pollutants from entering waterways . Examples of eco-hydrological approaches can be found worldwide, including in Iraq, Japan and Poland.

Given the costs and difficulty associated with restoration of degraded groundwater systems, and the frequent time lag between the discharge of contaminants and their impacts on groundwater reserves, prevention is the most cost effective and often the only feasible means to protect such systems. Groundwater system do not have efficient self-cleaning capacities, hence polluted groundwater is difficult and expensive to treat in situ. Because groundwater condition cannot be readily observed, it is critical to focus on appropriate monitoring of groundwater supply and quality.

Self-Check 6	Written Test

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

1, Write down the strategically policy to improved water quality? (3 points)

2, what are the methods to prevent pollution? (2 point)

3, why wastewater treatment facilities are not working properly? (2 points)

4, what is the advantage of reuse of wastewater? (2 point)

5, Define the term Ecological restoration? (1 point)

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

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

Score = ___________

Rating: ____________

Name: ________________________ Date: _______________

Short Answer Questions

1.____

2.____

3.____

4.____

5.____

Information Sheet 7	. Identifying organizational procedures for maintaining water quality

7.1. Maintaining water quality

Water of poor microbial quality can have a significant impact on the health of community members by causing disease and contributing to the spread of epidemics. Water quality should therefore be monitored on a regular basis. Ideally, it should be tested by staff working with local and national government in support of the Healthy Villages programme. The community should request that such support is given by the local authorities, particularly if it suspected that the community water supply is contaminated. The test results should be provided to the community and if any problems arise, the community should request recommendations for solutions.

7.1.1. Microbial quality

The major concern of microbiological testing is whether faces have contaminated the water supply, as most of the infectious water-related diseases, such as cholera and dysentery, are caused by faces contamination. Although these diseases can also be transmitted through poor hygiene and inadequate sanitation, control of drinking-water quality is one of the main ways of preventing their spread.

7.1.2. Sanitary inspection

An analysis of water quality usually also includes a sanitary inspection. This is a visual assessment of the water supply, using standard forms to record information, to see whether faces pollution exists and whether such pollution could reach the water source. Sanitary inspections can be under taken by communities on a regular basis as part of operation and maintenance, and forms have been developed in several countries to help communities undertake these inspections. Many of the risks to the water supply relate to improper operation and maintenance activities in the area around the water source, and sanitary inspection can be used to ensure that these tasks are carried out to keep the water supplies safe.

7.1.3. Chemical quality

It may also be necessary to test community water supplies for harmful chemicals. Certain chemicals, such as fluoride, nitrate and arsenic, represent a health risk, whereas others, for example iron, manganese and sulfate, may cause consumers to reject the water because it is unpleasant to drink or stains clothes and causes other problems. Testing is usually done by health or water officials, but community members can play a key role by demanding that such analyses are carried out, and by informing officials of any developments that may cause contamination of the water supply. When a water supply is first developed, a full water quality analysis should be carried out. The community should request feedback regarding this analysis and ask for guidance concerning the suitability of the water source for drinking

7.2. Water Quality performance Indices

The water quality indices/parameters that describe the quality of water which are given below:

7.2.1.PH of Water

The pH is the concentration of hydrogen ions (H+) and hydroxyl ions (OH-) in the water. It is used to determine the acidic, basic or neutral behaviors of water. The pH values ranges from 1 to 14, which means, if pH of water is less than 7 then it is called acidic water whereas, pH equal to 7 as neutral and more than 7 is called the basic nature water. The pH of water and soil could not harm the plant growth directly. pH highly affects the efficiency of coagulation and flocculation process .

7.2.2. Electrical Conductivity (EC)

The electrical conductivity (EC) of water is defined as the capacity of water to transmit the electric current. It depends on the dissolved ions in the water and their charge and movement. Because it is a good solvent, water dissolved mineral salts in the form of ions, which hold the electric current due to ionic conduction. When the EC of water is high, it shows that there is high concentration of ions in the water. The EC indicates the number of total solids in water and is dependent on the temperature of water. The electrical conductivity of water also affects the plant growth.

7.2.3. Total Dissolved Solids (TDS)

The alinity behavior of water is indicated by total dissolved solids (TDS). TDS contain the anions (negatively change ions) and cations (+ve changes ions). Total dissolved solids change the color and properties of water.

7.2.4. Total Suspended Solids (TSS)

Total suspended solids (TSS) are the fine particles consisted of microorganisms, algae, mineral particles and organic matter, suspended in water. Total suspended solid is an indicator of erosion and sediment transport and it absorbs heat energy from sun resulted in water temperature increase and consequently, decrease the level of dissolved oxygen as we know warmer water holds less oxygen than cooler water.

7.2.5. Total Solids (TS)

Total solids (TS) are the combination of total suspended solids and total dissolved solids in the water and measured in milligrams per liter (mg/L). The dissolved solids pass through a filter of around 2 microns in size. Suspended solids are bigger in size than dissolved solids which includes clay, silt, algae, plankton, organic debris etc. those would not pass through a 2-micron filter. In water, the suspended and dissolved solids came from different sources such as soil erosion, sewage, fertilizer, industrial discharges, and road runoff.

7.2.6. Turbidity

The amount of cloudiness in the water is known as turbidity which is caused by dissolved or total suspended solids and most of the time those are invisible to the naked eye as smoke in air.

It is important parameter to measure for water quality. Turbidity can be caused by i.e. Silt, sand and mud; Bacteria and germs; Chemical precipitates. The turbidity is measured in Nephelometric Turbidity Units (NTU) defined by US Environmental Monitoring Standard unit. Turbidity is the values of light absorbing or light scattering property of water. High level of turbidity in drinking water possessed a higher risk to people for developing gastrointestinal diseases. Similarly, high level of material affects light penetration and productivity, recreational values, and habitat quality.

7.2.7. Color

The water color is an important indicator to define water and pollutants source. Water color represents the type of solid material present in it. Transparent water with low level of dissolved solids has blue color while yellow or brown color is due to the dissolved organic matter. The apparent blue color of water bodies is due to selective absorption and scattering of light spectrum. Some algae produce reddish or deep yellow waters. Similarly, the water rich in phytoplankton and other algae appears as green. True color could be measured by filtering the water after removing all suspended material).

7.2.8. Taste and Oder

Taste and order property of water is commonly used for drinking water. Taste is one of the traditional five senses and is a form of direct chemoreception. It is the ability to observe the flavour of contents such as food, certain minerals, and poisons. The following are the basic taste types: sour, salty, sweet and bitter. Taste in the drinking water is mainly due to cations such as sodium, potassium, calcium and magnesium after their dilution of approximately 100, 300 100 and 30 mg/L, respectively .

A human nose can detect the very low concentration of a substance and this is termed as odor (smells), which can be categorized as pleasant and unpleasant. Pure water is odorless. The primary sources of taste and odor were algae and bacteria while anthropogenic sources include sewage wastewater and chemical spills, which could affect the groundwater and surface water .

7.2.9. Calcium and Magnesium (Ca, Mg)

The calcium and magnesium in water resulted from the decomposition of calcium and magnesium aluminosilicates and from dissolution of limestone, magnesium limestone, magnesite, gypsum and other minerals. Calcium is an essential element for living organisms basically in cell physiology and mineralization of bones and shells. In water, magnesium is usually in less quantity than calcium. Moreover, in groundwater and surface water, the concentration by weight of calcium is very high. Whereas, the total concentrations of calcium and magnesium is referred as water hardness. When soap is added to hard water it forms precipitates on boiling.

7.2.10. Carbonates and Bicarbonates (CO_3^{2-}, HCO_3^-)

Carbonate and bicarbonate ions referred by the dissolving of carbon dioxide (CO_2) by naturally circulating waters. A bond between the carbon and the hydrologic cycle is known to be carbonate. The atmospheric carbon dioxide is partly intercepted by photosynthesizing vegetation, which is converted to cellulose starch and related carbohydrates. The concentration of carbonates in natural waters is a function of dissolved carbon dioxide, temperature, pH, cations and other dissolved salts.
Carbonate is a salt of carbonic acid, which originates from dissolving of carbonate minerals. A carbonate salt is formed when a positively charged ion, attaches to the negatively charged oxygen atoms of the carbonate ion. The bicarbonate ion (hydrogenated-carbonate ion) is an anion with a negative charge and is the conjugate acid of carbonate. The weathering of rocks contributes to bicarbonate content in water as mostly these are soluble in water and their concentration in water depends on pH of water. It is a principal alkaline constituent in almost all water sources, therefore, influences hardness and alkalinity of water. Many types of bicarbonate are

soluble in water at standard temperature and pressure, particularly sodium bicarbonate and magnesium bicarbonate; both of these substances contribute to total dissolved salts which are a common parameter for assessing water quality. The concentration of carbonates and bicarbonates should be under the limit in water and if the level of carbonates and bicarbonates is increased, it may be harmful for humans, animals and plants.

7.2.12. Sodium Adsorption Ratio (SAR)

Sodium adsorption ratio (SAR) is an easily measured property that gives information on the comparative concentrations of sodium, calcium and magnesium. The SAR can be calculated as: SAR = [Na+] / [(Ca2 + Mg2+)/2]1/2 (2) Where [Na+], [Ca2+], and [Mg2+] are the concentrations in meq/L of sodium, calcium, and magnesium ions. A high sodium ion in irrigation water affects the hydraulic conductivity (permeability) of soil and creates water infiltration problems.

This is because when sodium present in the soil in exchangeable form replaces calcium and magnesium, adsorbed on the soil clays and causes dispersion of soil particles (i.e. if calcium and magnesium are the predominant cations adsorbed on the soil exchange complex, the soil tends to be easily cultivated and has a permeable and granular structure). Due high value of SAR, the soil becomes hard and compact when dry and resultantly, reduces the infiltration rates of water and air into the soil affecting its structure. This problem is also related with several factors such as the salinity rate and type of soil. For example, sandy soils may not get damage as easily as other heavier soils when it is irrigated with a high SAR water.

7.2.13. Residual Sodium Carbonates (RSC)

It is used to predict the additional sodium hazard associated with CaCO3 precipitation involve calculation of the residual sodium carbonate. RSC is another alternative measure of the sodium content in relation with calcium and magnesium. This can be calculated as: RSC = (CO32- + HCO3-) – (Ca2+ + Mg+2) (3) Where, all concentration is in meq/L.

Self-Check 7	Written Test

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

1, ------ is used to determine the acidic, basic or neutral behaviors of water (3 points)

A. Total Dissolved Solids (TDS) B. Residual Sodium Carbonates (RSC)

C. PH D. Sodium Adsorption Ratio (SAR)

2,--- is another alternative measure of the sodium content in relation with calcium and magnesium. (2 point)

A. Total Dissolved Solids (TDS) B. Residual Sodium Carbonates (RSC)

C. PH D. Sodium Adsorption Ratio (SAR)

3.------ is an easily measured property that gives information on the comparative concentrations of sodium, calcium and magnesium. (2 points)

A. Total Dissolved Solids (TDS) B. Residual Sodium Carbonates (RSC)

C. PH D. Sodium Adsorption Ratio (SAR)

4, Taste in the drinking water is mainly due to cat ions such as(2 point)

A. sodium B. Potassium C. calcium and magnesium D. All

5,------- is an important indicator to define water and pollutants source (1 point)

A. Color B. Residual Sodium Carbonates (RSC)

C. PH D. Sodium Adsorption Ratio (SAR

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

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

Score = ___________

Rating: ____________

Name: _________________________ Date: ________________

Short Answer Questions

1.____

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Operation Sheet 1	.Conducting simple tests for assessing water quality

Directions: Conducting simple tests by using proper tools and equipment

Procedures

- Step 1- prepare sampling Equipment
- Step 2- collect sample
- Step 3- Transporting sample
- Step 4- conducting test
- Step5- Recording test result
- Step6- Report test result

LAP Test -1	Practical Demonstration

Name: _________________________ Date: ______________

Time started: _____________________ Time finished: ______________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hour.

Task1. Conducting simple tests for assessing water quality

Instruction Sheet	Learning Guide -27: Apply knowledge and understanding of the organization's systems and structure to work

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

- Identifying and describing Water and Waste systems and infrastructures
- describing organizations management structure and role relationships
- Reviewing organizational and application of key policy and procedure
- Reviewing and applying standard reporting procedures

This guide will also assist you to attain the learning outcome stated in the cover page. Specificity, upon completion of this Learning Guide, you will be able to understand &work:-

- Identify and describe Water and waste systems and infrastructure used by the organization to delivery its services.
- Review and describe organizations' management structure and role relationships
- Review and apply organization's key policies and procedures.
- Identify, review and apply standard reporting procedures and impact on own work.

Learning Activities

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets 1".2,3&4 Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
3. Accomplish the "Self-check 1".2, 3 &4

However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #2.

5. Submit your accomplished Self-check. This will form part of your training portfolio.
6. Read and try to understand the procedures discussed.
7. Your output will be evaluated and will form part of your training portfolio.

Information Sheet-1	Identifying and describing Water and Waste systems and infrastructures

3.1 Water and Waste water systems and infrastructures

3.1.1 Definition wastewater

Wastewater is water that has been used and must be treated before it is released into another body of water, so that it does not cause further pollution of water sources. Wastewater comes from a variety of sources. Everything that you flush down your toilet or rinse down the drain is wastewater. Rainwater and runoff, along with serious pollutants, go down street gutters and eventually end up at a wastewater treatment facility. Wastewater can also come from agricultural and industrial sources. Some wastewaters are more difficult to treat than others; for example, industrial wastewater can be difficult to treat, whereas domestic wastewater is relatively easy to treat (though it is increasingly difficult to treat domestic waste, due to increased amounts of pharmaceuticals and personal care products that are found in domestic wastewater.

Many different industries generate waste water streams that contain organic compounds. Nearly all of these streams undergo collection, contaminant treatment, and/or storage operations before they are finally discharged into either a receiving body of water or a municipal treatment plant for further treatment. During some of these operations, the waste water is open to the atmosphere, and volatile organic compounds (VOC) may be emitted from the waste water into the air.

Industrial waste water operations can range from pretreatment to full-scale treatment processes. In a typical pretreatment facility, process and/or sanitary waste water and/or storm water runoff is collected, equalized, and/or neutralized and then discharged to a municipal waste water plant, also known as a publicly owned treatment works (POTWs), where it is then typically treated further by biodegradation.

In a full-scale treatment operation, the waste water must meet Federal and/or state quality standards before it is finally discharged into a receiving body of water. A storage basin contains the treated water until the winter months (usually January to May), when the facility is allowed to discharge to the receiving body of water. In the illustration, the receiving body of water is a slow-flowing stream. The facility is allowed to discharge in the rainy season when the facility waste water is diluted.

Collection, treatment, and storage systems are facility-specific. All facilities have some type of collection system, but the complexity will depend on the number and volume of waste water streams generated. As mentioned above, treatment and/or storage operations also vary in size and degree of treatment. The size and degree of treatment of waste water streams will depend on the volume and degree of contamination of the waste water and on the extent of contaminant removal desired.

3.1.2. Collection Systems -

There are many types of waste water collection systems. In general, a collection system is located at or near the point of waste water generation and is designed to receive 1 or more waste water streams and then to direct these streams to treatment and/or storage systems. A typical industrial collection system may include drains, manholes, trenches, junction boxes, sumps, lift stations, and/or weirs. Waste water streams from different points throughout the industrial facility normally enter the collection system through individual drains or trenches connected to a main sewer line. The drains and trenches are usually open to the atmosphere. Junction boxes, sumps, trenches, lift stations, and weirs will be located at points requiring waste water transport from 1 area or treatment process to another.

A typical POTW facility collection system will contain a lift station, trenches, junction boxes, and manholes. Waste water is received into the POTW collection system through open sewer lines from all sources of influent waste water. As mentioned previously, these sources may convey sanitary, pretreated or untreated industrial, and/or storm water runoff waste water. The following paragraphs briefly describe some of the most common types of waste water collection system components found in industrial and POTW facilities. Because the arrangement of collection system components is facility-specific, the order in which the collection system descriptions are presented is somewhat arbitrary.

Waste water streams normally are introduced into the collection system through individual or area drains, which can be open to the atmosphere or sealed to prevent waste water contact with the atmosphere. In industry, individual drains may be dedicated to a single source or piece of equipment. Area drains will serve several sources and are located centrally among the sources or pieces of equipment that they serve. Manholes into sewer lines permit service, inspection, and cleaning of a line. They may be located where sewer lines intersect or where there is a significant change in direction, grade, or sewer line diameter.

Trenches can be used to transport industrial waste water from point of generation to collection units such as junction boxes and lift station, from 1 process area of an industrial facility to another, or from 1 treatment unit to another. POTWs also use trenches to transport waste water from 1 treatment unit to another. Trenches are likely to be either open or covered with a safety grating. Junction boxes typically serve several process sewer lines, which meet at the junction box to combine multiple waste water streams into 1. Junction boxes normally are sized to suit the total flow rate of the entering streams.

Sumps are used typically for collection and equalization of waste water flow from trenches or sewer lines before treatment or storage. They are usually quiescent and open to the atmosphere. Lift stations are usually the last collection unit before the treatment system, accepting waste water from 1 or several sewer lines. Their main function is to lift the collected waste water to a treatment and/or storage system, usually by pumping or by use of a hydraulic lift, such as a screw.

3.2. Layout and construction of wastewater collection systems

3.2.1. Gravity sewer layout

The largest component of a wastewater collection system is usually the gravity sewer. Gravity sewers follow the topography of the surrounding area, (lay of the land), to take advantage of the natural slope. They are designed to provide a flow velocity between 2 and 8 feet per second (fps), with 2.5 fps being ideal. If the velocity is too low, settleable solids will deposit in the sewer lines, if the velocity is too high, erosion and damage of the collection system will occur. Gravity sewers are divided into the following sections:

3.2.1. Building Sewers

A building sewer connects a building's internal plumbing to the public wastewater collection system. The building sewer may begin at the stub-out, the property line or some distance (such as 2 to 10 ft.) from the building's foundation. Where the building sewer ends marks the end of the building owner's responsibility for maintenance and repairs. Beyond the building sewer, the wastewater collection system operators are responsible for maintenance, cleaning and repairs. This division should be clearly spelled out in local sewer ordinances.

3.2.3. Lateral and Branch Sewers

Lateral and branch sewers are the upper ends of the wastewater collection system. Sometimes they are located in easements, although this should be avoided where possible due to problems of access and limited work space.

Main Sewers

Main sewers collect the flow from numerous lateral and branch sewers and convey it to larger trunk sewers.

Trunk Sewers

Trunk sewers are the main "arteries" of the wastewater collection system and convey the wastewater from numerous sewer mains to a wastewater treatment plant or to an interceptor sewer.

Intercepting Sewer

Sewer interceptors receive the wastewater from trunk sewers and convey it to the wastewater treatment plant.

Sewage treatment generally involves three stages, called primary, secondary and tertiary treatment.

Level of treatment

Sewage treatment is the process of removing contaminants from wastewater, primarily from household sewage. Physical, chemical, and biological processes are used to remove contaminants and produce treated wastewater (or treated effluent) that is safer for the environment. A by-product of sewage treatment is usually a semi-solid waste or slurry, called sewage sludge. The sludge has to undergo further treatment before being suitable for disposal or application to land.

Sewage treatment may also be referred to as wastewater treatment. However, the latter is a broader term which can also refer to industrial wastewater. For most cities, the sewer system will also carry a proportion of industrial effluent to the sewage treatment plant which has usually received pre-treatment at the factories themselves to reduce the pollutant load. If the sewer system is a combined sewer then it will also carry urban runoff (storm water) to the sewage treatment plant. Sewage water can travel towards treatment plants via piping and in a flow aided by gravity and pumps. The first part of filtration of sewage typically includes a bar screen to filter solids and large objects which are then collected in dumpsters and disposed of in landfills. Fat and grease is also removed before the primary treatment of sewage.

Pretreatment

Pretreatment removes all materials that can be easily collected from the raw sewage before they damage or clog the pumps and sewage lines of primary treatment clarifiers. Objects commonly removed during pretreatment include trash, tree limbs, leaves, branches, and other large objects.

The influent in sewage water passes through a bar screen to remove all large objects like cans, rags, sticks, plastic packets etc. carried in the sewage stream. This is most commonly done with an automated mechanically raked bar screen in modern plants serving large populations, while in smaller or less modern plants, a manually cleaned screen may be used. The raking action of a mechanical bar screen is typically paced according to the accumulation on the bar screens and/or flow rate. The solids are collected and later disposed in a landfill, or incinerated. Bar screens or mesh screens of varying sizes may be used to optimize solids removal. If gross solids are not removed, they become entrained in pipes and moving parts of the treatment plant, and can cause substantial damage and inefficiency in the process.

Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment. Some sewage treatment plants that are connected to a combined sewer system have a bypass arrangement after the primary treatment unit. This means that during very heavy rainfall events, the secondary and tertiary treatment systems can be bypassed to protect them from hydraulic overloading and the mixture of sewage and storm water only receives primary treatment.

Secondary treatment removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment.Tertiary treatment is sometimes defined as anything more than primary and secondary treatment in order to allow ejection into a highly sensitive or fragile ecosystem (estuaries, low-flow Rivers, coral reefs...). Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

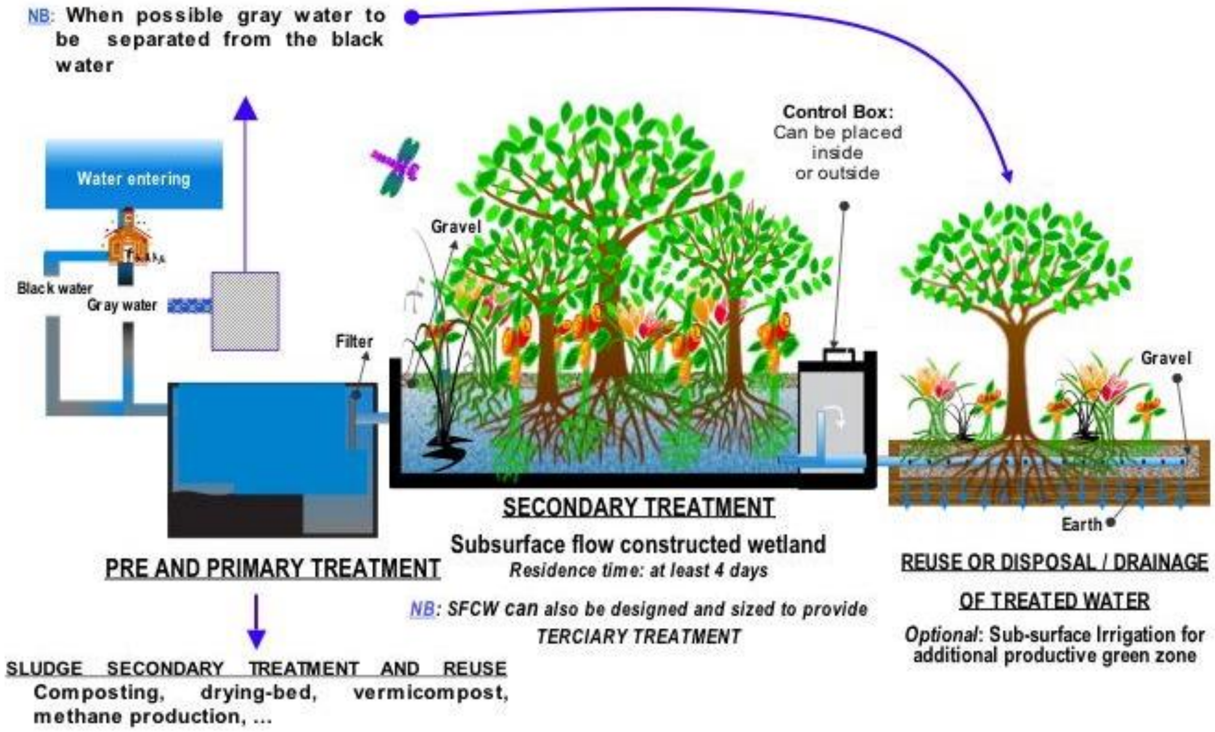

Figure-5: Characteristic of sewer system

3.3. Characteristics of gravity sewers

The following items are considered when determining the characteristics of a sewer line:

A. Slope of Sewer

As stated before, the slope of the sewer should follow the lay of the land as closely as practical provided the slope is adequate to produce gravity flow and maintain the minimum velocity (2 fps). Some areas will be too flat to permit exclusively gravity flow because the sewer lines would have to be buried excessively deep.

B. Design Flow

Wastewater collection systems are designed to convey the peak flow from a service area when the area has reached its maximum population density and has been fully developed.

C. Pipe Size

A sewer line should be at least large enough to allow the use of the cleaning equipment available. When sized properly, a sewer line should flow one half full during average daily flows. The air space above the half full sewer line helps to maintain aerobic conditions in the wastewater and provides some room for error in determining design flow.

D. **Location and Alignment**

Lateral, main and trunk sewers are generally constructed near the center of public roadways so that the length of building sewers is equalized and access is convenient. Pipes are generally laid as straight as possible to facilitate cleaning and for ease of installation. In order to avoid contamination, sewer lines must be located at least 2 ft. vertically below and 4 ft. horizontally away from potable water distribution lines.

E. **Depth**

Sewer lines are typically placed at a depth of 4 to 8 ft. The depth and width of a trench, the backfill materials and the method of compaction determine the load placed on the sewer line and therefore influence which piping materials are appropriate.

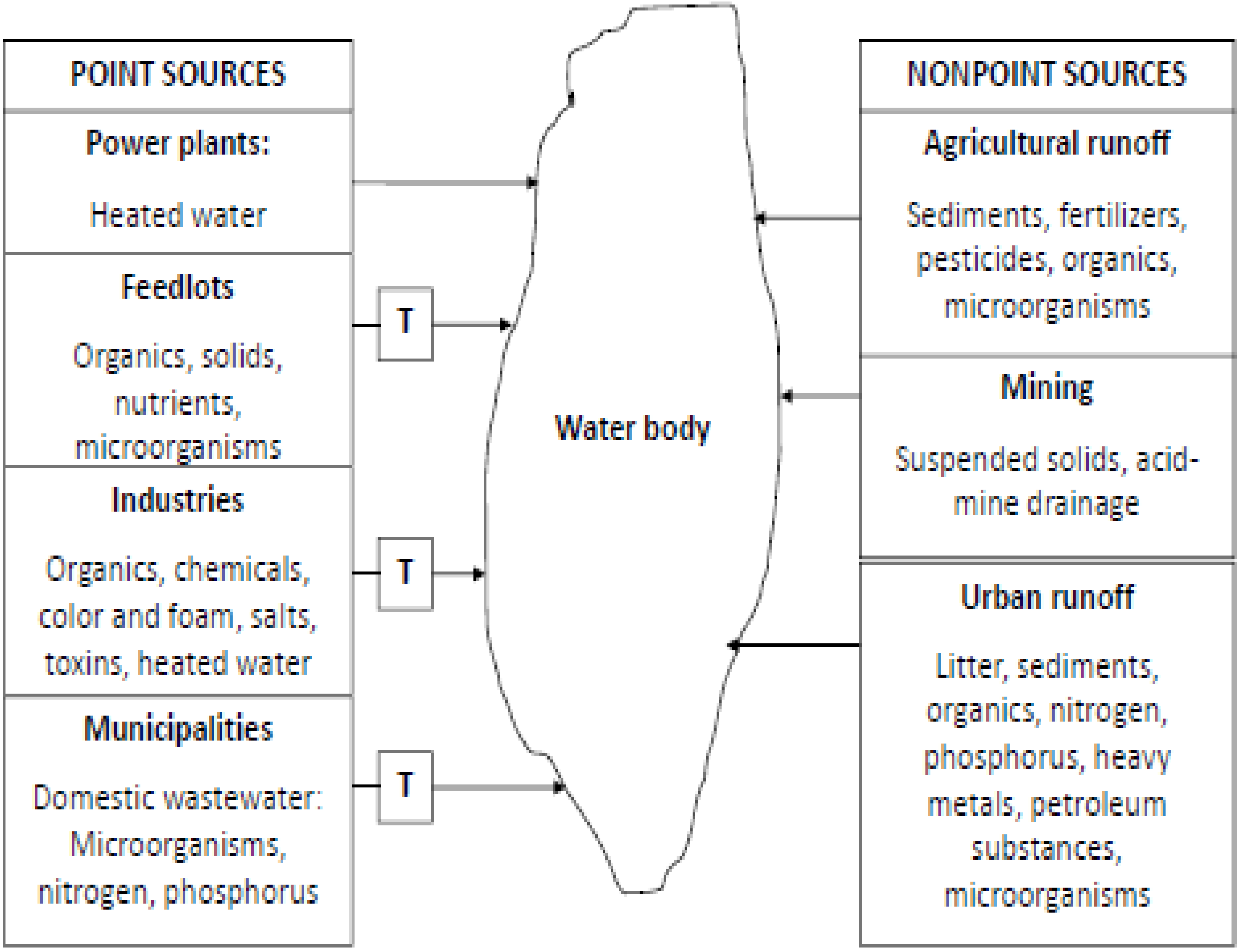

Figure-6. Major source of water pollutant

Causes of water quality degradation in the distribution system

1. Failures at the treatment barrier
2. Transformations in the bulk phase
3. Corrosion and leaching of pipe material
4. Biofilm formation
5. Mixing between different sources of water

Distribution Systems Water Quality

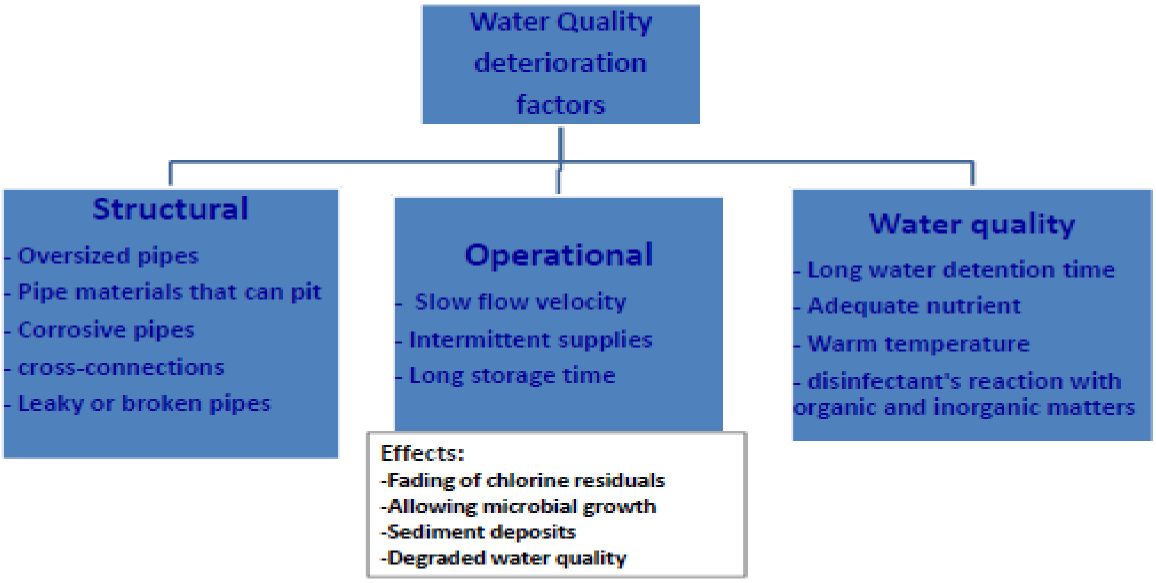

Figure-7: System operation modifications to maintain water quality

Minimize bulk water detention time

- Maintain positive pressure
- Control the direction and velocity of the bulk water
- Maintain a disinfectant residual in the distribution system
- Prevent cross-connections and backflow

3.5.Maintenance activities:

Try to keep contaminated water out of the trench and pipe; flush the line in the vicinity of the break; apply disinfectant to potentially contaminated components; disinfect new mains; disinfect storage tanks after construction, inspection, or maintenance; and Conduct bacteriological testing to confirm the absence of contaminatesprevent and eliminate cross-connections; cover and vent storage tanks; maintain an adequate separation from sewers; and enforce applicable building plumbing codes.

Self-Check -1	Written Test

Directions: Give short answer for the questions listed below

1. Define wastewater?
2. Explain the various source of wastewater
3. List the main component of wastewater collection systems
4. List the Causes of water quality de gradation in the distribution system

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

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

Score = ___________

Rating: ____________

Name: _________________________ Date: ________________

Short Answer Questions

1.____

2.____

3.____

4.____

5.____

Information Sheet-2	describing organizations management structure and role relationships

3.2 Management structure and role relationships

3.2.1 Roles and Responsibilities

Line Managers are responsible for:

• The implementation of this procedure in their area of responsibility and accountability

• Completing the online learning program for hazard management

• The identification of hazards and the completion of risk assessments using the appropriate Risk Assessment form

• The implementation of appropriate risk control measures in consultation with staff

3.2.2 Staffs are responsible for:

• Not placing themselves or others at risk of injury

• reporting any hazards associated with the working environment, work tasks or activities to their line manager as soon as becoming aware of them participating in the development of appropriate risk control measures for identified hazards to eliminate or minimize risk

• Using control measures as required.

Self-Check -2	Written Test

Directions: Give short answer for the questions listed below

1. Explain the Line Managers responsibility
2. Explain the staffs' responsibility

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

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

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

1.____

2.____

3.____

Information Sheet-3	Reviewing organizational and application of key policy and procedure

3.1 Organizational key polices and procedure

A Standard Operating Procedure (SOP) is a set of written instructions that document a routine or repetitive activity followed by an organization. The development and use of SOPs are an integral part of a successful quality system as it provides individuals with the information to perform a job properly, and facilitates consistency in the quality and integrity of a product or end-result. The term "SOP" may not always be appropriate and terms such as protocols, instructions, worksheets, and laboratory operating procedures may also be used.

3.2. Purpose

SOPs detail the regularly recurring work processes that are to be conducted or followed within an organization. They document the way activities are to be performed to facilitate consistent conformance to technical and quality system requirements and to support data quality. They may describe, for example, fundamental programmatic actions and technical actions such as analytical processes, and processes for maintaining, calibrating, and using equipment. SOPs are intended to be specific to the organization or facility whose activities are described and assist that organization to maintain their quality control and quality assurance processes and ensure compliance with governmental regulations.

If not written correctly, SOPs are of limited value. In addition, the best written SOPs will fail if they are not followed. Therefore, the use of SOPs needs to be reviewed and re-enforced by management, preferably the direct supervisor. Current copies of the SOPs also need to be readily accessible for reference in the work areas of those individuals actually performing the activity, either in hard copy or electronic format, otherwise SOPs serve little purpose.

3.3. Benefits

The development and use of SOPs minimizes variation and promotes quality through consistent implementation of a process or procedure within the organization, even if there are temporary or permanent personnel changes. SOPs can indicate compliance with organizational and governmental requirements and can be used as a part of a personnel training program, since they should provide detailed work instructions. It minimizes opportunities for miscommunication and can address safety concerns. When historical data are being evaluated for current use, SOPs can also be valuable for reconstructing project activities when no other references are available. In addition, SOPs are frequently used as checklists by inspectors when auditing procedures. Ultimately, the benefits of a valid SOP are reduced work effort, along with improved comparability, credibility, and legal defensibility.

SOPs are needed even when published methods are being utilized. For example, if an SOP is written for a standard analytical method, the SOP should specify the procedures to be followed in greater detail than appear in the published method. It also should detail how, if at all, the SOP differs from the standard method and any options that this organization follows.

3.4.Checklists

Many activities use checklists to ensure that steps are followed in order. Checklists are also used to document completed actions. Any checklists or forms included as part of an activity should be referenced at the points in the procedure where they are to be used and then attached to the SOP.

In some cases, detailed checklists are prepared specifically for a given activity. In those cases, the SOP should describe, at least generally, how the checklist is to be prepared, or on what it is to be based. Copies of specific checklists should be then maintained in the file with the activity results and/or with the SOP. Remember that the checklist is not the SOP, but a part of the SOP.

3.5. Document Control

Each organization should develop a numbering system to systematically identify and label their SOPs, and the document control should be described in its Quality Management Plan.

In general, technical SOPs will consist of five elements: Title page, Table of Contents, Procedures, Quality Assurance/Quality Control, and References:

1. **Title Page**
2. **Table of Contents**
3. **Procedures -** The following are topics that may be appropriate for inclusion in technical SOPs. Not all will apply to every procedure or work process being detailed.

A. Scope and Applicability (describing the purpose of the process or procedure and any organization or regulatory requirements, as well as any limits to the use of the procedure),

B. Summary of Method (briefly summarizing the procedure),
C. Definitions (identifying any acronyms, abbreviations, or specialized terms used),
D. Health & Safety Warnings (indicating operations that could result in personal injury or loss of life and explaining what will happen if the procedure is not followed or is followed incorrectly; listed here and at the critical steps in the procedure),
E. Cautions (indicating activities that could result in equipment damage, degradation of sample, or possible invalidation of results; listed here and at the critical steps in the procedure),
F. Interferences (describing any component of the process that may interfere with the accuracy of the final product),
G. Personnel Qualifications/Responsibilities (denoting the minimal experience the user should have to complete the task satisfactorily, and citing any applicable requirements, like certification or "inherently governmental function"),
H. Equipment and Supplies (listing and specifying, where necessary, equipment, materials, reagents, chemical standards, and biological specimens),
I. Procedure (identifying all pertinent steps, in order, and the materials needed to accomplish

the procedure such as:

- Instrument or Method Calibration and Standardization
- Sample Collection
- Sample Handling and Preservation
- Sample Preparation and Analysis (such as extraction, digestion, analyses identification, and counting procedures)
- Troubleshooting
- Data Acquisition, Calculations & Data Reduction Requirements (such as listing any mathematical steps to be followed)
- Computer Hardware & Software (used to store field sampling records, manipulate analytical results, and/or report data), and
- Data and Records Management (e.g., identifying any calculations to be performed, forms to be used, reports to be written, and data and record storage information).

3.6.Quality Control and Quality Assurance Section

QC activities are designed to allow self-verification of the quality and consistency of the work. Describe the preparation of appropriate QC procedures (self-checks, such as calibrations, recounting, re-identification) and QC material (such as blanks - reinstate, trip, field, or method; replicates; splits; spikes; and performance evaluation samples) that are required to demonstrate successful performance of the method. Specific criteria for each should be included. Describe the frequency of required calibration and QC checks and discuss the rationale for decisions. Describe the limits/criteria for QC data/results and actions required when QC data exceed QC limits or appear in the warning zone. Describe the procedures for reporting QC data and results.

3.7. Reference Section

Documents or procedures that interface with the SOP should be fully referenced (including version), such as related SOPs, published literature, or methods manuals. Citations cannot substitute for the description of the method being followed in the organization. Attach any that are not readily available

Relevant company policy and procedures used to provide standardized cleaning services are listed below.

- Ethiopian Standards, DACCA standard
- Environmental regulation/legislation, Pollution, EIA and Waste Management Legislation
- Organizational procedures, Waste management institution standard
- Addis Ababa solid waste management policy, Published in 1995
- Addis Ababa solid waste management and disposal regulation, Regulation 13/1996
- OHS acts and regulation, Published by civil servant and social affair bur roué
- Emergency procedure guide, Published by the Organization
- Ethiopian Code of Dangerous Goods, Published by Ethiopian Standard Authority

The following are basic principles and procedures of cleaning:

1. Written cleaning protocols should be prepared, including methods and frequency of cleaning. These should include policies for the supply of all cleaning and disinfectant products
2. standard precautions (including wearing of personal protective equipment as applicable) should be implemented when cleaning surfaces and facilities (see appendix 3)

3. cleaning methods should avoid generation of aerosols
4. all cleaning items should be changed after each use and cleaned and dried before being used again. They should also be changed immediately following the cleaning of blood or body fluid/substance spills, cleaned and dried. Single use cleaning items are preferred where possible such as cleaning cloths which should be lint free
5. sprays should not be used as they can become contaminated and are difficult to clean. sprays are not effective as they do not touch all parts of the surface to be cleaned
6. detergents should not be mixed with other chemicals
7. All cleaning solutions should be prepared fresh before use.

Procedure for routine surface cleaning

8. All cleaning solutions should be prepared immediately prior to use.
9. Work surfaces should be cleaned (wiped over) with a neutral detergent and warm water solution, rinsed and dried before, and after, each session or when visibly soiled. Spills should be cleaned up as soon as practical.
10. When a disinfectant is required for surface cleaning, the manufacturer's recommendations for use and OH&S instructions should be followed.
11. Buckets should be emptied after use, washed with detergent and warm water, rinsed in hot water and stored dry - turn upside down.
12. Mops should be laundered or cleaned in detergent and warm water, rinsed in hot water then stored dry. Mop heads should be detachable or stored with mop head uppermost.

Self-Check -3	Written Test

Directions: Give short answer for the questions listed below

1. What is standard operating procedure?
2. What is the purpose of standard operating procedure?
3. What is the benefit standard operating procedure
4. List the relevant company policy and procedures used to provide standardized cleaning services.

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

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

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

1.____

2.____

3.____

It has no reference

TTLM technical quality evaluation and editing and finalizing has done by FTA experts

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3	Merawi					
4	Muluken					

FTA

August 8 2020