SEWAGE FILTER MEDIA AND POLLUTION OF THE AQUATIC ENVIRONMENT

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SURFRIDER FOUNDATION EUROPE

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POLLUTION OF OUR BEACHES AND WATERCOURSES BY PLASTIC BIOMEDIA, BACTERIAL BIOFILM CARRIERS USED IN THE WASTEWATER TREATMENT PROCESS

SURFRIDER
FOUNDATION EUROPE

Right: biomedia on the beach at Cenitz (64)
© Surfrider Basque Coast

This study into the pollution of our beaches and waterways by the various kinds of biomedia used in the wastewater treatment process has been produced by the NGO Surfrider Foundation Europe.

Surfrider has been working for the past 25 years to protect Europe's oceans, seas, coast, and the people who enjoy them.

This makes Surfrider one of the few NGOs focusing specifically on the fate of our oceans and coastal planning, campaigning on six main thematic areas – Marine litter, climate change, water quality and health, wave protection, coastal development and maritime transport

With a membership of over 9,000 people and 30 local chapters throughout Europe, Surfrider lobbies the European institutions directly. It is a major player in the environmental movement in Europe, especially in France.

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Commission européenne

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AGENCE DE L'EAU ADOUR-GARONNE
PYRENEES ATLANTIQUES LE DEPARTEMENT

TABLE OF CONTENTS

TABLE OF FIGURES

GLOSSARY

- A

Aerobic: an aerobic environment contains oxygen. Aerobic organisms require oxygen for their metabolic reactions to take place.

Ammoniacal nitrogen (Ammonia): this is the combination of nitrogen (N) and hydrogen (H). Its chemical formula is NH_4^+. Microbes break down ammonia through the process of nitrification, transforming it into nitrates.

Anaerobic: an anaerobic environment has no oxygen. Anaerobic organisms can grow and be biologically active without oxygen.

- B

Bacterial biofilm: a layer of microorganisms that forms on surfaces in contact with water.

Bacterial biomass: the total bacterial organic matter contained in a wastewater treatment basin.

Bioreactor: a tank or cistern in which organic matter is broken down by bacteria in the biological stage of wastewater treatment.

BOD: Biochemical Oxygen Demand is measured (in mg/l) over a period of 5 days (BOD5). This represents the amount of oxygen that microorganisms need over the course of five days in order to break down the organic matter in wastewater at a temperature of 20°C.

The average BOD5 value for domestic effluent is between 150 and 500 mg/l.

For example, to ensure minimum performance levels, effluent does not exceed a BOD5 value of 25 mg/l at urban wastewater treatment plants treating an organic pollution load in excess of or equal to a BOD5 value of 120 kg/ day.

- C

Carbohydrate: organic compounds formed from carbon, hydrogen and oxygen. Carbohydrates include starch, sugars and cellulose. Along with fats and proteins, they make up the essential components of all living things.

Clogging: progressive blocking of pipes, drains or filters through the accumulation of deposited material (in this case biomedia).

COD: Chemical Oxygen Demand (mg/l) represents virtually everything that can use up oxygen in water, such as mineral salts and organic compounds. COD is commonly used as a means of characterising effluent.

The COD value is always higher than BOD5 because many organic substances can be oxidised chemically but not biologically.

For example, in order to ensure minimum performance levels at urban wastewater treatment plants treating an organic pollution load in excess of or equal to a COD value of 120 kg/day, the effluent must not exceed a COD value of 125 mg/l.

The average COD level of domestic effluent is between 300 and 1,000 mg/l.

Combined sewer: water purification system in which domestic wastewater and surface water travel to the wastewater treatment plants through the same pipes.

- D

Denitrification: stage in which nitrates are transformed into gaseous nitrogen (N_2) or ammonia (NH_3).

- E

Effluent: term used to describe domestic and industrial wastewater arriving at the wastewater treatment plant.

Eutrophication: enrichment of an aquatic or terrestrial environment with nutrients (nitrates and phosphates), which can lead to rapid growth of plant matter. In the aquatic environment, this growth of algae etc. and the increase in animal activity involved in breaking down the organic matter leads to oxygen in the water falling to critically low levels.

- H

Heterotroph: an organism that does not produce its own organic matter, but rather ingests or absorbs other organic molecules.

Hs: significant wave height, the unit used to describe the state of the ocean surface. This represents the average height (measured from crest to trough) of the highest third of the waves.

- L

Lipids: hydrophobic fats that make up the fatty matter of living things.

- M

MSFD: the Marine Strategy Framework Directive (2008/56/EC, MSFD) aims to achieve or maintain good marine environmental status by 2020. This means healthy, clean and productive seas and well-functioning marine ecosystems, with associated goods and services that are safeguarded for the use of future generations.

- N

Nitrate: nitrates are used extensively in inorganic fertilisers, as food preservatives, and as a chemical raw material in various industrial processes. Microbial action can reduce nitrates to more toxic nitrites (NO2-). In the water, these substances may come from the decomposition of plant or animal matter, agricultural fertilisers, manure, domestic and industrial wastewater, precipitation, or from geological formations containing soluble nitrogen compounds.

Nitrates are generally found only in very low concentrations in ground and surface waters. However, these levels can become much higher as a result of the leaching of agricultural soil or of pollution by human or animal waste.

Nitrification: biological process through which nitrates are produced in the environment. This process takes place in two distinct stages. Ammonia is first oxidised into nitrites, which are themselves then oxidised into nitrates.

- O

Organic matter: matter manufactured by living beings (plants, animals, fungi and other microorganisms).

Organic nitrogen: this accounts for most of the nitrogen in the soil. It comes from farming waste or animal faeces and is made up of various components of nitrogen.

- P

Phosphates: phosphoric chemical compounds used in the production of fertilisers. These are partly responsible for the eutrophication of aquatic environments.

PE (Population Equivalent): unit of measurement used to calculate the capacity of a wastewater treatment station. This unit is based on the amount of pollution produced per person per day. 1 PE = 60g of BOD5/day, i.e. 21.6 kg of BOD5/year.

The European Directive of 21 May 1991 defines population-equivalent as the biodegradable organic load at a biochemical demand for oxygen over five days (BOD5) of 60 grams of oxygen per day.

Pouzzolane: light, powdery volcanic rock from the Massif Central area of France used as a filter in the aquarium trade. The rock's structure makes it suitable as a base for bacterial cultures.

Proteins: amino acids and all their oligomers and polymers.

- R

Riverine input: project led by Surfrider Foundation Europe using a scientific protocol to quantify and identify waste being discharged into the catchment area of the Adour river. *www.riverineinput.surfrider.eu*

- S

Separate sewer: water purification system made up of two separate networks connected to a wastewater treatment plant – one for wastewater and one for stiorm water. In order to prevent the treatment basins overflowing in the event of heavy rain, surface water can be released untreated directly into the receiving water body.

Swell: wave movement on the ocean surface caused by the wind blowing on large, unobstructed expanses of ocean.

- T

Tutorial: learning guide designed to support new users of a specific tool.

- W

WWTP (wastewater treatment plant): facility used to treat domestic and industrial wastewater before they are discharged back into the environment.

- Z

Zeolite: a microporous mineral used as a filtration material in the aquarium trade.

Below: Zéolithe © Assaros / Wikipédia / CC

01
INTRODUCTION

1.1. MARINE PLASTIC POLLUTION

All the world's oceanic and coastal ecosystems are threatened by plastic waste. Around 20 million tonnes of waste flow into the world's oceans each year, of which between 8 and 18 million tonnes are plastic.

Plastic poses a serious threat to the marine and coastal environment. Aside from the harm that plastic can potentially cause to marine species (strangulation, entanglement, ingestion, transportation of invasive species) as well as on the sea bed (smothering) and to humans (socioeconomic and physical impacts), plastics also break up into small pieces through exposure to UV light (photodegradation) and mechanical abrasion. Plastics degrade very slowly in the natural environment, and as they do so they also release toxic substances (chemical additives, flame retardants, etc.), which can act as endocrine disruptors, for example.

Microplastics can also adsorb high concentrations of persistent organic pollutants (POP) such as polychlorobiphenyls (PCBs) and DDT.

Around 20 million tonnes of waste flow into the world's oceans each year, of which 8 to 18 million tonnes are plastic

Left: Biomedia and microplastics removed from the digestive tract of a fulmar from the Faroe Islands © J.A. van Franeker / Wageningen Marine Research

Below: Fulmar © D.R.

1.2. REGULATORY CONTEXT

In 2008, European policymakers adopted the Marine Strategy Framework Directive (MSFD) 2008/56/EC, which establishes a framework for action across the European Union in the field of marine environmental policy.

This directive requires Member States to adopt strategies to reduce the impacts of human activities on the marine environment, with a view to achieving or maintaining good environmental status by 2020 in the marine waters for which they are responsible. The MSFD includes 11 descriptors that define good environmental status. Descriptor 10 focuses on marine litter. In France, a sub-region is considered to have achieved good environmental status within this descriptor if the properties and quantities of marine litter there cause no damage to the coastal or marine environment.

This Directive recognises marine litter for the first time as an indicator of the ecological status of marine waters, and pushes EU Member States to take the necessary measures to reduce human impact on the marine environment.

The problems caused by marine litter affect every part of society and should be the focus of relevant measures at all levels. It is also particularly important to reduce waste at source through regulations and innovative production solutions.

In this regard, the Member States have greatly increased their commitment to international, European and national accords to prevent the proliferation of marine litter, particularly plastic. Research has been carried out to identify the sources of such waste, and this has shone a light on the need to find shore-based solutions. A circular economy package is currently being discussed at European level.

This package aims to review the waste directives and have pave the way for the European plastics strategy and the proposal of new EU rules to reduce single-use plastic. Those new regulations are a positive move in the fight against marine waste, with talk of overall reductions and ambitious targets being set.

Industry also has a key role to play in the fight against marine waste. Industrial solutions relate to all areas of business. The focus must be on reducing pollution at source (eco-design, sourcing of materials, collecting and recycling waste, pollution risks resulting from heavy rainfall and wastewater systems etc.).

To help support these preventive measures, Surfrider Foundation Europe wishes to share the results of its research into biomedia pollution with all relevant stakeholders and has drawn up a range of measures to help to effectively prevent this type of pollution at source.

Below: Surfrider delivering a presentation to policymakers
© Surfrider Foundation Europe

1.3. BIOMEDIA POLLUTION

Large numbers of small plastic cylinders have been found washed up along French coasts since 2008, particularly on beaches in the Bay of Biscay. These objects have been identified as the media used as bacterial biofilm carriers in the wastewater treatment process. In this report they will be referred to as biomedia (although the term filter media can also be used). Pollution in the form of these plastic cylinders now seems to affect every coastline in the world.

Surfrider Foundation Europe was one of the first organisations to focus on the proliferation of these biomedia in the marine environment, and how they are adding to the problems caused by plastic pollution in our oceans. Surfrider has monitored the evolution of biomedia pollution both within the Adour-Garonne river basin and at European level.

Surfrider has become a leader in this field, having researched the processes in which these biomedia are used in order to identify and understand the mechanisms by which they end up being lost into the aquatic environment.

This work has involved making information requests and conducting interviews with wastewater industry experts in order to gain an objective understanding of how biomedia use could lead to losses, and to work together to come up with workable and environmentally-friendly solutions.

Opposite: *Biomedia on a beach in Guéthary*
© Surfrider Basque Coast

1.4. OBJECTIVE OF THIS REPORT

The aim of this report is to share the data that Surfrider has gathered over the course of its seven-year investigation into biomedia pollution with all interested stakeholders in the wastewater treatment sector. Although several reports on the use of biomedia already exist, these focus on processes for optimising their use, and do not consider the environmental impact when biomedia are lost – making this the first report to provide an objective overview of how biomedia are used along with an inventory of system malfunctions.

The coasts of the Bay of Biscay, which have been particularly affected by mass strandings of biomedia, have been the perfect research area for this study. However, in drawing up our recommendations, we have expanded our study area to include coasts around the whole of Europe, given the large number of pollution incidents elsewhere too.

Firstly, we present an overview of wastewater treatment operations, before moving on to focus on specific procedures involving biomedia. We then look at how biomedia are used and the most significant pollution incidents that have taken place, in an effort to understand how these have arisen. The information gleaned from these proven cases of system failures, along with the input of industry professionals, have enabled us to produce a suite of recommendations on biomedia use, with a view to reducing future losses of biomedia into the environment.

Our overarching goal is to prevent such incidents. By providing an overview of the current situation and engaging in constructive discussions with the various players in the industry, we hope to help provide an understanding of the scale and origin of the problem in order to avoid future losses into waterways, primarily through the implementation of best practices.

Below: © Helloquence - Page right: © Benjamin Punzalan

02
BACKGROUND TO WASTEWATER PURIFICATION AND BIOLOGICAL TREATMENT

Here we provide an overview of the wastewater treatment system as a whole, from installation to management, in order to aid understanding of the processes in which biomedia are used.

2.1. KEY PLAYERS IN THE WASTEWATER BUSINESS

Various key players are involved in the process, from the installation of wastewater treatment plants through to commissioning and management.

Contracting authority and contractor

Local authorities are responsible for public municipal wastewater treatment in their local areas, and must also supervise private sewage systems. Construction of such plants is therefore usually undertaken by town councils or groups of local councils (where they have shared requirements). These are called the contracting authorities.

Examples: Town of Dax, Sivom Côte Sud, Côte Basque Adour conurbation.

The local authorities may request the help of specialist sewage contractors to assist them in designing, building or upgrading a wastewater treatment plant. This assistance may take effect at the conclusion of the works, or may involve management of the entire project.

In some cases, assistance is provided to the contracting authority, facilitating the connection between it and the contractor, and providing support to the overall running of the project.

Construction companies

Many private companies offer wastewater treatment plant design and building services, each using their own technologies. The main companies in this field in France are Vinci, Veolia, Suez-Degrémont, Artelia and SAUR. Each of these uses subsidiary companies to carry out the works.

Above: Usine de traitement des eaux usées
© Droits réservés

Operators

Once the work is complete and the plant has been handed over, it may be operated by various kinds of players and in various formats (public company, lease, etc):

- A local authority may operate a plant itself by means of a public company.

Example: La Réole municipal multiservice public company.

- Inter-authority federations may also be created to ensure public operation in an area that groups together various local authorities.

Examples: Haute Garonne Joint Water-Wastewater Treatment Federation, Pays de Lorient Conurbation Authority.

- Companies that design wastewater treatment plant projects usually also offer contracting authorities an operation and maintenance service, with contracts spanning anything from a few months to several decades.

Examples: Lyonnaise des Eaux in Biarritz, SAUR in Lasseube.

2.2. OVERVIEW OF OPERATIONS IN A SEWAGE TREATMENT SYSTEM

Water used by both households and industrial sites must pass through a wastewater treatment system in order to protect public health, the environment and water resources.

There are two major types of systems – combined sewer systems, in which rainwater and domestic wastewater are channelled through the same pipes, and separate sewer systems, which allow domestic water to be treated separately from rainwater.

Discharges of treated wastewater are subject to regulations to reduce their impact on the receiving waters and to significantly limit the risk of eutrophication. Eutrophication is caused by the addition of unlimited quantities of nutrients, which causes runaway algal growth, ultimately depleting oxygen levels in the water and even asphyxiating life in rivers.

Various chemical, physical and biological levels are monitored, such as biochemical oxygen demand (BOD) and chemical oxygen demand (COD). These indicators reflect the organic pollutant load in the water. Other levels such as suspended solids (SS) or total nitrogen (TN) may also be measured in sensitive areas. Phosphorous and total phosphorous (TP) may also be subject to specific monitoring in a sensitive area.

Organic pollutants may come from sources such as domestic (garbage, excrement), agricultural (slurry) or industrial (paper mills, dairies, abattoirs, tanneries, fish farms, etc.).

Wastewater treatment facilities are specially designed for each site, according to the sensitivity of the receiving water as well as other more specific factors (location, treatment process, number of inhabitants, etc.).

© Pixabay

2.3. DISCHARGE REGULATIONS

No matter what its source, water discharged from plants must comply with the relevant water quality standards of the receiving waters. Several ministerial orders[1] set out the conditions and regulations for monitoring wastewater systems (plants and networks), designed to ensure the quality of waterways or, where necessary, to conduct remedial work to restore the water quality.

These national regulations must ensure compliance with the European objectives set out in the Water Framework Directive (WFD)[2]. The WFD sets targets for conserving and restoring the condition of surface waters (fresh water and coastal waters), as well as groundwater. Its overarching objective was to achieve good status in all these environments across the whole of Europe by 2015.

Minimal performance thresholds are set according to a range of criteria:
- the receiving water
- volume
- the nature of the effluent (wastewater)
- the techniques and capacities of the wastewater treatment systems

There are 4 groups of wastewater treatment facilities governed by their own specific regulations.

These can be divided up by the load of the untreated water they receive and whether or not they are collective public sewer systems:
- wastewater treatment plants for urban areas treating an overall organic BOD5 pollution load in excess of 120 kg/day (> 2 000 inhabitants)
- wastewater treatment plants in urban areas required to treat an overall organic BOD5 pollution load less than or equal to 120 kg/day
- non-municipal wastewater plants receiving an overall organic BOD5 pollution load in excess of 1.2 kg/day.
- non-municipal wastewater plants receiving an overall organic BOD5 pollution load less than 1.2 kg/day.

To comply with these regulations, wastewater (both domestic and industrial) generally passes through the treatment stages set out below.

Below: Wastewater treatment plant in the town of Folschviller

[1] Order of 21 July 2015 on municipal and non-collective wastewater treatment systems, with the exception of non-collective wastewater treatment facilities receiving an overall organic BOD5 pollution load of less than or equal to 1.2 kg/day

[2] Directive of 23 October 2000 (2000/60/EC) setting out a framework for the management and protection of water at river basin level across Europe.

The minimum regulatory threshholds set to reduce organic pollutants[3]

PARAMETER	OVERALL ORGANIC POLLUTION LOAD RECEIVED BY THE PLANT IN KG/DAY OF BOD5	MAXIMUM LEVEL TO BE OBSERVED, DAILY AVERAGE	MINIMUM OUTPUT REQUIRED, DAILY AVERAGE	CUT-OFF LEVEL, DAILY AVERAGE
DBO5	< 120 ≥ 120	35 mg (O2)/l 25 mg (O2)/l	60 % 80 %	70 mg (O2)/l 50 mg (O2)/l
DCO	< 120 ≥ 120	200 mg (O2)/l 125 mg (O2)/l	60 % 75 %	400 mg (O2)/l 250 mg (O2)/
Suspended solids (*)	< 120 ≥ 120	/ 35 mg/l	50 % 90 %	85 mg/l 85 mg/l

DISCHARGES IN AREAS SENSITIVE TO EUTROPHICATION	PARAMETER	OVERALL ORGANIC POLLUTION LOAD RECEIVED BY THE PLANT IN KG/DAY OF BOD5	MAXIMUM LEVEL TO BE OBSERVED, YEARLY AVERAGE	MINIMUM OUTPUT REQUIRED, YEARLY AVERAGE
Nitrogen	NGL (1)	> 600 and ≤ 6000 > 6 000	15 mg/l 10 mg/l	70 % 70 %
Phosphorous	Total P	> 600 and ≤ 6 000 > 6 000	2 mg/l 1 mg/l	80 % 80 %

NB: It is estimated that 80 to 95% of organic pollutants are treated upon discharge from secondary treatment. The remaining pollution will be naturally broken down in the environment.[4]

[3] Order of 21 July 2015 on municipal and non-municipal wastewater treatment systems, with the exception of non-municipal wastewater treatment facilities receiving an overall organic BOD5 pollutant load less than or equal to 1.2 kg/day

[4] OPECST report no. 2152 (2002-2003) by M. Gérard MIQUEL, produced on behalf of the French Parliamentary Office for the Evaluation of Scientific and Technological Options, submitted on 18 March 2003

2.4. MAIN STAGES IN THE WASTEWATER TREATMENT PROCESS

2.4.1. PRIMARY TREATMENT (OR PRE-TREATMENT)

Primary treatment uses various processes to get rid of a large proportion of the suspended solids (large waste items, grit, etc.) and oils in the water:

Screening

Larger items of waste are trapped and removed by mesh screens.

Grit removal

Smaller solid particles fall to the bottom of the settlement tanks.

Oil and fat removal

Oils and fats rise to the top either statically or by small air bubbles being diffused into the tank and are then skimmed from the surface.

Primary settlement

Any of the finest suspended solids (SS) that have not been captured in the de-gritting process settle under the force of gravity to form a sludge that is then collected by a pumping system.

2.4.2. SECONDARY OR BIOLOGICAL TREATMENT

Secondary treatment involves the removal of matter held in solution in the water (organic matter, mineral substances, etc.) using processes similar to natural ones that enable aquatic environments to clean themselves.

Biological treatment techniques harness the activity of bacteria to break down organic matter in the water being treated. Different procedures can be used to reduce carbon and nitrogen-based pollution depending on the nature and the volume of effluent to be treated. Supplementary physical-chemical treatment processes are generally also needed to remove phosphates, non-biodegradable pollutants and compounds that are toxic to the natural environment, such as pesticides or PAHs[5].

This secondary settlement treatment allows these pollutants, concentrated by the microorganisms, to be recovered in the form of sludge

2.4.3. TERTIARY TREATMENT

After the water has been separated from the sludge through settlement in a clarification basin, the purified water is then generally discharged to the natural environment at the secondary treatment outflow point.

However, the water may undergo additional treatment if it is going to be reused for industrial or agricultural purposes, or if the receiving waters have been granted a specific level of protection.

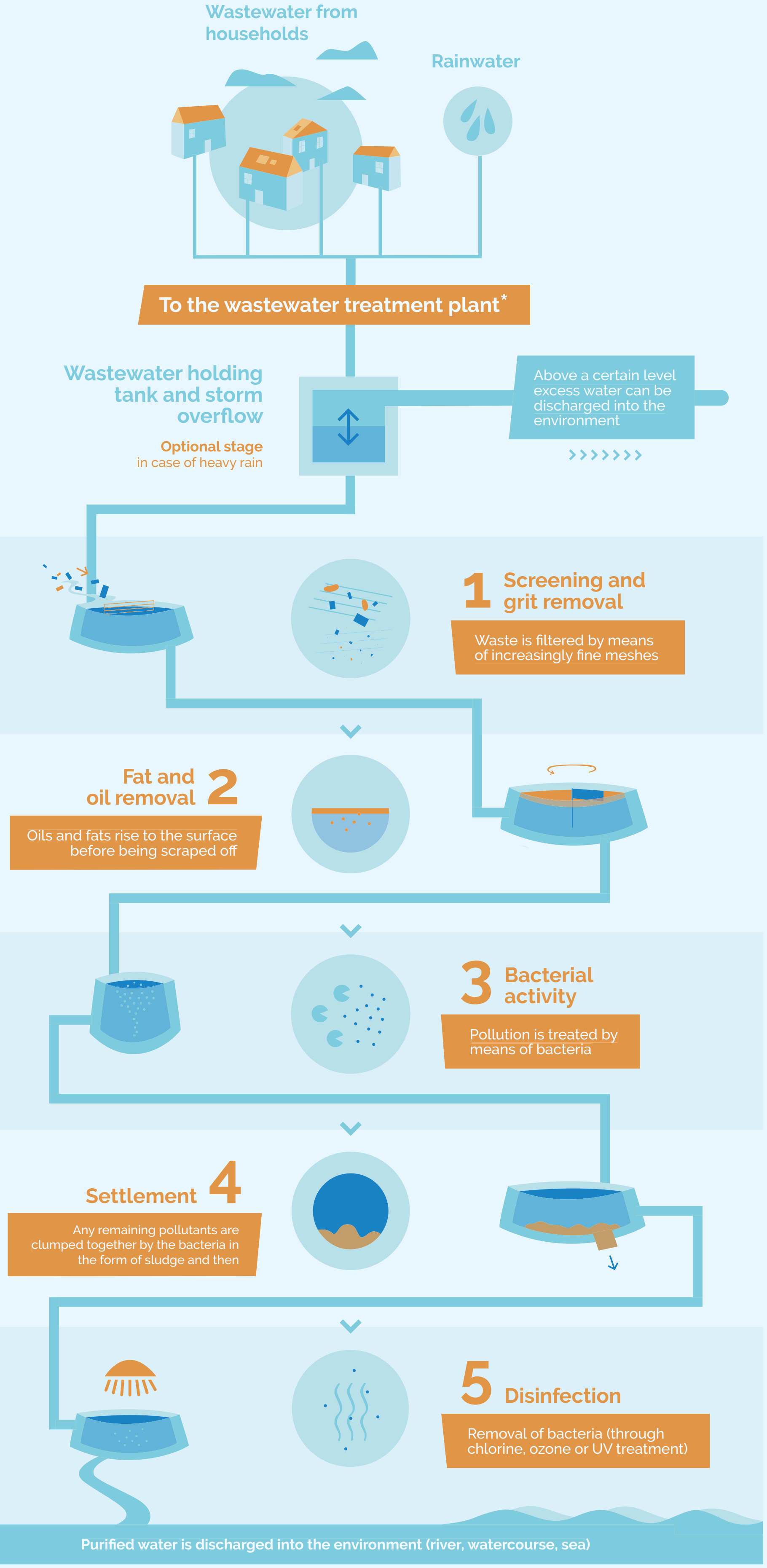
For example, disinfection is carried out to remove bacterial pollution in places where effluent is discharged into sensitive receiving waters (swimming or shellfish farming areas). This treatment is usually done by means of chlorine, ozone or UV.

2.4.4. SLUDGE TREATMENT

The residual sludge is then also treated, according to how it is going to be used. There are three main destinations for sludge – spreading on agricultural land, composting and incineration.

Figure 1 :
The functioning of a wastewater treatment plant (combined sewer system) © Surfrider Foundation Europe

[5] Hydrocarbures Aromatiques Polycycliques


Wastewater from households
Rainwater
To the wastewater treatment plant*
Wastewater holding tank and storm overflow
Optional stage in case of heavy rain
Above a certain level excess water can be discharged into the environment
1 Screening and grit removal
Waste is filtered by means of increasingly fine meshes
Fat and oil removal 2
Oils and fats rise to the surface before being scraped off
3 Bacterial activity
Pollution is treated by means of bacteria
Settlement 4
Any remaining pollutants are clumped together by the bacteria in the form of sludge and then
5 Disinfection
Removal of bacteria (through chlorine, ozone or UV treatment)
Purified water is discharged into the environment (river, watercourse, sea)

2.5. FOCUS ON BIOLOGICAL TREATMENT

During this stage, organic matter is broken down by heterotroph bacteria.
Nitrogenous matter is broken down by nitrifying bacteria such as Nitrobacter and Nitrosonomas.

Secondary biological treatments can be divided into extensive and intensive processes:

Above: Nitrobacter seen under the microscope © alketron.com

2.5.1. EXTENSIVE BIOLOGICAL PROCESSES

These are processes that harness the environment's own natural purification capacity. Water can be treated by a reed bed, through lagooning, recreation of a wetland area or through percolation, none of which involve any mechanical intervention.

The wastewater is channelled slowly through a series of basins, with the water remaining in each of them for several days or even weeks. Depending on which basin it is in, the organic matter is broken down by the bacteria naturally present in the water, either anaerobically (without any need for oxygen) or aerobically (requiring oxygen).

This form of water treatment, which is particularly well suited for small communities (with small volumes of wastewater), can get rid of 80 to 90% of the BOD, 20 to 30% of the nitrogen, and also significantly reduces levels of pathogens in the water. The main disadvantages of this system are the large area required as well as the often-lengthy treatment time (> 3 days).

2.5.2. INTENSIVE BIOLOGICAL PROCESSES

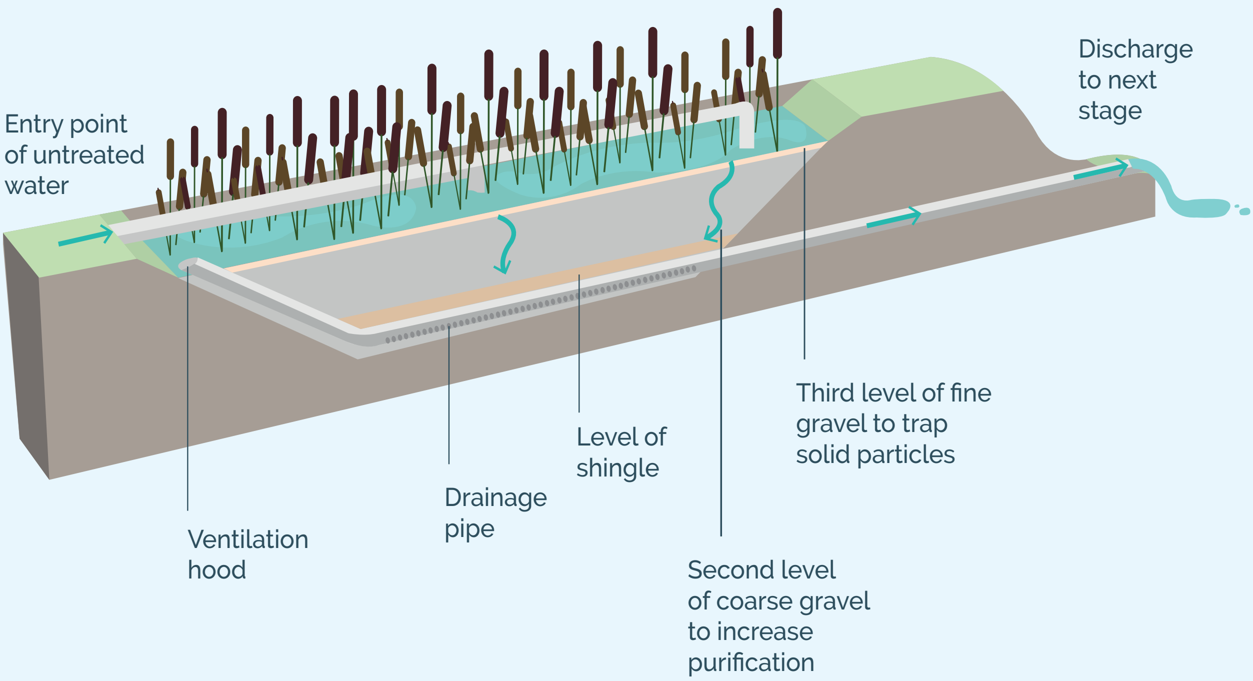
The objective of these processes is to treat the carbon and nitrogen (C and N) load of the wastewater to ensure it complies with current regulations. All these processes use bacterial cultures combined with mechanical treatment and artificial oxygenation to treat the wastewater more quickly and in limited spaces.

During the biological treatment by the bacteria, carbon is removed aerobically. Molecules such as fats and carbohydrates are broken down quickly, with up to 90% of the carbon load being eliminated in just a few hours. Nitrogenous material is removed in two main and consecutive stages – nitrification (aerobic) and denitrification (anaerobic).

The main aim of these intensive processes is to confine the microorganisms in small areas, speeding up the natural processes whereby organic matter is transformed and broken down.

Figure 2 : Example of extensive biological process – a reed bed filter

The wastewater filters slowly through a series of basins.
The organic matter is broken down by bacteria naturally present in the water.



Above: Wastewater treatment plant using reed bed filters at Dohem (62)
© AEAP

There are two major categories of intensive biological processes:

2.5.2.1. Free-living culture installations: Activated sludge

The bacterial culture is maintained in an aerated basin, where it is continuously mixed, facilitating the biodegradation process by keeping the bacteria in contact with the polluting particles. This is an aerobic system. The bacteria break down the carbon-based organic matter into CO_2 as well as the nitrogenous matter. The phosphates, meanwhile, clump together and settle out.

After remaining for a period of between 8 to 50 hours in an aeration basin, the effluent is sent on to a clarification basin. The sludge is then sent to a special treatment unit, depending on whether it will be used for spreading on farmland or disposed of, or is partly reinjected into the aeration tank in order to maintain the population of bacteria at a sufficient level.
This circulation of sludge from the clarification basin to the aeration basin maintains the bacterial mass at a constant level in the aeration basin.

Above: Activated sludge plant © IRSTEA

Activated sludge treatment removes 85 to 95% of the BOD5, depending on the installation[6]. This biological treatment is currently the simplest and the most commonly used system in France.

2.5.2.2. Fixed culture installations

In fixed bed culture processes, the microorganisms (bacteria) used to break down the organic matter are grown on a variety of supports in the form of biofilms.

The supports provided for the growth of this biomass (multicellular community) mean a larger number of cells can develop, thereby increasing the purification capacity of the installation. Fixed bacteria are usually more active than those in free cultures, because they are protected by the biomedia.

The activity of a bacterial culture depends primarily on the exchange surface between the biofilm and the oxygenated effluent. The greater the surface area, the greater the cleaning capacity. This area is generally indicated in m^2 of colonised surface/m^3 of the support.

However, in free cultures such as activated sludge processes, the purifying microorganisms clump together in flocs. This reduces the exchange surface, and consequently the system's effectiveness and performance.

The development of this biofilm of bacteria is extremely important for each of the fixed culture processes, and so proper maintenance and cleaning of the growth support are essential.

[6] OPECST report no. 2152

Above: Rotating biological contactors
© Roinville-sous-Auneau city

There are several solutions for optimising the exchange surface between the biofilm and oxygenated effluents, such as trickle filters, rotating biological contactors, biological filters, fluidised bed reactors and mixed solutions.

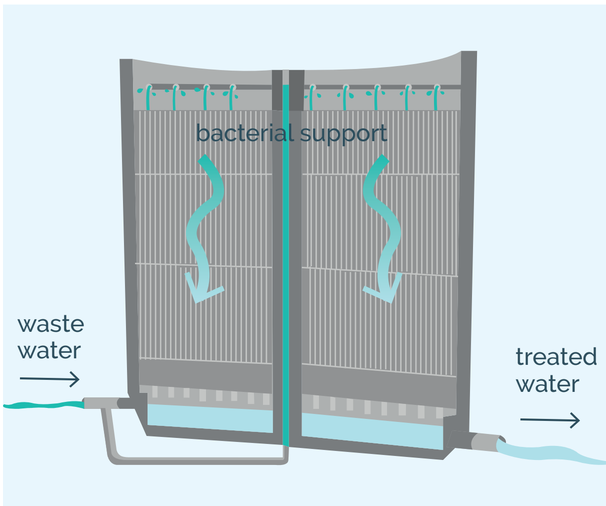


Figure 3 : Schéma d'un réacteur à lit bactérien coupe verticale

Trickle filters

In this system, the bacterial biomass (in the form of a biofilm) colonises a porous support in an aerated tank. This support may be mineral (pouzzolane, volcanic rock) or plastic. The fixed culture is not immersed, and the effluent is treated by trickling down over the support from the top of the tank.

This process accounts for a little over 16% of the municipal wastewater treatment facilities in the Adour-Garonne area, compared with 10.3% throughout France as a whole.

Rotating biological contactors

These comprise porous plastic discs that the bacterial biofilms grow on, which are partially submerged in semi-cylindrical tanks. These discs rotate around an axis, and so are alternately exposed to the air and submerged (aerobic/ anaerobic). While the discs are exposed to the air, this aerates the effluents and encourages the growth of the bacterial biofilm. When they are immersed, the organic matter can be broken down.

Page right: Saint-Prex wastewater treatment plant
© Frank Odenthal

This process is used in places where only small volumes are to be treated, not exceeding 2,500 PE, and it only accounts for 3.3% of the municipal intensive secondary biological treatment installations in the Adour-Garonne area (and 4.2% in France overall).

Biological filters

These granular supports, providing a large colonisation surface area for bacterial biofilms, are placed at the bottom of the basins containing the effluent. Unlike in trickle filters, this process uses biomass attached to an immersed support. It is aerated by means of an oxygen injection filter close to the support. This system is used on the same scale as the rotating biological contactors.

Fluidised bed reactors

This is the process involving the use of biomedia. The bacteria are fixed to plastic carriers (biomedia), which have a density similar to that of water, and provide a significant colonisable surface. These free-moving carriers are mixed with the effluent within the bioreactor. The biomedia are kept suspended in the basin by mechanical aeration or mixing. This significantly increases the contact surface between the effluent and biofilms, thereby improving the basin's purification capacity.

The various technologies requiring the use of biomedia are set out in chapter 4 of this report.

Mixed installations

Very rarely used, these are combined processes in which the bacteria are partly fixed on fluidised bed-type supports, and partly in the form of free-floating clumps, as in an activated sludge process. This process enables organic matter to be broken down producing smaller quantities of sludge compared with classic activated sludge processes.

Opposite: Biomedia in a reactor
© Inter Aqua Advance - IAA A/S (IAA)


EPURATION

03 WASTE-WATER TREATMENT IN FLUIDISED BED BIO REACTORS

Biological treatment using fluidised bed bioreactors has heralded a technological and economic revolution in the world of wastewater treatment. This process revolves around the use of biomedia, and here we look at the reasons for its development.

3.1. HISTORY

The MBBR (Moving Bed Biofilm Reactor), or fluidised bed system, was developed in 1989 by the Norwegian University of Science and Technology in Trondheim (NTNU) and the Foundation for Scientific and Industrial Research (SINTEF), commissioned by the company Kaldnes (Kaldnes Miljø-Teknologi - KMT). The aim of this project was to create smaller treatment units and bioreactors that could more effectively treat the nitrogen load in wastewater. The weather conditions and extremely cold winters in Norway mean wastewater treatment plants there are generally covered, and so need to be more compact. Meanwhile, new and stricter legislation was coming into force at European level, requiring that many wastewater treatment structures be upgraded. Specialist wastewater treatment R&D company Anox AB adopted this procedure and developed it for different industrial sectors, such as the paper industry. These two companies quickly became market leaders in the field of high-performance biological wastewater treatment.

In 2000, Anox AB and Kaldnes signed a cooperation agreement, which two years later led to Kaldnes being bought by Anox. Since 2007, AnoxKaldnes™ has been part of Veolia Water Solutions & Technologies, a subsidiary of Veolia Water.

The benefits offered by this technology meant it was rapidly sold all over Europe and it was very successful Internationally too.

Today, many companies have developed their own moving bed biofilm reactor technologies, giving rise to a wide range of names, such as MBBR, R3F® and FBBR (Fluidized Bed Bio Reactor), to name just some of the most recent additions.

Above: Press articles extolling the virtues of biomedia

3.2. PRINCIPLES

The aim of fluidised bed bioreactor system is to provide the bacteria with an environment that will allow them to develop optimally in a compact space, in order to break down the pollutants in the water. This optimisation depends on two major factors – the supports or carriers upon which the bacteria can develop, and access to nutrients.

The support is provided by the biomedia, which are made of plastic, either polyethylene (PE) or high-density polyethylene (HDPE). These are added to the bio reactors at a rate of 30 to 70% of the volume of the basin. This means there are hundreds of thousands[7] or even millions of pieces of plastic in each reactor. Their honeycombed, colonisable structure and their density, which is similar to that of water (1 g/cm^3), makes it easy to keep them moving within the tank.

This movement should be uniform, to ensure an optimal level of contact between the microorganisms and the effluent to be treated (nutrient). This process depends upon the type of support chosen and the rate at which the treatment basins are refilled.

Biomedia can be used in different phases of the biological treatment process – pre-treatment, secondary treatment, and even in combination with activated sludge. This flexibility means this system can be a very attractive option for new wastewater treatment plants. Fluidised bed bioreactors can also be introduced during upgrades at older wastewater treatment plants. This makes it possible to increase plants' treatment capacity without the need to build any new basins – an approach that is often heavily driven by financial or space constraints.

The parameters used to calculate the volume of biomedia needed for water treatment are incoming flow, discharge flow, and effluent temperature. The optimal functioning of the wastewater treatment infrastructure therefore depends heavily on this calculation, which impacts on the whole plant's performance and ability to achieve its objectives.

Above: Bacteria colonising biomedia
© Headworks International

[7] 132 155 unités / m^3 pour la société Water Management Technologies
www.w-m-t.com/Products/WaterTek_MB3_Moving_Bed_Media.php.

3.3. ADVANTAGES

Both the scientific literature and our interviews with wastewater treatment specialists (see Annex I) have underscored the many advantages of using the moving bed biofilm reactor system, with the following list highlighting just some of them:

Adaptability

Moving bed biofilm reactors are very flexible because of their stable reaction to fluctuating influent concentrations (Gonzales et al, 2001). This means they can be adapted as required by varying the biomedia top-up rate depending on the pollutant load to be treated. This means the plant can rapidly adapt to seasonal variations in pollutant loads (BOD and COD) resulting, for example, from particular farming activities or the tourist season (Laurent, 2006).

High concentration of available biomass

The shape of the biomedia provides very good living conditions for the bacteria, providing them with a large colonisation surface of between 200 and 1,200 m^2/m^3, depending on the model. Living within this structure, the bacteria are protected from abrasion caused by the plastic pieces moving around inside the reactor. The large volume of biomedia placed in the tanks therefore enables the development of a very large concentration of biomass (Nicolella, 2000 ; Venu Vinod, 2005 ; Kargi, 1997).

Lengthy biomass survival time

The biomass remains in place for a long time, up to several weeks, which means a high concentration of nitrifying bacteria, despite their slow growth rate, and regardless of the influent (Nicolella, 2000).

Improved mass transfer

The continuous agitation of the biomedia in the reactor enables the biofilm to remain in contact with the organic matter, thereby ensuring there are no areas of stagnation in which there would be reduced contact between the media and organic matter. The high concentration of biomass and the large surface area of biofilm both contribute to improved contact between the different phases (Nicolella et al, 2000 ; Jianping et al, 2003 ; Vinod et Reddy, 2005).

Reduced water retention time

This process is generally characterised by a retention time in the aeration tank of between 4 and 6 hours – compared with 8 to 50 hours in the case of activated sludge treatment (Gonzales et al, 2001 ; Kargi et Karapinar, 1997 ; Jianping et al, 2003).

Ease of cleaning

The media can be agitated either by aeration or the water can be moved with the help of rotors to ensure continuous mixing of the media. This agitation means there is no need to wash the supports – unlike in fixed bed processes using pouzzolane or zeolite, in which the beds become clogged, leading to reduced capacity, poor mixing and lowered oxygen transfer.

The dead bacteria fall away when the biomedia bump into each other. This results in a layer of sludge forming on the surface, which can be easily removed (Kargi et Karapinar, 1997). This 'self-cleaning' phenomenon means there is no need for secondary reactors to be used while the unit is being cleaned.

A compact procedure

Plants using MBBR technology have a footprint 10 to 50% smaller than classic activated sludge systems with an equivalent capacity. This is because moving bed bioreactors do not need large aeration tanks.

The combination of these factors means the MBBR system is very easy to use, with better cleaning capacity, and lower construction costs than classic activated sludge systems. These many advantages explain the development and uptake of this process throughout the world.

3.4. LIMITATIONS AND DISADVANTAGES

While this process has some clear advantages, it also has inherent risks and constraints:

Poor bacterial activity at low temperatures (<5°C)

The bacteria in the reactors are virtually inactive at temperatures below 5°C. The effectiveness of the process, whatever the type of wastewater treatment plant, is therefore highly dependent on temperature, and so it varies from season to season. Some plants, for example in Norway or in mountainous areas, are kept under cover to reduce these fluctuations.

An energy-hungry and costly process

Energy consumption is an indirect environmental impact of the wastewater treatment process. The large volumes of biomedia used in this process, which must be kept in continuous movement through aeration or mechanical mixing, means the energy used is significant, leading to not negligible operation costs. This cost is even higher if the process is not functioning at optimal levels.

The energy required to aerate the basins at an activated sludge plant accounts for 40 to 80% of the plant's total consumption.

If agitation is poor, the biomedia flow with the current and eventually end up clogging the effluent mesh, causing malfunctions. It is therefore of utmost important that the tanks are kept sufficiently agitated, which requires very significant energy consumption.

This energy expenditure means plant developers are today studying options for reducing the energy consumption of their processes.

Energy consumption can be up to 50% higher than that of a classic activated sludge system

Above: Moving bed bioreactor at the WWTP in Saillon (Switzerland) © Gaël Bost / Surfrider Léman

Case study of aeration-related energy consumption at two wastewater treatment plants, according to two criteria (example taken from the French Federation of Waste Management and Environmental Services (FNADE) report no.38 on the R3F process):

- Specific mixing power (air diffuser power relative to volume of the bioreactors)

- Energy consumption relative to flow of BOD5 removed

Given that an MBBR plant is around three times more compact than an activated sludge plant, the comparison has been based on equal volumes. The results show very high relative energy consumption:

Specific mixing power (W/m³)		Specific energy consumption (KW/Kg of BOD5 removed)	
St Sorlin d'Arves (73)	Vars – St Marcelin (05)	St Sorlin d'Arves (73)	Vars – St Marcelin (05)
179	144	8,6	8,9

These figures, at a similar level for the two sites, are very high, and can be explained in part by:

- Measures implemented during the winter, including heating of the plants (around 7% of the total),

- Facilities operating at 50% of their nominal load and the fact that some sections were not yet operating at fully optimised levels, in particular bioreactor aeration (for example, at one site, one of the diffusers was working at its maximum air flow).

Energy consumption at the plant can be visualised as broken down below:

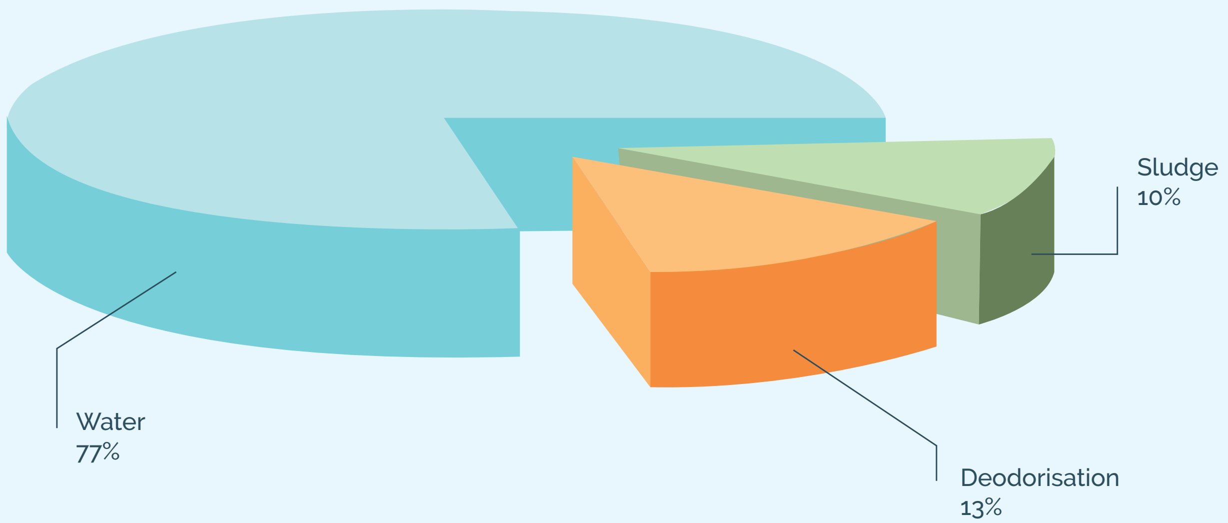


Figure 4 : reakdown of energy consumption
Overview of wastewater facilities at Saint Sorlin d'Arves and at Vars - St Marcellin (source FNADE-2014)

Biological treatment accounts for the largest part under the water heading, representing between 73% and 88% of the energy consumed by this segment, depending on the site.

Slow colonisation of biomedia by the bacterial biofilms

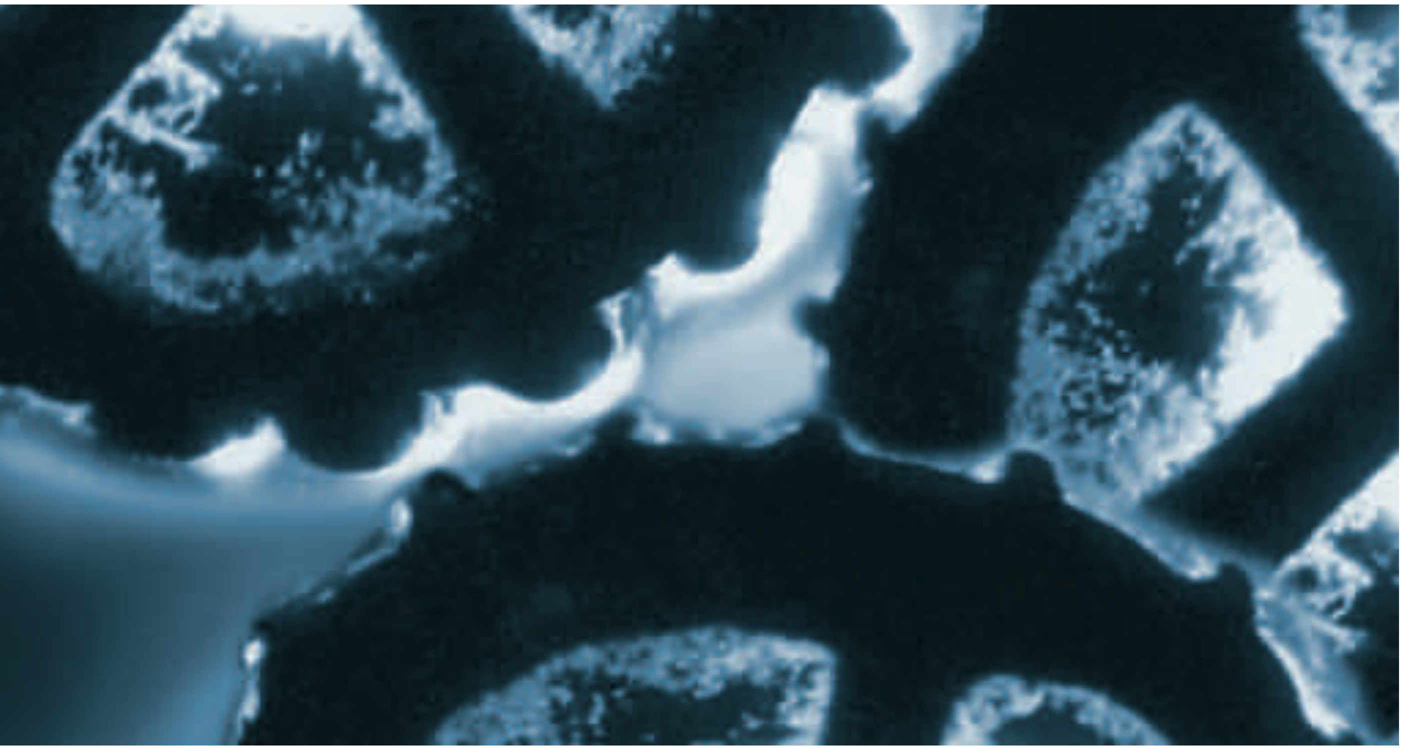
The slow colonisation of the biomedia means the process needs a long start-up time. (Nicolella et al., 2000). It is difficult to monitor the thickness of the biofilm, which is essential for the good functioning of the reactor, given the large volume of biomedia and microscopic size of the bacteria. The colonisation of the media is incredibly important, and a reduction in effectiveness can be observed in cases where the structures have become obstructed or the density of the biomedia is altered.

Loss of biomedia

Significantly, losing biomedia also has financial implications, given that biomedia cost an estimated €500 per m^3. Incidents could involve the loss of anything from a few thousand pieces up to several million, and so is not something that operators want to happen. Responsibility for clean-ups after accidental spills could also result in additional costs – as has been the case in the United States, for example (see section 8.3)

As we have seen, this technology offers some major benefits in terms of compact footprint, ease of use and construction costs. However, it also uses a lot of energy, with consumption up to *"50% higher than classic activated sludge systems"*, as stated in the 38th report from FNADE[8], with this point in fact being its main disadvantage. Precise fine-tuning is required, and in order to operate optimally the system needs an adaptation period with expert support.

The colonisation of the biomedia, their concentrations in the reactors, and the way in which they are mixed, all continue to be the focus of numerous technological innovations being developed by various construction companies.



Above: Colonised biomedia

Page right: Biomedia found in the Seine © Renaud Francois

[8] MBBR processes for wastewater treatment. Focus on R3F process. J.P. Canler, J.M. Perret. Technical document no.38.

04
SPECIALIST WASTEWATER TREATMENT BUSINESSES

4.1. DIFFERENT TYPES OF BIOMEDIA: TRACKERS OF POLLUTION EVENTS

As explained previously, the company Kaldnes developed the MBBR process and the plastic biomedia it uses back in 1989, before patenting this system in 1991.

Today, most of the leading firms working in the wastewater industry have adopted this process and developed their own models of plastic carrier, with different names.

A huge range of wastewater treatment processes now use biomedia to enhance their effectiveness. Each plant must fine tune its own system to adapt to its own specific constraints, the multiple technologies involved (chain of treatment, mixing methods, etc.) and numerous models of biomedia available.

Each type of biomedia has a different shape and surface area, expressed in m^2/m^3 of matter, and is designed for a particular purpose, making the biomedia a specific factor at each plant.

This also means biomedia can be used to track uses and processes and can be traced back to their source if they are found in the environment.

4.2. LEADING FRENCH CONSTRUCTORS OF WASTE WATER TREATMENT PLANTS

There are three leading companies in the wastewater treatment sector in France today, all offering integrated treatment systems using the MBBR process. These are Veolia, Vinci and Suez-Degrémont. All the biomedia produced by these companies are made from the same type of plastic, either PE or HDPE, which can also be found under the name «Virgin PE».

AnoxKaldnes™ – Veolia[9]

This is the original technology developed by Kaldnes (KTM), and is sold by Veolia Water STI, which bought out the Swedish company AnoxKaldnes™ in 2007. In 2010, Veolia had over 500 MBBR plants in operation in over 50 countries.

Veolia, like several other developers, offers its MBBR reactors in different combinations:
- Pre-treatment (BASTM™ process),
- Post-treatment, following lagooning (Lagoon Guard™ process),

- Addition of media to all or part of the volumes containing activated sludge (HYBASTM™ treatment process).

Veolia now offers five types of carrier models, these being: Kaldnes™ K1, Kaldnes™ K3, BiofilmChip™ M, BiofilmChip™ P and F3.

This range means the company can offer carrier adapted to variable wastewater, treatment methods and discharge regulations in different places.

Vinci Environnement[10]

Vinci Environnement has developed its own biomedia and wastewater treatment system. Called R3F®, it is the leader in the French market, with 20 facilities (in 2013).

Adapted for use in both municipal and industrial wastewater treatment systems, it offers a range of options, such as its R3F activated sludge pre-treatment procedure.

Degrémont – Suez Environnement[11]

Degrémont, a subsidiary of Suez Environnement, markets the Meteor® technology and three different types of biomedia.

It also offers two different types of technologies:
- Meteor®MBBR (simple Moving Bed Biofilm Reactor)
- Meteor®IFAS (Integrated Fixed film Activated Sludge)

On a smaller scale, there are also some companies that had no initial connection to wastewater treatment, but that have diversified their businesses to develop and produce their own biomedia.

4.3. BIOMEDIA PRODUCERS

Stöhr GmbH & Co.KG[12]

This German company specialises in producing plastic items and offers a large number of different models adapted for various uses in wastewater treatment plants. Their products can be customised, meaning they can be designed specifically for a purpose, leading to great interest among ornamental pond enthusiasts.

Stöhr GmbH & Co.KG has patented the Hel-X® product.

Above: Example of biomedia sold by Störh GmbH

[9] www.veoliawaterst.com/mbbr/fr/?bu=doc
[10] http://tinyurl.com/ybgsbkaf
[11] http://tinyurl.com/yczhg5lm et http://tinyurl.com/ycco236k
[12] hwww.hel-x.eu/front_content_018.html
[13] www.mutag.de/mutag_biochip_fr/

Multi Umwelttechnologie AG[13]

Multi Umwelttechnologie AG sells the Mutag BioChip™. These are easily recognisable as they are much flatter and wider than most other biomedia.

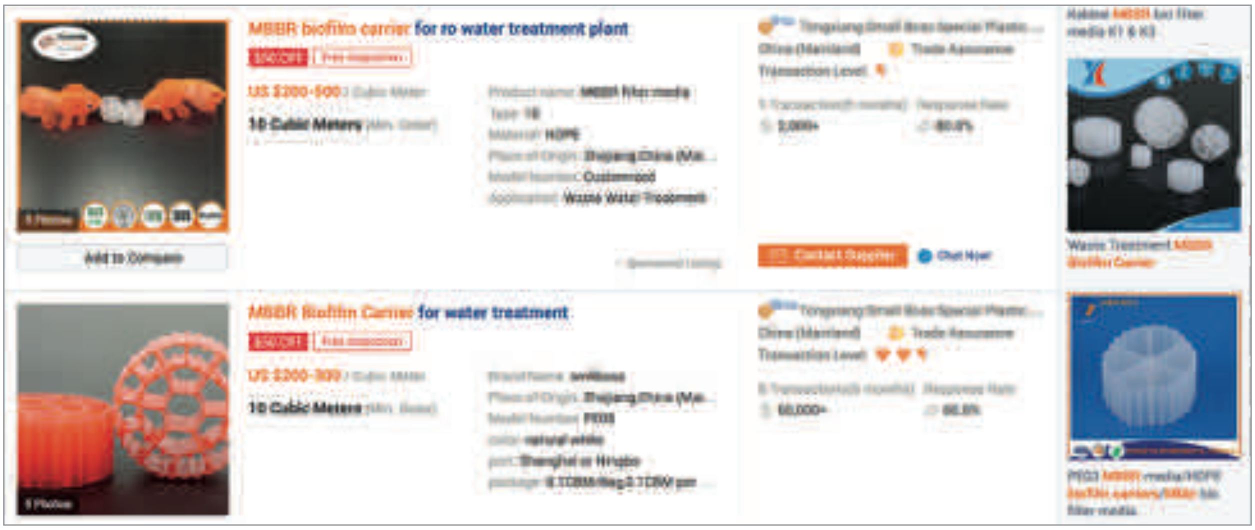
Opposite: Example of biomedia developed by Mutag BioChip™.

4.4. IMITATION AND COUNTERFEIT BIOMEDIA

Fake biomedia, copies of products sold by the major wastewater specialist companies, are proliferating rapidly as the process becomes more and more popular.

The shape of these fake media is often similar. However, this is not good enough on its own, because the very nature of the plastics used plays an important role in the treatment process.

Counterfeit biomedia may be made from a mixture of different kinds of plastics, such as Polyethylene (PE), Polypropylene (PP) or Polyvinyl Chloride (PVC). This can lead to the supports being abraded more quickly, with their non-uniform density leading to poor mixing of the biomedia in the treatment tanks.
These products can be found easily on online sales sites on the Internet, with nearly all of them coming from China.



Above: Examples of fake biomedia available on online sales sites

05
USERS

Moving bed biofilm reactor systems are used today for treating wastewater in public and industrial WWTPs, as well as in individual private systems and also in the farming sector.

5.1. MUNICIPAL SEWAGE TREATMENT

If a dwelling is connected to the local sewage network, this becomes part of the municipal mains wastewater treatment system – which is the most common system in urban areas.

In 2015, there were 21,079 wastewater treatment plants in France, with over 80% of households being connected to a mains sewage system. Nearly all towns with a population over 10,000 today have their own wastewater treatment plant. WWTPs using biomedia can be found all across France, but identifying them is difficult as they are not required to specify whether or not they use biomedia in their terms of reference. However, the French Federation of Waste Management and Environmental Services (FNADE) reported that 26 collective wastewater treatment plants were using the MBBR process in 2016.

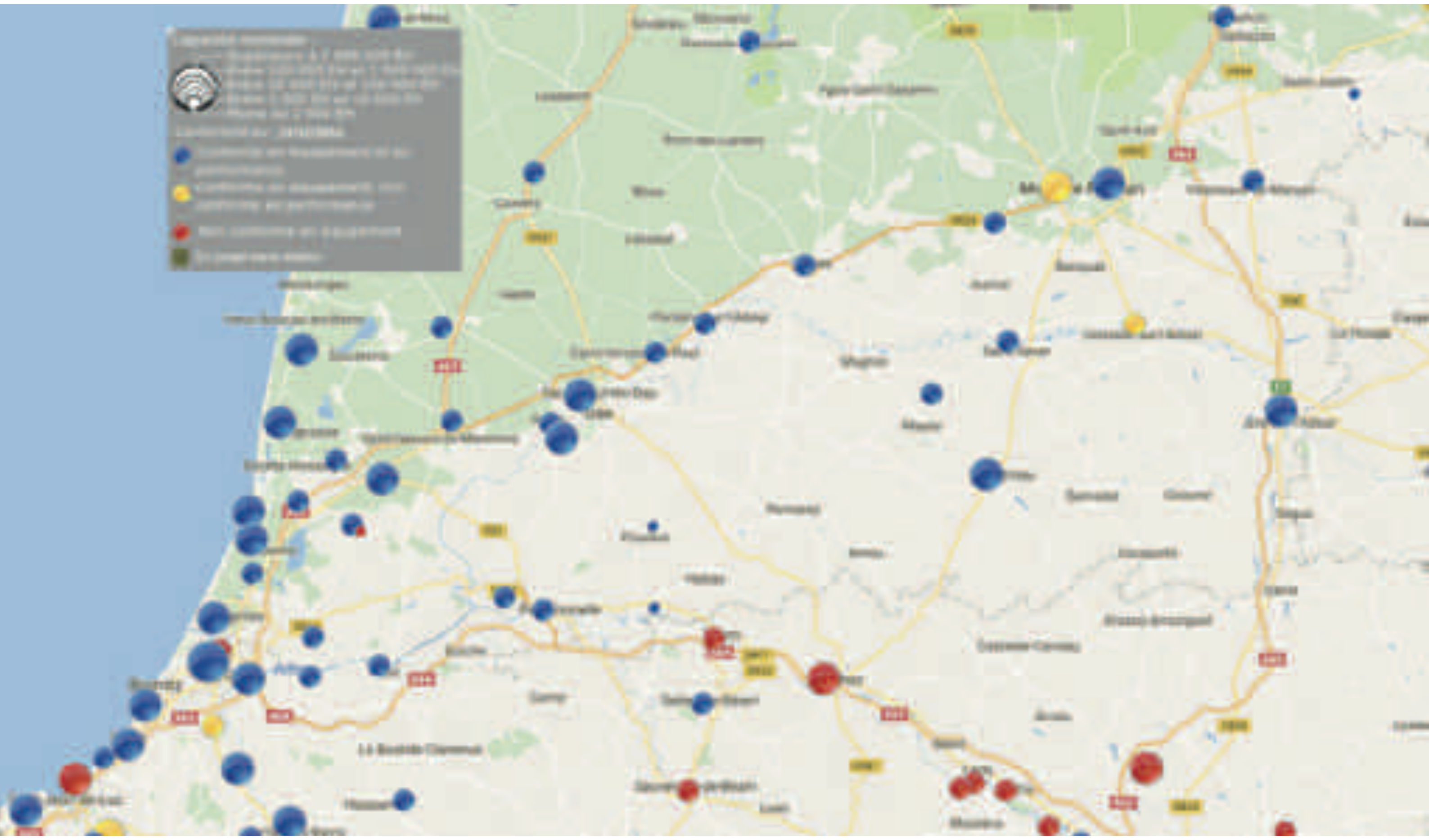


Figure 5 : map of public wastewater treatment plants in south west France - December 2016 © assainissement.gouv.fr

Some urban centres choose these wastewater treatment processes in order to boost the treatment capacity of existing plants or to reduce the footprint of new plants. As explained previously, the many advantages of this process *(see chapter 3.3)* seem to be attracting more and more customers.

MBBR processes can be used by communities and towns ranging in size from a few thousand to many tens of thousands of inhabitants.

The great variation in the sizes of plants using this system can be illustrated by the distribution of plants using the MBBR process in the PACA region (Provence-Alpes-Cotes d'Azur), ranging from 2,600 PE in Chateauneuf le Rouge (13) to 93,333 PE in Bormes les Mimosas (83).

5.1.1. NEW PLANTS, UPGRADED PLANTS

Operators wishing to enhance the effectiveness of their wastewater treatment systems have two main options. They can either build a new plant or overhaul an existing one.

It may not be possible to build a new WWTP using the fluidised bed process if land is not available or because of space constraints, non-existent equipment or the need for equipment to be replaced.

If a plant is to be upgraded while retaining existing structures, introducing a biomedia process can make it possible to meet water treatment targets by boosting the treatment performance without any need to increase the plant's footprint. However, specific measures are required if upgrading an existing plant to adapt it to the requirements of the new system.

Example New plant

Village Neuf (68) :

NOMINAL CAPACITY: 82,000 PE

REFERENCE FLOW: 26,240 m^3/day

MAXIMUM INFLUENT LOAD: 82,000 PE

INFLUENT FLOW: 24,100 m^3/day

MAIN TREATMENT PROCESS: Activated sludge (R3F)

Above: Village Neuf WWTP
© Village Neuf town hall

Figure 27 R3F reactor – Quéven WWTP

Example Upgraded plant

Quéven (56) :

NOMINAL CAPACITY: 82,000 PE

REFERENCE FLOW: 26,240 m^3/day

MAXIMUM INFLUENT LOAD: 82,000 PE

INFLUENT FLOW: 24 100 m^3/day

MAIN TREATMENT PROCESS: Activated sludge (R3F)

Examples Closed plants

Villard de Lans (38)

NOMINAL CAPACITY: 44,500 PE

REFERENCE FLOW: 12,900 m^3/day

MAXIMUM INFLUENT LOAD: 27,000 PE

INFLUENT FLOW: 9,390 m^3/day

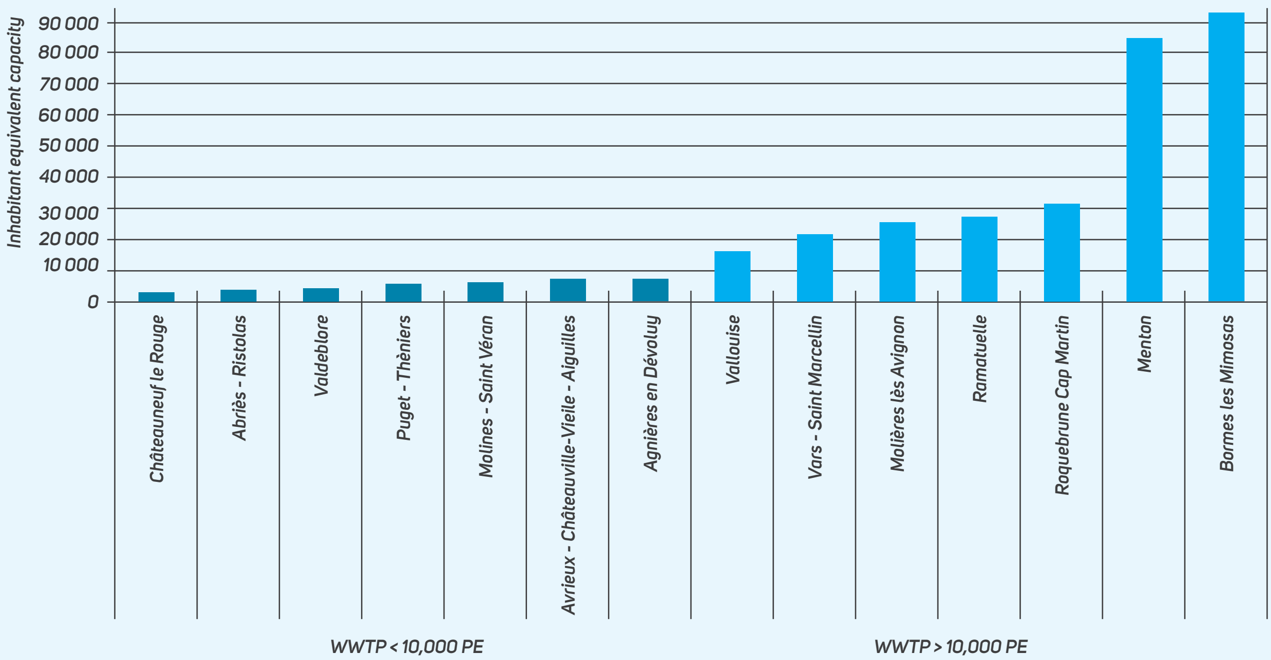
MAIN TREATMENT PROCESS: mixed culture

5.1.2. OPEN PLANTS, CLOSED PLANTS

Depending on a plant's location it may be necessary to cover the reactors, especially in cold weather conditions or if strong odours can be a problem.

Opposite: Skiing in Villars de Lans
© Villars de Lans tourist office

Figure 6 : istogram of plants using the MBBR process in the PACA region © ARPE PACA - N. Wepierre



Above: Villard de Lans WWTP
© vercors.org

St Jean d'Arves (73)
NOMINAL CAPACITY: 17,000 PE
REFERENCE FLOW: 2,670 m³/day
MAXIMUM INFLUENT LOAD: 14,355 PE
INFLUENT FLOW: 797 m³/day
MAIN TREATMENT PROCESS: biofilter

These mountain plants must cope with the demands of their winter climates as well as heavy variations in demand linked to their tourist industry.

Example Open plant

Heudebouville (27)
NOMINAL CAPACITY: 14,800 PE
REFERENCE FLOW: 800 m³/day
MAXIMUM INFLUENT LOAD: 5,316 PE
INFLUENT FLOW: 279 m³/day
MAIN TREATMENT PROCESS: prolonged aeration activated sludge (very low load), R3F process

5.1.3. PLANTS IN REGIONS WITH EXTREME SEASONAL VARIABILITY

Some regions, with extreme changes in seasonal conditions caused by tourist arrivals, farming or vine-growing activities, need wastewater treatment systems that can cope with dramatic variations of load.

Meursault (21)
NOMINAL CAPACITY: 22,000 PE
REFERENCE FLOW: 1,200 m³/day
MAXIMUM INFLUENT LOAD: 16,030 PE
INFLUENT FLOW: 1,035 m³/day
MAIN TREATMENT PROCESS: medium load activated sludge, R3F process

Molines St Veran (05)
NOMINAL CAPACITY: 6,000 PE
REFERENCE FLOW: 1,270 m³/day
MAXIMUM INFLUENT LOAD: 6,030 PE
INFLUENT FLOW: 686 m³/day
MAIN TREATMENT PROCESS: mixed cultures, R3F process

Above: Vineyards in Meursault
© Beaune and Pays Beaunois tourist office

5.2. PRIVATE OFF-MAINS SEWAGE TREATMENT

Unlike mains wastewater systems, off-mains wastewater treatment, also called domestic or individual systems, are facilities that are not (directly) connected to the public network.

When several isolated dwellings (hamlets) that are not connected to the mains sewage network are linked up to the same independent wastewater treatment plant, this is known as a semi-collective system. These independent facilities, be they domestic or industrial, are subject to regulations, and must regularly be inspected by the dedicated Service Public d'Assainissement Non Collectif (SPANC). Depending on the volume of effluent to be treated, these can range from industrial wastewater treatment plants able to treat many thousands of PE or micro-plants designed to treat much smaller volumes.

In general, these systems are used to meet the challenges of isolated locations, specific arrangements (fish ponds), treat wastewater from small industrial businesses before they are discharged to the environment, or for pre-treatment of industrial effluent prior to it being discharged into the municipal sewage network.

Private wastewater systems are used today to treat around 10% of the domestic wastewater generated by the population of France.

5.2.1. MICRO-PLANTS (1-50 PE)

Micro sewage plants are an independent wastewater treatment solution. These enable domestic or industrial wastewater to be discharged into the environment, following treatment and in accordance with regulations, ensuring the preservation of public and environmental health.

Operating on the same principal as municipal wastewater treatment plants, they use biological systems for both primary and secondary treatment of effluent. Micro-plants can be divided into four major groups:

- Trickling filter micro-plants: the bacteria are attached to a support that the effluent passes through.
- Moving bed micro-plants: the bacteria are attached to supports (biomedia) that move around inside the tank.
- Micro-plants using free-living cultures, in which the bacteria are suspended in the water and sludge.
- Sequencing batch reactors (SBR): This process is similar to activated sludge, but with the biomass settling out in the aeration tank rather than in a separate settlement tank.

Above: Installation of a micro purification Oxyfix® plant ©Eloy Water (www.eloywater.fr)

These are concrete or plastic tanks. All the wastewater treatment processes take place inside these, with each plant having the capacity to treat from 1 to 20 PE. The tanks are divided up into compartments (settlement tank, reactor, clarifying tank) or linked (one tank for each role). The biomedia inside these closed tanks are never replaced and are only cleaned in exceptional circumstances (to prevent any damage to the biofilm). The sludge is emptied out from the separate part of the settlement tank, so the biomedia are not affected during this process. It is essential for the biomedia to remain inside these micro plants and it seems very unlikely that they could escape.

Installation of these kinds of plants in France is regulated, with plants requiring permits from the Ministry for Ecology, Sustainable Development and Energy[14]. A list of permitted installations can be found on the Ministry's website.

5.2.2. CONTAINERISED WASTEWATER PLANTS (50 – 1,000 PE)

Containerised plants have been adapted from the process used in micro-plants and are designed to meet similar needs – i.e. to treat domestic or industrial wastewater that cannot be discharged to the municipal network. These compact plants can provide a semi-collective service, treating water from around 50 to 1000 PE. In order to cope with additional constraints in terms of the volumes to be treated or geographical isolation, these mobile treatment plants have been fitted inside shipping containers. These modulable and tough systems can be attached to different means of transport to be moved over long distances, making them easy to relocate. They can treat up to several thousand PE (around 4,000). These containers use a variety of wastewater treatment techniques, adapted to the requirements of each situation. Moving bed biofilm reactor systems figure among the range of available solutions.

These facilities are especially useful for temporary and mobile purposes (such as military or humanitarian operations), mining and oil industry work sites, construction sites, refugee camps, research stations, base camps on glaciers, in deserts and other places with extreme climates or in small spaces (ships).

Above: Wastewaterbox containerised plant ©Cohin environnement

5.2.3. NON-PUBLIC INDUSTRIAL WASTEWATER TREATMENT

Companies producing industrial effluent are subject to special measures. These are generally Installations Classified for the Protection of the Environment (ICPE[15]). All industries, no matter what they produce, are obliged to treat their effluent (Water Law 1992[16]). Industrial effluent may then be discharged back into the environment either after treatment by the business itself (independent treatment), or after being discharged into the municipal sewage network.

A company wishing to discharge its industrial effluent into

[14] http://tinyurl.com/ybjk4sxt
[15] In France, an Installation Classified for the Protection of the Environment (ICPE), is any facility operated or owned by any physical or moral person, public or private, that could cause any danger or inconvenience to local residents, public health, safety, public hygiene, agriculture, the protection of nature and the environment, or the preservation of special sites and monuments.

the municipal wastewater system must hold a discharge permit. This authorisation, issued by the local authority, details the wastewater treatment system's capacity to transport and treat this industrial effluent. If this option is used, the industrial effluent must be pre-treated in order to remove the specific pollutant load coming from the industrial process and not broken down by the local authority's water treatment system.

Industrial wastewater can be differentiated from domestic wastewater due to the higher and more uniform concentration of pollutants it contains, given the specific nature of industrial activities. To meet legal requirements, companies may also set up their own wastewater treatment plants, which can provide more specific forms of treatment. Industrial or agricultural wastewater may contain large quantities of heavy metals, plant health products or other pollutants that cannot necessarily be properly treated by municipal systems. In these cases, industrial effluent is not mixed with domestic wastewater until such time as it no longer poses any risk to municipal sewers or treatment systems.

Treating industrial wastewater is a complex matter. Each facility is a different case, which needs its own specially-adapted equipment and processes in order to fulfil its requirements. Strict environmental constraints, protections and the large volumes of water involved in industrial processes mean companies must adopt methods to limit their water consumption and encourage water recycling.

In this study we have focused on several industrial sectors operating in the Adour-Garonne catchment area or nearby, which need to treat significant volumes of water as part of their operational processes.

5.2.3.1. Paper and cardboard industry

According to INSEE, the French national economic statistics office, there were over 1,400 companies involved in the paper and cardboard industry in France in 2011, with a combined turnover of almost €19 billion (or 2% of total national industrial turnover) and added value in excess of €4 billion (again 2% of the industrial total). Within this sector, the main activity of 9% of the companies (126) was the manufacture of paper pulp, paper and cardboard.

The paper manufacturing process requires the use of enormous amounts of water, and its effluents can contain a wide range of pollutants, such as:
- Suspended solids (fibres, sawdust, ashes, etc.)
- Dissolved organic matter
- Inorganic compounds (metals, salts)
- Hydrocarbons (lubricants)
- Fatty acids and resins from the wood

Many other substances can also be found in the effluent. This industry's discharges are therefore very specific and require appropriate treatment before permissible discharge into the receiving water.

In Aquitaine, the industrial exploitation of the Landes pine forest has led to the development of numerous paper businesses such as Smurfit Kappa in Facture-Biganos (33), Gascogne Paper in Mimizan (40) and Mondi Lembacel at St Jean d'Illiac (33).

The Smurfit Kappa business uses processes developed by Suez Dégremont that use biomedia to better treat paper industry effluent.

The Saint Michel paper mill in Saint Michel d'Entraygues (16) on the banks of the Charente river uses the patented

[16] Water Law no. 92-3 of 3 January 1992

FlooBed®[17] system developed by Hydroflux Industrial. Other businesses in France and Spain, close to the Adour-Garonne river system, also use biomedia. For example, the Papelera del Oria paper mill in Villabona (Guipuzcoa, Spain) on the Oria river, has been using this process since the early 2000s. It uses an installation produced by ATM SA, using a mixture of KNS and AMB Bio Media.

5.2.3.2. Chemical wood processing industry

The wood industry in Aquitaine is not just limited to paper production. Some companies have developed chemical processes to produce derivatives from natural wood components.

Some companies, like DRT in Vielle-Saint-Giron (40), specialise in resins derived from the maritime pine. The compounds they produce are in turn used to manufacture a wide variety of other products such as elastomers, adhesives, spices, perfumes, chewing-gums, inks, biocides, detergents, and pharmaceutical and cosmetic products. It has been using Veolia Water's BAS Process™ with K3-type biomedia since 2011.

5.2.3.3. Agrifood industry

The agrifood sector is the third most important industry in Aquitaine after intermediate product industries (wood, chemicals, etc.) and equipment (machines, accessories, etc.). The most important agrifood business in the region is the meat production industry, with 232 companies accounting for almost 30% of turnover. Other leading industries include fruit and vegetable canning, wine production and dairy production[18].

The agrifood sector:
- Overall turnover: €7 billion
- Exports: €1.1 billion
- Number of industrial companies: 700
- Overall workforce: 30,000 paid workers
- National ranking: World's top producer of foie gras, leading French fish-farming region, biggest contributor to the regional trade surplus.

Effluent from the agrifood industry is generally characterised by a heavy load of organic matter and fats, which must also undergo specific treatment.

Dairy production

Le Petit Basque, a dairy dessert manufacturing plant in Saint-Médard-d'Eyrans (33), uses Veolia Waters' MBBR process in the Nouvelle Aquitaine region.

Wine production

This industry, which has a very strong presence in south west France, is subject to seasonal patterns. At harvest time significant volumes of wastewater are sent to treatment plants and must be treated quickly and effectively.

However, none of the interviews we have conducted to date (with the Police de l'Eau (French water and river management police), SATESE (technical assistance service for wastewater treatment sector), etc.) have revealed any instance of these businesses using MBBR systems.

This system is used in other regions to filter a proportion of the waste discharged during the vine processing or the wine-making process.

In Burgundy, the wastewater treatment plants in the towns of Ladoix Serrigny (21) and Meursault (21) have been extended and upgraded to be able to treat the

[17] http://www.hydrofluxindustrial.com.au/product-item/mixed-bed-biological-reactors/
[18] http://agreste.agriculture.gouv.fr/IMG/pdf/Gar14p142-149.pdf

peak pollution from wine-related effluent during harvest and racking (between October and February). This upgrade work has enabled the Meursault (21) plant to go from treating 6,000 to 22,000 PE during the harvest period. The system installed is the R3F process, developed by Vinci Environnement.

MBBR technology has also been used in the wine industry in northern Spain since the early 2000s. Some companies such as DAS USA supply several producers[19]:
- Nuestra Señora Del Romero - Cascante
- Bodegas Olarra - Logroño
- Bodegas y Viñedos Casa del Valle - Toledo
- Bodegas Haro - Haro
- Bodegas Marques del Puerto - Logroño
- Bodegas Juan Alcorta - Logroño

On a wider scale, DAS USA has also developed its Moving Bed Biofilm Reactor technology for numerous agrifood businesses, such as:
- Gutarrag
- Congelados de Navarra - Fustiñana (Spain)
- Coca Cola Europe (Spain)
- Enaquesa - Pamplona (Spain)
- Vega Mayor - Milagro (Spain)
- Jamones Ancin - Ancin (Spain)
- Servair - Vitry en Artois (France, 62)
- Le petit cuisinier- Le Mesnil Amelot (France, 95)

Given the importance of the agrifood industry in the Adour-Garonne region it is quite likely that biomedia are being used in wastewater treatment systems in this sector on a wider scale.

5.2.3.4. Fish farming

Some 441 commercial fish farms classified by ICPE and IOTA[20] were listed in France in 2013. However, it has not been possible to obtain any information about whether or not these businesses are using biomedia in their water treatment processes.

Farming fish in a pond requires significant levels of water treatment in order to prevent the fish from asphyxiating and dying. The advantages of using processes involving bacteria attached to plastic carriers (small footprint, ability to cope with a varying load, treatment effectiveness) make this system particularly suitable for this activity. French operators seem to have been largely influenced by the big fish farming operations in Scandinavia, which pioneered the use of this technology.

The largest number of fish farming operations in France can be found in the Adour-Garonne basin. The departments of Gironde, Les Landes and Pyrénées Atlantiques alone have 7, 22 and 25 such operations, respectively. There are a further 15 distributed throughout the rest of the Adour-Garonne region, with a total of over 130 fish farming sites (of all types) in Aquitaine.

When we met with the managers of two aquaculture farms in Gironde specialising in sturgeon (L'écloserie de Guyenne, belonging to the company Sturgeon in Saint-Seurin-Sur-l'Isle (33), and the sturgeon farm in LeTeich (33), they both confirmed the effectiveness of this process. *(see annex I.A)*.

19 http://www.dasusa.com/wastewater_food_industry.htm et http://www.eecusa.com/wineries_wwtp.htm
20 IOTA : Installations, Ouvrages, Travaux ou Aménagements au titre de la loi sur l'eau

5.3. UNREGULATED WASTEWATER TREATMENT SYSTEMS

Other domestic facilities operated by private individuals, such as swimming pools, natural lakes and ornamental ponds also require regular water treatment. There are no regulations on discharges from these kinds of private installations at this time.

Koi carp farming is one of the main reasons for the creation of ornamental ponds. A large community of enthusiasts are involved in this activity, making use of numerous specialist magazines and websites offering guidance and selling specific materials.

Inspired by professional fish farms, many amateurs use biomedia to filter the water in their ponds. These can be micro purification plants bought commercially or home-made versions rigged up from plastic bins, for example.

Unfortunately, the suppliers of these items often deliver them without any explanation of how to use them, leaving the purchasers to work out how to install and use them on a trial and error basis.

The only source of recommendations for amateurs on how to use this technology seems to be experimentation and knowledge-sharing with others in the community, primarily through specialist forums. Information through these networks is mainly in the form of numerous discussions and videos, resulting at times in very rough and ready installations that are sometimes clearly harmful to the environment.

Many amateur users can therefore be responsible for many of the problems and incidents resulting from a lack of information. *(see annex III).*

Above: Koi carp © Evan McDougall

5.4. WASTEWATER TREATMENT AT SEA

Cruise ships can at times have many thousands of passengers and crew on board, resulting in the production of large amounts of wastewater.

Over 120,000 litres of wastewater can require treatment each day in order to reduce a ship's environmental impact. Some ships are therefore equipped with their own specially-designed wastewater treatment systems to meet their needs (limited space, large amounts of wastewater) using MBBR technology to optimise wastewater treatment performance in a small space.

Companies that specialise in wastewater treatment systems for ships and offshore activities have equipped some cruise ships with compact sewage treatment systems.

The main types of systems used include CleanSea® developed by Headworks and EVAC MBBR developed by Evac.

It is possible that biomedia could be lost from these kinds of systems, although this has never been directly observed.

Above: tourist cruise liner © Billy Pasco

6
THE SPREAD OF BIOMEDIA IN THE NATURAL ENVIRONMENT

Biomedia spread through the environment if they escape from wastewater treatment plants, firstly through freshwater systems and then in the sea. Some of them will end up being washed up on the coast, sometimes thousands of kilometres from their source.
To understand how they spread, it is essential to understand the environmental, weather and water-related factors that interact with these items of floating debris.

6.1. LAND-BASED SOURCE AND TRANSPORTATION IN WATERWAYS

Biomedia escaping water treatment plants can, like any unnatural element entering the environment, end up in the sea. They can be transported in water courses over hundreds of kilometres from their point of discharge, just as a drop of water will also follow the same route through the water cycle. This means biomedia can be dispersed over vast areas.

The upstream – downstream connection
It is estimated that 80% of all the waste found on our coasts has a land-based source[21]. The main vectors for the spread of pollution from inland areas to the oceans are rivers. WWTPs generally discharge into water courses, and this is therefore the principal means by which biomedia are lost into the environment. Rainfall impacts on water levels and river flows. The ebb and flow between low and high-water levels affects how a water course is able to remobilise waste deposited on its banks. When water levels rise significantly, this can remobilise waste, or lead to water getting into sensitive areas, for example from wastewater treatment plants or old rubbish dumps.

Once they are picked up by the rivers, these waste items follow their route downstream. Estuaries mark the interface between the land and sea, and it is here, at river mouths, that waste finds itself flowing out into the marine environment.

A perfect illustration of this was the biomedia pollution incident at Corbeil-Essonnes, which could be tracked from its source right down to the mouth of the Seine *(see section 8.1.1)*.

Above: Waste on the banks of the Adour river
© Surfrider Foundation Europe

[21] UNEP, 'Marine litter a global challenge' 2009.

6.2. TRANSPORT OF WASTE IN THE MARINE ENVIRONMENT

6.2.1. CURRENTS

The world's oceans are in a state of perpetual motion, thanks to the forces acting on water masses (winds, tides, Coriolis force) and their physical-chemical properties.

From river mouths, waste can be transported many thousands of kilometres by surface currents. This is particularly true in the case of floating plastic waste, which faces few obstructions as it moves around in the marine environment.

Waste from North America, for example, is often found on European beaches.

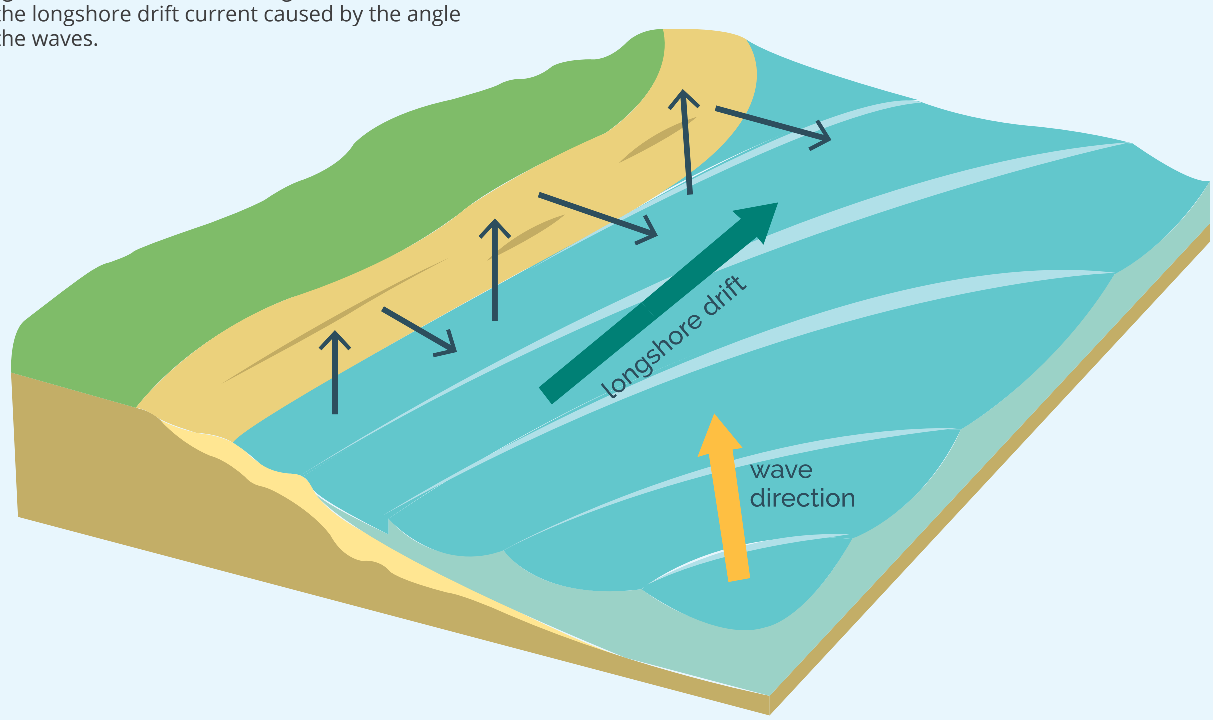
(Read more about this subject in the case study of lobster pot tags on pages 62 and 63).

6.2.2. LONGSHORE DRIFT

At a local level, the angle at which the waves hit the shore creates a longitudinal current along the coasts and for a few hundred metres out to sea. This can transport both sediment and waste in a particular direction and is called longshore drift.

Figure 7 : Graphic showing the process of longshore drift

Progressive movement of sand grains under the actions of the longshore drift current caused by the angle of the waves.



6.3. CASE STUDY: BAY OF BISCAY

6.3.1. GENERAL BACKGROUND

The Bay of Biscay (1–8°W, 43–48°N), stretching from the Penmarc'h headland (Britanny) to Cape Ortegal (Galicia), is a semi-enclosed area, affected by the sub-polar and sub-tropical Atlantic gyres (Pollard, 1996), forming part of the circulation of the northern Atlantic Ocean.

Water masses in the Bay are subject to currents that vary throughout the seasons, under the influence of temperature variations, winds, tides and density gradients (Charria, 2013 ; Pingree and Le Cann, 1989). The continental shelf is narrow along the Spanish coast (~ 30 km) but expands towards the north along the French coast, reaching a width of almost 180 km along the coast of Brittany.

Water flowing out of the Loire, Garonne and Dordogne rivers accounts for 75% of all the freshwater reaching he Bay, with an annual average flow of 900 m^3/s from the two estuaries. This part of the Bay, because of being semi-enclosed between France and Spain, is subject to strong oceanic forces as well as terrestrial ones, displaying extreme spatial and temporal variability.

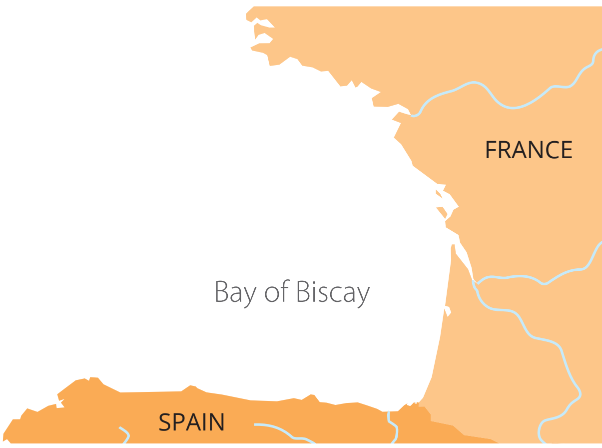


Figure 8 : Map of the Bay of Biscay

6.3.2. PREVAILING WINDS

The strongest winds are generally seen in the north of the Bay of Biscay, coming from the west-south-west. Further south, the relief of the Spanish landmass means winds most often come from the west, not exceeding level 7 on the Beaufort scale (Le Cam and Baraer, 2013).

6.3.3. SWELL

During the summer, the average height of waves (Hs) reaching the southern coasts of the Bay of Biscay is slightly over 1m.

The greatest wave heights are generally recorded offshore in winter. They are around 3m along the coast, although they can be higher out at sea (http://candhis.cetmef.developpement-du-rable.gouv.fr).

Waves throughout the whole year come primarily from the north west.

6.3.4. LONGSHORE DRIFT IN THE BAY OF BISCAY

The surface currents in the Bay of Biscay display strong seasonal variability:

From April to September

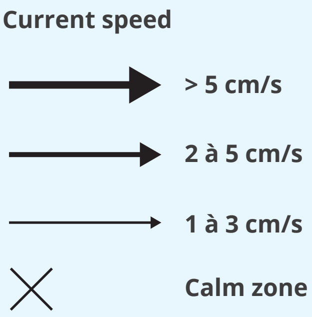
Spring is a transitional period in which the wind is generally from the north west. The surface currents therefore travel move progressively southwards. Deepwater currents travel in a south easterly direction.

In summer, the movement on the continental shelf is reversed. Under the effect of the prevailing north west wind, the surface currents travel primarily to the south, while along the Spanish coast they head west (Lavín et al., 2007).

Page right: Buoys washed up on a beach in Brittany, probably after having crossed the Atlantic © Gilbert Mellaza

From October to March

The whole of the Bay of Biscay is the focus of a huge cyclone effect. The winds generally come from the south west. On the continental shelf, a north westerly current starts to appear in the autumn. This current can last until December, sometimes attaining a speed of 30 cm/s. It brings warm water from the south eastern corner of the Bay up to the north towards Brittany. Along the coast, the current heads north west, while along the Spanish coast the current travels in an easterly direction.



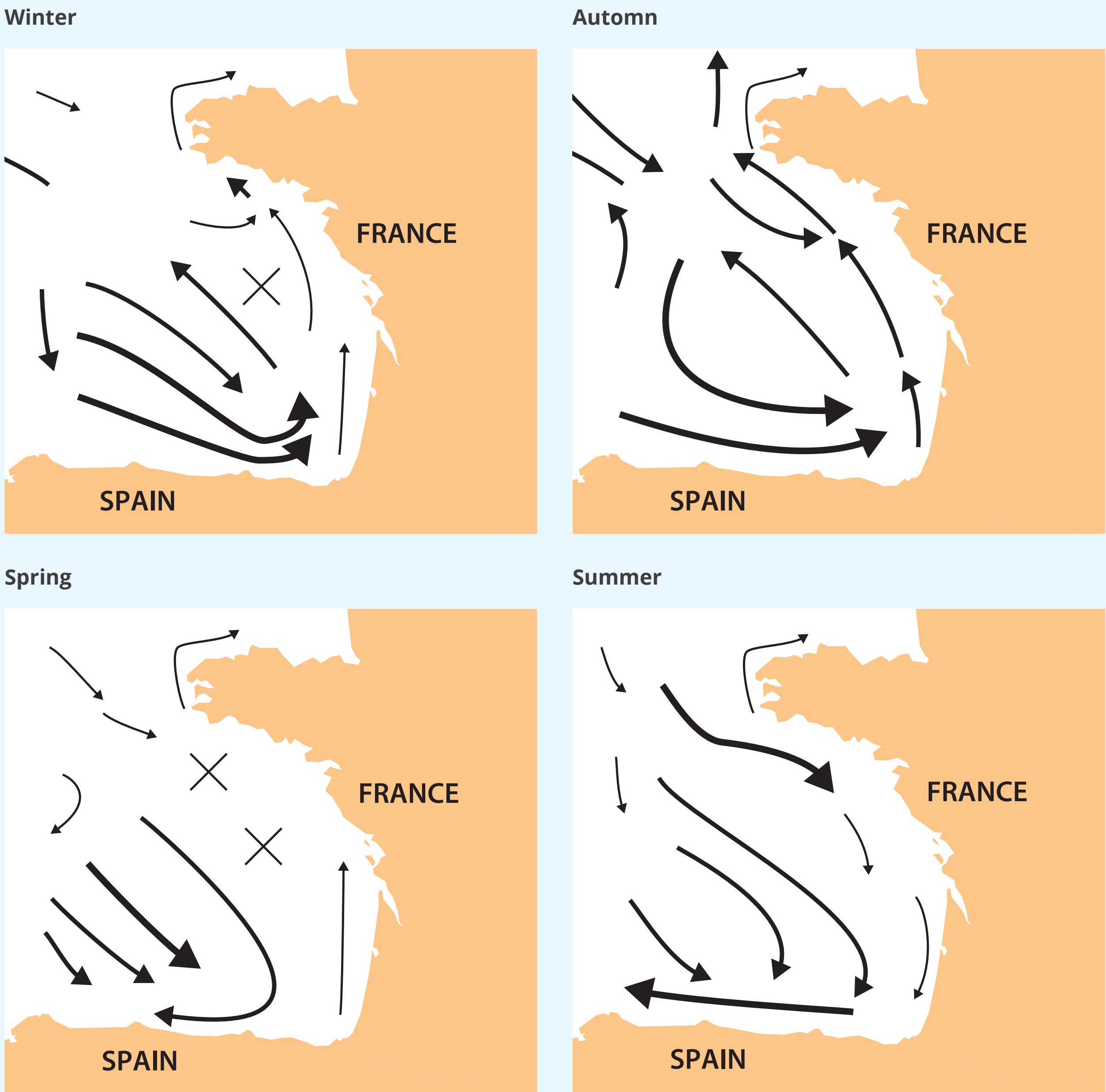


Figure 9 : seasonal surface currents in the Bay of Biscay © Charria et al. 2011, IGN, ESRI, SHOM, IFREMER

Trans-Atlantic drift: the ocean journey of lobster pot tags

"After nearly two years there's still plenty I'm learning. But one thing is sure", wrote Harold Johnson from Maine, United States in his now-discontinued blog The Flotsam Diaries, "The same oceans that divide us, connect us…. Plastics from my part of the world can make the 3,000-mile crossing unscathed, washing up on Irish and British shores".

Johnson was able to make this claim because he had found a failsafe indicator of this trans-Atlantic journey – the plastic marker tags attached to lobster traps. There are large numbers of lobster fishermen in the Gulf of Maine, but it's a highly-regulated business. Each pot must be marked with a plastic tag containing legally-required information – the trap owner's licence number, the authorised fishing zone, the trap number, state, year and region.

This is also a specific colour for each year.

For example, the green tag in the photo opposite displays the following data:

6841 A1 0789 ME 09 Z:G EEZ.

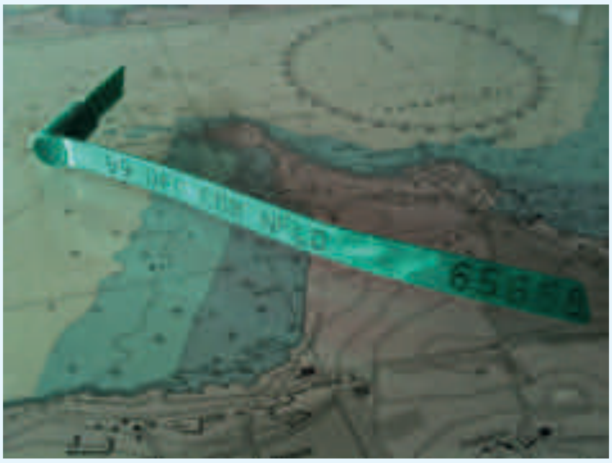
- 6841 is the number of the licence holder,
- A1 is the national region reference (in this case the coast of Maine),
- 0789 is the trap number,
- ME 09 represents the state and year: Maine 2009,
- Z:G identifies the local sector. The G is the furthest to the south west,
- Lastly the code EEZ shows that the trap can be deployed in deep water.

"This shows why each of these plastic tags is a true time capsule and an amazing source of information to anyone who knows how to read it", says the blog writer.

Each season sees a huge number of lobster traps set in the ocean. Often the identification tags become detached and drift in the current before washing up on European coasts, as in the case of this green tag (opposite), found in December 2011 by Andy Goodall in Newquay (Cornwall, United Kingdom), 12 years after it had been attached to a lobster trap.

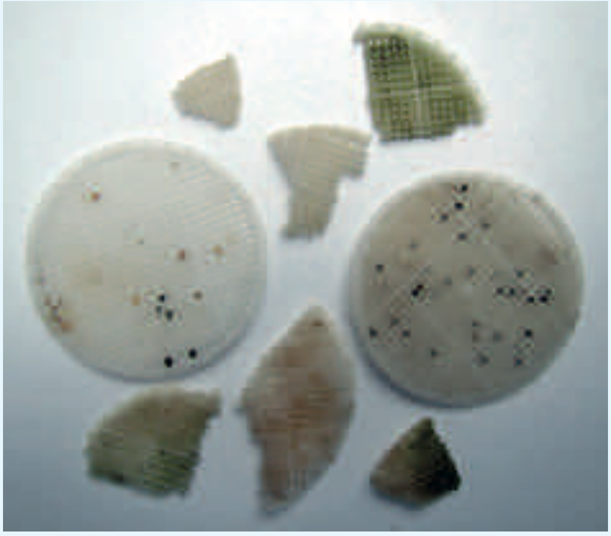
These are not just anecdotal reports. Communities in numerous parts of the Atlantic coast have built up whole data banks of these drifting lobster pot tags!

Above: the tag colour is changed each year. This photo, from top to bottom, shows the colours used in Maine from 1997 to 2010. © Harry Saco



In France, for example, Gilbert Mellaza collects lobster pot marker buoys and identification tags on the beaches of Plouzané in the Finistère area of Brittany. He classifies his finds according to their source – either Canadian or American.

In United Kingdom and France, beach cleaners also sometimes find biomedia along with the lobster pot tags, especially BioChip models, which bear an uncanny resemblance to the several million that escaped from the Hooksett wastewater treatment plant in 2011 (see section 8.3.2). They therefore believe that these biomedia have crossed the ocean. While this is possible, it cannot unfortunately be proven, given that biomedia – unlike lobster pot tags – do not bear an identification code.



Above: *Biochips collected on the beach at Freshwater West, Wales, in January 2016 by volunteers from the group Beachcombing Freshwater West.*

Below: *Similar-looking biochips collected on the other side of the Atlantic at Crane Beach, Ipswich, Massachusetts (USA) on 5 June 2016.*

Above: *Poster produced by the NGO Littora, asking members of the public to report lobster tags found on Canadian beaches.*

* http://theflotsamdiaries.blogspot.fr/2012/01/transatlantic-connections-part-i.html
** See the *Beachcombing Freshwater West page* on Facebook

6.4. DISPERSAL OF PLASTIC WASTE ON THE SOUTH-EAST COASTS OF THE BAY OF BISCAY

A study carried out in the Bay of Biscay in 1978 (Ibanez Artica, 1979[22]) gives us a better understanding of how small pieces of plastic debris are transported.

The study involved 15,000 plasticised tags being thrown into the sea every month for a year from various points along the Basque coast – the Zumaia lighthouse, the port of Hondarribia, in the Oria estuary, at Zarautz, in the Urrumea estuary at San Sebastian, in the Mundaka estuary and on the beach at Biarritz. The experimental protocol of this study is very close to what happens in reality and can be transposed to the case of biomedia spilled into the natural environment.

Above: Example of the plastic cards cast into the sea
© Instituto Geográfico Vasco

The cards were primarily put into the sea at points along estuaries – the same points where waste flowing out of river basins enters coastal water masses. The idea was to provide a way of visualising the flow of plastic debris (at least for small-sized debris, such as the cards used in this experiment) in the marine environment over the course of the seasons. Each plastic card had a unique number, so its start and end points could be used to understand the dynamics at work around the coast over the course of the year.

Coincidentally, one of the most significant spills of biomedia to date in Europe happened in the same area in the autumn of 2009, making it possible to compare the journey of the plastic cards and the dispersal route of the biomedia in the marine environment.

In this incident, millions of AMB type biomedia were lost into the river Oria, probably having escaped from two wastewater treatment systems at paper manufacturing plants *(see 8.2.1)*.

There are two main types of current throughout the year in this area: The first is characteristic of the winter months and is a uniform west-east movement parallel to the Cantabrian coast of Spain, which then moves from south to north along the French coast. These currents are at their strongest at the start of December, in February and November.

In the summer, from mid-July to late October, the currents vary, depending greatly on the direction of the prevailing wind.

[22] Hydrological studies and surface currents in the coastal area of the Bay of Biscay, Miguel Ibañez Artica, Instituto Geográfico Vasco, 1979

The currents alternate throughout the summer months, although they travel predominantly from east to west.

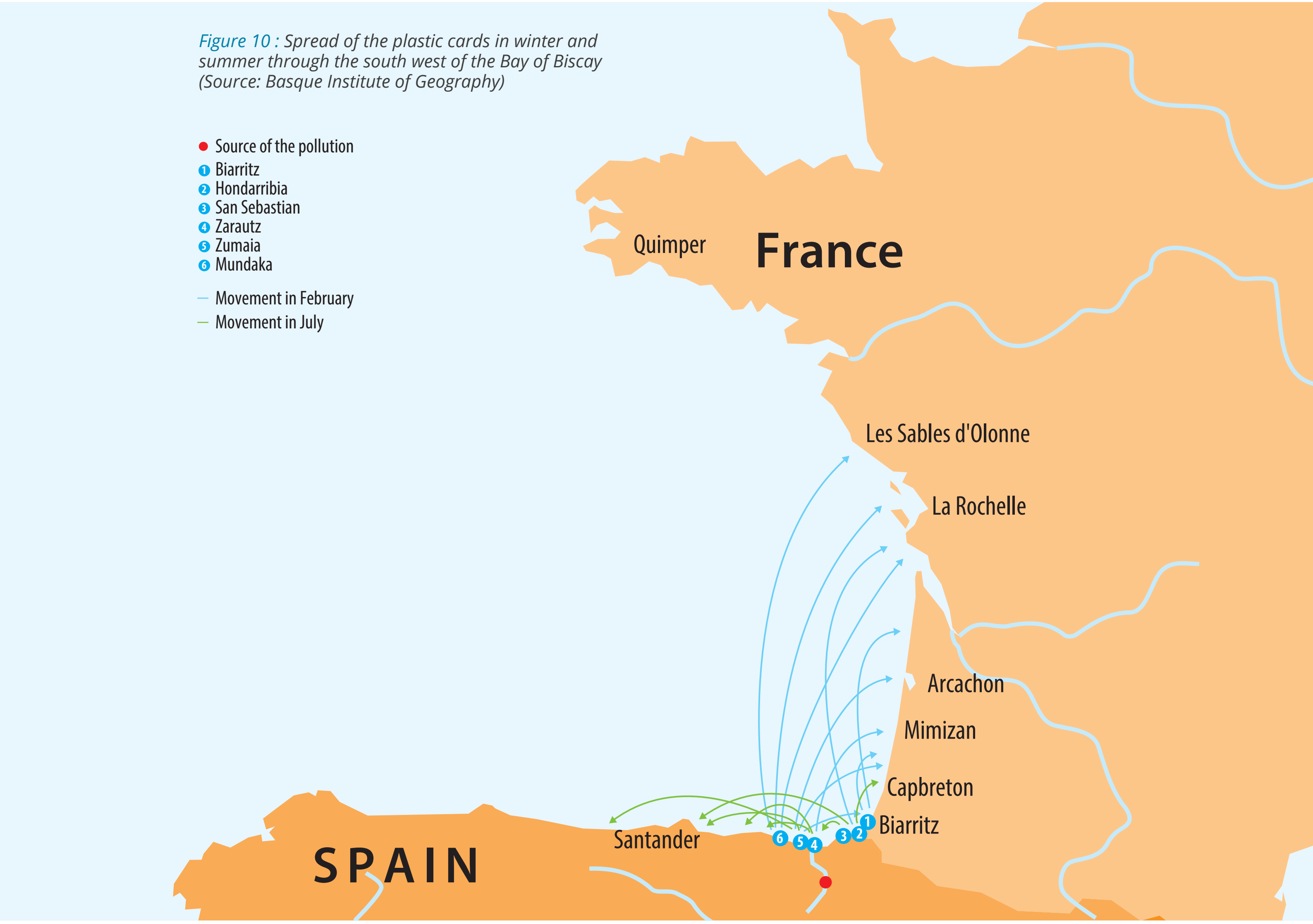
This study also showed that the plastic cards could travel very large distances, with some of them having covered more than 300 kilometres to reach the coast of the Vendée region in just three weeks.

The biomedia lost in the pollution incident precisely mirrored the study by the Basque Institute of Geography, travelling from west to east in the winter of 2010.

Starting out in the Oria, they were first noticed on the beaches of San Sebastian and then in Biarritz. In the following months they appeared in The Landes, Gironde, and later in Brittany. In the summer of 2010 they were found in the other direction in Cantabria, having travelled from east to west.

They are still found washing up on Atlantic coast beaches in the autumn of 2017, eight years after having been lost into the environment – although in smaller numbers.

Figure 10 : Spread of the plastic cards in winter and summer through the south west of the Bay of Biscay (Source: Basque Institute of Geography)



07
MONITORING BIOMEDIA POLLUTION

In 2007, a volunteer with Surfrider Foundation Europe started to notice biomedia on the beaches of the French Basque coast. Over the years, these media started to turn up in Aquitaine too, and then along all French and European coasts. Surfrider Foundation Europe has gained significant expertise and become the leading organisation working on this issue, thanks to its extensive network and the data collected by a network of external observers.

7.1. MONITORING BY SURFRIDER

7.1.1. OBSERVATIONS FROM VOLUNTEERS

Biomedia were observed for the first time on the beaches of the French coast in 2008. Little was known about these little plastic little plastic pieces and what they were used for when the Surfrider volunteer group on the Basque coast started to report them washing up on their beaches.

Above: Biomedia found by the volunteers along the Basque coast © Surfrider Basque Coast

A few months later, these strange items were identified when a volunteer group visited a WWTP in Ajaccio, Corsica. The volunteers were able to recognise the hitherto unidentified object, and by matching information we were able to show the link between water treatment stations and spills of the plastic little plastic pieces along the coasts. When we started to ask them, numerous volunteers reported the same items along all of Europe's coasts.

7.1.2. OCEAN INITIATIVES

For over 20 years the Surfrider Foundation Europe has been organising the *Ocean Initiatives*[23] programme, which aims to reduce marine litter and plastic pollution at source by raising awareness and cleaning up waste in lakes, rivers, beaches and on the seabed. This Europe-wide programme allows us to gather essential information on plastic pollution. The organisers of these clean-ups are asked to classify and count what they collect. Surfrider consolidates all these data, which are later shared and distributed to the wider public, media and public authorities.

Since 2013, *Ocean Initiatives* has included a specific section for reporting biomedia pollution by stating the type, number and density of biomedia found in aquatic environments, by means of an identification card *(see figure 11)*.

It is primarily thanks to this standardised observation method and the wide network of Surfrider volunteers that we have been able to carry out this study. These field studies will continue over coming years to ensure monitoring of the type and quantity of biomedia found in the environment.

[23] initiativesoceanes.org

Surfrider's strong regional presence means a large number of beach clean-ups have been conducted along France's Atlantic coasts, and particularly in Aquitaine, with biomedia repeatedly found there. To show that this is not a localised problem but something bigger, we have also included other discoveries made all over Europe.

For example, out of 1,184 beach clean-ups carried out during the 2015 Ocean Initiatives event, 519 categorisation sheets were filled out. Out of these, 117 showed that biomedia were present – in other words at 23% of the beaches cleaned where a count was conducted.

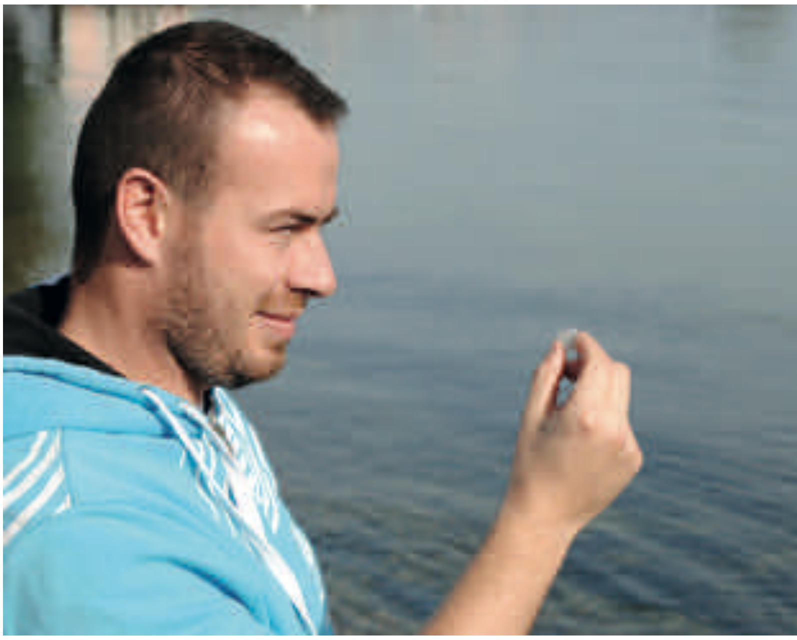
Over 87% of the biomedia reported by the beach cleanup organisers were found on the beaches of the Bay of Biscay and Spanish coasts, while 10% were found in the western Mediterranean.

It is in fact in the western Mediterranean that biomedia models 14 and 15 *(see Annex II)* have been found in their greatest numbers (48%). These are the same models as those used in two water treatment plants known to have experienced incidents in 2012, and which discharged into Lake Geneva and a tributary of the Rhône *(see section 8.2.3)*.

7.1.3. KEEPERS OF THE COAST

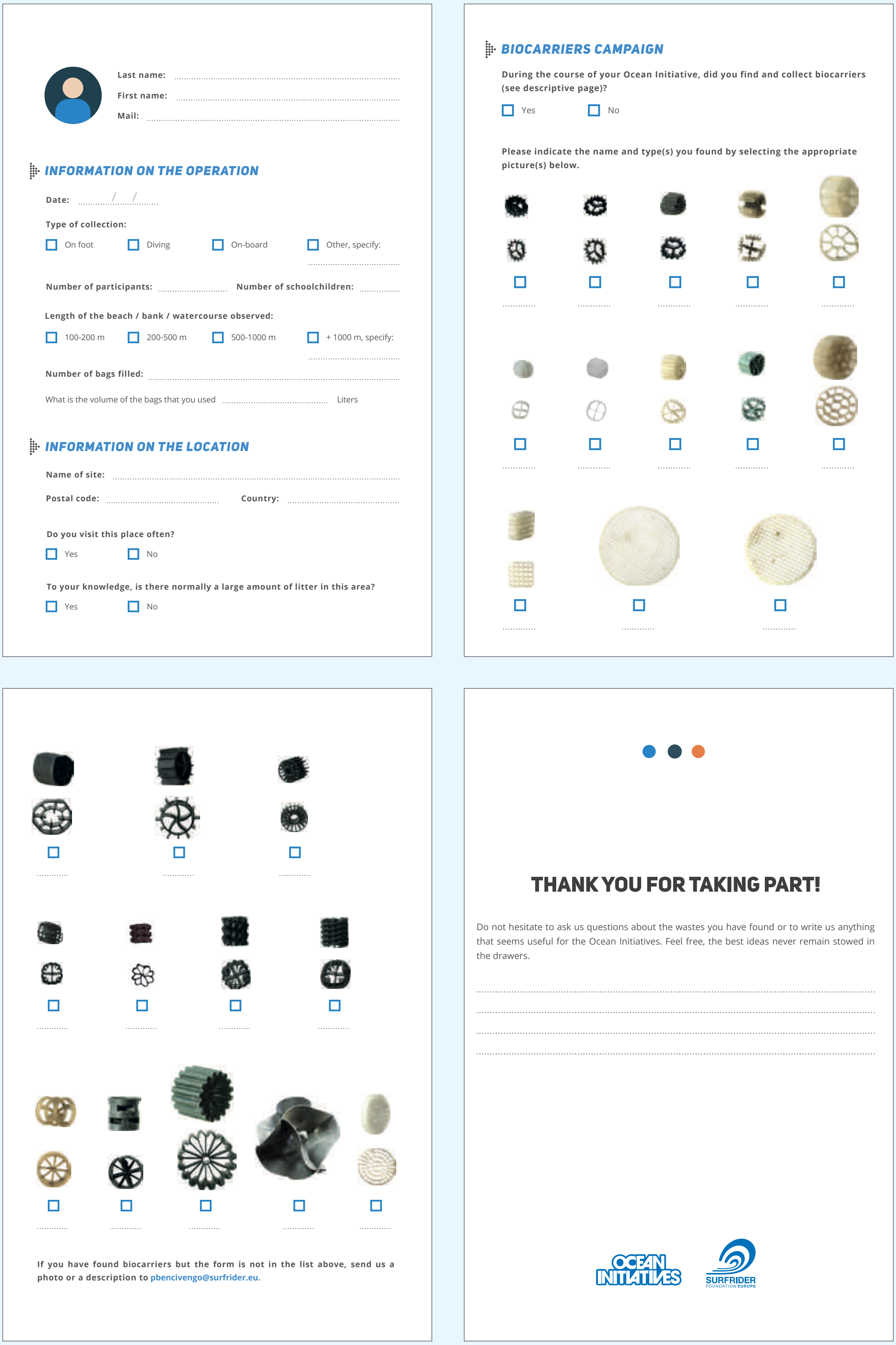
The aim of the Keepers of the coast programme run by Surfrider Foundation Europe is to combat all the threats facing our coasts (water pollution, artificialisation, waste, etc.). These committed environmental guardians – supported by the Surfrider teams – investigate the environmental impacts and threats in their regions. Working in the field, they carry out activities jointly agreed with Surfrider in order to achieve their goals. Volunteers or simply individuals who love their local coastline and the sea, they work in the interests of all to protect the marine environment and the many ways in which we use the sea.

The association's volunteers are made official Keepers of the coast[24] to protect the environment from biomedia pollution. Using a dedicated section on the Keepers of the coast website they have contributed a great deal of information to our research by investigating biomedia losses in their regions. The Keeper of the coast in Switzerland, for example, have helped us to better understand the source of the pollution incidents recorded in Lake Geneva. *(See section 8.2.3)*.



Above: Volunteer working in the battle against biomedia pollution in the Lake Geneva area

[24] www.keepersofthecoast.com



Last name: ....

First name: ....

Mail: ....

INFORMATION ON THE OPERATION

Date: ...../...../.....

Type of collection:

☐ On foot ☐ Diving ☐ On-board ☐ Other, specify: ....

Number of participants: .... Number of schoolchildren: ....

Length of the beach / bank / watercourse observed:

☐ 100-200 m ☐ 200-500 m ☐ 500-1000 m ☐ + 1000 m, specify: ....

Number of bags filled: ....

What is the volume of the bags that you used .... Liters

INFORMATION ON THE LOCATION

Name of site: ....

Postal code: .... Country: ....

Do you visit this place often?

☐ Yes ☐ No

To your knowledge, is there normally a large amount of litter in this area?

☐ Yes ☐ No

BIOCARRIERS CAMPAIGN

During the course of your Ocean Initiative, did you find and collect biocarriers (see descriptive page)?

☐ Yes ☐ No

Please indicate the name and type(s) you found by selecting the appropriate picture(s) below.

If you have found biocarriers but the form is not in the list above, send us a photo or a description to pbencivengo@surfrider.eu.

THANK YOU FOR TAKING PART!

Do not hesitate to ask us questions about the wastes you have found or to write us anything that seems useful for the Ocean Initiatives. Feel free, the best ideas never remain stowed in the drawers.

OCEAN INITIATIVES

SURFRIDER FOUNDATION EUROPE

Figure 11 : Biomedia classification sheets provided by Surfrider Foundation Europe as part of the «Ocean Initiatives» programme © Surfrider Foundation Europe

7.1.4. RIVERINE INPUT

The aim of Surfrider's Riverine Input project is to categorise and measure the waste and microplastics transported by rivers. This is done by monitoring, evaluating and describing the pollution in a river basin, and therefore what is flowing out of these water courses into the sea. The pilot project focused on the river Adour, and part of the project involved monitoring the biomedia washing up each month at eight clean-up points along the Adour river basin and the beach at the mouth of the river. The project began in March 2014. No biomedia were found on the banks of the Adour upstream from the tidal limit (around Dax). However, the downstream areas were significantly affected by biomedia pollution.

7.1.5. SCIENTIFIC QUANTIFICATION PROTOCOL

A better understanding of the issue is necessary in order to combat the increasing waste in the aquatic environment.

By monitoring waste on beaches using scientific measuring protocols (OSPAR protocol or harmonised European guidance on monitoring of marine litter) it is possible to identify and measure the waste found and also to work out the human activities at its source.

Identifying waste makes it easier to work out the sources and vectors by which the waste has entered the marine environment (for example waste discarded directly into the environment from the fishing industry or flushed down toilets, such as cotton buds).

These protocols enable us to gather qualitative and quantitative data about the waste found along the coasts, and therefore to establish trends relating to its concentration.

Surfrider started to use the OSPAR protocol in 2012 in order to support convention stakeholders, helping to build up a better databank of shared information, better understand the nature of the waste found and gain the most possible use from our activities. Five beaches are monitored thanks to OSPAR protocol in France and Spain.

The waste is quantified and identified using a master list[25] (of more than 120 items subdivided according to the materials they are made from and their uses). The master list is updatable – if a type of waste is regularly found on a beach that is not listed on the data sheet, this can be included in later versions once approved by the relevant authorities. This system makes it possible to include new types of waste found on beaches (for example, biomedia were included on the OSPAR protocol and European protocol master sheet thanks to the identification and quantification work done by Surfrider volunteers).

With biomedia now included on the master list, we now have the opportunity to monitor the development of specific biomedia pollution incidents.

Opposite: Categorising waste according to the OSPAR protocol
© Floriant Ledoux

[25] The master list is the list of waste items most frequently found on beaches. This list was developed on the basis of observations from a data gathering campaign.

7.2. EXTERNAL MONITORING

Aside from the biomedia observations by Surfrider Foundation Europe, there have also been many other reports by marine experts, people practising water sports and beachcombers or walkers who have learned about this issue through the media or information sheets (which can be found on the Surfrider website translated into several languages).

Many local environmental organisations throughout France and Europe have also been involved in monitoring biomedia.

Each of these organisations has been asked to work with Surfrider in order to put together a wider and unified database providing a global overview of these pollution incidents.

These new sources of observations have enabled us to simultaneously monitor the evolution of pollution incidents along rivers and right down to the coasts, identifying different pollution events in the natural environment.

7.2.1. SOS MAL DE SEINE

SOS Mal de Seine[25] has been conducting cleanups along the banks of the river Seine since 2008, using the OSPAR categorisation protocol, which includes biomedia. The group monitored pollution all along the river and right out to the Normandy beaches after thousands of biomedia were lost into the Seine from the Corbeil Essonnes-Evry WWTP in 2010 *(see section 8.1.1)*. The group's expertise and longstanding presence in the region makes SOS Mal de Seine a great source of information about spills of biomedia into the Seine-Normandy basin, from the Paris region right down to the Channel coast.

Above: Biomedia found along the banks of the Seine © SOS Mal de Seine

7.2.2. OBSERVERS IN THE MEDITERRANEAN

We also receive observations from other environmental and sports bodies, as well as marine and natural protection organisations, including:

- The Port-Cros National Park[26],
- The C.E.S.T.Med[27] (Centre for Research and Conservation of Mediterranean Sea Turtles) in Grau-du-Roi,
- The Environment and Biology Committee of the Interregional Pyrenees-Mediterranean Committee of the French Federation of Underwater Studies and Sports[28],
- The U Marinu[29] CPIE Bastia Golo Méditerranée Association in Bastia.

7.2.3. AUTHORISED FISHING ASSOCIATIONS

One of the responsibilities of the Associations Approved for Fishing and Protection of the Aquatic

[25] www.maldeseine.free.fr
[26] www.portcrosparcnational.fr
[27] www.cestmed.org
[28] www.ffessmpm.fr/la-federation/comite.htm
[29] www.umarinu.com

Environment (AAPPMA) is to manage riverbanks and watercourses used for fishing. Their members are fishermen with an intimate knowledge of their local environment who spend a lot of time on the ground. They have also contributed to our observations. Locally, the AAPPMA on the River Nive based in Saint-Jean-Pied-de-Port has been able to monitor pollution in the Nive *(see section 8.1.3*).

7.2.4. ASSOCIATIONS OF THE RIO MIÑO

Various associations (the association of rio Miño fishermen[30] and the ADEGA[31] environmental protection association) have alerted us to the presence of biomedia along the banks of the Rio Miño, the river bordering Spain (Galicia) and Portugal *(see section 8.2.2).* They have helped us in our investigations to pinpoint the sources of this pollution. Meanwhile the conservation organisation ANABAM[31] (Asociacion NAturalista del BAixo Miño) has conducted regular monitoring of this pollution event along the river and its impact on beaches. They have done a great job in their region, mobilising the media and local authorities in an attempt to identify the wastewater treatment plant that spilled the biomedia into the river.

7.2.5. WASTE FREE WATERS

Mosa Pura, which is now known as the Waste Free Waters Foundation[32], is an organisation headed by a former Dutch research professor who led a waste quantification programme in 2012 focusing on the river Meuse and specifically the Dutch stretch of the river.

Above: Small fishing boat © Nick Karvounis

[30] (Asociación de pescadores del río Miño Tomiño, Pontevedra)
[31] http://adega.gal/portada.php
[31] www.anabam.org
[32] https://wastefreewaters.wordpress.com

7.2. MAPPING OUR FINDINGS

Each year we produce a map of findings based on the information received through the Ocean Initiatives and one-off reports. While we cannot produce an exhaustive map using this data, it does give us a good idea of the extent of this type of pollution.

These observations have allowed us to show that this pollution is not just limited to the coast of Aquitaine, because over the years new findings have been reported along the Mediterranean coasts in France, Spain, Italy, Morocco and Algeria, as well as on the coasts of the Channel.

However, from the particularly large number of reports in the Bay of Biscay it seems that these coasts are especially affected by this type of pollution.

Biomedia have also been reported on the beaches of the Netherlands, the Canary Islands, the United States, in Canada, Guadeloupe and also on the banks of Lake Geneva, showing that these pollution incidents are numerous and have land-based sources. The dispersal of biomedia in the oceans is today a worldwide problem.

The quantification work carried out in 2010, 2011 and 2012 along all of the French coasts by the organisation SOS Mal de Seine for Ifremer (the French Research Institute for Exploitation of the Sea) confirmed Surfrider Foundation Europe's observations year after year.

Above: Biomedia on the banks of the Seine (92)
© SOSMaldeSeine

Figure 12 : Dispersal of biomedia lost in pollution incidents reported in 2010
© Surfrider Foundation Europe

The red dots indicate reports of biomedia, while the green dots show the sites of known pollution incidents.

Three major sources of pollution have been identified: a municipal wastewater treatment plant on the Seine in Paris and two companies on the banks of the river Oria in the Basque Country. It has not yet been possible to identify the source of the pollution event on the Miño, a river running between northern Portugal and Spain.

08
BIOMEDIA POLLUTION INCIDENTS

Numerous biomedia pollution incidents have been reported since 2007 along large stretches of European rivers and coasts. Follow-up investigations have been conducted at some of the sites suffering the most serious impacts, with a view to establishing the source of the discharge. The list below is not exhaustive but covers a large area.

8.1. FRANCE

8.1.1. CORBEIL-ESSONNES

This pollution event marked a key turning point in our investigation, as this was the first time it was possible to directly link biomedia found on beaches to their use in a WWTP.

General information:

REGION: Ile de France/Essonne (91)
TOWN: Corbeil-Essonnes
PLANT: Municipal WWTP opened in the 1960s, upgraded between 2007 and 2011 by Vinci Environment / SOGEA construction
OPERATOR: SIARCE (Syndicat Intercommunal d'Aménagement, de Réseaux et de Cours d'Eau)
PROCESS TYPE: R3F (Vinci) with Biochips and K1
QUANTITY OF BIOMEDIA IN USE: 3 000 m^3
NOMINAL CAPACITY: 96 000 PE - 15 000 m^3/day
ECEIVING WATER FOR EFFLUENT: Seine

Biomedia found: type Kaldnes K1 - Vinci

Account of the incident:

This incident happened when the WWTP was being recommissioned following the upgrade works, over the night of 11/12 February 2010. The biomedia clogged up the mesh through which the water was supposed to move into the next tank. Heavy rain then caused the basin to overflow over a period of several hours. In total around 800 m^3 of biomedia and 4,000 to 6,000 m^3 of wastewater were released straight into the river. The biomedia were soon appearing in their thousands on the banks of the Seine, with large numbers washing up around the WWTP and downstream. This accident meant the plant had to be closed down from 12 to 20 February 2010 *(see annex V)*.

Actions undertaken:

The pollution warning system was not implemented by staff at the WWTP, who kept the problem quiet until an article was published in the *Le Parisien* newspaper on 25 February 2010[33]. No remedial work of any kind was undertaken on the Seine, which led to the pollution

Left: Biomedia found on the banks of the Seine at the Poses tidal barrage in June 2010 © Laurent Colasse

spreading all along the banks of the river and right down to the sea.

Results:

By one month later, at the end of April 2010, the biomedia were found for the first time in the Boucles de la Seine Normande regional park on the coast near Honfleur.

A year later the biomedia could still be found at a rate of between 5 to 10 per linear metre along the beaches of Calais and Sangatte (62), over 200 km from the Seine estuary.

In 2017 at least 10 of this type of biomedia could be found every 100 metres of coastline throughout the whole of the Boucles de la Seine Normande regional park.

A criminal case was brought to the courts following the Corbeil-Essonne accident. The high court at Evry absolved the defendants (the intercommunal wastewater treatment syndicate, the company Vinci Environnement, and the Essonne water company) of any liability for polluting the water.

Above: Biomedia on the Butin beach in Honfleur, downstream from the Pont de Normandie bridge. © Laurent Colasse

8.1.2. MEDITERRANEAN COAST

Informations générales :

REGION: PACA / Languedoc – Roussillon
TOWNS: Cassis to Six-Fours-les-Plages, Marseille, La Ciotat, Porquerolles, Giens, Frontignan, Le Grau du Roi, Port Leucate, Ramatuelle, Villefranche sur Mer, Palavas, Canet en Roussillon, Le Pradet, Valras...

Background:

Biomedia have been found washing up on the shores of the Mediterranean since 2011. The numbers found have grown over time, and the models have become more diverse, making it seem likely that there have been escapes from various plants in France and certainly from other countries around the Mediterranean basin.

Biomedia found: Hel-X, KNS, K1, K3, K5, Biochip

In 2012, a biomedia was removed from the intestines of a dead marine turtle autopsied by C.E.S.T.Med (Centre for Research and Conservation of Mediterranean Sea Turtles). Since February 2014, the Marseille region has been experiencing a new wave of biomedia pollution,

[33] http://tinyurl.com/ydbhafgt

with K5 models by AnoxKaldnes™ being found daily in large numbers by Surfrider volunteers around Marseille and the Var river.

Likely source:

None of the wastewater plants in the region have officially acknowledged any losses into the environment.

A local specialist thinks that some of this marine debris has arrived from Italy, carried by the complex surface currents of the Mediterranean basin.

Top : K3 model biomedia washed up on the banks of the river Nive upstream from Saint-Jean-Pied-de-Port (64)
Above: biochips collected from the Var.

8.1.3. NIVE D'ARNÉGUY

eneral information:

REGION: Aquitaine, Pyrénées Atlantiques
TOWNS: Arnéguy and downstream areas

Biomedia found: Kaldnes K3

Account of the incident:

A biomedia spill took place in the autumn of 2012, with huge numbers washing up on the river banks. However, field inspections were not able to pinpoint any source.

Actions undertaken:

Despite our reports and the involvement of other local associations, no measures were implemented.

Results:

In the autumn of 2012, the beach at La Barre and subsequently beaches around Anglet and the southern Landes region were covered in K3 type biomedia. Associations of fishermen based along the Nive had also been reporting the same finds since the end of the summer. The furthest upstream point at which they were found was at Nive d'Arnéguy, within the town of Arnéguy. K3 biomedia are still found along the Aquitaine coast, illustrating the scale of this pollution event five years after the presumed spill.

8.2. ELSEWHERE IN EUROPE

8.2.1. ORIA (SPAIN)

General information:

REGION: Basque Country / Guipuzcoa
RECEIVING WATER: Oria river
PLANTS: 2 industrial WWTPs located at 2 companies close to the river: Oria paper mill (Villabona) and Amaroz paper mill (Tolosa until autumn 2009, when it moved to Legorreta).
PROCESS USED: MBBR by DAS USA / ATM SA[34]

Biomedia found: AMB and KNS

Account of the incident:

The company that installed the wastewater treatment system admitted there had been issues at two of its clients' sites. The pollution events observed were probably the result of two separate incidents *(see annex VI)*:
- in the winter of 2009/2010: a spill of millions of biomedia caused by a reactor overflowing.
- In November 2009 : an accident while a plant was being decommissioned as part of the work to relocate the company facilities.

Actions undertaken:

No remedial steps were taken, despite local outcry. The Amaroz paper mill also filed for bankruptcy, making it impossible to take any action against it.

Results:

During the winter of 2010, tens of thousands of AMB type biomedia washed up along the banks of the Oria river, on beaches in the Basque Country and then in Les Landes in France, before spreading out to cover the whole of France's Atlantic coast and the Cantabrian coast in Spain.

The biomedia from these two pollution events can still be found washed up on beaches along the whole Atlantic coast in 2017. As far as we know this event was the most serious to occur to date, both in terms of its long-lasting impact and the number of biomedia found along the French coast.

Above: AMB type biomedia found along all the Atlantic coast beaches in Spain and France

[34] www.dasusa.com/industrial_wastewater.htm

Above: K1 type biomedia found by fishermen along the Miño river

8.2.2. MIÑO RIVER (SPAIN/ PORTUGAL BORDER)

General information:

REGION: Galicia / Pontevedra
RECEIVING WATER: Miño or Minho river

Biomedia found: type Kaldnes K1

Account of the incident:

In February 2010, eel fishermen working in Galicia found themselves pulling up large numbers of biomedia in their nets in the Miño river on the border between Spain and Portugal. Investigations undertaken by the local environmental police (SEPRONA), supported by Surfrider, did not lead to any source being identified.

Between April and July 2013, a conservation association *(ANABAM, see section 7.2.4)* found large quantities of biomedia along beaches close to the mouth of the Miño river. These were the same model of biomedia as those found in 2010. However, their sudden arrival.

in large numbers makes it seem likely there was a new incident sometime in the summer of 2013, as reported in the local newspaper La Voz de Galicia[35]. In January 2014, the same plastic pieces could be found in their hundreds per square metre in the towns of A Guarda, A Pasaxe, Caminha, Goian and as far away as Tui.

[35] http://tinyurl.com/ycxsouop

8.2.3. NEMIÑA BEACH, MOUTH OF THE CASTRO RIVER (SPAIN)

General information:

REGION: Galicia, province of A Coruña

AFFECTED WATERS: the mouth of the Castro river, spill appears to have been into the sea.

PLANTS:

- Several municipal WWTPs discharge their effluent into the river. However, no biomedia were found upstream of the river mouth.
- A large fish farm (trout) is located at the mouth of the river, with some discharges being made directly into the sea.

BIOMEDIA FOUND: K1

Account of the incident:

In mid-November 2017, volunteers reported large numbers of biomedia on the beach at Nemiña in the town of Muxia in Galicia (Spain). On 16 and 17 November 2017, they collected over 900 biomedia all of the same kind (K1), as well as a few samples of a different model. In the following weeks around 150 to 200 biomedia were collected from the same beach. On 4 January 2018, 288 biomedia were found in a 50-metre transect, with some 698 biomedia counted along the whole beach.

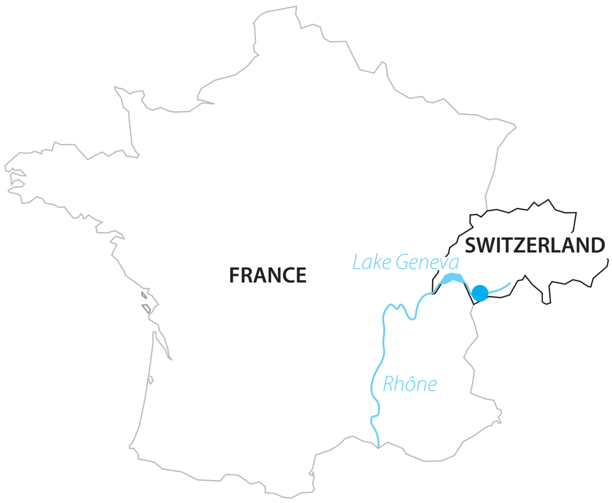
The absence of biomedia further upstream, and the presence of these plastic pieces in such large quantities on the beach nearest to the river's mouth, make it seem likely that a major spill happened at a facility in the immediate vicinity of the beach. The absence of biomedia on neighbouring beaches could be explained by the specific currents in the area and the orientation of the beach. The biomedia found look new (they have not undergone any alteration due to lenghty presence in the marine environment) which makes this seem like a recent spill.

Actions undertaken:

Local volunteers alerted the Muxia town hall, the police and the media. So far, this action has not resulted in any response from the local authority, and the police and press have not shown much interest either. Surfrider Foundation Europe is currently conducting investigations to find out if the companies located in the immediate proximity are using a wastewater treatment process, or if a local WWTP has experienced any incidents.

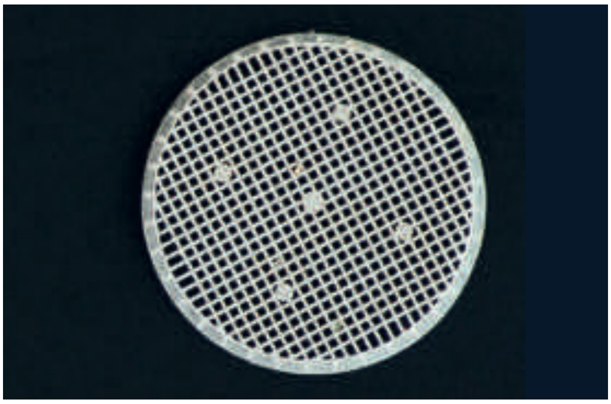
Above: Biomedia collected on the beach at Nemiña.
Opposite (top): The mouth of the Castro river, the beach at Nemiña, and the fish farm seen at the rear. © Turismo Galicia

Opposite (below): Biomedia collected on the beach at Nemiña



8.2.4. SWITZERLAND

Several pollution events hit Lake Geneva in 2012. Surfrider volunteers gathered a large amount of information about the causes and impacts of these incidents, as well as pinpointing three different sources *(see annex IV).*



8.2.4.1. Saillon

General information:

CANTON: Valais
TOWN: Saillon
PLANT: Municipal WWTP set up in 1982 and upgraded in 2007
INSTALLING COMPANY: Techfina / Alpha Umwelttechnik (subsidiary of Veolia Water).
PROCESS : MBBR – Veolia
NOMINAL CAPACITY: 6,000 PE – 1,200 m^3/day
REJET DES EAUX TRAITÉES : Salentse (a tributary of the Rhône)

Biomedia found: Biochips (Veolia Water)

Account of the incident:

In January 2012, following a planned reduction in the airflow used to keep the biomedia circulating, the outflow mesh became blocked, causing 3 to 5m^3 of biomedia to overflow.

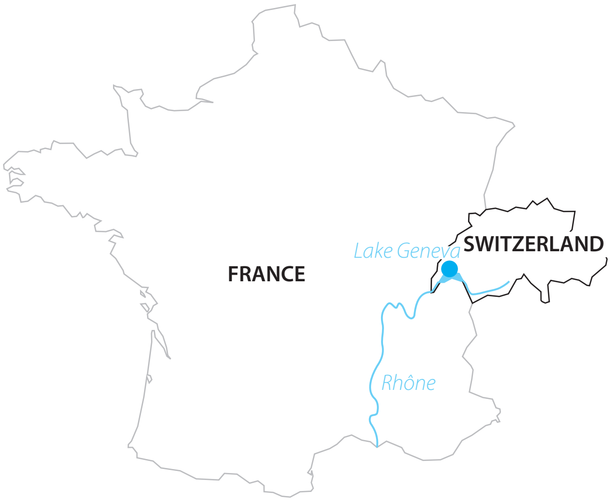
Actions undertaken:

- Re-establishment of the aeration parameters set out in the WWTP usage manual.
- Specific aeration systems put in place around the outflow grilles of the bioreactors to prevent blockages.
- A sensor and a permanent warning system put in place to regulate the amount of water arriving upstream of the reactor, in case of heavy water flow.

Results:

The plant has undertaken a wholesale upgrade.

Above: Bioreactor at the WWTP in Saillon (Switzerland)
© Surfrider Léman



8.2.4.2. Saint Prex

Informations générales :

CANTON: Vaud
TOWN: Saint Prex
PLANT: Joint municipal plant of Saint-Prex, Etoy and Buchillon. Started to operate in 1977 and equipped with biomedia since April 2012
INSTALLING COMPANY: Techfina
NOMINAL CAPACITY: 16,000 PE
RECEIVING WATER: Lake Geneva

Biomedia found:

BWT 15 model by Biowater Technology (JS Umwelttechnik)

Account of the incident:

The amount of water entering the plant increased dramatically following a violent storm on 17/18 September 2012. Manual attempts to use an overflow channel to reduce the influent flow caused a wave in the settlement tank.

This resulted in the biomedia being pushed towards the water exit mesh, which became blocked, leading to the basin overflowing.

A second failure occurred around the oxygen sensors in the aeration basin. The aerated storm water disrupted the sensors, which then sent a signal for the air supply in the tank to be reduced, which exacerbated the blockage. A subsequent investigation by a volunteer also showed that neither the plant's management nor the local authority followed the cantonal alert procedure.

Actions undertaken:

No steps were taken to contain the pollution during the storm event.

However, technical modifications have subsequently been made to the basins:
- modification of the diversion channel, which today responds automatically to changes in the influent flow at the WWTP.
- Water level sensors have been put in place, making it possible to detect different water levels and reduce the incoming flow. This system allows the diffusers to be overridden to increase air input and prevent the meshes from becoming blocked.

Above: Biomedia found on the banks of Lake Geneva in Saint-Prex © Frank Odenthal

- Installation of perforated stainless steel tubes welded horizontally to the outflow mesh, enabling water to continue to pass through even in the event of blockages.

Both the company that installed the system and the supplier of the biomedia have reacted following this pollution incident, now having precautions in their protocols in order to prevent any further incidents at the WWTP.

In December 2013, over a year after the incident, the town council of Saint-Prex reported on the technical improvements put in place following the spill to prevent any further problems of this kind. *(see Annex IV)*.

Results:

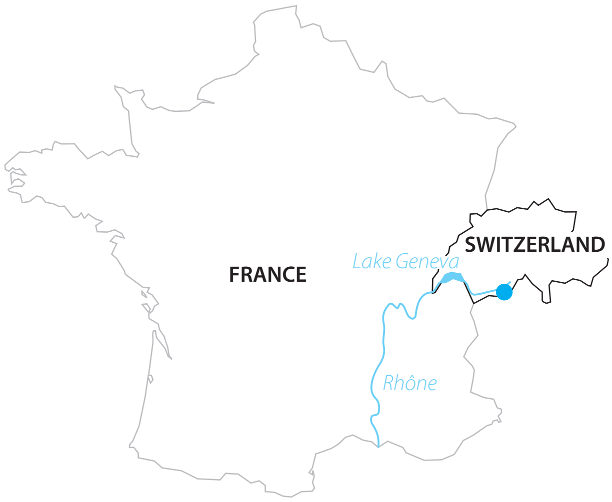
Thousands of biomedia were collected from all around the banks of Lake Geneva.

Although they are less common today, the biomedia still continue to wash up all around the lake, demonstrating the significant environmental impact of this kind of pollution.

The same biomedia, so characteristic of the pollution event in Lake Geneva, have also been found during *Ocean initiatives* clean-up events on the coasts of the Mediterranean, showing once again just how far this pollution can spread, and the key role that the river system plays in dispersing biomedia.

After being judged by local authorities to be underperforming, the WWTPs in the canton of Vaud are now undergoing a regionalisation process, which will regroup wastewater treatment so that the wastewater from several towns can be treated by a smaller number of new, more modern and effective WWTPs.

Above: Biomedia at the outflow of the WWTP in Evolène
© Frank Odenthal



8.2.4.3. Evolène (Suisse)

Informations générales :

CANTON: Valais
TOWN: Evolène
PLANT: Municipal WWTP that started operations in December 2010
INSTALLING COMPANY: Techfina/Alpha Umwelttechnik (Véolia Eau)
PROCESS: MBBR by Véolia Eau
TREATMENT CAPACITY: : 6,000 PE – 1,800 m^3/day
RECEIVING WATER:
Le Borgne (tributary of the Rhône)

Biomedia found: Biochip type

Account of the incident:

The influx of massive amounts of oxygenated storm water on 29 March 2012 led to an increase in the hydraulic load in the reactor holding the biomedia. This led to reduced activity of the air diffusers, which reduced the agitation of the biomedia, causing the reactor's retaining mesh to become blocked. The increase in the water level caused around 3 to 5m^3 of biomedia to overflow through an adjoining channel.

Actions undertaken:

No specific measures have been put in place to date, other than the regular beach cleaning carried out by local communities.

Results:

The biomedia released in this spill continue to wash up on the shores of Lake Geneva.

8.2.5. OTHER OBSERVATIONS

Other observations have shown biomedia pollution hotspots all over Europe, although the sources of these events have still not been identified.

Varying amounts of biomedia (ranging from the tens to several hundred) have been observed in the following locations on either a one-off or recurring basis:

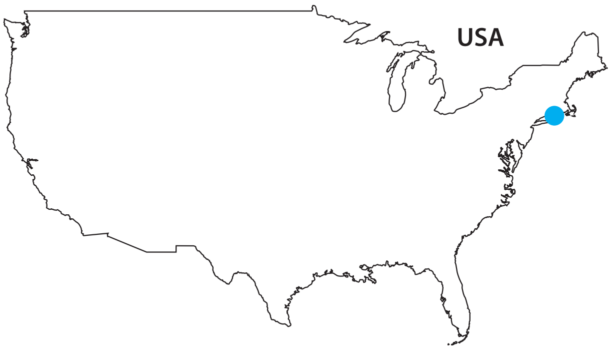
- Cornwall (United Kingdom) since January 2014
- Charlottenlund (Denmark) in November 2014
- On the island of Jersey in November 2016
- Bodri beach in Corsica, February 2017
- Zandvoort (Bloemendaal beach) in the Netherlands, July 2016
- San Remo, Italy, in April 2014
- Valencia, Spain in September 2014

Below: K5 biomedia in Charlottenlund, Denmark
© www.plasticchange.org

8.3. NORTH AMERICA

This problem has also affected vast areas of coast on the other side of the Atlantic. Local counties have provided numerous accounts of this type of pollution and how these events have been managed in America.

8.3.1. GROTON (USA)



General information:

STATE: Connecticut
TOWN: Groton
INSTALLING COMPANY: Degrémont
PLANT: Municipal WWTP that began operating in 2008
TREATMENT CAPACITY: 19,000 m^3/day
PROCESS: IFAS
RECEIVING WATER: Thames River

Biomedia found: Modèle K3

Account of the incident:

On 30 March 2010, the region around Groton was hit by torrential rain. The flood of water entering the wastewater treatment plant led to it becoming saturated, and a metal panel supposed to retain the biomedia rupturing.

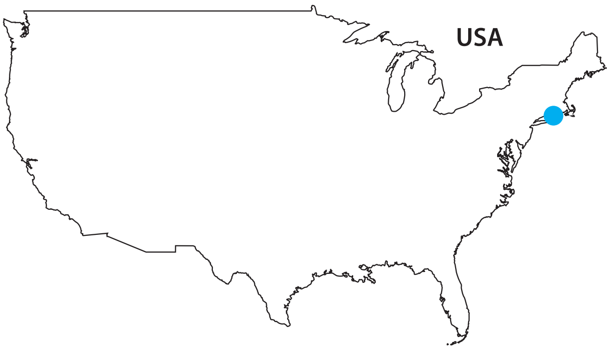
Results:

Around one million biomedia ended up in the environment, carried by the river and sea currents to end up on neighbouring shores and up to 50 kilometres away, on the beaches of Long Island.

Actions undertaken:

This pollution event happened just a few weeks prior to a global beach clean event. Groton's director of public works relied on this action to resolve the problem.

8.3.2. HOOKSETT (USA)



General information:

STATE: New Hampshire
TOWN: Hooksett
PLANT: WWTP that began operating in November 2010
INSTALLING COMPANY: Krueger (Veolia)
OPERATOR: Hooksett Sewer Commission
PROCESS: IFAS
TREATMENT CAPACITY:
2.2 million gallons per day (8,328 m^3/day)
RECEDIVING WATER: Merimack River

Biomedia found:

BioChip M model

Account of the incident:

On 6 March 2011, following heavy rain, 4 to 8 million BioChips spilled into the Merrimack river. Coastal areas in New Hampshire and Massachusetts were quickly impacted, and bathing waters were closed as a preventive measure. Around 19 towns were affected, but were not informed about the source of the pollution until five days later.

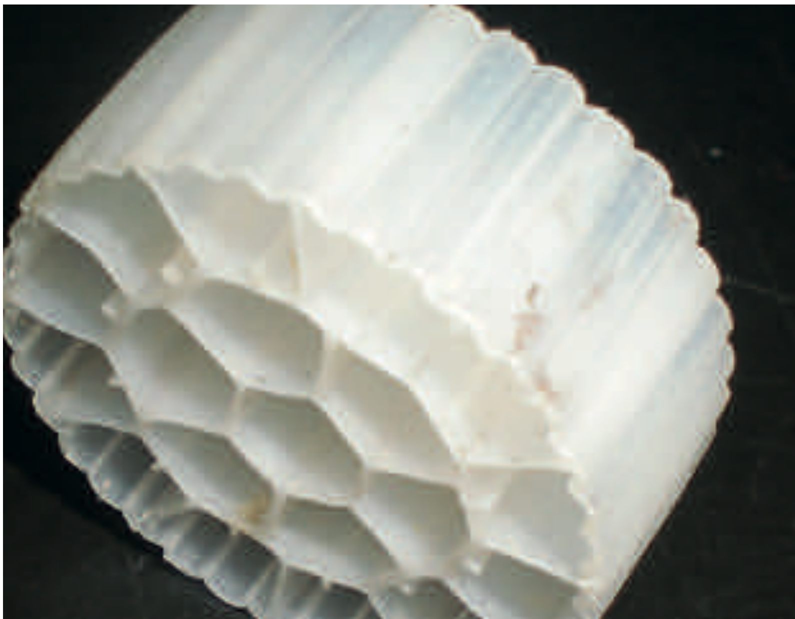
Actions undertaken :

Accidental spills of pollutants into the natural environment are classed as a crime in the state of New Hampshire. On 21 March 2011, the New Hampshire environmental services ordered the town of Hooksett to clean up the 'debris' within 10 days and to release a report detailing the clean-up within 30 days.
The town authorities therefore undertook the US$130,000 clean-up operations, with the work commissioned to Enpro Services.

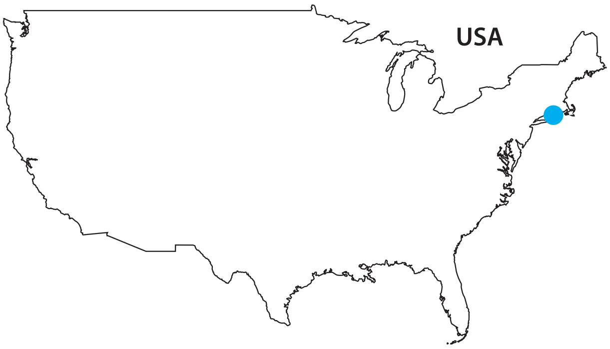
Results:

Over 85 coastal sites and 50 river sites were cleaned at a total cost estimated at US$1.5 to 2 million. This clean-up made it possible to limit the geographical spread of this pollution and its impact over time.

Below: Biochips collected along the banks of the Merrimack river
© Massachusetts Department of Environmental Protection



8.3.3. MAMARONECK (USA)



General information:

STATE: New York
TOWN: Mamaroneck
TREATMENT CAPACITY:: 78,000 m3/day
PROCESS: IFAS (Veolia)
RECEIVING WATER : Mamaroneck River

Biomedia found: K3 model

Account of the incident:

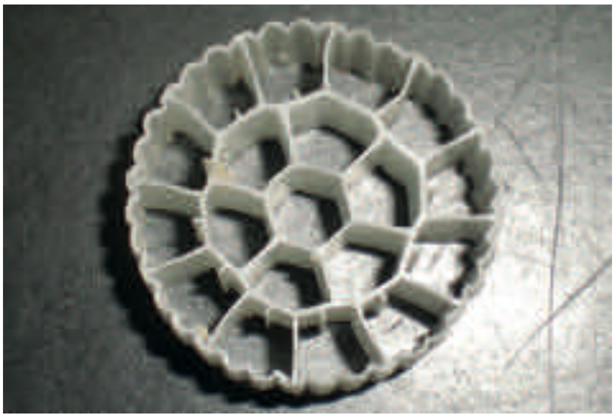
Biomedia losses occurred on three occasions in March 2011, while the IFAS process was being installed. The most significant of these losses happened in March 2011, when 400 m^3 of biomedia (i.e. several million discs), escaped from the newly-built Mamaroneck wastewater treatment plant following heavy rains. The measures in place to protect against such incidents were shown to be insufficient.

Actions undertaken:

Some 2 or 3 days after the pollution incident became apparent, operatives from the Mamaroneck county environmental department were charged with clearing up the biomedia until such time as they were no longer being found in large numbers. Work was carried out to adapt the retaining meshes on the tanks, which were the cause of the problem resulting in the spill.

Below: Biomedia found at Sunken Meadow Beach, a beach on the northern coast of Long Island near New York on 3 October 2011

8.3.4. TERREBONNE - MASCOUCHE (CANADA)



Les médias filtrants

Nous les récupérons

VIE MUNICIPALE

VOUS TROUVEZ DES MÉDIAS FILTRANTS?

De fortes pluies ont causé d'importantes inondations qui ont provoqué une perte de médias filtrants à l'extérieur des bassins de la Régie d'assainissement des eaux Terrebonne-Mascouche (RAETM).

Les médias filtrants sont des pièces de 2,4 cm de diamètre qui sont utilisées pour purifier les eaux usées de certaines stations d'épuration. Elles servent également sur les bateaux de croisière ou sont ajoutées aux bassins de traitement des eaux usées afin d'augmenter la capacité d'épuration dans un minimum d'espace. Les bactéries et les matières en suspension se fixent sur ces pièces de quelques millimètres, ce qui augmente la capacité d'épuration. Les médias filtrants ne présentent pas de risque pour la santé des humains. Toutefois, leur récupération est nécessaire afin de limiter les effets qu'ils pourraient avoir sur l'écosystème.

Vous trouvez des médias filtrants ?

La RAETM s'appuie donc sur la collaboration des municipalités riveraines du fleuve Saint-Laurent, des organismes environnementaux et des citoyens pour collecter les médias filtrants retrouvés.

Si vous en trouvez, acheminez-les à l'adresse suivante :

Régie d'assainissement des eaux
Terrebonne-Mascouche
3060, rue Saint-Charles
Terrebonne (Québec) J6V 1A1

Courriel : info@raetm.ca

Above: excerpts from municipal newsletters on the Madeleine Islands and the town of Saint Simon, asking the public to help collect the biomedia washed up and to send them to the public wastewater treatment company of Terrebonne Mascouche

General information:

PROVINCE: Québec
TOWNS: Terrebonne et Mascouche
OPERATOR: Terrebonne-Mascouche public water company
RECEIVING WATER:
Mille-Îles river, a tributary of the St Lawrence river

Biomedia found: K3 type

Account of the incident:

Significant quantities of biomedia were found on the beaches around the Gaspésie peninsula in the St Lawrence estuary on the Métis-sur-Mer coast in Canada in May 2011.

The biomedia were of various types, signifying multiple sources. The public wastewater treatment company of Terrebonne-Mascouche (near Montreal) acknowledged that it had lost around 100 m^3 of biomedia on 30 November 2010.

Actions undertaken:

A few months later, the Environment Ministry, having been made aware of the problem, requested the local authority to organise a clean-up, and install a mesh over the effluent outfall of its wastewater treatment plants in order to prevent any further spills.

Results:

The Environment Ministry is still investigating this case, with a view to a possible prosecution.

Further serious spills were noted in August 2015 in the Baie des Chaleurs in Gaspésie (Quebec). Quebec is a geographical area that is regularly frequented by marine mammals. The spread of these plastic items in the environment constitutes a major risk to some species, which could ingest these in large quantities, causing intestinal or respiratory obstructions, etc.

8.4. EVALUATION OF OBSERVED POLLUTION EVENTS

Out of the 14 major pollution incidents highlighted in the previous section, eight can be clearly linked to failures at wastewater treatment plants. All of the incidents at WWTPs leading to biomedia spilling out into the natural environment have been the result of heavy rainfall, which has caused blockages and even overflows, which have been difficult to manage.

The vagaries of weather and lack of awareness of the potential impact of possible biomedia spills are some of the greatest problems at wastewater treatment plants.

Out of the 10 major pollution incidents reported in Europe, none of these has resulted in any effective warning being issued by the wastewater treatment plant managers, which has in turn led to the biomedia spreading across huge distances in the environment.

These observations contrast strongly with the incidents in North America, where the environmental services have been much swifter to react, thanks to this type of pollution being legally regulated, forcing plant administrators to act quickly when incidents occur. This greater level of awareness of the problem has also led to legal cases being brought as well as clean-ups, in an attempt to reduce the environmental impact of these spills.

At a European level, regulations and management of such pollution events seem to be insufficient, as does understanding of how to manage sewage plants during storms. Meanwhile, works to commission biomedia reactors seem to be fairly rough and ready and undertaken without an appreciation of the risks.

Not a single pollution event in Europe has resulted in any effective warning being issued by wastewater treatment plant managers. This, in turn, has led to biomedia spreading across huge distances in the environment.

Above: Sign asking walkers to take care in case they find biomedia on the banks of the Merrimack river. © Massachusetts Department of Environmental Protection

Other kinds of biofilm carriers can also lead to plastic pollution events from wastewater treatment plants.

8.5. BIOBEADS

The biomedia mentioned in this report are not the only type of plastic used in the wastewater treatment process as bacterial biofilm carriers that can end up in the marine environment. Black plastic pellets called biobeads have been appearing for several years on beaches in Cornwall and further along the south coast in the United Kingdom, as well as on the French Channel coasts, in Belgium and the Netherlands. These biobeads are a type of nurdle (pre-production plastic pellets)[36]. They measure around 3.5mm to 4mm and are made from recycled polyethylene. Unlike normal nurdles, which are uniform in shape and smooth, biobeads are wrinkled or ridged. Most biobeads found on the beaches are black, but they can also be blue, white, grey, green or purple. Biobeads or BAFF (biological aerated flooded filter) media are used to filter wastewater at some tertiary treatment plants. Their wrinkled, ridged shape gives them a large surface area to be colonised by the bacteria. According to research by the Cornish Plastic Pollution Coalition[37], a group that has become an expert on this issue, 55 public wastewater treatment plants use biobeads and the BAFF system in the United Kingdom. Some 9 of the 600 treatment plants in the South West Water area (the region that has suffered the majority of biobead losses, and where these media are found in large amounts in the natural environment) use this system.

Above: Example of biobeads found on beaches.
© Claire Wallerstein

BAFF plants started to be introduced in the early 1990s, particularly being used in places where water treatment capacity had to be increased or where the area of sites was limited. Maintenance of this system has proved to be expensive and complicated.

Biobeads are used in huge numbers, packed together to a depth of 2.6m in reactors measuring 9.5 x 9.5m. The biobeads, themselves measuring 3.5 to 4mm, are retained inside the reactors by steel mesh sheets with 3mm holes. The Cornish Plastic Pollution Coalition estimates that each reactor contains around 5.4 billion of these plastic pellets – meaning that around 43.24 billion of them are used at a wastewater treatment plant such as the one in Plympton (Plymouth), which serves 85,000 people (and has 8 reactors).

Like other biomedia, these floating plastic pellets can also escape from wastewater treatment systems to pollute aquatic environments. Once at large in the environment and on beaches they are almost impossible to retrieve both because of their tiny size and the fact that they can blend in with natural sediment. Pollution incidents

36 Nurdles are small, lentil-sized industrial plastic pellets in the shape of balls, cylinders or discs. They are manufactured and used to make all our plastic objects. Billions of these are lost each year, ending up in watercourses and the marine environment, where they can be difficult to spot as they can look like natural grit in the sediment.

37 The Cornish Plastic Pollution Coalition is a network of over 30 environmental and beach-cleaning organisations and marine science experts working together to combat plastic pollution in Cornwall. This grouping represents the interests of several tens of thousands of people. www.facebook.com/yourshoreplastic

can involve significant quantities (several cubic metres) and travel large distances in the marine environment. Biobeads, like all other microplastics, have a serious environmental impact.

The Cornish Plastic Pollution Coalition has been recording these plastic pellets for several years in the United Kingdom. For example, in March 2017 several million biobeads were collected along a 100-metre stretch of beach at Tregantle (helped by use of a machine that can separate microplastics from the sand). Out of a sample of 587 nurdles collected on Chapel Porth beach in June 2017, 55% were found to be biobeads.

These biobeads have also been observed on a recurrent basis in France since 2010 by the NGO Robins des Bois. They have been found from the Cotentin Peninsula (Cherbourg) through the bay of the Seine, the bay of the Somme, and the Calais straits by the NGO SOS Mal de Seine, which has been commissioned by the French Ministry of Ecology to conduct an initial evaluation of marine pollution caused by nurdles and pellets. Biobeads have not been observed in the upstream areas of coastal rivers. However, they are found in high concentrations to the south of Boulogne-sur-mer (75 g of biobeads per litre of sand). Dr Jan van Franeker, an expert on the fulmar – a type of seabird that is heavily impacted by microplastics – has also found biobeads from Belgium up to the island of Texel in the Netherlands.

How do biobeads end up in aquatic environments?

Like other biomedia, biobeads can be found in aquatic environments following malfunctions at the WWTPs that use them, although this is not the only cause.

In 2010, South West Water experienced a major spill of biobeads (around 5 billion[38]) from the Newham treatment plant near Truro. This spill occurred when the steel mesh used to retain the biobeads within a reactor split, allowing the contents to escape. There was also another spill in 2009, following commissioning of the plant at Modbury.

Wessex Water, meanwhile, reported a malfunction at one of its plants leading to a spill of around 50 million pellets.

All the most serious incidents reported by the water companies have been linked to failures with the meshes designed to retain the biobeads within the system.

Aside from these major incidents, it also seems that biobeads can be lost into the environment on an ongoing basis, albeit in smaller quantities. South West Water says it has had to regularly top up the biobeads in the reactors at its WWTP in Plympton. The BAFF system there has been operating for 23 years, during which time there have been two top-ups replenishing the equivalent of 16% of the biobeads.

The water company had not tried to establish the cause for the loss of biobeads since the trade manuals provided by supplier FLI Water state that annual losses of up to 1% of biobeads may occur (although during normal operating conditions there should be no losses whatsoever).

The investigation also looked at whether there is any link between extreme weather events and losses of biobeads. The report authors also considered whether other causes could also lead to losses of biomedia, for example abrasion of the beads (which could allow them to slip through the holes in the retaining mesh) or losses to the sewage sludge that is then sold to famers to spread on the land (if biobeads clump together due to a heavy biomass load they could sink into the sludge).

Biobeads have also been lost to the environment due to

Above: Biobeads on a beach in Cornwall in 2015 following heavy rain. © Rob Wells

poor management practices on site, with unsatisfactory storage identified as one cause.

In April 2017, for example, vandals slashed open several dumpy sacks containing billions of biobeads at the Plympton site. The sacks were open and stored outdoors next to a river.

Tens of thousands of biobeads were found along the riverbanks near the site. Staff should be trained on how to handle biobeads on site (particularly during reactor maintenance and top-ups), to ensure that they are not spilled, to potentially be washed down storm drains and back into the environment. Best practice guidelines should also be communicated throughout the whole chain of production, transport etc.

The report authors have looked at other mechanisms by which the biobeads could have ended up on beaches. Aside from the incidents mentioned above, there are other possible sources, for example losses from container ships, other types of as-yet unidentified usage (e.g. aquarium trade, treatment of industrial effluents), spills from sites far away from the United Kingdom but washing up on its beaches at the mercy of the currents, or remobilisation of biobeads lost in a historic spill and buried under the sand following exceptional weather events.

The Cornish Plastic Pollution Coalition is now in discussions with the British water companies to prevent further losses of biobeads. One of the solutions proposed is to progressively replace the BAFF biobead system with larger biomedia.

It should be noted that another similar process has also been identified for treating wastewater, using balls of expanded polystyrene (EPS). This is called BIOSTYR™, and is a system designed by Veolia Water Technology. South West Water uses Biostyr™ in one of its largest WWTPs, while one of the largest British water companies, United Utilities, also uses this process in many WWTPs.

This is a cause for concern given the already great abundance of very light white spheres of expanded polystyrene (EPS) in aquatic environments.

[38] If 5 billion biobeads were to be placed end to end they would form a continuous line from Cornwall to New Zealand.

09

SYSTEM MALFUNCTIONS

The various pollution incidents compiled by Surfrider and described in the previous section underscore just how vulnerable these installations are to weather events. On top of this, there are very few measures in place to raise the alarm in the event of incidents relating to the use of biomedia.

Comparing the different incidents has enabled us to put together a list of the main kinds of malfunctions reported. This makes it easier to understand the causes of the problems, and as a result suggest recommendations that could help to fully prevent losses of biomedia into the environment.

9.1. CAUSE OF SYSTEM MALFUNCTIONS

On-site investigations and a study of the literature on this subject show that the main reason for losses of biomedia into the environment is due to overflows of the tanks in which they are held *(see annex I).*

In order to work out the possible causes of these overflows, it is important to take a look at how bioreactors are configured in order to focus on the possible critical spill points *(see figure 13)*.

Many bioreactors are not hermetically sealed. They have various influent and effluent channels to enable:

- Untreated water to enter the tank,
- Chemical agents to be added to the tank to treat the water,
- Treated water to leave the tank,
- Excess water to be removed from the reactor.

If things go wrong and the water level in the reactor rises, any of these channels can provide a means for biomedia to spill out into the environment. In addition, because the reactors are not always covered, overflows can even occur over the edges of the reactor itself.

9.2. DESCRIPTION OF OBSERVERD CASES

9.2.1. BLOCKAGE OF BIOREACTOR EFFLUENT MESH

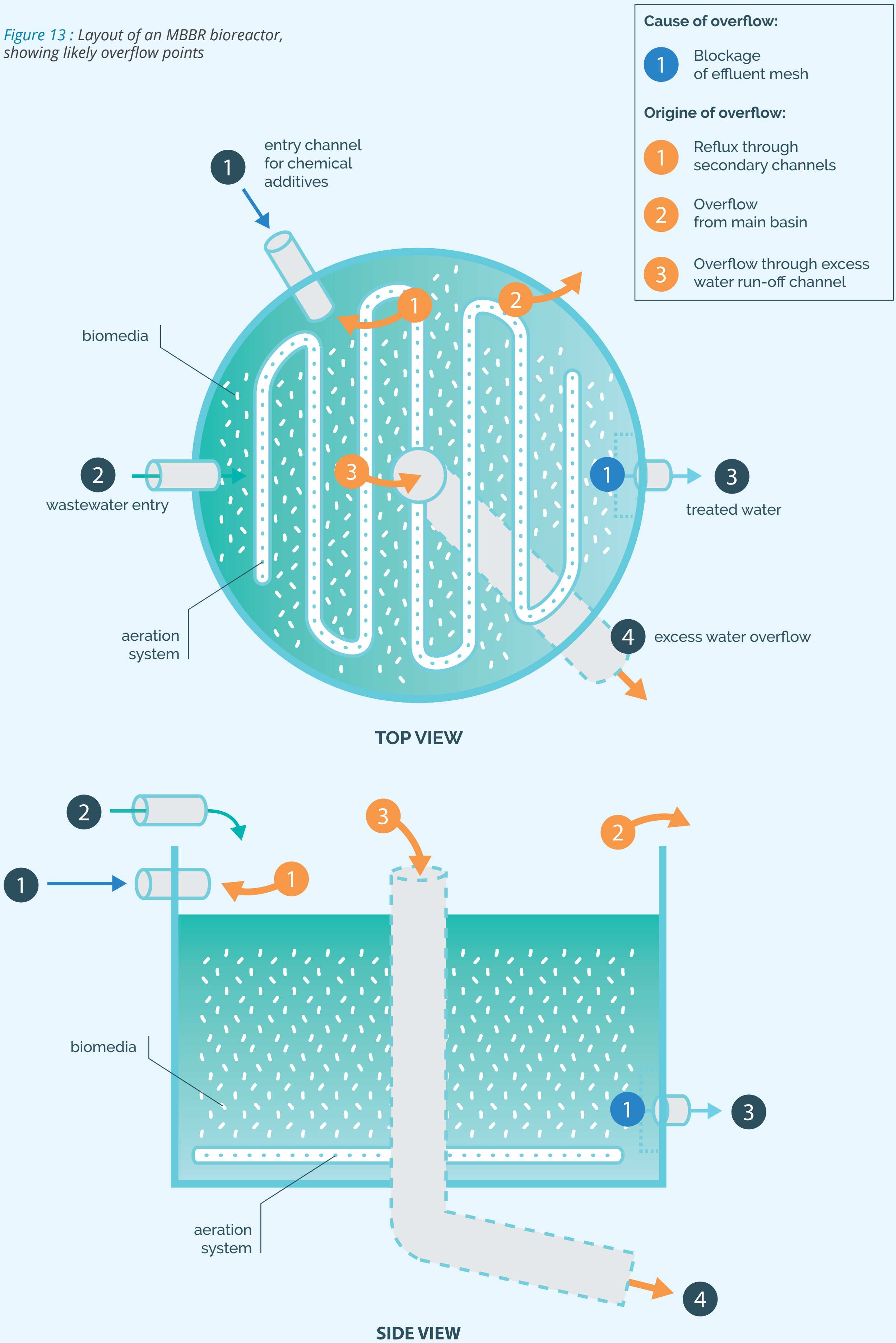
Effluent mesh becoming blocked is the number one cause of system malfunctions detected – and can have various causes.

Blockages are caused by the biomedia obstructing the grilles covering the tank's exit points. The flow of water leaving the tank carries the plastic biomedia with it, causing them to get stuck against the mesh.

This obstruction reduces the flow of water leaving the tank, creating a differential between the influent and effluent flow, and causing the water level in the tank to rise until it overflows.

In the incident in Evolène *(see section 8.2.3.3)* in Switzerland in 2012, the biomedia even passed through electrical ducts following the rise in water level, although this was an exceptional phenomenon that, luckily, has not been observed since.

Figure 13 : Layout of an MBBR bioreactor, showing likely overflow points



Above: Partially blocked mesh © D.R.

Various potential causes of blockages have been identified:

The wastewater treatment plant has not been adapted for use with biomedia:

Biomedia have been added to the reactors to boost their treatment capacity, but the flat effluent mesh has not been replaced by cylindrical mesh.

The biomedia are not being agitated:

Lack or failure of aeration systems, mixing rotors or flow inversion systems, all designed to keep the biomedia near the effluent mesh moving.

Poor process management strategy:

The plant manager decides to reduce biomedia agitation to a level below the manufacturer's guidelines in order to save energy. The biomedia do not move sufficiently[39] and end up blocking the effluent mesh.

Sensor malfunction:

The sensors in the reactor are used to test oxygen levels. When this level becomes too high, the sensors reduce the aeration levels and agitation of the biomedia. If this agitation becomes too weak, the meshes will be blocked. This can occur when storms result in large volumes of oxygen-rich water entering the system.

Selection of a biofilm carrier that is not suitable for the intended use:

Some case studies have shown that BioChip biomedia have a propensity to stick together and form clumps if they are not mixed with other models that allow them to detach from each other.

9.2.2. EXCESS AERATION

Excessive aeration levels in the basins due to poor system settings, human error or exceptional weather can cause the plastic biomedia to trap air bubbles in their cavities.

This dramatically decreases their density, so they float to the surface, and can potentially escape by overflowing the tank if the water level is high. This is likely to occur primarily in private, small-scale installations.

9.2.3. FAILURE OF SAFETY SYSTEMS

Sensors situated at different key points around the wastewater treatment system measure flows and open secondary channels in the event of any problem. However, faults with these can lead to overflows and loss of biomedia.

9.2.4. COMMISSIONING OF A NEW WASTEWATER TREATMENT PLANT

Problems can occur when a new wastewater treatment plant is commissioned. Theoretical calculations can be quite different from actual conditions on the ground or the reality of the completed project, and this can lead to losses *(see interview in Annex I-B)*.

Example: Mamaroneck *(see section. 8.3.3)*.

[39] See section 8.2.3 on pollution in Switzerland.

Above: Adding biomedia to a reactor © D.R.

9.2.5. LIMITATIONS OF THE COMBINED SEWER SYSTEM

In many localities, wastewater is still collected in a combined system. During periods of heavy rain wastewater treatment plants can receive excessive amounts of water, leading to overflows from the treatment tanks and losses of biomedia into the environment.

Example: Groton (Connecticut - USA) *(see section 8.3.1)*

9.2.6. POOR STORAGE OF BIOMEDIA

The way in which biomedia are stored can result in losses even before a biomedia process is put into operation at a plant.

Biomedia can be transported and delivered in open dumpy sacks of around 1 m^3.

Biomedia can spill from sacks during handling, and if these sacks are stored unprotected and in the open, this can also lead to spills or overflows during extreme weather events (rain and wind).

Example: river Oria *(see section 8.2.1)*

Above: utdoor storage in open containers and biomedia being lost into a public area © Surfrider Basque Coast

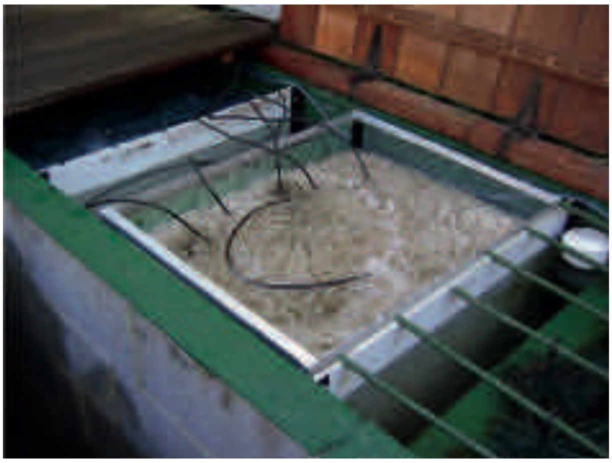
Biomedia losses are not generally caused by one single thing, but rather a combination of failures and/ or exceptional conditions

9.2.7. DIFFUSE POLLUTION

Some biomedia models can be found along river banks and coasts all year round in small quantities. These could be the remnants of major spills still turning up years later, such as those found on the Channel coasts after the Corbeil-Essonnes spill, but could also be from one-off small losses.

Micro water treatment plants installed by private individuals in order to treat water from their swimming pools or ornamental fish ponds, for example, are another potential source of pollution. These plants, sometimes installed without any expertise in the field, are completely unregulated and there is no guarantee that they will function correctly *(see annex 3)*.

Above: Uncovered bioreactors at Saillon in Switzerland were the source of the biomedia lost to the environment © Surfrider Léman



Above: Filtration systems using biomedia, made from garden waste bins © D.R.

10
RECOMMENDATIONS

The growing take-up of processes using biomedia and the proven cases of malfunctions and pollution incidents have led us to draw up this set of recommendations in the hope of preventing such events in future. We have based this work on the extensive expertise we have built up on this issue, along with numerous conversations with various stakeholders.

10.1. MUNICIPAL AND INDUSTRIAL WASTEWATER TREATMENT PLANTS

The main cause of biomedia being lost into the environment, as described in chapter 9, is an overflow of the tank in which they are used. Such overflows can take place due to heavy rain, blocking of the retaining mesh, or as a result of technical faults, poor maintenance or human error.

10.1.1. STOPPING BIOMEDIA FROM GETTING OUT OF THE TREATMENT PLANT

Ensure all channels are sealed

In the event of an overflow, water laden with biomedia can get out through influent pipes, the channels used to add chemical agents, treated water exit pipes, the overflow pipe if there is one, or even just over the edges of the basin.

It is therefore important to make sure that each of these potential exit pathways is completely impassable by biomedia. The addition of meshes with a smaller hole than the diameter of the biomedia used, overflow systems or buffer basins are all possible solutions to prevent overflows.

Secure external tank walls

If the water level rises in the basin and overflows the top, it is essential to stop the biomedia from escaping too.

This could be done by means of a mesh covering the edge of the tank, with holes smaller than the size of the biomedia, allowing them to be retained in the case of an overflow, while the water can still get out.

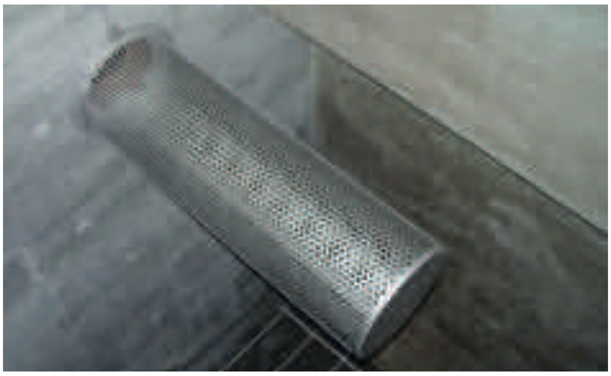
This has to be more than a net, which could be pushed off by the upward pressure of biomedia accumulating on the surface.

Use cylindrical grilles

The flow of liquid leaving the basin exerts a strong force on the biomedia, drawing them towards the exit point. They start to accumulate in front of the pipe hole. It is therefore crucial to systematically replace every flat mesh screen for a cylindrical grille, which will prevent the plastic biomedia from becoming stuck across the mesh and blocking it.

The circular grilles should not be placed too close to each other, near any other equipment or against the bottom of the tank, in order to prevent the biomedia from becoming wedged between two structures or between a grille and the bottom of the tank.

The grille should be attached by a continuous band of welded metal rather than just a few weld points, which could break and then allow biomedia to get through.



Above: Cylindrical grille
© FNADE

Control losses to the environment

It is preferable to safeguard the outflow into the environment in order to mitigate any upstream faults that could otherwise allow biomedia to get through the stages of the treatment process downstream of the bioreactor. The main way of doing this would be by installing grilles at the entrance of the discharge pipe and a buffer or overflow basin at the exit.

Pinpoint anomalies

Automatic control equipment using sensors allows any possible problems to be identified quickly and preventive action to be taken avoid blockages, overflows or even reflux – preventing biomedia from getting out into the environment. If any anomaly is detected, the system can adjust the air diffusion around the area of the grille to unblock the biomedia and increase the air pressure in the tank to re-suspend the biomedia. If this is not enough and the level continues to rise to a critical point, the system would be able to stop water from being fed into the reactor.

10.1.2. PREVENTING BLOCKAGES

Choose the right biofilm carrier

Biomedia in the shape of flat chips provide a larger surface for colonisation by bacteria (about twice as much compared with the K1 type), which means that much smaller tanks can be used. However, their shape can also cause them to clump together, blocking the effluent exit meshes. In addition, their extremely small apertures can easily become blocked, modifying the properties of the biomedia. To reduce the chances of this happening, they can in some cases be used in a mixture with other kinds of differently-shaped biomedia, as long as this is done in accordance with their usage recommendations. For example, some plants use a mixture of flat BioChip models with smaller K1 models.

The K1 has the advantage of having relatively large holes, which rarely become blocked, being able to break mid-sized bubbles down into smaller ones, ensuring a better rate of oxygen transfer (thereby optimising aeration costs), and being easy to get moving thanks to the little fins around its edges. This model is also compatible with the mechanical movement process (which uses less energy), and can be used in anoxic and anaerobic reactors, in which the aeration levels must be limited.

Ensure good basin aeration

Good air diffusion is paramount in order to ensure a uniform function level throughout the bioreactor. The biomedia are kept in suspension through air being injected at the bottom of the reactor through stainless steel channels, which produce relatively large bubbles, which are broken up by the action of the biomedia as they rise.

The decreasing density of the air injection system from one end to the other of the tank creates spiralling currents within the reactor, which mix the biomedia at optimal levels and keep them in contact with the biofilm. If the biomedia are not kept moving effectively, they can end up following a preferential route created by the passage of the effluent through the tank, and will accumulate over the retaining mesh at the reactor outflow.

Good aeration also de-clogs the biomedia by removing excess biofilm on them while allowing them to retain their water-purifying and mechanical properties.

When designing the air injection system, it is essential to include a specific blower system for unblocking the mesh. This provides an additional guarantee against a mass of plastic matter forming in this area.

The energy consumption of an MBBR, plant is generally 1.3 to 1.5 times greater than that of a standard activated sludge plant. In order to optimise the energy usage of the aeration system, mechanical agitators can be used instead of the air injection system in the reactors, in both anoxic or anaerobic conditions. However, it is essential to ensure that the agitator blades are protected and to choose the right biomedia for the purpose.

10.1.3. THE IMPORTANCE OF GOOD INFRASTRUCTURE

Encourage closed plants

Keeping the tanks containing the biomedia covered, or where possible placing these in closed buildings, reduces the risk of them escaping.

Any possible losses would be limited to the inside of the room in which the tanks are installed.

Use specially-adapted tanks

Boosting the performance of an existing activated sludge tank by just adding biomedia can turn out to be a very bad decision. The shape of the tank, its volume, its aeration system and the tank's exit meshes have not been designed to operate with this new process, which will increase the risks of malfunction.

Transport and storage

Biomedia should be transported in closed containers to prevent losses during handling and while topping up or changing the biomedia in a tank. Open dumpy sacks are not appropriate for storage.

All sites used to store biomedia, from production to end usage, should be protected from the weather. Storage should therefore be inside a locked building away from the water. Responsibility for handling of stored biomedia should be clearly defined and recorded (date, volume, type).

10.1.4. SUCCESSFUL COMMISSIONING

Train and supervise staff

Previous incidents repeatedly show that the commissioning of bioreactors is a crucial phase that is prone to malfunctions. It is important for operators and technicians, who will be in charge of ensuring the good day-to-day running of the installation, to be properly trained and provided with guidance during the start-up phase.

Follow recommendations

Several of the incidents reported have been directly linked to a poor understanding of the procedure and its inherent risks. The biomedia type and system adjustments recommended by the construction firm are not always followed. Depending on the particular circumstances, this might lead to poor agitation of the biomedia, leading to a risk of blockage, or overly-strong agitation, which could lead to the biomedia being washed up on the surface.

Properly following the constructor's recommendations could be enough to prevent incidents relating to poor system adjustments. It is therefore important that constructors provide plant management with good information about the risks associated with use of biomedia.

However, in practice, it is clear that the theoretical calculations used for oxygenation, mixing, influent and effluent flow and the volume of biomedia added may not be quite right. It may therefore be necessary for the installing company to take responsibility for correcting these.

10.1.5. BUILD UP EXPERTISE

Keep staff informed

Staff members who will be in charge of ensuring the good daily running of the installation must receive the correct training to do this.
Posters displaying the relevant regulations and information about the process, along with other documentation, should be readily accessible and regularly updated.

Communication with top experts

A maintenance contract must be in place, and also the possibility to contact – in real time – an expert within the organisation who is familiar with the design of the bioreactor.

Any modification to the parameters and operations of the equipment should be noted down in a document that will make it possible to understand how such changes will impact on the operation of the bioreactor.

10.1.6. FORESEEING VARIATIONS IN LOAD

Be prepared for heavy rain

The sensors used to measure water levels in the basins should be regularly maintained and checked to ensure they are working properly, especially prior to times when stormy weather is most likely.

Checking by both staff members and through automatic procedures may be necessary at times when there is a strong likelihood of exceptional weather.

Develop storm basins

Storm basins can be built into combined systems upstream of the WWTP to help better regulate the inflow of water, thereby preventing wave effects in the tanks.

Adapt reactors to the effluent they will treat

A specific reactor should be dedicated to treating ammonia, for example. Nitrifying bacteria grow fairly slowly, and so it is necessary to foresee extreme or rapid seasonal variations in load that will occur because of the extra ammonia even before this additional seasonal load has occurred.

A specific anoxic reactor, without an air injection system but with mechanical mixing, must be put in place to get rid of the nitrate that forms as a result of the treatment of the ammonia (denitrification).

Several more modestly-sized reactors can be built at plants that experience extreme variations in seasonal load. Although more expensive to build, this kind of set-up means some reactors can be kept waiting, with very short aeration phases at times when the plant's full treatment capacity is not needed. This ensures greater purification power for times of high load.

10.1.7. REDUCE WATER ENTERING WASTE WATER TREATMENT PLANTS

Develop separate systems

Separating rainwater from domestic wastewater prevents excessive amounts of wastewater arriving at the treatment plants, particularly during storms. A separate system limits the risks of basins overflowing at the plant because of excess water levels. This also reduces disturbances to the aeration sensors when large amounts of highly-oxygenated water enter the plant.

Reduce surfaces that are impermeable to rainwater

Urban water systems that are designed to allow rainwater to filter naturally into the ground are a great help in reducing the amount of water entering WWTPs. This can be done by retaining areas of natural ground, or by installing infiltration basins. Putting these preventive measures in place reduces the risk of WWTPs malfunctioning and the potential loss of biomedia.

10.1.8. PROPER INCIDENT MANAGEMENT

Too often, no announcement is made about ongoing or recent incidents by either the technical staff and managers of a plant or local elected officials. This limits the chance of recovering the biomedia, which spread rapidly once they reach a waterway.

Effective prevention plans should be drawn up in order to raise these users' awareness about potential problems and the need to react quickly in the event of an incident. These plans should be supplemented by clean-up protocols to be followed in the event of an incident (temporary nets or booms to be placed on the surface of the watercourse, manual collection of spilled biomedia, etc.). These plans should be posted around the plant's site in order to raise operators' awareness about this issue and how to react quickly in the event of an incident.

10.1.9. OBLIGATIONS ON POLLUTERS

It is often difficult to be 100% certain in identifying those responsible for biomedia spills. Prosecutions are rare and difficult without evidence from relevant officials, despite complaints lodged by conservation organisations.

In France, a prosecution for water pollution offences was attempted against the Syndiicat Intercommunal d'Assainissement et de Restauration de Cours d'Eau, the company Vinci Environment, and the Essone water company following the accident at Corbeil-Essonnes (see section 8.1.1).

Even though the biomedia pollution was proven and continues to impact the environment, the judges in this case found the defendants not guilty because there was no evidence of the biomedia being harmful, and because they could not be defined as a 'substance', as set out in French environmental law. In addition, it was not possible to establish the reason for the loss of the biomedia, and so it was impossible to attribute any blame or lack of care on the part of the defendants.

10.2. INDIVIDUAL SMALL-SCALE PLANTS

10.2.1. INFORMING THE PUBLIC

Biomedia are easily accessible in garden centres or on specialist online sales sites. However, they do not come with any instructions, leaving users to work out for themselves how to use this technology, about which they may know nothing.
This lack of official information leads to a variety of home-made systems being installed, many of which are quite unreliable.

Both buyers and sellers need good information in the form of guides to help improve the performance of these installations while also reducing the risk of pollution.

These guides could contain information such as a checklist of points to go through before starting up the system, and indicating the amount of biomedia required according to the type and volume of effluent to be treated.

Recommendations on putting in place a safety system to prevent overflows, and provision of an emergency phone number to call in the event of an incident could also help to limit spills into the environment.

This information should be included in the usage instructions on these products, and also distributed among sales points and on specialist websites.

These recommendations should also be provided on specialist web forums in order to raise awareness about the problems of biomedia pollution among the wider public.

Above: Natural biomedia made from calcareous worm casts © Reef Builders

10.2.2. ENCOURAGE CLOSED SYSTEMS

If it is not possible to set up a closed micro-station, private owners should be strongly encouraged to follow recommendations similar to those for WWTPs, particularly concerning covered filter tanks and installing wastewater treatment systems in an enclosed space.

10.2.3. ENCOURAGE USE OF NATURAL MEDIA

There are numerous other kinds of non-plastic biofilm carriers that can also treat water from ornamental ponds and lakes very effectively. Volcanic rocks such as pouzzolane act as good natural supports for bacterial growth, and are well suited to small-scale private installations.

10.2.4. DECLARE INSTALLATIONS

Also useful would be a requirement for private installations to be declared and subject to checks by the Services Public d'Assainissement Non Collectif (SPANC).

11
CONCLUSION

Biomedia can be found wherever water needs to be treated, be this in municipal or industrial wastewater treatment plants, at vineyards, fish farms, livestock farms or even in private dwellings.

We have been able to better understand the source of pollution incidents since 2010, thanks to the numerous finds of biomedia along our coasts, eyewitness reports, interviews, and the heavy involvement of numerous volunteers.

Because of the marine currents that impact it, the Bay of Biscay coast is a major site for biobead strandings. Given the widespread dispersal of this type of pollution once in the environment, and particularly in the sea, its origin is often difficult to trace.

This is why it is essential to act at the source of any potential pollution, starting from the use of the biomedia. A good understanding of the environmental risks associated with the use of biomedia, from the earliest stages of setting up wastewater treatment plants, is critical. Above all this involves raising awareness, particularly among wastewater treatment plant operators, who should in any case not ignore the impact of biomedia pollution given their cost and the risk that operators run if they are found to be responsible for a particular pollution incident.

Our study has revealed a lack of reactiveness and responsibility on the part of WWTP operators when incidents occur leading to spills of biomedia. At European level, clean-up actions following pollution events are the exception rather than the rule. This means biomedia from spills that took place over five years ago can still be found polluting our environment and coasts. Biomedia lost regularly but in small quantities into watercourses also contribute to this source of permanent pollution.

In North America, however, biomedia spills have been viewed more seriously, sometimes resulting in hefty fines for environmental offences. In addition, operators of plants that have experienced malfunctions have been required to conduct clean-ups. These solutions, as well as helping to resolve the immediate problem, have also made operators take responsibility for the impact of the pollution caused.

The use of biomedia in wastewater treatment processes is growing exponentially, which in turn increases the risk of incidents. This is why it is so important to implement information and prevention measures, and protocols for raising the alarm, as well as additional low-cost steps that could help to largely prevent biomedia losses and reduce the risk of pollution if they get out into the environment.

Above: Biomedia lost from the Saint Prex WWTP (Switzerland) and washed up on the banks of Lake Geneva © Frank Odenthal

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13
ANNEXES

ANNEX I

I.A. INTERVIEWS WITH TWO FISH FARM MANAGERS

We ask the same questions to:

- Philippe Benoît, operations manager at the Ecloserie de Guyenne (Guyenne hatchery) (Sturgeon company) in Saint-Seurin-Sur-l'Isle (33660).
Interview conducted in July 2013

- Emmanuel Bonpunt, manager of the Teich sturgeon farm (33470).
Interview conducted in November 2013

Why did you choose biomedia? What are the advantages of this system? Is it cost effective?

Philippe Benoît
"It's a really good process, streets ahead of the others. It's easy to use and keep clean and it's really durable too. (Previously Mr Benoît was using Biogrog, a different process that he found less practical).

This is a process that is often used in marine fish farms.

This system lets you save water as you only use 10% new water each day, so you are only discharging 1 to 2 m3 per hour into the river (which is very little). In a more traditional system that pumps the water, which flows straight out of the basin, you are replacing 100% of the water every hour.

The downside is that the pump and the aeration required mean you use a lot of energy, so you need to ensure optimal performance and fine tune your system."

Another important point is that these systems can be easily and quickly dismantled. If one day you need to change your installation, that is a perfectly practical thing to do. This is something that greatly influenced his choice.

"If we'd used any other process I would have aged a lot quicker! The other types get clogged up, you have to clean them a lot, constantly monitor the water quality... it's exhausting"

- Emmanuel Bonpunt

The biomedia themselves are expensive to buy.

Emmanuel Bonpunt
Mr Bonpunt wanted to expand his operation in the early 2000s. This meant he needed to consider a new water filtration system. A friend told him about this Danish process, and following a visit to some Danish fish farms he decided to try out the 'curlers' for himself. His expansion project took four years, during which time he was also thinking about the best system to use.

Over this period he tested three – zeolite, Biogrog and biomedia. The first two processes require the basins to be totally filled with the media, which is restrictive. You also have to regularly clean the media. The main advantage of biomedia is that they are self-cleaning (any dead bacteria become detached as the media bump into each other in the basin). This means there are no particular maintenance requirements.

He does not even see the energy costs as a negative, because these are fairly similar to the costs of other systems. In fact it takes about the same amount of energy (in terms of water, electricity and physical effort) to clean zeolites and Biogrog.

Did you receive any financial assistance (from the water agency or other sources)?

Above: Biomedia used at L'Esturgionnière (33470) © Copyright Surfrider Foundation Europe

Philippe Benoît : There was funding for the whole hatchery. And the fact is that this process, which offers such great water savings (requiring 100 times less water) really tipped the balance.

Emmanuel Bonpunt
L'Esturgeonnière received funding for its reed bed filter.

How long have you been using biomedia for?

Philippe Benoît
For 10 years in the Sturgeon operation and four years at the Ecloserie de Guyenne.

If you have good quality water (especially if it is soft water), you can retain it for a really long time. Mr Benoît was one of the first people to use this system in France.

Emmanuel Bonpunt
Our system has been up and running since 2006.

How did you find out about this filtration system? Is there a catalogue where you can find filtration equipment, or did a salesperson come to see you?

Emmanuel Bonpunt
A friend told him about this process being used in Denmark. People working in the industry also receive catalogues offering all sorts of materials: Aquaculture; COFA (Coopérative Française de l'Aquaculture); Aqualor etc...

Which models to you use?

Philippe Benoît
After trying a different model that he didn't like, Mr Benoît chose KNS based on word-of-mouth recommendations, his own experiences and a fact-finding trip to Denmark, where he was able to talk about it with other operators.

Emmanuel Bonpunt
Mr Bonpunt uses two different models. The photo above shows the Bioélément RK model from RKPLAST used in biological and mechanical filtration systems, requiring just half an hour's aeration each day to clean them. Right: media for a fluidised bed reactor. Curler Advance X-1 system from Inter Aqua.

Who are your suppliers?

Philippe Benoît
Mr Benoît did not want to reveal who was his supplier.

Emmanuel Bonpunt
A company called Acui-T supplied the curlers to Mr Bonpunt. The initial cost was €500/m^3. By placing an order for 180m3, l'Esturgeonnière got a reduced price of €473/m^3.

Have you tried any other suppliers?

Philippe Benoît
The manager of the "écloserie de Guyenne" has not tried other suppliers, and also told us that he did not want to use Kaldnes biomedia as he says the little fins break easily.

Emmanuel Bonpunt
Mr Bonpunt was adamant that he did not want to use low quality Chinese copies, while the Kaldnes system (the commonest on the market today) was not available for direct sale or in sufficient quantities at the time he was setting up his operation.

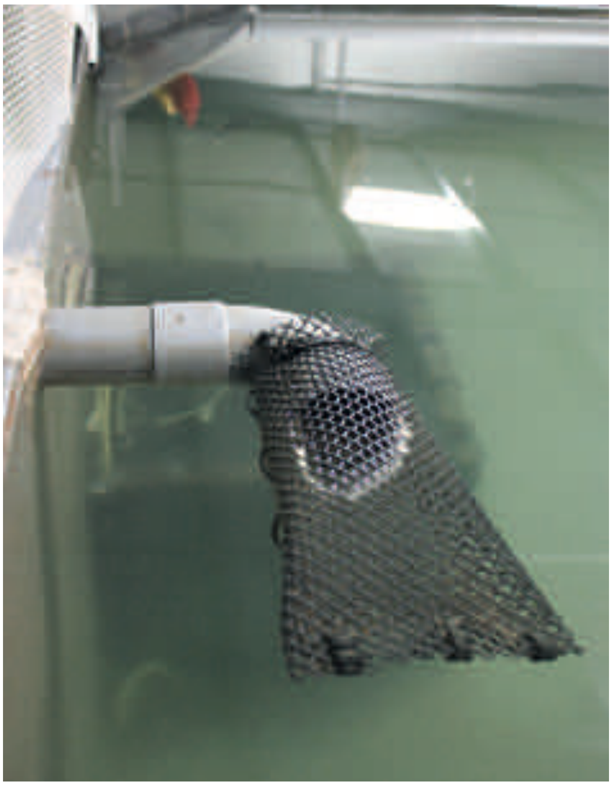
Would it be possible for biomedia to escape?

Philippe Benoît
« It's not possible. The water is pumped in the river, then it passes through a drum filter (a mesh that removes the largest particles). The water is then sent through a biological filter (which contains the biomedia) to reduce its ammonia levels, and then through a UV filter to stabilise the amount of bacteria. »

An occasional biomedia could escape from time to time, but Mr Benoît has installed mesh devices to prevent them from leaving the basin.

This means the biomedia are easy to retrieve. The installation is in a closed building. The only way in which there could be any spill from this operation (a minimum of around 3-4 pieces of plastic) would be if the plastic mesh covering the outflow pipe to the river were no longer in place (human error or accident).

Mr Benoît has experienced regular losses of biomedia from the tank at his other operation. They were becoming stuck over the protective mesh, always in



At the Guyenne fish hatchery, top : biofiltration tanks
Above: Mesh to prevent biomedia reflux.

the same place, and were at risk of getting out into the environment. His solution to this was to place the retaining meshes at an angle, thereby preventing any clumping together of the biomedia and any risk.

Emmanuel Bonpunt
This is a closed circuit. The river water is pumped from 300 metres away from the operation (300 L/s). The water enters a geothermal borehole to be heated (this borehole was already present and is under lease), then the water has gas removed.

After this there is a mechanical 60 µm filter, two types of biological filter (depending on the curler model), and lastly another 45 µm mechanical filter. In addition there is also a 90 m^3 hatchery separated from the main operation.

At the end of this process, the water passes through a recycling plant and then finishes its journey through the farm through a reed bed.

What are the technical features of your installations?

Philippe Benoît
Philippe Benoît did not answer this question, saying that this is confidential information resulting from a lot of work to fine tune the best usage conditions for his operation.

At l'Esturgionnière, top : Biological filter tanks
Above: mechanical filter

The number of biomedia is calculated by the weight of granulated feed given to the fish. Each operation has its own recipe, which will also differ according to which system is used. This costs several hundred euros /m^3.

Emmanuel Bonpunt
Mr Bonpunt uses 180 m^3 of biomedia. The models he uses provide a surface area of 800 m^2/m^3 for colonisation by the bacteria. His operation is able to filter 1,000 m^3 of water/hour.

Does this process have any disadvantages?

Philippe Benoît
The Sturgeon manager doesn't think there are any downsides to this system.

Emmanuel Bonpunt
It may surprise some people, but the energy usage really isn't a problem for l'Esturgeonnière. In fact our current energy expenditure shows we're using 12 kW/h.

With our previous fixed bed system, we were using about 37 kW/h because of the cleaning and unblocking we had to carry out for seven hours per day using air and water.

Our energy use in one day is (12 kW/h) x (24 hours per day) = 288 kW/day for the fluidised bed reactor – compared with (37 kW/h) x (7 hours per day) = 259 kW/day for the fixed bed system.

Using the fluidised bed reactor has therefore not increased our energy expenditure to any significant degree.

The aeration channels in the final tanks in our filtration system have a tendency to get blocked – we don't know why. There is less movement in the tank and the biomedia end up getting clogged around the water outfall pipe. This means we have to regularly use a pressure washer to clean them and stop this from happening.

Unfortunately flakes come off the Advance X-1 curler media, sold by Inter Aqua, during this jet washing maintenance. It is possible that the flakes could be getting into the environment, although this has never been observed.

Does your system require any specific form of maintenance?

Philippe Benoît
Mr Benoît disinfects his biomedia once per year. However, this is a measure designed to ensure the good health of his fish rather than maintenance of the material itself.

Emmanuel Bonpunt
Because they are in constant movement, the biomedia are self-cleaning. The plastic pieces bump into each other, which detaches any dead bacteria..

Have you experienced any problems or losses?

Philippe Benoît
We did not have any problems at the Ecloserie de Guyenne when installing the system. We just had a few weeks of finding our feet, time needed to stabilise the aeration system needed to keep the biomedia in motion, but this did not lead to any losses.

He has noticed one or two biomedia escaping very occasionally.

Mr Benoît told us he knows of other people who have experienced blockages. He says the key factor is the quality of the pumped water. The water at Saint-Seurin-Sur-l'Isle is of a very high quality and very soft.

Emmanuel Bonpunt
There was an accident in 2006 (when they started using the process), when 200 to 300 litres of curlers were lost into the environment.

This was due to a small fault in a narrow section of the system because of water continuously entering the circuit.

Can problems arise during storms and sudden arrivals of large amounts of water?

Emmanuel Bonpunt
No, the circuit at l'Esturgeonnière can cope with an additional 20 to 30% of water. Following the loss in 2006 we put meshes in place to prevent biomedia from leaving the system.

Do you need to change the biomedia after a certain length of time? Do they get damaged after a time?

Philippe Benoît
No, at Sturgeon we have been using biomedia for 4 and 10 years at our two operations, and they are in very good condition.

Emmanuel Bonpunt
No, the Advance X-1 curlers from Inter Aqua that we use at l'Esturgeonnière do break down a little bit, but not to the extent we need to renew our stock.

How do you remove the dead bacteria?

Emmanuel Bonpunt
We treat the sludge on site at l'Esturgeonnière using mechanical filtration.

Do you think you will change your process at some stage? Would you be prepared to invest in a better-performing system?

Philippe Benoît
Mr Benoît believes the biomedia process is the most effective at the moment, and that this will continue to be the case for some time.

If a new, better-performing system were to be introduced in future, he would be prepared to change.

Emmanuel Bonpunt
Mr Bonpunt also says this is the best system at the moment. He does not see that anything else could be invented that would promise better performance.

Could a reed bed type filter system be used in the fish farming industry?

Philippe Benoît
In an ideal world we would use reed beds or a filter to treat the effluent from the drum filter, but the discharges would exceed the authorised limits.

Emmanuel Bonpunt
At l'Esturgeonnière we use a reed bed filter at the end of the system, and this helps us to meet our discharge requirements.

Is this a widespread practice in fish farming?

Philippe Benoît
No, this process is still not very widespread. It's used a lot in northern Europe, especially Denmark.

Emmanuel Bonpunt
Not in France, but all the operations in Denmark and other countries in northern Europe use this system, primarily because of their weather conditions.

Do you know any other fish farms that use it?

Philippe Benoît
One in Charente Maritime, the trout farms in Denmark, the Charles Murgat fish farm at Beaufort in Isère, L'Esturgeonnière.

Emmanuel Bonpunt
The Picton fish farm in Charente.

I.B.INTERVIEW WITH A TECHNICAL OPERATIVE AT A WATER TREATMENT PLANT

We had the chance to interview an operative who worked for several months on starting up a wastewater treatment plant using biomedia.

He would only give this interview on condition of anonymity.

Have you heard about beaches being polluted with plastic biomedia?
Yes, I know about this, I've heard of two spills of biomedia from plants in the Rhône Alpes region.

Do you know any more about these incidents?
This process is actually still quite rare in France, particularly in municipal wastewater treatment plants (WWTPs). In many cases system function tests are carried out during commissioning, with adjustments made according to the results observed. As I understand it, biomedia losses have generally occurred during commissioning, due to poor understanding of the process.

Are these losses inevitable?
I don't know. But it is clear that several types of incidents crop up repeatedly in the scientific and technical publications on this subject.

The first of these is the meshes becoming blocked. The effluent water flow creates a sucking effect, and large numbers of biomedia end up stuck to the grilles, partially obstructing them. Because the water is now leaving the tank more slowly, the level rises, and you can end up with an overflow.

On top of this, if the mixing isn't effective enough the biomedia have a tendency to rise to the surface. Even with just a minimal overflow thousands of plastic carriers will escape. You can find them all over the place around the tanks. Others end up in the clarification and settlement tanks before getting into the pipes leading out into the receiving water.
Overflows can also result from a malfunction of the flow sensors. In other words, if the water level in a basin rises rapidly (for example in the event of heavy rain), a sensor should trigger a secondary circuit to come online to release the excess water entering the system and prevent an overflow. If this sensor doesn't work properly the tank will overflow and the biomedia escape!

Some installers sell this process by saying it can boost a wastewater treatment plant's effectiveness without the need for any construction work – all you need do is add the biomedia.
I have actually heard of a case where people wanted to reuse an old clarification tank as a bioreactor with biomedia. This led to blockage problems, because the outflow mesh didn't have an aeration bar to blow air to remove the biomedia collected around the grille.

Were there any particular problems in commissioning the wastewater treatment plant that you worked on?
Not in terms of overflows because this was a covered plant.

What type of biomedia are used in that plant?
K1 biomedia from Kaldnes and 'chips' (flat biomedia). They were delivered to us in sacks containing 5 to 10m3 and came from Spain.

Is there any reason why installers would want to release these plastic biomedia into the environment?
No, quite the opposite. It's very expensive to fit out a treatment plant. It is not in anybody's interests to lose them.

Do you have anything else to add?
I have heard that oil tankers use biomedia to clean out their tanks, but I don't know any more about this.

I.C. VISIT TO THE WASTE WATER TREATMENT PLANT IN QUÉVEN

Surfrider visited the WWTP at Quéven in October 2015, where we met Jean-François Mainguy, who is head of the public water company of the Pays de Lorient conurbation.

Who manages the WWTP?

Responsibility for wastewater treatment rests today with the Pays de Lorient conurbation authority.

How many people work here?

There are two maintenance staff who check on the facilities every day, and a sector supervisor.

Introduction to the Quéven WWTP

The treatment plant has existed since 1976 on its current site in Radenec. It underwent a modernisation in 1991, when it adopted the Kruger (Biodénitro) system. At that time the plant's capacity was 15,000 PE.

The plant underwent a further development in 2011/2012, with the construction of three new basins:

- One buffer basin to regulate the flow entering the bioreactor (R3F).
- a bioreactor (R3F) containing 170 m3 of biomedia in order to reduce carbon.
- An aeration tank, which is very effective for reducing phosphate levels.

The towns of Quéven and Gestel have grown, as well as the agrifood industry in the local area, meaning the former plant reached the limits of its capacity (16,943 PE).

There was then a strong demand among local industries to increase their permits to discharge into the municipal network. The increase in the plant's capacity allowed us to meet this demand while retaining a significant margin for the development of additional housing in the local area and possibly more industries too.

What was the reason for this renovation?

The municipal authority at that time launched a tender to upgrade the plant.

What were the main problems with this upgrade?

The town was happy with the location of the existing WWTP plant, and they were also happy with how it operated. However, they wanted to adapt their existing systems to increase its treatment capacity without increasing the WWTP's footprint.

What process was selected for this development at the plant?

The process selected was R3F, installed by SOGEA (Vinci).

Did you receive any funding to carry out this work?

The extension work received subsidies from the Loire-Bretagne water agency totalling €1,126,135, €936,550 from the Morbihan general council, €282,257 from the town of Gestel and €2,159,044 from the town of Quéven.

Was there any interruption to the water treatment process during the works?
No, some of the effluent from the south of the town was sent to Lorient. Apart from this the remaining wastewater could be treated in the existing basins until the upgraded section was connected.

How did you find out about the biomedia process?
The local authority put the work out to tender, and Vinci suggested this treatment system.

Membrane processes were also suggested, but their costly maintenance meant the local authority could not justify them.

What was your motivation in adopting this process?
This development allowed us to double the plant's wastewater treatment capacity at a relatively low cost, going from a treatment capacity of 15,000 to 30,000 PE.

This system also allows us to meet the needs of local industries, as this system is well able to tolerate variations in load and is good at breaking down carbon.

The cost effectiveness of this technology was also a major argument in favour of adopting it.

Who was the installing company?
SOGEA carried out the installation.

What work was carried out at the plant in order to adapt it to the R3F process?
Addition of three tanks and upgrade of certain elements of other tanks.

Did you receive support during the implementation of the process?
SOGEA offers an aftersales service, and was available during all the launch stages in order to ensure the plant was fine-tuned and to ensure that the anticipated performance levels were met. Today, however, the team at the Quéven WWTP no longer has any need of their help.

Did you encounter any difficulties during the commissioning of the plant? If so, what?
Yes, in the early months we noticed significant amounts frothing. The basin was not functioning properly, and we suffered overflows of foam. We were very concerned about the effectiveness of the process.

Since the source of the problem could not be established, the R3F had to be drained and the biomedia recovered by vacuum. Some of them did escape from the basin. It is very likely that the wind and rain led to some of them escaping into the environment.

The problem was identified during our inspections, and it turned out to be caused by an IT programming error, which stopped the agitation of the biomedia for several minutes at night. The programming was corrected, and we have not experienced any problem with the functioning of the R3F since then.

What volume of biomedia does the reactor contain?
170m^3. The biomedia were delivered by SOGEA in dumpy sacks when the process was being installed.

What type/model of biomedia is used?
BMX1

Have you tried any other models or suppliers?
No, we have used the same ones since the beginning.

Does this system require any particular maintenance?
No, none, the biomedia don't need to be changed or cleaned.

People often point to the high energy consumption

required to keep the biomedia moving. Did you compare your costs before and after?

The agitation is maintained by three air pumps, one of which is a back-up. We haven't compared costs, but our energy usage has definitely increased.

How has the plant beein operating?

The former plant worked at full capacity with an effective system (Kruger), on occasion being able to triple the capacity of the denitrification basin. The system operated in optimal conditions, but it was close to its limits, leaving no margin for variations in load, especially given the increasingly strict discharge consents.

Nowadays one of the local companies has improved its pre-treatment system and produces virtually no effluent. The population, contrary to expectations, has also stabilised. This means the plant now operates at less than 30% capacity, and this has resulted in a reduction in the system's water treatment capacity due to a lack of nutrients for the bacterial biofilm.

In order to preserve the bacteria in the R3F and aeration tanks, the wastewater travelling through the buffer basin is separated, with one part going to the R3F and the other to the aeration tanks. This means the system is working at far from optimal levels right now. The old process would have been sufficient for these requirements, and at a lower cost.

Have you experienced any malfunctions?

Yes, during the process start-up demarrage phase. The buffer basin allows us to maintain a regular flow of wastewater entering the R3F basin. This should prevent any overflow due to an increase in water entering the system.

Given the plant's treatment capacity and the low level of influent, this situation is very unlikely to occur at the moment.

Have you ever noticed the grilles becoming blocked?

There hasn't been any blockage because there is a «cylindrical sieve» that air is injected onto, preventing the biomedia from travelling into the other basins.

Can you estimate how many biomedia have been lost?

No, it's difficult to estimate. There has not been any catastrophic spill, but we definitely have found some on the ground, and so they could potentially have been transported to the environment by wind and rain.

Have you heard about any biomedia losses from other plants? Did you know that this can happen?

He did not seem to know anything about other cases, but it did not surprise him that this could happen given that they have experienced problems themselves.

What modifications are essential for adapting a WWTP for using biomedia?

We did not need to adapt any existing material at Quéven because the R3F system was added in parallel to the existing treatment systems. However, there is essential work such as putting in place the grilles and protection around the edges of the tank.

The edges of the R3F tank are raised with plastic borders to prevent any biomedia being lost through overflows or when they are being agitated by the air bubbles. Even so, some biomedia can still end up being projected into the air by the air bubbles.

ANNEX II

TYPES OF BIOMEDIA COLLECTED FROM COASTLINES DURING PRODUCTION OF THIS REPORT

1. Unknown model (Ø 8 mm, depth 3 mm)
Probably a copy of KNS

2. KNS (Ø 8 mm, depth 8 mm)
More commonly known as a Bio carrier, KNS is sold on most koi carp sites aimed at people raising fish in domestic ponds. These are regularly used in a mixture with AMB biomedia made by ATMSA, which also supplies the paper industry in northern Spain. These have been found regularly and continuously along France's Atlantic coast since the autumn of 2009 and since 2012 in the Mediterranean.

3. Unknown model (Ø 8 mm, depth 6 mm)
Probably a copy of KNS

4. Curler Advance Bio-Media (Ø 10 mm, depth 8 mm)
Model developed by the Danish company Interaqua. Only used in aquaculture.

5. K1 (Ø 6 mm, depth 8 mm)
One of the two leading models produced by AnoxKaldnes™ and now copied by numerous manufacturers. Found in the plants installed by Veolia and sold on all hobby aquarium sites. This is the type of biomedia that spilled into the Seine in February 2010 from the Corbeil-Essonnes plant. It is also the model that was found following the pollution event in the Miño river on the northern border between Spain and Portugal, also in February 2010.

6. BMX1 (Ø 6 mm, depth 8 mm)
Model produced by Vinci Environnement, this biomedia is primarily used in the R3F process.

7. 8 AMB Biomedia (Ø 13 mm, depth 9 mm)
Model manufactured by DAS USA in the United State and distributed by ATM SA in Spain (Navarre). Found along the entire Atlantic coast in Spain and France. Suspected source: pollution incident on the Oria river in 2009.

9. Unknown model (Ø 18 mm, depth 8 mm)
Model with a design similar to the K2 created by Anox Kaldnes. Rarely used.

10. K3 (Ø 25 mm, depth 10 mm)
Along with the K1 and biochips, this is one of the leading models in the market, created by AnoxKaldnes™. Today it is sold and installed by Veolia and also sold on hobby aquarium sites. There are numerous copies of this model, which was also the type involved in the pollution incident at Nive d'Arnéguy in the summer of 2012.

11. K5 (Ø 25 mm, depth 4 mm)
Model from the AnoxKaldnes™ range. This model has been found in large quantities on the beaches of the Mediterranean since February 2014.

12. BWT 15 (Ø 15 mm, depth 4 mm)
Developed by Biowater Technology. Retrieved in large numbers from the banks of Lake Geneva (Switzerland).

13. BioChip M (Ø 45 mm, depth 2 mm)
Created by AnoxKaldnes™ and today sold and installed by Veolia and sold on hobby aquarium sites. Retrieved in large numbers from the banks of Lake Geneva (Switzerland).

14. BioChip P (Ø 45 mm, depth 3mm)
Model similar to BioChip M.

15. Hel-X® range (Ø 13 mm, depth 13 mm)
Products made by Stöhr GmbH & Co.KG.
Found since 2011 along the Mediterranean.

16. Hel-X® range (Ø 17 mm, depth 17 mm)
Products made by Stöhr GmbH & Co.KG.
Found since 2011 along the Mediterranean

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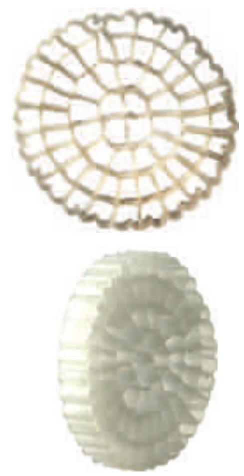

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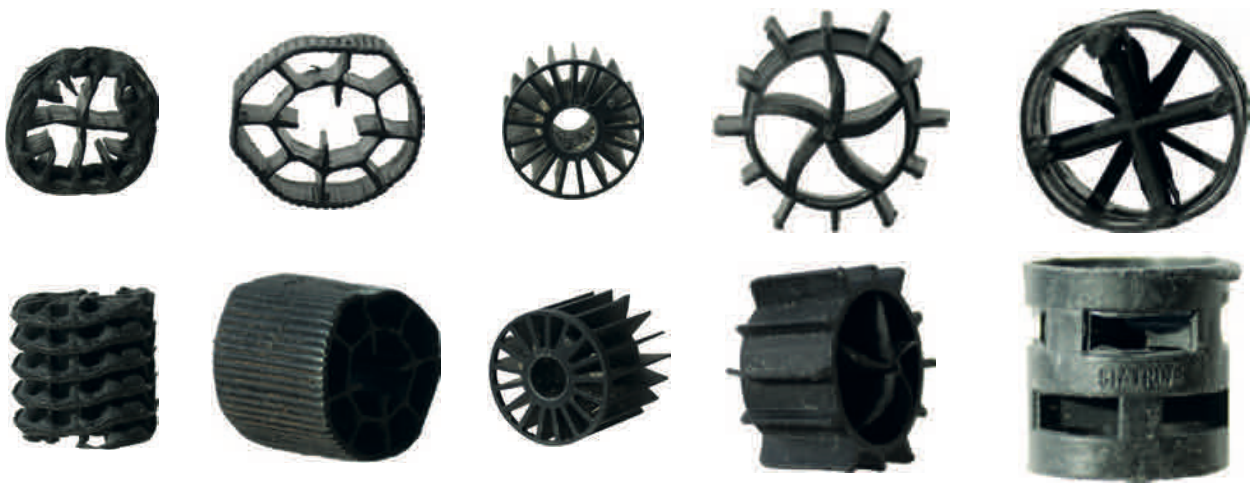

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17. Hel-X® range (Ø 15 mm, depth 15 mm)
Products made by Stöhr GmbH & Co.KG.
Found since 2011 along the Mediterranean

18. Meteor 450 (Ø 22 mm, depth 15 mm)
Developed by Suez / Degrémont for the American market. Found on beaches at Aytre and Molliets.

19. Unknown model (Ø 15 mm, depth 15 mm)
Used in the L'Esturgeonnière fish farm (33470)

20. Biofill type C (Ø 28 mm, depth 20 mm)
Developed by the company BioFill. Found on beaches in the French Basque Country and the south of "département des Landes" (the Landes department).

21. Plastic Pall Rings (Ø 25 mm, depth 25 mm)
Developed by the Pall Ring Company

22. Plastic Pall Rings (Ø 28 mm, depth 28 mm)
Developed by the Pall Ring Company

23. Biofill type A (Ø 70 mm)
Developed by the company BioFill. Found in small quantities on beaches in the French Basque Country and south of the Landes department. According to some sources, this model has also been found for around 15 years in Brittany.

24. Bioringen Filter Media (Ø 48 mm, depth 30 mm)
Model name and brand unknown. Model available on most German hobby aquarium sites. Anecdotal reports of finds in south west France.sud-ouest.

ANNEX III

EXCERPTS OF DISCUSSIONS ON THE FORUM OF THE WEBSITE NISHIKIGOI-BASSIN.FR SPECIALISING IN HOBBY KOI CARP FARMING

Excerpt from discussion no. 1

The water pressure forces the bio balls up to the surface, which can lead to a blockage at the outflow, causing an overflow.

Excerpt from discussion no. 2

You put the Kaldnes biomedia in a filter compartment and a month later they're everywhere. So they really need to be closed off. If they're static are they easier to control?

Excerpt from discussion no. 3

Forget about it, Kaldnes are a great mechanical filtration system, but they get blocked and cause overflows. Believe me, my tank started to empty, I was lucky...

Ah, you've got rid of your static Kaldnes, I thought you were happy with them. How did the overflow happen?

Did the water **lift** *the Kaldnes up?*

Yes that was it, and as soon as the Kaldnes were gone it stopped. They weren't static. They were moving slightly but it wasn't enough. You need a lot of movement to stop them getting blocked.

Excerpt from discussion no. 4

So coming back to Kaldnes, they are kept moving by the bubbles from the air diffusers in order to achieve optimum performance. I've had various problems with them. The Kaldnes are 11 or 12 mm in diameter, so I placed a vertical mesh with 10 mm holes on the wall separating the partitions to stop them from getting into the next tank. But some of them still got through the mesh – I don't know how. Others travelled up the mesh, which was a major headache as they were pushed by the water current towards the next tank, accumulating in front of the mesh and blocking the water from getting through.

This caused the water level to drop in the next tanks because the pump kept on pumping. I've tried various types of grilles without getting any better results. So I've come up with a radical solution. I've built a cage that is smaller than the filter tank, allowing the water to pass easily between the cage and the edges of the tank.

Screenshot of the home page of the website http://nishikigoi-bassin.xooit.fr/index.php

ANNEX IV

IV.A. LETTER SENT ON ON 11 DECEMBER 2013 FROM THE TOWN COUNCIL OF SAINT PREX TO THE COMMUNAL COUNCIL

Communication no 37/12/2013

Subject: discharge of biomedia from wastewater treatment plant

Madame Chair, councillors,

We experienced an overflow while commissioning the fluidised bed reactor at the end of the primary settlement tanks in April 2012.

The supplier half filled an initial basin before adding the plastic carriers (or chips). Since the new chips do not sink easily, and because of the large number that had to be added to the basin, chips ended up spread around the WWTP (especially in the primary settlement basin). Some of these plastic chips were later found in the environment.

If there is a sudden increase in the incoming water flow, the chips in these fluidised bed reactors can be pushed and become stuck over the outflow grille. They can completely block it, leading to the basins overflowing.

This is what happened on 27 and 28 September 2012, when the rate of influent flow rose to almost 200 l/s (before the spill).

At first, we thought the incident had been restricted to within the WWTP, and it was not until later that we realised that some of the chips had escaped into the environment.

Since then we have put in place a certain number of technical upgrades in order to ensure there will be no future overflows. We have done everything to mitigate overflow issues as quickly as possible.

The modifications we have made should mean there will be no future losses of plastic biomedia into the environment.

IV.B. INTERVIEW WITH THE INSTALLERS AND MANAGERS OF THE SAINT PREX WWTP ABOUT LOSS OF BIOMEDIA

Report of the meeting on Wednesday 23 October 2013 in Saint-Prex with Mr Villey (from the GED research office), the managing director of Techfina, the manager of the Saint-Prex WWTP and Gael Bost, Surfrider Léman volunteer

Why did you choose this process over another option?

Before the works, the Saint-Prex WWTP had a treatment capacity of 10,000 population equivalent. The town was growing so we wanted to increase the WWTP's capacity from 10,000 PE to 15,000 PE. This is why we came to the decision of altering the primary settlement basin. One-third of the primary settlement basin was modified to contain a tank for the fluidised bed (using Biowater Technologie BWT15 model biomedia). This alteration made it possible to support the culture, by delivering more air to the existing bacteria (activated sludge after the primary settlement basin). The tank holding the biomedia therefore 'smooths the way' by treating the water in this tank to relieve the activated sludge basin.

In total, this modification has made it possible to go from 10,000 to 15,000 PE. However, this doesn't mean that this basin alone can treat the water for 5,000 PE. It's important to understand that the tank has been added to an existing WWTP, and all it does is enable us to carry out a kind of 'pre-treatment' for the water.

Biomedia systems, or fluidised beds, are 4 to 5 times more effective than an activated sludge basin and take up much less room.

We also decided on this process because it was less complicated and the most straightforward (limited works and costs, easy set-up and maintenance). Another alternative could have been a physical-chemical treatment process, but that would have cost a lot more.

How effective is this compared with other processes?

Biomedia systems, or should I say fluidised bed reactors, are 4 to 5 times more effective than an activated sludge basin and take up much less room. It has been a policy for several years in the Canton of Vaud to have WWTPs close to the people who use them. This is why nearly every town in the canton has its own WWTP, nearly all of which up until now have been built as activated sludge plants. However, in 2004 the national government decided to ban the spreading of sewage sludge on agricultural land. The Canton of Vaud is an important farming area, so it had been easy to deal with the sludge by spreading it on the land. However, once the ban came in, this had a dramatic impact on operations at the WWTPs in the canton, which all of a sudden had to deal with the sludge that had previously been spread on the land. The national government also required each WWTP to manage its own sludge. This has meant that, since 2010, the WWTPs have started to increasingly group together, because this change and the modifications to the WWTPs are still a problem today.

What cost implications has this had?

Building a new plant for the level of demand in each town would have been much too expensive. So the plants were enlarged by laying down a slab and two walls. Maintenance costs €100,000 per year per WWTP.

What is the minimum level of PE at which it is recommended to use biomedia?

This is not what is taken into account at all when deciding whether to choose biomedia or another solution. It depends on whether it's a newly-constructed plant or a modification to an existing WWTP. You need to come up with the most appropriate solution in each case (the simplest to implement, and therefore the one involving the least work and cost).

You have to take a number of things into consideration:
- The number of PE to be served,
- The available land area (geographical zone): if there is space then activated sludge will be the first choice in 99% of cases,
- Budgetary limitations,
- The effluent quality that must be met (the discharge consents may vary in different countries and cantons).

So there are generally three solutions:
- Activated sludge. This is the cheapest process to put in place, and the easiest to maintain. However, this requires a lot of space.
- Fluidised bed reactor (biomedia tank). This is a mid-ranking process. It's more expensive than activated sludge but takes up much less space and is also more effective (4 to 5 times more effective for a tank of the same size).
- Biofiltration, which works against the current, and so uses a great deal of energy. However, this is the most effective method today. There are various kinds (pouzzolane, polystyrene balls, etc.).

Once the biomedia are in the tank you never need to take them out, clean them or change them. They are there for the whole lifetime of the WWTP...

This is therefore currently the best wastewater treatment system. It takes up the least space, but nevertheless requires heavier equipment than the other systems, and also uses a lot of energy.

How many biomedia do you use per tank?
The tanks are filled to a maximum level of 60% of their volume.

What happened to cause the spill into the environment?
A violent storm led to an increase in the influent flow. The overflow channel is operated manually, and it took too long to activate it to divert the incoming flow. This caused a kind of 'wave' in the settlement basin, which pushed the biomedia down and then caused the basin to overflow. The other problem during storms is that the water has a higher oxygen content. The oxygen sensors registered this increase and sent this information to the diffusers, which reduced the air being blown into the tank. This reduced the mixing and led to the biomedia causing a blockage and the activated sludge basin overflowing.

Who raised the alarm about this problem?
A water level sensor in the tank triggered a visual alert (a flashing light which alerted the on-duty technician, who was actually the WWTP manager).

How did the first person on the scene react?
They activated the entry channel, which manually reduced the flow of water entering the WWTP.

How many biomedia were lost?
To tell you the truth you know more about it than me. I didn't think the plastic pieces had got out into Lake Geneva, or if they had done only a few. I thought they had ended up in the settlement basin or that they had sunk down to the bottom of the activated sludge basin.

Has the plant been modified since then?
- The 'diversion' channel has been modified. It now acts automatically according to the incoming flow.
- Installation of water level sensors. Several sensors detect any rise in water level, and act to reduce the flow by activating an additional air diffusion to prevent blockages.
- Installation of perforated stainless steel tubes welded horizontally to the outflow grille, enabling the water to get through even in the event of blockages.

Had any of you been forewarned about the risks of blockages/ overflows/ spills?
(Answer from the managing director of Techfina) In Evolène it was the WWTP operator who undertook the modifications by making a hole in one of the tanks. We didn't even know this had been done, and this was the reason why the biomedia got it. If this alteration hadn't been made the media would have remained in the tank.

In the case of Saillon, the cantonal authority alerted us to the spill into the environment. The WWTP never contacted us after the incident to ask us what to do. It seems that the problem was down to their decision to reduce the air being diffused in an effort to cut costs. This is calculated according to the anticipated flow and show not be modified in order to avoid blockages.

So the thing is that we only just found out about these

Above: Attempts to recover biomedia lost from the wastewater treatment plant at Evolène © Frank Odenthal

incidents. Now we are of course taking great care with each project, and we have had to adapt our ongoing projects in order to mitigate this problem with the process.

Are you aware of any other users of biomedia aside from municipal WWTPs?
Vegetable and meat packing businesses, and it's also being trialled in fish farms.

Do people at WWTPs using biomedia receive any particular training regarding their use?
(Answer from managing director of Techfina) Our supplier introduced us to this new process and gave us a lengthy explanation of how it works, but did not warn us about the risks of overflows. Did they not want us to know about this or did they not know themselves? I don't know. We are still working with the supplier today to investigate and put solutions in place for WWTPs using this process.

(Answer from the research office) The training given for wastewater treatment engineers must surely include training on this new process, but given that it's a long time since we've been in school I can't be certain of this.

What is the lifetime of a WWTP?
For the equipment 25 years, and 50 years for the building. For the biomedia over 50 years! Once they are in the tank there's no need to take them out, clean them or change them. They are there for the whole lifetime of the WWTP. And nobody's really thought about problems until now because it's such a recent process.

IV.C. LETTER FROM THE ENVIRONMENTAL PROTECTION SERVICE OF THE CANTON OF VALAIS TO THE COMPANY TECHFINA REGARDING THE POLLUTION OF LAKE GENEVA

CANTON DU VALAIS
KANTON WALLIS

Département des transports, de l'équipement et de l'environnement
Service de la protection de l'environnement
Section protection des eaux

Departement für Verkehr, Bau und Umwelt
Dienststelle für Umweltschutz
Sektion Gewässerschutz

TECHFINA SA

M. Jean-Luc Staub
Av. des Grandes-Communes 8
1213 Petit-Lancy/Genève

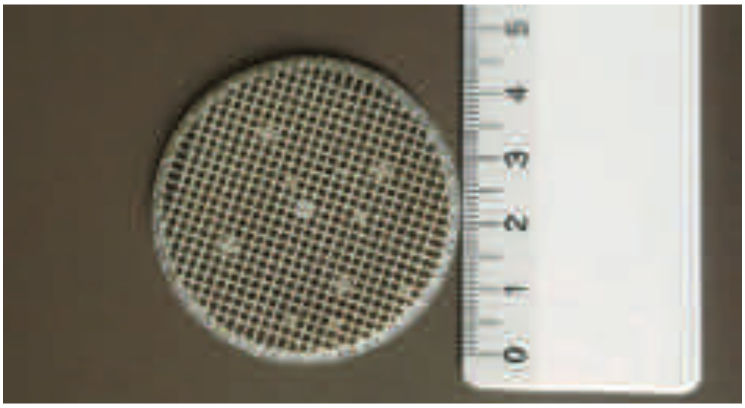
Notre réf. Marc Bernard / Pierre Mange
Votre réf. /

Date 03 août 2012

Pollution du Lac Léman par des supports de biologie fixée

Monsieur Staub,

Nous avons été sollicités en date du 2 août 2012 par le Canton de Vaud qui remarque depuis environ 2 mois, dans le lac Léman, principalement le Haut Lac, mais également jusqu'à Lausanne, la présence de milliers de « filtres » en plastique flottant sur la surface de l'eau (diamètre de 4,7 cm / épaisseur de 2 mm, cf. photo). Un même constat est effectué par divers professionnels du lac (pêcheurs, SIGE, écoles nautique, gardes ports, garde-pêche) en patrouillant sur le lac.



Le Canton de Vaud nous questionne quand à la provenance de ces éléments flottants et nous demande notre concours afin de faire stopper ces déversements importants.

Vous n'êtes pas sans ignorer les pertes de supports des lits fluidisés Kaldnes qui ont été constatés sur les STEP de Saillon (1er janvier 2012) et d'Evolène (29 mars 2012).

En tant que fournisseur d'équipement pour les deux STEP susmentionnées, et afin de pouvoir répondre à nos collègues vaudois, nous nous permettons de vous demander de nous fournir les éléments suivants :

Bâtiment Mutua, Rue des Creusets 5, 1950 Sion
Tél. 027 606 31 70 · Fax 027 606 31 54 · e-mail : marc.bernard@admin.vs.ch

1. la confirmation de la correspondance des disques retrouvés sur le lac avec ceux perdus sur les STEP de Saillon et d'Evolène ;

2. une évaluation des quantités perdues (volume, nombre d'éléments) sur chacune de ces STEP ;

3. la confirmation que ces déversements importants ont été jugulés ;

4. la description des mesures prises pour éviter de nouveaux déversements à venir.

Selon notre compréhension de la problématique, ces pertes de support ont dans les deux cas été entraînées par un colmatage des tamis en sortie des bassins à lit fluidisé, par suite d'aération insuffisante.

Nous avons constaté sur la STEP de Saillon combien l'aération de nuit doit être maintenue importante, même en l'absence de besoin avéré pour la biomasse, dans le simple but d'éviter un colmatage des tamis.

Pouvez-vous nous informer de quelle manière votre système d'épuration pourrait être modifié sur ces deux STEP afin de garantir le brassage nécessaire autour des tamis sans entraîner une consommation énergétique excessive pour l'aération de l'ensemble des bassins ?

Dans l'attente de vous lire, et en restant à votre disposition pour tout renseignement complémentaire, nous vous prions d'agréer, Monsieur Staub, l'expression de nos meilleures salutations.

Marc Bernard
Chef de section

Annexe

Copie à Etat de Vaud, Service des eaux, sols et assainissement, MM. Vioget, Strawczynski et Jaquerod, Ch. des Boveresses 155, CH-1066 Epalinges
CIPEL, ACW – Changins, Route de Duillier 50, CP 1080, 1260 Nyon 1
Administration communale de la commune d'Evolène, Case postale 83, 1983 Evolène
Exploitant de la STEP d'Evolène, M. Escobar, 1983 Evolène
Administration communale de la commune de Saillon, Rue du Bourg 19, 1913 Saillon
Exploitant de la STEP de Saillon, M. Mendes, Traverse de la STEP, 1913 Saillon

2/2

IV.D. RESPONSE FROM THE COMPANY TECHFINA TO THE ENVIRONMENTAL PROTECTION DEPARTMENT OF THE CANTON OF VALAIS IN RELATION TO THE POLLUTION OF LAKE GENEVA

techfina

Techfina S.A.
5, avenue des Grandes-Communes
1213 Petit-Lancy Genève
Téléphone [illegible]
Téléfax [illegible]
E-mail [illegible]
Compte postal [illegible]

03 sept. 2012

Canton du Valais
Service de la protection de l'environnement
A l'att. de M. Marc Bernard
Bâtiment Mutua
Rue des Creusets 5
CH – 1950 Sion

V. réf. N. réf. [illegible] Petit-Lancy, le 31 août 2012

Concerne : Pollution du Lac Léman par des supports de biologie fixée

Monsieur,

Nous faisons suite à votre courrier du 3 août 2012 reçu le 14 août dernier concernant les pertes de supports de biologie fixée et vous prions de bien vouloir trouver ci-dessous nos éléments de réponses à vos diverses questions :

1. Les disques retrouvés en surface du lac correspondent effectivement aux supports livrés dans les STEP de Saillon, d'Evolène et de Lausanne (livraison Alpha Umwelttechnik).

2. Les quantités perdues par les STEP de Saillon et d'Evolène n'ont pas été évaluées. Pour cela, il faudrait vider l'eau des réacteurs pour estimer le volume de supports restant.

3. Ces deux déversements étaient des événements ponctuels dus chacun à un concours de circonstances particulières. Ces déversements ont été jugulés.

4. STEP d'Evolène : début avril 2012, des arrivées massives d'eaux claires parasites fortement chargées en oxygène dissous ont augmenté ponctuellement la charge hydraulique des réacteurs et ont entraîné une baisse du régime de marche des surpresseurs d'air (du fait que la demande en oxygène était moindre) donc une baisse de l'intensité du brassage. Cela a provoqué une augmentation du niveau d'eau dans les réacteurs biologiques et une perte de chips par le réacteur n° 3. Les chips ont rejoint l'exutoire par une conduite d'écoulement des eaux de surface raccordée sur ce réacteur pour l'éventuel écoulement du FeCl3 lors des livraisons. Une grille provisoire a été installée par l'exploitant évitant toute perte de chips par cette conduite. La grille définitive est en cours de fabrication.

[illegible]

Genève – Winterthur – Metz

techfina

5. STEP de Saillon : elle est en service depuis juin 2007 et a fonctionné sans problèmes hydrauliques jusqu'à l'événement de janvier 2012. Cet événement est probablement lié à la modification des consignes d'oxygène qui sont, normalement, de 2.5 mg/l pour l'abattement des composés organiques et 4.5 mg/l pour la nitrification. Ces valeurs, plus élevées que pour une boue activée, s'expliquent par la limitation de diffusion à travers le biofilm. En diminuant des consignes d'oxygène plus basses, le besoin d'air diminue d'une part en raison du meilleur transfert d'oxygène et d'autre part suite à la disparition des bactéries nitrifiantes. La première mesure consiste donc à rétablir les paramètres d'aération tels que nous les avons indiqués. L'exploitant a également installé des sondes de niveau dans les réacteurs. Lorsque le niveau monte, le régime des surpresseurs augmente et l'exploitant est averti.

   Selon les données que nous avons reçues de la STEP de Saillon, pour 2009 par exemple, la charge effective est de 4500 EH alors que la STEP est dimensionnée pour 3500 EH. Ceci est en contradiction avec une concentration élevée d'oxygène dissous, même pendant la nuit. La faible consommation d'oxygène pourrait être liée à la perte de biomasse (pertes des chips) ou de la nitrification.

6. Afin d'assurer un bon brassage autour des grilles de sortie des réacteurs, on pourrait envisager l'installation d'une aération spécifique des tamis fonctionnant selon la mesure de niveau effectuée dans les réacteurs.

Nous vous souhaitons bonne réception de la présente et tout en restant à votre entière disposition pour tout renseignement complémentaire, nous vous prions d'agréer, Monsieur, nos salutations distinguées.

TECHFINA S.A.

Jean-Luc Staub   Thierry Dinu

ANNEX V

V.A. PRESS RELEASE ISSUED BY THE MANAGEMENT OF THE WWTP AT CORBEIL ESSONNES

25 February 2010 – 16h30

Incident at the wastewater treatment plant of the SIARCE (Syndicat Intercommunal d'Aménagement, de Réseaux et du Cycle de l'Eau) in Corbeil-Essonnes.

An incident at the SIARCE wastewater treatment plant over the night of 11 February caused a water treatment tank to overflow.

This overflow led to partially-treated water and biomedia (small 1cm media coated with inert and environmentally harmless bacteria used to treat the wastewater) being spilled into the Seine.

The relevant authorities were immediately informed on 11 February.

Expert advice is being sought to establish the causes of this incident and the corrective measures required.

As a preventive measure, additional monitoring equipment and checks have also been put in place in order to prevent any further malfunction.

V.B. ARTICLE FROM THE LE PARISIEN NEWSPAPER ABOUT THE POLLUTION INCIDENT IN THE SEINE

BY: Julien Solonel and Benjamin Jérôme
DATE: 25.02.2010, 07h00

HEADLINE: Plastic discs pollute the Seine
INTRODUCTION: The white plastic discs are out there and they are hundreds of thousands! A week later they can now be found floating on the Seine in Paris, near the confluence with the Essonne.

All you need do is go to the Quai François-Mauriac (XIIIe) and watch them floating on the surface as the water flows past. For over a week now thousands of these plastic discs have been polluting the Seine, from the Essonne in the upper reaches of the river and right through Paris. Called biomedia, these discs, which are just a few millimetres in diameter, are used to treat wastewater in sewage plants.

They should of course never be discharged into rivers.

"I noticed the first of them on 15 February", said Willy Goisbault, a 32-year-old carpenter who lives on a barge in Villeneuve-la-Garenne (92). "I left a sieve in the current for 20 minutes and I collected several dozen. I would say there are hundreds of thousands of them in the whole Seine". Willy and his neighbour Renaud alerted the water police (see box). Agents arrived by Zodiac on 19 February in order to take samples, and removed debris right up into the heart of the capital. "We discovered a pollution incident and conducted an investigation. We have identified several wastewater treatment plants upstream of Paris that could be the source of this incident," said Fabien Esculier, head of the water police.

But things aren't moving fast enough for Renaud and Willy, who are still seeing the plastic pieces floating past their portholes. The two young men, driven by their environmental conscience, decided to take things into their own hands. Yesterday, they travelled up the Seine to pinpoint the exact source of the waste. *"We found at least a tonne of similar discs coming from a plant where works are being carried out by the Syndicat inter-communal d'assainissement et de restauration de cours d'eau (Siarce) in Corbeil-Essonnes"*, said the two eco-warriors, who are planning to bring a civil case for pollution once their information has been verified. The water police are due to confirm today whether the Corbeil plant is the source of the incident, and will launch possible prosecution proceedings. However, Jean-François Bayle, the first vice president of Siarce,

We found a slick of them three metres long and 70 cm high around the wastewater treatment plant...
So many biomedia! They are even on the banks, although they'll surely be carried away as soon as the water level rises...

is doubtful.: *"I was not aware of this pollution event. I am going to investigate to find out whether or not we have been involved in this incident"*.

Fabien Esculier said: *"This pollution incident has no direct negative impact on public health, although it does affect other river users and the landscape. If there is a large amount of waste, we should remove it from the Seine."* Willy and Renaud, meanwhile, describe it as "real environmental disaster. Animals can eat this waste, which will get straight into the food chain". One thing is certain – this new form of pollution isn't only affecting Paris. Over the past few months there have been numerous reports of millions of these little discs washed up on beaches in Vendée, the French Basque Country and in Spain too.

V.C. FIRST ARTICLE WRITTEN BY JOURNALISM STUDENTS

BY: Hélène Lauria and Audrey Salor
DATE: 02.05.2010
HEADLINE: Quiet, we're polluting!
INTRODUCTION: Two months ago between 500 and 800m^3 of plastic 'camemberts' started drifting along the Seine following an incident at the Evry wastewater treatment plant - an incident that went almost unnoticed.

You can hardly see them. Hardly anything has been said about them. And yet no less than 500 m^3 of filter media, each measuring around a centimetre across and used as a support for bacteria used in wastewater treatment plants and other applications, have been found in the Seine.

They could have gone totally unnoticed but for the determination of two riverside residents. Willy Goisbault and Renaud François live on barges at Villeneuve-la-Garenne. Over the course of three days in mid-February they saw *"millions of little balls"*. Consulting the website of the NGO Surfrider Foundation, they found out that these were filter media. Concerned, they tried to contact Greenpeace, then France Nature Environnement (FNE) and the Ministry of Ecology, but all in vain. Ten days later the little plastic balls were still floating past their port holes.

On the advice of Surfrider Foundation, they headed off up the Seine to find out where the filter media were coming from. They found the answer not far from the Evry (Essonne) wastewater treatment plant, which is run by the Syndicat intercommunal d'assainissement et de restauration des cours d'eau (Siarce). *"We came upon a slick around three metres long and 70 cm deep,"* says Renaud. *"So many filter media! They were even on the riverbanks, although they'll surely be carried away as soon as the water level rises"*.

"No information about the situation was made public until several days later".

Siarce sent out a press release just a few hours after an article appeared in the newspaper Le Parisien on 25 Feb., saying that over the night of 11/12 February the plant had suffered *"an overflow of a wastewater treatment tank"*.

Jacky Bonnemains, chairman of the environmental NGO Robin des Bois, said this incident *"was a clear-cut case of negligence"*. The NGO has launched proceedings against X for pollution of aquatic resources at the high court in Evry. Possible penalty: a €75,000 fine and two years in prison.

Although the outcome of the whole affair is still uncertain, Robin des Bois points to *"a manifest lack of transparency"* in Siarce's press release, which states that the water police were informed *"immediately"* about what had happened.

Sébastien Mollet, who works for the water police's National Office for Water and the Aquatic Environment (ONEMA), said: "We were not informed within a reasonable timeframe about this pollution event, given that we are normally the first to be provided with such information". This comment was backed up by Sylvain Cortade, head of the ONEMA inter-departmental service, who said: "We only found out about this accident several days after it happened following publication of an article in Le Parisien".

"A colossal amount"

Something else that doesn't add up: Jean-Jacques Azria, communications and logistics manager at Siarce, said: *"No more than 3 m3 of filter media got out into the Seine"*. However, the water police see things differently. An initial estimate by one source is put at *"500 to 800 m3 of filter media and 4,000 to 6,000 m3 of wastewater – a colossal amount!"* A second said *"800 m^3"*. This is the equivalent of a 25x15m swimming pool.

This quantity is "absolutely not confirmed" by Jean-Jacques Azria, who complains about the incident having been "blown out of all proportion". This may not have happened if Siarce's press release hadn't been so slippery. Jacky Bonnemains says: "They are still going to have problems justifying themselves".

V.D. SECOND ARTICLE BY THE JOURNALISM STUDENTS

BY: Hélène Lauria and Audrey Salor
DATE: 02.05.2010
HEADLINE: Environment: An insidious impact
INTRODUCTION: Hazardous to marine life and non-biodegradable, the filter media are now heading for the sea.

Carried by the currents, the little plastic discs are continuing their journey with total impunity. More than two months since the incident at the Evry wastewater treatment plant. Sébastien Mallet, from the water police's National Office for Water and the Aquatic Environment (ONEMA), says: *"No direct action has been taken to remove the filter media from the Seine"*. The only barriers to their course are the floating barrages put in place by the Paris conurbation's inter-departmental water treatment federation.

These are useful, but not really good enough for the job. Laurent Colasse, a chemist and director of the NGO SOS Mal de Seine, which is fighting to combat the growing amount of waste along the Seine, is taking great interest in the route being followed by the filter media. He started finding them in March along a riverbank in the town of Bardouville (Seine-Maritime), some 310km from the site of the incident. A month later, the biomedia had reached Yville-sur-Seine, just 70 km upstream from the sea.

Already *"some have arrived at the mouth of the Seine"*, says Colasse – a predictable outcome. Jacky Bonnemains, chairman of the NGO Robin des Bois, who is leading a working group on marine waste as part of the Grenelle environment round table initiative, says: *"This type of pollution will reach the sea easily, carried by the currents"*. Once it spills out into the North Sea, the waste from the Seine will continue on its way towards the west of Denmark.

If you go to the Quai François-Mauriac, you can see them floating on the surface as you watch the water flowing past. After a week, thousands of plastic cylinders are polluting the Seine...

"Indisputable consequences"

...Even if they don't wash up on our coasts. François Verdet, manager of the Basque chapter of the NGO Surfrider Foundation, gives a grim overview of the situation.

"It's shocking. These filter media are supposed to take pollutants out of the water, but here we are finding them on our beaches". He says the tourist industry is also a victim of this type of pollution. *"Tourism is the lifeblood of the regions. Communities along the coast need financial support to clean up their beaches"*, he complains. These little chunks of polypropylene, which can adsorb micropollutants from the sea, will remain in the marine system for several decades if not hundreds of years.

Jacky Bonnemains highlights the *"indisputable consequences for wildlife"*. The chairman of Robin des Bois says: *"You can find filter media in the digestive tracts of marine mammals and birds. These aren't a direct cause of death, but have an aggravating impact on the animals' health. They think they are eating but they are filling their digestive systems with inedible objects"*. François Verdet says the same thing: "Plastic ends up breaking down into microscopic particles. It can be found throughout the whole ecosystem and the food chain.

Above: Biomedia washed up on the banks of the Seine
© Willy Goisbault et Renaud François

ANNEX VI

VI.A. REPORT FOR THE TOWN COUNCIL OF SAN SEBASTIAN BY THE AÑARBE WATER MANAGEMENT COMPANY ON ITS INVESTIGATION INTO BIOMEDIA ON BEACHES

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NOTAS SOBRE LA PRESENCIA DE BIOSOPORTES (*CARRIER*) DE DEPURACIÓN DE AGUAS RESIDUALES Y BASTONCILLOS DE PLÁSTICO EN LAS PLAYAS GUIPUZCOANAS

Enrique Noain Cendoya
Presidente de Aguas del Añarbe-Añarbeko Urak, S.A.

Marzo de 2010

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NOTAS SOBRE LA PRESENCIA DE BIOSOPORTES (*CARRIER*) DE DEPURACIÓN DE AGUAS RESIDUALES Y BASTONCILLOS DE PLÁSTICO EN LAS PLAYAS GUIPUZCOANAS

1. Introducción

Se redactan estas notas a solicitud del Alcalde de San Sebastián y Presidente de la Mancomunidad de Aguas del Añarbe, con motivo de la inquietud suscitada por la aparición, en fechas recientes, de un gran número de pequeñas piezas de material plástico en las playas donostiarras.

El pasado 22 de enero de 2010, por el técnico de la Unidad de Investigación Marina de Azti (Centro tecnológico en investigación marina y alimentaria), D. Raúl Castro Uranga, miembro de la Mesa del Agua de la Agenda 21 de Donostia-San Sebastián, se formula a los miembros de la citada Mesa (entre los que se encuentra Aguas del Añarbe) la pregunta de si se conocía la naturaleza de las pequeñas ruedas o discos de plástico que estaban apareciendo en las playas, y de las que adjuntaba una fotografía.

Por Aguas del Añarbe se contestó en esa misma fecha dando cuenta de cómo las pequeñas ruedas se habían identificado con precisión como soportes plásticos, biosoportes o "carrier" ("portador" o cargador) utilizados en la depuración de aguas residuales, tanto urbanas como -muy especialmente- industriales, sobre todo en las de reducido tamaño y cargas contaminantes muy altas.

Fotografía facilitada por R. Castro

2. Naturaleza y utilización de las piezas de plástico aparecidas

El objeto de esas ruedas de material plástico, con radios y aletas exteriores e interiores, es ofrecer una superficie muy elevada en proporción a su volumen; superficie en la que se hace fácil se adhieran comunidades de microorganismos (bacterias) que, al tapizar esas superficies de plástico, forman lo que se denomina una "biopelícula".

Es la tecnología de depuración denominada MBBR (*Moving bed biofilm reactor*-reactor de biopelícula de lecho móvil) la que utiliza esos biosoportes o *carrier*, "sembrándolos" o esparciéndolos en las propias aguas residuales, de manera que las bacterias formen sobre ellos un biofilm, a partir del cual el propio metabolismo de los microorganismos va eliminando o degradando la carga contaminante presente en las aguas para su propio desarrollo y crecimiento. La materia contaminante presente en las aguas residuales constituye, pues, el alimento o sustrato necesario para el crecimiento de la biopelícula.

En esas depuradoras (generalmente pequeñas o compactas, o que han necesitado una ampliación por aumento de la entrada de cargas contaminantes sin disponerse de

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superficie para aumentar el volumen de su tratamiento biológico), el agua tratada sale al medio hídrico a través de un colector equipado de rejillas que retienen el biosoporte dentro del reactor.

En el supuesto de una rotura de esas rejillas de retención, se puede producir el escape masivo de los millares de biosoportes o carrier utilizados en el proceso de depuración. También puede ocurrir que las rejas de retención se colmaten por completo con los carrier utilizados, subiendo el nivel de la arqueta o tanque final, que llega a llenarse por completo y a rebosar por el aliviadero, vertiendo igualmente las indeseadas piezas de plástico.

(Ver página informativa adjunta de la empresa Anoxkaldnes, diseñadora y fabricantes de piezas de este tipo)

3. Noticias sobre la aparición de los biosoportes en las playas vascas

El pasado jueves 11 de marzo de 2010 El Diario Vasco publicaba en su página 11 un reportaje (que se adjunta) sobre la aparición en las playas de la costa guipuzcoana de las piezas en cuestión que, de manera imprecisa, calificaba de "filtros".

El hecho de que el reportaje diera cuenta de su aparición en playas de Motriku, Orio, Getaria, Hondarribia, Zarautz... permitía apreciar ya el carácter generalizado del problema, a la vez que hacía suponer, junto con el hecho de que las corrientes más frecuentes en la costa cantábrica desplazan los elementos flotantes desde el oeste hacia el este, que el origen del problema podría encontrarse en Bizkaia o incluso fuera de la Comunidad autónoma Vasca, pudiendo proceder de Santander, Cantabria o Galicia.

Sin embargo, el hecho de que la depuradora más cercana que utiliza este proceso es, según se cree saber, la de Hendaya, así como la afirmación del técnico de Azti de que, en las fechas en que él dio cuenta del problema, las corrientes parecían discurrir en sentido contrario (de este a oeste), hizo simultáneamente sospechar de la citada depuradora hendayesa.

En todo caso, el mismo día en que El Diario Vasco publicaba su reportaje, Aguas del Añarbe envió al citado medio informativo una nota explicativa de la naturaleza de las piezas plásticas, aclarando terminantemente que no provenían del sistema de saneamiento y depuración del Añarbe.

4. Alarma del Alcalde de San Sebastián – Inspección ocular de las playas

Sin que desde entonces hubiera habido más noticias al respecto, el pasado sábado 27 de marzo por el Alcalde de San Sebastián se señaló a esta Presidencia la presencia masiva de piezas de plástico en la playa de la Zurriola, solicitando se investigara en todo lo posible su naturaleza y procedencia.

Ese mismo día, personal de Aguas del Añarbe procedió a una inspección ocular en las playas de La Zurriola (en bajamar) y La Concha (en pleamar). El que suscribe, por su parte, procedió a idéntica tarea en la mañana del domingo 28 de marzo en los extremos oriental y occidental de la playa de Ondarraitz de Hendaya.

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En la playa de Ondarraitz pudo apreciarse la presencia de numerosas piezas de plástico. En compañía próxima de los biosoportes cilíndricos (las "rueditas") han aparecido también numerosísimos bastoncillos de material plástico de dos tamaños distintos y muy variados colores, que son de dos tipos, con diámetros de 3 y 4 mm y longitudes de 72 y 83 mm, respectivamente. Los más delgados tienen unas pequeñas estrías en ambos extremos, mientras los más gruesos tienen una ventanita o recorte de 2 x 3 mm en uno de sus extremos.

En lo que respecta a las ya tantas veces citadas rueditas, se trata de idénticos elementos a los detectados inicialmente por el técnico de Azti, Sr. Castro, apareciendo biosoportes de tres diferentes tipos y tamaños. Los mayores, presentes en escaso número, tienen un diámetro de 24 mm (probablemente una pulgada anglosajona); los de tamaño intermedio, que constituyen la abrumadora mayoría y son de color negro, verde pálido y blanco o translúcido, tienen un diámetro de 12,5 mm (equivalente a media pulgada); por último, han aparecido ejemplares -también muy escasos- de color negro y diámetro 9 mm.

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Efectuado un somero y elemental ejercicio de contaje para cuantificar la densidad de los elementos aparecidos, puede decirse que en el extremo oriental de la playa de Ondarraitz (en las proximidades de las formaciones rocosas conocidas como "las gemelas") se han encontrado 42 ruedas o biosoportes cilíndricos por cada 100 metros lineales de la huella dejada por la pleamar, acompañados de 66 bastoncillos en idéntica longitud (40% de ruedas y 60% de bastoncillos).

Por contra, en el extremo occidental de la playa (proximidades del espigón derecho de la desembocadura del Bidasoa), la densidad encontrada ha sido de 34 ruedas por cada 100 metros lineales, y de 10 bastoncillos en idéntica longitud (77% de ruedas y 23% de bastoncillos).

Esa somera experiencia permite quizá aventurar la hipótesis de que la transmisión de los elementos flotantes está teniendo lugar de oeste a este, en la medida en que el espigón protegería en ese caso a la parte de playa más cercana del depósito de estos elementos, que se produciría con más facilidad y en mayor número en el extremo oriental de la playa, donde la conformación de la línea de costa presenta un cierto obstáculo a la corriente transversal.

Así, el total de elementos encontrados de los dos tipos es más elevado en el extremo oriental (108 en total) que en el occidental (44 en total). La notoria mayor proporción de bastoncillos en el extremo oriental pudiera quizá también deberse a una eventual mayor velocidad de traslación de estos elementos (más ligeros y estilizados) respecto a la de las ruedas.

En la playa de la Zurriola se ha apreciado una densidad en principio superior al de las ruedas encontradas en Hendaya, si bien no se ha llevado a cabo un contaje por unidad de longitud o superficie. El tipo, color y dimensiones de las ruedas o biosoportes cilíndricos es exactamente el mismo que el de los hallados en Hendaya

(Ver fotografías en la página siguiente)

Por su parte, la inspección ocular de la playa de La Concha no apreció elemento alguno de esta naturaleza, si bien ha de recordarse que se efectuó poco tiempo después de la pleamar y quedando muy poca anchura de arena libre.

5. Origen de los bastoncillos encontrados

En cuanto a los bastoncillos, y si bien en un principio se desconocía su origen, utilidad o uso, posteriores averiguaciones permiten aventurar, con alta probabilidad de acertar, las siguientes explicaciones:

Los de mayor tamaño, como se ha dicho, cuentan con ventanita o recorte en uno de los extremos y parecen ser, simplemente, el soporte de las "piruletas" o chupetes de la conocida marca "Chupa Chups", de consumo tan extendido entre la población infantil. Se cree saber que la muesca que ostentan en uno de sus extremos fue introducida en un determinado por razones de seguridad, para evitar que la bola de caramelo pudiera desprenderse (cuando todavía cuenta con un diámetro considerable) y producir un atragantamiento peligroso para los niños. Lo que se logra cuando, al conformar con caramelo fundido la bola del chupete, una parte se introduce por la ventanita o muesca asegurando la fijeza de la bola de caramelo al bastoncillo-soporte.

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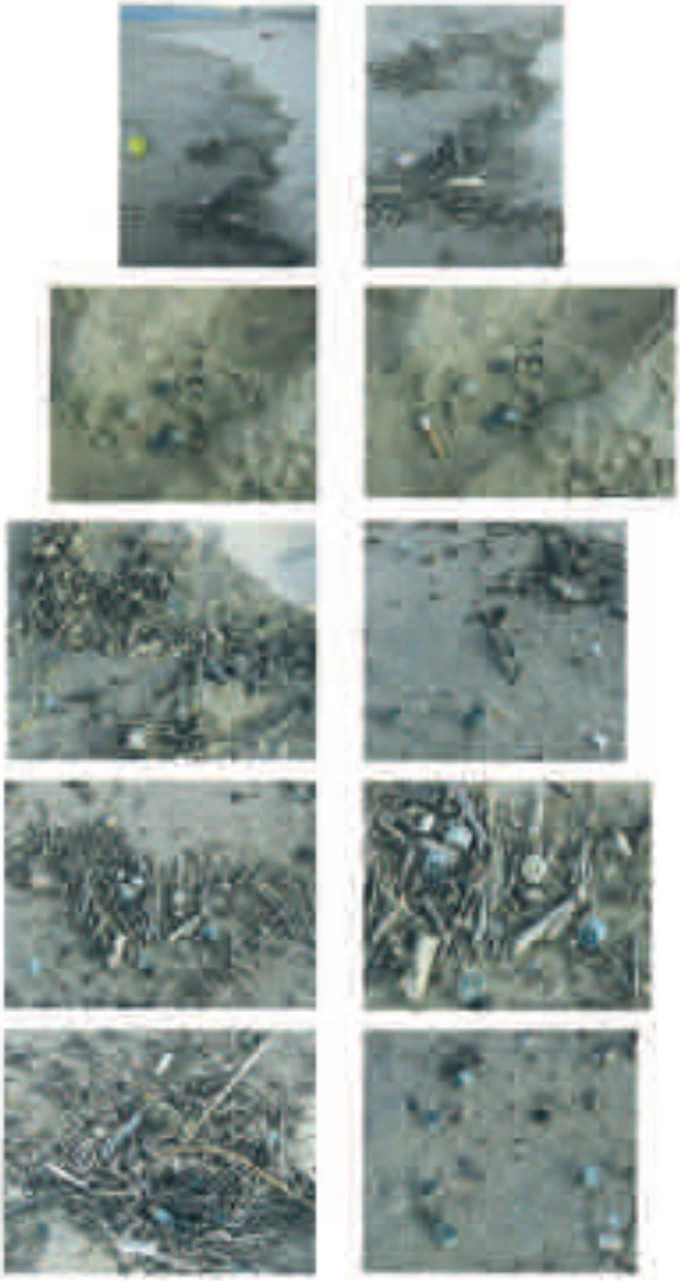
Por su parte, los restantes bastoncillos, de menor diámetro y con estrías en las dos caras de sus extremos, son, casi con total seguridad, parte de los bastoncillos que se utilizan para la higiene o limpieza de los oídos y las fosas nasales de niños y adultos. Los ligeros restos de algodón hallados todavía en alguno de los bastoncillos encontrados acreditan esa hipótesis.



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6. El problema en Galicia y en Francia.

En la mañana del día de hoy, y al emprender averiguaciones acerca del problema, se ha podido comprobar cómo en la Comunidad Autónoma de Galicia la cuestión saltó a la prensa con el mayor relieve a partir del 16 de febrero pasado (ver copias anejas). Desde esa fecha, y hasta el 13 de marzo, han sido numerosos los reportajes y noticias al respecto, de cuya lectura cabe deducir la alarma social causada.

De hecho, se ha recurrido al parecer al SEPRONA (Servicio de Protección de la Naturaleza de la Guardia Civil), Comandancias Navales, Aquamuseum y otros organismos. Por su parte, la representante del BNG en el Congreso de los Diputados ha tramitado una iniciativa parlamentaria demandando al Gobierno la investigación del problema.

En otro ámbitos, la ONG Surfrider, de ámbito europeo, ha manifestado también que viene desarrollando una campaña al respecto (ver documentación aneja), acreditando que el problema se extiende a las costas francesas; habiéndose puesto de manifiesto también la presencia de elementos de este tipo en las riberas del Sena y en Irlanda.

7. Sondeo entre organismos e instituciones competentes

También en la mañana de hoy se ha procedido por Aguas del Añarbe a efectuar un sondeo informativo ante diversos organismos e instituciones competentes en la materia, en averiguación de los conocimientos o información que eventualmente pudieran poseer sobre la cuestión objeto de estas notas, obteniéndose los siguientes resultados:

AZTI: el técnico D. Raúl Castro, que proporcionó a Aguas del Añarbe las primeras noticias al respecto, no tiene nueva información relevante. Dirigió también en su momento la pregunta inicial al técnico de la Dirección General de Obras Hidráulicas de la Diputación Foral D. Félix Izco, que reportó incidencias de vertido de una empresa guipuzcoana, usuaria de estos elementos.

Delegación de Costas de Gipuzkoa: los guardas de Delegación han advertido la presencia de los biosoportes y han efectuado el oportuno parte a los técnicos de la Delegación, sin que haya habido después actuación alguna.

SEPRONA: careciendo la Comandancia de la Guardia Civil de Gipuzkoa de unidad del SEPRONA, los intentos de entrar en contacto (directamente y a través de la unidad de Navarra) con la unidad central del SEPRONA en Madrid han sido infructuosos.

SOS Deiak: han efectuado, a requerimiento de Aguas del Añarbe, numerosos contactos deduciéndose de los mismos que no conocen nada del asunto las siguientes instancias:

- Salvamento marítimo de Bilbao.
- Salvamento marítimo Finisterre.
- Salvamento marítimo central.
- SEPRONA de Cantabria.
- SOS Galicia.

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ATM: Empresa privada dedicada al proyecto, construcción y suministro de plantas de depuración, particularmente industriales. Aguas del Añarbe ha podido contactar indirectamente con su técnico director, D. Andoni Urrutikoetxea. Ha dado cuenta de que dos empresas guipuzcoanas han tenido incidentes o averías en sus instalaciones de depuración que cabe decir, con casi total certeza, han supuesto el desbordamiento de sus balsas de tratamiento biológico por haberse tupido las rejas de retención de este tipo de biosoportes. No se ha facilitado el nombre de las empresas en cuestión.

Agencia Vasca del Agua: confirman los dos vertidos antes aludidos, sin dar tampoco cuenta del nombre de las empresas implicadas. Uno de los incidentes fue investigado directamente por la Agencia, que tuvo conocimiento directo del mismo a través de su guardería. Los vertidos conocidos en Gipuzkoa tuvieron lugar en el mes de noviembre pasado, apareciendo a partir del mes de enero los residuos en las playas. Conocen episodios de este tipo en el Sena, en Irlanda y en el Reino Unido, y dan cuenta de la preocupación existente en el sector industrial fabricante y distribuidor de estas técnicas de depuración por lo repetido de estos incidentes.

8. Conclusiones

La desafortunada aparición de tan numerosos residuos plásticos en las playas parece deberse a la lamentable coincidencia en el tiempo de los siguientes hechos o factores:

1. **Un comportamiento incívico de la población en general que arroja en la vía pública, en la playa, o en los ríos y cauces hídricos los bastoncillos de soporte de los caramelos infantiles conocidos como "Chupa Chups". Bastoncillos de materia plástica de larga vida como desechos en la naturaleza que son arrastrados por las lluvias y las aguas de los ríos y del mar hasta las orillas de las playas.**

2. **Idéntico comportamiento con los bastoncillos de higiene nasal y auricular utilizados, si bien extraña más su presencia en el mar por tratarse de un artículo utilizado mayoritariamente en el hogar.**

3. **Los episodios de vertidos incontrolados producidos en dos empresas guipuzcoanas por rebosamiento de sus tanques de tratamiento biológico al haberse tupido las rejas de retención de los biosoportes utilizados en sus procesos de depuración; elementos también de naturaleza plástica, de larga vida como residuos y alta visibilidad.**

4. **Posible incidencia también de episodios de vertido acaecidos en cursos fluviales o en la costa de la Comunidad Autónoma de Galicia u otras que pudieran ser arrastrados hasta nuestras costas.**

5. **Si bien los orígenes 1º y 2º del problema detectado son de muy difícil (y en todo caso a largo plazo) solución, el origen 3º (y aún el 4º) resultan ser más ocasionales en el tiempo y no habrían de repetirse. Sin perjuicio de instar a las autoridades de la Agencia Vasca del Agua en Gipuzkoa la**

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más atenta vigilancia y sanción de estos episodios, parece de todo punto recomendable emprender una campaña ocasional de limpieza de las playas para retirar todo lo que hasta ahora se haya depositado en su arena, en la confianza de que, no repitiéndose a corto plazo nuevos incidentes de vertido, las aportaciones posteriores de estos residuos (los biosoportes) vayan disminuyendo sensiblemente o puedan llegar a desaparecer.

Enrique Noain Cendoya
Presidente

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VI.B. 10 APRIL 2010 ARTICLE FROM THE NEWSPAPER EL DIARIO VASCO

La costa de las rueditas de plástico

Miles de biosoportes usados en depuradoras invaden las playas de Gipuzkoa

Al menos dos empresas guipuzcoanas han tenido escapes de estas piezas en los últimos meses

:: **JUANMA VELASCO**

SAN SEBASTIÁN. Los paseos por la playa definitivamente ya no son lo mismo. Donde antes había conchitas, algas y, cerca de las rocas, tímidos cangrejos andarines, ahora hay hileras e hileras de rueditas de plástico mezcladas entre las ramas y otros objetos que arrastran la corriente. Las hay de varios colores. Unos días han aparecido en Mutriku, otros en Orio, en Hondarribia, en Zarautz... Hace no mucho le tocó el turno a la playa de la Zurriola de San Sebastián, que amaneció llena de miles de estas pequeñas piezas misteriosas. Más de uno se habrá preguntado, ¿de dónde sale tanta rueda invasora?

Pues bien, estas piezas de plástico son biosoportes que se utilizan en plantas depuradoras de agua, principalmente en industrias. Es una tecnología «en auge», aunque las grandes estaciones depuradoras de aguas residuales urbanas de Gipuzkoa, como la EDAR de Loyola o la de Atalerreka de Hondarribia, no se sirven de este sistema.

Estos biosoportes se utilizan para el crecimiento de bacterias que se alimentan de la materia contaminante y depuran así el agua, que se suelta a los ríos. Habitualmente se encuentran en balsas cerradas en las que entra el agua sucia. Tras el proceso de limpieza, una rejilla permite salir el líquido depurado y retiene dentro los biosoportes. Pero puede haber averías. De hecho, la Agencia Vasca del Agua (URA) ha detectado al menos dos incidentes en empresas de Gipuzkoa que utilizan un sistema de depuración de este tipo y que han provocado el escape de miles de estos biosoportes. Uno de estos problemas tuvo lugar en noviembre, en el Oria.

No obstante, la aparición de estas colonias de rueditas es un fenómeno periódico en distintas playas de Gipuzkoa y no se descarta que provengan de otros puntos de la costa cantábrica, arrastrados por las corrientes.

Preocupación de Elorza

No en vano, el problema no se circunscribe a Gipuzkoa, ni a la costa vasca. Las noticias de las invasiones de estas piezas se extienden desde Galicia –donde han aparecido millones– hasta el Reino Unido, pasando por el Sena, en París.

Hasta ahora, las advertencias de la presencia de estas piezas habían llegado de grupos de surfistas y ecologistas que denunciaban la «contaminación» que provocaban. Pero el propio alcalde de Donostia, Odón Elorza, se hizo eco de la preocupación tras comprobar la presencia «masiva de piezas de plástico» en la playa de la Zurriola, por lo que solicitó que se investigara su procedencia. Técnicos de Aguas del Añarbe se desplazaron al arenal de Gros y a la playa de Ondarraitz de Hendaya para comprobar la presencia de estas rueditas. Hicieron fotos y elaboraron un informe.

En el arenal. Decenas de ruedas sobre la arena de la playa de La Zurriola, en San Sebastián. :: MICHELENA

En el texto remitido al alcalde se explica que ya en enero de este año un representante del Azti-Tecnalia, centro tecnológico experto en Investigación Marina y Alimentaria, llevó a la Mesa del Agua de Donostia la preocupación sobre si se conocía la naturaleza de las piezas.

Los técnicos de Aguas del Añarbe contactaron con una empresa, con sede en Gipuzkoa, dedicada a la construcción y suministro de estas plantas de depuración, quien le dio cuenta que «dos empresas guipuzcoanas han tenido incidentes o averías en sus instalaciones de depuración» que han provocado «el desbordamiento de sus balsas de tratamiento biológico por haberse tupido las rejas de retención de estos».

En el informe se explica además que la Agencia Vasca del Agua confirmó los dos incidentes, que ocurrieron en noviembre, aunque los primeros residuos comenzaron a aparecer en enero en las playas. La agencia investigó uno de los dos incidentes. Asimismo, señalan que en URA dan cuenta de la «preocupación existente en el sector industrial fabricante y distribuidor de estas técnicas de depuración por lo repetido de los incidentes».

Fuentes de la Agencia Vasca del Agua señalaron a **DV** que uno de los incidentes ocurrió en una empresa en el Oria a finales de noviembre. «Hubo un desbordamiento del depósito y en el agua que se escapó contenía estos soportes que se usan en estos reactores biológicos. La propia empresa se ocupó de retirar los soportes que encontró en el cauce del río, pero la corriente se llevó muchos río abajo».

Concentrados mar adentro

Desde URA destacan la dificultad de recoger estas piezas que, «como tienen la misma densidad del agua, ni flotan en la superficie ni se sedimentan en el fondo». Fuentes consultadas no descartan que haya bolsas de estas rueditas mar adentro.

El informe insta a la Agencia Vasca del Agua a la «más atenta vigilancia y sanción de estos episodios» y que se emprenda una campaña de limpieza en las playas.

Una empresa que se dedica a la distribución de estos sistemas de depuración lo dice claramente: «Los plásticos no son biodegradables, pero son inocuos. El impacto ecológico es sobre todo visual».

Un experto en investigación marina asegura que los soportes «se concentran mar adentro». Lo que se ve en la costa podría ser sólo la punta del iceberg del problema. No hay que olvidar que estas piezas ni flotan ni se hunden.

«Además de las molestias para los humanos que usamos las playas, el mayor peligro es para la fauna, ya que los pueden ingerir tanto los peces grandes como los mamíferos marinos», añade el experto. No en vano, los biosoportes son piezas de plástico muy pequeñas con diámetros de entre 9 y 24 mm, detalla el informe de Aguas del Añarbe.

Según denuncian desde Surf Rider Fondation, una asociación que trabaja en todo el mundo por la salvaguarda del mar y del litoral, los fabricantes de estas pequeñas piezas «no han previsto un ciclo de reciclaje para tratar estos soportes una vez han sido utilizados».

Mientras el problema persiste, grupos de surfistas como Orioko Surf Taldea realizan batidas para recorrer las playas y limpiar la costa. «Un fin de semana recogimos 100 kilos de desecho, donde había muchas ruedítas», señala uno de los surfistas. Todavía quedan muchas mar adentro y seguirán dando que hablar.

Bacterias que limpian las aguas contaminadas

Las rueditas de plásticos no son otra cosa que biosoportes que se usan en el tratamiento de aguas residuales que tengan un alto contenido en materia orgánica. Según explica una empresas que se ocupa a la distribución de estos sistemas de depuración, «se trata de un proceso biológico en el que se utilizan bacterias que crecen en el agua. Los biosoportes de plástico se utilizan para que estos microorganismos crezcan adheridos a los plásticos, de forma que el rendimiento de la depuradora mejore». En cada planta hay miles de piecitas a las que las bacterias se adhieren y se alimentan de la materia contaminada del agua. Eso sí, estos plásticos tienen que estar «siempre» dentro de la balsa o reactor biológico. «Es polietileno de alta densidad que ni se degrada ni se repone».

Desde esta empresa, explican que la aparición de estas rueditas en la costa se debe a «que por alguna mala operación haya habido un accidente y esos plásticos se han salido por una rejilla, algo que es difícil, o se hayan desbordado». Según explica, existen sistemas para evitar los desbordes. Esta tecnología de depuración está en auge y se utilizan principalmente en empresas, aunque también para depurar aguas de transatlánticos, piscicultura... «Es una tecnología muy buena, con muchas ventajas y beneficios y una calidad de agua depurada muy buena», añaden.

ANNEX VII

LIST OF MEDIA REPORTS FOCUSING ON ENVIRONMENTAL POLLUTION CAUSED BY BIOMEDIA

Un insólito vertido en el Miño llena de miles de piezas plásticas las peneiras de los pescadores – **La Voz de Galicia**. 16.02.10
Surfrider traque les « camemberts de la mer », de Paris au Portugal – **Eitb.com** 26.02.10
Soir 3 Ile de France – **France 3**. 25.02.10
Une usine de Corbeil soupçonnée de polluer la Seine – **Le Parisien**. 25.02.10
El misterio de los quesitos de plástico – **Alaplaya.com**. 25.02.10
Pescadores del Miño recogen una nueva remesa de plásticos – **La Voz de Galicia**. 20.02.10
Aneis de plástico en praias e ríos: poluir para limpar? – **Adega**. 19.02.10
La piezas de plástico que invaden el Miño provienen de una depuradora – **La Voz de Galicia**. 26.02.10
Los plásticos del Miño tocan tierra – **La Voz de Galicia**. 23.02.10
Embarras autour d'une pollution au plastique dans la Seine – **Rue 89**. 02.03.10
Milaka plastikozko piezek Gipuzkoako hondartzak hartu dituzte – **Eitb.com**. 05.03.10
Los filtros de plástico invaden la costa de Gipuzkoa – **Diaro Vasco**.13.03.10
Plainte contre X pour la pollution de la Seine aux rondelles plastiques – **Usinenouvelle.com**. 11.03.10
Araztegiei plastikozko piezak itsasora isuri izana egotzi diete hainbat taldek – **11 Barri**. 15.03.10
Des millions de camemberts en plastique dans l'eau – **France Info**. 163.03.10
Invasion de roues plastiques à Contis Plage – **Contis Plage.** 18.03.10
Etrange pollution aux « camemberts » dans les eaux des Seine – **Le Courrier des Yvelines**. 17.03.10
Pollution sur la côte océane – **Sud Ouest**. 03.04.10
La costa de las rueditas de plástico. **Diario Vasco**. 10.04.10
Dossier « biomédias » – **19/20 France 3 Aquitaine**. 17.04.10
Le mystère des petits « camemberts » à la mer – **Sud Ouest**. 18.04.10
Le camembert en plastique... Un nouveau venu dans la pollution. **Le Sans Culotte 85**. 04.10
Vertido de biosoportes en la costa Gipuzkoa – **ETB / Euskadi Directo**. 19.04.10
Vous reprendrez bien un peu plus de camemberts? – **La Minute Verte / France Bleue Pays Basque**. 22.06.10
El descontaminador contaminante – **www.surf30.net**. 02.07.10
Pollution : c'est quoi ces ronds en plastique sur les plages ? – **Blog Surf Prévention**. 15.07.10
Ecologistas denuncian la contaminación del litoral por miles de biosoportes de plástico de depuradoras – **Europapress**. 20.08.10
La Consejería dice que los plásticos de las depuradoras no son de Cantabria – **El Diario Montanes**. 21.08.10
Aparecen miles de biosoportes de depuradoras en las playas – **El Diario Montanes**. 23.08.10
El misterio de las rueditas de plástico – **www.naturalsurfing.com**. 04.10.10

Enquête Surfrider sur les media filtrants – **http://blog.surfrider.eu**. 12.10.10
Biofilters wash up on Atlantic beaches – **www.driftsurfing.eu**. 12.10.10
Les stations d'épuration à l'origine d'une pollution des eaux – **Ecologie-blog.fr**. 03.10.11
Ecologistas piden que se identifique a responsables de vertido de biosoportes – **EFE Verde**.
L'invasion des media filtrants : des stations d'épuration à l'origine de cette nouvelle pollution majeure des eaux – **cdurable.info**. 07.11.10
No alarms at Hooksett plant that dumped disks – **Union Leader**. 16.03.11
Millions of disks, tons of raw sewage spilled from Hooksett plant – **Union Leader**. 16.03.11
Cost of sewage disk cleanup mounts – **Union Leader**. 01.03.11
Disks that escaped from Hooksett treatment plant used to grow bacteria – **Nashua Telegraph**. 21.03.11
Hooksett Says It Plans To Pay For Disk Cleanup – **WMUR9**. 18.03.11
NH sewage plant sends disks down Merrimack – **Lowellsun**. 20.03.11
Treatment plant disks put beachgoers to work – **Union Leader**. 08.03.11
Public information: DES boots it on Hooksett spillk – **Union Leader**. 24.043.11
Beach Mystery Came From Mamaroneck Treatment Plant – **The Loop**. 16.07.11
Plastic circle invasion courtesy of Conn. sewer plant – **The Block Island Times**. 29.07.11
Les gardiens de la côte, une vigie citoyenne – **France 3 Aquitaine**. 08.03.11
Littoral : ces « gardiens de la côte » qui combattent la pollution – **AFP**. 29.07.12
François Verdet, un « gardien de la côte » devenu spécialiste de la pollution plastique – **20 Minutes**. 08.08.12
Peut-on se fier au label Pavillon Bleu ? – **France 2**. 14.08.12
La chronique des Gardiens de la Côte – **Radio Lazer**. 16.10.13
Kläranlagen verschmutzen Strände – **Der Tagesspiegel**. 30.07.13
Reaparece en A Guarda la plaga de las fichas de depuradora – **La Voz de Galicia**. 31.07.13
El Seprona investiga el vertido de piezas de plástico al Miño – **La Voz de Galicia**. 31.07.13
«Hay miles y del mismo modelo pero no creo que sean los del 2010» – **La Voz de Galicia**. 25.10.13
Ausgerechnet Kläranlagen spülen Plastik ins Meer – **VDI Nachrichten.** 29.10.13
Generation Change: Holding polluters to account – **Deutsche Welle (DW)**. 10.11.13
Klärwerke als Umweltsünder – **Neues Deutschland.** 04.12.13
Mystère des «chips» du lac résolu par des écologistes – **20 Minutes**. 09.01.14
El Miño se cubre de plásticos – **La Voz de Galicia.**. 10.01.14
Denuncian unha vertedura de millóns de pezas de plástico ao río Miño – **Television de Galicia**.. 05.01.16
Les Verts veulent éliminer les «biochips» des plages – **24 Heures**. 04.01.2016

NOTES


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