Lagoons – Operation and Management in New Brunswick

Lagoons

- Provide secondary treatment to domestic wastewater by the action of bacteria stabilizing the organic matter in the wastewater.

Benefits of lagoons:

- Achieves the treatment standard presently required by the DELG
- High degree of treatment in cold climate conditions
- Withstand high flow and organic loading fluctuations
- Less costly than mechanical systems
- Low level energy requirements
- Less operator skill and attention required than mechanical systems
- Relatively easy to maintain

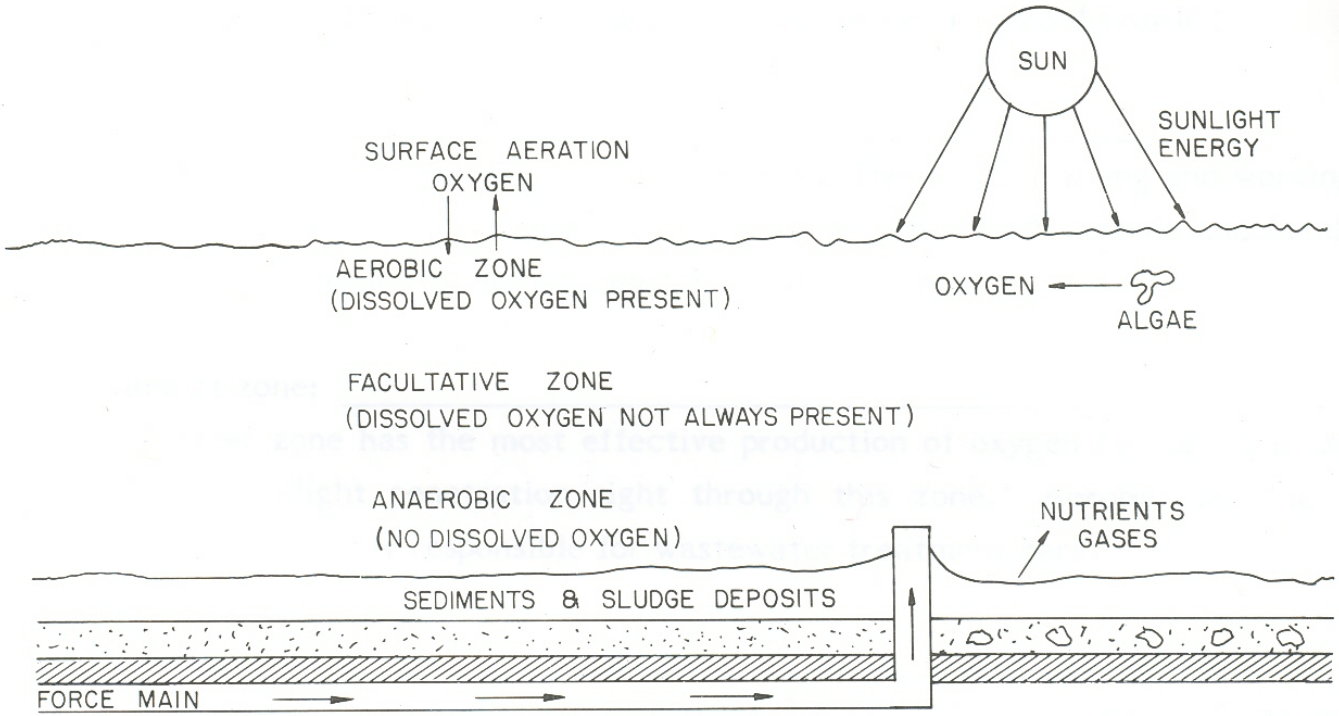
Disadvantages of Lagoons

- Algae in effluent
- Less effective in removing Ammonia then other technologies
- Pond turnover and other odour issues
- Potential leakage concerns
- Long-term solids accumulation
- Larger foot-print required

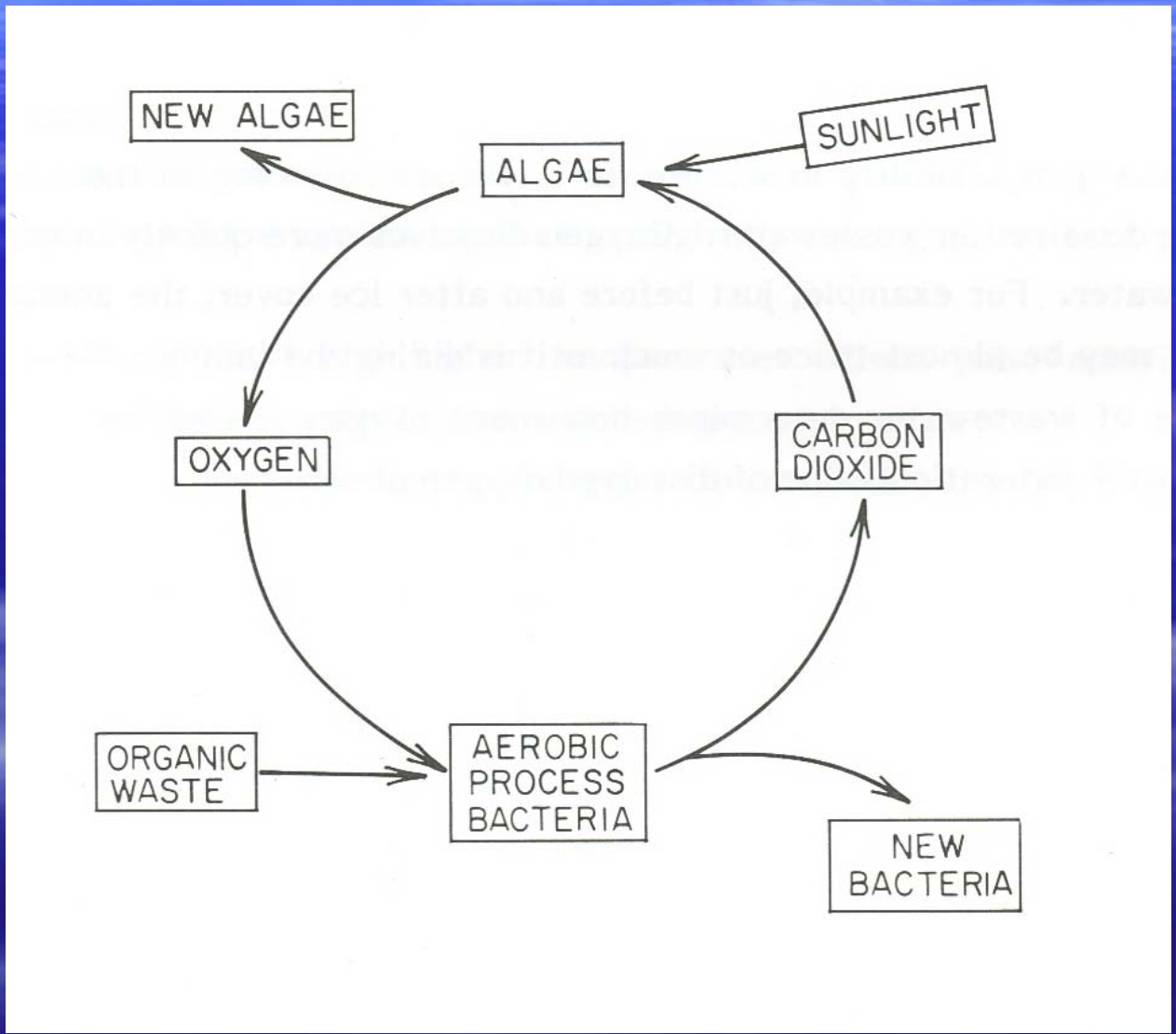
Facultative Lagoons

- Facultative ponds are shallow ponds, open to the sun and air
- Facultative ponds have three layers of treatment in the pond:
  - aerobic bacteria
  - facultative bacteria
  - anaerobic bacteria
- Each decompose organic matter in three different zones

Facultative Lagoon



Facultative lagoon



Aerobic Zone

- In the **aerobic** zone, bacteria use dissolved oxygen to decompose organic waste through oxidation.
- The oxygen comes from wind action and photosynthesis.
- Algae reacts with sunlight to produce new cells, releasing oxygen as a by-product.

Facultative Zone

- At a depth of 2 feet, sunlight penetration is reduced in the pond and dissolved oxygen levels become limited.

- **Facultative** bacteria can decompose organic matter under varied oxygen availability.

Anaerobic Zone

- In the **anaerobic zone**, wastewater solids, bacteria and algae settle on the bottom of the pond and form a sludge layer.

- Anaerobic digestion occurs where bacteria converts organic matter into different volatile organic acids.

Aerated Lagoons

- Aerated lagoons use mechanical or diffused aeration equipment to increase dissolved oxygen levels throughout the pond.

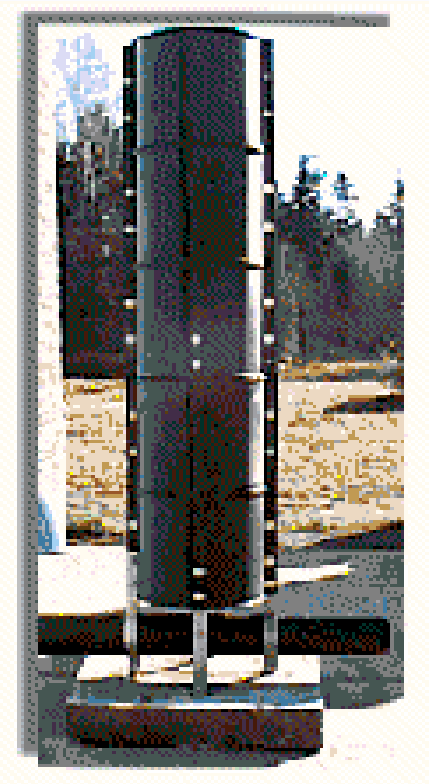
- Aerated lagoons are deeper than facultative lagoons (3 – 4.5 m).

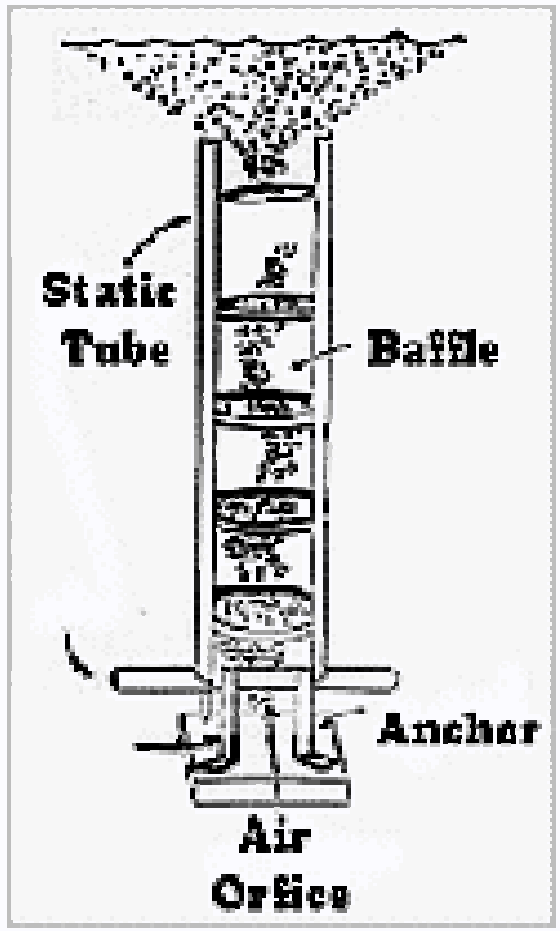
Aeration Equipment

- Mechanical agitation
  - Aspirators
  - Splashers
- Diffused air
  - Surface/sub-surface
  - Static tubes

Mechanical Mixers

Coarse Bubble Static Tube



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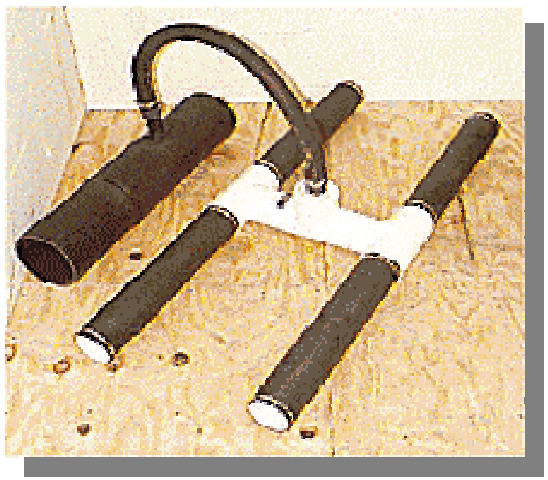
Fine Bubble Aeration




STOP MACHINE BEFORE OPENING DOORS
ARRÊTER LA MACHINE AVANT D'OUVRIR LES PORTES
PARAR LA MAQUINA ANTES DE AVRIR LAS PUERTAS
ATLANTIC COMPRESSED AIR

Aerated Lagoons

- Organic wastes in aerated lagoons are decomposed by oxidation, synthesis, and endogenous respiration
- Oxidation – organic matter (carbon based) oxidizes to produce CO_2, H_2O and NH_3
- Synthesis – energy produced through oxidation converts some organic waste to new cell tissue
- Endogenous respiration – when original organic waste is depleted, bacteria consumes other bacteria to obtain energy (reduces bacteria levels)

Lagoon Design

- Lagoon side slopes
  - 2.5:1 to 3:1
- Aeration Requirements
  - 2 mg/L oxygen levels maintained at all times
- Rectangular shapes usually constructed to provide even distribution of the mixing and aeration intensity
- Inlet and outlet piping should be located as far away as possible (minimize short-circuiting)
- Floating baffles also minimize short circuiting
- Final outlet pipe – at least 4 feet below lowest level

Lagoon Construction

- Lagoon Liners
  - Clay
    - Must demonstrate clay has characteristics to retain water
  - Liners
    - usually HDPE geomembrane

Clay Liner

Liners

Liners

Liner “Whales”

Lifting of Liner

Biochemical Oxygen Demand (BOD)

- Measures the organic strength in the wastewater.
- 5 Day Biochemical Oxygen Demand test measures the amount of oxygen required in a five day period by the microorganisms in consuming the organic material in the wastewater.
- Normal domestic sewage varies between 150 – 250 mg/L BOD.

Suspended Solids (SS)

- Suspended solids removal is as important as BOD removal for preventing receiving stream pollution.
- Normal domestic sewage has similar SS and BOD concentrations (150 – 250 mg/L SS).
- Suspended solids are difficult to remove from lagoon effluents due to the high concentration of algae (particularly facultative lagoons).

pH

- The pH of the influent and effluent will vary throughout lagoons (6-9).
- pH variability is due to several factors:
  - natural alkalinity and hardness of the water
  - type and volumes of industrial and commercial wastes
  - the lagoon itself
- Algae reactions in lagoons raise the pH (9.5 or above).

pH

- pH may decrease when septic wastes or acid industrial wastes are added.
- Combination of organics, natural alkalinity and enough detention time must be right.
- Industrial loads with high acidic wastes often add sodium nitrate to improve alkalinity.

Dissolved Oxygen

- Good indicator of the activity of an aerobic lagoon
- No less than 1.0 mg/l in the pond or effluent (septic conditions)

Flow

- Flow measurement Indications
  - Hydraulic loading (flows should be less than design flow)
  - Indicates the extent of infiltration in the collection system
  - When related to BOD and SS reductions, it describes effect on overall treatment
  - Required for calculating chemical dosages

Disinfection

- Disinfection of wastewater effluent in New Brunswick:
  - the receiving water body is a shellfish harvesting area
  - a recreational area (beach)
  - may have an effect on a drinking water supply

- Disinfection methods:
  - Chlorine
  - Ultra-violet radiation
  - Engineered Wetland
  - Ozone

Chlorine Disinfection

-Chlorine gas
-Sodium Hypochlorite
-Calcium Hypochlorite
-Chlorine Dioxide

De-chlorination

- Sulphur dioxide
- Activated Carbon

UV Disinfection

UV Disinfection

Engineered Wetland

New Brunswick's Wastewater Lagoons

- New Brunswick has over 120 municipal wastewater treatment facilities, including 95 lagoon systems.

- The lagoons range from facultative lagoons to aerated lagoons with additional tertiary treatment.

Approvals to Operate

- Every municipal wastewater treatment facility requires an Approval to Operate under Regulation 82-126, Clean Environment Act.
- The Approvals to Operate outline:
  - lagoon effluent limits
  - monitoring requirements
  - operator training and certification
  - emergency reporting procedures

Effluent Limits

- Any new system must meet 20/20 effluent limits (20 mg/l BOD, 20 mg/l SS) year round (8:1 Dilution)
- Tertiary treatment (more stringent limits) are required if discharging water body does not meet 8:1 dilution

Effluent Limits

- Disinfection is required if the discharge water body is a shellfish harvesting area, a designated recreational area, or may impact a drinking water supply.
- Disinfection limits may vary depending on the receiving water body, but generally the recreational limit of 200 MPN/100 ml faecal coliform is used.
- Some older lagoons have less stringent limits (20/40) from May to October only. These effluent limits will be modified as the systems upgrade.

Effluent Release

- Continuous effluent release
  - Effluent continuously released into receiving water body
- Seasonal effluent release
  - Lagoon volume is large enough to retain water in the lagoon to only discharge at certain times of the year
    - Only during winter months
    - 2 weeks in Fall and 2 weeks in Spring (shellfish harvesting area)
- Tidal effluent release
  - Effluent is only released during high tide

Chlorine Limits

Disinfection:

- Total chlorine residual of between 0.3 mg/l and 0.7 mg/l must be maintained after a retention time of 30 minutes based on the average daily effluent flow.

De-chlorination

- Total chlorine residual of 0.0 mg/l must be maintained.

Monitoring Requirements

- Based on the Classification of the facility.
- Based on ACWWVCP guidelines
- Most lagoons fall under the Class I facility.
- Class I is the lowest level, ranging from 0 to 30 points.

Wastewater Treatment Classification

- Currently wastewater treatment facilities fall under four classifications using a point system for different areas of the facility:
  - population served
  - flows
  - type of wastewater
  - type of treatment system
  - disinfection
  - additions of chemicals
  - laboratory facilities at the plant.

Monitoring

- Typically in New Brunswick, an aerated lagoon with disinfection will receive approximately 20-25 points.

- Facilities with a higher classification have more frequent testing requirements.

Monitoring

STATION	PARAMETERS	FREQUENCY
Influent	Dissolved oxygen, pH, temperature	Twice-a-week
Stabilization Pond	Colour, odour, scum, aeration pattern	Twice-a-week
Effluent	Dissolved oxygen, pH, temperature & flow	Twice-a-week
Effluent after Chlorination (after 30 min retention)	Total residual chlorine	Twice-a-week (May to October)
Effluent after De-chlorination	Total residual chlorine	Twice-a-week (May to October)
Effluent	Faecal Coliform	Three times a year (May to October)
Influent	Biochemical Oxygen Demand (BOD) Suspended Solids (SS)	Once a month (April to Nov)
Effluent	Biochemical Oxygen Demand (BOD) Suspended Solids (SS)	Once a month (April to Nov)
Effluent	Total Phosphorus (TP), Nitrates (NO_X, Total Kjeldahl Nitrogen (TKN), Ammonia Nitrogen (NH_3N)	Three times a year (Spring/summer/fall)

UV Monitoring

Station	Parameter	Frequency
Effluent	Faecal coliform	Once a week

Monitoring

- Monthly Testing (BOD & SS)
  - Usually lagoon operators collect the samples and send them to a laboratory for analysis, as the facility does not have the resources to have a full laboratory.
- Quarterly Testing (Nutrients)
  - No limits currently.
  - Operator collects samples and send to the laboratory for analysis.

Monitoring

- Weekly Testing (DO, pH, Temp & flow)
  - Tested twice a week.
  - Usually done by the operator at the facility using handheld monitoring equipment.

- These tests enable the operator to monitor the lagoon for changes and hopefully remediate problems before the system has operational problems and exceed effluent limits.

Operator Training and Certification

- ACWWVCP Program
- Operator is required to become certified to the Classification of the facility
- Collection system operator will be required to obtain certification to the classification in near future.
- Training is encouraged, but not required through approval.

Emergency Reporting

Recording

- All bypasses at the treatment plant or at a pump station must be recorded.

Reporting

- All bypasses due to mechanical or electrical failure must be reported to the DELG immediately.
- Bypass events caused by natural occurrences, such as heavy rains or snow melt do not need to be reported. **

Reporting System

- DELG notifies other government officials of a discharge event by e-mail:
  - Environment Canada
  - Fisheries and Oceans
  - NB Dept of Health and Wellness
  - Adjacent jurisdictions, where necessary

Annual Report

- Municipalities with Class I Facilities must submit an annual report to the DELG
  - Monitoring results
  - All bypass events
- Class II Facilities prepare quarterly reports

Nutrient Removal

- Currently no nutrient limits on most systems.

- Phosphorous Removal:
  - Chemical Precipitation
    - Alum (Aluminum Sulphate)
    - Iron (Iron Sulphate
    - Calcium (lime – Calcium Carbonate)
  - Biological
    - Aeration adjustments

Alum Addition

Nutrient Removal

Ammonia Removal:

- Ammonia has been declared a toxic substance by CEPA Act (EC).
- Systems greater than 5000 m^3/d are affected.
- Currently no ammonia removal systems in NB.

Lagoon Maintenance

- Regular monitoring of influent and effluent.
- Remove duckweed and scum.
- Cut grass and weeds along berm.
- Control cattails.
- Maintain fence surrounding lagoon.
- Control rodents and other animals.

Duckweed

Cattails

Thank you