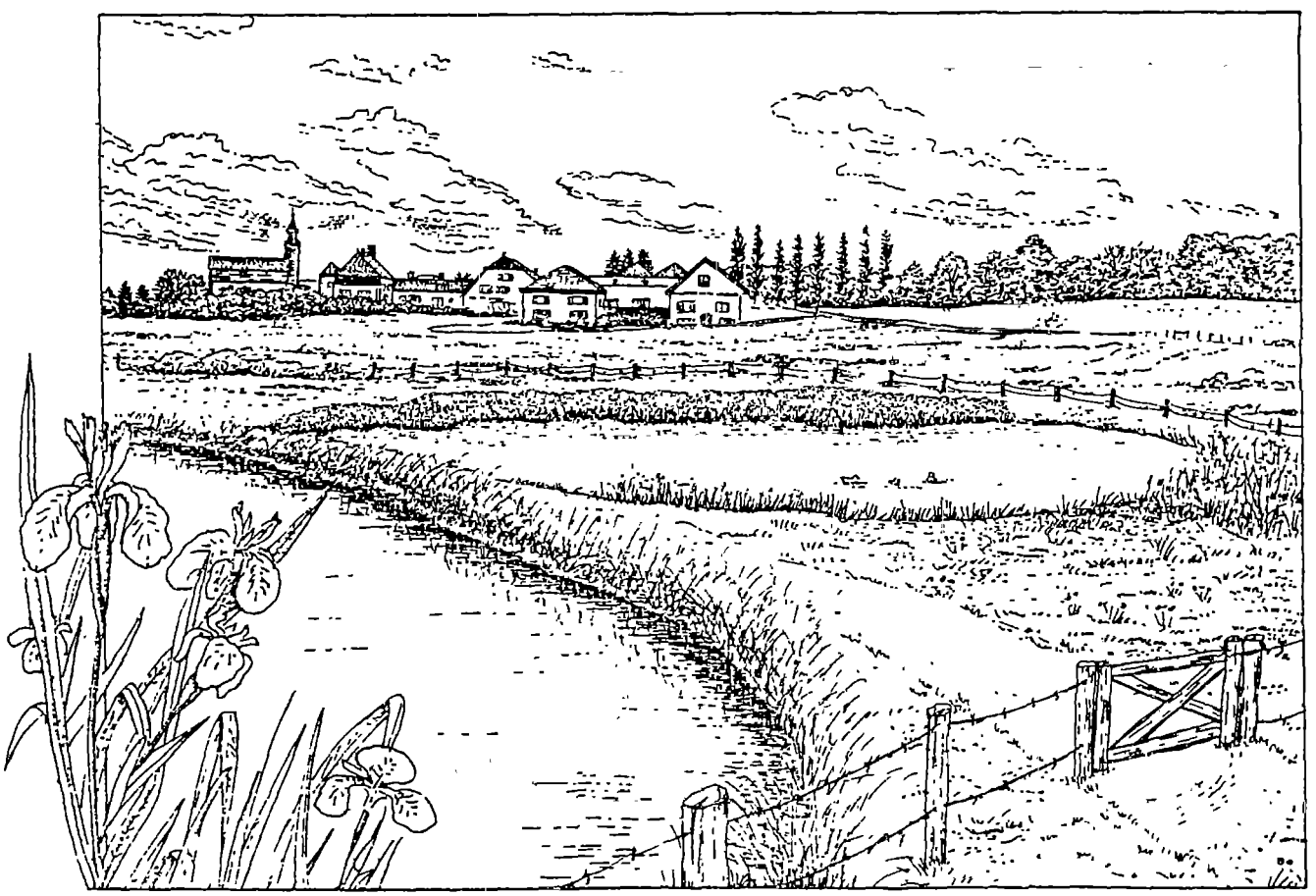
NATURAL WASTEWATER LAGOONS MANAGEMENT

A technical guide for small communities



CEMAGREF

MINISTERE DE
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ET DE LA FORET

WORLD HEALTH ORGANIZATION
REGIONAL
COPENHAGEN

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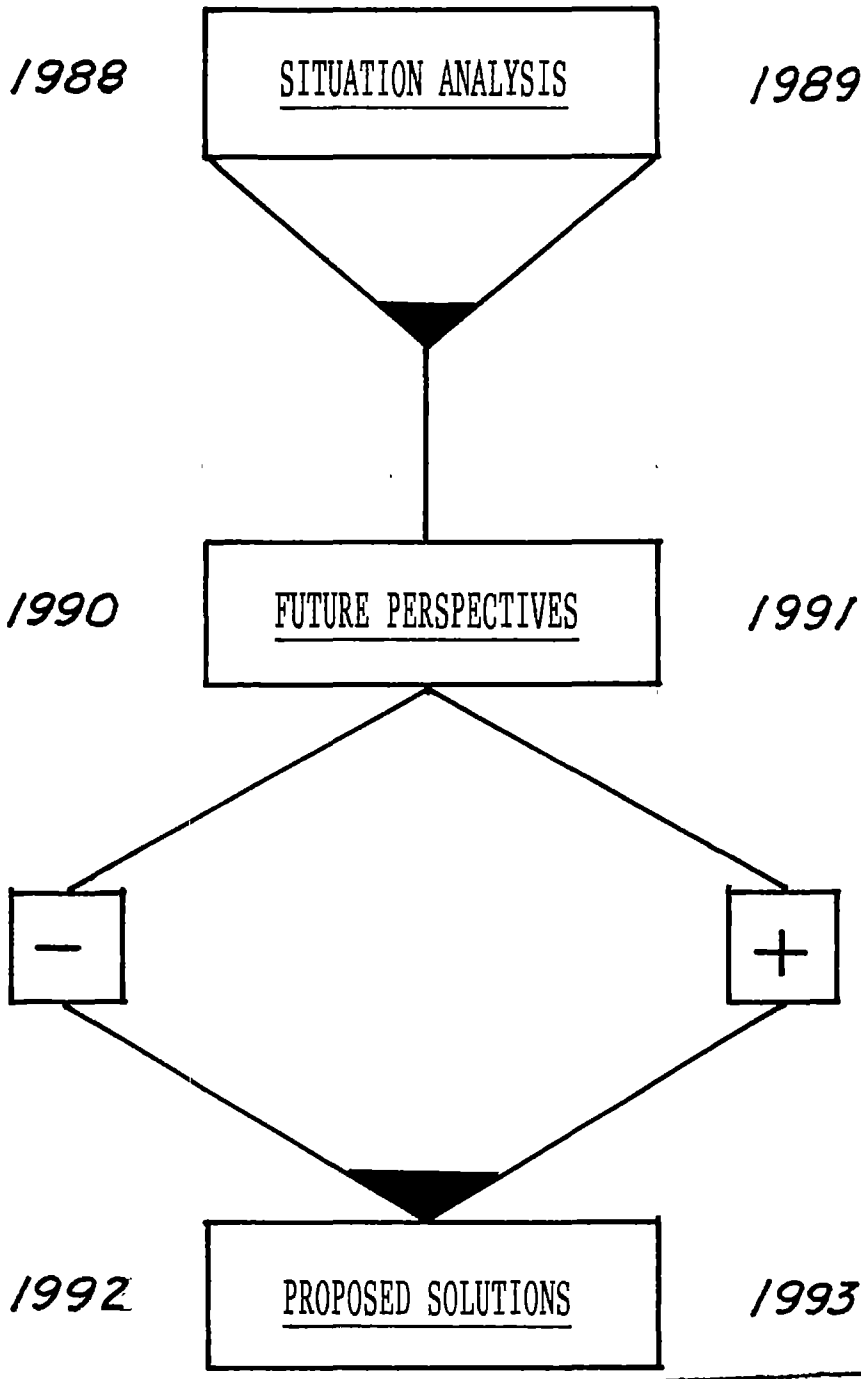
WHO OMS

World Health Organization, Regional Office for Europe, - 8 Scherfigsvej DK 2100 Copenhagen

Original version in French: decembre 1985: English version : novembre 1989.



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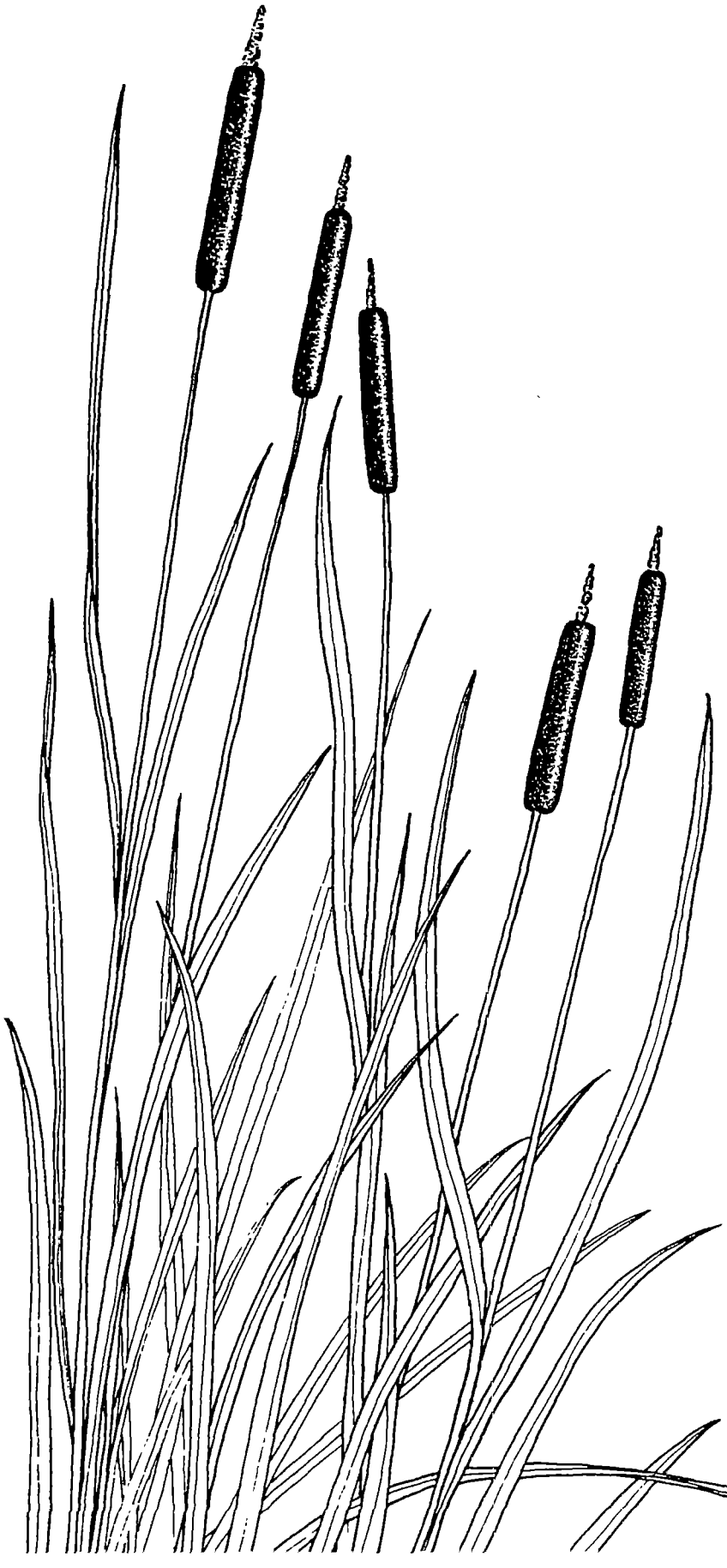

NOTES:

During a meeting on "Waste Stabilization Ponds Technologies" carried out in Lyon, France, by CEMAGREF, A WHO/EURO Collaborating Centre, the Working Group recommended that the Guidelines prepared by CEMAGREF on the Operation and maintenance of Natural Lagoons, should be translated into english, in order to make this document available to the techniciens of english speaking countries operating natural wastewater treatment lagoons.

Although the operations and methods described in this document are valid for the conditions prevailing in the southern part of France, the same criteria and principles can be applied when preparing similar guidelines for natural lagoons operating under different geographical conditions

THE OPERATION OF NATURAL WASTEWATER LAGOONING FACILITIES

A TECHNICAL GUIDE FOR SMALL COMMUNITIES

INTRODUCTION

In recent years, natural lagooning has become increasingly popular for the treatment of wastewaters from rural communities of less than 1 000 people in size ("small communities"). The number of facilities now in operation is estimated to be over 600 and several hundreds are now under construction.

Since natural lagooning involves no electromechanical component*, the operating costs are low. This is no doubt why this sanitation system is favoured by many communities.

However, a minimum number of routine maintenance tasks are necessary to keep the ponds tidy and to ensure that the plant performances are retained. Whereas the responsibility of the contractor in charge of the project engineering is to design an efficient and reliable facility, the responsibility of the owner will be to ensure that the plant remains fully operational.

Most of the maintenance operations involved may be handled by staff not specifically trained in water purification techniques. This manual intends to provide practical basic recommendations for the efficient running of lagooning facilities.

The first part of the manual is a reminder of the chief technical data pertaining to the lagooning technique. The daily operation tasks are described in the second part of this brochure and the third part provides (in form of data sheets) the necessary infomartion to help the operator in detecting malfunctions, identifying the causes thereof and deciding on the appropriate corrective action.

* Unlike "aerated ponds" which are not decribed here.

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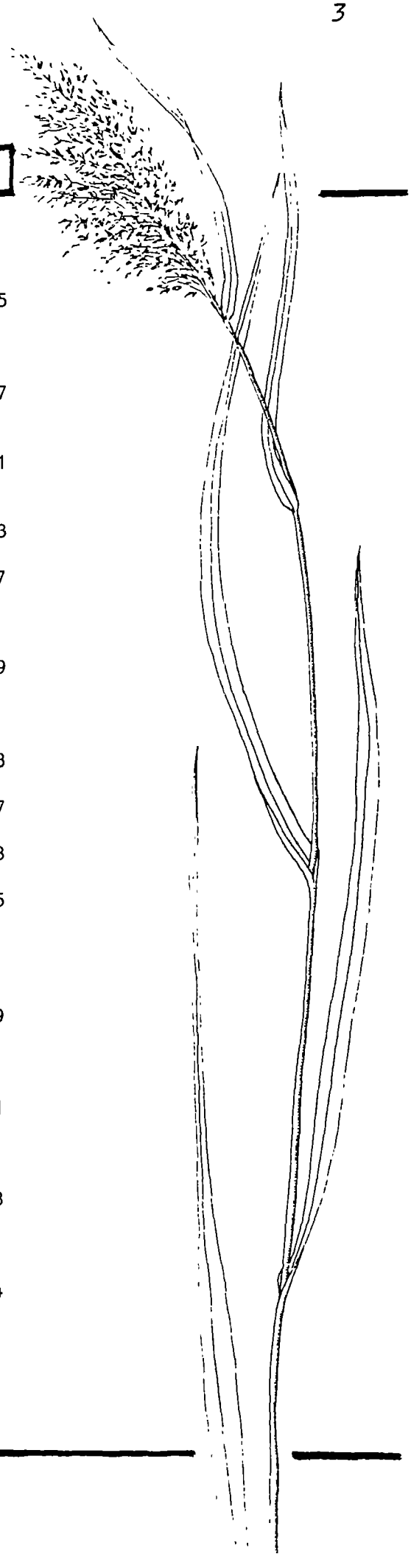
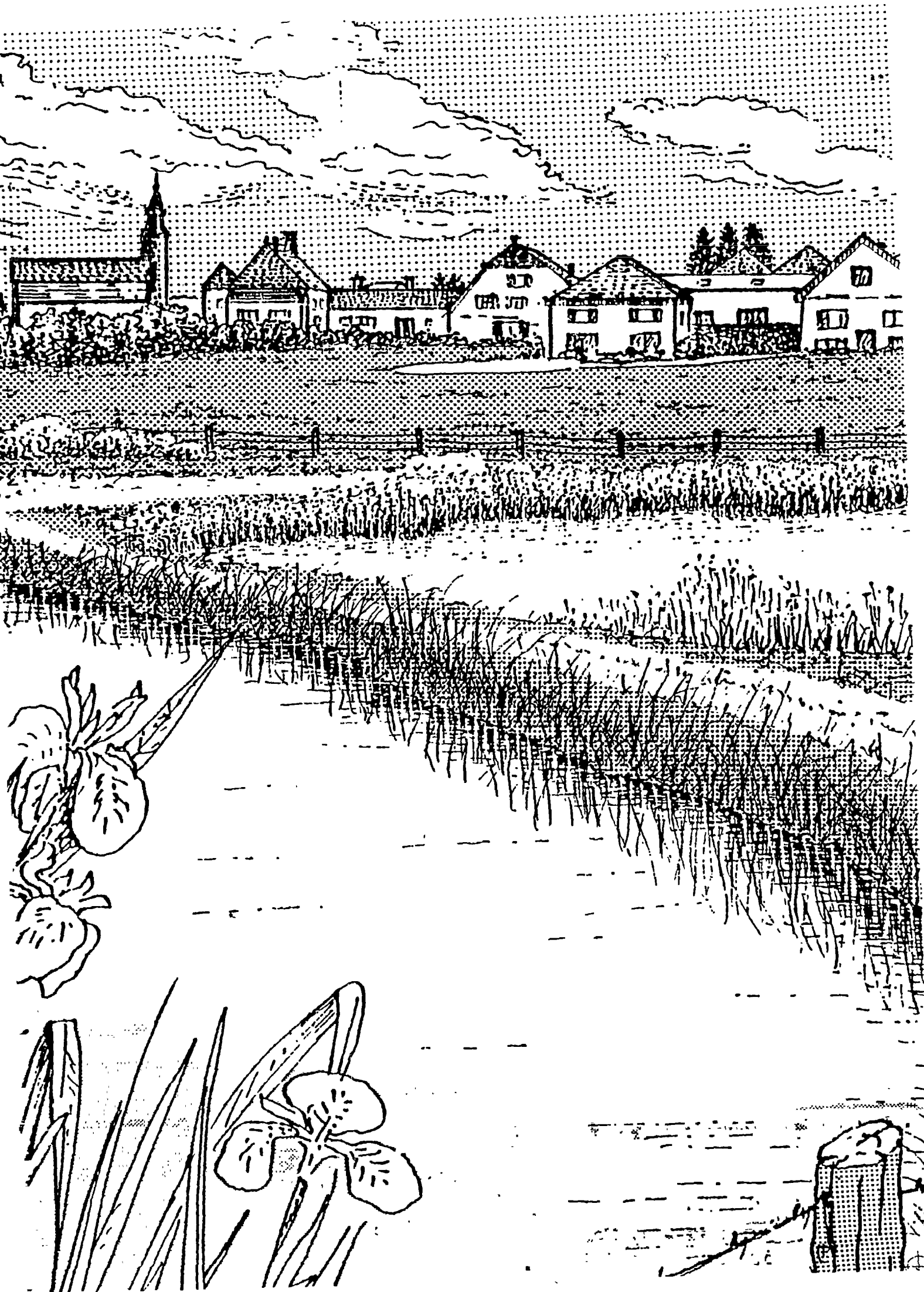
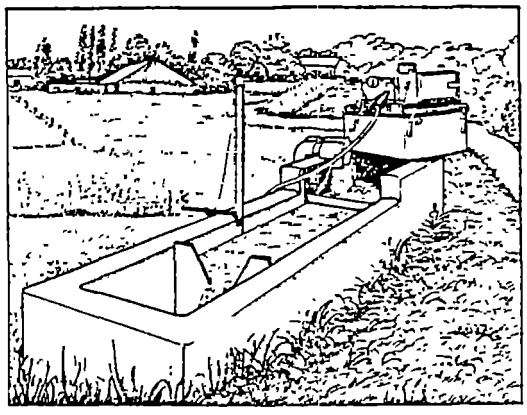
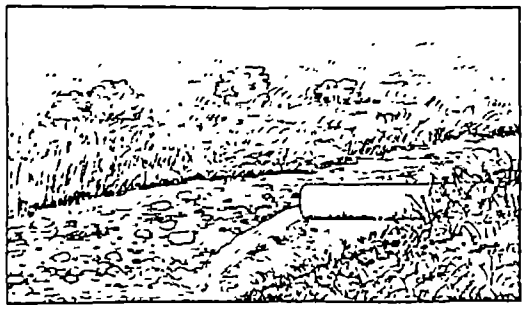




1. WASTEWATER PURIFICATION BY LAGOONING





Wastewaters in small rural communities.

Their quantity and composition

Quality control

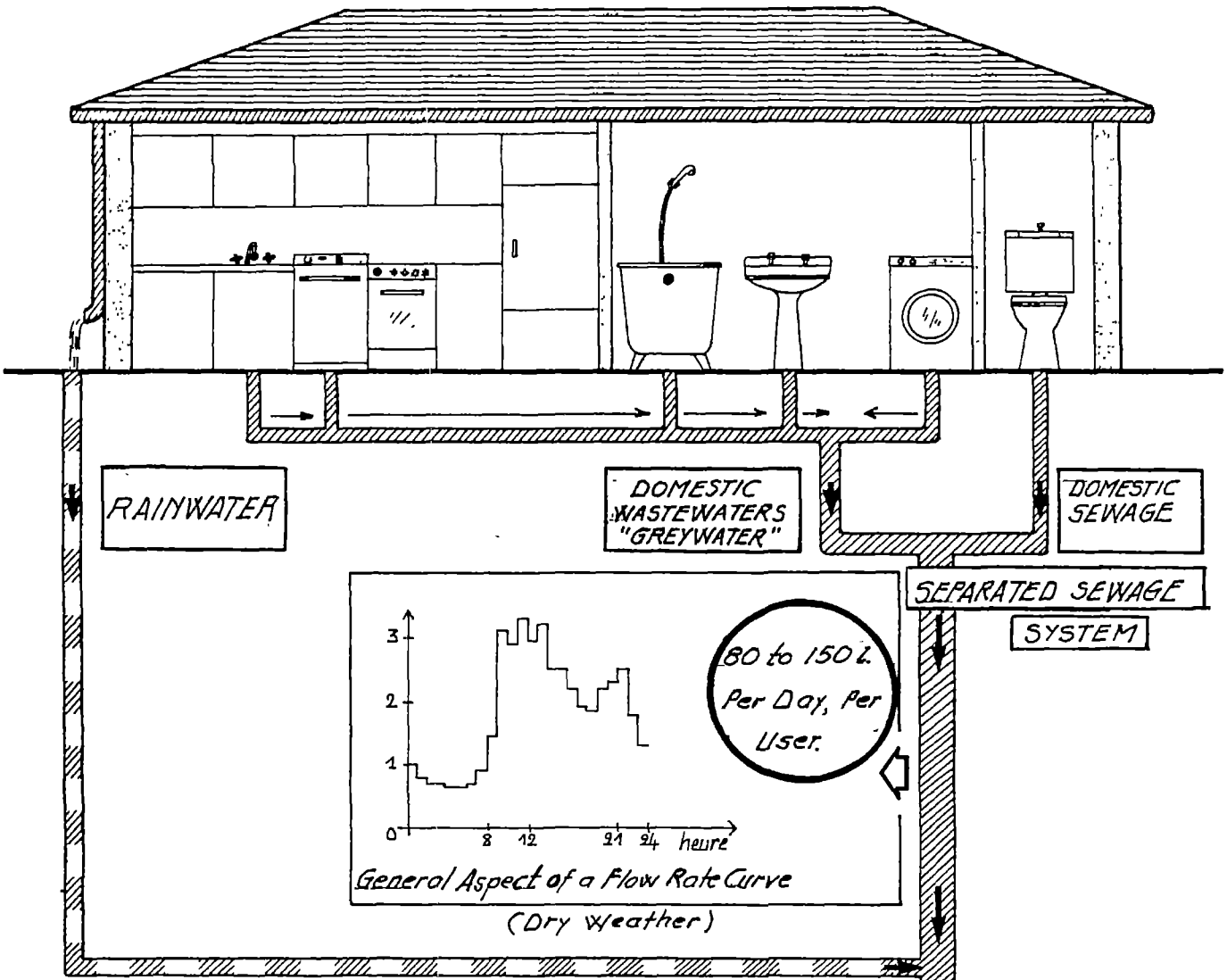
Discharge standards

The operation of purification lagoons.

Life in the ponds

The purification mechanisms

The design of purification lagoons



RAINWATER

DOMESTIC WASTEWATERS "GREYWATER"

DOMESTIC SEWAGE

SEPARATED SEWAGE SYSTEM

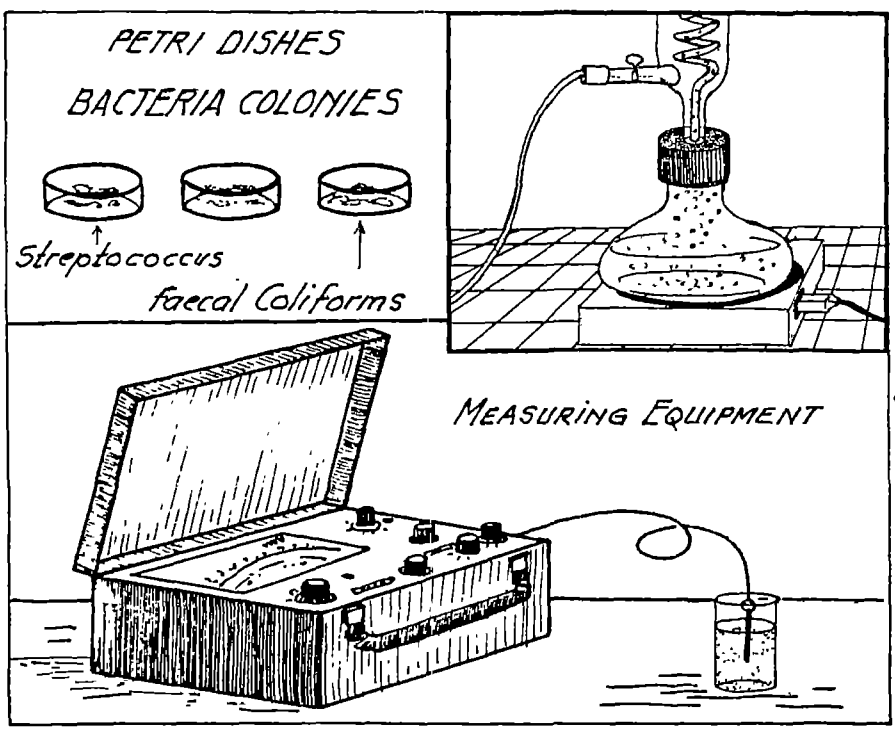
General Aspect of a Flow Rate Curve (Dry Weather)

80 to 150 L. Per Day, Per User.

COMBINED SEWAGE SYSTEM

(When rainwater is mixed with sewage)

One single unitary Pipe.



TO A WASTEWATER TREATMENT PLANT.

WASTEWATERS IN SMALL RURAL COMMUNITIES

ORIGIN

Wastewaters are collected in sewage systems that carry wastes from single households, business houses and institutions (e.g. schools, restaurants) connected to the system. They can carry domestic sewage coming from toilets containing organic matter which may be contaminated by pathogenic germs, together with other residual waters (grey waters) coming from the other household facilities.

COLLECTION

Effluents are not produced regularly during the day. In case of a sewage system collecting only wastewater (separate system), the flow is practically nil in night-time and may reach three to four times the mean flow at peak time. Sewage systems also frequently collect waters of miscellaneous origins (e.g. drainage water, rain-water) that constitute an additional inflow which varies according to meteorological conditions. In some cases, the sewage system can be designed to collect sewage as well as rain-water (combined sewage system). A special device, called storm by-pass, can be incorporated to limit the flow admitted in the purification plant during periods of heavy rainfall.

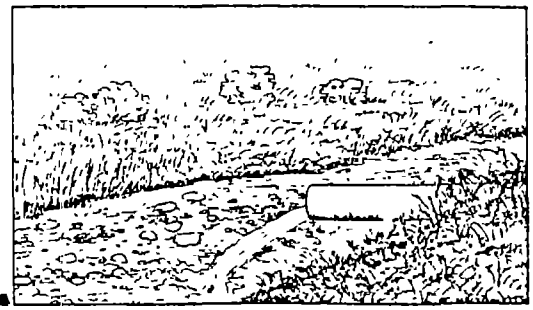
COMPOSITION

Wastewaters, whether they are diluted with rain-water or not, contain polluting elements that may put the discharge environment at risk. This is why a sanitation facility is necessary.

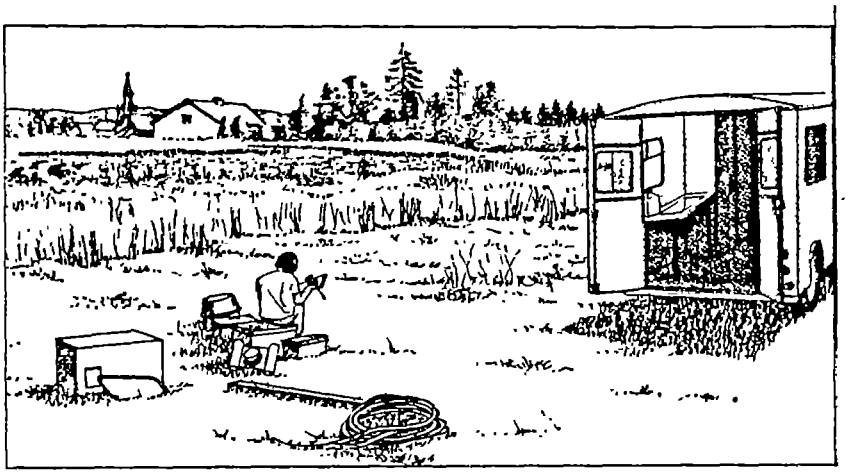
The main pollutants are:

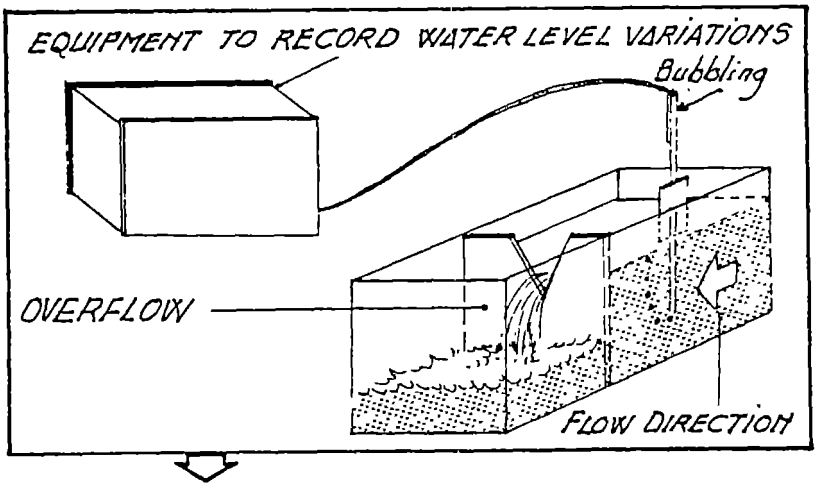
- organic matter of a varying degree of biodegradability,
- nitrogen compounds of organic or mineral origin,
- phosphorus compounds coming primarily from detergents.

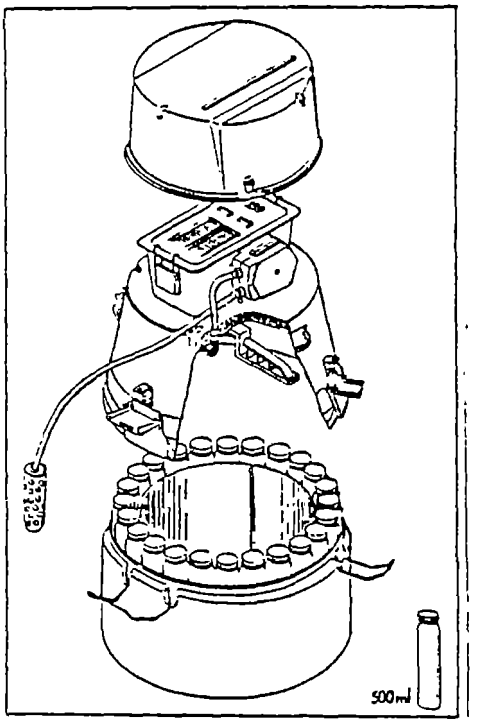
These compounds are either dissolved or in suspension in the liquid environment.



Water Quality Control Equipment



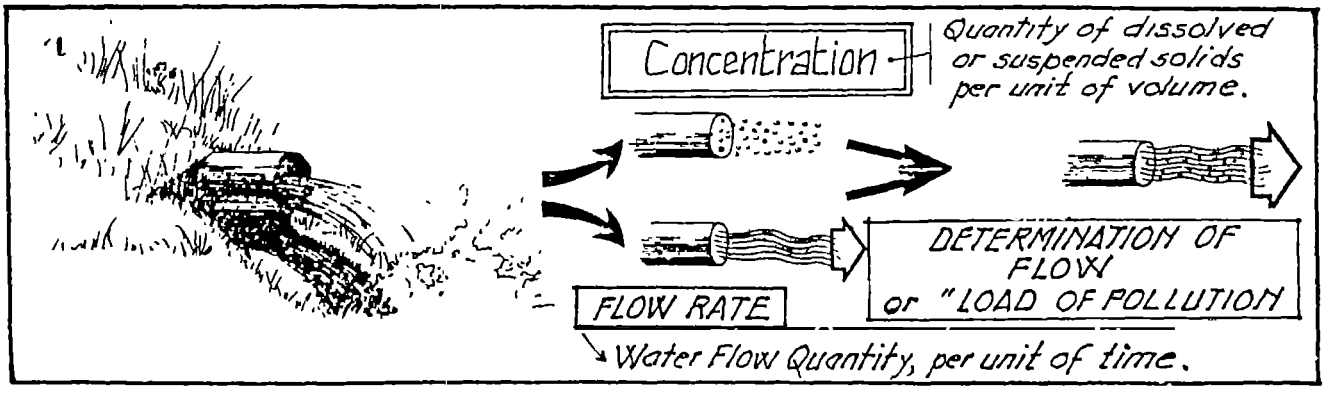




AUTOMATIC WATER SAMPLER
i.e. 24 flasks/day

MEASUREMENT OF FLOW RATES

CONCENTRATION DOSAGE IN THE LABORATORY



QUALITY MEASUREMENT

To design and manage a purification plant as well as to monitor its efficiency, it is essential to be able to assess the quality of wastewaters. For this purpose, several standard tests are available:

TSS — Total Suspended Solids: Organic or mineral particles which can be easily separated from the liquid by a filtration of centrifugation process.

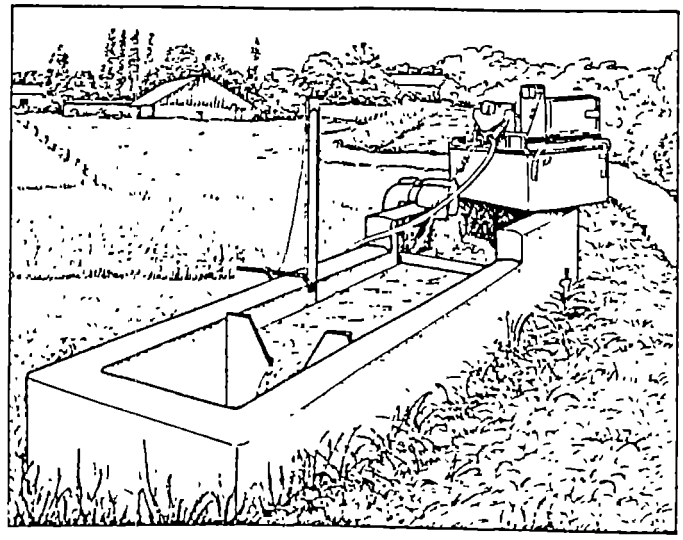
COD — Chemical Oxygen Demand: The amount of oxygen needed for chemical oxidation (destruction) of organic matter. This provides an indirect means of appreciating the concentration of organic matter in wastewaters.

BOD_5 — Biochemical Oxigen Demand in five days: Biological test allowing the amount of organic matter which is easily biodegradable to be determined. The BOD_5 value corresponds to the amount of oxygen needed, in a given time, to biologically oxidize the organic matter. The COD/BOD_5 ratio provides an indication of the biodegradability of the wastewaters.

N.P — Content of nitrogen and phosphorus compounds in their various chemical forms.

Counting of germs indicating that the environment is contaminated: (streptococcus, faecal coliforms). They enable to assess the health hazards due to bacterial contamination.

Wastewaters in small communities usually have a fairly high degree of biodegradability and are free from toxic products. As a result, they are suitable for purification by biological processes such as natural lagooning.



DISCHARGE STANDARDS

The discharge of treated effluents produced by plants serving more than 500 people is subject to an authorization which is delivered by the local authorities in charge of the water control policy.

The authorization refers to the quality standards laid down by the French Ministry act of November 4, 1980. The chief concern of the plant operator is, therefore, to make sure that the discharge conforms to the regulations established. Normally, regulations take into account both, the purification techniques potential, and the sensitivity of the environment where the discharge will take place

In case of discharge into a watercourse, (which is the most frequent one), the main parameters to be taken into consideration are the load of suspended solids (TSS), (concentration multiplied by admission flowrate), and the flow of organic matter (COD, BOD_5) and of "kjeldhal" nitrogen (organic nitrogen + ammoniacal nitrogen)

In the case of discharge into environments sensitive to eutrophization (lakes, reservoirs, some watercourses), special attention must be given to all nitrogen compounds ("total" nitrogen) and to phosphorus compounds.

The bacteriological quality of the effluent must be taken into consideration when it is discharged close to a shellfish breeding area, a fishfarm, a bathing area or to water supplies for animal or human consumption (in the latter case, the mineral nitrogen content must also be measured).

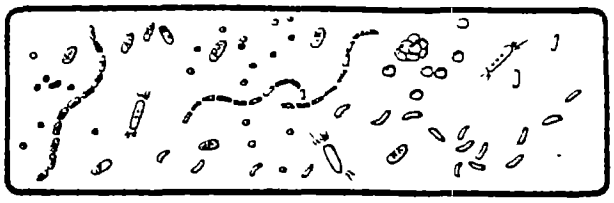
LAGOONING PERFORMANCE

Whether it is used as a main treatment or as a secondary treatment after a biological purification plant, natural lagooning allows to obtain the following discharge quality:

	As main treatment	As complementary treatment
1st group	Level d	Level e
2nd group	NK1 level (NGL1 level in some case)	NGL1 level (NGL2 level in some cases)
3rd group	Approx. 70% of phosphorus eliminated, i.e. quality close to TP1	PT1 level
Bacteriological quality	of the order of: -100 faecal coliforms in 100 ml -100 to 1,000 faecal streptococcus in 100 ml	

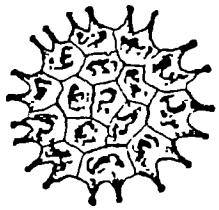
THE LIVING ORGANISMS

BACTERIA

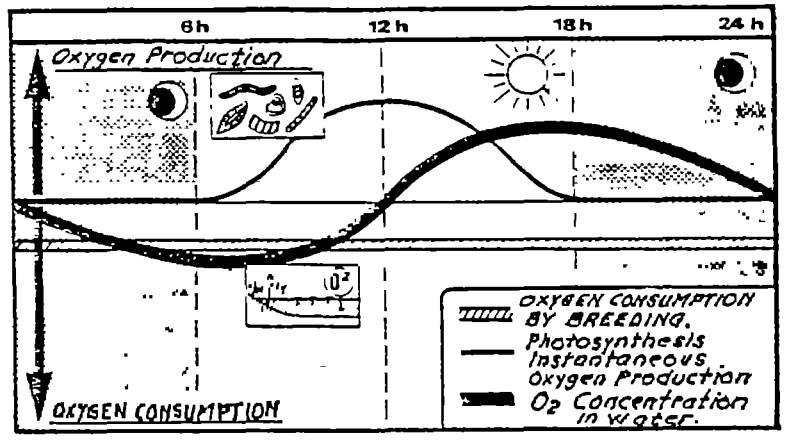


ALGAE

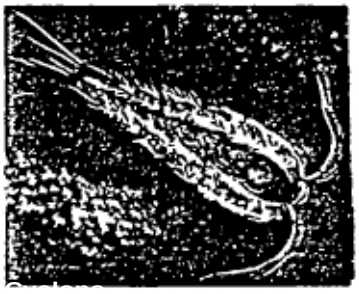
Oxygen Concentration in an aquatic system varies on hourly basis.



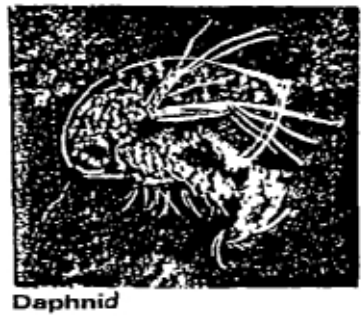
Pédiasbrum boryanum Chlorococcale



ZOOPLANKTON



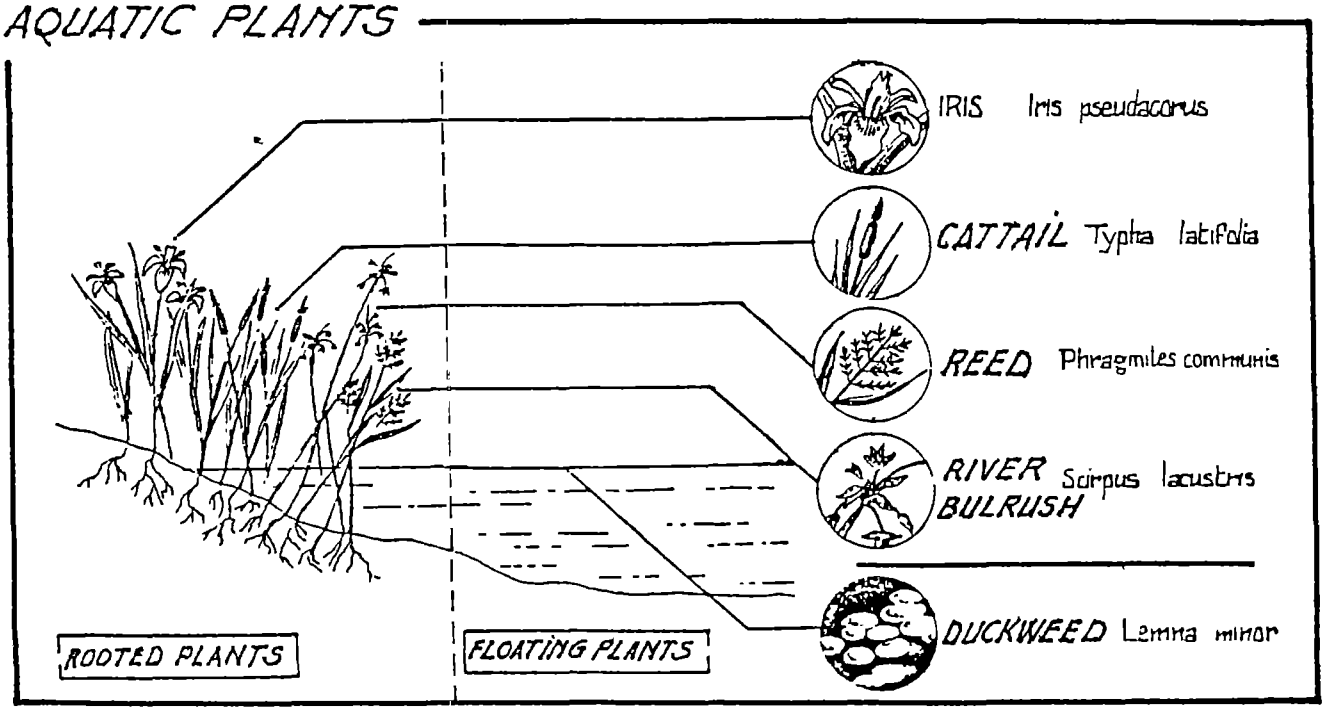
Cyclops



Daphnid

Rotifera.

AQUATIC PLANTS



THE OPERATION OF PURIFICATION LAGOONS

LIFE IN THE PONDS

Lagooning ponds are naturally colonized by a great variety of living organisms, most of them invisible to the naked eye. The main groups encountered are:

Bacteria: These are microorganisms which can absorb most of the organic matter. They reject decomposition products in the form of carbon dioxide and soluble materials into the environment. There are two types of bacteria:

- Those that can develop in the absence of oxygen (anaerobic bacteria),

- Those that need oxygen to live (aerobic bacteria).

In lagoons, the former are found at the bottom of the ponds and in sludge while the latter, aerobic bacteria, are predominantly found in the water. The oxygen necessary for their breething partly comes from exchanges between air and water (stirring of the liquid surface by wind), but primarily from the activity of microscopic algae in suspension in the water.

Algae: These are microscopic plants, and, as all plants, they contain chlorophyl, hence the green colour of the ponds. Chlorophyl allows them to use sunlight as a source of energy: this is the basis of the process known as photosynthesis. Algae develops in daylight by taking carbon dioxide and mineral salts from the water and rejecting oxygen into it.

Thus, algae are the main oxygen producers in lagoons. This production essentially takes place in the surface water layer (20 to 50 cm thick layer).

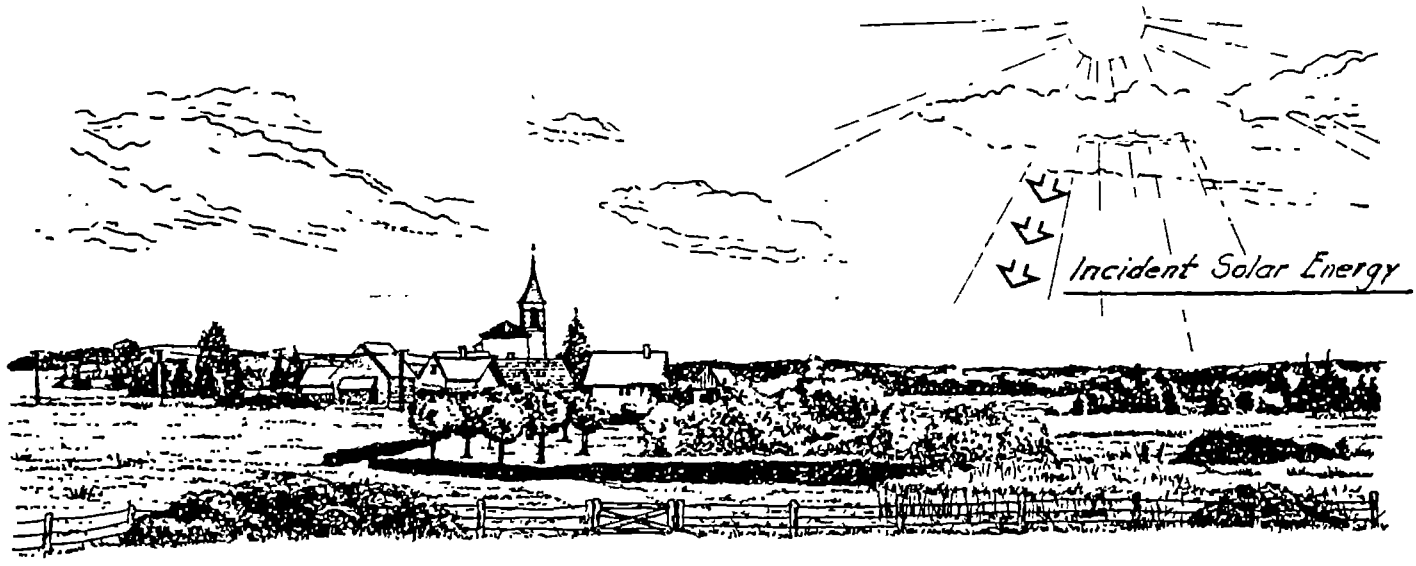
Zooplankton: This term designates small or microscopic size animals which live in the water of the ponds. They are, for example, shellfish such as daphnids that feed by filtrating suspended solids, e.g. organic matter, bacteria, algae. When they develop, i.e. in the hot season and in less heavily loaded ponds, their activity may be intense and they partly contribute to the clarification of water.

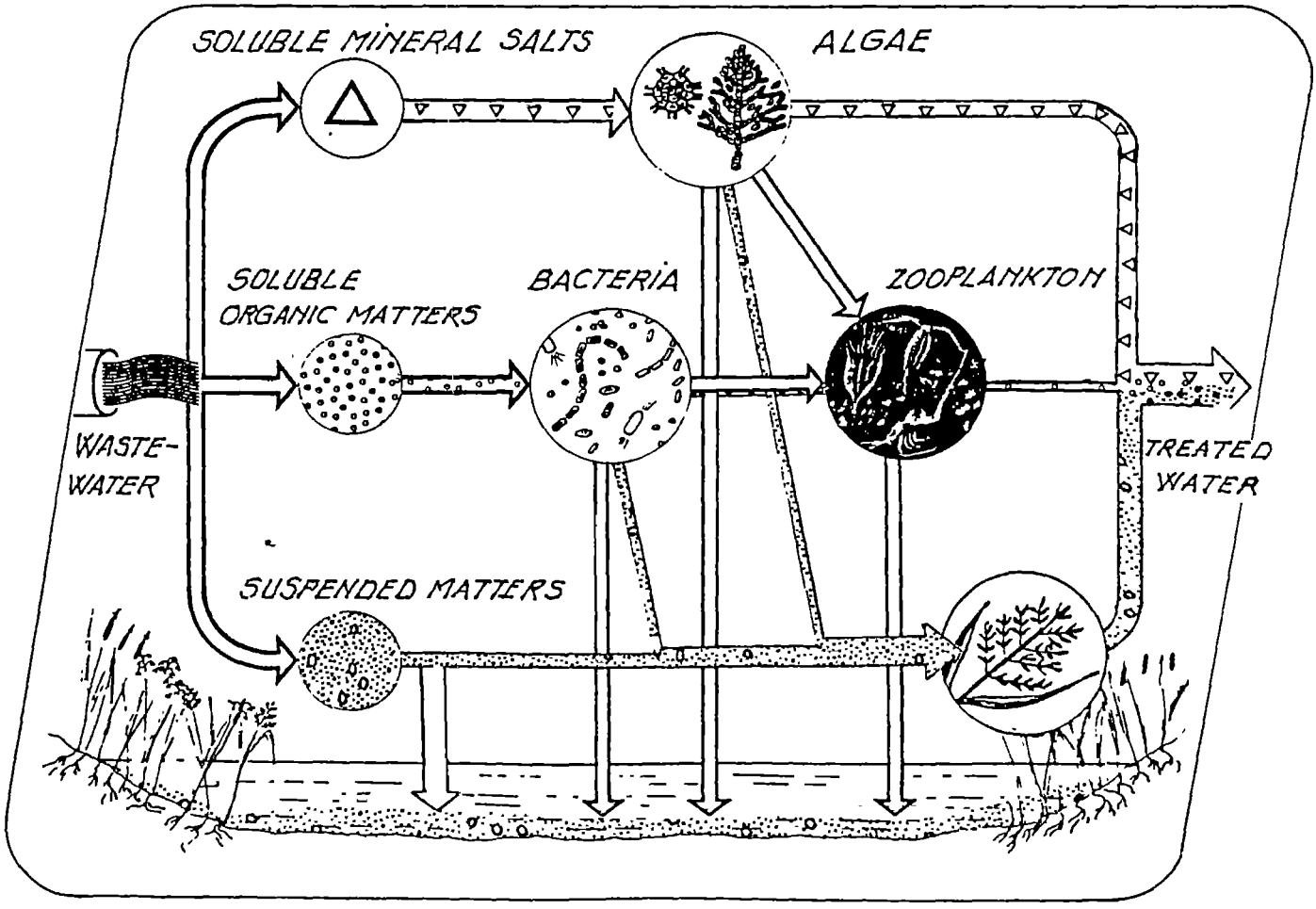
"Macrophyte" aquatic plants: Two types must be distinguished:

- rooted plants which have an underground stem or rhizome. They essentially play a role of support or shelter for bacteria, algae and zooplankton which can settle on the submerged portion of the stems or develop close to it and, thus, contribute to diversifying and balancing the biological activity.

- floating plants such as duckweeds colonizing some lagooning ponds. They play a favorable role in the purification process provided their development is kept under control (assimilation of nitrogen and mineral phosphorus, in particular), but their excessive proliferation may jeopardize the correct operation of the plant (see chapter 3).

THE PRINCIPLE OF NATURAL LAGOONING





The above diagram illustrates the main factors responsible for the degradation of the polluting load.

THE PURIFICATION MECHANISMS

The polluting load is decomposed by various agents which are all closely interrelated and have complementary effects:

- Mineral salts which are assimilated by algae and which, in turn, may be absorbed by microorganisms in the zooplankton.

- Organic matters which are dissolved in water and which are decomposed by bacteria. Mineral salts produced by this decomposition process, in turn, contribute to the growth of algae (see above). Bacteria are, themselves, a nutrient for the zooplankton.

- The larger part of suspended solids present in wastewaters settle at the bottom of the ponds. A fraction of them is absorbed directly by the zooplankton. The suspended solids found in the effluents are not of the same nature as those found in the wastewaters: they consist of mixture of wastes, bacteria, algae and zooplankton.

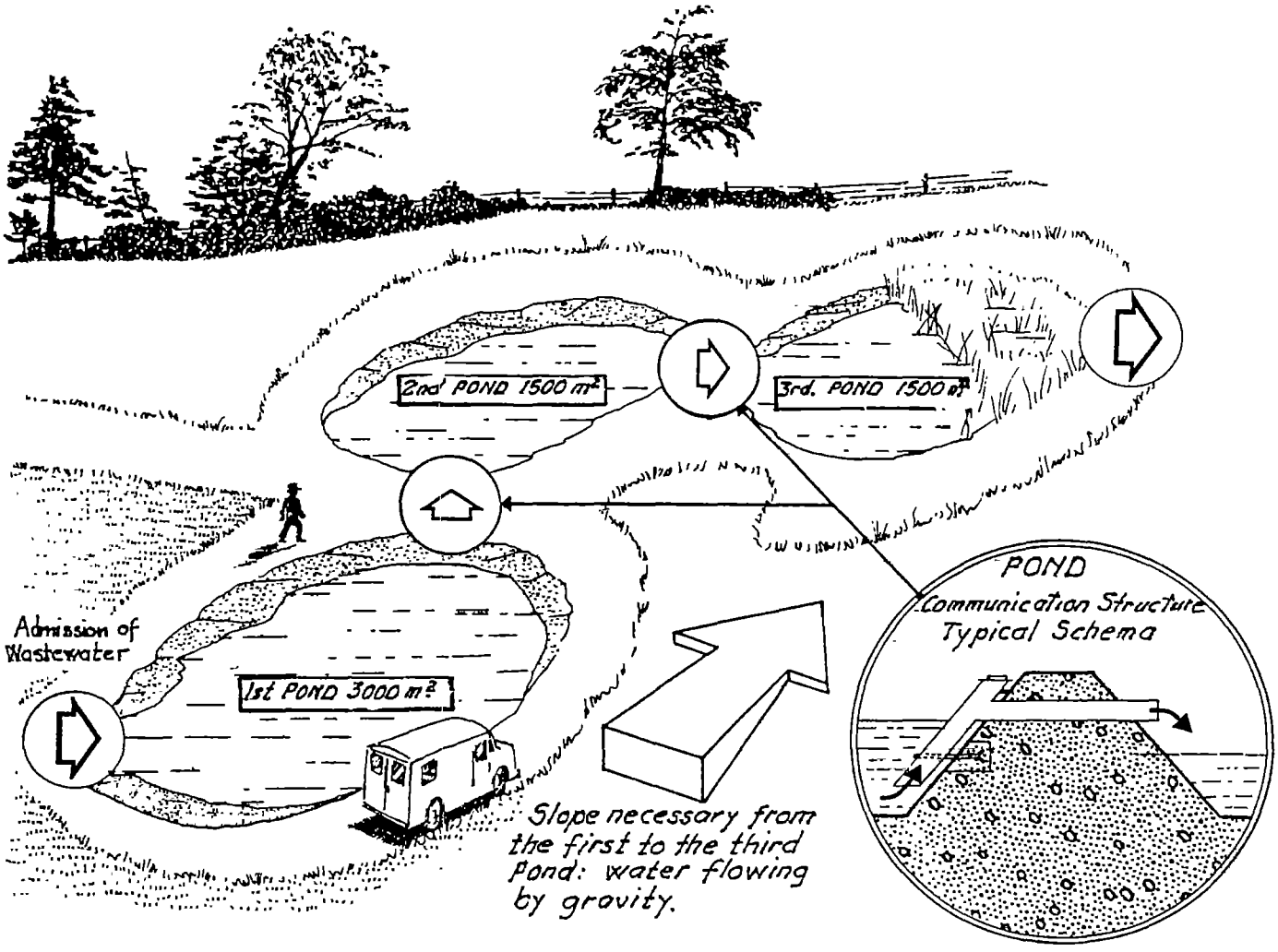
The polluting load extracted from the effluent finally becomes entrapped into the sediment through the settling of suspended solids and dead plankton organisms. As this sediment is biologically active (bacteria, sludge worms), the process of deposit stabilization continues at this level.

For the plant to operate satisfactorily, it is necessary to achieve an equilibrium between the bacterial and algae activities:

If the growth of bacteria is excessive, the oxygen demand can no longer be satisfied by algae. The phenomenon can be further intensified by a self-induced process and rapidly lead to the creation of anaerobic conditions in the ponds. This is what is observed in the case of overloaded lagoons.

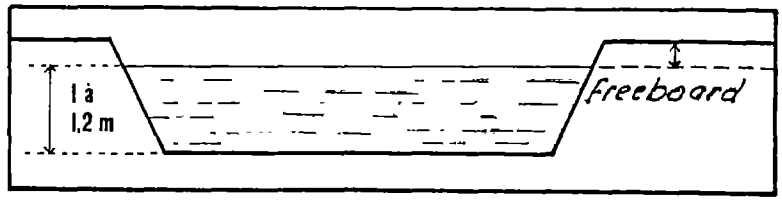
The opposite phenomenon (excessive growth of algae) can also be observed and lead to disturbances, in particular with the wasting away of the excess of algae. The zooplankton activity and the presence of macrophyte areas contribute to limiting this phenomenon.

TYPICAL INSTALLATION FOR 600 PEOPLE

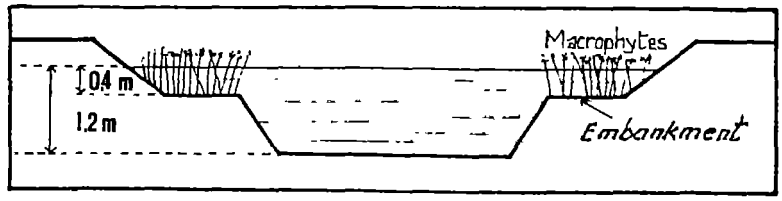


SCHEMA OF DIFFERENT LAGOONS

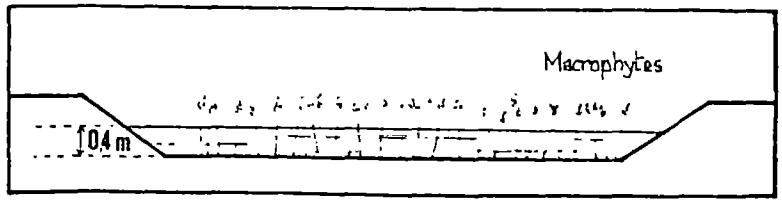
MACROPHYTE LAGOON



MIXED LAGOON



MICROPHYTE LAGOON



THE DESIGNING OF PURIFICATION LAGOONS

LAGOON DESIGN AND PURIFICATION MECHANISMS

For the lagooning system to develop maximum efficiency, the purification plant must be designed according to a number of principles which are briefly outlined below:

The installation comprises several ponds (generally 3) arranged in a series; the first pond is a microphyte pond which occupies roughly half the total surface area.

The shape of the ponds and the location of the communication systems should allow for the satisfactory distribution of the fluid and limit hydraulic short circuiting. The arrangement of the ponds must take into account the topography of the site and the integration of the plant into the environment.

Watertightness of the ponds must be realized according to the principles determined after a land survey which needs to be made prior to the construction. Its purpose is to ensure that the level of water in the ponds will constantly remain at the level set by the constructor. The height of water is usually 1,2 m for microphyte lagoons and 0,4 m for macrophyte lagoons.

The total surface area of water, determines the required minimum useful capacity of the ponds so as to avoid organic overloads and guarantee the optimum retention time of the effluent. A surface area of 10 m^2 of pond per inhabitant is a commonly accepted standard for the primary treatment of domestic effluent in a rural environment. For complementary treatment plants following a biological treatment facility, the common sizing criterion is the retention time. A retention time of 30 days which corresponds to an area of approximately 5 m^2 per user is generally recommended.

LAGOON DESIGN AND OPERATION

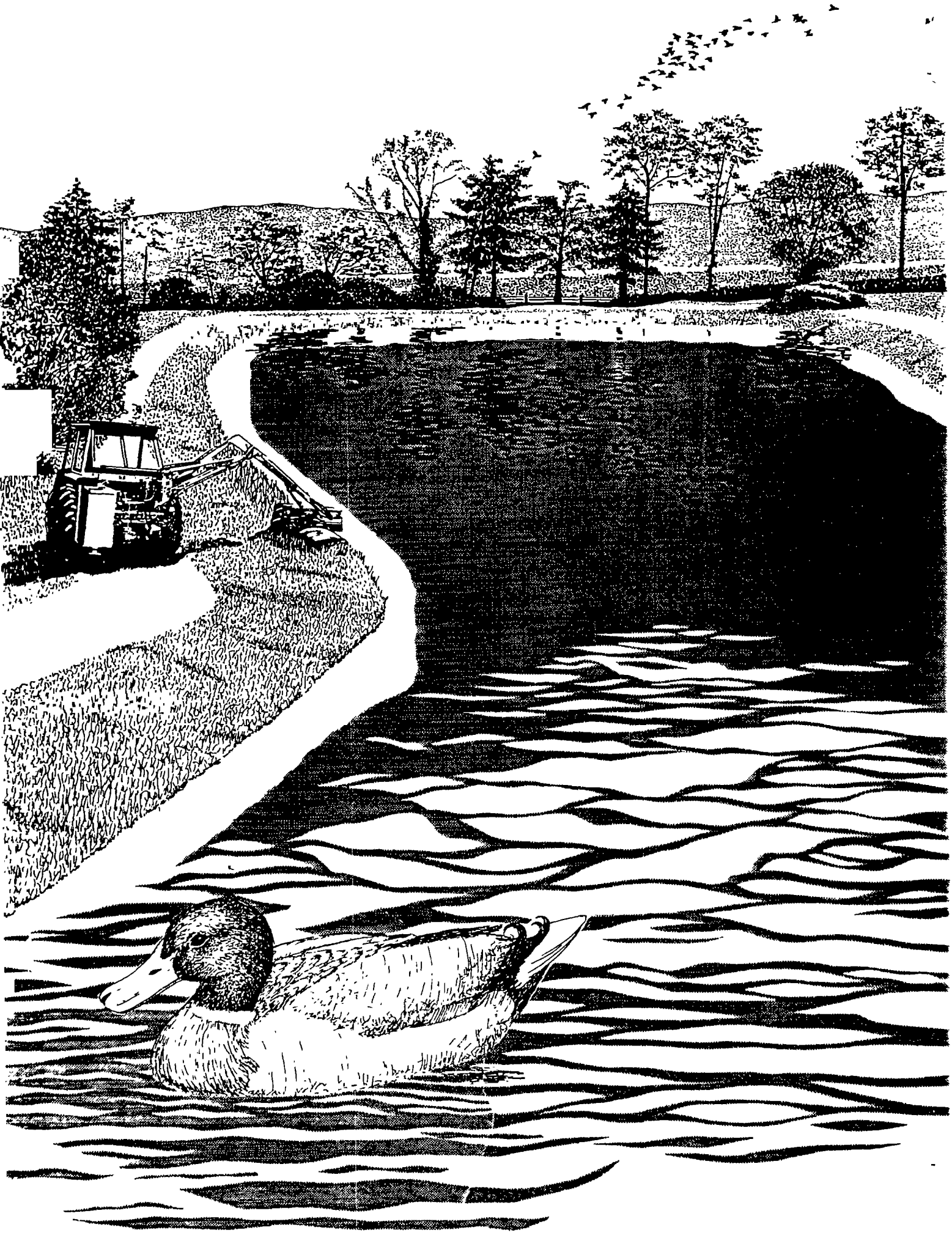
To facilitate the operation of the lagoons, the following elements should be included in the plant design:

- Access to the ponds: a 3 m wide track (approximately) must be made around the ponds with a connecting path to the road network to allow for the easy access of maintenance vehicles.

- Location and design of the pretreatment units (bar screen, etc.): these must be readily accessible and should be designed so as to only necessitate weekly maintenance.

- Flow measurement devices must be installed at the plant inlet and outlet for inspection.

- The macrophyte-planted zones should be judiciously sized and located to allow for easy week cutting.



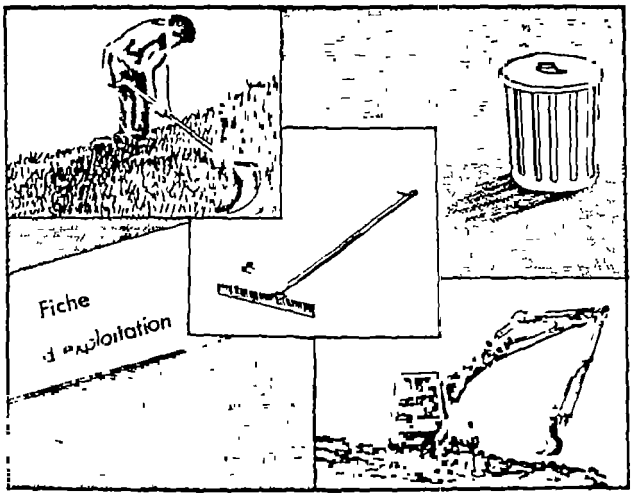
2.. THE OPERATION

COMMISSIONING

- The filling of ponds
- The planting of vegetation

THE ROUTINE OPERATION TASKS

- The maintenance of pretreatment facilities
- The maintenance of the surroundings
- Supervision



THE CUTTING OF MACROPHYTES

- Equipment needed for the cutting of macrophytes.

THE CLEANING OPERATIONS

- Removal of sludge
- Sludge disposal

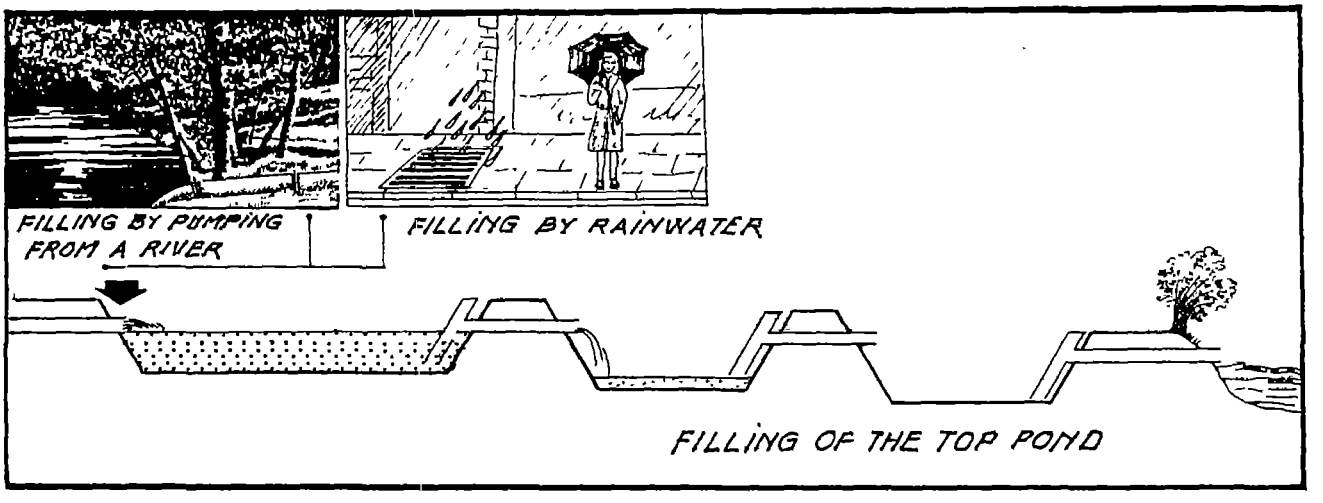
THE OPERATION

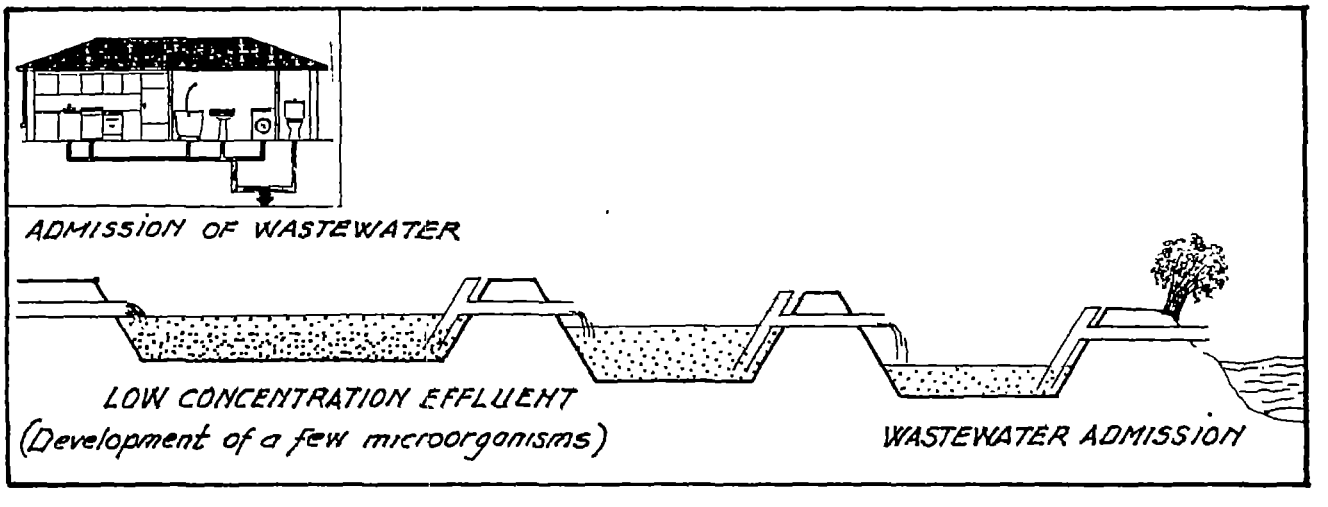
The rustic character of natural lagoons allows for a larger functioning autonomy and also for a more flexible maintenance operation. Considering that no electromechanic devices are needed for this method of wastewater treatment, there is no reason to fear accidental breakdowns that may stop the purification process.

However, there is no reason to believe that natural lagoons can function without the human intervention. It is absolutely necessary to carry out regular maintenance tasks in order to ensure, not only the adequate flow of wastewater from one pond to another, but also the desired purification performance and the easy access to the lagoon site.

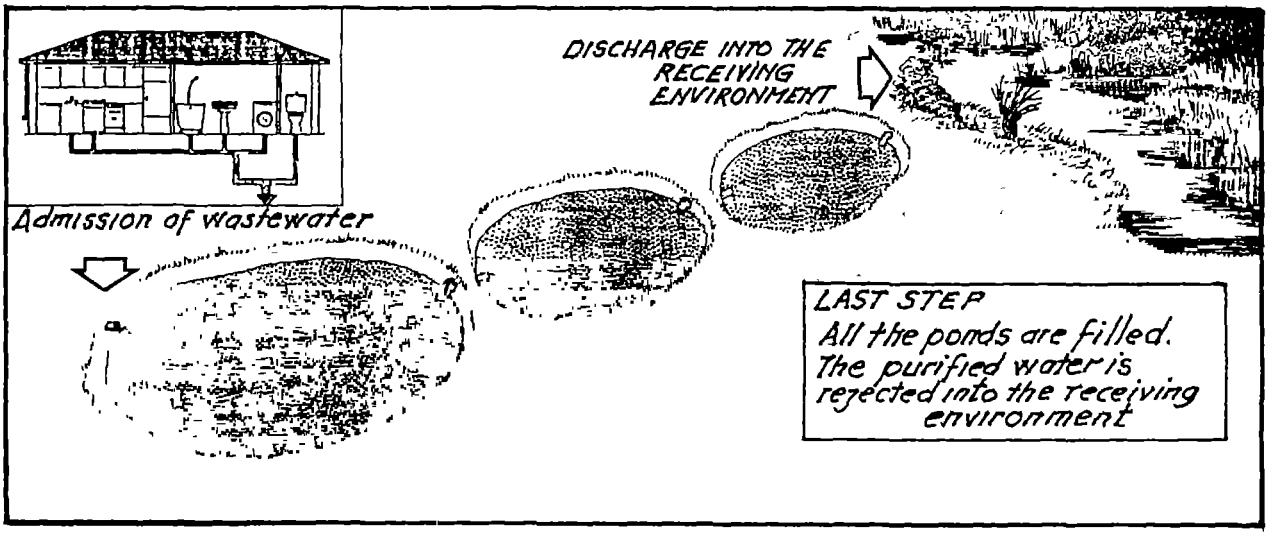
A large proportion of the regular operations which are needed for the proper maintenance of a lagoon, does not require scpecialized techniciens, nor the use of supplies others than those which are available in the rural surrounding. Therefore, an ordinary community foreman, with experience in public work operations, should be able to keep the lagoon functioning. Based on this assumption, the following pages are devoted to the detailed description of the technical elements required for the implementation of a programme of operation for a wastewater natural lagoon.

FILLING OF PONDS





THE NORMAL OPERATION OF LAGOONS



COMMISSIONING

Being the transition point between the construction and operation stages, the commissioning of lagoons generally offers an opportunity for the operator or the financing community to carry out a first intervention. At this stage, two operations must be envisaged: the filling of the ponds and the seeding of the macrophyte lagoons. The cost of both these operations is generally integrated into the overall cost of the project.

THE FILLING OF PONDS

Wastewater should not be admitted into the ponds without them having been filled beforehand. Indeed, the time needed to fill the ponds solely with effluent is very long (several months), especially when, as it is frequently the case, only part of the sewage network and the related connections can be put into operation at the time of the plant commissioning.

This can lead to a transition period giving rise to nuisance such as offensive odours and which, if it is prolonged, may impair the future operation of the plant.

Besides, the prior filling of the ponds permits the gradual "loading up" of the facility, allowing living organisms which play a fondamental role in the purification process to develop in the ponds.

Finally, the prior filling of the ponds enables to rapidly detect any leakage problem.

In practice, only the top pond(s) of the installation need to be filled with fresh water:

- If the installation is close to a watercourse, the simplest method consists, when it is possible, in filling the ponds by pumping water from a river, using a motor pump or a water scoop.

- If no natural water supply is available nearby, a solution consists in filling the ponds from the local sanitation of drinking water system (fire hydrants) but this can sometimes be a costy option.

- If the system design permits it, rainwater can be used to fill the ponds by temporarily connecting the rainwater collection system to the wastewater network.

MAIN MACROPHYTE SPECIES WHICH CAN BE USED FOR PLANTING AROUND LAGOONS

Reed
Phragmites communis

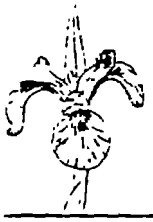
A 1 to 4 m high, hardy plant with a long creeping rhisome which can develop roots up to 60 cm deep. Growing around natural water stretches, it colonizes the zone of water with yearly height fluctuations, and can live in a height of water varying between 0 and over 1 meter.

Rush
Scirpus lacustris

A 1 to 3 m high, hardy plant with a creeping root. It needs a permanent water height to develop. It forms around natural water ponds a vegetation belt which grows inside the reed belt. When the water level is too low, it may be easily choked by other plants.

Cattail
Typha latif lia or angustifolia

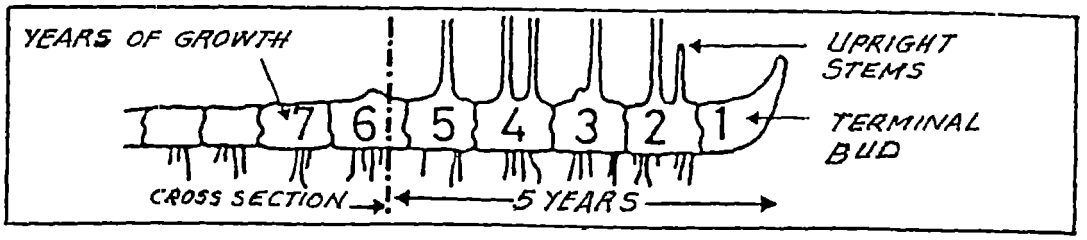
Perennial and hardy plant, of 1 to 3 meters height, which also possesses rhizomas. It multiplies rapidly within one single season and contrary to the reeds, it only needs a few centimeters of permanent water height to develop.



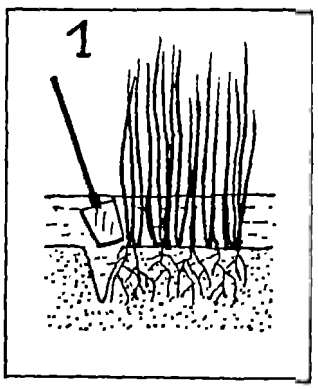
Yellow iris

A 40 cm to 1 m high, hardy plant with yellow flowers from April to July. It develops a long rhizome and a large root mass. It grows in less water than reeds or simply in damp soil.

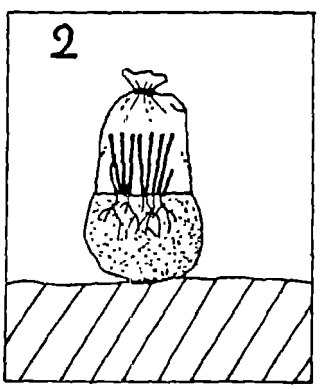
RHIZOME OF A MACROPHYTE



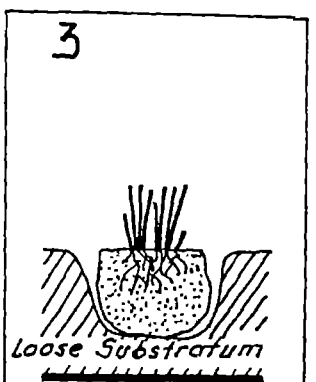
THE PLANTING



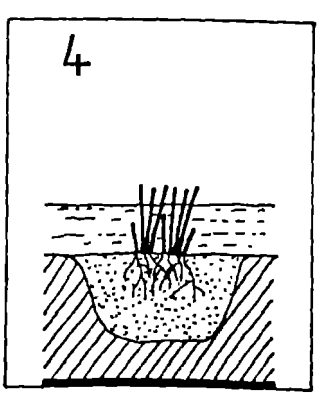
Digging out of the plant and its rhizome with a spade



Cutting stems needed. Place plant in plastic bag to prevent drying out. Immediate transport needed.



Transplanting into the lagoon



Filling pond with water.

THE PLANTING OF VEGETATION

To enable the rapid colonization of macrophyte lagoons by the chosen species, it is necessary to plant aquatic vegetation. This task can be entrusted to a professional horticulturist, but in most cases, a more economic solution for the owner is to carry out this operation with the assistance of the contractor. This operation will be conducted in the following way:

Locating of areas in the proximity of the lagoon where plants can be selected and extracted in sufficient quantities for transplantation. The table on the opposite page illustrates the main species commonly found in France and which can be used for lagoons. The spotting and selection of the plants should be done during the design stage of the project.

Extraction of the plants For the plants to take root again, it is necessary to extract the underground stem of rhizome which lies at about 10 cm under the surface of the ground. Each seedling should be left with a sufficient rhizome lengh (20 centimeters about) and with four to five upright stems (refer to figure).

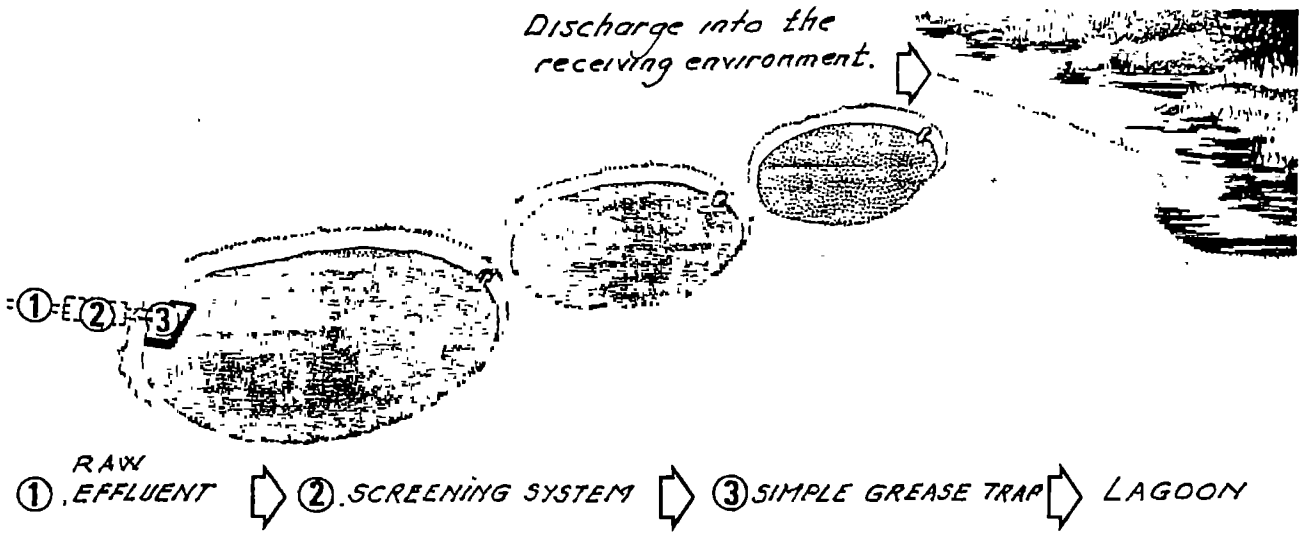
The plant must be uprooted by hand or with a spade. If the land area is sufficiently extended and the quantities to be extracted are large, mechanical devices (e.g. hydraulic excavator) can be used to remove a layer of soil about 20 centimeters deep containing the rhizomes. This layer must, then, be broken into lumps for transplantation.

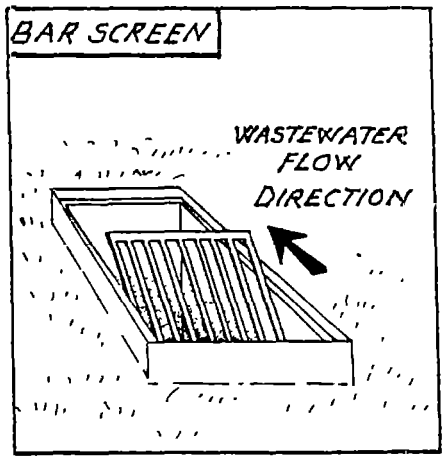
It is necessary to plant approximately five seedlings per square meter of pond area.

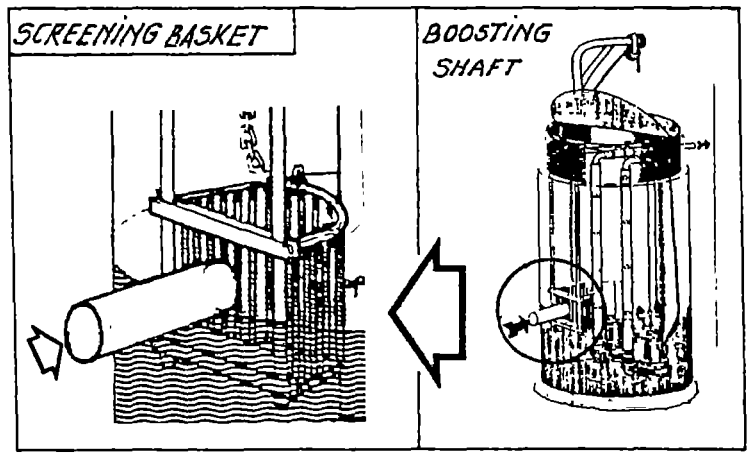
Transport and packaging. Planting must be carried out shortly after the excavation. During transport, the seedlings must be sheltered from air by being placed in basins or plastic bags. The upright stems can, if necessary, be cut provided a length exceeding the depth of the pond where they are to be transplanted is left.

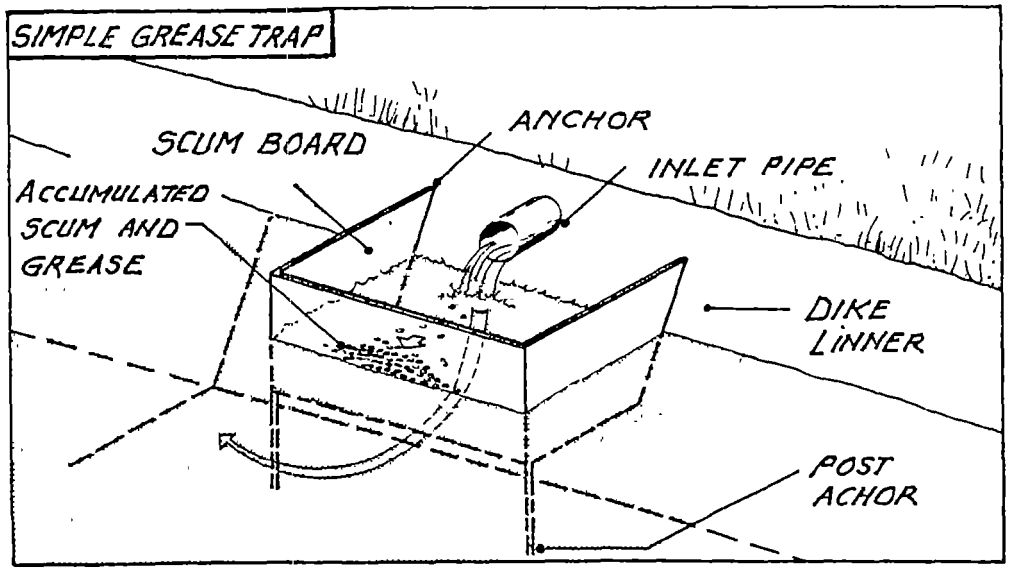
Planting must be made in the substrate which has been excavated from the bottom of the lagoon and when the ponds are being filled with water. The rhizomes should be planted every 50 cm and a few centimeters deep into holes made with a spade (one hole for each seedling). If the machine is used, furrows should be made parallel and then closed up. The most favorable time for planting is the spring season.

THE PRETREATMENT UNITS









THE ROUTINE OPERATION TASKS

THE MAINTENANCE OF PRETREATMENT UNITS

In natural lagooning systems, pretreatment units are facultative, especially if the sanitation sewerage includes a boosting shaft with screening basket used to stop the larger particles.

Pretreatment units, however, help in keeping the ponds tidy by eliminating the scum.

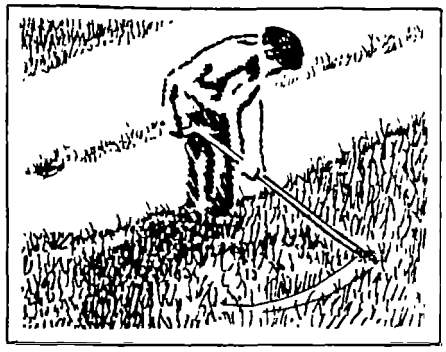
Upstream of the top pond, a bar screen may be installed to retain the large solids and a grease trap with a scum board to stop the floating material such as grease, debris, etc. can also be provided.

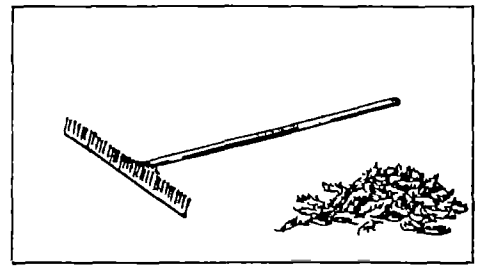
When they are correctly sized, the pretreatment units (i.e. bar screens, grease traps) only require weekly maintenance to prevent blockage and excessive accumulation of organic matter. In the hot season, however, frequent inspection of the bar screen will prevent the release of odours, particularly when the quantity of wastes increases as in the tourist season, for example. Should more frequent maintenance work turned out to be necessary, modifications of the purification installation should have to be envisaged with the plant designer.

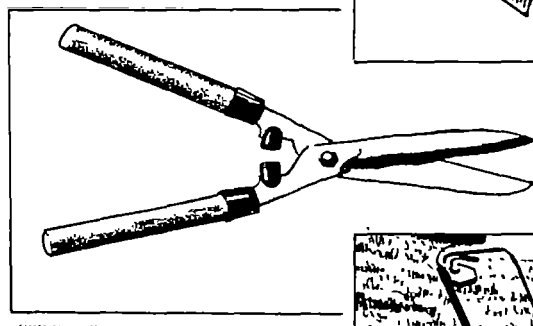
On small facilities, cleaning operation are carried out using small hand tools such as grid combs, rakes, scum removal equipment, etc.

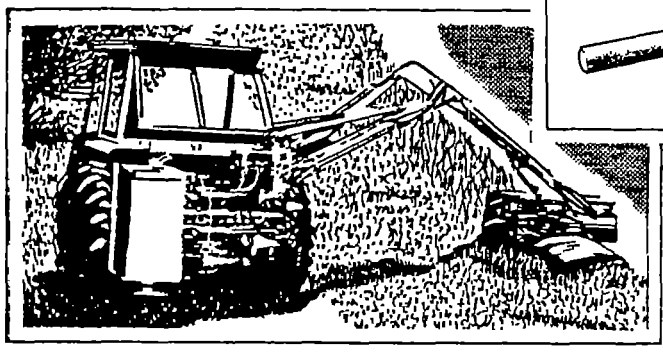
The refuse which is removed from the pretreatment units may be allowed to drain before being introduced into closed containers and then discharged into a dump. If regular garbage collection is not assured in the plant, the refuse can be buried on the spot, provided thet the trench made is sufficiently deep to cover all the wastes produced.

VEGETATION CUTTING

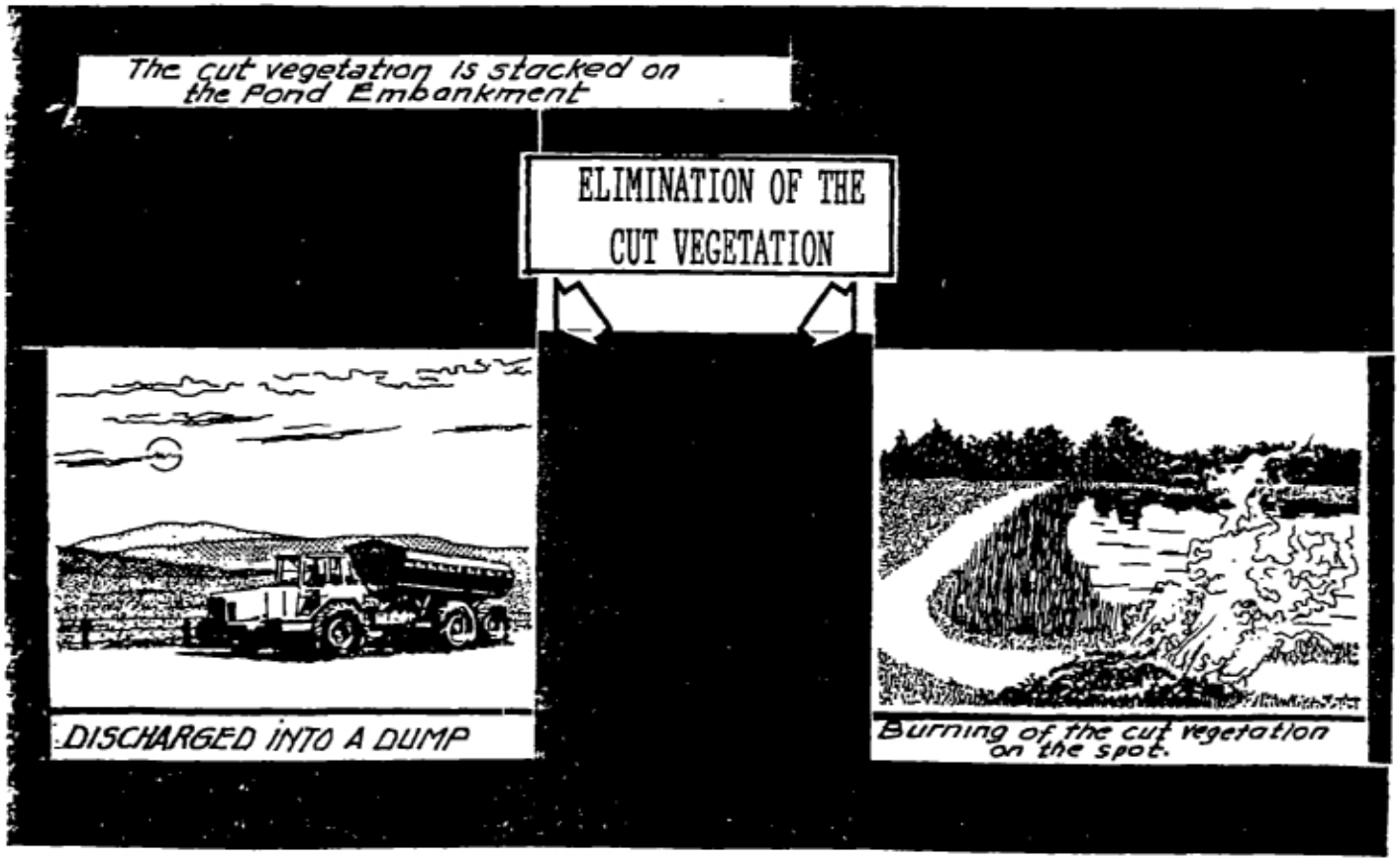








ELIMINATION OF CUT VEGETATION



MAINTENANCE OF THE SURROUNDINGS

It is essential to keep the installation in good condition and to control the growth of vegetation which may impair access to the pond and colonize the embankments.

Terrestrial vegetation. The sides of the access roads and the top of embankments should be cleaned approximately once a month during the growth season. This can be done mechanically by using the type of machine which will be readily available (cutter bar mounted on an agricultural tractor) or more specifically adapted to small facilities (for example, a motor power driven mower).

The waterside vegetation colonizing the inside of embankments may, if no maintenance is performed, gradually invade the pond and eventually reduce the useful surface area, leading sometimes to nuisance such as colonization by rodents or breeding of mosquito larvae. Grass should be cut one or twice a year in one of the following ways:

- manually (with a scythe) in small installations,

- mechanically, with an oblique lateral cutter bar or a gras cutting basket fixed to a hydraulically-driven arm for small installations, or when the embankments of ponds are high.

In both cases, the cut grass must be removed and either stacked and burnt on the spot or taken to a dump.

The use of herbicide to control waterside vegetation should be avoided: a chemical treatment does not eliminate the cut grass which rots on the spot and the toxic products used may more or less severely impair the correct functioning of the installation.

POND MAINTENANCE RECORD SHEET

Pond location:

Date and time: Air temperature: C

Weather conditions:

Pumping station (if there is one):

* elapsed time meter reading: No.1 No.2

* electricity meter reading:

* observations: (flooding)

Access road: conditions, (vegetation, damages); maintenance carried out

Pond site surroundings: conditttions, maintenance carried out

Pretreatment works: conditions, maintenance carried out

* screen (s):

* other (grit, grease removal):

VISUAL INSPECTION OF PONDS

POND NUMBER	1	2	3	OBSERVATIONS
Colour of water green grey/brown red/pink milky/clear				
Odour				
Floating Scum or foam				
Floating macrophytes				
Rooted macrophytes				
State of embamkments (erosion, rodent damage, vegetation)				
Inlet and outlet (blockage)				
Water level (high, normal, low)				
GENERAL OBSERVATIONS, other maintenance carried out:				

SUPERVISION

The regular maintenance of pretreatment facilities is an opportunity for the overall inspection of the installation. The early detection and the accurate diagnosis of malfunctions will make it possible to call the technical services on time.

The operator in charge of the plant shall more particularly check on the following points:

Correct water flowing: The lowering of the water level should be noted and the communication systems between the ponds cleared when necessary;

Presence of scum: Note the backing-up of sludge, filamentous algae, duckweed, etc., and remove them when accumulated in a section of the pond;

Colour of water: The water should normally be green or greenish-brown. A change in colour may be an indication that a particular species of microorganisms is developing;

Embankments: Repairing of any damage on the embankments caused by rodents;

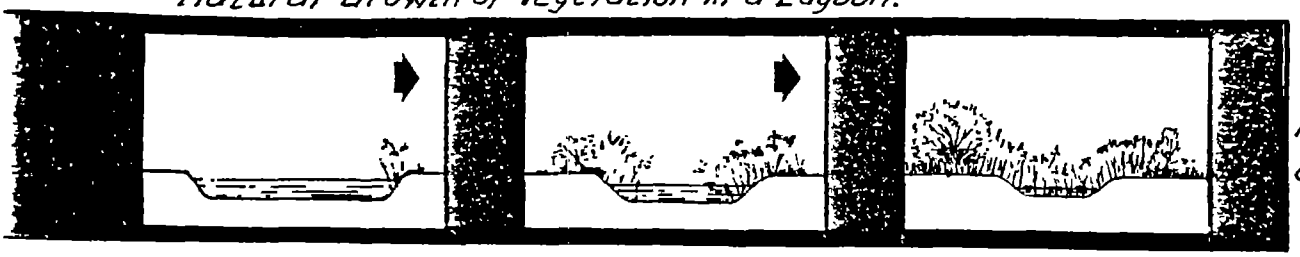
Offensive smells: Indicate that a part of the installation is overloaded.

These observations can be periodically written down (every month, for example) on a log book similar to the model shown on the opposite page. The operator can, thus, become rapidly informed of malfunctions and organize the necessary maintenance interventions on time.

Moreover, the regular keeping of an operating report allows for a yearly assessment of the time required for maintenance and the overall operating costs. This document can also be of great help to the technical assistance team.

WEED CUTTING : A NECESSITY

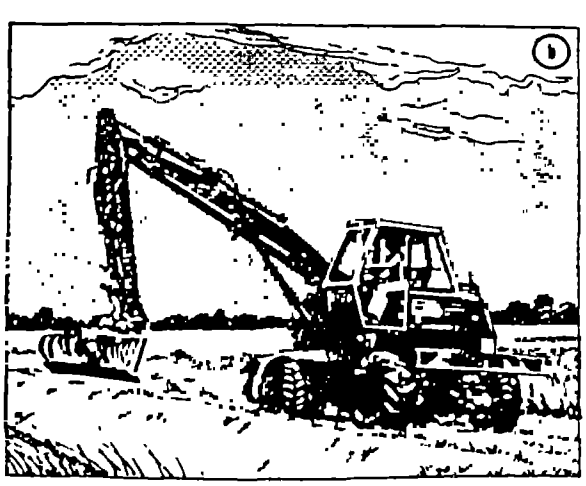
Natural Growth of Vegetation in a Lagoon.

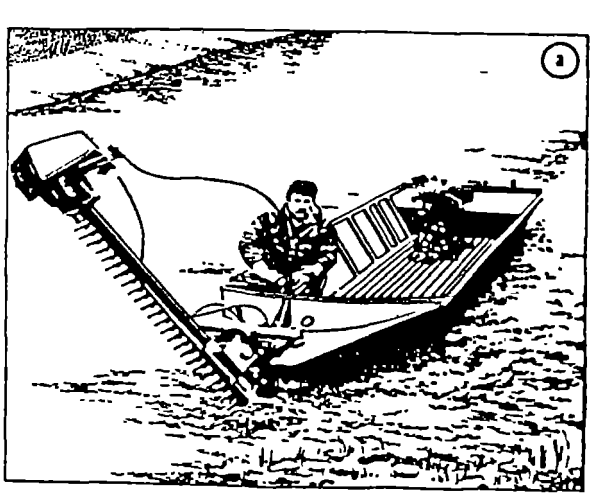


The cutting of macrophytes controls this growth.

MECHANICAL EQUIPMENT FOR WEED CUTTING

TYPE (French manufacturer or importer)	CHARACTERISTICS	ADVANTAGES	DRAWBACKS	OTHER POSSIBLE USAGE OF THE EQUIPMENT
SIMPLE WEED CUTTING BOAT (GIBEAUX, ROLBA) (a)	* front cutting unit horizontal cutter bar adjustable in height and orientable for some models. * min. width: 1.3 m * min. length: 4 m	Easy transport and and launching. Clean cut. Possibility of embankment cutting with orientable block.	* Necessity of recovering the wastes	* suitable for cleaning small watercourse and channels. * also model with lateral cutter bar or cutter bar mounted on hinged arm.
WEED CUTTING AND COLLECTING BOAT (MUDCAT, ROLBA, etc.)	* front cutter bar coupled with grid-type conveyor bring the grass into the boat. * min width: 2.3 m * min length: 7.2 m	Easy recovery of the weeds. Can be used for the removal of floating vegetation (duckweeds	* Uneasy transport and launching. * Not very flexible (cleaning of borders, corners of ponds)	* cleaning of lakes, ponds, water stretches
LIFTING WEED CUTTING BOAT (GIBEAUX, etc.)	* can be fixed instead of the cutting unit on some boats. * rake fixed to two mobile arms with a collecting basket placed in between.	Allows for floating plant collection.	* The draught may be limiting (50 cm about for the basket)	
WEED CUTTING BASKET (POCLAIN)	* basket equipped with a bar that can be fixed to the boom of a power shovel. * cutting width: 2.5 m * span 5 m	Simultaneous cutting and collecting. Work done from the embankment.	* Reduced span * Necessity of access roads.	* cleaning of embankments, sanitation ditches and trenches. * some models can be fixed laterally to tractors (wgt. 1800kg) 25 hp)





THE CUTTING OF MACROPHYTES

The operation is intended to keep the installation in good order and to control the gradual filling of the ponds. It should be carried out once a year, at the end of the summer or at the beginning of the autumn.

The shape of macrophyte ponds and the planted areas around mixed lagoons must be designed taking into consideration the maintenance requirements, particularly of the equipment which the user is likely to employ for the grass cutting operation.

The practical accomplishment of this operation depends on the size of the planted areas and on their location in the ponds, as summarized in the table below:

Accessibility of planted area with resp. to size	Fully accessible from the embankment	Partly accessible from the embankment
Small area (e.g. 3 000 m^2)	Hand cutting from the embankment	Hand cutting from the embankment on foot (waders) or from a light boat (allowing cut grass to be stored)
Large area (e.g. 3 000 m^2)	Mechanical cutting from the embankment (weed cutting basket)	Weed cutting boat

In all cases, cutting shall be done above the water surface so as to allow the vegetation to grow again normally and the cut grass shall be removed from the ponds.

Equipment necessary for the cutting of macrophytes

Manual cutting

The cutting of grass on the embankments can be carried out manually. The depth of macrophyte lagoons allows one to wade through water (with waders). The necessary tooling consists of a scythe with a long handle, a sickle and hedge cutting type tools. A small boat nearby will be used to stack the cut grass and take it away.

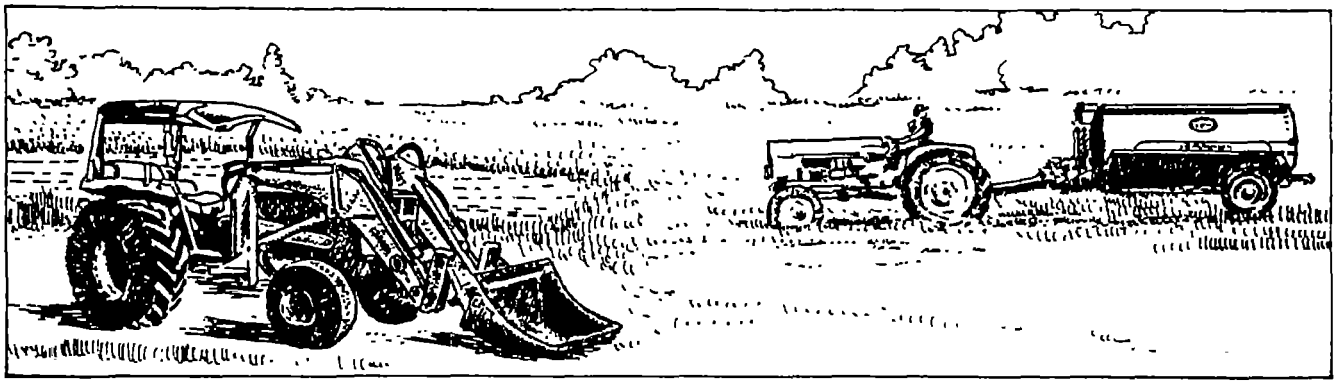
Mechanical grass cutting

The running of a sanitation pond seldom justifies alone the purchase of grass cutting machines which a costy investment (at least 120 000F). This equipment however, may be made available in the following cases:

- when the installation is situated in an area rich in ponds,
- when a local corporation of public services possess this equipment,
- when the equipment is purchased by an association of communities running an installation or a community running several lagoon facilities.

Depending on the size of the planted areas, on the availability of local staff and on the overall costs of the equipment, the operator will decide on the most appropriate grass cutting method.

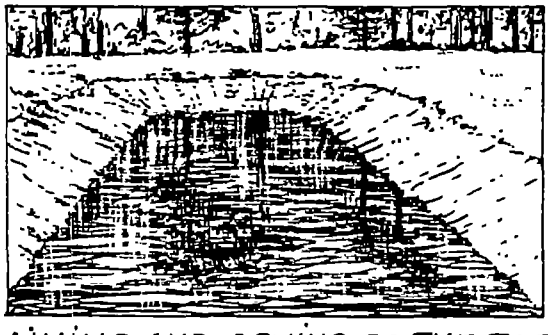
SLUDGE REMOVING EQUIPMENT



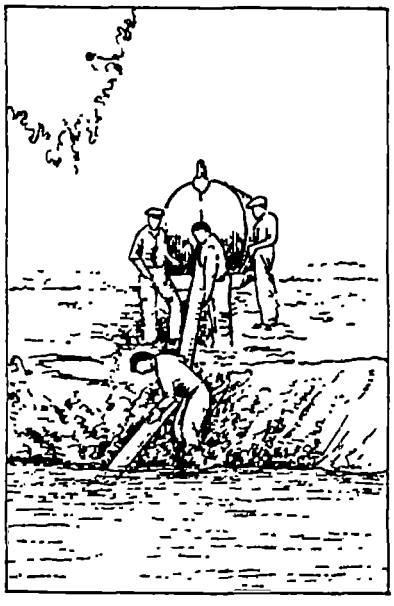
TRACTOR WITH DREDGING BUCKET

MOBILE PUMP AND SLUDGE REMOVAL RESERVOIR CONNECTED TO A TRACTOR

SLUDGE REMOVAL BY PUMPING



DRAINING AND DRYING OF THE TOP POND



Installation of the Pump

Sludge Pumping Out

THE CLEANING OPERATION

The treatment of wastewater in lagoons leads to the accumulation of sludge (or sediment) in the top pond which amounts, in a year, to approximately 0,1 m^3 of sludge per inhabitant.

Often, a large amount of sludge accumulates in the vicinity of the wastewater inlet where it forms a sedimentation cone; the remaining sludge is uniformly distributed at the bottom of the lagoon.

SLUDGE REMOVAL

Depending on the type of deposit, on the available equipment (pumps, power shovels, etc.) and on how often the cleaning operation must be carried out, the desludging operation will be performed according to one of the following methods:

Elimination of sedimentation cones: Depending on the plant design and more particularly on the effluent inlet structure and the type of treated wastes, this operation should be carried out every one to five years, as soon as the deposit is causing noticeable nuisance such as the rising of sludge to the water surface, offensive odours, hindrance to flow, etc. Since the sludge is mostly fluid, it can be drawn off by any type of pump without the previous emptying of the pond.

Cleaning without lowering the water level: This operation, is less frequent than the one described above but it is similar. It concerns other preferential areas of sludge accumulation which are located by probing the pond.

Cleaning after lowering the water level: Sludge drawing off may be facilitated by lowering the water level, especially when the operation is done using a bucket or a grab. This technique shall be used to extract the thicker sludge.

Complete cleaning: After about ten years of operation, the complete cleaning of the top pond may become necessary. The necessity will be felt when the amount of accumulated sludge is an obstacle to the efficiency of the treatment and impairs the correct flowing of the effluent into the ponds, causing hydraulic short-circuiting or reducing the retention times. The complete cleaning of the pond is a major operation which necessitates the assistance of a specialized company. The methods adopted will depend on the characteristics of the facility. The main steps of the operation are described hereafter:

Assessment of the amounts to be drawn off by probing into the ponds; (use of sounding-rod)

Isolation of the top pond if permitted by the configuration or shape of plant, (possibility of using a by-pass, having a second pond near the wastewater inlet or having several tops-ponds functioning in parallel).

Emptying. When these systems are provided, it is interesting to use the level control devices of the communication structures and the bottom drainage systems, otherwise, the water can be pumped into the next pond.

Sludge drawing off. This is done from the embankment of the lagoon by means of a pump or a mechanical shovel, taking care of preserving the pond tightness.

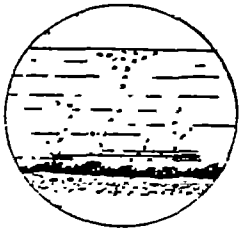
Sludge disposal

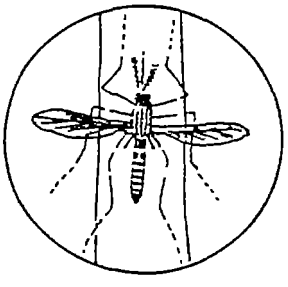
When the quantity of sludge to be removed is limited, it can simply be deposited on the pond embankments.

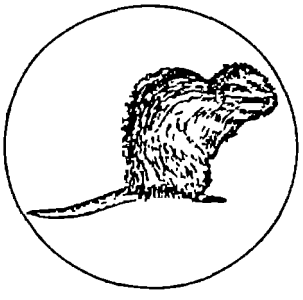
With larger quantities, however, the most satisfactory solution for disposing of the sludge is to deposit it on agricultural land near the purification plant. The sludge being well stabilized and highly mineralized, it is likely to constitute a good fertilizer.

Thus, the date for the complete cleaning should be chosen in accordance with the agricultural calendar and with the type of cultivation made on the land receiving the sludge. Besides, the agricultural re-use of sludge coming from purification plants is governed by local health regulation and by a specific legislation.

3 - THE DETECTION OF PROBLEMS OF OPERATION AND THEIR SOLUTION







THE LAGOONS AT THE SAINTES MARIES DE LA MER

Drawing made after the brochure:

Wastewater Disposal at "Saintes Maries de la Mer" - A pilot Operation.

THE DETECTION OF PROBLEMS OF OPERATION AND THEIR SOLUTION

Thanks to the experience acquired from the lagooning facilities operating in France, it is possible to identify the problems likely to arise during the operation of purifying lagoons.

Most of these difficulties are easy to solve, provided:

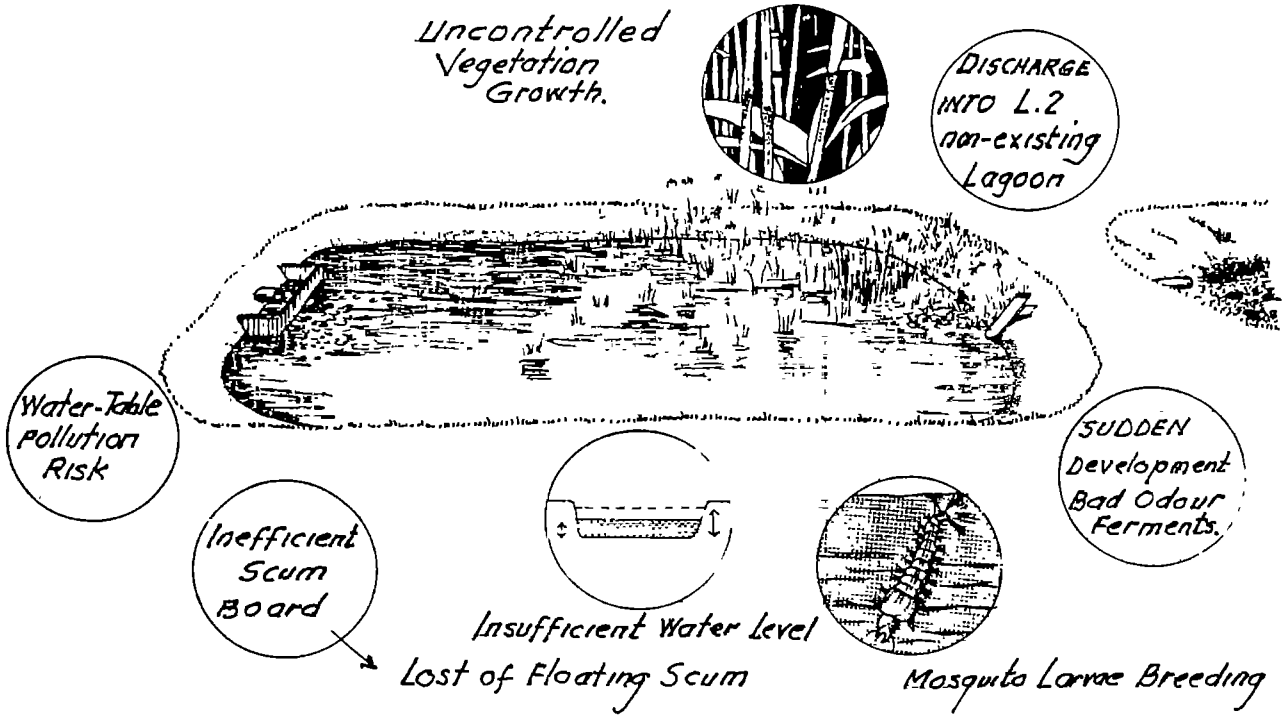
- that they are detected sufficiently early,
- that their cause is accurately identified,
- that on-site intervention is made with no delay.

The following sheets provide the necessary information to enable the operator to detect malfunctions on time, to determine the causes thereof and to decide on the appropriate remedial action.

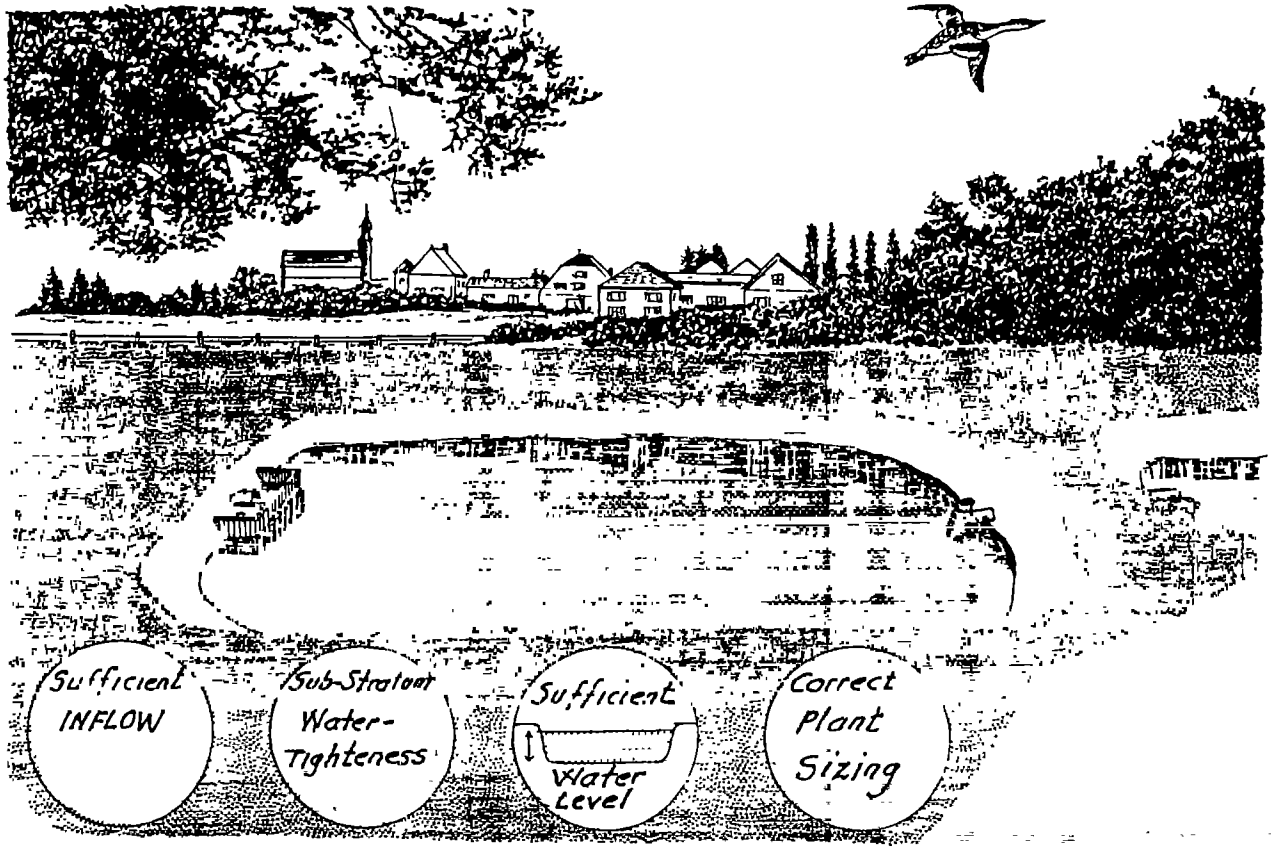
Routine maintenance should allow most of these problems to be solved. In some cases, however, specialized companies must be called in to supply assistance and support and the sooner the competent technical services will be summoned, the better for the plant.

The following sheets also provides a number of guidelines which should be considered at the design stage of the project to prevent specific problems from arising during the functioning of the plant.

The effects of inadequate filling of the ponds:



THE LAGOON NORMAL OPERATION



DIFFICULTIES RELATED TO THE FILLING OF PONDS

SHEET 1

Symptoms / Observations

During the filling of the ponds with water: difficulty in filling the top pond with clean water or, once the installation has been supplied with wastewaters: impossibility to fill ponds No.2 and 3 rapidly.

During operation: stoppage of flow between the ponds and lowering of the water level by more than 20 cm during several weeks in the dry season.

Medium term effects

Nuisance: odours, mosquitos.

In some cases: contamination of groundwater.

Colonization of microphyte lagoons by aquatic plants. Deterioration of the plant aspect.

In macrophyte lagoons: withering of planted vegetation.

Probable causes

Deficient watertightness in the design stage.

Deterioration of the pond watertightness.

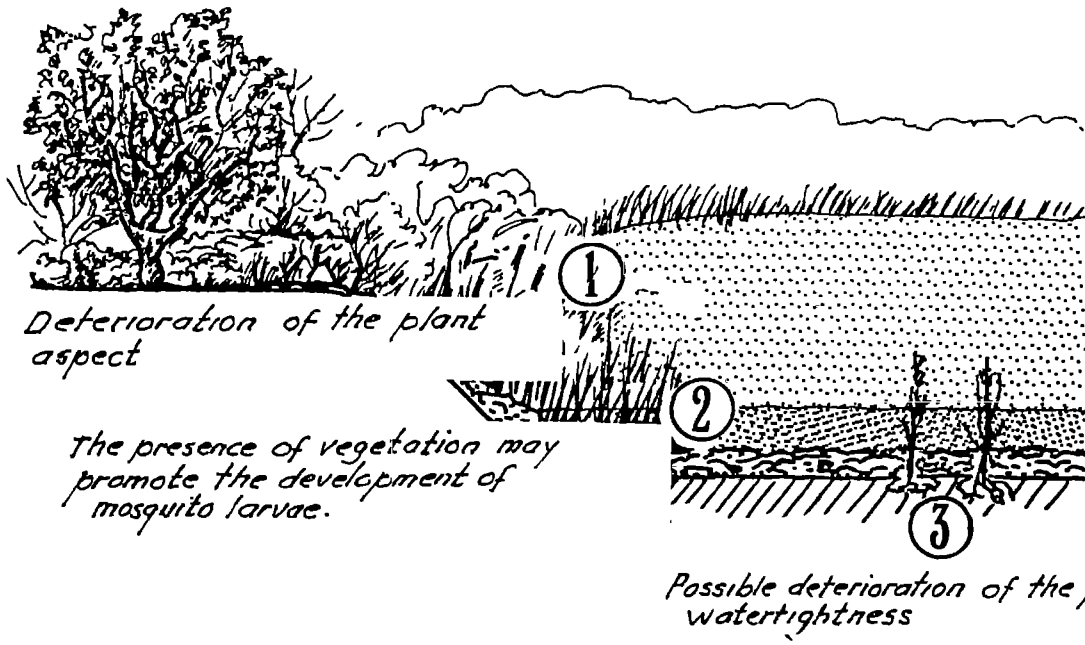
Underloaded installation (insufficient inflow with respect to the nominal capacity of the plant).

Remedies

Watertightness: repair of the sealing liner after emptying of the incriminated pond(s) or treatment with bentonite.

Insufficient inflow or oversize plant design: if the installation has ponds in parallel, reduce the number of ponds being utilized. Otherwise introduce additional water into the system, provided a low cost supply can be found.

EXCESSIVE VEGETATION GROWTH

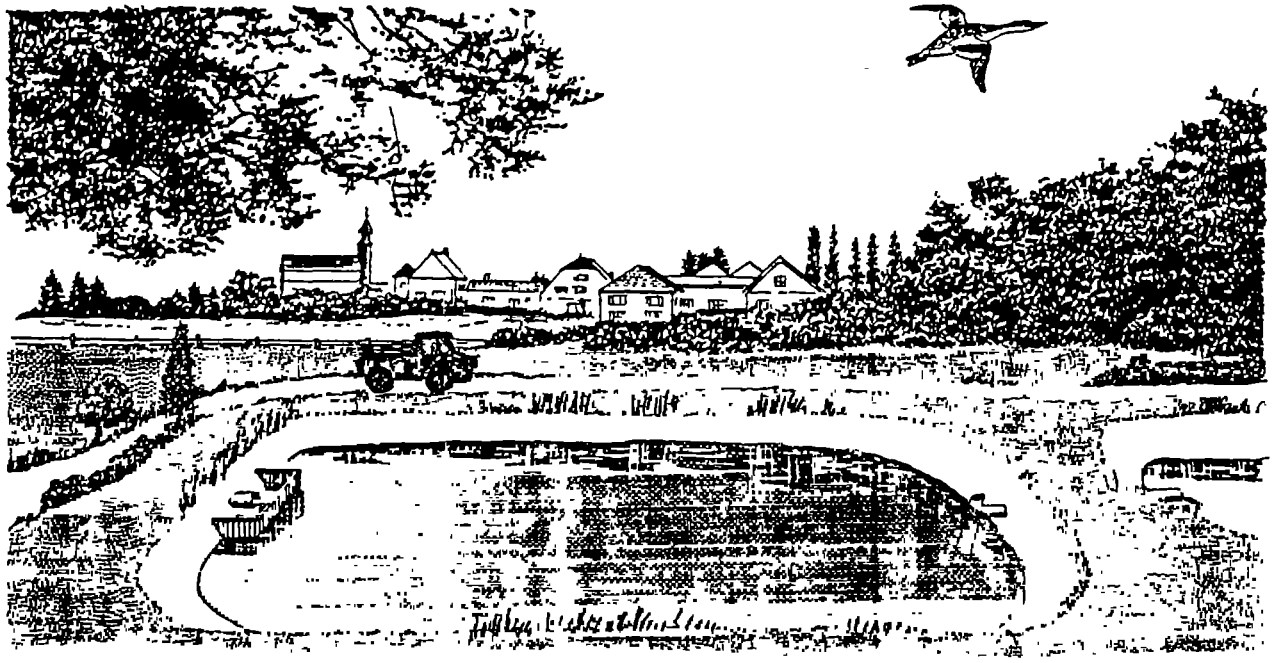


Deterioration of the plant aspect

The presence of vegetation may promote the development of mosquito larvae.

Possible deterioration of the pond watertightness

PREVENTIVE CONTROL OF VEGETATION GROWTH



- TREES ARE PRUNED AND SCRUBY VEGETATION IS TRIMMED
- WEEDS ARE REGULARLY CUT
- THE WATER LEVEL IS KEPT TO THE REQUIRED LEVEL
- THE SLUDGE IN EXCESS IS REMOVED

THE GROWTH OF VEGETATION INSIDE THE PONDS AND ON THE EMBANKMENTS

SHEET 2

Symptoms / Observations

Rooted plants begin to grow sporadically on the border of or inside macrophyte ponds.

Medium term effects

Deterioration of the plant aspect.

The presence of vegetation may promote the development of insect larvae (mosquitos).

Possible deterioration of the pond bottom watertightness.

Probable causes

Insufficient water level in the ponds.

Extensive sludge deposits.

Defective maintenance (waterside vegetation).

Remedies

Regular maintenance of the embankments: weed cutting once or twice a year.

Increase the water level in the ponds: it should not be lower than 1 m (this may require modifying the communication structures between the ponds).

Partial or overall cleaning of the pond.

ODOUR RELEASE

SHEET 3

Symptoms / Observations

Sensorial detection.
Colour of the water in the ponds.
Gas bubbles rising to the surface.

Medium term effects

Nuisance for the neighbours.
In some cases, reduction of the treatment efficiency.

Probable causes

Overloaded or undersized facility.
Bad water circulation; lowering of the water level in the ponds.
Sludge deposits reaching the water surface.
Concentrated, fermentable or septic effluents.
Special meteorological conditions (transient phenomenon at the end of the summer).

Solutions

Improve the circulation of water and the distribution of wastewater in the top pond.
Eliminate the sedimentation cones.
By-passing of septic tanks; separate treatment of industrial, agricultural or liquid manure effluents.
If it is a transient phenomenon affecting the first pond only, it is possible to envisage disolving temporarely the water of the first pond by recirculation of the water from the second pond.

CHANGE IN WATER COLOUR OF THE PONDS

SHEET 4

Symptoms / Observations

If the aspect of the water becomes milky, and takes a white, brown or pink colour, this is an indication of the intense development of microorganisms (bacteria).

Medium term effects

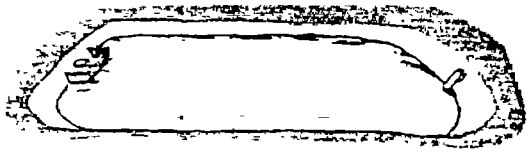
Deterioration of the treatment efficiency.
Release of odours.

Probable causes

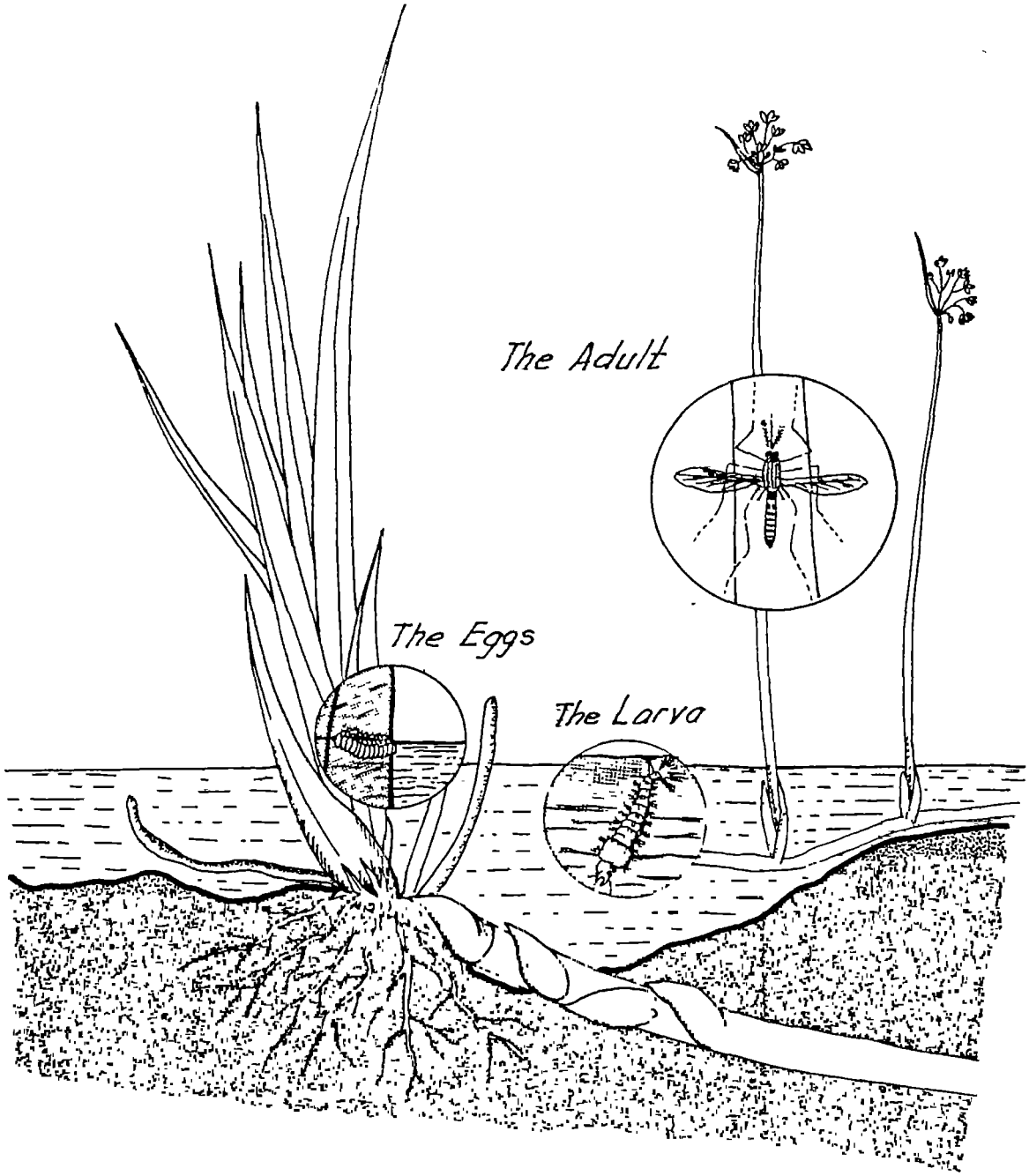
Overloaded or undersized ponds.
Effluents with a high degree of septicity.
Presence of highly fermentable industrial or farm produce wastes.
Penetration of light hindered by a layer of scum or floating vegetation at the surface.
Special climatic conditions (transient phenomenon in summer).

Solutions

Build extra capacity into the plant.
By-passing of septic tanks connected to the plant.
To separate the treatment of effluents coming from agro-industrial and food factories, or to allow for pre-treatment of such effluents.
Removal of floating scum or vegetation if it covers the whole pond surface.
See also the sheet "Release of Odours", opposite page.



THE DEVELOPMENT CYCLE OF A MOSQUITO



Mosquito larva prefers to develop in still and shallow ponds with vegetation

NUISANCE RELATED TO MOSQUITOS

SHEET 5

Symptoms / Observations

Justified complaints* from the people living in the plant vicinity.

Medium term effects

Has no incidence on the plant operation.

Probable causes

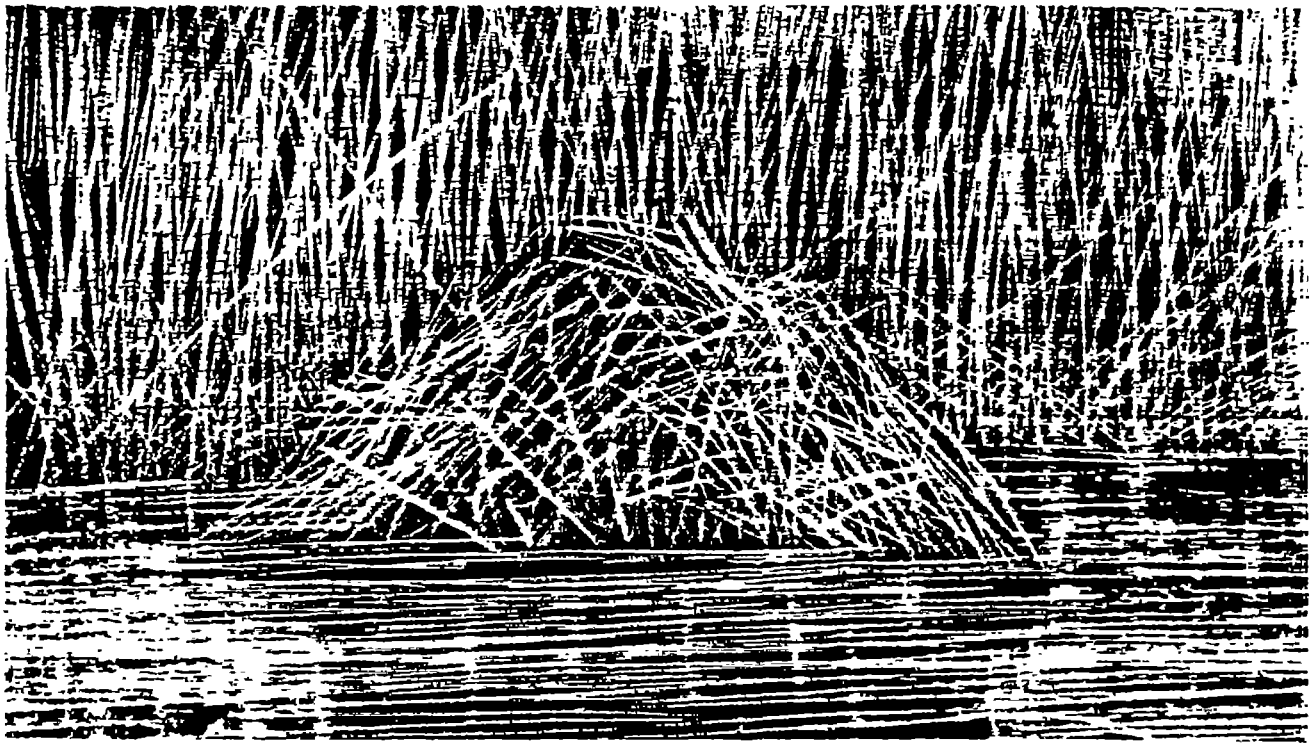
Presence of macrophyte lagoons.
Bad maintenance of the macrophyte lagoon surroundings.
Growing of vegetation in the ponds due to insufficient water level or to excessive accumulation of deposits.
Area already strongly populated with mosquitoes.

Solutions

Locate the lagoons sufficiently far from housings (over 300 m of distance) if mosquito breeding is frequent in the area, then, prohibit the use of macrophyte lagoons.
To ensure the regular maintenance of macrophyte lagoons and keep the water level constant in the ponds.
Line the edges of the lagoon with lean concrete.
Chemical protection is possible, (larvicides), but should be conducted in conjunction with the public services in charge of mosquito control.
Biological measures: gambusia is a species of fish that feeds on mosquito larvae. They colonize some lagooning ponds in the South of France. Their actual efficiency in this respect has been confirmed.

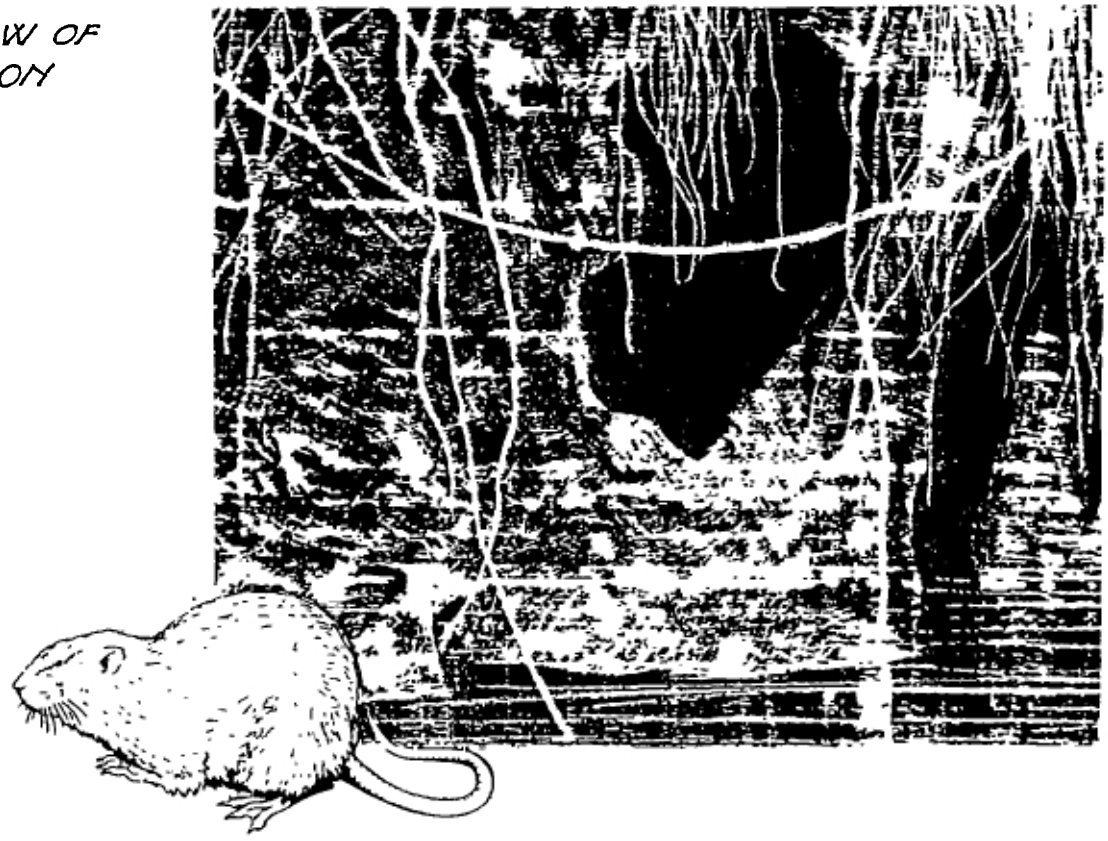
* Purification lagoons are not normally a preferential site for the development of mosquito larvae. This problem is specific to certain areas, especially in the South of France.

DAMAGE CAUSED BY RODENTS



1. HUT OF MUSK RAT

2. BURROW OF RACOON



THE PROLIFERATION OF RODENTS

SHEET 6

Symptoms / Observations

Presence of rodents access holes (burrows), in the embankments.
Huts in the ponds.

Medium term effects

Deterioration of the embankments.
Destruction of planted macrophytes.

Probable causes

Absence of regular inspections of the ponds (to prevent the settlement of rodents).
Areas favourable to the development of such animals (South West of France, regions with many pools).

Solutions

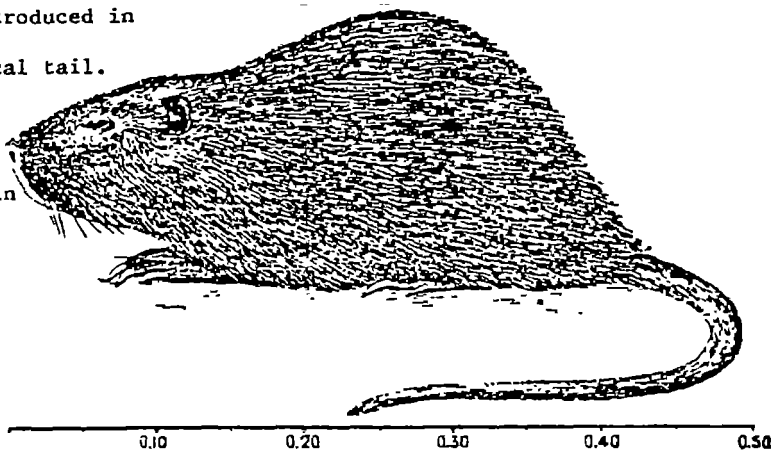
Perform regular maintenance of the installation and, if necessary, set traps and poisonous baits (mix traps and baits).
If the plant permits: raise temporarely the water level so as to flood the burrows and destroy the litter.
Provide an additional protection on the embankments: enrockments, geotextiles, lean concrete during the construction stage.

THE DIFFERENT SPECIES OF RODENTS

THE RACOON

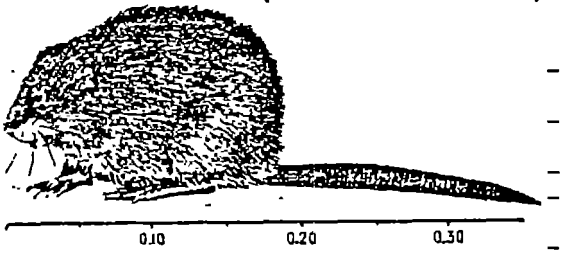
(Miocastor Coypus)

- Originating from South America, it was introduced in Europe 60 years ago.
- It has webbed forlegs and a long cylindrical tail.
- Weight of the adult: 8 to 10 kg.
- It is a strictly herbivorous rodent which mostly feeds on phragmites and scirpus.
- It builds huts and sometimes burrows.
- It fears the presence of man and settles in unfrequented marshes.



THE MUSK RAT

(Ondatra zibethica)

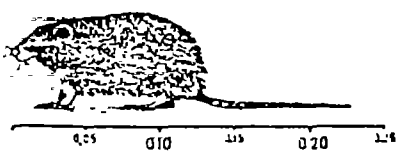


- Originating from America, it was introduced in Europe in 1905.
- It has partially webbed forelegs and a flat tail and is sturdily built.
- Weight of the adult: 1 to 1,5 kg.
- It is a herbivorous rodent which feeds on aquatic plants and also on terrestrial plants (cultures).
- It does not fear the neighbourhood of man.
- It builds burrows and digs extensive networks of galleries at the border of still water ponds.
- It occasionally builds huts.

THE WATER RAT

(Arvicole amphibius)

- Originating from Europe, it inhabits the borders and embankments of ponds and watercourses.
- It may cause extensive damage by digging galleries.
- Weight of the adult: 250 g.
- Its diet is variable. In the water, it eats fish, eggs and young fishes.



SHEET 6
(cont'd)

THE CONTROL METHODS

General remarks

Rodents do not normally attack lagoons. Problems generally arise in regions where populations have already settled at the proximity of natural or artificial ponds. The regular presence in ponmd of the plant attendant, expecially if he is accompanied by a dog, may seriously discourage some species (racoons) settling in the lagoons.

The most efficient way of controlling rodents is to act on a regional basis, within the frame of programmes aimed at verifying the location of the animals, assessing the size of populations and determining the appropriate method of destruction.

The setting of traps

It is a very efficient method if the trops are set by someone experienced. This method is recommended when a small local colony must be destroyed. There are different types of traps: wire traps, palette traps and hoop nets.

From the legal point of view, it is essential to refer to the hunting regulations prevailing in the district, prior to any intervention.

Poisonous baits

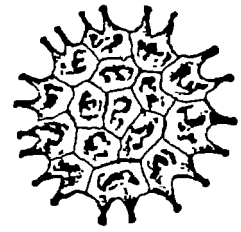
The bait generally consists of a piece of apple, carrot or beetroot; the poison used generally has an anticoagulating effect. The baits must be introduced in "false burrows", i.e. holes dug close to the areas colonized by the rodents.

Before setting poisonous baits, it is important to take the necessary steps to prevent any accidental poisoning of pets, cattle or game.

In all cases, it will be essential to make decisions in collaboration with the operators and organizations concerned.

A HIGH CONCENTRATION OF ALGAE IN THE EFFLUENT

SHEET 7



Pediastrum boryanum Chloroccocale

Symptoms / Observations

The quality of the effluent is not in accordance with reject standards due to a high concentration of algae.

Very pronounced green colour of water in the last pond.

Medium term effects

Inefficiency of the treatment.

Deterioration of the receiving environment quality.

Probable causes

Climatic or temperature conditions favourable to the development of algae (seasonal phenomenon).

Presence of a macrophyte pond not planted with vegetation.

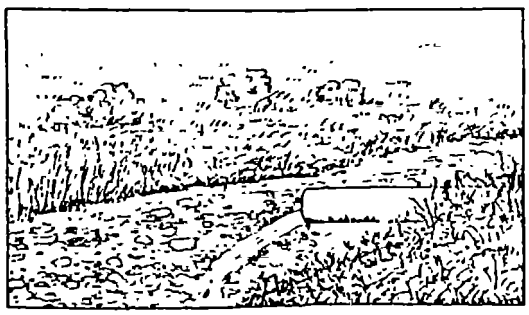
Solutions

Intensive planting of the macrophyte lagoons.

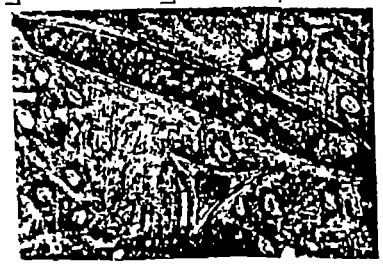
Insertion of an additional macrophyte lagoon or a planted trench between the lagoons and the receiving environment.

Installation of a water intake at the bottom of the pond (limited effect).

Additional filtration (sand filter). This solution entails additional operating constraints.



Euglenien (euglena oxyuris)



PRESENCE OF FOAM AND FLOATING DEBRIS

SHEET 8

Symptoms / Observations

Presence of sludge or organic debris floating at the surface.
Wastes floating at the surface.

Medium term effects

Odours.
Promotes the development of insect larvae.
If a large quantity of floating material is present, it may hinder the penetration of light and, hence, the algae activity.

Probable causes

Rising of sludge to the surface.
Presence of grease or hydrocarbons in the wastewater.
Combined sewage systems carrying various wastes.

Solutions

The rising of sludge to the surface is a frequent phenomenon in spring. If the facility is old and the phenomenon important, the partial or total cleaning of the pond should be considered after locating the sludge deposits.

Presence of grease: installation of a scum board at the inlet point of the wastewater in the top pond. Regular maintenance of the inlet structure must be assured.

Periodic removal of scums if the phenomenon is not very pronounced or limited in time.

DUCKWEEDS

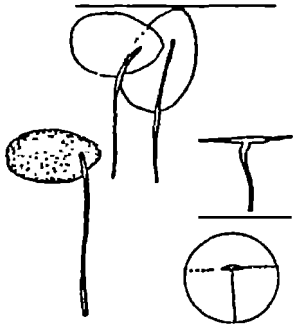
Duckweeds are floating plants which frequently colonize lagooning ponds. In France, there are five main duckweed species. These can be identified with the help of the sketches hereunder:

IDENTIFICATION KEY OF LEMNACEAE

*Drawing derived from "La Flore de Coste"(1937), and from the Columa pamphlet (1973): "the aquatic environment".

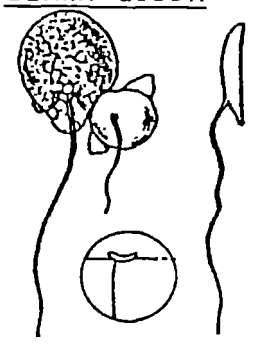
Only one root under each plant.

LEMNA MINOR



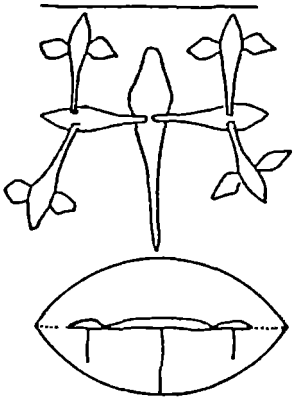
Flat duckweed with no thickness - most common kind

LEMNA GIBBA



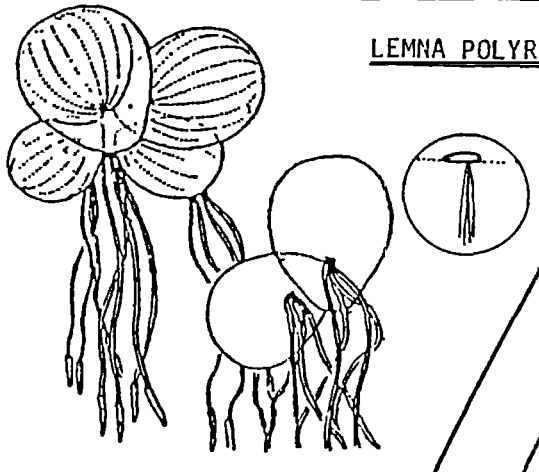
Rounded duckweed having a visible "thickness" - spongy aspect noticeable on the underside - common species.

LEMNA TRISULCA



Plants in the form of spear heads joined in threes of fours - often floating in mid-water - common species (probably not present in purification lagoons).

SEVERAL ROOTS UNDER EACH PLANT.



LEMNA POLYRRHIZA

Rather common species, 4 to 8 mm in height. A few ribs can be observed on the surface (probably not present in purification lagoons)

ROOTLESS PLANT.

WOLLFIA ARRHIZA

Rare species of very small size: 0,5 to 1 mm. almost hemispherical. (It is probably not present in purification lagoons).

THE PROLIFERATION OF FLOATING PLANTS

SHEET 9

Symptoms / Observations

Fast development of plants (duckweeds, filamentous algae) at the surface of pond.

Medium term effects

The complete covering of the ponds by vegetation prevents light from penetrating and therefore reduces the algae activity. This in turn lowers the oxygen content in water and diminishes the treatment efficiency. This may sometimes generate offensive odours.

Probable causes

Unknown. Duckweeds seem to grow preferentially in small, often underloaded ponds sheltered from the wind. Filamentous algae generally develop in unheavily loaded lagoons (combined sewage system, low rate of inflow).

Solutions

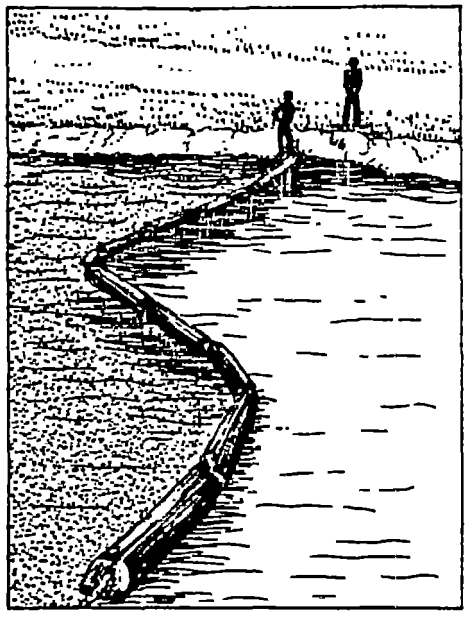
Manual or mechanical removal of the plants (see next sheets): Approximately three crops a year are necessary for duckweeds.

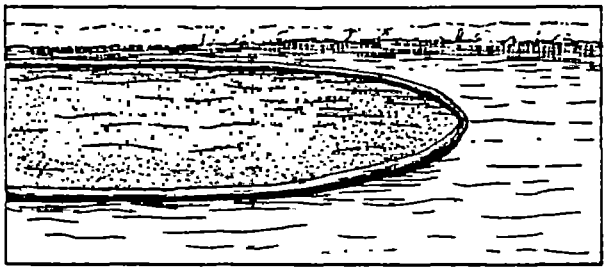
THE ORIGIN OF DUCKWEED IN LAGOONS

Unlike rooted macrophytes, duckweeds are not voluntarily introduced in lagoons. Their presence, however, can be observed in more than a third of the plants in operation. If present in a limited quantity, they do not impair the plant operation. However, if they grow in excess and too rapidly - as this is often the case - the ponds may quickly become covered with a thick layer of vegetation which will eventually result in severe problems relating to the operation of the plant.

DUCKWEED HARVESTING

1st STEP: THE PLANTS ARE CONCENTRATED IN AN AREA OF THE POND



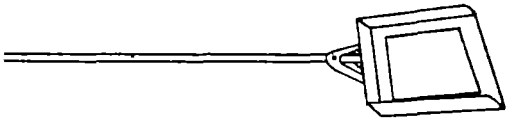


One of the following methods shall be used:

a) Either timbers towed by ropes from the embankments,
b) Or a nylon net (2 mm square mesh) tied to a rope at its top part, ballasted- at its bottom part and towed from the embankment.
c) Or an anti-pollution type- floating dam. A very efficient but very costy- system, (300 to 400 Francs per meter) and difficult to tow from the embankment. If the pond is large an agricultural tractor and two persons at least are required.

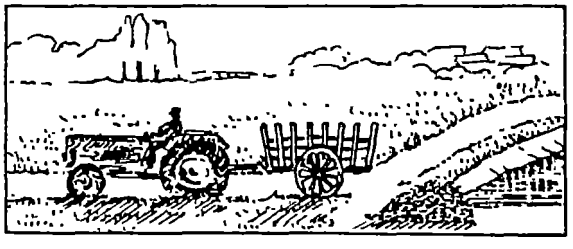
2nd STEP: THE HARVESTING

a) **Manually:** using specially made screen rakes.
b) **Mechanically:** the use of a high rate pump (60 m^3/hr) permits to rapidly and efficiently remove the unwanted vegetation. A 3000 m^2 pond can be cleaned by 3 to 4 persons in half a day. The method consists in manually holding the hose at the water-duckweek interface.

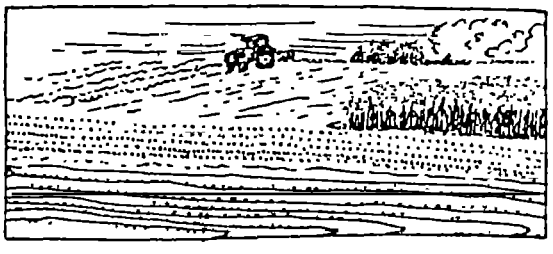


3rd STEP: STORAGE AND TRANSPORT

a) Transport in an agricultural rack-type trailer.
b) In a chassis-mounted mesh type hopper, to facilitate
- dripping of water.



4th STEP: THE RECYCLING



Duckweeds have a high nitrogen content (higher than lucerne), which make them particularly fit for reuse as "green" fertilizer. The spreading on agricultural land seems to be the most appropriate end-use of these plants.

SHEET 9
(cont'd)

The chemical control of duckweeds

The advantages of the chemical control of duckweeds is the rapidity and, to some extent, the easiness of implementation. It has, however, a few drawbacks:

- The plants are left to decay on the spot with the consequence of increasing the organic loading of the ponds and the volume of deposits which necessitates more frequent cleaning.

- The chemical products used are often expensive.

- The related secondary toxic effects may impair the plant correct operation.

Among the products fit for use in aquatic environments, the chemical compounds containing "DIQUAT" seem to be the most efficient against duckweeds and having minimum side effects if the specified quantities are not exceeded. However, the use of a chemical treatment in purification lagoons is strongly advised against.

The biolobical control of duckweeds

(acc. to CEMAGREF BORDEAUX/SATESE from LES DEUX SEVRES)

Macrophytofagous "chinese carps" (Ctenopharyngodon idella) can develop in the last ponds of lagoons but they may escape from them. Since the possibility of the natural reproduction of their species in Europe is not to be excluded, one should be extremly cautious in using them. In the present state of knowledge, the use of chinese carps should be strictly avoided. Besides, the efficiency of this fish is very much limited to cold water (temperatures under 15-20 °C).

Ducks, geese or swans can efficaciously limit the development of duckweeds: based on experiments conducted abroad, a population of 5 to 8 ducks per ha would be sufficient to assure a preventive control. The birds, however, tend to disturb the pond surroundings by their motions and contribute to the enrichment of the environment with their excrement. In addition, it is necessary to sedentarize them on the lagoon ponds (building of shelter, additional food supply).

The manual or mechanical control of duckweeds (see opposite page)

This remains at present the most efficient method for controlling the proliferation of duckweeds at a reasonable cost. (see chapter 4: Yearly operating costs).

Harvesting is carried out in several steps which may involve the use of hand or mechanical tools, specialized equipment,or of ad-hoc tools.

Harvesting should be made whenever the plants cover the whole surface of the pond, which represents approximately three to four crops a year.

FREQUENCY AND DURATION OF THE ROUTINE OPERATION TASKS

The data presented here are based on a medium size plant serving 500 to 600 people and featuring embankments planted with grass. Provided a few modifications are made to take into consideration the equipment used, the remoteness and the provisional assessment for each particular case. (Warning: the time needed for the individual operations is not directly proportional to the size of the plant).

Operation	Frequency	Duration	Required staff	Total number of work days in a year	Material used
General monitoring and pretreatment unit maintenance	Once a week	1 hour	1	7	Hand tools, grid comb, scum removal equipment, garbage bins.
Maintenance of vegetation belt	4 times a year	1 day	1	4	Motor scyther hand tool.
Cutting of riverside vegetation	Twice a year	1 day	1	2	Hand scythe, rake.
Cutting of weeds in the macrophyte lagoons	Once a year	1 day	2	2	Hand tools, small boat, if necessary
Miscellaneous: small repairs, floating scum removal, partial cleaning, repair of embankments				5	Hand tools and small equipment according to the needs

APPROXIMATIVE ESTIMATION OF THE COST FOR CLEANING THE TOP POND (AFTER TEN YEARS OF OPERATION)

Thickness of the sludge deposit: 1 to 2 cm per year, hence a total of 10 to 20 cm.

Quantity to be drawn off: 3 000 m^2 x (0,1 to 0,2 m) = 300 m^3 V 600 m^3.

Cost of sludge extraction: varying between 30 to 50 F/m^3 (in 1985) depending on the actual conditions.

Cost of operation "C": 9 000F C 30 000F.
Hence, a cost per inhabitant and for each year comprized between 1,5 and 5 Francs.

4. THE COST OF OPERATION

(annual cost for a typical installation)

The frequency and duration of the regular operational tasks, as well as the equipment required are summarized in the table on the opposite page.

The most expensive item is manpower. Approximatively twenty days of work for a local community worker or for an attendant, are required.

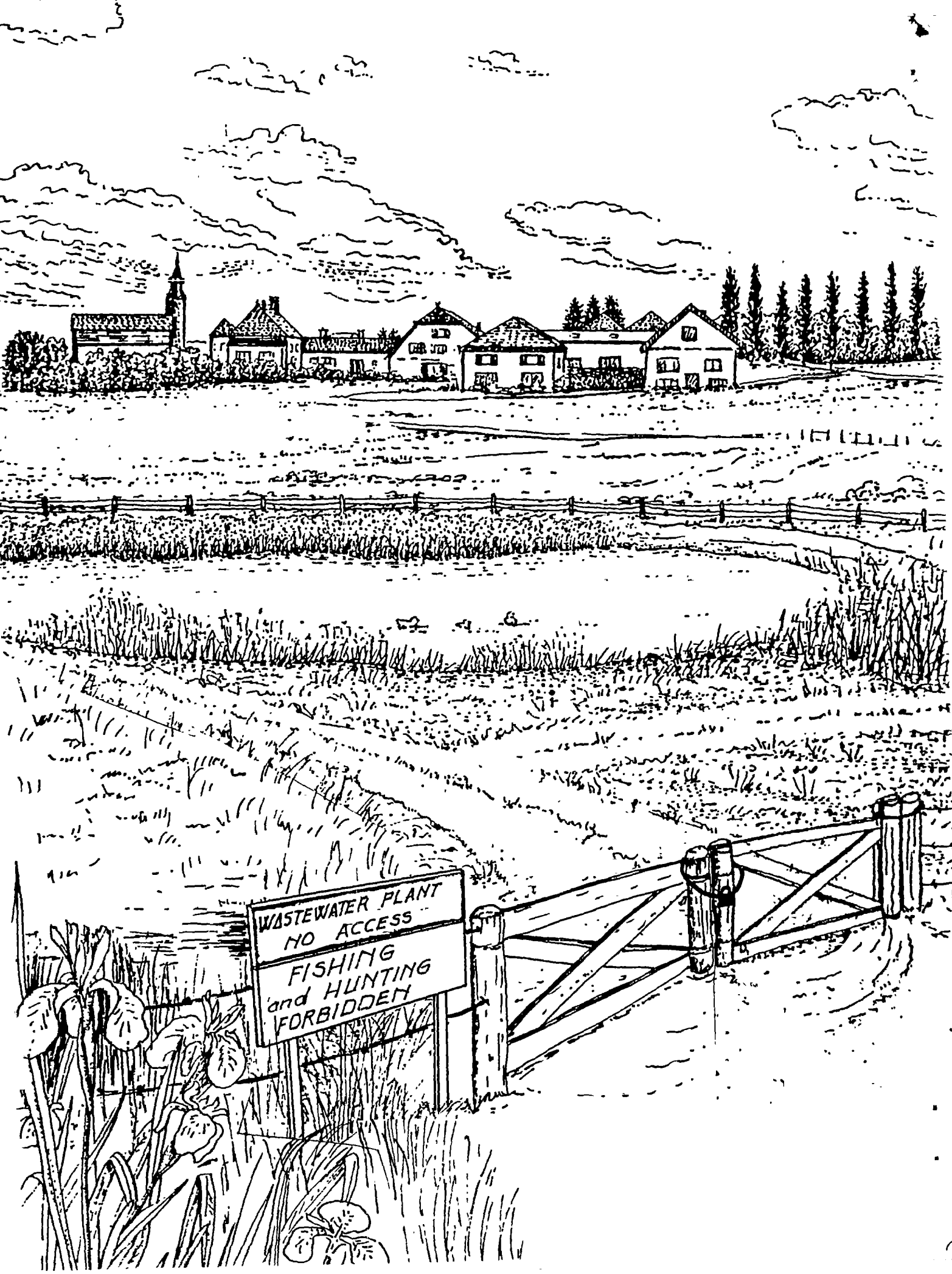
Assuming an hourly cost of manpower of 40 Francs, plus some small supplies, the replacement cost of the small tooling, and the rent or purchase of mechanical equipment, the annual cost of the plant's current operation amounts to 8 000 Francs in 1985. (i.e. about 15 Francs per inhabitant equivalent). If we correlate this with the amount of water used per capita ($50m^3$/inhabitant a year), the price is $0,30F/m^3$.

The above-mentioned estimations will need to be adjusted to the various different conditions that may occur, i.e.:

- The proliferation of rodents is frequent in some regions and necessitates regular visits of the attendant, as well as the setting of traps and baits (sheet No.6, page). The related cost corresponds to approximately 6 days of work per year, whatever method is used to control the rodents (trapping of poisoning). This represents an additional expense of about 5 Francs per inhabitant per year.

- The development of floating plants such as duckweed in the ponds (see sheet No.9, page),is also frequent. The cost of their removal can be estimated by means of the table on the opposite page. The frequency of this operation is three times a year and the time required for 2 operators is 2 days. Considering a total number of twelve days per year for the removal operation, the rent of the specialized equipment required must be added. This amounts to a total additional cost of approximately 10 Francs a year per inhabitant.

- Although this is not a frequent operation, the complete cleaning of the top pond (about once every ten years) must be taken into consideration. The cost of this operation, however, can only be assessed on a case by case basis (see opposite page).


WASTEWATER PLANT
NO ACCESS
FISHING
and HUNTING
FORBIDDEN

5. SAFETY

If correctly operated, the purification lagoons have a pleasant aspect and look very much like natural water stretches. This ressemblance may precisely be a danger to the ill-informed public such as children, fishermen or hunters attracted by waterfowl, etc.

It should be reminded that lagoons are a sanitation system which must not be mistaken with recreational grounds, as therefore:

- Health hazards should not be disregarded.

- The owner of the installation may be held fully responsible in the
- event of an accident (fall into a pond, etc.)

A number of measures must be taken with regards to safety in the installation:

- The perimeter of the installation should be restricted to only the operating staff who should be informed of the basic rules concerning hygiene (i.e. washing of parts of the body exposed to the effluents, wearing of protective clothing, separate washing of protective clothing, etc.).

- Warning posters may be placed at the entrance of the installation.

These provisions must be aimed at ensuring the public safety and facilitating the integration of the plant into the life of the community. This will be the best guarantee for the satisfactory operation of the installation.

ADDITIONAL INFORMATION

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La valorisation agricole des boues de stations d'épuration. Environnement (Ministère), 64 p.

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M. VAUCOULOUX, CEMAGREF, 1983,

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Réalisation : M. GUILLON
Diffusion : - Service de production de cinéma scientifique de l'Université de Lille (U.S.T.L.) SN 3 ; 59655 VILLENEUVE D'ASCQ Cedex ;
- Service CINEMA du Ministère de l'Agriculture. 78, rue de Varenne, 75007 PARIS.

(couleur, 16 mm, son optique, durée 23 mn).