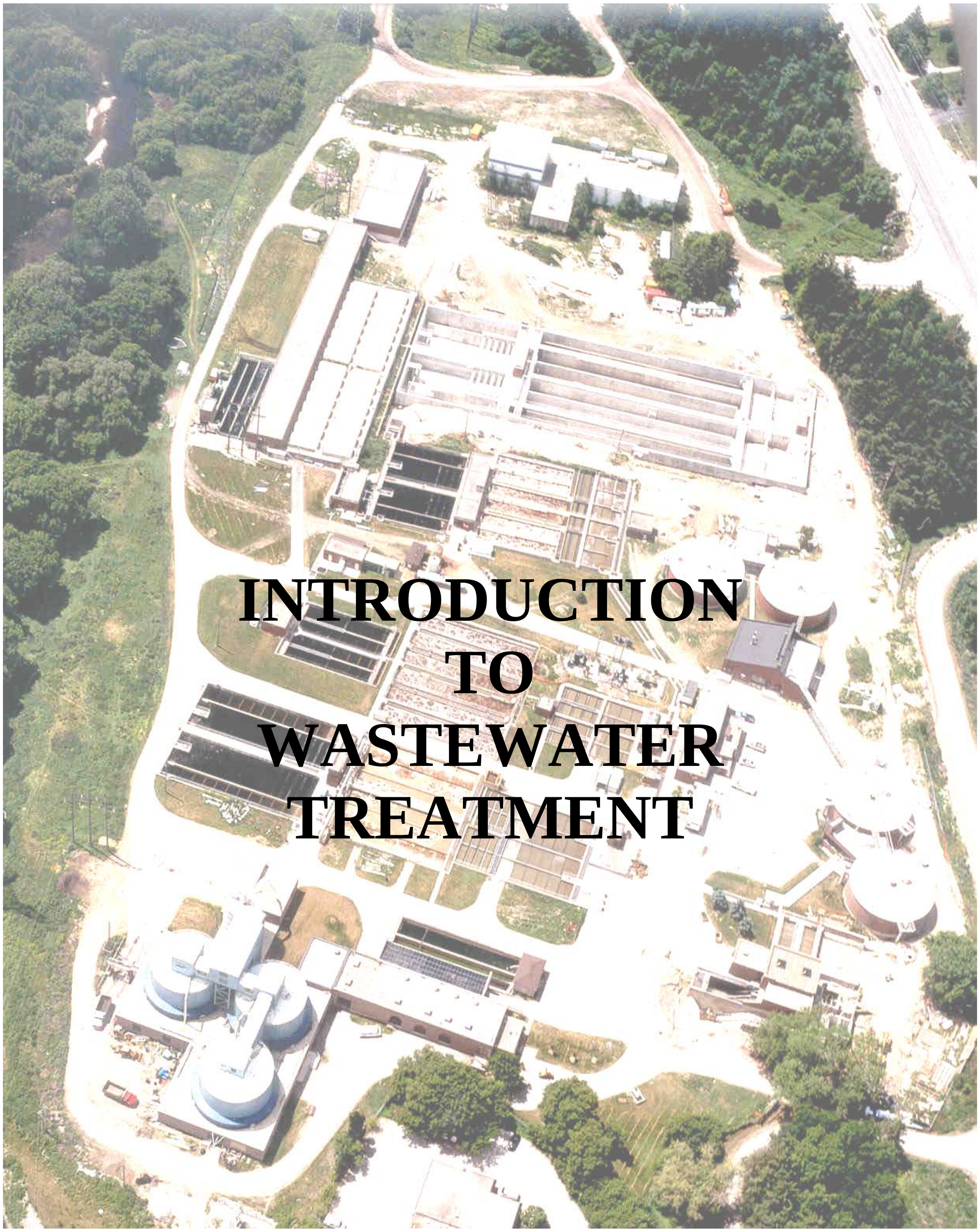

INTRODUCTION TO WASTEWATER TREATMENT

INTRODUCTION

The following material will introduce the reader to the water pollution abatement and control measures practiced by the City of Guelph, Environmental Services Department, Wastewater Services Division.

1.0 HISTORY

You may be surprised to learn that the treatment of wastewater is a relatively modern practice. Although sewers to remove foul-smelling water were common in ancient Rome, it was not until the 19^{th} century that large cities began to understand the necessity of reducing the amount of pollutants in the used water they were discharging to the environment.

Despite large supplies of fresh water and the natural ability of surface waters to cleanse themselves over time, populations had become so concentrated by 1850 that outbreaks of life-threatening diseases became commonplace. These outbreaks were traced to pathogenic bacteria in the polluted water.

What happens in a wastewater treatment plant is essentially the same as what occurs naturally in an ocean, lake, river or stream. The function of a wastewater treatment plant is to speed up this natural cleansing process. The practice of wastewater collection and treatment has been developed and perfected, using some of the most technically sound biological, physical, chemical and mechanical techniques available. As a result, public health and water quality are protected better today than ever before.

2.0 SOURCES

Wastewater can be defined as the flow of used water discharged from homes, businesses, industries, commercial activities and institutions which is directed to treatment plants by a carefully designed and engineered network of pipes. This wastewater is further categorized and defined according to its sources of origin. The term “domestic wastewater” refers to flows discharged principally from residential sources generated by such activities as food preparation, laundry, cleaning and personal hygiene. Industrial/commercial wastewater is flow generated and discharged from manufacturing and commercial activities such as printing, food and beverage processing and production to name a few. Institutional wastewater characterizes wastewater generated by large institutions such as hospitals and educational facilities.

Typically 200 to 500 litres of wastewater are generated for every person connected to the system each day. The amount of flow handled by a treatment plant varies with the time of day and with the season of the year.

3.0 TREATMENT OBJECTIVES

The overall water management objectives of wastewater treatment are associated with the removal of pollutants and the protection and preservation of our natural water resources.

Of specific concern is protection of human health by the destruction of pathogenic organisms present in wastewater prior to treated effluent being discharged to receiving waters.

4.0 WATER POLLUTION CONTROL LEGISLATION

Environment Canada is the federal government agency responsible for environmental protection. Legislation in the form of the Environmental Protection Act provides overall direction for environmental protection in Canada.

The Ontario Ministry of the Environment (MOE) is the provincial government agency responsible for environmental protection in the province of Ontario. One of its tasks is the provision of clean water through pollution control and prevention.

To accomplish its water quality objectives the MOE produced legislation in the form of the Ontario Water Resources Act (OWRA). This legislation in conjunction with various regulations made under the OWRA set out legal requirements for managing environmental issues.

The City of Guelph, Environmental Services Department, Wastewater Services Division (WSD), is engaged in wastewater, storm water and water quality management for the area which it serves. The WSD manages and operates the Wastewater Treatment Plant located at Hanlon and Wellington Street West and is responsible for meeting the treatment standards prescribed by MOE legislation. Further to these requirements, the city has enacted legislation specific to its wastewater operation passed by city council in the form of the Sewer Use By-law (1996)-15202. This By-law specifies the wastewater quality and quantity standards which must be met by wastewater generators who discharge to the city sewer collection and treatment system.

In addition to these pieces of legislation the MOE and the Municipal Engineers Associated of Ontario (MEAO) are jointly involved in developing additional legislation, namely, the Ontario Ministry of Environment Industrial Strategy for Abatement program (MISA). The program includes strategies for the development of analytical systems, adopting plans to address spills into systems, generation of an industrial inventory and an audit of enforcement activities. Certain wastewater pollutants, primarily from industrial sources, have the potential to seriously disrupt the various wastewater process operations and may present serious health risks to the public and employees associated with its treatment. The mandate of the MISA program is to eliminate and control such industrial wastewater discharges at their source.

5.0 WASTEWATER TREATMENT PROCESS

By definition, process means a series of actions or changes. Treatment facilities incorporate numerous processes which in combination achieve the desired water quality objectives. These processes involve the separation, removal and disposal of pollutants present in the wastewater.

The treatment of wastewater is accomplished by four basic methods or techniques; physical, mechanical, biological and chemical.

Physical methods of treatment include the use of tanks and other structures designed to contain and control the flow of wastewater to promote the removal of contaminants.

Mechanical treatment techniques involve the use of machines, both simple and complex in design and operation.

The action of bacteria and other micro-organisms are biological methods of treatment, which play a vital role in the removal of pollutants which cannot be effectively achieved by other means.

Chemical treatment methods enhance the efficiency of other process operations and provide specialized treatment as a result of their addition at various treatment stages.

6.0 DESCRIPTION OF PROCESS OPERATIONS

To gain an understanding of the process operations associated with wastewater treatment it is necessary for the reader to become familiar with the terms and expressions common to this field of work.

The following sections detail the specifics of wastewater treatment and have been formatted to assist readers new to the field encountering this terminology for the first time. These terms and expressions are initially presented in ***bold italic type*** and may be referenced alphabetically in Section 9.0 Glossary of Terms.

6.1 COLLECTION SYSTEM

The collection, or sewer system, is a series of pipes specially designed to transport the millions of litres of wastewater generated each day. Sewer piping is categorized by the type of flow it transports namely **sanitary, storm** and **combined sewers.** The City of Guelph collection system is constructed as a separated sanitary and separated storm sewer collection system. The sanitary system is directed to the wastewater treatment plant. In newer and future development areas of the city the storm system is direct to storm water management systems strategically located throughout the city. In older developed areas of the city storm water is discharged directly to the river. Treatment plants which are connected to storm or combined sewers receive much higher than normal flows during heavy rainfalls and snowmelts.

When and wherever possible collection systems are designed as gravity flow systems. Gravity flow sewer piping is laid with a slope steep enough to maintain a wastewater flow velocity of approximately 0.75 metres per second. This velocity is sufficient to keep all of the materials present suspended in its flow. In areas where it is geographically impossible to allow for gravity flow, lift stations are provided to receive wastewater from low lying areas and pumps are used to transport the wastewater for further transport by gravity sewers.

The complex sewer collection system must be properly maintained to prevent **infiltration, inflow or exfiltration** from occurring within the system. The integrity and function of the collection system is achieved through routine inspection, cleaning and repair and planned replacement of system components.

6.2 PRELIMINARY TREATMENT

Influent to treatment plants contains pieces of wood, rags, plastics and other debris. Sand, eggshells and other coarse **inorganic** material is present in the flow in addition to **organic** matter from household, industrial, commercial and institutional water use.

Preliminary treatment provides for the removal of large debris and heavy inorganic material contained in the wastewater flow.

One of the first treatment operations involves screening of the influent wastewater flow. Mechanical screens consisting of parallel bars or stepped plates placed at an angle in the path of the wastewater flow are used to remove this debris. Mechanical rakes clear debris from the bars and these screenings are washed and compressed to remove excess water and ultimately disposed of by burial in a landfill. Removal of these materials protects the treatment plant's piping and downstream equipment from blockage and/or damage.

Following screening operations the wastewater flow passes into aerated channels designed to slow the flow velocity to 0.3 metres per second. Here heavy inorganic materials separate from the wastewater and settle. The settled inorganic material is referred to as grit. Periodically, the settled grit is removed from the channels, washed and ultimately disposed of by burial in a landfill. Grit is very abrasive and its removal early in the treatment process reduces wear on pumps and other equipment. This inorganic material would otherwise eventually settle in other process areas and take up effective treatment volume or capacity.

6.3 PRIMARY TREATMENT

The wastewater, with large debris and grit removed is directed to **primary treatment** operations. By volume wastewater is greater than 99.9 % water and less than 0.1 % solid material in the form of dissolved, suspended, and settable solids.

Although this may seem a very minuscule quantity of material, if left untreated and discharged serious negative affects would be experienced in the **receiving waters**. The separation and removal of a significant portion of this material is accomplished during primary treatment.

During primary treatment wastewater flows into and through large settling tanks or clarifiers where the flow velocity is reduced to afford hydraulic **detention times** of between 2 and 4 hours. Here initial separation occurs, with 40 to 50 % of the heavier settle able solids forming a raw or primary sludge on the bottom of the settling tanks, and lighter materials to float to the tanks surface. This sludge, with a typical volatile solids content of 75 %, is collected and discharged to other process operations for further treatment. The floated materials, primarily consisting of fats, oils and grease are skimmed from the tanks surface and are also directed to further treatment operations.

The non-settle able dissolved and suspended solid materials remaining in the wastewater flow exiting the settling tanks, referred to as primary effluent, are directed to other process operations to undergo further treatment. Primary effluent contains 60 to 70 % of the total solids contained in the plant influent.

6.4 ANAEROBIC DIGESTION

During primary treatment initial separation of the materials present in the wastewater was accomplished producing raw or primary sludge and primary effluent. The physical characteristics and organic strength, as measured by the **biochemical oxygen demand (BOD)**, of each product are uniquely different. **Secondary treatment** processes serve to further treat these products and are typically biological forms of treatment.

The sludge produced during primary settling is directed to large enclosed tanks void of free molecular oxygen, known as **digesters**. Here **anaerobic bacteria** utilize the organic material present in the sludge as a food source and produce carbon dioxide and methane gas. The action of these anaerobic bacteria stabilize the raw or primary sludge and alters the characteristics of the original sludge improving its dewaterability for further processing.

During the digestion period, typically 15 to 28 days, conditions suitable to maximize the biological activity of the anaerobic bacteria are maintained. The digester tank contents are heated to maintain a temperature of 35- 37 degrees Celsius, mixed to provide contact of organic material with bacteria and prevent the formation of a scum blanket.

Anaerobic digestion usually takes place in two stages. Contents of the second stage digestion tanks are periodically allowed to rest unmixed to encourage settling of the stabilized digested biosolids. Solids are withdrawn and directed to solids handling operations for excess water removal and further processing.

The end products of digestion are **stabilized biosolids** and a relatively clear liquid called **supernatant** which is withdrawn or overflows the secondary digestion tanks. Supernatant is returned to the plant influent to again undergo treatment and remove material which it contains.

Gas produced during digestion is comprised of 35 % carbon dioxide and 65 % methane by volume and is used to fuel the facilities hot water boilers and cogeneration engines. Heat energy produced is used for digester and domestic building heating. Electrical energy generated is consumed on site and offsets the total quantity of electricity required to be purchased.

6.5 ACTIVATED SLUDGE

The organic material present in the primary effluent, which overflows the primary settling tanks exhibits certain characteristics which require additional forms of treatment. This organic material is comprised of dissolved and finely divided suspended or, **colloidal solids** which account for the turbid appearance of the primary effluent.

By nature, the dissolved organic material present in the influent will remain in solution in the liquid flow during primary treatment. The colloidal solids present are very small in size and mass and do not settle during primary treatment. It is not possible nor practical to increase the detention time of the wastewater in the primary tanks in an effort to remove these colloidal solids. Increased detention times would promote the development of **septic** conditions within the settling tanks and solids removal efficiencies would actually decrease.

To treat the primary effluent waste stream a secondary biological treatment process is used known as the **activated sludge process**. This process effectively removes the dissolved organic material in addition to a portion of the colloidal matter and converts the remaining colloidal material to a biological sludge which rapidly settles. Activated sludge consists of sludge particles produced by the growth of organisms in the presence of free dissolved oxygen. The term “activated” comes from the fact that the particles are alive and teeming with bacteria, fungi and protozoa. These micro-organisms cleanse the wastewater by using the organic material present as a food source to grow and reproduce. The organisms stabilize soluble or colloidal solids by partial **oxidation** forming carbon dioxide, water, and sulphate and nitrate compounds.

There are many variations or modifications of the activated sludge process however basic principles of operation apply to all. Wastewater to be treated is thoroughly mixed with the activated sludge to form what is termed **mixed liquor**. The mixed liquor flows through large aeration basins which allow for detention times between 4 to 6 hours. Here, oxygen is dissolved into the mixed liquor by blowing air through the flow or by mechanical surface mixers which splash the mixed liquor into the air allowing oxygen from the atmosphere to be dissolved. Following this aeration period the **aerobic** organisms present in the mixed liquor are directed to a secondary clarifier where they **flocculate** and settle to form a sludge. A portion of this settled sludge is sent back to the beginning of the process as return activated sludge to maintain and continue the process. Sludge produced in excess of process requirements is wasted or discharged from the treatment system back to the primary settling tanks or a separate sludge thickening operation.

6.6 CHEMICAL TREATMENT

Although primary and secondary treatment operations are efficient in removing most wastewater pollutants, some pollutants require special forms of treatment for their removal. Phosphorous is one such pollutant of special concern. Left untreated, phosphorus contained in the final effluent of a wastewater treatment plant may have a serious negative impact on receiving waters. Phosphorous is one of the major nutrients associated with the growth of aquatic plants. Sources of phosphorous include; human waste, detergents containing phosphate additives and corrosion control chemicals used in water supplies and industrial discharges. High concentrations of phosphorous in receiving waters promote excessive growth of algae and aquatic plants which may disrupt the natural ecological balance of the receiving water. Rapid deterioration of water quality could result in acceleration of the eutrophication process of the receiving body of the water.

Phosphorus removal methods may be characterized as being either biological or **chemical precipitation** techniques. The present practice is the use of a metal salt which reacts with soluble phosphorous to form an insoluble precipitate. This precipitate settles with the sludge during settling operations and is thus removed from the wastewater flow. The most common metal salt in use is ferrous chloride, also known as “pickled liquor”. This metal salt solution is a readily available waste by-product of steelmaking operations.

Application points for iron solutions are typically immediately upstream of the primary settling tanks, at the influent end of the aeration tanks, or at both points simultaneously. It is important that chemicals used for phosphorous precipitation be intimately mixed with the wastewater to ensure uniform dispersion to achieve maximum removal efficiencies.

Another essential chemical treatment practiced at wastewater treatment facilities involves **disinfection** of the final effluent. Disease causing or **pathogenic** micro-organisms are potentially present in all wastewaters due to human discharges. These micro-organisms must be removed or killed before treated wastewater is discharged to receiving waters. **Chlorination** for disinfection purposes results in the destruction of essentially all of the pathogenic micro-organisms and thus prevents the spread of waterborne diseases. To further protect receiving waters sodium bisulphate is added following disinfection to dechlorinate the wastewater effluent prior to discharge.

6.7 DEWATERING

Dewatering is a solid handling process operation. Stabilized biosolids from secondary anaerobic digestion are directed to dewatering to remove excess water. This operation reduces the volume and increases the dryness of the solids for further processing. Feed solids typically 1.5 to 2 % on solids content are processed through mechanical belt filter presses, which yield filter cake typically 18 to 19 % in solids content. The feed solids are conditioned with a polymer-coagulating agent and squeezed between woven mesh filter belts. The excess water removed, termed filtrate, and wash water used to clean the woven filter belts is directed back into the wastewater flow for treatment.

6.8 COMPOSTING

Composting is an aerobic biological process providing for the **decomposition** of the organic matter present in the dewatered cake by bacteria and fungi in the presence of oxygen. The City of Guelph is the first wastewater facility in Canada to utilize a high rate, totally enclosed in vessel composting facility. Composting occurs naturally such as decomposition of leaves on a forest floor. This naturally occurring process can be optimized and accelerated by establishing ideal controlled conditions in a bio-mechanical process system. Temperature, food and oxygen availability is controlled to provide for optimum composting conditions.

The process begins by mixing proportionate amounts of dewatered cake, amendment material and a recycle of previously composted material. Amendment is derived from waste wood and provides a carbon-based food source to compliment the nitrogen-rich dewatered cake. The amendment also increases the dryness and porosity of the mix to allow efficient movement of air and oxygen transfer through the compost mass**.** The recycled compost is introduced to supply an active population of micro-organisms in addition to increasing the dryness of the mix. The combined feed material is introduced into the top of a Bio Reactor using a series of screw conveyors and vertical elevating conveyor, Compost material moves in a plug flow fashion from the top of the reactor vessels to the bottom. Material is withdrawn from the bottom of the Bio Reactor vessel and transferred to the top of the Cure Reactor. Heat generated by the growth of the microorganisms raises the temperature of the compost material. Temperatures range between 40 and 60 degrees Celsius or greater are maintained for a minimum period of three consecutive days, which provides for pasteurization and safeguards against harmful bacteria and viruses.

6.9 TERTIARY TREATMENT

Tertiary treatment process operations are incorporated at the City of Guelph Wastewater treatment plant. These are necessitated by the sensitivity and assimilative capacity of the Speed River which receives effluent discharge. Tertiary treatment or effluent polishing operations practiced are nitrification for the removal of ammonia nitrogen and sand filtration for the additional removal of suspended solids.

Ammonia nitrogen, like phosphorus is a nutrient which can promote the excessive growth of algae and aquatic plants which may disrupt the natural ecological balance of the receiving water. Nitrification is an aerobic biological process whereby nitrifying bacteria convert ammonia first to nitrite and subsequently to nitrate. Secondary treated effluent is directed to **Rotating Biological Contactors** (RBC) where this conversion takes place. Thirty-two RBC shafts configured in four parallel treatment trains are employed. Each shaft is 7.6 metres long with a media diameter of 3.6 metres and media surface area of 13,750 m. the media is submerged 40 % in the secondary effluent flow. Driven by air, the shafts slowly revolve in the wastewater at a rate of 1.3 rpm. Bacteria attached to the media converts the ammonia to nitrite and nitrate.

The treatment facility incorporates four low head sand filters for further removal of suspended solids and associated BOD and phosphorus. Each filter is comprised of numerous independent filter cells. Silica sand and anthracite of specific quality is used as the filter medium. RBC effluent is distributed to the filters which provide automatic backdating of the filter media. Filter backwash is directed to the primary treatment process for removal of contained solids.

7.0 DISCHARGE CRITERIA

To ensure the quality of our natural water resources the MOE determines and sets the allowable limits for effluent discharged from wastewater treatment facilities and rated hydraulic capacities within the province through the issue of Certificates of Approval. As may be expected the size of receiving water is important consideration in setting allowable discharge limits. The smaller the body of water the receiving stream represents typically the more stringent the discharge limits.

The principle elements for which discharge standards are prescribed are:

Hydraulic Capacity Rating
TOD total oxygen demand
BOD biochemical oxygen demand
TP total phosphorous
TSS total suspended solids
CR chlorine residual
NH_3 ammonia nitrogen
TKN total kjeldahl nitrogen
EC E. coliform

Hydraulic capacity ratings govern community growth related issues to ensure adequate treatment capacity is available and maintained.

Excessive BOD in the final effluent above the receiving waters natural cleansing ability may deplete the water body of its available oxygen supply and result in stagnant conditions.

Effluent high in TP or NH_3 will encourage growth of algae and aquatic plants which may disrupt the natural ecological cycle of the receiving water.

Discharges containing large quantities of TSS may also result in oxygen depletion resulting from **decomposition** of the organic material present in the receiving water.

Inadequate disinfection of a treatment facilities final effluent may result in the discharge of pathogenic bacteria as indicated by FC bacteriological analysis to receiving waters and lead to an outbreak of waterborne disease.

8.0 CONCLUSIONS

To accomplish treatment of wastewater for the City of Guelph on a 24 hours a day, 7 day per week basis is a demanding task. The proactive approach adopted by the city in providing this essential service will ensure the protection of our natural water resources.

To ensure the service requirements of planned future expansion within the city boundaries millions of dollars have been directed towards modernization and expansion of the various treatment facilities. Modernization will incorporate the use of the best available pollution control technology. The future holds exciting challenges in the wastewater treatment field, which must be met to ensure the protection of our environment.

9.0 GLOSSARY OF TERMS

Sludge particles produced by the growth of organisms (including zoogleal bacteria) in aeration tanks in the presence of free dissolved oxygen. The term "activated" comes from the fact that particles are teeming with bacteria, fungi, and protozoa. Activated sludge is different from primary sludge in that sludge particles contain many living organisms which can feed on materials present in the incoming wastewater.

Aerobic
A condition in which free dissolved oxygen is present in the aquatic environment.

Aerobic Bacteria
A bacterium, which lives and reproduces only in an environment containing oxygen which is available for their respiration (breathing). Oxygen combined chemically; such as in water molecules (H_2O) cannot be used for respiration by aerobic bacteria.

Anaerobic Bacteria
Bacteria that do not utilize free dissolved oxygen to survive but derive oxygen from compounds such as sulphate

Biochemical Oxygen Demand (BOD)
The rate at which microorganisms and chemicals use the oxygen in water or wastewater while stabilizing decomposable organic matter under aerobic conditions. In decomposition, organic matter serves as food for the bacteria and energy results from the oxidation.

Chemical Precipitation
Precipitation induced by the addition of chemicals.

Chlorination
The application of chlorine to water or wastewater, generally for the purpose of disinfection.

Coagulation
The use of chemicals that cause very fine particles to clump together into larger particles. This makes it easier to separate the solids from the liquids by settling, skimming, draining or filtering

Colloids
Very small, finely divided solids (particles that do not dissolve) that remain dispersed in a liquid for a long time due to their small size and electrical charge.

Combined Sewer
A sewer designed to carry both sanitary wastewater and storm or surface water runoff.

Decomposition, Decay
Processes that convert unstable materials into more stable forms by chemical or biological action. Waste treatment encourages decay in a controlled situation so that material may be disposed of in a stable form. When organic matter decays under anaerobic conditions (putrefaction), undesirable odours may be produced. Aerobic processes in common use for wastewater treatment produce much less objectionable odours.

Detention Time
The time required to fill a tank at a given flow or the theoretical time required for a given flow of wastewater to pass through a tank.

Digester
A tank in which sludge is placed to allow decomposition by micro-organisms. Digestion may occur under anaerobic (most common) or, aerobic conditions.

Disinfection
The process designed to kill most micro-organisms in wastewater, including essentially all pathogenic (disease-causing) bacteria. There are several ways to disinfect with chlorine being most frequently used in water and wastewater treatment plants.

Effluent
Wastewater or other liquid raw, partially or completely treated flowing from a basin, treatment process, or treatment plant.

Flocculation
The gathering together of fine particles to form larger particles.

Infiltration
The seepage of groundwater into a sewer system, including service connections. Seepage frequently occurs through defective or cracked pipes, pipe joints, connections or access chamber walls.

Inflow
Water discharged into the sewer system from sources other than regular sanitary connections. This includes flow from yard drains, foundation drains and around access covers. Inflow differs from infiltration in that it is a direct discharge into the sewer rather than a leak in the sewer itself.

Influent
Wastewater or other liquid raw or partially treated flowing into a reservoir, basin, treatment process, or treatment plant.

Mixed Liquid
When return activated sludge is mixed with primary effluent or raw wastewater this mixture is referred to as mixed liquor as long as it is in the aeration tank. Mixed liquor also may refer to the contents of mixed aerobic or anaerobic digesters.

Organic Waste
Waste material, which comes mainly from animal or plant, sources. Organic waste generally can be consumed by bacteria and other small organisms. Inorganic wastes are chemical substances of mineral origin.

Oxidation
Oxidation is the addition of oxygen, removal of hydrogen, or the removal of electrons from an element or compound. In wastewater treatment, organic matter is oxidized to more stable forms.

Pathogenic Organisms
Bacteria, viruses or cysts which can cause disease (typhoid, cholera, dysentery).
There are many types of bacteria which do not cause disease and which are not called pathogenic. Many beneficial bacteria are found in wastewater treatment processes actively treating organic wastes.

Precipitate
To separate (a substance) out in solid form from a solution, as by the use of a reagent. The substance is precipitated.

Preliminary Treatment
The removal of metal, rocks, rags, sand, eggshells, and similar materials which may hinder the operation of a treatment plant. Preliminary treatment is accomplished by using equipment such as bar/step screens, comminutors, and grit removal systems.

Primary Treatment
A wastewater treatment process that takes place in a rectangular or circular tank and allows those substances in wastewater that readily settle or float to be separated from the water being treated.

Receiving Water
A stream, river, lake or ocean into which treated or untreated wastewater is discharged.

Rotating Biological Contactors
Secondary biological treatment device consisting of a rotating shaft surrounded by plastic discs called media, which is partially submerged in the wastewater to be treated. A biological slime layer which attaches to the media effects treatment.

Secondary Treatment
A wastewater treatment process used to convert dissolved or suspended materials into a form more readily separated from the water being treated. Usually the process follows primary treatment. The process commonly is a type of biological treatment followed by secondary clarifiers that allows solids to settle out of the water being treated.

Septic
This condition is produced by anerobic bacteria. If severe, the wastewater turns black, gives off foul odours, contains little or no dissolved oxygen and creates a heavy oxygen demand.

Stabilize
To convert to a form that resists change. Organic material is stabilized by bacteria which convert the material to gasses and other relatively inert substances. Stabilized organic material generally will not give off obnoxious odours.

Storm Sewer
A separate sewer that carries runoff from storms; surface drainage, street wash and snow melt and do not include domestic and industrial wastes.

Supernatant
Liquid removed from settled sludge. Supernatant commonly refers to the liquid between the sludge on the bottom and the scum on the surface of an anaerobic digester. This liquid is usually returned to the influent of the treatment plant or to the primary clarifier.

Suspended Solids
Solids that are very small in size and mass which do not readily settle.

Volatile
A volatile substance is one that is capable of being evaporated or changed to a vapour at a relatively low temperature.