HAMILTON CHILDREN'S WATER FESTIVAL

TEACHER'S MANUAL

PREPARED BY

HAMILTON INDUSTRIAL ENVIRONMENT ASSOCIATION

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2 Teachers' instruction

This instruction manual works in tangent with the Children's Activity Book, that can be found using the QR code on the back of the bookmark (contained in the program package) or at HIEA'S website (www.hiea.org).

Ask the students to follow along on their devices where possible, or along on a projected screen in the classroom. If this not possible, the information will also be available in the printed hardcopy of the teacher's manual.

This manual contains information relating to wastewater and its treatment using examples from the steel industry in Hamilton, that plays a very important role in the development of Hamilton.

After the information has been discussed with the students a number of activities will follow. They are:

A. A teacher led activity- this activity involves two sections
    a. The making of simulated wastewater. This water will be used in the second section of this activity.
    b. The making of a mini wastewater treatment plant, to simulate how wastewater is treated in an industrial wastewater treatment setting.
B. Children's activity pages- The teachers manual and the children's activity book will contain activity pages for the students to complete. It is recommended that the teacher prints (double-sided) sheets of activities and give to students to be completed as students will not be able to complete the activities online.

SAFETY NOTE: There is a safety note (see page14) included in the Teacher led activity as it contains the use of Alum. The version of Alum to be used is kitchen grade, however, it is highly suggested that students do not handle this material.

3 Introduction

This booklet is designed by the Hamilton Industrial Environmental Association (HIEA), for grade four students participating in Hamilton's Annual Children's Water Festival. The main objective is to help students better understand the role of local industries in wastewater management. This booklet will allow them to understand what wastewater is and how we clean it to ensure that it is safe for humans, animals and the environment.

HIEA member companies are environmental stewards who are using this opportunity to highlight how they control and prevent water pollution. HIEA members are located in Hamiltonians backyard, and therefore ensuring safe water for the community is of utmost importance.

Students will have the opportunity to learn about where different types of wastewater comes from and will get to make simulated wastewater and a mini waste water treatment plant. They will then experiment to see firsthand how it works for the hands-on activity.

These activities continue to highlight the set mission and mandate of HIEA;

"Care for our environment and improve the quality of life in our communities through sustainable operations, open dialogue with our neighbours, and local partnerships that support environmental education for Hamilton students"

4 Teaching Objectives

1. Understand what wastewater is.
2. Understand the difference between Industrial wastewater, commercial wastewater, domestic wastewater, agricultural wastewater and stormwater wastewater.
3. Identify the stages of wastewater treatment.
4. Identify the different sections of a wastewater treatment plant.
5. Understand the effects of wastewater pollutants on the environment.
6. Understands the benefits of wastewater treatment.
8. Understand what local industries are doing to treat their wastewater.

5 What is wastewater?

Teachers note: Today students will learn about wastewater and the different types of wastewater. Ask the students:

1. ***If they ever wondered where the water they use at home or school goes?***
2. ***If they know what wastewater is?***
3. ***To name some of the things you may find in wastewater?***
4. ***If they can think of somewhere where wastewater comes from?***

5.1 Do you know where wastewater comes from?

Wastewater can be generated naturally through precipitation (rain and snow), can come from households (showers, dish water), and it can be the result of the activities of businesses, industry, and agriculture. The components of wastewater will vary depending on how it was created. Wastewater is composed of mostly water and small amounts of contaminants. Even though there seems to be a lot of water on the earth we still need to preserve it for future generations. When we clean or 'treat' wastewater, it can be used over and over again. Treated wastewater can be released safely back into ponds, streams, lakes, rivers, or can be sent to a city's water treatment plant for further purification.

5.2 Different types of wastewater

Teachers Note: Ask the students:

1. ***If they know the difference between wastewater, freshwater and saltwater.***
2. ***If they know that different types of wastewater exist?***
3. ***To you tell me some different types? Hint: think about all the places you go that use water. Car wash, restaurant, etc.***

5.2.1 Domestic Wastewater

Domestic Wastewater - This refers to any water that was used for residential activities such as toilet flushes, showers, kitchen and laundry. We sometimes call this sewage.

5.2.2 Industrial Wastewater

This wastewater is the result of industrial activities such as manufacturing, mining and power generation. The components of industrial wastewater differ depending on the type of industry using it. It contains impurities that must be specially treated and/or disposed of before being released back to the environment or re-used by the industry.

5.2.3 Commercial Wastewater

This includes any water that was used for non-domestic activities such as in restaurants, auto-body shops, and hair salons. Sometimes commercial wastewater contains pollutants and must be managed appropriately.

5.2.4 Agricultural Wastewater

This is water that has been used in various ways to grow our food. It also includes runoff surface water from farm lands contaminated with agricultural chemicals and sediments.

5.2.5 Stormwater wastewater

This refers to runoff which comes from rain and melting snow and is not absorbed into the ground. Harmful substances from roads, farms, and cars are carried in the storm water where they enter storm sewers that flow into natural water bodies. If the water is polluted it can harm aquatic life and water quality, effecting recreational activities such as swimming and fishing.

6 What are some of the things we find in untreated wastewater?

Typical things requiring treatment may include solid materials, fats-oils-grease, bacteria, heavy metals and other regulated chemicals and substances.

6.1 What are the effects of pollutants in wastewater?

When pollution is present in water and is released into the environment, it can be result in harmful impacts such as:

a. Not enough oxygen for fish and aquatic plants

b. Too much nutrients in the water can lead to eutrophication, which is an overgrowth of algae

c. Pathogens, bacteria or viruses that can cause disease, can pollute the water, and be harmful for aquatic organisms and humans (drinking water, swimming)

d. Metals such as mercury or lead can be toxic to a variety of species.

7 How does raw wastewater become clean water?

Teachers note: Ask the students:

1. ***Why they think we should clean wastewater before putting it back into the environment.***
2. ***Now that we know what wastewater is, do you think we could go ahead and reuse the water?***
3. ***Would it be safe or would it need to be cleaned first?***
4. ***Why would we need to clean it?***
5. ***What would happen if we did not clean the wastewater and it went back into the environment?***

7.1 Why must we clean wastewater?

Wastewater contains many contaminants that can be unsafe for the environment and for humans. Therefore, before water can be re-used, it must be cleaned. A number of Industrial Plants in the Hamilton area treat the wastewater that they make. For extra measure, they also send it to the city treatment plant to be further treated.

Industries have a lot of rules to follow when it comes to protecting the environment. It is law that they remove any contaminants before the water can be safely discharged to the city water treatment plant, to a water body, or reused in plant operations. Industries

manage their wastewater from their processes and also make sure they have systems in place that prevent any accidental releases of untreated wastewater to the natural environment. Industry, particularly in Hamilton, Ontario use resources efficiently, and value that the Earth's limited resources need to be conserved, used longer, and recycled.

Some other reasons as to why we need to clean wastewater:

- Clean water is a finite resource and is important for the environment and for our own health
- Clean water is very important for our plants and animals who live in water or depend on it to survive. As part of natural ecosystems, human health is directly related to the health of our fresh water systems.
- Human's love water for recreation such as swimming and fishing, and
- If water is not properly cleaned it may carry diseases especially to persons who live, play and work close to the water.

8 Treatment Methods for wastewater:

Teachers Note: Ask Students

1. ***If they think that cleaning water from industries would be similar to cleaning water from their houses? Why or Why not?***
2. ***If they know about the steel industry in Hamilton and that Hamilton is home to a number of steel companies.***

8.1 Local examples of industrial waste water treatment.

Explain to students the similarities that exist with Municipal and Industrial wastewater treatment and highlight the only difference is the substances it contains. Municipalities and industries clean their water in a similar process. We are going to see how a local industry cleans their wastewater.

8.2 **Stelco Holdings Inc.**: A local example of an on-site industrial wastewater treatment plant

Stelco Holdings Inc. is one of Hamilton's own industrial plants that treats their wastewater before sending it to the municipal treatment plant. Their system is a smaller version of the city water treatment plant and operates much the same. An essential part of water treatment is using 'bugs', which are nature's natural water purifiers. These simple bacteria breakdowns or 'eat' wastes in the water playing a critical role in water purification. This very important step removes harmful substances produced from manufacturing activities that the municipal water treatment system is not able to effectively treat. This process of double-treatment ensures that all water that is eventually released into the Hamilton harbour is free of harmful contaminants.

8.3 How does Stelco clean their wastewater?

1. **Equalization** – water used for cooling equipment and machines is collected & stored prior to treatment
2. **Aeration** – wastewater flows to bioreactors where, through a series of stages, beneficial bacteria break down organic material and clean the water
3. **Chemical Treatment** – chemicals react with compounds in the water, causing fine particles to attach together making larger molecules
4. **Clarification** – effluent is gravity fed through clarifiers where larger particles settle to the bottom of the tank where is it removed (sedimentation)
5. **Storage** – Large tanks store cleaned water before it is discharged
6. **Discharge** – cleaned water is discharged to City of Hamilton sewer for additional treatment before discharge back into the lake
7. **Sludge dewatering** – water is removed from the solids taken from the bottom of the tanks before being sent to landfill.

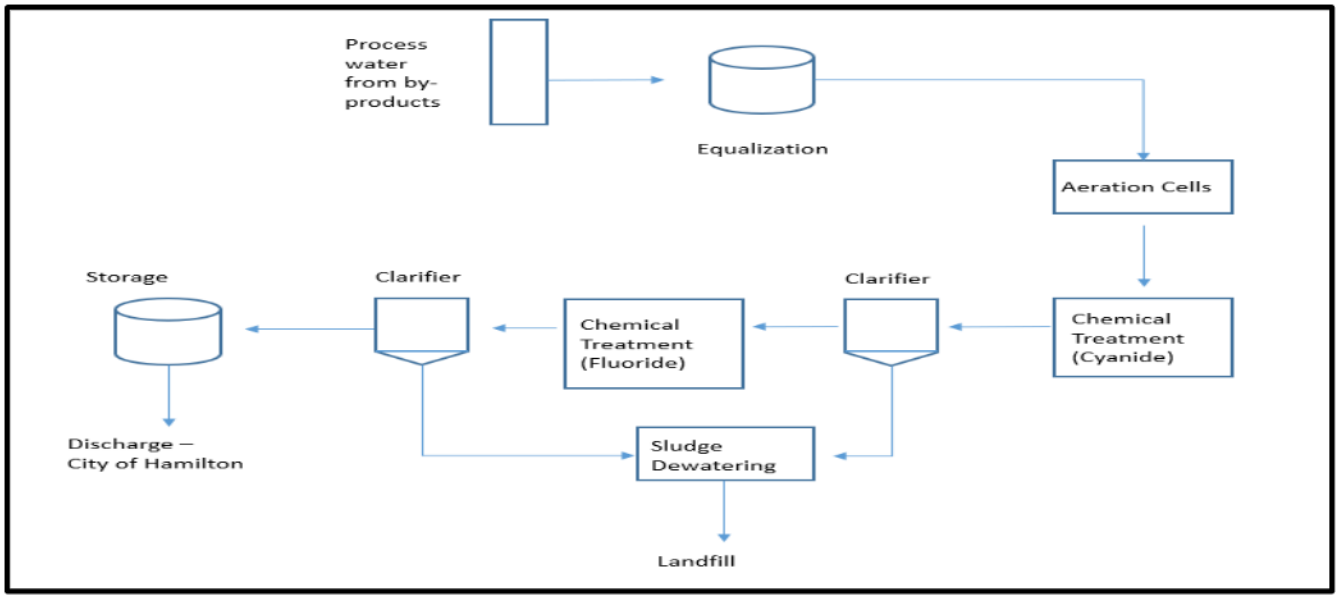

Figure 1- Diagram showing detailed steps of water treatment at Stelco's water treatment facility.

(A more simplified version is available in the children's activity book

9 Now that the water has been cleaned, how do we know it is safe to reuse?

Teachers note: Ask students:

1. ***If they could drink the water as it is now (from wastewater treatment in section 1.10? (Hint: No, still contains impurities that are not up to the standard of drinking water.). Explain their answer.***

Testing! In order to determine if the water is 'clean' we have to test it in a laboratory. There are a number of things we can test for, but the most common things are pH, Oxygen levels and presence of solids.

How do we know what levels are acceptable? The Canadian and Ontario government have rules or laws in place to protect water quality. These laws tell us the acceptable levels of all additional substances that we can find in pure water. These levels are safe for humans, animals, plants and the environment as a whole.

10 Teacher Led activities

10.1 Activity1- Creating a simulated wastewater

Since we now know that the process of cleaning domestic water and industrial water are very similar, let us create a simulated sample of wastewater from materials we can find around us at home and school.

Wastewater Contaminants List:

- 1.5 liters water
- 5 grams coffee grounds
- 40 grams sand
- 15 grams vegetable oil
- 1-ounce liquid soap
- Large plastic jug

Instructions:

In a large jug pour all items and mix well. This water will be used for your water treatment plant.

10.2 Activity 2- Water Treatment Simulation

In this activity students will create a simulated water treatment plant. This process will show how industrial water is first cleaned before being sent to the city of Hamilton's sewer treatment plant. Under normal circumstances when something needs to be cleaned, we use water. Therefore, in this activity students will learn how to remove harmful substances from wastewater.

SAFETY NOTE:

1. Only the teacher is allowed to handle the bleach and alum. Make sure that the alum to be used in this activity is PURE ALUM. Some alum may be ammoniated. Mixing ammonia with bleach creates harmful fumes.)

2. Never taste the water. Wash hands thoroughly after activity. Always wear safety goggles.

Materials:

- 2 x 10 z plastic cups
- 1 x 2L soda bottle cut in two
- 1tsp alum *
- 2 cups wastewater
- 1 cup clean sand
- 1 cup clean aquarium gravel
- 1 teaspoon measuring spoon
- 4 cone shaped coffee filters
- 2 tbsp disinfectant* (very dilute bleach water – approximately 4 drops of bleach in one quart or 32 ounces of water)

Item	Picture
10 oz Plastic cups	
2L Soda bottle	
Alum	
Coffee filters	
Gravel	
Sand	

Procedure:

1. First stage is Aeration: Pour the wastewater back and forth between two cups. The water releases trapped gases and absorbs more oxygen
2. Second stage Chemical treatment/ Coagulation: add one teaspoon of alum to the wastewater and mix well using a mixing spoon. The powdered alum when dissolved in water will form tiny stick particles called floc'. These flocs' will then cause the dirt molecules in the water to stick together and become large and heavy enough to sink to the bottom (sedimentation)
3. Leave the mixture untouched for approximately fifteen minutes (see figure 2)

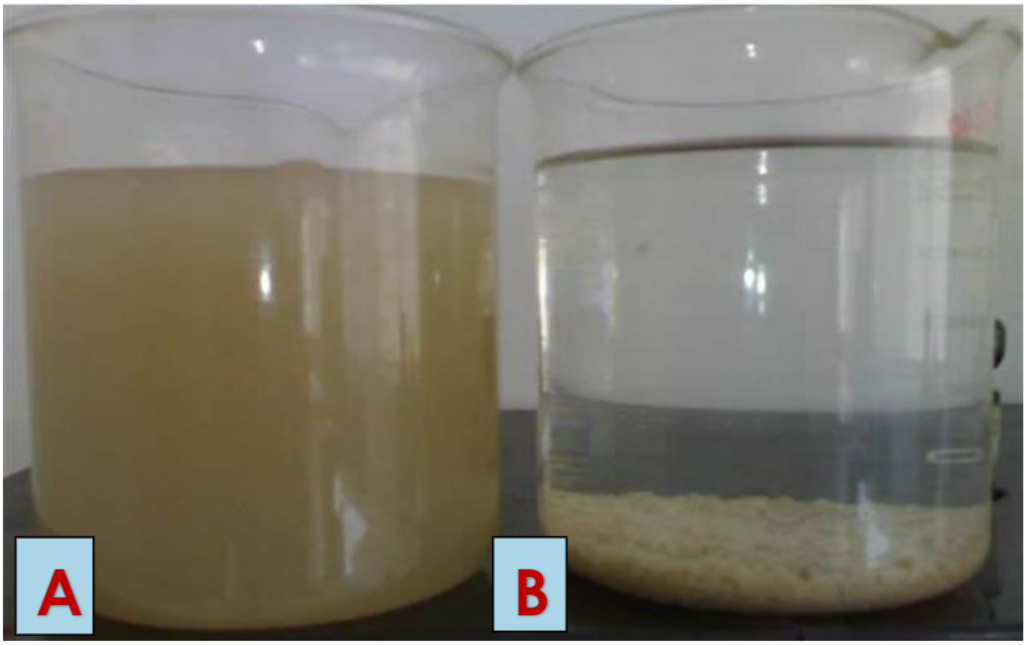

Figure 2: Beaker with wastewater before Alum was added **(A)** and after Alum was added and the solution allowed to settle **(B).**

4. Take this time to set up the filtration step.
5. Filtration: Line the paint filter with two coffee filters. Then add a layer of gravel inside the filter system and then add a layer of sand on top.

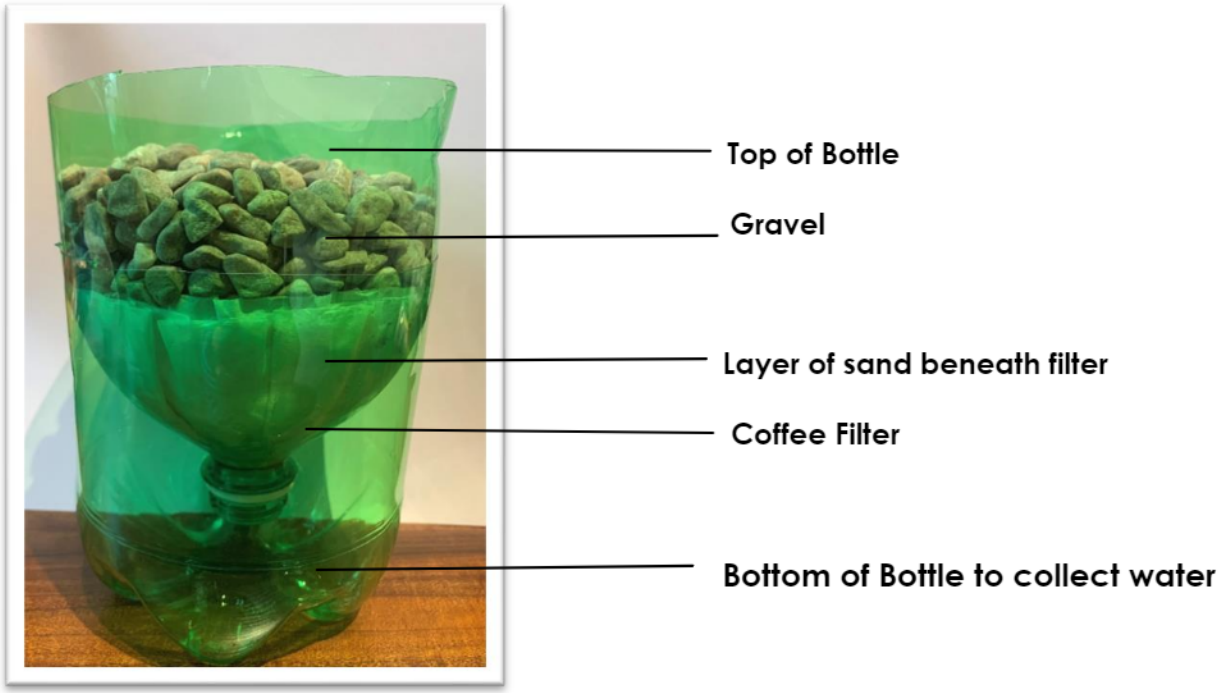

Figure 3: Figure showng set up of Water treatment apparatus. The top of the bottle inverted into the bottom half with a layer of coffee filters, then sand layer then gravel layer.

6. Add filter inside the top half of the soda bottle and place top of water bottle neck down inside the other half of the soda bottle. Pour mixture that was allowed to settle into the filter. The floc' particles are not trapped to the sand and gravel layers.
7. To the newly cleaned wastewater, add a small amount of disenfectant to the sample to kill any bacteria that is present in the water.

Disposal and clean up:

1. At the end of the activity have students dispose of wastewater outside close to a grassy area and away from ant waterways.
2. Separate the gravel from the sand . these can then be laid out to dry separately and used again.
3. Wash out plastic bottles and containers and dispose of them in the recycling bin

4. Dispose of the coffee filter in organics bin.
5. Dispose of the paint filters in the garbage bin.
6. Wash up measuring spoons and return them to original package/box.

11 Making the Connection:

1. Do you know the difference between clean water and raw wastewater?
2. What happened with this water treatment process?
3. How does the water treatment process differ between industries and the municipalility?
4. Why can't we use this water for drinking right now?
5. Why is it important to treat the water?

HELP THE TREATED WASTEWATER

FIND ITS WAY TO THE RIVER

FILL IN THE BLANKS

- HARMFUL
- QUALITY
- TREATED
- WASTEWATER
- PATHOGENS
- EUTROPHICATION
- PRIMARY
- SOURCE
- UNTREATED
- CLEAN
- PROTECT
- WATER
- RESOURCE
- RULES

1._____ wastewater contains many _____ contaminants.

2. Too many nutrients in the _____ can lead to _____, which is an overgrowth of algae in the _____.

3. _____, bacteria or viruses in untreated _____ can lead to diseases and therefore harmful to aquatic organisms and humans.

4. _____ water is a finite _____ and is important for the environment and for our own health.

5. The government has _____ in place to protect the _____ of water.

MATCH THE WORDS TO THEIR CORRECT MEANING

DEFINITIONS

- WATER HAS BEEN USED FOR DIFFERENT ACTIVITIES
- WASTEWATER FLOWS TO BIOREACTORS, WHERE THROUGH A SERIES OF STAGES, BENEFICIAL BACTERIA BREAK DOWN ORGANIC MATERIAL AND CLEAN THE WATER
- SITES WHERE SOLID GARBAGE IS DISPOSED
- UNWANTED MATERIALS FOUND IN WASTEWATER THAT ARE REMOVED
- WATER THAT HAS GONE THROUGH THE TREATMENT PROCESS AND IS READY TO BE USED IN HOMES OR DISPOSED OF IN THE ENVIRONMENT
- AN OVERGROWTH OF ALGAE IN RIVERS AND LAKES BECAUSE OF TOO MANY CHEMICALS
- TINY PLANTS THAT ARE NATURAL TO WETLAND AREAS BUT WHICH CAN OVERGROW IF THERE IS TOO MUCH POLLUTION
- LARGER PARTICLES SETTLE AT THE BOTTOM OF THE TANK WHERE IS IT REMOVED

TERMS

WASTEWATER

AERATION

LANDFILL

CONTAMINANTS

TREATED WASTEWATER

EUTROPHICATION

ALGAE

SEDIMENTATION

MATCH THE WORDS TO THEIR CORRECT MEANING

DEFINITIONS

- A TANK WHERE SLUDGE SINKS TO THE BOTTOM AND SCUM RISES TO THE TOP
- HEAVY WASTE THAT SINKS TO THE BOTTOM OF A TANK OF WATER
- LIGHT WASTE LIKE OIL AND GREASE THAT FLOATS TO THE TOP OF THE WATER
- WATER USED FOR COOLING AND GENERATED THROUGH OUR PROCESS IS COLLECTED & STORED PRIOR TO TREATMENT
- A TANK WITH AIR BUBBLES THAT HELP TO BREAK DOWN CONTAMINANTS IN THE WATER
- A PROCESS BY WHICH WASTEWATER IS CONVERTED BACK INTO WATER THAT IS FREE FROM CONTAMINANTS AND CAN BE DISCHARGED BACK INTO THE WATER
- CLEAN WATER IS TREATED WITH CHLORINE OR ULTRAVIOLET RAYS TO DESTROY BACTERIA
- WATER IS REMOVED FROM THE SOLIDS TAKEN FROM THE BOTTOM OF THE TANKS BEFORE BEING SENT TO THE LANDFILL.
- NATURAL FERTILIZER MADE FROM SLUDGE

TERMS

CLARIFIER

SLUDGE

SCUM

EQUALIZATION

BIOREACTOR

WASTEWATER TREATMENT

DISINFECTION

SLUDGE DEWATERING

COMPOST

ACTIVITIES

Find the words in the puzzle.
Words can go in any direction. Words can share letters as they cross over eachother

L U W J Y Q P M F C P D S R D
Z A A E T Q N R O C I D T E I
W Y I Z T B D M F S W O N T G
P W H R C L M L I T E M A A E
W G U R T E A N W B O E T W S
O G R Y R S F N A W E S U E T
F C N C N E U I D Z Q T L T I
Y Q I A C S R D E S M I L S O
G A E T P E Y B N O Z C O A N
L L I C T S X Q E I N I P W Q
C O C C T N E M T A E R T F I
N O A N O I T A Z I L A U Q E
K B N A E R A T I O N R O A W
S O S L U D G E F L W G O R S
S E D I M E N T A T I O N N X

AERATION
COMMERCIAL
DOMESTIC
POLLUTANTS
TREATMENT

BACTERIA
DIGESTION
EQUILIZATION
SEDIMENTATION
WASTEWATER

CLEAN
DISINFECTION
INDUSTRIAL
SLUDGE
WETLANDS

This manual has been brought to you by the Hamilton Industrial Environmental Association (HIEA) who has been a proud supporter of the Children's Water Festival since 2008.

We hoped you learned a lot!

HIEA is a non-profit association (Incorporated in 1998) whose 14 members represent local private sector industries.

info@hiea.org

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