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 than 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

SURFACE AERATION
OXYGEN

AEROBIC ZONE
(DISSOLVED OXYGEN PRESENT)

OXYGEN
ALGAE

SUNLIGHT ENERGY

FACULTATIVE ZONE
(DISSOLVED OXYGEN NOT ALWAYS PRESENT)

ANAEROBIC ZONE
(NO DISSOLVED OXYGEN)

NUTRIENTS
GASES

SEDIMENTS & SLUDGE DEPOSITS

FORCE MAIN
Facultative lagoon

Diagram:
- NEW ALGAE
- ALGAE
- SUNLIGHT
- OXYGEN
- CARBON DIOXIDE
- ORGANIC WASTE
- AEROBIC PROCESS BACTERIA
- NEW BACTERIA
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.
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
Fine Bubble Aeration
Aerated Lagoons

- Organic wastes in aerated lagoons are decomposed by oxidation, synthesis, and endogenous respiration.
- Oxidation – organic matter (carbon based) oxidizes to produce CO2, H2O and NH3.
- 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
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 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).
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 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.
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.
<table>
<thead>
<tr>
<th>STATION</th>
<th>PARAMETERS</th>
<th>FREQUENCY</th>
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<tbody>
<tr>
<td>Influent</td>
<td>Dissolved oxygen, pH, temperature</td>
<td>Twice-a-week</td>
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<tr>
<td>Stabilization Pond</td>
<td>Colour, odour, scum, aeration pattern</td>
<td>Twice-a-week</td>
</tr>
<tr>
<td>Effluent</td>
<td>Dissolved oxygen, pH, temperature &amp; flow</td>
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<tr>
<td>Effluent after Chlorination</td>
<td>Total residual chlorine</td>
<td>Twice-a-week (May to October)</td>
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<tr>
<td>(after 30 min retention)</td>
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<tr>
<td>Effluent after De-chlorination</td>
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<tr>
<td>Effluent</td>
<td>Faecal Coliform</td>
<td>Three times a year (May to October)</td>
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<td>Influent</td>
<td>Biochemical Oxygen Demand (BOD)</td>
<td>Once a month (April to Nov)</td>
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<td>Effluent</td>
<td>Total Phosphorus (TP), Nitrates (NO₃⁻),</td>
<td>Three times a year (Spring/summer/fall)</td>
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<td>Total Kjeldahl Nitrogen (TKN), Ammonia Nitrogen (NH₃N)</td>
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# UV Monitoring

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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
Thank you