THE CLEAR WATER MUSKETEERS

CHAMPLAIN COMPANY

Guide for Mister
D'Artagnan's Musketeers

THE WATER
QUALITY GRADE

Guide for Mister d'Artagnan's Musketeers

Water Quality Grade

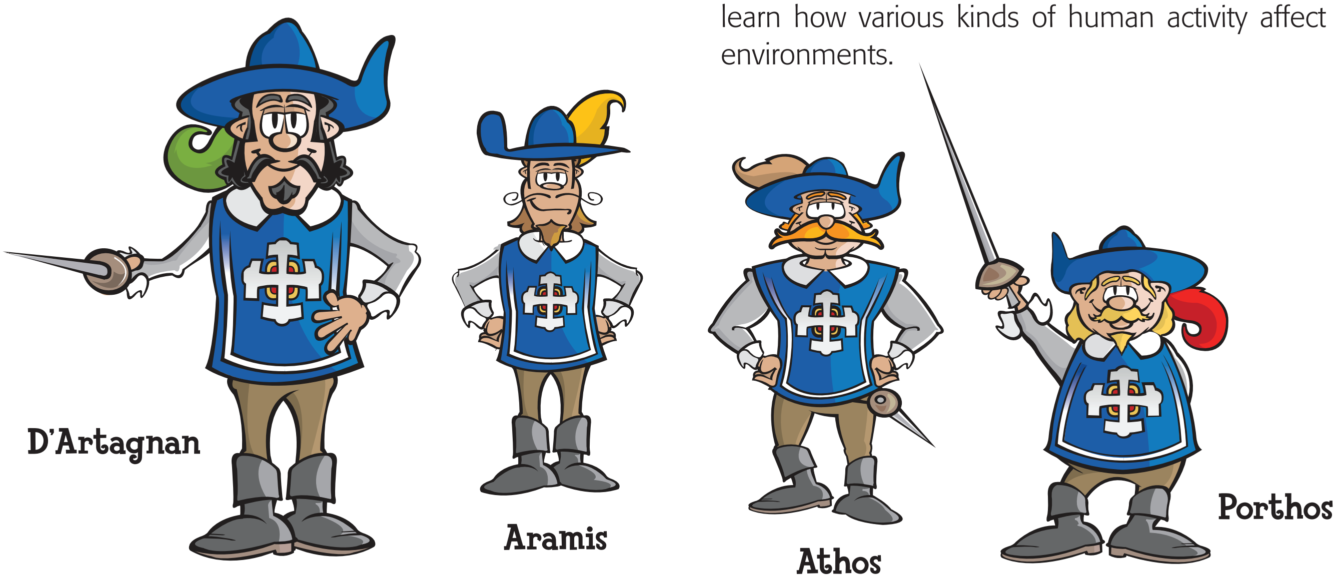
The Clear Water Musketeers are in charge of protecting the water in their community. With Mister d'Artagnan, the clear water musketeers will learn to analyze problems related to water quality. D'Artagnan was fearless and very determined, but acted cautiously. He used his intelligence to solve every problem that occurred during his missions. Mister d'Artagnan's musketeers will practice evaluating water quality and explore solutions to reduce pollution at the source.

There are three other grades in the clear water musketeers program:

The Basin Grade: Mister Porthos' musketeers learn about the land through which the rivers and lakes flow.

The Aquatic Ecosystem Grade: Mister Aramis' musketeers discover the secret relationships between organisms living in various aquatic environments.

The Water Usage Grade: Mister Athos' musketeers learn how various kinds of human activity affect aquatic environments.



The four musketeers were featured in a story written by Alexandre Dumas in 1844: their names were **Aramis**, **Athos, Porthos** and **d'Artagnan**. The story took place in the 17^{th} century, from 1610 to 1670.

Name: ______________________________

School: ______________________________ Class: ______________________________

Quality of life is linked to water quality

Water is an essential component of all life on Earth, which started some 3.5 billion years ago when microscopic cells (bacteria) multiplied in the water! In the course of the evolution of life on Earth, food webs and ecosystems have greatly evolved; some species disappeared, while others took their place.

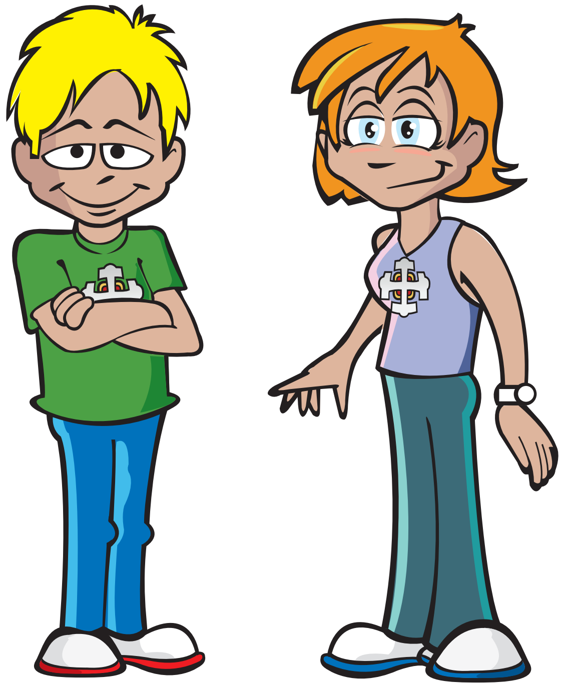
The water cycle, which is linked to climate, has always had a great influence on an ecosystem's evolution: the surface runoff carries soil particles while living organisms depend on the availability of water. Flowing water also carries masses of substances as it makes its way through the continents to the sea. Those substances that are harmful for living organisms are called water contaminants.

How has life managed to endure with all the contaminants present in water? Nature has developed mechanisms to clean up water through evaporation, filtration through the ground and biological degradation in aquatic environments. With time, all animal and plant species have developed relatively efficient mechanisms to rid themselves of harmful substances.

Unfortunately, human activities have developed on a large scale on the planet and have produced a large quantity of contaminants. Humans have also developed several non-natural substances that living organisms cannot eliminate. Some of these substances are toxic.

The Missisquoi Bay basin has been here since the Champlain Sea withdrew at the end of the last glaciation, some 12,000 years ago in our part of the world.

Since then, the water has been contaminated. In this Clear Water Musketeer's guide, we will learn to evaluate water quality as well as explore ways to reduce water contamination.



Musketeers Aqualine and Riviero will help you along your quest to improve the water quality in the Missisquoi Bay basin. You can follow the example of d'Artagnan who always found the best ways for accomplishing his missions.

From the Champlain Sea to Lake Champlain

More than 12,000 years ago, all of Quebec was covered in ice almost two kilometres thick. The melting glaciers retreated towards the north, allowing the saltwaters of the Atlantic to form an inlet on the continent through the Quebec City area. The saltwater combined with the freshwater left over by the melting glaciers to create a huge interior sea almost as salty as the ocean.

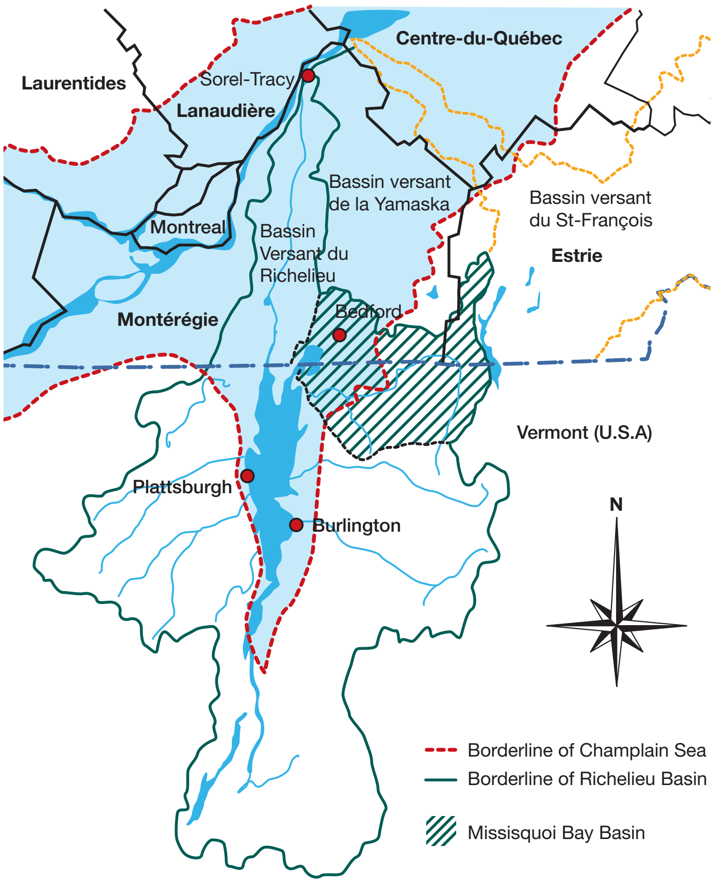
Champlain Sea

From the years 12,000 to 9,500, the Champlain Sea covered the area between the Appalachian mountain range south of the St. Lawrence River up to the Laurentians plateau north of the river. The sea also covered Lake Champlain as we know it up to the foot of Mount Sutton to the east.

On the circumference of the Champlain Sea was a sandy beach and on the bottom of the sea was a thick layer of sediments: mainly clay mixed in with some organic matter. When the sea retreated 9,500 years ago, it left long stretches of sand that can still be seen as sand pits. The ancient clay sediments of the Champlain Sea can be found at the bottom of Missisquoi Bay, but they have been covered by new sediments brought in by the streaming water since then.

Once the sea had retreated, the mineral-rich sediments were exposed to the air and colonized by plant life. The first plants consisted of tundra shrubs, as it was still very cold. Gradually, coniferous trees made their way from the south to produce forests of pines, firs and eastern hemlocks. Following them were hardwood trees such as sugar maples, yellow birch and oak. Many swamps still present today were formed around Missisquoi Bay at that time.

Map of the Champlain Sea



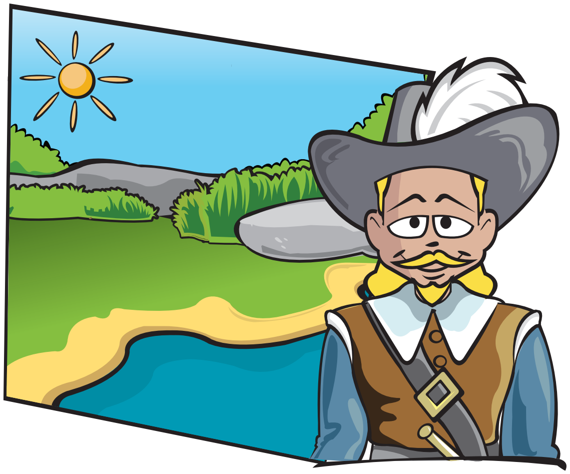
In the Champlain Sea, there were saltwater fish, including beluga whales. Do belugas still swim in Lake Champlain?

The Champlain Sea retreated, leaving a freshwater lake where the beluga whales could not survive anymore. Beluga whale skeletons have been found in the lake's ancient seabed sediments, and fossils of shellfish were found on the mountains surrounding it.

Credit: adapted from a map by Patrick Desautels (CBVBM) and a map of the Champlain Sea by Pierre J.H. Richard and Serge Occhietti.

Lake Champlain

Five thousand years ago, Amerindians traveled across the area to take advantage of the abundant fish and game. In the summer, the Iroquois built longhouses at the mouth of the Pike River and feasted on northern pike. The Abenakis frequented the Missisquoi Bay and Missisquoi River Valley because of the vast natural resources for hunting and fishing, stone for their tools and clay for their earthenware. According to historians, the Amerindian word *Missisquoi* might mean: "where there are many aquatic birds."



In 1609, Samuel Champlain, an explorer and geographer commissioned by the King of France, began a journey on the Richelieu River with the Montagnais and Huron Amerindians of Quebec City. In birch bark canoes, he battled many rapids upriver to reach a great lake on July 14, 1609. In his writings, he notes that the region held an abundance of wild game: white-tailed deer, fallow deer, fawn, bears and many beavers in the small rivers. He adds that he had never seen nicer vines and chestnut trees. Champlain was so taken by this beautiful great lake that he named it after himself.

By 1733, human occupation greatly transformed the natural environment of Lake Champlain in the seigneuries and in the townships, the first of which in Quebec was established in Dunham in 1796. The sediments left over by the Champlain Sea made excellent farmlands. At the start of colonization, the waters flowing through the rivers and through Missisquoi Bay had a nice natural quality. With urban, agricultural and industrial development, water contamination has become very significant. Studying the sediments in Lake Champlain will allow us to trace the evolution of water quality up to now.

Champlain described fish of a disturbing size in Lake Champlain: eight to ten feet long, with a 2.5-foot snout containing a double row of sharp teeth and a body covered in silvery scales so hard that they cannot be pierced by a knife. He would have been referring to very large longnose gars, a species that can still be found in Missisquoi Bay, though much smaller!

Head of the skeleton of a Missisquoi Bay longnose gar.

More visible contaminants

Obviously, what is most visible is the garbage and debris that has been conveyed by the water. However, we can also see particles in suspension in the water, as well as matter floating on the surface. When we don't control the contaminants we release in the water, we produce a genuine pollution soup!

Debris

Every spring it is surprising to see so much garbage at the water's edge. This debris is left over by the overflow of water caused by melting snow and spring rains. All the garbage that is thrown on the ground can end up in ditches, and eventually end up in the streams and lakes. Debris takes a long time to decompose because it is made up of resistant materials such as cans, bottles, plastics and even wood. This garbage is not harmless, as it can hurt the organisms living in the water and on the shores. It is important to organize clean-up activities in order to solve this problem. The best way to fight this kind of pollution is not to throw garbage on the ground, or worse, directly in the water!

Floatables

We can also see floatables on the surface of the water, particularly oils, grease, oil-based paints, etc. These substances form a film on the surface of the water preventing oxygen from entering the water. Without oxygen there cannot be life – that's the rule! On top of that, floatables can coat the feathers of birds, weakening them, and eventually killing them. Other floating substances are harmless, like tree pollen, but not very aesthetic.

Plastic ring carriers for cans can be a death trap for aquatic animals. In order to better understand how difficult it is for animals to get out of these traps, place your hand in one of the circles and try to remove it without using your other hand!

Some substances create foam when they are stirred up by water. Foam made up of chemicals can be seen near industrial wastewater. Generally, this is produced by organic matter that sticks together to create a white or brownish foam. This foam is not dangerous, but indicates that there is too much organic matter for the river or lake to stay healthy.

EXERCISE 1 EASILY IDENTIFIABLE CONTAMINANTS

What types of contaminants have you already seen in water? Could you have removed them?
(Answer on page 17)

Debris: ____________________

Floatables: ____________________

Suspended solids: ____________________

Suspended solids

In water, many particles are carried over long distances. There are soil particles that have been brought over by rain waters and melting snow. Soil is natural, but when there is too much of it in water, it can be harmful to the aquatic organisms living there! The particles prevent the sunlight from penetrating into the water. Without sunlight, aquatic plants cannot grow and animals do not see well enough to nourish or protect themselves. The particles lodge themselves in the gills of fish and in the filters of mussels, and can cause them to get sick.

There are also particles that colour the water, such as paint pigments, rust, soot, stone, cement or asphalt dust, as well as decomposing organic matter. Domestic wastewater contains many particles that give it an appearance that varies from grey to black. In very clear lake water, the sunlight can penetrate as far as eight metres, allowing us to see very well under water. When the water contains too many particles, however, we cannot even see our own feet while swimming!

Some contaminants will also stick to particles, such as phosphorus, a nutrient for plants, or toxic metals like chrome, copper, lead and mercury. A large amount of particles settles on the bottom of the water forming sediments containing all of these pollutants.

Credit : Clotilde Boillot

Sampling sediments at Missisquoi Bay
Using a long tube that they drive through the mud, University of Laval and University of Vermont researchers have collected core samples of sediments for analysis in their laboratories

ALL GARBAGE CONTAMINATES WATER

- Just one drop of petroleum oil can make up to 25 litres of water unsuitable for drinking.
- Many objects decompose in water, releasing substances that are toxic to animals, such as lead sinkers, mercury batteries, iron objects that rust, wood coated with tar oil, glue and varnish, etc.
- Young aquatic birds can die of hunger because their parents feed them plastic particles floating in the water, mistaking them for fish eggs.
- Ocean currents have created a 3.4 million km^2 zone in the North Pacific Ocean containing 3.5 million tons of garbage coming from the shores and from ships.

Less visible contaminants

Several substances, such as sugar and salt, seem to disappear when stirred in water. These substances do not really disappear: they simply dissolve in water. They are mixed in with the H_20 water molecules. Clear water can therefore contain invisible substances and microorganisms.

Toxic substances

Salt and sugar are not toxic, even if they can be unhealthy for you in large doses. Other substances, however, are very harmful and can contaminate us if they are placed in water: pesticides (insecticides, herbicides, fungicides), metals (lead, copper, mercury, chrome), solvents used for degreasing, stripping and dry-cleaning, as well as all petroleum derivatives.

The spiny softshell turtle, a threatened species
Several animals are sensitive to contaminants found in water, particularly the young, like this Missisquoi Bay spiny softshell turtle barely a few days old.

Many substances are also toxic for aquatic organisms, particularly for fish. When other animals eat fish contaminated with toxins, the toxic substances can accumulate in their bodies. This means that there can be a possible concentration of toxic substances throughout the food web – for example, from the plankton to small fish, then to bigger fish and finally to the bears.

Nutrients

Some substances found in water are nutrients that are used as plant fertilizers. For example, a fertilizer whose label is marked 7-10-8 indicates that it contains 7% nitrogen, 10% phosphorus and 8% potassium. When there is too much nitrogen and phosphorus in the water, the aquatic plants will grow too rapidly and invade the entire area. Microscopic algae will multiply and turn the water green. All these plants and algae will then die and be decomposed by bacteria using up all the oxygen in the water.

Animals and humans use phosphorus in their diet, as it is essential for the development of their bones and their teeth, as well as for the development of energy molecules in their cells. A large quantity of phosphorus is therefore found in domestic wastewater and in animal feces, some of which are used as fertilizers (manure and animal slurry).

Microorganisms

Other elements can be found in water that are not easily seen: microorganisms. They are living organisms that are invisible to the naked eye because they are made up of very few cells. A microscope is used to detect microscopic organisms such as algae and bacteria.

Bacteria in water can cause very serious illnesses. Fecal coliforms are present in domestic wastewater and animal feces. These bacteria are an important part of our digestive system. If these are detected in a body of water, however, it means that there has been wastewater contamination. In wastewater, several types of pathogenic bacteria can be found that cause waterborne diseases such as gastroenteritis.

EXERCICE 2 INSPECTING WATER

Are the following elements visible in water?
Yes, no, it depends... but what does it depend on?
(Answer on page 17)

Microscopic algae ______________________

Coliform bacteria ______________________

Grass fertilizer ______________________

Motor oil ______________________

Insecticide ______________________

Soil particle ______________________

Laundry soap ______________________

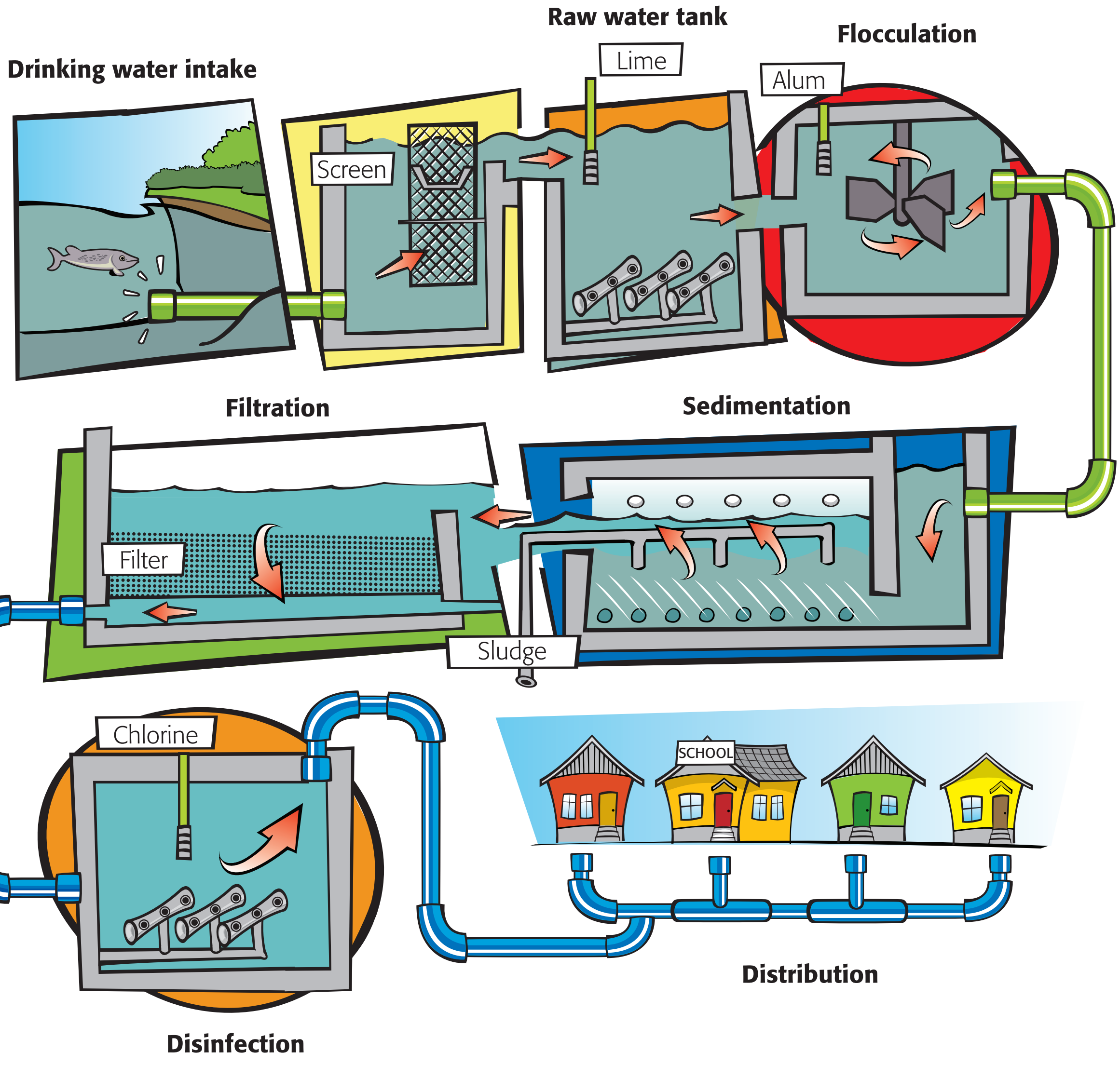
Fabric dyes ______________________

Cyanobacteria are a growing problem because there are so many nutrients that they can feed on in the water, especially phosphorus. The word cyan means blue, and the proliferation of cyanobacteria means the littoral zone will turn blue-green, and sometimes even turquoise. They can release invisible toxic substances called cyanotoxins that can affect the skin, liver or nervous system. That is why it is forbidden to swim in areas containing high concentrations of cyanobacteria.

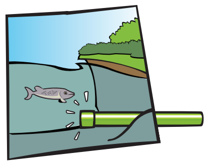
Even in streams where the water is very clear, tiny organisms exist that are difficult to see. These are protozoa with funny names, Giardia and Cryptosporidium, and can cause severe cramps and fevers. Luckily, these organisms are eliminated in the treatment of drinking water.

Drinking water treatment chain

Highly contaminated water requires a complex treatment to make it potable and safe, for all its domestic and commercial uses. Since this treatment is very expensive, it is better to make sure that the water is as clean as possible at the start of the treatment chain. The water contamination must therefore be reduced to make it easier to clean.

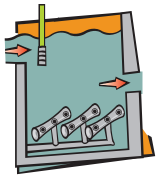


Drinking water intake



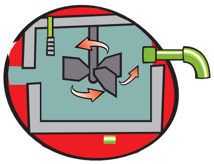
The water is brought to the treatment facilities through a pipe fitted with a grill that filters debris, pieces of wood, floating objects, plastic bags and fish. A screen is then used to filter the smaller pieces like leaves and cigarette butts.

Raw water tank



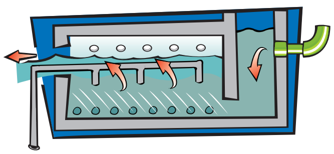
In this tank, tests are made to evaluate water quality before it is treated. Some additives are added, like lime, which is used to reduce the water acidity level.

Flocculation



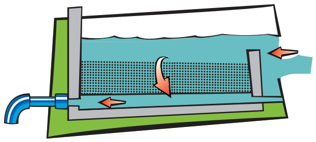
Some suspended solids are too small to be removed with a screen. A coagulant, usually activated alum, must first be added. A coagulant will bring the particles together so that they form large clumps. The water containing the clumps is then sent to the next tank.

Sedimentation



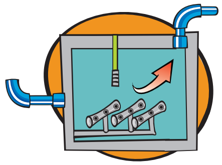
In this tank, the water is clarified by letting the clumps settle on the bottom. The sediments formed by the clumps will then be dredged out as sludge to be treated in a specialized landfill site. The clarified water at the top of the tank will continue on to the filtration tank.

Filtration



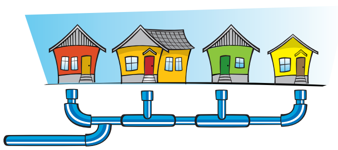
Even though the water is quite clear at this point, it may still contain dissolved substances and particles. The water passes through filters made up of gravel, sand and finally activated carbon. This filtration step allows removing organic matter and micropollutants (like pesticides) from the water and even eliminates odour while improving its taste.

Disinfection



Even if the water is now crystal clear, we must make sure that there are no bacteria or other invisible microorganisms left. Products like chlorine are used to eliminate them. Ozone (O_3), a very powerful molecule that does not leave a bad taste, is sometimes used.

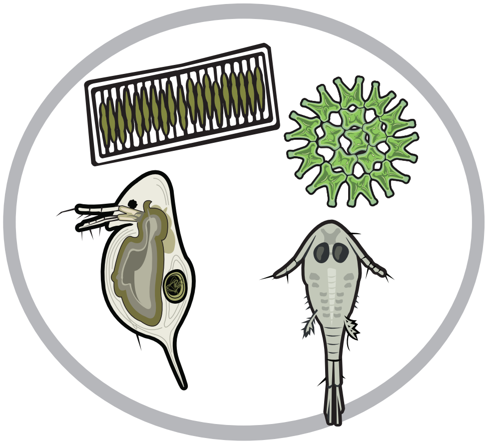
Distribution



It is now completely safe to distribute the potable water to all homes and companies. Chlorine is added at different points along the way in the water supply system. The wastewater produced by the different uses will be recovered by the sewage system and redirected toward the wastewater treatment plant.

Natural purification of water

The water flowing into the basin benefits from a free natural cleansing system. Organisms that decompose contaminants can be found at the surface of the water while ground water is filtered by the soil, which also contains beneficial microorganisms.

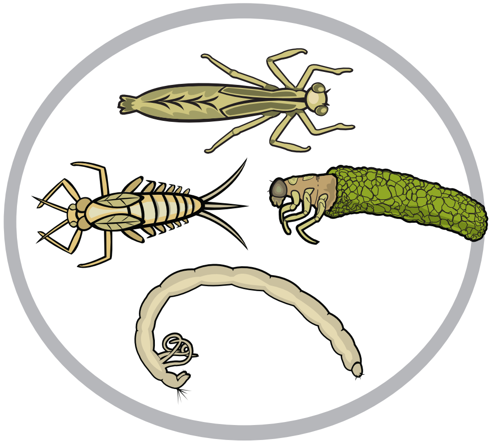


Plankton in water
Phytoplankton: diatome Fragilaria and green algae Pediastrum.
Zooplankton: Daphnia and Cyclops.

Surface water

In streams and rivers with strong currents, the churning of the water helps the oxygen mix into it. As we know, this oxygen is required for aquatic life to thrive and is also necessary for the survival of microorganisms like bacteria and plankton, which feed off organic matter and other contaminants present in the water. These organisms create a process of biodegradation of the contaminants, allowing the water to be naturally purified. This process, called self-purification, is limited. We must avoid polluting the water, otherwise the microorganisms will not be sufficient and the water will quickly deteriorate.

The same phenomenon of self-purification can be found in a body of water with little flow. Suspended particles will also settle on the bottom of the water and in the wetlands. In the layer of sediments, organisms called benthos feed off organic matter and contaminants. In that layer, aquatic larvae of several insects like mayflies, ephemera and dragonflies, as well as types of worms and crayfish are found. All these organisms are detritivores who feed on detritus. They are an essential part of the water purification process, but need enough oxygen to survive. If there is not enough oxygen, a process called eutrophication of water occurs in which the body of water quickly deteriorates and fills up with sediment.



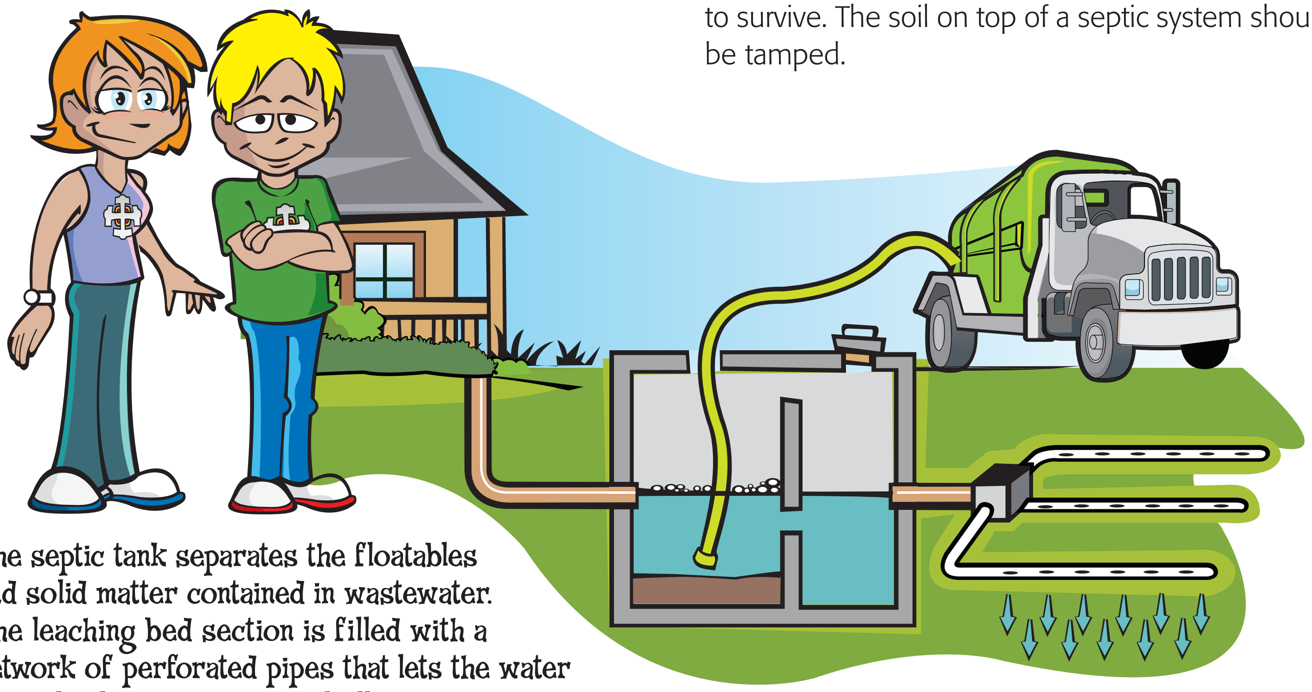
Invertebrates found in sediment
Larvae of dragonflies, ephemera, mayflies and flies.

Groundwater

Water permeating the ground may carry with it many contaminants. Once in the ground, the particles are trapped in the soil. Soil contains microorganisms and invertebrates that feed off the organic matter brought by water. Roots can also absorb some of the contaminants found in groundwater. There will therefore also be a natural water purification process in the ground. Some soils filter better than others. Clay soil is not very efficient, since water cannot easily pass through it, while water will easily pass through sand.

Septic systems

This principle of a natural purification process is used in septic systems for homes that are not connected to a sewage system. The first section of a septic system is a drainage ditch, where water is stored temporarily. In this ditch, particles settle on the bottom and bacteria begin the biodegradation process. Floating matter stays on the surface where more bacteria are active. The clarified water exits the ditch through a network of perforated pipes that lets the water seep slowly through the soil. This section is called a leaching bed. Here, bacteria and other organisms like earthworms eliminate contaminants still present in the water. It is very important that the ground be well aerated so that the microorganisms have enough oxygen to survive. The soil on top of a septic system should never be tamped.



The septic tank separates the floatables and solid matter contained in wastewater. The leaching bed section is filled with a network of perforated pipes that lets the water seep slowly through the soil, allowing it to be filtered naturally.

Protecting the shores

Vegetation on the shores plays a large role in purifying the watercourses, and filters rainwater and surface runoff before they join the lakes and rivers. The plant roots hold the ground together, preventing the ground and banks from eroding. Vegetation is also beneficial for the fauna by creating shelters, shade and cool zones. Three layers of vegetation can be found on the shores: trees, shrubs and herbaceous plants.

Trees

A row of trees bordering a river .

Trees absorb many contaminants from the water flowing by them on their way to rivers and lakes. They also absorb contaminants found in the air. Trees by the water create shade, which is essential in keeping the water temperature from rising. Water that gets too hot will be harmful to the fish as it holds less oxygen than fresh water does. Trees create shade that protects the fish while the branches that have fallen in the water provide shelters from strong currents and from predators.

Shrubs

Shrubs are ligneous plants with bark that look like little trees. Their height can vary from one to eight metres. Shrubs have very deep, intertwined roots. These roots create a network that keeps the soil in place. Shrubs filter the surface runoff and feed off the nutrients, like phosphorous, found in water and soil. Several berry-producing shrubs attract a large variety of birds along the water and serve as shelter for the fauna.

The cranberry bush attracts birds.

EXERCISE 3 THE RIGHT SHRUB AT THE RIGHT PLACE

Where would you plant the following shrubs:
at the foot or on the shelf of the bank?
(Answer on page 17)

Cranberry bush__________ **Sweet gale** ______________

Willow shrub____________ **Dogwood** _______________

Honeysuckle_____________

Herbaceous plants

Herbaceous plants form what is called the herbaceous layer. This layer of vegetation lives on the ground, protecting it from the rain. Raindrops slide along their leaves rather than bounce hard on the ground. Rain hitting the ground directly erodes the soil, which means that soil particles are dislodged and swept away by the water. That is why water takes on a brownish, murky appearance after rain. Vegetation lies down on the ground to protect it from the rain.

Herbaceous plants protect the shores from heavy rains.

Planting method

The bank is the inclined part of the shore. Shrubs that love to keep their roots wet will be planted low, at the foot of the bank, while those that prefer dry ground will be planted on top, on the shelf of the bank. There are three steps involved in planting.

1-Digging

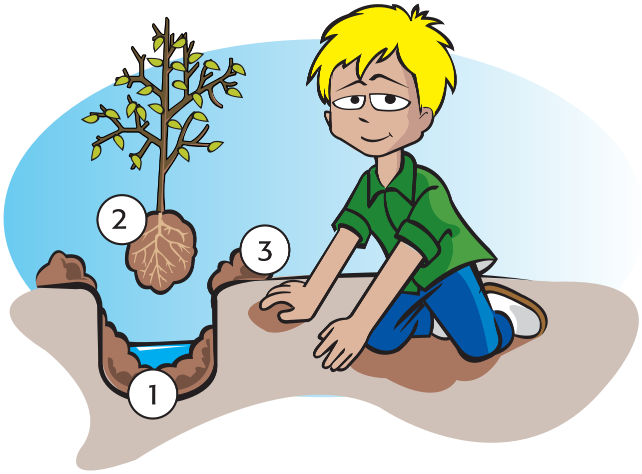
- Dig a wide hole larger than the root ball (one third larger)
- Soak the hole before planting

2-Placing the plant

- Plant the shrub deeply enough so that the root ball does not stand above the hole
- Fill in the rest of the hole with soil, tamping it well
- Water it so as to remove all air pockets around the roots

3-Saucer area

- Form a saucer around the plant by creating a collar along the edge of the hole to hold the water
- Water it by filling in the saucer area several times until it stays full for a few minutes
- Water the plant several times a day (filling in the saucer area) during the first week or more



Analyzing water quality

Parameters are particular characteristics that can be measured to evaluate water quality. These characteristics, which can be classified as physical, chemical and biological, are analyzed using specialized equipment that determine water quality. However, simple observations can also give a good idea of its quality.

Physical parameters

The physical parameters of water are characteristics of its physical state: its temperature, colour, transparency level, level of suspended particulate matter (SPM), turbidity (murkiness level) and odour. Temperature can be evaluated using a thermometer, while the other parameters can be evaluated simply by using sight and smell. To measure the level of transparency, tie a black and white object to a rope graded in centimetres, then plunge it into the water until it cannot be seen anymore.

Chemical parameters

Evaluating chemical parameters is more difficult. To measure the level of acidity, you can use a pH paper (litmus) or a pool test sampler. Normally, when the test turns pink, it means the water is more acidic, and when it turns blue, it is more alkaline (basic). If there is a lot of oxygen in the water, bubbles appear when you shake it. A probe can be used to measure the concentration of oxygen in water in mg/l. The warmer the water is, the less oxygen it can hold. A small laboratory sampler measures how much nutrients, like phosphorus, are present in the water by changing its colour. The concentration of phosphorus is measured in milligrams per litre of water.

Biological parameters

Good eyesight is needed to measure biological parameters. Through a specimen jar of water, one can observe zooplankton, tiny wiggling zoomicrobes. Phytoplankton (vegetable plankton) usually turns the water green. A petri dish must be used in order to observe fecal coliforms. Only a laboratory analysis allows one to observe the different species of bacteria, cyanobacteria, protozoa, etc.

Example of results for good water quality

Parameters	Results in the lake
Temperature	20 to 25° C
Acidity	pH 6.5 to 8.5
Oxygen	> 5 mg/l
Coliforms	< 200 /100 ml
Colour	slightly tinged
Transparency	> 2 metres
SPM	< 6 mg/l
Phosphorus	< 0.020 mg/l
Odour	fresh vegetation
Zooplankton	fairly abundant

Glossary

Animal slurry: the liquid excretions of farm animals such as cows, pigs and poultry. Animal slurry is used as a farm fertilizer.

Bacteria: microscopic one-celled organisms with no nucleus that is not a plant or an animal.

Bank: the elevated slope immediately bordering a river or lake that links the shore to the littoral zone, an area lying in shallow water.

Benthos: living organisms that reside at the bottom of the water.

Biodegradation: a process in which organic matter is decomposed by living organisms present in water.

Concentration: the amount of a product present in a given volume of water.

Diatom: microscopic algae enclosed in a silica-based pod and making up the bulk of vegetable plankton.

Erosion: process in which soil particles will be dislodged and swept away by water or wind.

Eutrophication: an abundant accumulation of nutrients (nitrogen, phosphorus) accelerating the growth of algae and aquatic vegetables when the water temperature rises, depleting the water of its oxygen.

Fecal matter: residue left by animals or humans after digestion.

Fungicide: a substance used to destroy microscopic mushrooms.

Humus: the dark organic material in soils that is produced when vegetable matter decomposes.

Invertebrates: animals that have no backbone (worms, insects, mollusks)

Ligneous: of or like wood.

Micropollutant: a chemical pollutant that is present in very low concentration in a given environment and that is very difficult to eradicate.

Organic matter: matter derived from the decay, debris or discharge of living organisms.

Pathogenic: capable of causing diseases.

pH: used to express the acidity of a solution on a scale of 0 to 14, where less than 7 represents acidity, 7 neutrality, and more than 7 alkalinity (opposite of acidity).

Plankton: tiny living organisms suspended in water. Phytoplankton refers to plant species (algae) and zooplankton refers to animal species (protozoa and invertebrates).

Protozoa: microscopic one-celled organisms that are more complex than bacteria.

Self-purification: a relatively slow natural process that allows aquatic ecosystems to reduce or eliminate contaminants present in water.

Solvent: a substance, usually liquid, capable of dissolving another substance.

Tundra: an arctic plains where vegetation grows very slowly and intermittently and that enjoys but a brief summer.

ANSWERS TO THE EXERCISES

Exercise 1: Easily identifiable contaminants
On our own, we can remove the debris and floatables with the help of a screen, but not the suspended solids.

Exercise 2: Inspecting water
Microscopic algae: yes, if the colour is green. Coliform bacteria: no. Grass fertilizer: no. Motor oil: yes. Insecticide: no. Soil particles: yes. Laundry soap: yes, if there is foam. Fabric dyes: yes.

Exercise 3: The right shrub at the right place
On the shelf of the bank: Cranberry bush, Dogwood, and Honeysuckle.
At the foot of the bank: Sweet gale and Willow shrub.

Exercise 4: The Charente Basin
Atlantic Ocean; from east to west.
From upstream to downstream: La Rochefoucauld, Aigre, Angoulême, Cognac, Saintes, Rochefort.
Animals that cannot be found in Quebec: barbel, cistude, coypu, and minnow.
Animals that cannot found in Charente: stonecat, spiny softshell turtle.
Different uses of water: locks, oyster culture.

Books

Samuel de Champlain, Father of New-France, Dundurn Press, 2004

A Drop of Water: A Book of Science and Wonder
Walter Wick, Scholastic Press, 1997.

Magic School Bus.
At the Waterworks, Joanna Cole, Scholastic Inc.

Where Does Water Come From?
C. Vance Cast, 1992, Barron's.

Web Sites

AQUAJUNIOR - Fun with Water:
www.aquajunior.com/fr_index.html

Eco Kids: The Story of Water
www.ecokids.ca/pub/eco_info/topics/water/story_of_water/index.html

The Water Heroes Story
www.on.ec.gc.ca/greatlakeskids/heroes-story1-e.html#content

Map of the Charente Basin

Credit: EPTB-Charente

EXERCISE 4 THE CHARENTE BASIN

Samuel Champlain was born in Brouage, which is in the Charente basin. You can explore this territory as Champlain would have done. (Answer on page 17)

Web sites: www.jumelage-charente-richelieu.net/
www.fleuve-charente.net/espace-de-publication/le-bassin-versant

Into what body of water does the Charente River flow?

____

In what direction does the Charente river flow:
from north to south or east to west?

____

List the name of the cities going from upstream to downstream:
◯ Aigre ◯ Angoulême ◯ Cognac
◯ La Rochefoucauld ◯ Rochefort ◯ Saintes

The Charente basin and the Missisquoi basin are very similar. Which of the following animals cannot be found in the Missisquoi Bay Basin, and which cannot be found in Charente? barbel, cistude, coypu, eel, German carp, heron, stonecat, lamprey, minnow, muskrat, otter, pike, spiny softshell turtle, trout

____

There are different uses of water in the Charente basin. Wich one cannot be found in the Missiquoi Bay Basin? Fishing, locks, oyster culture, boating, swimming.

____

Mission

In a ditch near you

In a ditch near you, evaluate the quality of the water and the aquatic environment it represents. Accompanied by an adult, bring: gloves, boots, a thermometer (for a pool or for fishing), litmus paper, a transparent plastic container, a wooden ruler, a small shovel, a notebook and a waterproof crayon.

Evaluation of water quality

Debris	Garbage, materials left on the side by water
Contaminants	Types, where they come from
Colour of the water	Blue, brown, green, grey, orange
Turbidity	Clear water or suspended solids in the water
Odours	Plant material, rotten eggs, methane (gas), ammonia (disinfectant)
Temperature	In the water, with the thermometer at the end of a rope
pH	Litmus paper or liquid indicator: pink = acid, blue = alkaline
Oxygen	Air bubbles can be seen in the water when it is shaken
Coloured film	Oil will not separate when parted with a wooden stick; it will follow the end of the stick. However, a film of iron oxide will separate.

Evaluation of aquatic environment

Speed of the current	Measure the distance between two spots along the ditch, then measure the speed at which a floating object moves to cross that distance
Vegetation	Trees, shrubs, grass cover
Type of soil	Try to roll a pinch of soil between your fingers: clay will form a ball, silt will stain your fingers and sand will slide out
Erosion	Formation of gullies, loss of earth, collapsed bank
Aquatic plants	Rushes, flowery plants, floating plants
Algae	Green algae, filaments on the rocks, gelatinous masses
Zooplankton	Put the water in a transparent container. Are there particles moving?
Sediments	Measure the thickness using a stick or a ruler
Benthos	Place a clod of sediment in a container with some water. Can you see any organisms?
Presence of animals	Calls and sounds, tracks, plants eaten, feathers and hairs

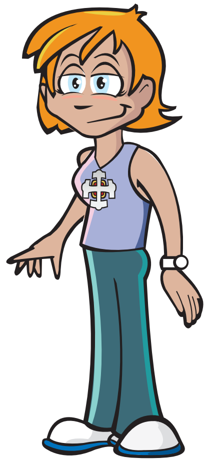
What are your conclusions? Are there solutions to improve the quality of the water in the ditch?

The oath

We are Mister d`Artagnan's Clear Water Musketeers and our mission is to protect water, with honour and with pride. Everywhere we go, and in all our actions, we will make sure not to contaminate the water.

Production

Corporation Bassin Versant Baie Missisquoi – 2009



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