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By:

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Theme

Treatment procedur of waste water in Saida area

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Dedication

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Dedication

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Unfortunately our project is not accomplished yet because of corona virus so I ask you to accept my apologies thank you

Sommaire

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Symbols

biochemical oxygen demand (BOD),

chemical oxygen demand (COD)

total organic carbon (TOC).

polychlorinated biphenyls (PCBs)

Protein carboxylic acid (-CO2H)

pKa (The negative log of the acid ionization constant)

hypochlorous acid (HOCl)

hydrochloric acid (HCl).

hypochlorite ions (OCl–)

Organization for Economic Cooperation and Development [OECD

General Introduction

General Introduction

Water is one of the most important molecules on the surface of our planet and in living organisms. It has very specific properties which are responsible for its very broad utilisation in nature and our daily life. Life could not exist without water. A brief overview of some water properties A. Water Properties are presented to encourage observation of them in daily life. Associated experiments are also suggested. In lesson B. Water Cycle, local and global water cycles are generally distinguished. Regarding Groundwater, specific aspects of regional and local conditions recharge and climate characteristics are summarized. In lesson C. Ground and Drinking Water , the occurrence of different types of natural drinking water sources are presented.

Do the pupils know about any living organism which can exist without needing water at least every now and then? Is there any flower that does not fade, any animal that does not die without water? Every species on earth, whether it is a big animal like an elephant or a small insect like a bee or an ant, depends on water. Human Beings not only depend on water to survive but they consist of 60-¬-70 % water. Water bodies are also important habitats for living creatures (e.g. sea, swamp, lakes and rivers). Water is a very important element in our daily life. We need water for the production of goods for (daily) consumption (clothes, food, etc.), transportation (rivers, sea, etc.) or recreation (swimming, skiing, ice-¬-skating). Water is also essential for everyday activities like cooking, drinking and cleaning. Water is a very crucial element for life and especially for our well-¬-being and prospering. To gain a deeper understanding of our drinking water's vulnedability, it is helpful to know some of its properties. These properties are sometimes very astonishing (and on a first glance more or less hidden) and show us an admirable, vibrant, and vivacious element**.**

everyone understands that water is essential to life. But many are only justnow beginning to grasp how essential it is to everything in life – food,energy, transportation, nature, leisure, identity, culture, social norms,education, gender equality and virtually all the products used on a dailybasis. In particular, water, energy and climate change need to be tackledtogether, and these are linked to agriculture too. Therefore, this paper isonly a piece of the puzzle and should not be viewed in isolation fromother sustainability concerns

Water, a substance composed of the chemical elements hydrogen and oxygen and existing in gaseous, liquid, and solid states. It is one of the most plentiful and essential of compounds. A tasteless and odourless liquid at room temperature, it has the important ability to dissolve many other substances. Indeed, the versatility of water as a solvent is essential to living organisms. Life is believed to have originated in the aqueous solutions of the world's oceans, and living organisms depend on aqueous solutions, such as blood and digestive juices, for biological processes. In small quantities water appears colourless, but water actually has an intrinsic blue colour caused by slight absorption of light at red wavelengths. Although the molecules of water are simple in structure (H2O), the physical and chemical properties of the compound are extraordinarily complicated, and they are not typical of most substances found on Earth. For example, although the sight of ice cubes floating in a glass of ice water is commonplace, such behaviour is unusual for chemical entities. For almost every other compound, the solid state is denser than the liquid state; thus, the solid would sink to the bottom of the liquid. The fact that ice floats on water is exceedingly important in the natural world, because the ice that forms on ponds and lakes in cold areas of the world acts as an insulating barrier that protects the aquatic life

below. If ice were denser than liquid water, ice forming on a pond would sink, thereby exposing more water to the cold temperature. Thus, the pond would eventually freeze throughout, killing all the life-forms present. Water occurs as a liquid on the surface

of Earth under normal conditions, which makes it invaluable for transportation, for recreation, and as a habitat for a myriad of plants and animals. The fact that water is readily changed to a vapour (gas) allows it to be transported through the atmosphere from the oceans to inland areas where it condenses and, as rain, nourishes plant andanimal life. (See hydrosphere: The hydrologic cycle for a description of the cycle by which water is transferred over Earth.).

Chapter I: General Information on Waste water

Chapter 1 : General Information on Waste Water

Wastewater refers to all effluent from household, commercial establishments and institutions, hospitals, industries and so on. It also includes stormwater and urban runoff, agricultural, horticultural and aquaculture effluent.

Effluent refers to the sewage or liquid waste that is discharged into water bodies either from direct sources or from treatment plants. Influent refers to water, wastewater, or other liquid flowing into a reservoir, basin or treatment plant.

Sewage is also wastewater. It is wastewater originating from toilets and bathroom fixtures, bathing, laundry, kitchen sinks, cleaners, and similar dirty water that is produced in households and public places. Water used to irrigate turf and gardens, swimming pools, roof drainage, surface runoff and stormwater are all wastewater but not classified as sewage In simple terms, wastewater is all the dirty water from municipal sources (poop, urine and faecal sludge). This includes black water, gray water and yellow water. All dirty water from all the schools, restaurants, commercial establishments, hospitals, farms, floodwater and all the possible dirty water you can think of is considered wastewater. Some wastewater contain hazardous dissolved toxins and chemicals, whiles others contain particles, sediments and suspended matter of all sizes.

Agriculture (irrigation, livestock watering and cleaning, aquaculture) uses about 69% to 90% of global fresh water use, and the bulk of it is returned to the soil, waterways or discharged with added nutrients and contaminants.

I. les types des eaux usées / Types of wastewater

I.1.Types of wastewater

1.1.What is sewage?

Sewage is wastewater that comes from domestic activities. That includes houses, public toilets, restaurants, schools, hotels and hospitals. These buildings all produce a lot of wastewater on a daily basis, which generally contains urine and faeces.

1.2.What is non-sewage?

Non-sewage covers all other types of wastewater. That includes rainwater and stormwater from flooding, water from commercial activity like garages or laundrettes and water from industrial plants.

1.3.Blackwater

Blackwater refers to wastewater contaminated with human waste. Blackwater comes from flush toilets and bidets, and contains human waste such as urine and feces as well as toilet paper. Blackwater can also include water from food preparation sinks, dishwashers and other sources. Raw sewage is classified as blackwater.

Blackwater is a haven for dangerous bacteria and pathogens that must fully decompose before being released into the environment. It can also be contaminated with dissolved chemicals and particulates, making contact even more dangerous.

When it comes to home flooding emergencies, blackwater floods are the most dangerous and the most destructive. Because of the grossly unsanitary conditions of the water,Contact with blackwater via ingestion or skin contact can cause illness in both humans and pets

1.4.Greywater

Greywater, or sullage, refers to wastewater that is not contaminated with fecal matter. As far as household wastewater goes, greywater could include water from bathtubs and showers, washing machines, dishwashers, and sinks. It generally contains fewer pathogens than blackwater and can be reused for non-potable purposes, such as toilet flushing. Greywater still contains small amounts of contaminants and can induce illness if ingested.

Floods by greywater can be caused by a weather event, an overflowing plumbing fixture or appliance or even a broken pipe. This type of greywater can saturate carpeting, furniture and drywall. If you experience a home flood with greywater, take caution when beginning the cleaning process. Wear protective gear, and keep children, pets and individuals with a compromised immune system away from the flooded area. If the flood is extensive, such as several inches of water in the basement, it is advisable to hire professionals to safely clean up and decontaminate the area. Cleanup must begin immediately--greywater can become blackwater in as little as 48 hours

Types of Wastewater

Type of Wastewater	Source of wastewater
Gray water	Washing water from the kitchen, bathroom, laundry (without faeces and urine)
Black water	Water from flush toilet (faeces and urine with flush water)
Yellow water	Urine from separated toilets and urinals
Brown water	Black water without urine or yellow water

Figure 01: Types of Waste water

1.5.Clean Water

Floodwater that does not post an immediate health threat is known as clean water. Seems obvious, right? Clean water floods can result from malfunctioning appliances, toilet holding tanks, and melting snow and rainwater. Clean water home floods are generally safe for you to clean up yourself.

I.2.Industrial waste water

The wastewater from industries varies so greatly in both flow and pollutional strength. So, it is impossible to assign fixed values to their constituents. In general, industrial wastewaters may contain suspended, colloidal and dissolved (mineral and organic) solids. In addition, they may be either excessively acid or alkaline and may contain high or low concentrations of colored matter. These wastes may contain inert, organic or toxic materials and possibly pathogenic bacteria. These wastes may be discharged into the sewer system provided they have no adverse effect on treatment efficiency or undesirable effects on the sewer system. It may be necessary to pretreat the wastes prior to release to the municipal system or it is necessary to a fully treatment when the wastes will be discharged directly to surface or ground waters.

2.1.Industrial Wastewater Characteristics

The physical and chemical characterization presented below is valid for most wastewaters, both municipal and industrial

2.3.Physical characteristics

The principal physical characteristics of wastewater include solidscontent, colour, odour and temperature.

2.4.Total Solids

The total solids in a wastewater consist of the insoluble or suspendedsolids and the soluble compounds dissolved in water. The suspendedsolids content is found by drying and weighing the residue removed bythe filtering of the sample. When this residue is ignited the volatile solidsare burned off. Volatile solids are presumed to be organic matter,although some organic matter will not burn and some inorganic saltsbreak down at high temperatures. The organic matter consists mainly ofproteins, carbohydrates and fats. Between 40 and 65 % of the solids in an

average wastewater are suspended. Settleable solids, expressed asmillilitres per litre, are those that can be removed by sedimentation.Usually about 60 % of the suspended solids in a municipal wastewater are settleable (**Ron & George, 1998**). Solids may be classified in another wayas well: those that are volatilized at a high temperature (600 °C) and thosethat are not. The former are known as volatile solids, the latter as fixedsolids. Usually, volatile solids are organic.

2.5.Colour

Colour is a qualitative characteristic that can be used to assess the generalcondition of wastewater. Wastewater that is light brown in colour is lessthan 6 h old, while a light-to-medium grey colour is characteristic ofwastewaters that have undergone some degree of decomposition or thathave been in the collection system for some time. Lastly, if the colour isdark grey or black, the wastewater is typically septic, having undergoneextensive bacterial decomposition under anaerobic conditions. Theblackening of wastewater is often due to the formation of varioussulphides, particularly, ferrous sulphide. This results when hydrogensulphide produced under anaerobic conditions combines with divalentmetal, such as iron, which may be present. Colour is measured bycomparison with standards.

2.6.Odour

The determination of odour has become increasingly important, as thegeneral public has become more concerned with the proper operation ofwastewater treatment facilities. The odour of fresh wastewater is usuallynot offensive, but a variety of odorous compounds are released whenwastewater is decomposed biologically under anaerobic conditions.

2.7.Temperature

The temperature of wastewater is commonly higher than that of the water supply because warm municipal water has been added. The measurementof temperature is important because most wastewater treatment schemesinclude biological processes that are temperature dependent. Thetemperature of wastewater will vary from season to season and also withgeographic location. In cold regions the temperature will vary from about7 to 18 °C, while in warmer regions the temperatures vary from 13 to 24°C **(Ron& George, 1998)**

I.3.chemical characteristics

3.1. Inorganic chemicals

The principal chemical tests include free ammonia, organic nitrogen, nitrites, nitrates, organic phosphorus and inorganic phosphorus. Nitrogen and phosphorus are important because these two nutrients are responsible for the growth of aquatic plants. Other tests, such as chloride, sulphate, pH and alkalinity, are performed to assess the suitability of reusing treated wastewater and in controlling the various treatment processes **(Rein, 2005).**

Trace elements, which include some heavy metals, are not determined routinely, but trace elements may be a factor in the biological treatment of wastewater. All living organisms require varying amounts of some trace elements, such as iron, copper, zinc and cobalt, for proper growth. Heavy metals can also produce toxic effects; therefore, determination of the amounts of heavy metals is especially important where the further use of treated effluent or sludge is to be evaluated. Many of metals are also classified as priority pollutants such as arsenic, cadmium, chromium, mercury, etc.

Measurements of gases, such as hydrogen sulphide, oxygen, methane and carbon dioxide, are made to help the system to operate. The presence of hydrogensulphide needs to be determined not only because it is an odorous and very toxic gas but also because it can affect the maintenance of long sewers on flat slopes, since it can cause corrosion. Measurements of dissolved oxygen are made in order to monitor and control aerobic biological treatment processes. Methane and carbon dioxide measurements are used in connection with the operation of anaerobic digesters.

3.2. Organic chemicals

Over the years, a number of different tests have been developed to determine the organic content of wastewaters. In general, the tests may be divided into those used to measure gross concentrations of organic matter greater than about 1 mg/l and those used to measure trace concentrations in the range of 10^{-12} to 10^{-3} mg/l. Laboratory methods commonly used today to measure gross amounts of organic matter (greater than 1 mg/l) in wastewater include (1) biochemical oxygen demand (BOD), (2) chemical oxygen demand (COD) and (3) total organic carbon (TOC). Trace organics in the range of 10^{-12} to 10^{-3}mg/l are determined using instrumental methods including gas mass spectroscopy and chromatography. Specific organic compounds are determined to assess the presence of priority pollutants **(Metcalf & Eddy, 1991).** The BOD, COD and TOC tests are gross measures of organic content and as such do not reflect the response of the wastewater to various types of biological treatment technologies

3.4.Volatile organic carbons (VOC)

Volatile organic compounds such as benzene, toluene, xylenes, trichloroethane, dichloromethane, and trichloroethylene, are common soil pollutants in industrialized and commercialized areas. One of the more common sources of these contaminants is leaking underground storage tanks. Improperly discarded solvents and landfills, built before the introduction of current stringent regulations, are also significant sources of soil VOCs. Many of organic substances are classified as priority pollutants such as polychlorinated biphenyls (PCBs), polycyclic aromatic, acetaldehyde, formaldehyde, 1,3-butadiene, 1,2-dichloroethane, dichloromethane, hexachlorobenzene (HCB), etc,. In Table1 1, a list of typical inorganic and organic substances present in industrial effluents is presented.

Tables N° 01 : Volatile organic carbons (VOC)

Substances PresentinWastewaters from:

AceticacidAcetaterayon, beetrootmanufact

Acids Chem.manufact,mines, textilesmanufact

AlkaliesCottonand strawkiering, wool scouring

Ammonia Gas andcokeandchem.Manufacture

ArsenicSheepdipping

Cadmium Plating

Chromium Plating, chrometanning, alumanodizing

Citricacid Soft drinks andcitrusfruitprocessing

Copper Copperplating, copperpickling

Cyanides Gasmanufacture, plating,metalcleaning

Fats, oils, greaseWool scouring, laundries, textileindustry

Fluorides Scrubbingoffluegases, glass etching

FormaldehydeSyntheticresins andpenicillinmanufact

Freechlorine Laundries, papermills, textilebleaching

HydrocarbonsPetrochemicalandrubberfactories

Freechlorine Laundries, papermills, textilebleaching

Mercaptansmills Oilrefining, pulp

NickelPlating

Nitrocompounds Explosives andchemicalworks

Organicacids Distilleries andfermentationplants

Phenols Gas andcokemanufact., chem. Plants

Starch Foodprocessing, textileindustries

Sugars	Dairies, breweries, sweet industry
Sulfides	Textile industry, tanneries, gas manufact.
Sulfites	Pulp processing, viscose film manufact.
Tannic acid	Tanning, sawmills
Tartaric acid	Dyeing, wine, leather, chem. Manufacture
zinc	Galvanizing zinc plating, rubber process

3.5.Heavy metal discharges

Several industries discharge heavy metals, it can be seen that of all of the heavy metals, chromium is the most widely used and discharged to the environment from different sources. As shown in Fig. 1-2, many of the pollutants entering aquatic ecosystems (e.g., mercury lead, pesticides, and herbicides) are very toxic to living organisms. They can lower reproductive success, prevent proper growth and development, and even cause death.

However, chromium is not the metal that is most dangerous to living organisms. Much more toxic are cadmium, lead and mercury. These have a tremendous affinity for sulphur and disrupt enzyme function by forming bonds with sulphur groups in enzymes. Protein carboxylic acid ($-CO_2H$) and amino ($-NH_2$) groups are also chemically bound by heavy metals. Cadmium, copper, lead and mercury ions bind to cell membranes, hindering transport processes through the cell wall. Heavy metals may also precipitate phosphate bio-compounds or catalyze their decomposition.

3.6.Ammonia

Ammonia is the initial product of the decay of nitrogenous organic wastes, and its presence frequently indicates the presence of such wastes. It is a normal constituent of some sources of groundwater and is sometimes added to drinking water to remove the taste and odour of free chlorine. Since the pKa (The negative log of the acid ionization constant) of the ammonium ion, NH_4^+, is 9.26, most ammonia in water is present as NH_4^+ rather than NH_3.

3.7.Cyanide

Cyanide ion, CN^-, is probably the most important of the various inorganic species in wastewater. Cyanide, deadly poisonous substance, exists in water as HCN which is a weak acid. The cyanide ion has a strong affinity for many metal ions, forming relatively less toxic ferrocyanide, $Fe(CN)_6^{4-}$, with iron (II), for example. Volatile HCN is very toxic and has been used in gas chamber executions in the United States. Cyanide is widely used in industry, especially for metal cleaning and electroplating. It is also one of the main gas and coke scrubber effluent pollutants from gas works and coke ovens. Cyanide is widely used in certain mineral processing operations.

3.8.Other inorganic pollutants

Hydrogen sulphide, H_2S, is a product of the anaerobic decay of organic matter containing sulphur. It is also produced in the anaerobic reduction of sulphate by microorganisms and is developed as a gaseous pollutant from geothermal waters. Wastes from chemical plants, paper mills, textile mills and tanneries may also contain H2S. Nitrite ion, NO−2, occurs in water as an intermediate oxidation state of nitrogen. Nitrite is added to some industrial processes to inhibit corrosion; it is rarely found in drinking water at levels over 0.1 mg/l.

3.8.1. Organic pollutants

Effluent from industrial sources contains a wide variety of pollutants, including organic pollutants. Primary and secondary sewage treatment processes remove some of these pollutants, particularly oxygen-demanding substances, oil, grease and solids. Others, such as refractory (degradation-resistant) organics (organochlorides, nitro compounds etc.), and salts and heavy metals, are not efficiently removed. Soaps, detergents and associated chemicals are potential sources of organic pollutants. Most of the environmental problems currently attributed to detergents do not arise from the surface-active agents, which basically improve the wetting qualities of water. The greatest concern among environmental pollutants has been caused by polyphosphates added to complex calcium, functioning as a builder.

Bio-refractory organics are poorly biodegradable substances, prominent among which are aromatic or chlorinated hydrocarbons (benzene, bornyl alcohol, bromobenzene, chloroform, camphor, dinitrotoluene, nitrobenzene, styrene etc, ..). Many of these compounds have also been found in drinking water. Water contaminated with these compounds must be treated using physical and chemical methods, including air stripping, solvent extraction, ozonation and carbon adsorption.

First discovered as environmental pollutants in 1966, polychlorinated biphenyls (PCB compounds) have been found throughout the world in water, sediments and bird and fish tissue. They are made by substituting between 1 and 10 Cl atoms onto the biphenyl aromatic structure. This substitution can produce 209 different compounds

3.8.2.Thermal pollution

Considerable time has elapsed since the scientific community and regulatory agencies officially recognized that the addition of large quantities of heat to a recipient possesses the potential of causing ecological harm. The really significant heat loads result from the discharge of condenser cooling water from the ever-increasing number of steam electrical generating plants and equivalent-sized nuclear power reactors. Large numbers of power plants currently require approximately 50 % more cooling water for a given temperature rise than that required of fossil-fuelled plants of an equal size. The degree of thermal pollution depends on thermal efficiency, which is determined by the amount of heat rejected into the cooling water. Thermodynamically, heat should be added at the highest possible temperature and rejected at the lowest possible temperature if the greatest amount of effect is to be gained and the best thermal efficiency realized. The current and generally accepted maximum operating conditions for conventional thermal stations are about 500 °C and 24 MPa, with a corresponding heat rate of 2.5 kWh, 1.0 kWh resulting in power production and 1.5 kWh being wasted. Plants have been designed for 680 °C and 34 MPa; however, metallurgical problems have kept operating conditions at lower levels. Nuclear power plants operate at temperatures of from 250 to 300 °C and pressures of up to 7 MPa, resulting in a heat rate of approximately 3.1 kWh. Thus, for nuclear plants, 1.0 kWh may be used for useful production whereas 2.1 kWh is wasted .Most steam-powered electrical generating plants are operated at varying load factors, and, consequently, the heated discharges demonstrate wide variation with time. Thus, the biota is not only subjected to increased or decreased temperature, but also to a sudden, or “shock,” temperature change. Increased temperature will cause remarkable reduction in the self-purification capacity of a water body and cause the growth of undesirable algae . The addition of heated water to the receiving water can be considered equivalent to the addition of sewage or other organic waste material, since both

pollutants may cause a reduction in the oxygen resources of the receiving waters. shows that increased temperatures cause the growth of undesirable algae.

In most cases, the increases in temperature are small and probably do not cause biological harm outside the mixing zone. In fact, little data exists to support the claims of extensive heat damage from power plants on the biota. Furthermore, besides entrainment problems, few substantiated fish kills have been reported as a result of power plant operations. The possible effects of heat on fish may be summarized here:

a- Direct death from excessive temperature rise beyond the thermal death point.

b- Indirect death due to less oxygen available, disruption of the food supply, decreased resistance to toxic materials, decreased resistance to disease, predation from more tolerant species and synergism with toxic substances.

c- Increase in respiration and growth.

d- Competitive replacement by more tolerant species.

e- Sub-lethal effects.

While each of these factors could be important at a specific location, the temperature rises typical of most power plants are usually not high enough to be of concern. It is interesting to note that field research studies on the effects of heat on the environment have been hindered, both in the United

States and Europe, because of the lack of sufficient temperature elevations below existing power plants.

3.8.3.Pollution load and concentration

In most industries, wastewater effluents result from the following water uses:

• Sanitary wastewater (from washing, drinking, etc.);

• Cooling (from disposing of excess heat to the environment);

• Process wastewater (including both water used for making and washing products and for removal and transport of waste and by-products); and

• Cleaning (including wastewater from cleaning and maintenance of industrial areas).

Excluding the large volumes of cooling water discharged by the electric power industry, the wastewater production from urban areas is about evenly divided between industrial and municipal sources. Therefore, the use of water by industry can significantly affect the water quality of receiving waters. The level of wastewater loading from industrial sources varies markedly with the water quality objectives enforced by the regulatory agencies. There are many possible in-plant changes, process modifications and water-saving measures through which industrial wastewater loads can be significantly reduced. Up to 90 % of recent wastewater reductions have been achieved by industries employing such methods as recirculation, operation modifications, effluent reuse or more efficient operation. As a rule, treatment of an industrial effluent is much more expensive without water-saving measures than the total cost of in-plant modifications and residual effluent treatment. Industrial wastewater effluents are usually highly variable, with quantity and quality variations brought about by bath discharges, operation start-ups and shut-downs, working-hour distribution and so on.

I.4.The Principal Parameters of Water Quality

4.1. ACRYLAMIDE

- **Chemical Symbol or Formula**: C3H5NO.
- **Units Used for Analytical Results:**µg/l compound.
- **Normal Method(s) of Analysis**: Chromatography [C/D]
- **Occurrence/Origin:** Synthetic chemical which is the monomer from which polyacrylamide isderived.
- **Health/Sanitary Significance:** Highly toxic, acrylamide is a carcinogenic substance. It can also be absorbed readily through unbroken skin and it affects the central nervous system.
- **Background Information:** Polyacrylamide is used as a flocculant aid in water treatment and the polymeric substance inevitably contains traces of acrylamide monomer.

• **Comments:** The WHO Guidelines note that "the most important source of drinking-water contamination by acrylamide is the use of polyacrylamide flocculants that contain residual, acrylamide monomer" and adds that "concentrations in drinking-water can be controlled byproduct and dose specification

ALKALINITY

- **Chemical Symbol or Formula** :Not Applicable

- **Units Used for Analytical Results:** mg/l $CaCO_3$.

- **Normal Method(s) of Analysis:** Titration with Sulphuric Acid

- **Occurrence/Origin:** The alkalinity of a natural water is generally due to the presence of bicarbonates formed in reactions in the soils through which the water percolates. It is a measure of the capacity of the water to neutralise acids and it reflects its so-called buffer capacity (its inherent resistance to pH change). A poorly-buffered water will have a low or very low alkalinity and will be susceptible to pH reduction by, for example, "acid rain." At times, however, river alkalinity values of up to 400 mg/l $CaCO_3$may be found; they are without significance in the context of the quality of the water. Health/Sanitary Significance: There is little known sanitary significance attaching to alkalinity (even up to 400 mg/l $CaCO_3$), though unpalatability may result in highly alkaline waters.

- **Background Information:** Alkalinity in natural waters may also be attributable to carbonates and hydroxides. Sometimes analysis is carried out to distinguish between the alkalinity elements and this is done by using different indicators in the titration procedure and by making appropriate calculations. The indicators most commonly employed are phenolphthalein (colour change aroundpH8.3) and methyl orange (colour change around pH4.5), resulting in the additional termsphenolphthale in alkalinity and methyl orange alkalinity; the latter is synonymous with total alkalinity. Alkalinity is involved in the consequential effects of eutrophication [over-enrichment] of waters. Where a high degree of photosynthesis occurs, as discussed below under "Oxygen ,Dissolved" (q.v.), there is a high consumption of carbon dioxide by algae. As any free carbon dioxideinitially available is consumed, more is produced in a series of related chemical equilibrium reactions, as follows: 1.$H^+ + HCO_3^- \Leftrightarrow H_2CO_3[H_2O+CO_2]$2.$H^+ + CO_3^{--} \Leftrightarrow HCO_3^-$3.$H_2O \Leftrightarrow H^+ + OH^-$ .As the carbon dioxide is consumed by photosynthesis, more is produced (reaction 1, left toright) by the action of bicarbonate ions, present as alkalinity, and hydrogen ions to give undissociated carbonic acid (carbon dioxide and water).

Any carbonate ions present will then react with more hydrogen ions to replace the bicarbonate consumed (reaction 2, again left to right). Both these reactions consume hydrogen ions, more of which are produced as in reaction 3 (equilibrium again to the right). A net overall effect is the production of hydroxyl ions and an increase in the pH . It is not uncommon for extreme photosynthetic activity to produce pH levels high enough to cause serious damage (even death) to fish

4.2.ALUMINIUM

- **Chemical Symbol or Formula:** Al.

- **Units Used for Analytical Results:** mg/l Al.

- **Normal Method(s) of Analysis:** Colorimetry [B]; Atomic Absorption Spectrometry [B/C].

- **Occurrence/Origin:**Aluminium is one of the most abundant elements in the earth's crust. Asalt, aluminiumsulphate, is very widely used for colour- and colloid-removal in the treatment of waters for drinking. Health/Sanitary Significance: Not originally considered to be a significant health hazard in drinking waters, aluminium has more recently been shown to pose a danger to persons suffering from kidney disorders. It causes neurological problems and has been cited as a contributory factor to Alzheimer disease. However, the WHO Guidelines for Drinking-Water Quality2states that: There is a need for further studies, but the balance of epidemiological and physiological evidence at present does not support a causal role for aluminium in Alzheimer disease. Therefore, no health-based guideline value is recommended.

- **Background Information**: The compound aluminiumsulphate ("alum") is very widely used in water treatment to remove colour and non-filtrable matter in raw waters. The alum is hydrolysed and is converted to a flocculent hydroxide which, being dense and insoluble, precipitates bringing with it the offending colour and turbidity particles. With careful plant control it is possible to ensure that residual aluminium levels are acceptable (i.e. 0.2 mg/l Al or less, above which discoloration may occur).

- **Comments:**Aluminium levels are limited under the Drinking Water Directive 198/83/EC]

4.3.AMMONIA

- **Chemical Symbol or Formula:** NH3.

- **Units Used for Analytical Results:** mg/l N.

- **Normal Method(s) of Analysis:** Colorimetric (Manual; Nessler's Reagent) [A/B];Colorimetric (Automated; Berthelot Reaction) [B/C].

- **Occurrence/Origin:** Ammonia is generally present in natural waters, though in very small amounts, as a result of microbiological activity which causes the reduction of nitrogen-containing compounds. When present in levels above 0.1 mg/l N, sewage or industrial contamination may be indicated. Health/Sanitary Significance: From the viewpoint of human health the significance of ammonia is marked because it indicates the possibility of sewage pollution and the consequent possible presence of pathogenic micro-organisms.

- **Background Information:** The form of the ammonia - whether it is "free" (as NH3) or «saline"(as NH4+) in slightly acid waters - depends on the pH and these forms are not distinguished from one

another during analysis. The different terms commonly applied to the forms of ammonia are as follows: total ammonia (NH3&NH4+)total ammonium (NH3&NH4+)free ammonia (NH3)free and saline ammonia (NH3&NH4+) ionised ammonia (NH4+) andun-ionised ammonia (NH3).The different forms arise from the pH/temperature related equilibrium reactions:1.NH3+H2O⇔NH3.H2O2.NH3.H2O⇔NH4++OH–.The ammonia tolerances for fishery waters are narrow and have been considered and reported on by the European Inland Fisheries Advisory Commission. Research has shown that it is the un-ionised species of ammonia which is most harmful to freshwater aquatic life and to gamefish, in particular. Arising from the complex relationship between total ammonia concentration, pH and temperature there emerges a level for total ammonia of around 0.3 mg/l NH3which is considered to be that which would contain the limiting amount of un-ionised ammonia (see Appendix 3 for full details). Because of the ease of natural interconversion from one form to another - this could be brought about by pH changes caused by algal activity, for example – the total ammonia levels should be very low.

- **Comments:** Before the advent of microbiological techniques for assessing the potability of a water the analysis for ammonia was used as an indication of sewage contamination, often in conjunction with chloride, because both are present in significant quantities in sewage. High ammonia levels interfere with chlorination processes in water treatment, an aspect which is discussed in detail below (see "Chlorine"). The formation of chloramine compounds (which are much less portends infect ants than free chlorine) by reaction between the added chlorine and the ammonia present in the water necessitates an increased use of chlorine if disinfection efficiencies are to be maintained

ANTIMONY

- **Chemical Symbol or Formula:** Sb
- **Units Used for Analytical Results**: mg/l Sb.
- **Normal Method(s) of Analysis:** Atomic Absorption Spectrometry [B/C]
- **Occurrence/Origin:** Naturally occurring trace element used in metal industry and in flame retardant materials. Antimony can occur naturally in water from weathering of rocks but is more likely to arise from effluents. Health/Sanitary Significance: Although the health effects of antimony have not been established definitively, there is evidence of actual or potential carcinogenicity of some antimony compounds. Accordingly, concentrations are limited in drinking water
- **Background Information:** Antimony levels in freshwater streams in the US can be around 1µg/l.
- **Comments:** Antimony levels are limited under Drinking Water Directive [98/83/EC].

4.5. BARIUM

- **Chemical Symbol or Formula:** Ba.
- **Units Used for Analytical Results:** mg/l Ba. Normal Method(s) of Analysis: Turbidimetric [A/B];

Atomic Absorption Spectrometry [B/C].

- **Occurrence/Origin:** Naturally occurring mineral (e.g. in barytes), which has in the past been mined in several places in Ireland, including Benbulben in County Sligo. According to the WHO Guidelines, while food is the main source of barium intake by humans, where barium occurs in drinking water supplies the latter can contribute a significant proportion of total intake. Health/Sanitary Significance: Excessive amounts of barium can cause muscular, cardiovascular and renal damage. Although not markedly toxic, barium in excess quantities is clearly undesirable.

- **Background Information:** In normal surface waters levels are likely to below as traces of barium will react with sulphate present to form the highly insoluble barium sulphate.

4.6.BENZENE

- **Chemical Symbol or Formula:** C6H6.
- **Units Used for Analytical Results:**µg/l compound.
- **Normal Method(s) of Analysis:** Gas Chromatography [C].
- **Occurrence/Origin**: Constituent of some petroleum products; industrial raw material; solvent. Health/Sanitary Significance : Carcinogenic substance which also affects the central nervous system adversely.
- **Background Information:** Emissions from motor vehicles account for most of the benzene in the air, which can in due course reach the aquatic environment. Pollution from industrial sources can also introduce benzene to water.
- **Comments:** Benzene is not a naturally-occurring constituent of water.

4.7. BENZO (a)PYRENE3

- **Chemical Symbol or Formula:** C20H12.
- **Units Used for Analytical Results:**µg/l compound Normal Method(s) of Analysis: High-Pressure Liquid Chromatography [C]
- **Occurrence/Origin:** Synthetic complex aromatic organic compound formed by pyrolysis or combustion of organic materials. See discussion of “Polycychc Aromatic Hydrocarbons” below. Health/Sanitary Significance: Benzo (a) pyrene is a carcinogenic and mutagenic substance which is considered to be highly undesirable in drinking water,

even though the WHO Guide lines indicate that food is the main source of human exposure to this type of substance.

- **Background Information:** See “Polycyclic Aromatic Hydrocarbons” below.

- **Comments**: The undesirability of the presence of, and the need to restrict the concentrations of, benzo (a)pyrene is indicated clearly by its designation as a discrete parameter in Drinking Water Directive,in contrast to its former inclusion as a constituent of the group parameter“ Polycyclic Aromatic Hydrocarbons” (q.v.).

4.8.BERYLLIUM

- **Chemical Symbol or Formula:** Be.

- **Units Used for Analytical Results:** mg/I Be.

- **Normal Method(s) of Analysis:** Colorimetric (Aluminon) [B]; Atomic Absorption Spectrometry[B/C]

- **Occurrence/Origin:** The major source is combustion of fossil fuels, the metal reaching water through atmospheric fall- or wash-out. Weathering of rocks and soils, as well as discharges, also contributes .Health/Sanitary Significance: The metal and its compounds, if inhaled for example, are very toxic and can lead to a variety of respiratory and other diseases. The picture regarding the toxicity of beryllium and compounds in water and food is, however, very unclear and there is no compelling evidence in favour of restriction, hence the lack of standards.

- **Background Information:** It is used in brass and other alloys and also in the aircraft and space industries.

- **Comments:** It is significant that WHO refers to the low level of exposure risk. The parameter is listed in both the Surface Water and Drinking Water Directives - though without any limit values being quoted, hence its omission from the corresponding Regulations.

BORON

- **Chemical Symbol or Formula:** B.
- **Units Used for Analytical Results:** mg/l B. Normal Method(s) of Analysis: Colorimetric(Curcumin)[B];Atomic Absorption Spectrometry [B/C]
- **Occurrence/Origin:** Naturally occurring trace element. Used in cleaning compounds and in alloys. Health/Sanitary Significance: Although excessive amounts of boron can cause nervous problems, the element is not considered a problem in drinking water. It has been identified as a danger to crops when present in irrigation water at the 1 - 2 mg/l concentration range.
- **Background Information:** Present in seawater around 5 mg/l.
- **Comments:** The Surface Water and Drinking Water Regulations specify limits

BROMATE

- **Chemical Symbol or Formula**:BrO_3^-.
- **Units Used for Analytical Results:**µg/l BrO_3^-.
- **Normal Method(s) of Analysis:** Ion Chromatography [C]
- **Occurrence/Origin:** Occurs when bromide ions [Br^-] present in water are oxidized by ozone and some other oxidizing agents (including, it is believed, chlorine).Health/Sanitary Significance: Both carcinogenic and mutagenic.
- **Background Information:** Has come into prominence along with trihalomethanes [THM; q.v.],both being formed by the action of chlorine on constituents in water before it is distributed.
- **Comments:** Bromate was not a deter in and in the earlier Drinking Water Directive

CADMIUM

- **Chemical Symbol or Formula:** Cd.
- **Units Used for Analytical Results:**µg/l Cd.
- **Normal Method(s) of Analysis:** Atomic Absorption Spectrometry [B/C]
- **Occurrence/Origin:** In ores, including those of zinc. Cadmium in water is due nearly exclusively to industrial discharges (e.g. from electroplating, paint-making, manufacture of plastics etc) and landfill leachates.

- **Health/Sanitary Significance:** Very highly toxic, hence severe restrictions on its concentrations in waters.

- **Background Information:** The metal is very strongly adsorbed on muds, humus and organic matter, leading to the possibility 'of entry to the food chain via fish and fish food, and subsequent accumulation in tissue.

- **Comments:** The principal physiological effects of cadmium are bone damage, chronic kidney disease, cancer and hypertension. The metal is also highly toxic to aquatic life.

CALCIUM

- **Chemical Symbol or Formula:** Ca.

- **Units Used for Analytical Results:** mg/l Ca.

- **Normal Method(s) of Analysis:** Titration (Calcium Hardness) [A]; Atomic Absorption Spectrometry [B].

- **Occurrence/Origin:** Occurs in rocks, bones, shells etc. Very abundant.36

- Parameters of Water Quality - Interpretation and Standards Health/Sanitary Significance: High levels may be beneficial (see below) and waters which are rich in calcium (and hence are very hard) are very palatable.

- **Background Information:** This element is the most important and abundant in the human body and an adequate intake is essential for normal growth and health. The maximum daily requirement is of the order of 1 - 2 grams and comes especially from dairy products. There is some evidence to show that the incidence of heart disease is reduced in areas served by a public water supply with a high degree of hardness, the primary constituent of which is calcium, so that the presence of the element in a water supply is beneficial to health.

- **Comments:** Despite the potential health benefits of calcium abundance there are problems associated with hardness, as discussed below (q.v.)

CARBON DIOXIDE (FREE)

- **Chemical Symbol or Formula:** CO2

- **Units Used for Analytical Results:** mg/l CO2.

- **Normal Method(s) of Analysis:** Titration with Sodium Carbonate [A; field test]; Nomo graph [Alkalinity/Total Dissolved Solids] [B]

- **Occurrence/Origin:** From air, algal respiration, organic breakdown .Health/Sanitary Significance : None.

- **Background Information:** The chemical equations given for "Alkalinity" (q.v.) show the interrelationship between carbon dioxide, bicarbonate and carbonate. The primary interest in free carbon dioxide concentrations arises in connection with the behavior of waters in distribution systems - whether they will be corrosive or whether they will tend to deposit insoluble calcium carbonate as scale.

- **Comments**: High levels of free carbon dioxide may also enhance the effects of deoxygenation and of high ammonia concentrations. Excessive levels of carbon dioxide may have adverse effects on aquatic life.

CHLORIDE

- **Chemical Symbol or Formula:** Cl^-

- **Units Used for Analytical Results:** mg/l Cl.

- **Normal Method (s) of Analysis**: Titration (Mohr Method: Silver Nitrate) [A]

- **Occurrence/Origin:** Chloride exists in all natural waters, the concentrations varying very widely and reaching a maximum in sea water (up to35,000 mg/l Cl). In fresh waters the sources include soil and rock formations, sea spray and waste discharges. Sewage contains large amounts of chloride, as do some industrial effluents. Health/Sanitary Significance: Chloride does not pose a health hazard to humans and the principal consideration is in relation to palatability.

- **Background Information:** At levels above 250 mg/l Cl water will begin to taste salty and will become increasingly objectionable as the concentration rises further. However, external circumstances govern acceptability and in some arid areas waters containing up to 2,000 mg/l Clare consumed, though not by people unfamiliar with such concentrations. High chloride levels may similarly render freshwater unsuitable for agricultural irrigation.

• **Comments:** Because sewage is such a rich source of chloride, a high result may indicate pollution of a water by a sewage effluent. Natural levels in rivers and other fresh waters are usually in the range 15-35 mg/l Cl - much below drinking water standards. What is normally important to note in a series of results from a river, for example, is not the absolute level, but rather the relative levels from one sampling point to another. An increase of even 5 mg/l at one station may give rise to suspicions of a sewage discharge, especially if the free ammonia levels (q.v.) are also elevated. In coastal areas, however, elevated chloride values may be due to sea spray, or sea water infiltration, and not necessarily to discharges. Normal raw water treatment processes do not remove chloride.

CHLORINE, RESIDUAL

• **Chemical Symbol or Formula:** Cl2.

• **Units Used for Analytical Results:** mg/l Cl.

• **Normal Method(s) of Analysis:** Colorimetric (DPD) [A;in-situ test].

• **Occurrence/Origin:** Water treatment processes, industrial effluents, chlorinated sewage and other effluents. Health/Sanitary Significance: No direct significance at the relatively tiny levels used in water treatment processes.

• **Background Information:** Water supplies are disinfected to destroy or deactivate microorganisms which can produce diseases such as cholera, typhoid and so on, and the process is the most important in water treatment. Disinfection maybe achieved in various ways but the vast majority of supplies are treated with chlorine which is a powerful oxidising agent and an extremely efficient disinfectant. It is relatively easy to handle and is also cost-effective, hence its almost universal use. Chlorine is very reactive and will only remain, as discussed below, in treated waters of high quality. It is not a constituent of unpolluted natural waters. The primary effects of chlorination are extremely beneficial and for many minor water supplies the process may be the only treatment deemed necessary. Quite low levels are effective for disinfection in normal circumstances, but should the ammonia or organic content of the water be high then the water may have an appreciable "chlorine demand" and a higher chlorine input maybe needed to achieve a given degree of protection. As in many cases the treatment works for a public water supply may be a considerable distance from the ultimate consumers, it is essential that continuing protection be afforded along the distribution system, particularly if it is old and prone to leaks and/ or infiltration of extraneous matter. The philosophy underlying chlorination is therefore to ensure that there is a chlorine residual which will protect against recontamination. Dosage, contact time and other factors in thechlorinattion process will be adjusted so that a concentration of 0.1-0.3 mg/l Cl remains after 30minutes' contact. Chlorine reacts with water to form hypochlorous acid (HOCl) and hydrochloric acid (HCl).The former is a weak acid which dissociates to give hypochlorite ions (OCl–) and there is a chemical equilibrium between the dissociated and the undissociated forms (the latter actually effects the disinfection) but it is very common to add the chlorine as hypochlorite solution.

• Parameters of Water Quality - Interpretation and StandardsBecause of the reactivity with reducing agents and organic matter these free residual forms may not persist and there may not therefore be continuing protection. Ammonia will also react with chlorine forms to give mono-chloramine (NH2Cl), di-chloramine (NHCl2) and tri-chloramine (NCl3), depending on relative concentrations and pH. The mono- and di-chloramines have significant disinfection power which persists. Because of this it is sometimes the practice to add ammonia in the chlorination stage to give a combined residual rather than a free residual. The results of a complete analysis will therefore show from the relative proportions of free and combined residuals the extent to which disinfection can be maintained during distribution of as upply. Free chlorine is a more efficient disinfection agent than the chloramines but, being more reactive, it is more likely to disappear fairly quickly from solution; the combined chlorine, on the other hand, gives longer-lasting protection. Two further points should be noted about the use of chlorine. First, if a water is polluted by phenols or by trace organic compounds released from decaying algal growths, chlorination can giverise to very severe taste and odour problems, rendering

the water unfit to drink. Second, it should also be noted about chlorination that where a water contains even small amounts of organic(humic) colouring matter, the reaction between it and the added chlorine will give rise toundesirable chlorinated by-products [e.g. trihalomethanes; q.v.] which are also subject torestriction.

• **Comments:** Although chlorine is a poisonous gas, its toxicity to humans is not a consideration in drinking water supplies as a water would be unacceptable on organoleptic grounds long before the onset of directly toxic effects. There are, however, strict limits on its concentration in fishery waters as its toxicity to aquatic life forms is much more marked.

CHLOROPHYLL

- **Chemical Symbol or Formula:[**Complex chemical structure; rarely used]

- **Units Used for Analytical Results:**μg/l or mg/m3chlorophyll (total)4Normal Method(s) of Analysis: Solvent extraction/Colorimetry [B]

- **Occurrence/Origin:** Naturally-occurring green pigment in algae, cyanobacteria, plants, vegetation. **Health/Sanitary Significance:** No direct implications for health or sanitation.

- **Background Information:** Chlorophyll is perhaps the single most important parameter in the assessment of the water quality of lakes, particularly in regard to their trophic quality (i.e. whether or not, or to what degree, they are enriched due to the presence of nutrients such asphosphorus and - to a much lesser extent - nitrogen in the form of nitrate}. Excessive nutrient presence in lakes promotes the growth of algae which in overabundance cause serious environmental problems. In over-enriched - eutrophic - lakes "algal blooms" can occur. These are sur face accumulations of cyanobacteria (formerly classified as blue-green algae), i.e. dense masses of algae which can be swept by the winds into bays or along the lake shore (where they can decay, causing further problems), and which can seriously disrupt the dissolved oxygen regime. In day time, when conditions are bright or sunny, the algae will carry out photosynthesis, consuming carbon dioxide and releasing oxygen to the waterbody (see "Oxygen, Dissolved"). In darkness, however, the algae respire, consuming dissolved oxygen the levels of which may become critically low - low enough, in fact, to cause fish mortality. Cyano bacterial and algal material can release trace organic components which can cause severe problems on two main accounts. Firstly, the compounds released by cyanobacteria can prove toxic to animals ingesting the water in which they are present. It has been necessary in some instances for local authorities to warn the public not to walk dogs along affected lakeshores or to allow them access to the water. Secondly, in cases where algae are present they can give rise to taste and odour problems if the water is used as drinking water source. One characteristic of waters affected by algal presence is a musty taste or odour . The tastes and odours are much more pronounced if the water is chlorinated prior to distribution as drinking water. In some instances the severity of the taste and odour has been such that temporary closure of the supply was needed. There are no mandatory standards for chlorophyll concentrations in water, nor are the rereferences to the parameter in the various EU Directives relating to water quality. However, the Organization for Economic Cooperation and Development [OECD] in 1982 proposed a trophic classification scheme for lake waters which has been adopted (with modifications) in Ireland by the EPA, and which forms the basis for the reporting of quality status in lakes. This scheme is shown in the table below and alongside it is a summation of the corresponding environmentalcharacteristics.

- **Comments:** While not mandatory, the modified OECD classification is an invaluable tool in the categorization of Irish lake waters.

CHROMIUM

- **Chemical Symbol or Formula**: Cr.
- **Units Used for Analytical Results**: mg/l Cr.
- **Normal Method(s) of Analysis :** Atomic Absorption Spectrometry [B/C].
- **Occurrence/Origin:** Natural occurrence is in ore, but chromium arises in surface waters from discharges from electroplating, tanning, textile, paint and dyeing plants. Health/Sanitary Significance: Chromium is toxic, to a degree which varies with the form in which it occurs, whether as the trivalent CrIII or the hexavalent CrVI form. The latter is considered the more hazardous but because it is difficult to distinguish by analysis the figures quoted below refer mainly to the total chromium concentrations.
- **Background Information:** The element is an essential dietary requirement - in limited amounts - and a deficiency can lead to disruption of glucose metabolism. Indeed, it has been reported that chromium deficiency is of greater nutritional concern than overexposure. However, itis considered that the element is carcinogenic (at high concentrations), though much more evidence of this is needed, and it can act as a skin irritant. Hence its limitation in domestic water supplies.The deaths of livestock resulting from watering in chromium-contaminated water have been reported from time to time.

- **Comments:** There is an extensive list of criteria/standards/recommendations for this element.

COBALT

- **Chemical Symbol or Formula:** Co.
- **Units Used for Analytical Results:** mg/l Co.
- **Normal Method(s) of Analysis:** Atomic Absorption Spectrometry [B/C].
- **Occurrence/Origin:** Occurs in ores. Presence in water due to discharges. Health/Sanitary Significance: Little significance in water due to low level of occurrence. The metal and its compounds are hazardous as solids or strong solutions.
- **Background Information:** Cobalt is contained in the Vitamin B12molecule and as such is an important dietary requirement, being provided by green vegetables, in particular. It is rarely found in natural waters and, accordingly, there are few recommendations as to its limitation.
- **Comments:** The lack of standards for drinking water reflects the minimal risk.

COPPER

- **Chemical Symbol or Formula:** Cu.
- **Units Used for Analytical Results:** mg/l Cu.
- **Normal Method(s) of Analysis:** Atomic Absorption Spectrometry [B/C]
- **Occurrence/Origin:** Ores; industrial wastes. Health/Sanitary Significance: Copper is not particularly toxic to humans (indeed, it is an essential dietary requirement) and medicinal doses up to 20 mg/l are not unknown. However, astringent tastes in water can be caused by levels above 1 mg/l Cu.
- **Background Information:** This element is present naturally in metalliferous areas but more often its presence in waters is due to attack on copper piping. Rarely, its occurrence may be due to its use as an algicide. Unless used with great care for algal control there is a grave risk of fish kills, as it is as a toxicant to fish that copper is of greatest interest. In recent years there has been at least one major fish kill attributed to the

improper use of copper as an algal toxicant. Copper is an element the toxicity of which to fish varies widely with the hardness of the water.

- **Comments:** A problem associated with high levels of copper in water is galvanic corrosion of tanks.

CYANIDE

- **Chemical Symbol or Formula:** CN–
- **Units Used for Analytical Results:** mg/l CN.
- **Normal Method(s) of Analysis:** Colorimetric (after distillation) (B]; Specific Ion Electrode (after distillation) [B].
- **Occurrence/Origin:** Industrial effluents (principally electroplating).Health/Sanitary Significance: Cyanide is a reactive, highly toxic entity which in excessive amount will cause mortality rapidly to humans and to fish.
- **Background Information:** It is a common constituent of industrial wastes, especially from metal plating processes and electronic components manufacture.
- **Comments:** Due to its reactivity cyanide does not persist in the environment
- Parameters of Water Quality - Interpretation and Standards Cryptosporidium: Notes[1]While the Directive does not include Cryptosporidium in. any of its lists of parameters, Article 4stipulates that: "For the purposes of the minimum requirements of this Directive, water intended for human consumption shall be clean and wholesome if it: ...is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to public health."

CYANIDE

- **Chemical Symbol or Formula:** CN–
- **Units Used for Analytical Results:** mg/l CN.
- **Normal Method(s) of Analysis:** Colorimetric (after distillation) (B]; Specific Ion Electrode (after distillation) [B].

- **Occurrence/Origin:** Industrial effluents (principally electroplating).Health/Sanitary Significance: Cyanide is a reactive, highly toxic entity which in excessive amount will cause mortality rapidly to humans and to fish.

- **Background Information:** It is a common constituent of industrial wastes, especially from metal plating processes and electronic components manufacture.

- **Comments:** Due to its reactivity cyanide does not persist in the environment. Cyanide : Recommended or Mandatory Limit Values

-DICHLOROETHANE

- **Chemical Symbol or Formula :** $C_2H_4Cl_2$.

- **Units Used for Analytical Results:**µg/l $C_2H_4Cl_2$.

- **Normal Method(s) of Analysis**: Gas Chromatography [C].

- **Occurrence/Origin:** Synthetic organic solvent used in various industries. Health/Sanitary Significance: Toxic substance which causes a variety of ill-effects in humans, including eye damage, dermatitis, narcotic effects etc.

- **Background Information:** The compound is alternatively known as ethylene dichloride. It is used as a solvent for a variety of materials, especially rubber.

- **Comments:** This only limit for this substance occurs in Drinking Water Directive [98/83/EC]

EPICHLOROHYDRIN

- **Chemical Symbol or Formula:** C_3H_5ClO.

- **Units Used for Analytical Results**: µg/l C_3H_5ClO.

- **Normal Method(s) of Analysis:** Gas Chromatography [C].

- **Occurrence/Origin:** Synthetic chlorinated solvent. Health/Sanitary Significance: Toxic substance which is a strong skin irritant and which can cause kidney and other damage.

- **Background Information:** Solvent for resins, gums, enamels, cellulose, lacquers etc.

• **Comments:** This is another of the series of chlorinated solvents the concentration of which in drinking water is subject to strict controls

FLUORIDE

• **Chemical Symbol or Formula**: F–.

• **Units Used for Analytical Results**: mg/I F.

• **Normal Method(s) of Analysis:** Colorimetric (after distillation) [B]; Specific Ion Electrode [B].

• **Occurrence/Origin:** Occurs naturally in quite rare instances; arises almost exclusively from fluoridation of public water supplies and from industrial discharges. Health/Sanitary Significance: Health studies have shown that the addition of fluoride to water supplies in levels above 0.6 mg/l F leads to a reduction in tooth decay in growing children and that the optimum beneficial effect occurs around 1.0 mg/l.

• **Background Information:** At levels markedly over 1.5 mg/l an inverse effect occurs and mottling of teeth (or severe damage at gross levels) will arise. For this reason there is a constraint on fluoride levels, the effects of which vary with temperature.

• **Comments:** It should be noted that fluoride levels in fluoridated public water supplies in Ireland are legally restricted to the range 0.8-1.0 mg/l F. The same legislation specifies the distillation procedure for fluoride analysis. In making the 1988 Drinking Water Regulations the then Minister for the Environment fixed 1.0 mg/l F [1,000 μg/1 F] as the MAC. Thus the limit value for fluoride in Ireland is one-third less than that which applies elsewhere in the EU

IRON

• **Chemical Symbol or Formula:** Fe.

• **Units Used for Analytical Results**: mg/l Fe.

• **Normal Method(s) of Analysis:** Colorimetric (o-PhenanthroIine) [B]; Atomic Absorption Spectrometry [B/C]

• **Occurrence /Origin**: Geological formations (especially under reducing conditions); acid drainage; effluent discharges. Health/Sanitary Significance: The objections to iron are primarily organoleptic, but there has been recent medical concern about high levels in drinking water.

- **Background Information:** Iron is present in significant amounts in soils and rocks, principally in insoluble forms. However, many complex reactions which occur naturally in ground formation scan give rise to more soluble forms of iron which will therefore be present in water passing through such formations. Appreciable amounts of iron may therefore be present in ground waters. Severe problems can be caused in drinking water supplies by the presence of iron although there is normally no harmful effect on persons consuming waters with significant amounts of iron. Rather ,the problems are primarily aesthetic, as the soluble (reduced) ferrous (Fe++)iron is oxidisedinair to the insoluble ferric (Fei+++) form, resulting in colour or turbidity (or, in severe cases, precipitate formation). Laundry becomes stained if washed in water with excessive iron, and vegetables likewise become discoloured on cooking. Taste problems may also occur. When waters rich in iron are used to make tea (in which tannins are present) there may be a reaction giving rise to off-colours which may in severe cases resemble that of ink. Problems have been reported also with the addition of such waters to whiskey.

- **Comments:** The metal is quite harmful to aquatic life, as evidenced by laboratory studies, but in nature the degree of toxicity may be lessened by the interaction of the iron with other constituents of a water. Should the metal be converted to an insoluble form then the iron deposits will interfere with fish food and with spawning

LEAD

- **Chemical Symbol or Formula**: Pb.

- **Units Used for Analytical Results**: mg/l Pb.

- **Normal Method(s) of Analysis:** Atomic Absorption Spectrometry s [B/C/D]

- **Occurrence/Origin:** Leaching from ores; effluent discharges; attack on water pipes. Health/Sanitary Significance: Toxic cumulative poison.

- **Background Information:** Lead is one of the most commonly determined heavy metals. Because it accumulates in body tissue it follows that strict limits on its presence in raw and finished drinking waters must be imposed. Particular attention is paid to this element as in many older houses extensive use is made of lead piping and there is a danger of lead being brought into solution ("plumbosolvency"). Levels may be quite marked in samples taken first thing in the morning when the initial yield will be of water which has been standing in such pipes for perhaps twelve hours. Hence the recommendation that drinking water pipes be flushed briefly in the morning before the water is consumed.

- **Comments:** The comments accompanying the standard in the Drinking Water Regulations reflect the fact that some waters which are in prolonged contact with old lead pipes are liable to dissolve possibly significant amounts of the metal. However, in Ireland there are no perceived risks from the normal daytime use of such water/plumbing combinations when throughput is likely to be high. In the EU as a whole, however, there is heightened concern about lead in drinkingwater, as is shown clearly in the notes below pertaining to Drinking Water Directive [98/83/EC]

MAGNESIUM

- **Chemical Symbol or Formula:** Mg.

- **Units Used for Analytical Results:** mg/l Mg.

- **Normal Method(s) of Analysis:** Titration with EDTA [A]; Atomic Absorption Spectrometry[B/C].Occurrence/Origin :Major constituent of geological formations. Health/Sanitary Significance: Indirect (in conjunction with Sulphate, q.v.).

- **Background Information :** Like calcium (q.v.), magnesium is abundant and a major dietary requirement for humans (0.3-0.5 g/day). It is the second major constituent of hardness (see above) and it generally comprises 15-20 per cent of the total hardness expressed as $CaCO_3$.Itsconcentration is very significant when considered in conjunction with that of sulphate (q.v.).

- **Comments:** Magnesium sulphate is used medicinally as "Epsom Salts," a laxative.

MANGANESE

- **Chemical Symbol or Formula:**Mn.

- **Units Used for Analytical Results:** mg/l Mn.

- **Normal Method(s) of Analvsis:** Colorimetric (Persulphate) [B]; Atomic Absorption Spectrometry [B/C].

• **Occurrence/Origin:** Widely distributed constituent of ores and rocks. Health/Sanitary Significance :No particular toxicological connotations; the objections to manganese - like iron - are aesthetic.

• **Background Information:** As with iron, manganese is found widely in soils and is a constituent of many ground waters. It, too, may be brought into solution in reducing conditions and the excess metal will be later deposited as the water is reaerated. The general remarks for iron (q.v.) apply to manganese but the staining problems with this metal may be even more severe, hence the quite stringent limits. A second effect of the presence of manganese much above the limits is an unacceptable taste problem.

• **Comments:** Toxicity is not a factor, as waters with high levels of manganese will be rejected by the consumer long before any danger threshold is reached.

MERCURY

• **Chemical Symbol or Formula:** Hg.

• **Units Used for Analytical Results:**µg/l Hg.

• **Normal Method(s) of Analysis**: Flameless Atomic Absorption Spectrometry [C]; or ICP [inductively-coupled plasma] Spectroscopy [D].

• **Occurrence/Origin :**Normally from industrial waste discharges. Health/Sanitary Significance: Very toxic, especially in organo-mercury compounds (e.g.methyl-mercury).

• **Background Information:** This is a very toxic element, the hazards of which are magnified by the accumulation of organo-mercury compounds in fish. It is generally industrial in origin (dental amalgams, anti-fouling paints, plastics manufacture, Hgttery-making, paper-making and so on) though some comes from the natural environment.

• **Comments:** There have been some major pollution incidents (notably in Japan) where both death and severe damage to health has been caused to many people consuming fish and shellfish contaminated by heavy industrial discharges of mercury.

METHYLENE BLUE-ACTIVE SUBSTANCES

• **Chemical Symbol or Formula:** Not applicable [Bulk parameter].Units Used for Analytical Results: mg/l reference material (Lauryl sulphate; Manoxol OT etc.)

- **Normal Method(s) of Analysis:** Methylene Blue/Solvent Extraction [B]

- **Occurrence/Origin:** Synthetic materials in domestic and industrial wastes
- **Health/Sanitary Significance :**No immediate implications as other problems (see below) will prevent consumption of waters with these materials present.

- **Background Information:** Often abbreviated to MBAS, the designation of this parameter is the chemically correct term for the group of compounds commonly known as anionic detergents. To cloud the issue further, the non-specific terms surf octants (surface active agents) and syndets (synthetic detergents) are also used on occasion, the former more frequently. Synthetic detergents, fall into three groups - anionic, cationic and non-ionic. The last-mentioned are all substituted polymers of ethylene oxide which do not ionise in water. They are more expensive than the anionic type but are coming into greater use. The cationic types are salts of quaternary ammonium hydroxide and are known for their properties of disinfection. The major group comprises the anionic detergents which are all sodium salts of organic sulphates or sulphonates. Such entities form ion pairs with the reagent methylene blue, a property which forms the basis of their estimation. The results are quoted as mg/l standard reference material. Some authorities specify lauryl sulphate which is used increasingly as a standard. However, UK practice has been to use a chemically similar but distinct material, ManoxolOT (sodium di-octyl sulphosuccinate), and it is therefore important to note which terms are used to express the results. It is worth noting that other terms have been used in connection with synthetic detergents. "Hard" and "soft" detergents are those which are biodegraded with difficulty and with easy ,respectively. The designations have nothing to do with the hardness of the waters in which they are used. Some of the original anionic detergents were very hard; structurally they were of the "ABS" (alkyl benzene sulphonate) type. Later, there was a move towards the much more biodegradable ("soft") linear alkylate sulphate/ sulphonate ("LAS") detergents. This was to help eliminate the major problem of foaming .In the US very severe foaming problems were encountered in the days of first use of synthetic detergents. Other disadvantages associated withthem include interference with the reaeration of water which is low in dissolved oxygen, and the synergistic foaming effects which can

arise when waters containing sub-foaming concentrations of different types of detergents are mixed. Most detergent preparations contain around 20 per centsurface active agent (which is all that is determined in this test): the rest of the formulation consists of so-called "builders" which enhance the properties of the active constituent. Chief among these are phosphates which are of major environmental significance (see below).

- **Comments**: It should be noted that, as there may be some extraneous matter which will also react with methylene blue, the analysis is more correctly designated as "methylene blue active substances" than as anionic detergents, even though the latter may in fact represent 100 per cent of levels found

MOLYBDENUM

- **Chemical Symbol or Formula**: Mo.
- **Units Used for Analytical Results** : mg/l Mo.
- **Normal Method(s) of Analysis:** Atomic Absorption Spectrometry [B/C]
- **Occurrence/Origin:** Industrial effluents, but low occurrence rate .

Health/Sanitary Significance :None.

- **Background Information:** Natural molybdenum levels in waters likely to be used as sources of public supply are very low and, in any event, human toxicity caused by this metal is very rare. However, the sensitivity of livestock to the element has been found to be significant although no specific limits for water have apparently been set for animal drinking water
- **Comments:** There are no applicable standards for this element

NICKEL

- **Chemical Symbol or Formula:** Ni.
- **Units Used for Analytical Results:** mg/l Ni.
- **Occurrence/Origin:** Principal sources are minerals and industrial wastes.

Health/Sanitary Significance: Very limited.

- **Background Information:** This is another metallic element which is of moderate concern because of possible carcinogenicity as far as humans are concerned; it also has variable harmful effects on aquatic life. It is toxic to plant life, too, and is a hazard to fish.

NITRATE

- **Chemical Symbol or Formula:** $NO_3^–$
- **Units Used for Analytical Results**: mg/l N or mg/l $NO_3^–$.
- **Occurrence/Origin:** Oxidation of ammonia: agricultural fertilizer run-off.

Health/Sanitary Significance: Hazard to infants above 11 mg/l N [50 mg/l NO_3].

- **Background Information:** Relatively little of the nitrate found in natural waters is of mineral origin, most coming from organic and inorganic sources, the former including waste discharges and the latter comprising chiefly artificial fertilizers. However, bacterial oxidation and fixing of nitrogen by plants can both produce nitrate. Interest is centred on nitrate concentrations for various reasons. Most importantly, high nitrate levels in waters to be used for drinking will render them hazardous to infants as they induce the "blue baby" syndrome (methaemoglobinaemia). The nitrate itself is not a direct toxicant but is a health hazard because of its conversion to nitrite [see also below] which reacts with blood hemoglobin to cause methaemoglobinaemia.68

- Parameters of Water Quality - Interpretation and Standards of increasing importance is the degree to which fertilizer run-off can contribute to eutrophication problems in lakes. Sewage is rich in nitrogenous matter which through bacterial action may ultimately appear in the aquatic environment as nitrate. Hence, the presence of nitrate in ground waters, for example, is cause for suspicion of past sewage pollution or of excess levels of fertilizers or manure slurries spread on land. (High nitrite levels would indicate more recent pollution as nitrite is an intermediate stage in the ammonia-to-nitrate oxidation). In rivers high levels of nitrate are more likely to indicate significant run-off from agricultural land than anything else and the parameter is not of primary importance per se. However, it should be noted that there is a general tendency for nitrate concentrations in rivers to increase as a result of enhanced nutrient run-off; this may ultimately lessen their utility as potential sources of public water supply. Nitrite concentrations in rivers are rarely more than 1 - 2 per cent of the nitrate level so that it may therefore be acceptable to carry out the analytically convenient determination of nitrate + nitrite at the same time. This determination is correctly referred to as total oxidized nitrogen.

- **Comments:** Although the topic of the units in which analytical results are expressed is dealt with in detail in Appendix 2, it should be noted here that very often nitrate results as expressed asNO3rather than as N and that there is over a four-fold difference between the applicable limit values, the former being the higher

NITRITE

- **Chemical Symbol or Formula:**NO2–
- **Units Used for Analytical Results**: mg/l NO2–.
- **Normal Methods of Analysis:** Manual or Automated Colorimetry [A/B]
- **Occurrence/Origin**: Generally from untreated or partially treated wastes.
- **Health/Sanitary Significance**:Methaemoglobinaemia-causing agent [cf. Nitrate].
- **Background Information:** Nitrite exists normally in very low concentrations and even in waste treatment plant effluents levels are relatively low, principally because the nitrogen will tend to exist in the more reduced (ammonia; NH3)or more oxidized (nitrate;NO3)forms. Because nitrite is an intermediate in the oxidisation of ammonia to nitrate, because such oxidation can proceed in soil, and because sewage is a rich source of ammonia nitrogen, waters which show any appreciable amounts of nitrite are regarded as being of highly questionable quality. Levels in unpolluted waters are normally low, below 0.03 mg/l NC) 2. Values greater than this may indicate sewage pollution.
- **Comments:** The significance of nitrite (at the low levels often found in surface waters) is mainlyas

an indicator of possible sewage pollution rather than as a hazard itself although, as mentioned above under "Nitrate" (q.v.), it is nitrite rather than nitrate which is the direct toxicant. There is, accordingly, a stricter limit for nitrite in drinking waters. In addition, nitrites can give rise to the presence of nitrosamines by reaction with organic compounds and there may be carcinogenic effects

PHOSPHATES

- **Chemical Symbol or Formula**:PO4–––.
- **Units Used for Analytical Results:** mg/l P.

- **Normal Method (s) of Analysis**: Manual or Automated Colorimetry.

- **Occurrence/Origin:** Phosphorus occurs widely in nature in plants, in micro-organisms, in animal wastes and so on. It is widely used as an agricultural fertiliser and as a major constituent of detergents, particularly those for domestic use. Run-off and sewage discharges are thus important contributors of phosphorus to surface waters.
- **Health/Sanitary Significance:** None.

- **Background Information:** The significance of phosphorus is principally in regard to the phenomenon of eutrophication (over-enrichment) of lakes and, to a lesser extent, rivers. Phosphorus gaining access to such water bodies, along with nitrogen as nitrate, promotes the growth of algae and other plants leading to blooms, littoral slimes, diurnal dissolved oxygen variations of great magnitude and related problems, as discussed elsewhere in this volume. There is considerable debate as to the availability of the various forms of phosphorus (orthophosphate, polyphosphate, organic phosphate and so on) for the growth of algae although itis considered that orthophosphate is the most readily used form. Phosphorus may be in true solution, in colloidal suspension or adsorbed onto particulate matter, and it is very difficult todifferentiate between the various fractions by separation (e.g. filtration) or analysis. A useful parameter is orthosphosphate (strictly, total filtrable and non-filtrable orthophosphate) which is the phosphate responding to the analytical procedure without any pre-treatment such ashydrolysis or oxidative digestion. Caution must be exercised in considering the results of phosphorus analysis as the element exists in bound and unbound forms which are very difficult to separate totally in analysis. There is always the likelihood, for example, of some of the bound polyphosphate forms being changed by hydrolysis to orthophosphate under the actual analytical conditions. However, the determination of orthophosphate as specified is of great use in highlighting the presence of one of the most important nutrients and the results are of special interest in waters receiving sewage discharges. The importance of controlling phosphorus levels in the Irish aquatic environment is highlighted by the publication (in May 1997) by the Minister for the Environment and Local Government of a 10-year strategy paper entitled Managing Ireland's Rivers and Lakes – A Catchment-Ba-sed Strategy Against Eutrophication. This document deals with the topic of phosphorus levels (expressed as mg/l median Molybdate-

Reactive Phosphate [MRP]9)and it sets out interim statutory standards, in terms of MRP, for the year 2007 for water in several quality classes, rivers and lakes being treated separately.

• **Comments:** These statutory standards are presented below, following the details of phosphorus standards in other legislation.

POTASSIUM

• **Chemical Symbol or Formula:** K.

• **Units Used for Analytical Results:** mg/l K.

• **Normal Method(s) of Analysis:** Flame Photometry [B/C], Atomic Absorption Spectrometry [B/C].

• **Occurrence/Origin:** Geological formations.

Health/Sanitary Significance : None, except at gross levels

• **Background Information**: Potassium is an essential constituent of many artificial fertiliser formulations, and hence its determination is often carried out on lake waters when an assessment is being made of nutrient input. However, potassium tends to be "fixed" in soils and is not that easily leached out. There are no implications of toxicity.

• **Comments**: Very often potassium is measured on samples solely to permit the calculation of an"ion balance" for the verification of the analysis

SILVER

• **Chemical Symbol or Formula:** Ag.

• **Units Used for Analytical Results:** mg/l Ag.

• **Normal Method(s) of Analysis:** Atomic Absorption Spectrometry [B/C]

• **Occurrence/Origin:** Ores, industrial wastes (e.g. photographic effluents).

- **Health/Sanitary Significance:** Metal of varying toxicity.

• **Background Information:** This metal is toxic, especially to micro-organisms, and its soluble salts are excellent disinfectants. It is not considered particularly toxic to humans and, as it is likely to be found only in very low levels (such that it would be practically impossible to reach hazardous levels through consumption of water and food), few limits have been set. However, it has been reported that restrictions on its use were introduced to discourage the use of silver as adisinfectant because of possible health effects if used unduly liberally.

- **Comments:** Nowadays, economic considerations are likely to restrict the discharge of silver.

SODIUM

- **Chemical Symbol or Formula:** Na.
- **Units Used for Analytical Results:** mg/l Na.
- **Occurrence/Origin:** Abundant constituent of rocks and soils.

Health/Sanitary Significance: Causes hypertension if taken in excess.

- **Background Information**: Sodium is always present in natural waters. It is also an essentialdietary requirement and the normal intake is as common salt (sodium chloride) in food; daily consumption

may amount to 5 grams or more. The main reason for limiting it is the joint effect which it exercises with sulphate (see below) but too excessive an intake (the latter normally being2-3 times the dietary threshold) can cause hypertension, as mentioned.

- **Comments:** Sodium sulphate is used medicinally as a laxative ["Glauber Salts"]

SULPHATE

- **Chemical Symbol or Formula**:SO4—.
- **Units Used for Analytical Results:** mg/l SO4
- **Occurrence/Origin** :Rocks, geological formations, discharges and so on .

- **Health/Sanitary Significance:** Excess sulphate has a laxative effect, especially in combination with magnesium and/or sodium.

- **Background Information**: Sulphates exist in nearly all natural waters, the concentrations varying according to the nature of the terrain through which they flow. They are often derived from the sulphides of heavy metals (iron, nickel, copper and lead). Iron sulphides are present in sedimentary rocks from which they can be oxidized to sulphate in humid climates; the latter may then leach into watercourses so that ground waters are often excessively high in sulphates. As magnesium and sodium are present in many waters their combination with sulphate will have an enhanced laxative effect of greater or lesser magnitude depending on concentration. The utility of a water for domestic purposes will therefore be severely limited by high sulphate concentrations, hence the limit of 250 mg/l SO4.

- **Comments:**Other problems are associated with sulphate. In polluted waters in which the dissolved oxygen i.e. zero, sulphate is very readily reduced to sulphide causing noxious odours.Waters containing sulphates in excess will also attack the fabric of concrete sewer pipes.

SULPHIDE

- **Chemical Symbol or Formula:** S—.

- **Units Used for Analytical Results:** mg/l S.

- **Occurrence/Origin** : From anaerobic decomposition of organic matter in water or in waste, and from bacterial reduction of sulphate.

Health/Sanitary Significance: Toxic effects on man and aquatic life (see discussion below).

- **Background Information**: The principal interest in sulphide arises because of its toxicity, and also the odour problems associated with the presence of undissociated hydrogen sulphide (H2S)which is produced by anaerobic reduction of sulphate. There is an equilibrium relationship between the dissociated and undissociatedH2S forms which is dependent on pH. If the latter isabove 8 there will be no odour problems but as the pH drops to under 7 any H2S present will giverise to offensive odours. This is because the chemical equilibria:H2S⇔H++HS–⇔H++S—will shift to the left, favouring the presence of undissociated hydrogen sulphide, which is a highly toxic substance. It is the H2S species which particularly affects aquatic life and which has caused fatalities to persons working in sewers.

• **Comments:** A problem associated with sulphide is the so-called "crown corrosion" of concrete sewers. If these are not well ventilated the H2S present can be converted by aerobic bacteria resident on the sewer walls above the level of the wastewater to sulphuric acid which will then attack the sewer

TELLURIUM

• **Chemical Symbol or Formula:**Te.

• **Occurrence/Origin** : Minerals and wastes (porcelain, enamel, glass, electronic).

Health/Sanitary Significance: Toxic metal.

• **Background Information:** Among the effects of ingestion of tellurium are nausea, vomiting and depression, but these are rarely found because of the comparatively low exposure risk.

• **Comments:** The lack of reference in the Directives (apart from Dangerous Substances and Ground Water) indicates an absence of immediate concern over tellurium.

TETRACHLOROETHYLENE

• **Chemical Symbol or Formula**: C2Cl4.

• **Units Used for Analytical Results**: µg/l C2Cl4.

• **Normal Method(s) of Analysis:** Gas Chromatography [B/C].

• **Occurrence/Origin:** Synthetic solvent used extensively in dry-cleaning industry; also used to a significant extent for degreasing metals. Health/Sanitary Significance: Toxic solvent which can cause narcosis, dermatitis and ultimately fatal intoxication. However, when handled according to proper procedures and with adequate ventilation, tetrachloroethylene may be used without problems.

• **Background Information**: Synonyms for tetrachloroethylene are tetrachloroethene and per chloroethylene. It is the most commonly used dry-cleaning solvent.

- **Comments:** As with all chlorinated solvents, this substance should be handled with care, and in well-ventilated areas.

THALLIUM

- **Chemical Symbol or Formula**: Tl.
- **Units Used for Analytical Results**: mg/l Tl.
- **Occurrence/Origin** : Minerals, but more often from discharges .

Health/Sanitary Significance: Causes a wide variety of effects including nausea, vomiting, pain and, ultimately, death.

- **Background Information:** The metal is used at 2-3% concentration in rodent poisons, and is also used in the electrical components industry.
- **Comments:** As with tellurium there is a low risk of exposure

TIN

- **Chemical Symbol or Formula:** Sn.
- **Units Used for Analytical Results:** mg/l Sn.
- **Normal Method(s) of Analysis:** Atomic Absorption Spectrometry [B/C].
- **Occurrence/Origin** :Ores, effluents from tin-plating and alloy manufacture.

Health/Sanitary Significance :Little concern regarding tin itself and its inorganic compounds ,but see next parameter below.

- **Background Information:** Tin has only rarely been found in water - and then only in trace con-centrations. The level of exposure from foods, natural as well as canned, is rather higher than would be expected to result from consumption of a water supply.
- **Comments**: No specific standards have been laid down for (inorganic) tin

TITANIUM

- **Chemical Symbol or Formula**: Ti.
- **Units Used for Analytical Results**: mg/l Ti.

- **Occurrence/Origin** : Minerals and industrial wastes; found rarely.

- **Background Information**: The metal is used in some bronze alloys and in steel to increase greatly its tensile strength.

- **Comments:** No quality criteria or standards specified.

TRICHLOROETHYLENE

- **Chemical Symbol or Formula**:C2HCl3.

- **Units Used for Analytical Results:**µg/l C2HCl3.

- **Occurrence/Origin**: Synthetic solvent used in various industrial and manufacturing processes(e.g. solvent for paints, varnishes, resins etc); used in dry-cleaning and in metals degreasing. Health/Sanitary Significance :Potential carcinogen. Causes narcosis and effects similar toalcohol inebriation. See also "Tetrachloroethylene," which is a very similar compound.

- **Background Information:** Trichloroethylene is used in the manufacture of organic chemicals and pharmaceuticals, and it also has some medical uses.

TRIHALOMETHANES

- **Chemical Symbol or Formula:**CHX3[where X indicates chlorine (Cl) and/or bromine (Br)atoms.

- Units Used for Analytical Results:[µg/l compound(s).

- **Occurrence/Origin:** Synthetic constituents of some chlorinated drinking waters. Health/Sanitary Significance: Some of the compounds are actual or potential carcinogens and have also been held responsible for other physiological

- ill-effects.

- **Background Information**: Trihalomethanes, as the name indicates, are derivatives of the simplest organic compound - methane, CH4- in which three of the hydrogen atoms are substituted by halogen atoms. The principal halogens are fluorine (F2), chlorine (Cl2), bromine (Br2) and iodine (I2), but, while many combinations are theoretically possible, the term trihalomethanes is applied to four specific compounds containing only chlorine and/or bromine as the halogen elements. Thefourcompoundsare:chloroform[$CHCl_3$]-bromodichloromethane[$CHBrCl_2$]-dibromochloromethane ($CHBr_2Cl$) - bromoform ($CHBr_3$).As two of the four substances arechloroform and bromoform, the alternative design ationhaloformsis quite frequently applied to the group, which, however, is most often referred to simply as THMs. THMs are unwelcome by-products of the disinfection by chlorination of water containing organic matter. The most common source of such matter is the natural color of many raw waters which are abstracted from surface water sources, principally rivers and streams. While very many of the larger public water supplies derived from such sources will involve multi-stage treatment, including flocculation (coagulation) which is aimed specifically at colour removal, the opposite is the case with very many smaller supplies where the sole stage of treatment is disinfection, invariably chlorination. As a powerful oxidising agent, chlorine breaks down the complex - and inert – organic molecules which are the coloring agents, forming smaller, reactive entities which react with chlorine (and with bromine derived from the oxidation by chlorine of bromide naturally present) to form the THM compounds, the most abundant of which is chloroform. There is thus a fairly straight forward relationship between the degree of color in the water prior to chlorination and the quantities of THMs present following chlorination. If colour is present at the point of chlorination, THMs will be formed. They will also be formed if the multi- stage treatment of a colored raw water includes a pre-chlorination process, where chlorine is added at the outset toreducethecomplexityoforganicmaterialspresentinordertomakethemmoreamenabletosubsequent treatment stages. The latter will not remove any THMs formed at the initial stage and they will pass through to the final water. It may be noted that, in sharp contrast, the chlorination of ground waters - which are essentially uncolored - will give rise to negligible, if any, THM concentrations.

- **Comments**: While the presence of THMs in drinking water is a relatively widespread phenomenon, and one which is a matter for concern, as reflected in the provisions of Drinking Water Directive [98/83/EC] - see below - it must be remembered that the compounds are not "new" or recent pollutants. In fact, their presence - though unknown and undetected - will have declined steadily over the century since chlorination was first introduced. This is because water treatment processes have been developed, improved and extended over the years, with the result that color levels nowadays are much lower than they were in earlier decades. Nonetheless, as the Directive indicates, the need for conformity with acceptable limits is a matter of priority. Another by-product of chlorination (which is a matter for equal if not greater concern) is bromate (q.v.)

URANIUM

- **Chemical Symbol or Formula**: U.
- **Units Used for Analytical Results** :mg/l U.
- **Occurrence/Origin:** Rare natural occurrence; equally rare in effluents. Health/Sanitary Significance: Highly toxic, with a variety of effects leading ultimately to death.
- **Background Information:** This radioactive element is used in the nuclear industry and is thus far from being universally encountered.There is no general concern in the context of drinking water quality.The EU controls arise in the Dangerous Substances and Ground Water Directives,which seek to limit discharges.
- **Comments:** There are atomic absorption spectrometric procedures for uranium analysis but (ICPanalys is excepted) their sensitivity is generally inadequate for very low levels

VANADIUM

- **Chemical Symbol or Formula**:V.
- **Units Used for Analytical Results :**mg/l V.
- **Occurrence/Origin**: Widespread in rocks and minerals.

Health/Sanitary Significance: Some undesirable physiological effects (e.g. ear, nose, throatirritation) but not a hazard of significance in water.

- **Background Information**: This element is naturally quite abundant and in addition relatively large amounts enter the environment from industrial and related activities.
- **Comments:** Levels for other than human life are quite low

VINYL CHLORIDE

- **Chemical Symbol or Formula:**C2H3Cl.

- **Units Used for Analytical Results**:µg/l C_2H_3Cl.
- **Occurrence/Origin**: Synthetic gaseous compound which polymerises very readily and is an important raw material in the manufacture of plastics. It is also used as a refrigerant.
- **Health/SanitarySignificance:**Being very volatile it can caused local frostbite, if spilled on skin, as it evaporates. More importantly, it is a suspected causative agent of liver cancer.
- **Background Information**: Although a very reactive monomer which forms plastic polymers very easily, it is almost inevitable that in some cases the resultant polymer - the most common of which is polyvinyl chloride or PVC - will contain vestigial amounts of vinyl chloride itself. Thus, in the first use, in particular, of vessels made of PVC there is the possibility of residual monomer gaining access to water. The note in Drinking Water Directive [98/83/EC] is appended with this in mind (q.v.).

ZINC

- **Chemical Symbol or Formula:** Zn.
- **Units Used for Analytical Results** : mg/l Zn
- **Occurrence/Origin:** Natural geological occurrence and from wastes.
- **Health/Sanitary Significance**: Inhalation of zinc-containing fumes can cause a variety of physiological effects, but principal significance of excessive amounts in water is that emetic effects occur.
- **Background Information**: Zinc is essential to man but if ingested in gross amounts it has an emetic effect. However, the concern in water supply arises in regard to taste not toxicity, and quite high levels are permissible. In fishery water, in contrast, the toxic action is much more important and very much lower limits have been imposed.
- **Comments** : The toxicity of zinc to aquatic life is (as with copper) dependent on the hardness of the water: it decreases with rising hardness

I.5.Total and Fecal Coliform

By definition **(Standard Methods, 1989),** the total Coliform (TC) group comprises allaerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteriathat ferment lactose with gas and acid formation within 48 hours at 35°C. Fecal Coliform(FC) are defined as those Coliforms which respond at an elevated temperature of 44.5°C.Thus a more accurate name for organisms which show positive on the FC test would beheat tolerant Coliforms.Among the Coliform group, there are four genera in the Enterobacteriaceaefamily,Escherichia. Klebsiella, Citrobactor. and Enterobacter **(Metcalf and Eddy, 1991).** Someof these genera are common in the intestinal tract of mammals (e.g. Escherichia coliandothers are common in soil and on the surface of plants e.g. Klebsiella).In addition to other kinds of bacteria, each person produces from 100 to 400 billionColiform organisms per day (**Metcalf and Eddy, 1991).** Since historically the primarypublic health concern has been diseases transmitted through human wastes, the absence ofColiform organisms is taken as an indication that a sample is free of disease-producingorganisms. After being isolated and associated with the fecal wastes of warm-bloodedanimals in late 1800s and early 1900s **(Cabelli, 1977),** Coliforms have been used asindicators for indexing health hazards in drinking and recreational waters.

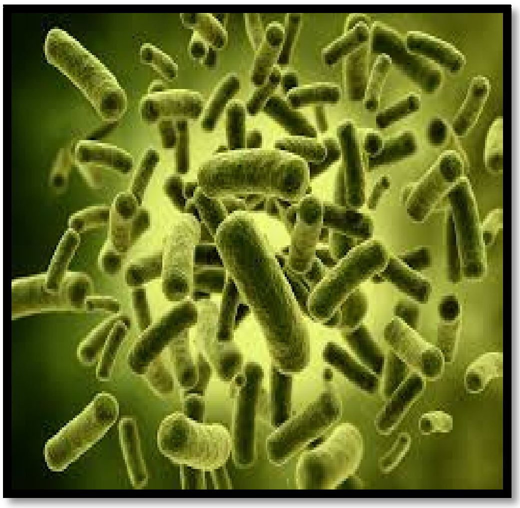


Figure 02: Fecal coliform

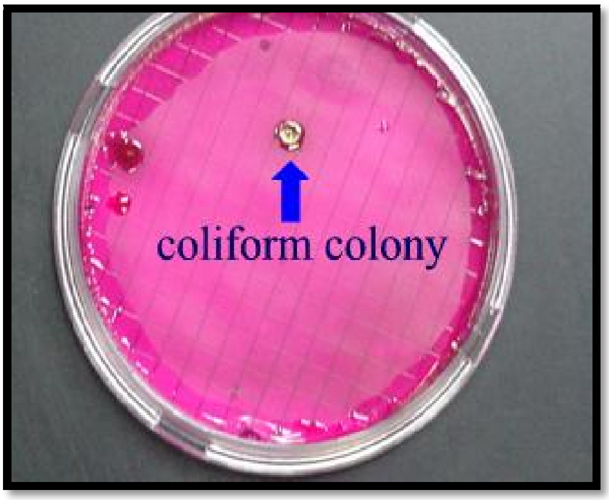


Figure 03:coliform colony

5.1.Escherichia Coli

Escherichia coli is a member of the Coliform bacteria population that may be used toindicate fecal sources. It is a normal and dominant inhabitant of the mammalian digestivetract. However, disease-causing strains of E. coli specie have been isolated from tapwater, drinking water sources, and mountain streams **(Standard Methods, 1989)**.Examination of pathogenic E. coli is not easy due to the uncertainty in determining thepathogenic nature of isolated E. coli strains. There is no biochemical marker that canseparate pathogenic from non-pathogenic strains and the relationship between serotype andpathogenicity is questionable **(Standard Methods, 1989).**The use of E. coli as an indicator organism is somewhat restricted by the fact That**(Tchobanoglous and Schroeder, 1985)** (1) E. coli is not a single species, (2) certain generaof the Coliform group such as Proteus and Aerobacter are normally found outside thehuman intestinal tract in soil, (3) other organisms found in water that do not represent fecalpollution

possess some of the characteristics attributed to E. coli. and (4) E. coli identicalto that found in humans is also found in the intestinal tract of other warm-blooded animals.However, primarily because studies had shown that E. coli was a much better indicator ofdisease risk than was FC

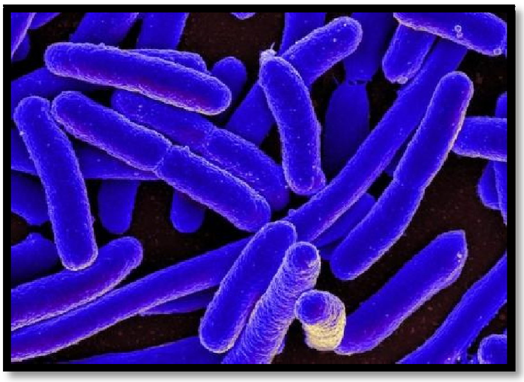
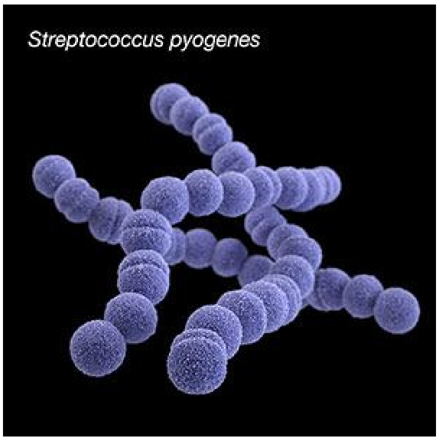


Figure 04: Escherichia Coli **Figure 05: Escherichia Coli colony**

5.2.Fecal Streptococcus

The fecal streptococcus (FS) group consists of a number of species of the genusStreptococcus. They are characterized as gram-positive, cocci bacteria which are capableof growth in brain-heart infusion broth. The normal habitat of FS is thegastrointestinal tract of warm-blooded animals so that the presence of them is an indicationof contamination of fecal wastes.



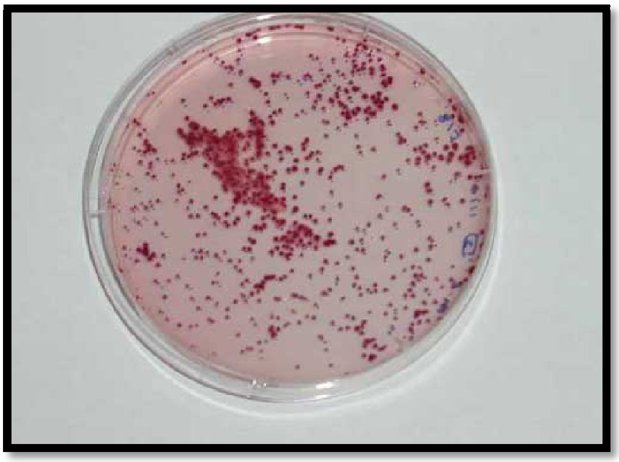
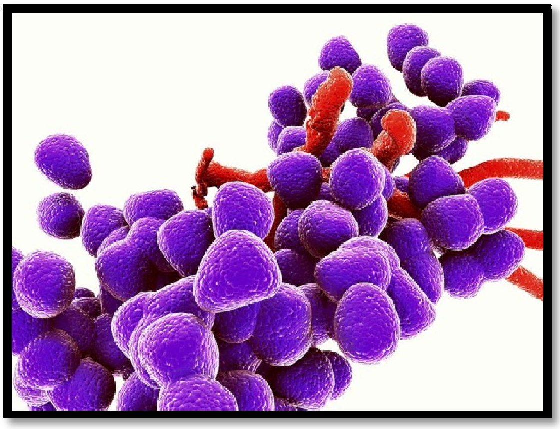


Figure06: Fecal Streptococcus

Figure 07: Fecal Streptococcus colony

5.3.Enterococcus

The enterococcus group includes two strains of the FS that is most human specific. Theseare S. faecalis and S. faecium **(Metcalf and Eddy, 1991).** They can be differentiated fromother streptococci by their ability to grow in 6.5% sodium chloride, at pH 9.6, and at both10°C and 45°C. Studies at marine and fresh water bathing beaches indicated thatswimming-associated gastroenteritis was related directly to the quality of the bathing waterand that enterococci were the most efficient bacterial indicator of water quality



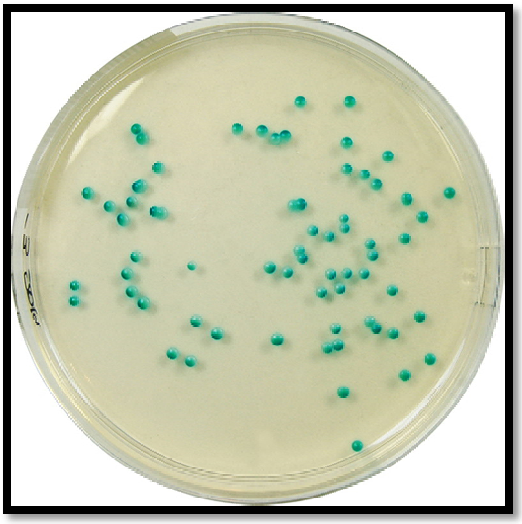


Figure 08 : Enterococcus

Figure 09 :Enterococcuscolony

I.6.L'Origine de l'eau usée Pollution de l'eau

6.1.Water pollution

INTRODUCTION

Over two thirds of Earth's surface is covered by water; less than a third is taken up by land. As Earth's population continues to grow, people are putting ever-increasing pressure on the planet's water resources. In a sense, our oceans, rivers, and other inland waters are being "squeezed" by human activities—not so they take up less room, but so their quality is reduced. Poorer water quality means water pollution.

https://www.explainthatstuff.com/waterpollution.html

The quality of water can be dramatically a□ected be pollution. Water pollution is caused by foreign objects and chemicals entering the aquatic ecosystem or when natural chemicals build up in excess amounts.There are two types of water pollution:

Point Source – when pollutants enter the water course at specifc sites, such as a discharge pipe.

Di□use– when there isn't an obvious source of pollution and it occurs over a wide area. Examples include run-o□ from agricultural land and urban areas. This type of pollution can be difcult to identify and control. In Scotland, di□use pollution is the largest pollution pressure on the water environment.

Sources of water pollution

Ammonia NH3 Nitrates/Nitrites NOx Ammonium NH4 Arsenic As Hydrocarbons HxCx PhosphatePOx Phosphorus P Sulphur S Mercury Hg Selenium Se Lead PbSulphate SO2- 4

Pollution to the water environment can come from a wide range of sources. These include:

- Agriculture (crops and livestock)
- Atmosphere (acid rain)
- Aquaculture
- Forestry
- Illegal dumping of waste
- Industry

- Mines
- Sewage
- Urban areas and roads

Main pollutants

Ammonia (NH_3)/Ammonium (NH_4)

(Agriculture, aquaculture, industry, urban)Ammonia is highly toxic to fsh and can convert intonitrates.

Nitrate (NO_3)/Nitrite (NO_2)

(Agriculture, industry, aquaculture, sewage)These can accelerate aquatic plant growth leading toeutrophication.

Toxic metals

(Mining, urban, industry)These include arsenic (As), mercury (Hg), selenium (Se)and lead (Pb) and can persist in the environment fordecades. They can be poisonous to aquatic life and mayslow down their development.

Crude oil (Hydrocarbons (HxCx))

(Urban, industry)This mainly enters the marine environment in oil spillsand can have detrimental e□ects on marine animals,plants and birds.

Phosphorous (P)/Phosphate (PO_4^{3-})

(Agriculture, urban)Similar in e□ect to nitrates, these can also lead toeutrophication of water bodies.Sulphates/sulphide minerals(minerals containing S^{2-})(Mining)

Sulphur dioxide mixes with water particle in the air to formacid. This falls as acid rain leading to acidifcation of waterbodies. Sulphide minerals can be unearthed during themining process and are a leading cause of acidifcation ofwater in mines. When this acidic water is discharged it isknown as acid rock drainage. The most common mineralassociated with this process is pyrite (FeS_2).

Eutrophication

E utrophication is the process through which a body of water becomes enriched with chemicals such as nitrates and phosphates. Algae and other aquatic plants then feed on these nutrients leading to excess growth. This leads to a reduction in the amount of dissolved oxygen available as algal blooms on the surface restrict the amount of sunlight penetrating the water limiting photosynthesis which causes the death and decomposition of plant life underwater. The lack of dissolved oxygen also kills all animal life in the water body.

6.2.Bioaccumulation and biomagnifcation

B ioaccumulation is the build-up of toxic substances in a food chain. A common example in aquatic systems is the accumulation of heavy metals such as mercury (Hg) in fsh. At the start of the chain, mercury is absorbed by algae in the form of methylmercury ($CH3Hg+$). Fish then eat the algae and absorb the methylmercury and since they are absorbing it at a faster rate than it can be excreted, it

accumulates in the body of the fsh. Further up the food chain, predatory fsh and birds then absorb the mercury from the fsh they consume, which then accumulates in their bodies eading to a higher concentration of the mercury in their own bodies than in the species they have eaten. This is known as biomagnifcation. This process can be dangerous to humans as we could consume fsh which have bioaccumulated mercury and absorb it ourselves, causing health problems such as damage to the central nervous system.

6.3.Endocrine disruptors

E ndocrine disrupting compounds (EDCs) are chemicals which can interfere with the normal function of hormones in aquatic animals. They can enter water courses through wastewater discharges from industry and sewage and also in agricultural run-off. Common EDCs entering the water environment are tributyltin which was widely used in anti-fouling paint on ships' hulls and phthalate esters which

are mainly used in plastics. They are known to impair growth and development in the animals, lead to reproductive abnormalities and can even cause some species to change sex

Chapter II
Presentation of the study area

Chapter II Presentation of the study area

II.7.Geographical location of the study area:

The province of Saida is located in the west of the country. It covers an area of 7,562 km2, it is limited to the north by the wilaya of MASCARA to the west by the wilaya of SIDI BELABES to the east by the wilaya of TIARET, and to the south by the wilaya of EL Bayadh .

At an altitude of 750 m, latitude 34 ° 52 N, and longitude 00 ° and 09 °

II.8. History of the WWTP:

The economic expansion of recent years and the phenomenon of urban and industrial concentration have caused a huge increase in pollution.

The wastewater was then directly discharged into the natural environment (the wadi) without prior treatment, but the size of the discharges leads to pollution of the natural environment and causes imbalances and nuisances.

8.1. Geographical location of the station in relation to the city of Saida:

The wastewater from the city of Saida is sent to an outlet which is the treatment plant, located downstream of the city.

The treatment plant is located in the northwest part of the city near the Saida wadi which is the receiving environment for treated water.

The choice of this site is based on a geological study which showed the nature of the soil to avoid any settlement of the structures and the existence of clay layers to avoid any contact by infiltration to the underground nappa.

The purification of water before its discharge into the natural environment thus becomes a necessity, it is necessary to protect nature, hence the commissioning of the treatment plant of Saida which will have to purify these urban and industrial waters.

Figure 10: Geographical location of the station in relation to the city of Saida

8.2. Presentation of the city of Saida:

The commune of Saida was under the authority of the Bey of Mascara in 1844, the colonial army established a redoubt administration under the Arab authority.

In 1864 Saida, the city's agglomeration, came under civil administration with the creation of mixed municipalities.

In 1880, Saida entered a fully-fledged commune, and saw the settlement of European populations from 1850, during this period Saida was under the district of Mascara.

In 1956, Saida was eaten away as the administrative center of the sub-prefecture.

In January 1960, Saida was devoured by the capital of the prefecture, until 1984, the commune of Saida included the current commune of doui-thabet.

The last administrative division which separates from the town of doui-thabetà reduces its surface to 75.84 KM2.

Occupying a central geographic position in the wilaya, the commune of Saida is limited: See fig N

- To the north by the town of Ouled Khaled
- To the east by the municipality of El Hassasna
- To the west by the town of doui-thabet
- To the south by the commune of Ain El Hadjar.

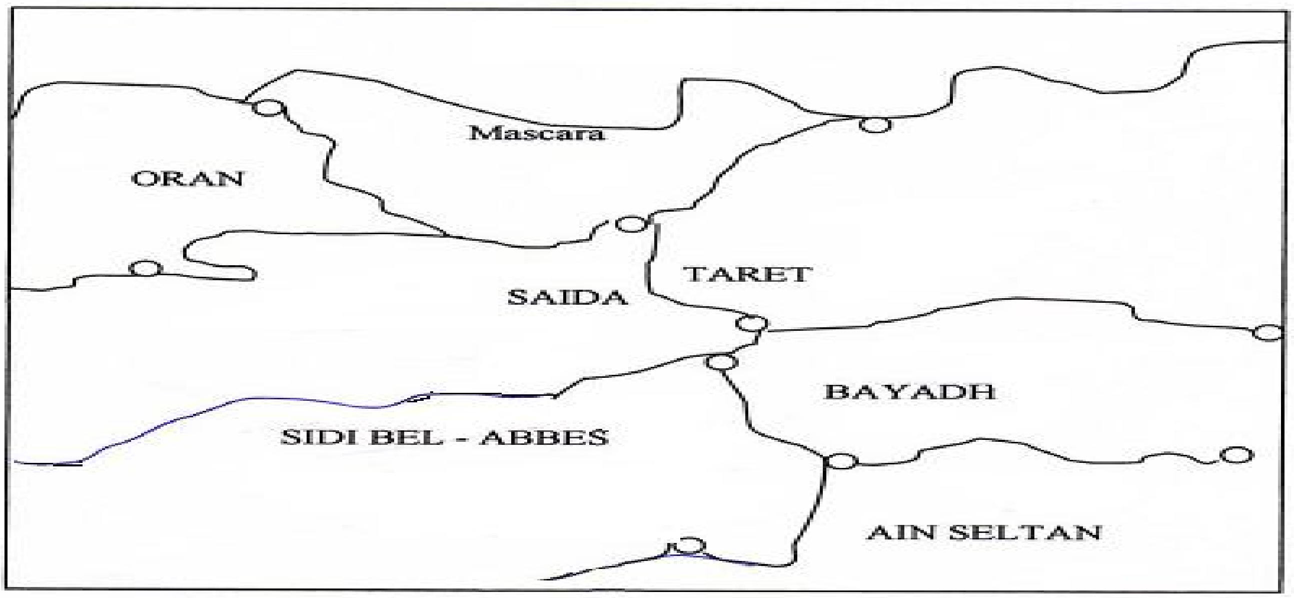


Figure 11: Carte Géographique de la wilaya de saida

8.3. Hydrogeological aspect:

Each development must go through a serious study of the water table because that of Saida is thermo-mineral.

8.4. The hydrographic network:

The majority of wadis drain into the basin of wadi Saida the important wadis are:

- The wadi tebouda which rises in Ain Beida about 3 km south of Ain El Hadjar.

- The Saida wadi which constitutes the embedding of the tebouda wadi.

- The Rebahia wadi which rises in Ain Zerga.

- L'oued Massil qui prend sa source à Ain Mettiouia

II.9. Climatology:

III-5-1-The climate of our area is semi arid with a hot summer where the temperatures reach 35 ° to 40 ° c, with a cold winter where the temperatures are between 0 ° and 4 ° c.

II.10.Rainfall:

The average rainfall varies between 200 and 600 mm per year, It is poorly distributed in time and space. Since 1980, the wilaya of Saida has experienced a high deficit (the average rainfall has often been less than 300mm).

Insufficiency leads to negative consequences in the agricultural and hydraulic sectors. During the 2000s, the level improved markedly.

MOIS	JAN	FEV	MAR	AVR	MAI	JUIN	JUIL	AOUT	SEP	OCT	NOV	DEC
P(mm)	44,8	33,8	27,1	35,8	38,4	5,9	6,3	8,5	26,7	57,5	45,7	39

Table N ° 02 Average monthly precipitation for the period 2000-2010 (O.N.M, 2016)

II.11. The Température :

Temperature is also a major climatic factor acting on the water cycle, in fact the average temperature in winter is 8.3 to 9.6 ° C with a minimum of 2.7 ° C and a maximum of 37, 1 C ° (ONM):

Mois	Jan	Fév	Mar	Avr	Mai	Juin	Juil	Aout	Sep	Oct	Nov	Déc
Température (c°)	8,3	9,6	12,4	14,2	18,4	24,1	28,1	27,4	22,8	18,9	12.5	9.6

Table N ° 03 average monthly minimum temperatures 2000 - 2010(O.N.M)

Mois	Jan	Fév	Mar	Avr	Mai	Juin	Juil	Aout	Sep	Oct	Nov	Déc

Température (c°)	2,7	3,5	5,5	6,7	10,7	15,3	19,1	18,8	15,2	12,2	7,0	4,7

Table N° 04 : Average monthly maximum temperatures from 2000 to 2010 (O.N.M 2016)

II.12.The winds:

In the wilaya of Saida the prevailing winds are from North and South, on the other hand, the siroco is a hot wind which dries up the atmosphere, and causes serious damage to the vegetation).

The wind class is reported as follows:

- The calm winds.

- The winds observed.

- Weak to moderate winds

- Strong winds.

- Strong winds (Siroco).

II.13.Operation of the SAIDA STEP:

The treatment plant is installed next to a sanitation collection network, just at the end of the water outlet to the natural environment. The sewage treatment plant is an installation which cleans up waste water to avoid the total destruction of aquatic and natural ecosystems due to polluted effluents; purification is a technique which consists in eliminating the undesirable matter that water carries with a view to its discharge into the natural environment or its reuse in various functions; the wastewater from the Saida station is subjected to the activated sludge process

13.1.Purification processes of Step Saida:

The wastewater treatment plant of the city of Saida is located at the level of the municipality of Saida on an area of 11.47 Hec and has a capacity of 150,000 Eq / Hab, it is designed to treat 30,000 m3 of water every day biologically worn.

The WWTP purification process is a biological process based on the principle of activated sludge, where the organic matter contained in the wastewater is degraded by bacteria put under favorable conditions, which transform them into mineral salts.

The treatment is done according to the following process:

13.2. Physical treatment:

*** Wastewater inlet to the storm overflow:**

Figure 11: Déversoir d'orage

The Storm Weir

Length: 20m

Width: 20m

Height: 2.5m

Total volume: 1.000m 3

Retention time at maximum flow: 24m

13.3. Pretreatment:

Pre-treatment devices are present in all treatment plants regardless of the downstream implementation processes.

Their purpose is to eliminate the coarsest solid or particulate elements, likely to interfere with subsequent treatments or damage the equipment; bulky waste (screenings) sand (grit removal), and fatty substances (degreasing, oil removal).

Figure 12: **(screenings) sand (grit removal),**

***Figure 13:* Fatty Substances (degreasing, oil removal).**

*** Screening**

It consists of passing the wastewater through a grid, the bars of which are more or less spaced, retain the coarsest elements, after cleaning the grids by mechanical, manual or automatic means, the waste is evacuated with household waste; sieving using screens with smaller spacing can sometimes complete this phase, the case of our STEP

Manual coarse screen: 01

Width: 1,500mm

Length: 6 .000m

Automatic end screens:

Number of fine screening channels: 0 2

Grid width: 1.000mm.

Net passage width: 660mm

Separation between bars: 10mm

Number of bars: 33

Separation between bars: 20mm

13.4. Desanding - De-oiling:

**** sand removal***

Carried out by decantation, sand removal aims to eliminate the sands and gravel; the flow of water at a reduced speed in a basin called desalter causes the deposit at the bottom of the structure.

These particles are then aspirated by a pump, the recovered sands are wrung, then washed before being sent to landfill.

**** Oil removal***

The oil removal operations consist of separating the oils and greases from the raw effluent by flotation.

The latter being products of density lower than water; the injection of micro bubbles of air makes it possible to accelerate the flotation of greases often these operations are combined in the same work.

Figure 14: Oil removal

Manual coarse screen: 01

- *Width: 1,500mm*
- *Length: 6 .000m*
- *Automatic end screens:*
- *Number of fine screening channels: 0 2*
- *Grid width: 1.000mm.*
- *Net passage width: 660mm*
- *Separation between bars: 10mm*
- *Number of bars: 33*
- *Separation between bars: 20mm*

13.5. Desanding - De-oiling:

**** sand removal***

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The oil removal operations consist of separating the oils and greases from the raw effluent by flotation.

The latter being products of density lower than water; the injection of micro bubbles of air makes it possible to accelerate the flotation of greases often these operations are combined in the same work

13.5. Biological treatment:

The mixing of oxygenation is ensured by 12 surface aerators with vertical axis the installed aerators have the characteristics

Figure 15:

Aeration basin (02 units)

Rectangular shape of:

Length: 66.0 m.

Width: 44.0 m.

Water height: 4.5 m.

Total depth: 5m

Concrete height: 5.60 m.

Total useful volume: 26,136 m³.

Pool equipment.

- *Number of turbine: 12*
- *Power of installed turbines: 75/55 KW*

- *02 0xymeters for measuring dissolved oxygen.*

Secondary clarification or decantation:

The mud-liquid separation is carried out in two clarification works. The characteristics of each work are as follows:

Figure 16:

Number: 02

Diameter: 43 m.

Unit surface: 1.452 m³.

Water height: 3.50 m.

Cylindrical volume: 5.0827 m³.

Tertiary treatment:

Chlorination, disinfection

It is the complementary treatment of wastewater before discharge, particularly in the case where we want to make treated water for irrigation (for specific conditions), Disinfection is provided for chlorine gas, the volume of the basin is calculated for a sufficient residence time at the flow rate in order to obtain a good effectiveness of the action of chlorine.

Figure 17: The chlorination

Length: 30m

Width: 12m

Useful height: 3.5m

Total height: 4mح

Volume: 1.260m

II.14. Sludge treatment

Thickening of sludge:

The excess sludge is forced back towards the thickener, it is a circular-shaped structure of the scraped type which is characterized by:

Figure 18: Sludge treatment

The dimensions of the thickener are:

- *Number: 01*
- *Diameter: 16 m.*
- *Height: 4 m.*
- *Surface: 201, 1 m 2*
- *Thickener volume: 804.25 m³.*
- *Production of excess sludge: 6800KG / L*

Sludge drying:

The thickened sludge is then extracted from the thickener and conveyed to the drying bed, the sizing of the beds is done on the basis of a drying time of three weeks, and a filling height of 0.4 m

Sludge dewatering on drying beds

Length: 30m

Width: 15m

Total number of beds: 20

Total area to be implemented: 9000 m 2

Annual sludge production: 83,865 m³ / year

Population equivalent per unit of area: 16.7 eq / inhabitant / m 2

Figure 19: **Overview of the treatment plant of the province of Saida**

* We could say that starting from used water and thanks to the treatment processes, it is possible to obtain a whole range of water of different qualities and each of these qualities can correspond to a particular use. It is clear that the treatments that exist can reduce the concentrations of pollutants.

Aim of Study

The reuse of treated wastewater, in particular for irrigation, is an increasingly common practice, encouraged by governments and official entities worldwide. Irrigation with wastewater may have implications at two different levels: alter the physicochemical and microbiological properties of the soil and/or introduce and contribute to the accumulation of chemical and biological contaminants in soil. The first may affect soil productivity and fertility; the second may pose serious risks to the human and environmental health. The sustainable wastewater reuse in agriculture should prevent both types of effects, requiring a holistic and integrated risk assessment. In this work we critically review possible different procedur of treated of wastewater. The diversified analysis can be used to achieve a sustainable wastewater reuse for irrigation.

PRATICAL SIDE

1. Physical water analysis

1.1. pH and Alkalinity

pH is a measure of the hydrogen ion concentration of the water as ranked on a scale of 1.0 to 14.0. The lower the pH of water, the more acidic it is. The higher the pH of water, the more basic, or alkaline, it is. pH affects many chemical and biological processes in the water and different organisms have different ranges of pH within which they flourish. The largest variety of aquatic animals prefer a pH range of 6.5 - 8.0. pH outside of this range reduces the diversity in the stream because it stresses the physiological systems of most organisms and can reduce reproduction. Low pH can also allow toxic elements and compounds such as heavy metals to become mobile and "available" for uptake by aquatic plants and animals. Again, this can produce conditions that are toxic to aquatic life, particularly to sensitive species like trout.

Changes in acidity can be caused by atmospheric deposition (acid rain or acid shock from snowmelt), surrounding rock, and wastewater discharges. Technically, the pH scale measures the logarithmic concentration of hydrogen (H+) and hydroxide (OH-) ions, which make up water (H+ + OH- = H20). When both types of ions are in equal concentration, the pH is 7.0 or neutral. Below 7.0, the water is acidic (there are more hydrogen ions than hydroxide ions). When the pH is above 7.0, the water is alkaline, or basic (there are more hydroxide ions than hydrogen ions). Since the scale is logarithmic, a drop in the pH by 1.0 unit is a 10-fold increase in acidity. So, a water sample with a pH of 5.0 is ten times as acidic as one with a pH of 6.0. pH 4.0 is 100 times as acidic as pH 6.0.

Alkalinity is a measure of a river's "buffering capacity," or its ability to neutralize acids. Alkaline compounds in the water such as bicarbonates (baking soda is one type), carbonates, and hydroxides remove H+ ions and lower the acidity of the water (which means increased pH). They do this usually by combining with the H+ ions to make new compounds. Without this acid neutralizing capacity, any acid added to a river would cause an immediate change in the pH. Measuring alkalinity is important to determining a river's ability to neutralize acidic pollution (as measured by pH) from rainfall or snowmelt. It's one of the best measures of the sensitivity of the river to acid inputs. Alkalinity comes from rocks and soils, salts, certain plant activities, and certain industrial wastewater discharges. Total alkalinity is measured by collecting a water sample, and measuring the amount of acid needed to bring the sample to a pH of 4.2. At this pH all the alkaline compounds in the sample are "used up." The result is reported as milligrams per liter (mg/l) of calcium carbonat

1.2.PH analysis method

We can use only a phmetre to analyse water PH

Figure 20: PH

https://wrrc.umass.edu/research/projects/acid-rain-monitoring-project/analysis-method-ph-and-alkalinity

2.Temperature

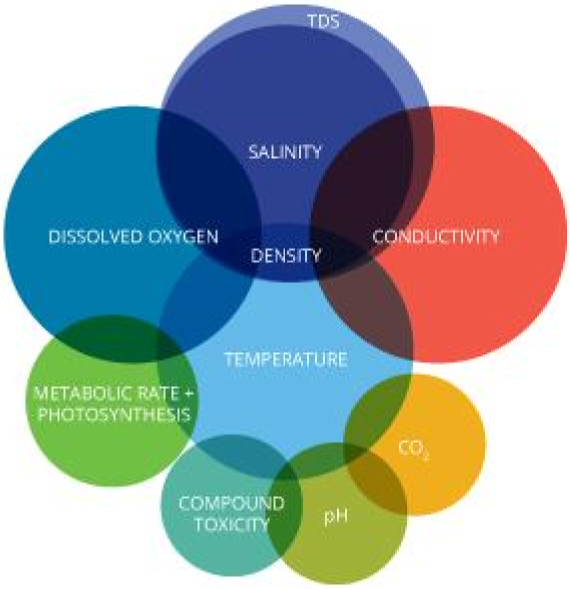
2.1.What is Water Temperature?

Water temperature is a physical property expressing how hot or cold water is. As hot and cold are both arbitrary terms, temperature can further be defined as a measurement of the average thermal energy of a substance [5]. Thermal energy is the kinetic energy of atoms and molecules, so temperature in turn measures the average kinetic energy of the atoms and molecules [5]. This energy can be transferred between substances as the flow of heat. Heat transfer, whether from the air, sunlight, another water source or thermal pollution can change the temperature of water

Water temperature plays a major role in the quality of aquatic life and habitats. Heat flow and the fluctuation of temperature determine what species will live and thrive in a body of water.

Water temperature has been defined as the “abiotic master factor” by JR Brett due to its effect on aquatic organisms . What does that mean for lakes, rivers and oceans?

3.Why the Temperature of Water is Important



Water temperature affects nearly every other water quality parameter.

Temperature is an important factor to consider when assessing water quality. In addition to its own effects, temperature influences several other parameters and can alter the physical and chemical properties of water. In this regard, water temperature should be accounted for when determining [7]:

– Metabolic rates and photosynthesis production
– Compound toxicity
– Dissolved oxygen and other dissolved gas concentrations
– Conductivity and salinity
– Oxidation reduction potential (ORP)
– pH
– Water Density

Temperature analyzing method

We can use temperature meter

Figure 21: **Temperature**

Turbidity: Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is a measurement of the amount of light that is scattered by material in the water when a light is shined through the water sample.

Turbidity analyzing method

To analyze water turbidity we use turbidity meter

Figure 22: **Turbidity**

Conductivity: conductivity of a substance is defined as 'the ability or power to conduct or transmit heat, electricity, or sound.

Conductivity analyzing method

to analyze water conductivity we use conductivity meter

Figure 23: **Conductivity:**

COCLUSION

The present report is an overview of water availability and distribution, water consumption, and wastewater treatment trends in Saida. Aspects of current practices of municipal wastewater treatment are discussed in addition to current standards, both for disposal into surface water, and impacts in terms of water savings, socio-economical and environmental benefits of wastewater treatment and reuse.

The current study has been carried out to support the use wastewater reuse in agriculture irrigation in farm workers.

The main health outcomes to be considered were gastro-intestinal infections including intestinal parasite infections (intestinal nematodes and protozoa), specific bacterial infections (e.g. cholera, typhoid), specific viral infections (enteroviruses, hepatitis A) and symptomatic diarrhoeal disease

However, **our project is not accomplished yet because of corona virus and** no development of hypothesis was stated in our work. **So we ask you to accept our apologies.**

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