

Wastewater Treatment Basics: Mechanical Plants and Lagoons

Presented by: Lucas Guinn,
Community Environmental
Management Advisor

RCAP

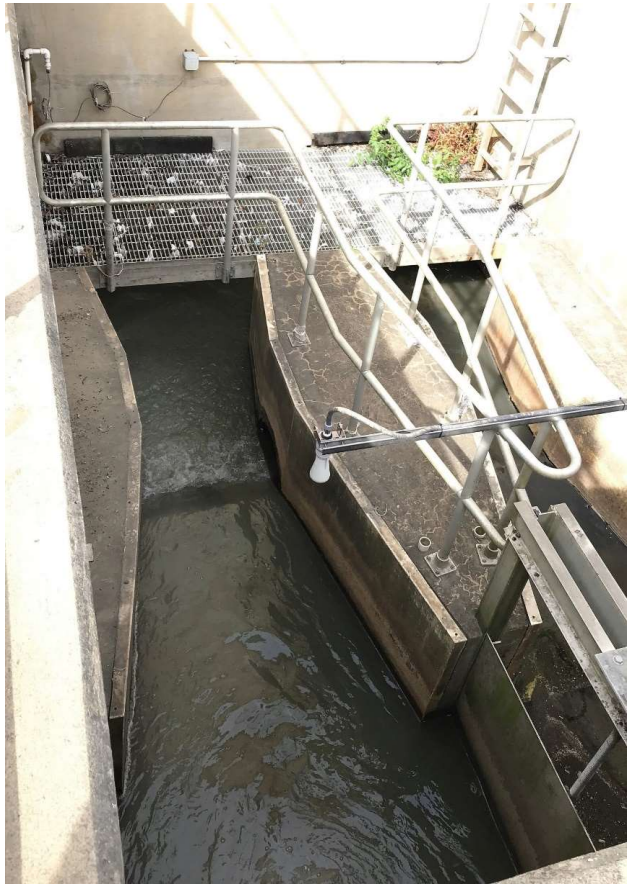
COMMUNITIES Unlimited

Acknowledgement

This training has been funded by the United States Environmental Protection Agency under an EPA Training and Technical Assistance for Wastewater Treatment Works for the Prevention, Reduction, and Elimination of Pollution.

The contents of this presentation do not necessarily reflect the views and policies of the USEPA, nor do they endorse trade names or recommend the use of commercial products mentioned here.

Learning Objectives



- Understand the need for wastewater treatment
- List components of wastewater treatment
- Identify major unit processes of treatment plants
- Understand the linkages between the liquid stream and solids handling sides of treatment

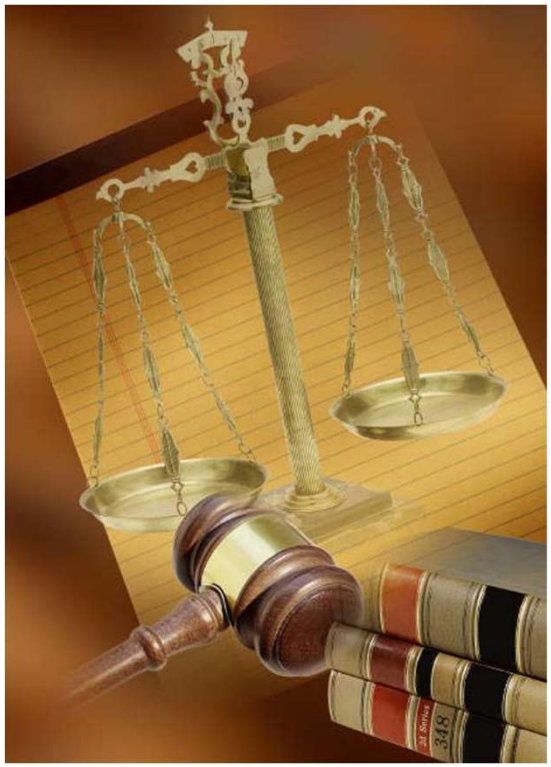
Why Should Our Customers Care?



Treatment of wastewater:

- Protects the health of humans, animals, and the environment
- Prevents groundwater and surface water pollution
- Uses energy to transport and treat
- Economics

Why Should Operators Care?



Regulations – Clean Water Act

- Passed in 1972 as the Federal Water Pollution Control Act

- As amended in 1977, this law became commonly known as the Clean Water Act.

Basics of the Clean Water Act



- Setting wastewater quality standards
- NPDES - permitting
- DMR - discharge monitoring report
- TMDL limits
- Effluent limits

Wastewater Types



- Domestic
- Commercial
- Industrial
- Storm water
- Inflow and infiltration

Are any of these systems/sources connected?

What is Wastewater?

- Water
- Solids
- Biochemical Oxygen Demand (BOD)
- Total Suspended Solids (TSS)
- Nutrients
- Fats, oils, and grease
- Bacteria and pathogens



Acronym Activity

- BOD DT WWTP
- TSS TS TDS
- DO MGD GPD
- FOG TOC UV
- POTW RBC TF
- NPDES RAS WAS
- CBOD MCRT SRT
- AS SBR PSI
- TMDL MANA WOR
- DAFT MBR ORP



What Does Wastewater Look Like?



What Does Wastewater Smell Like?



What is the pH of Wastewater?



What is the Temperature of Wastewater?



Collection Systems

Wastewater is collected and conveyed to the treatment plant

- A collection system is:
  - Pipes
  - Pumps
  - Lift stations
  - Appurtenances (manholes, valves, tanks, control structures, etc.)



Collection Systems

- Industrial/Commercial WW
  - Pre-treatment
  - Identification/monitoring of industrial users
  - Chemical(s) in use?
  - What treatment is required?
  - State regulated?
- Sewer-use ordinances
  - Local regulations

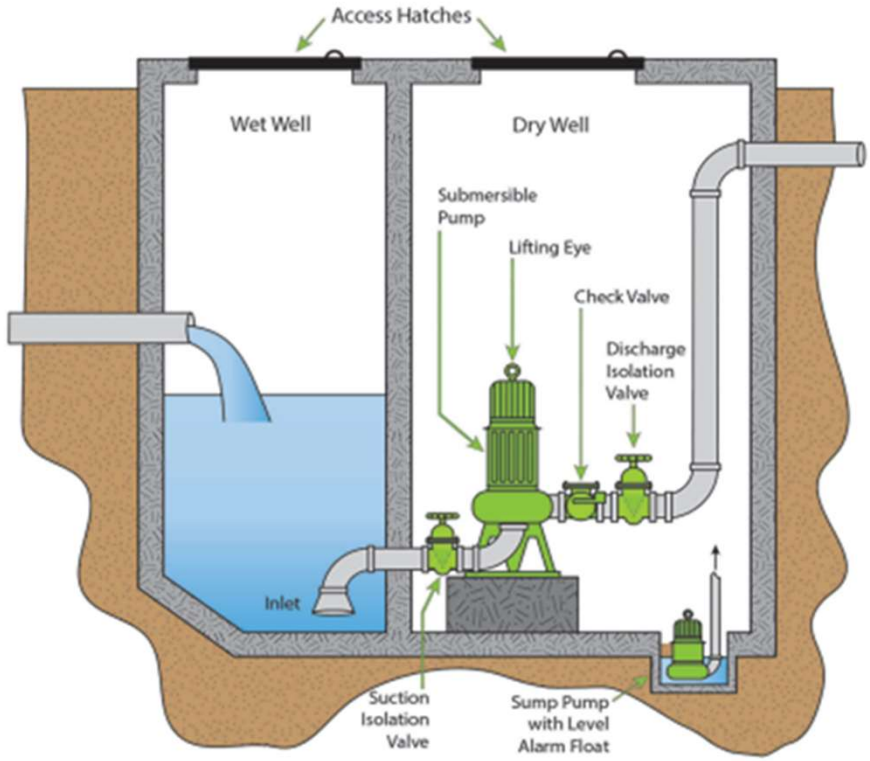


Wet Well Lift Stations



Pumps and Lift Stations

- Specialized pumps for each application;
  - Water, chemicals, solids or sludge
- Specialized lift stations;
  - Wet side dry side lift station
  - Wet well
  - Pit

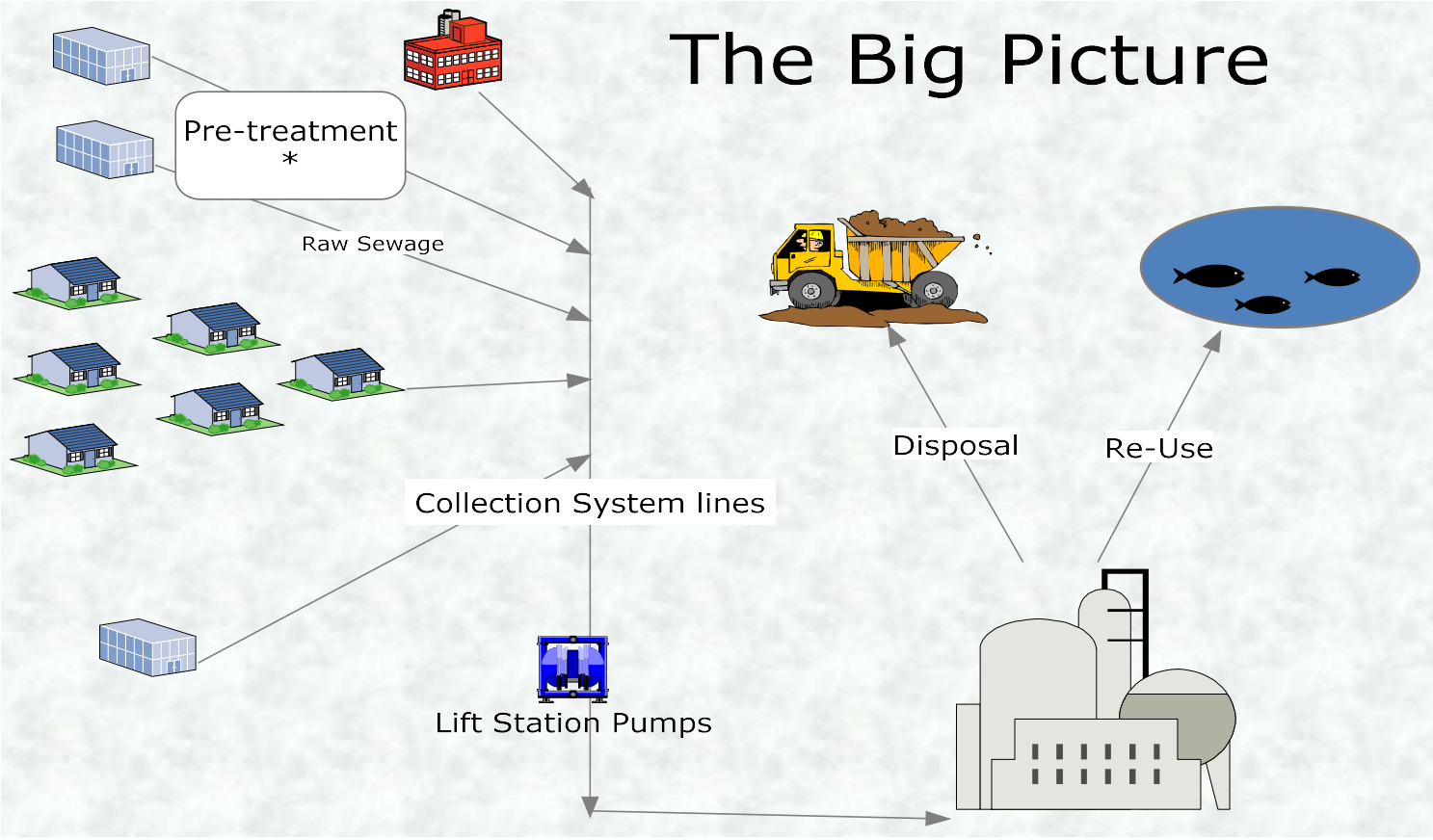


Lift Stations, Pumps & Wet Wells








The Big Picture
Pre-treatment
*
Raw Sewage
Collection System lines
Lift Station Pumps
Disposal
Re-Use

Wastewater is Treated in Three Ways

- Physical removal
  - Settling, screening, filtration
- Biological treatment
  - Promotes bacterial growth and digestion
  - Removes organics
  - Coverts nutrients
- Chemical treatment
  - Oxidation, formation of insoluble compounds, disinfection, and odor control

Physical Removal

- Settling
- Screening
- Filtration



Biological Treatment

- Biological treatment
  - Living organisms break down organic waste

Two types:

- Aerobic
- Anaerobic



Chemical Treatment

- Chemical treatment
  - Oxidation
  - Coagulation
  - Flocculation
  - Disinfection
  - Odor control



Methods of Treatment

Lagoons



Mechanical plants



Lagoons

- Use bacteria/single-cell organisms to treat WW
- Used primarily by smaller communities
- Maintenance:
  YES, it needs maintenance



Types of Lagoons - Discharge

Does the lagoon discharge?

- Total-retention – no discharge
- Surface water discharge, groundwater discharge, or treated wastewater reuse



Types of Lagoons - Process



What process does your lagoon use?

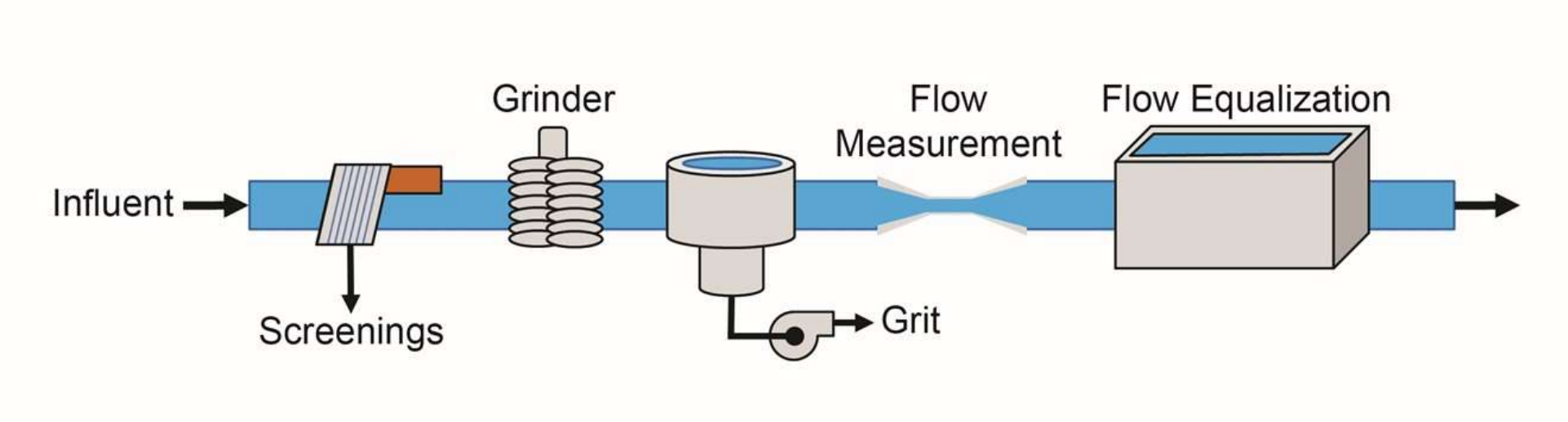
- Aerobic
- Anaerobic
- Facultative

Mechanical Plants



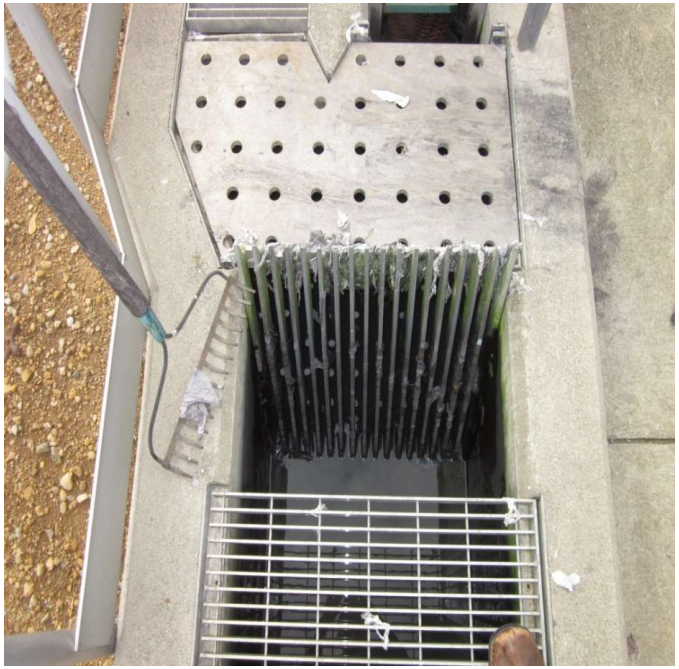


Preliminary Treatment or the "Headworks"



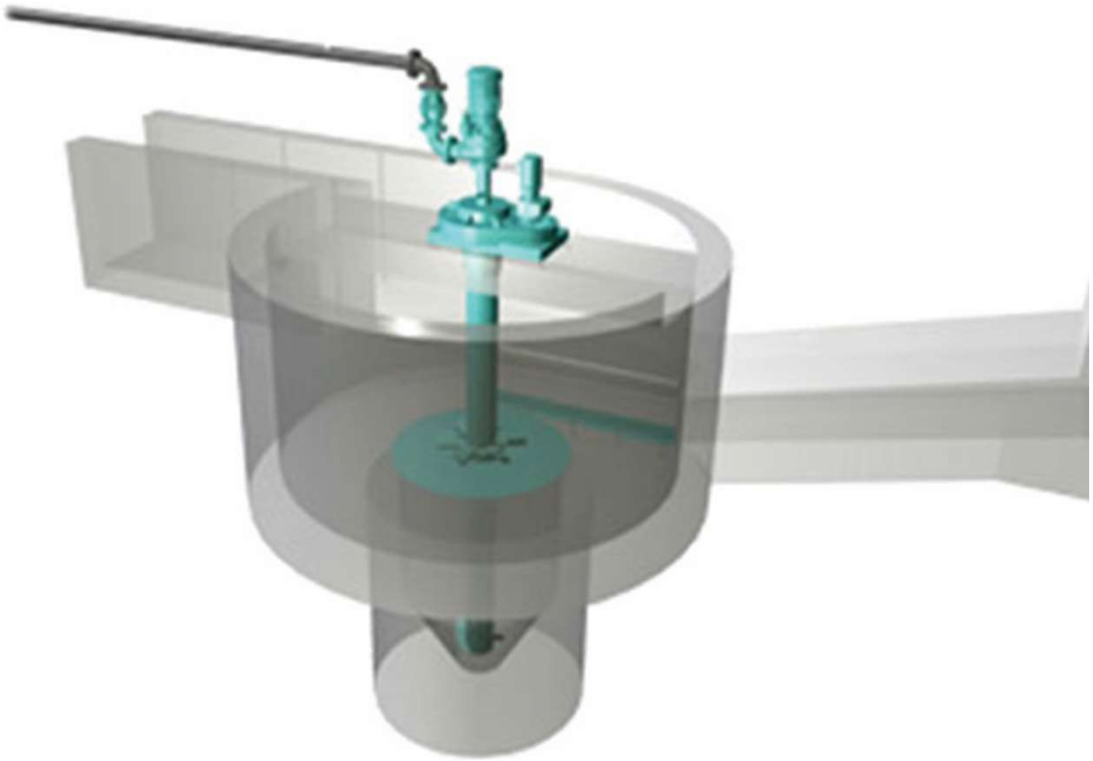
Screening







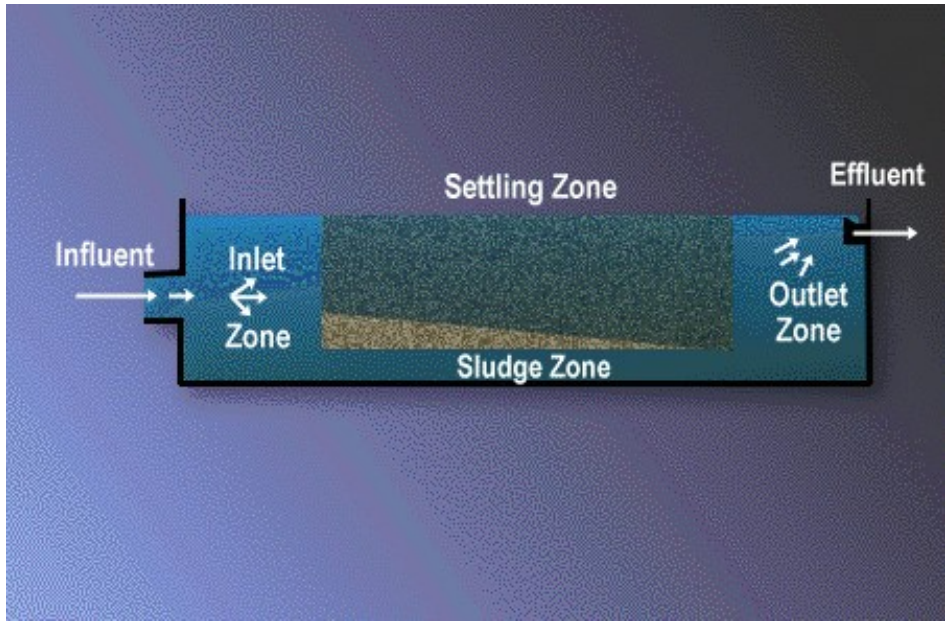
Grit Removal





COMMUNITIES Unlimited

Primary Treatment

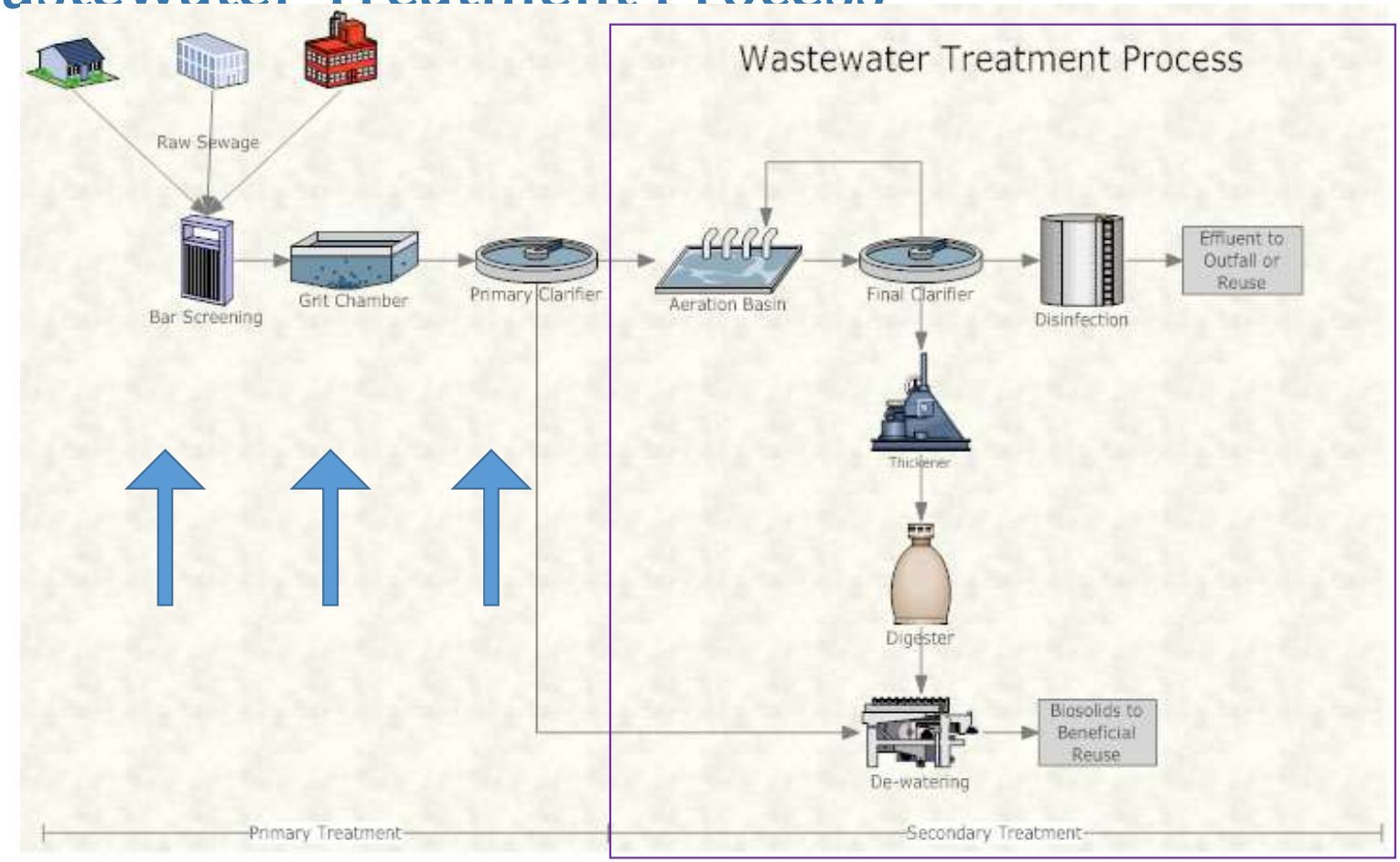


Physical means of removal



Clarification

Wastewater Treatment Process

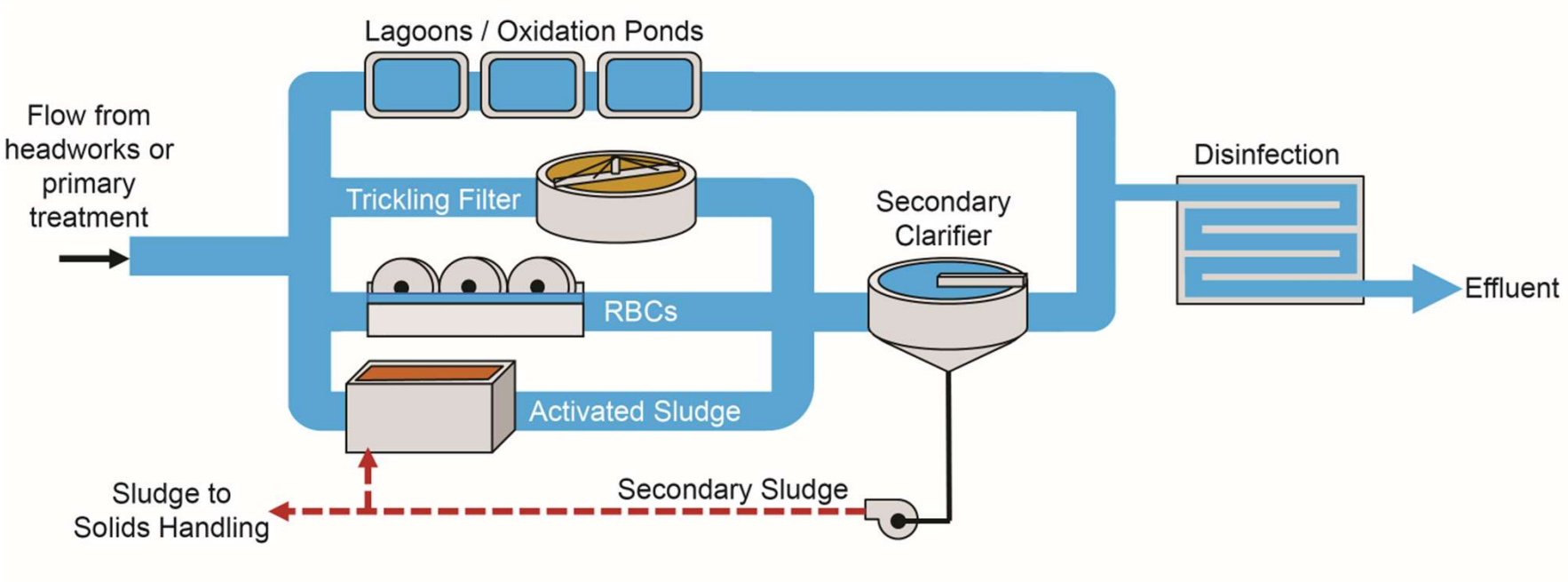


Secondary Treatment



- Remove dissolved organics
- Remove suspended organics
- Change non-settleable (colloidal) organics to settleable

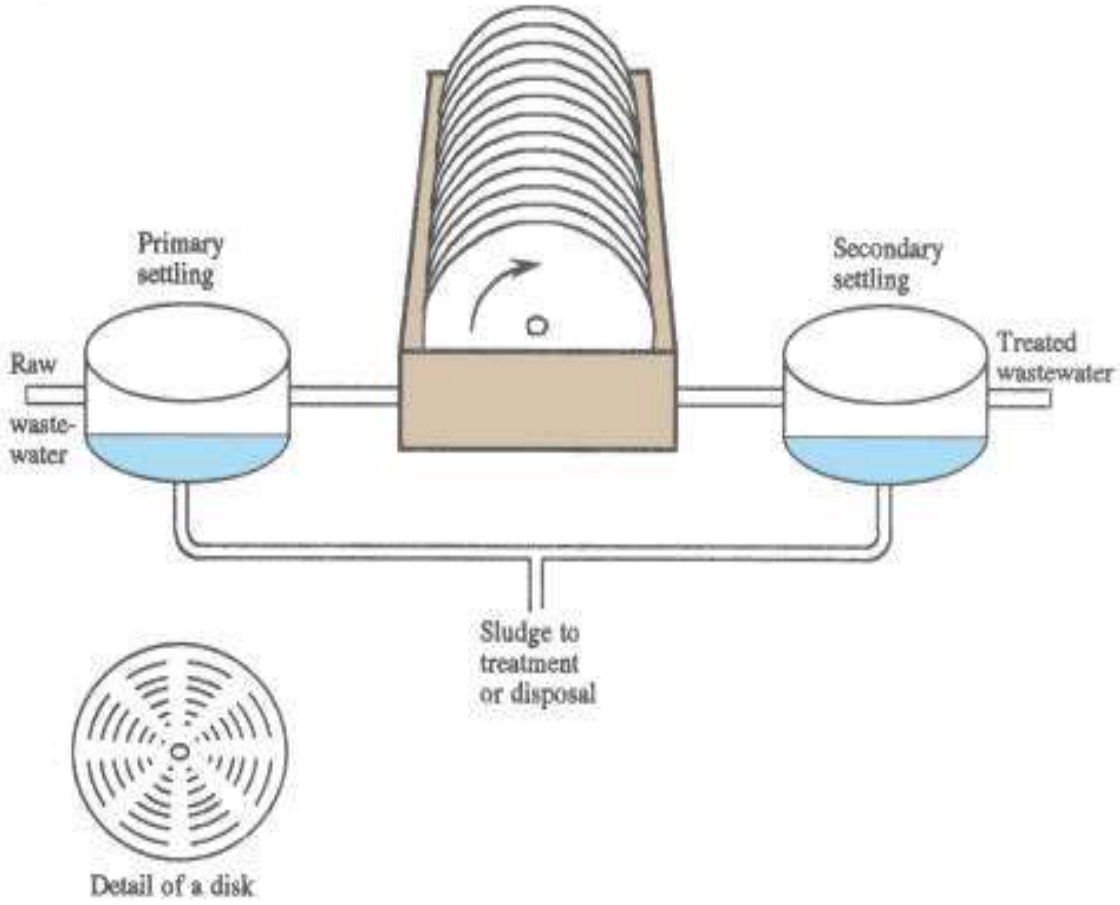
Secondary Treatment Options



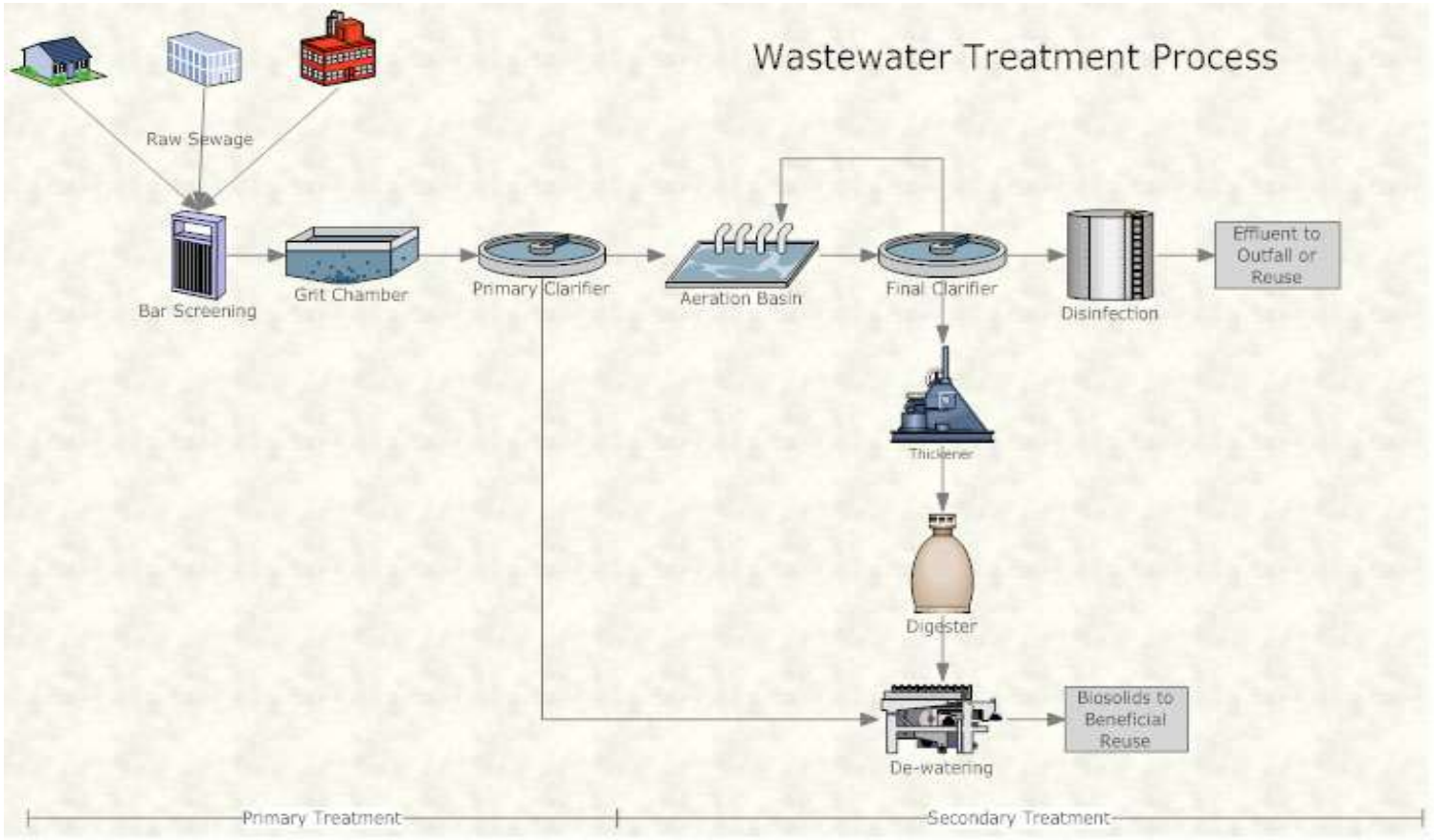
Trickling Filter Fixed Film



Rotating Biological Contactor Fixed Film



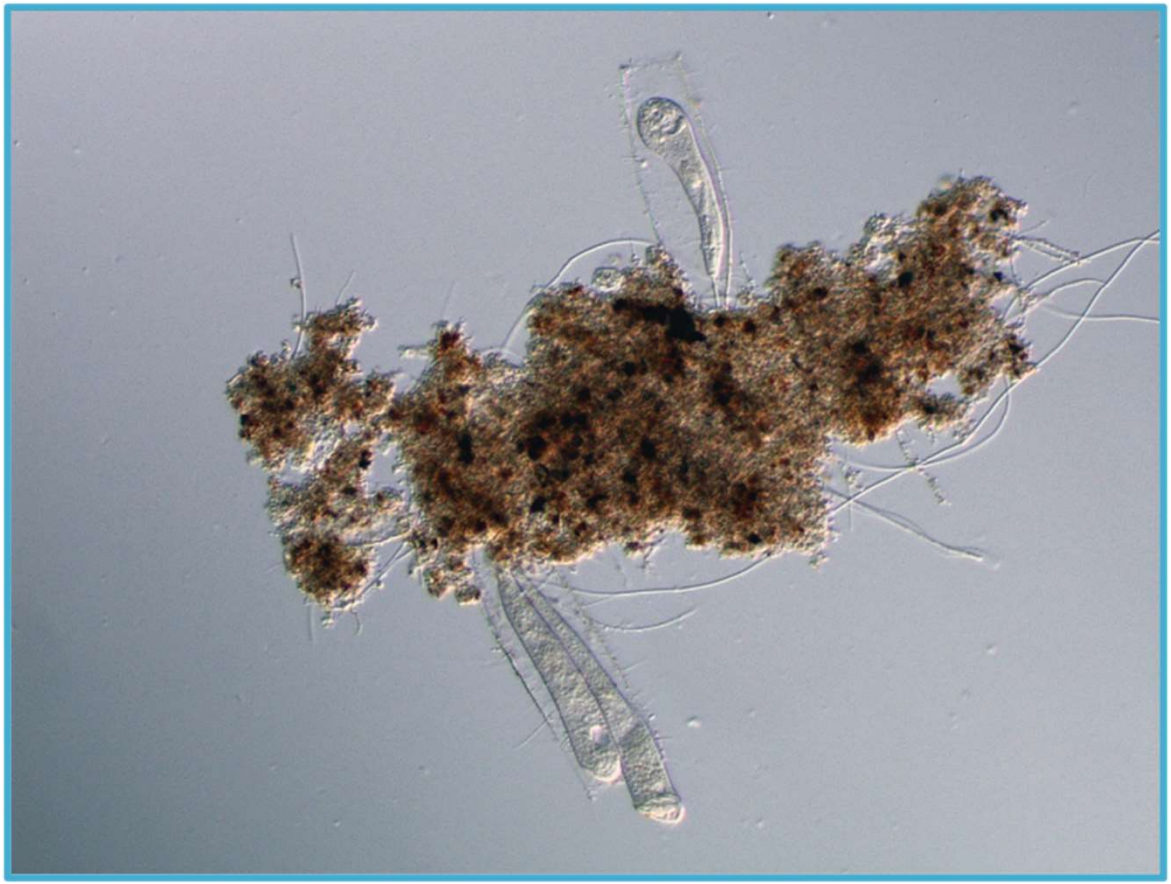
Activated Sludge - Suspended Growth



Activated Sludge



Activated Sludge Floc



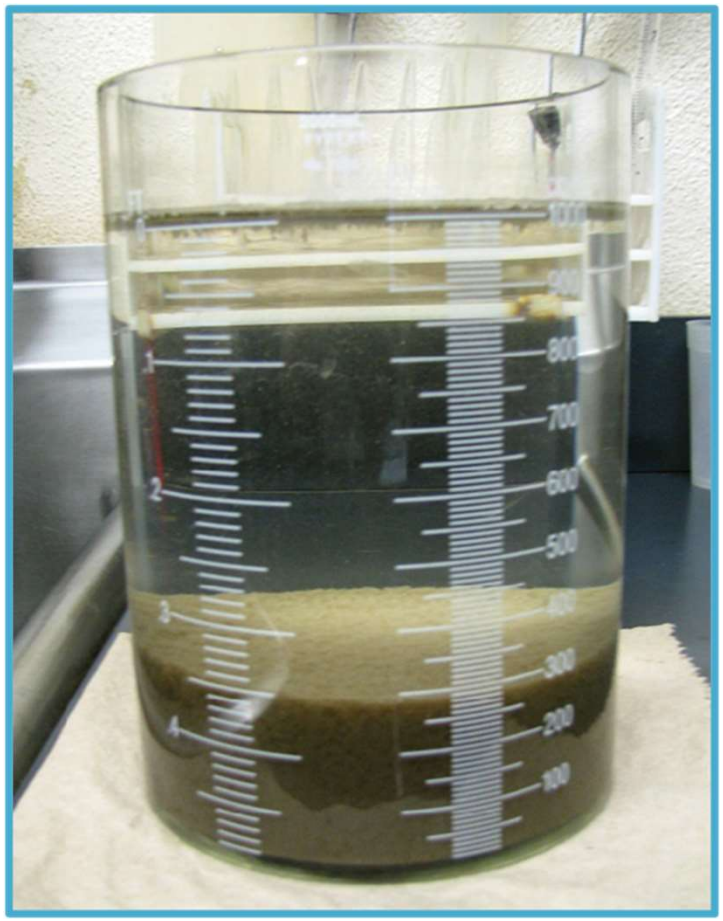
Course Bubble vs Fine Bubble Aeration



Combination of Fixed Film and Suspended Growth



Settleometer



Final Clarifiers Follow Secondary Treatment

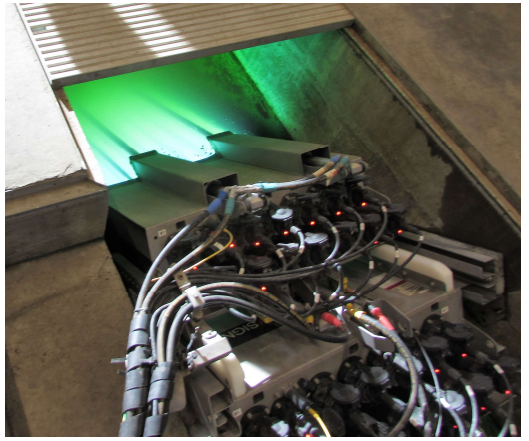


Disinfection

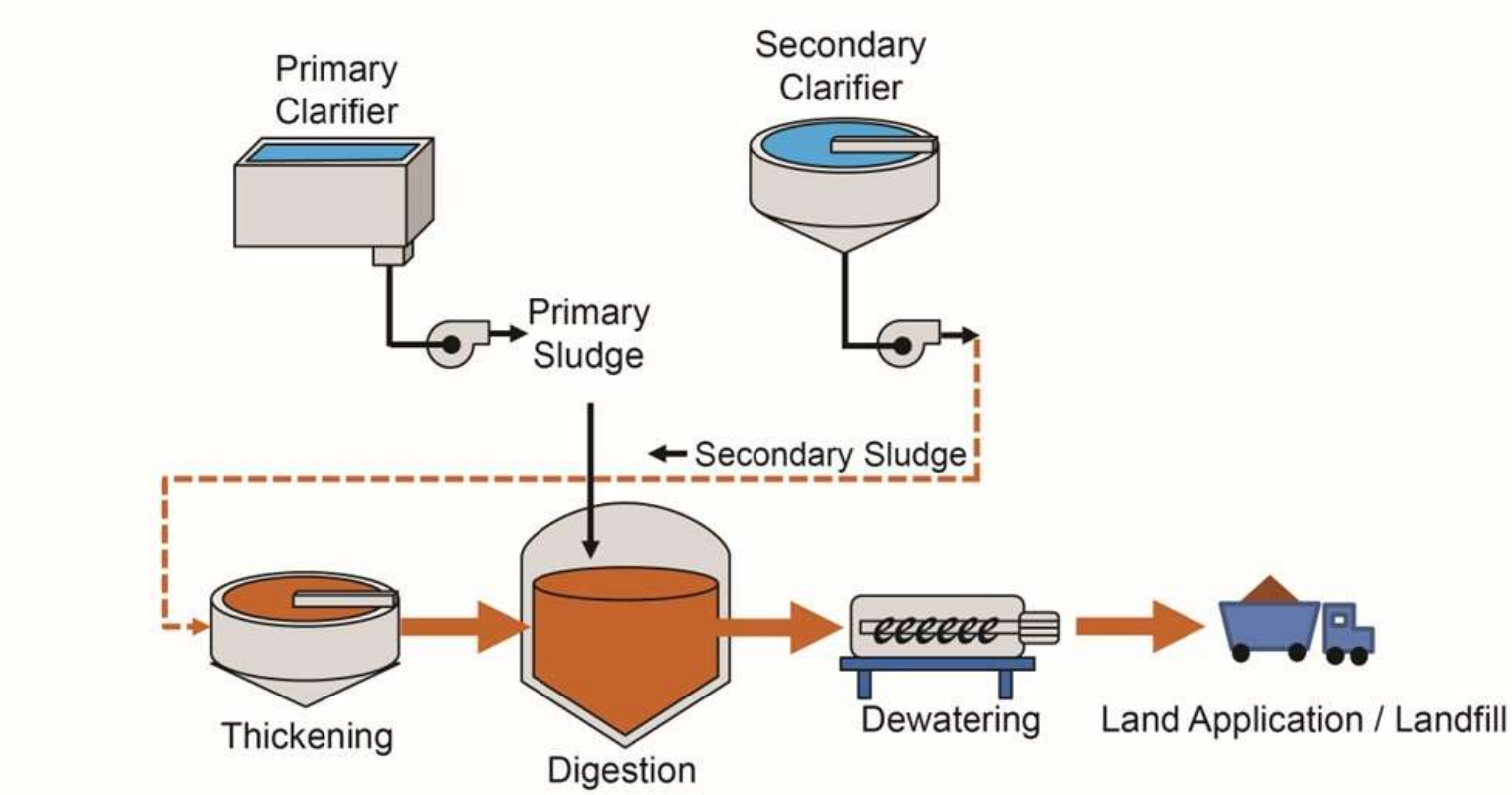


Disinfection:

- Chlorination
  - Gas
  - Hypochlorites
- Dechlorination
- Ozone
- Ultraviolet



Solids, Sludge, Biosolids



Solids Treatment

Thickening



Types of Thickeners:

Centrifuge

Rotary Drum

DAFT

Gravity Belt

Sludge Treatment

Aerobic Digestion



Anaerobic Digestion



Biosolids Dewatering

Dewatering



Types of Sludge Dewatering:

Centrifuge

Rotary Drum

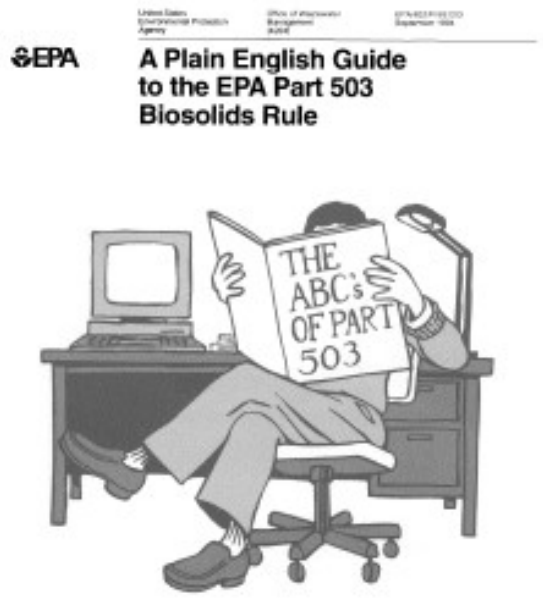
Gravity Belt

Belt Filter Press

Plate and Frame Press

Biosolids Disposal

Land application





Re-Use Considerations

- Lakes, streams and oceans
- Infiltration perk ponds
- Evaporation ponds
- Ground water recharge
- Center pivot spray irrigation
- Direct reuse



Overview of Commonly Interchanged Terms

- Lagoon
- Oxidation pond
- Stabilization pond
- Polishing pond
- Maturation pond
- Cell 1, 2, 3

Why Choose Ponds?

- Is land cheap?
- Is land available?
- Is the staffing minimal?
- Is capital low?
- Is local wastewater rates low?
- Is flow unpredictable?
- Is loading low?
- Is there industrial loading?



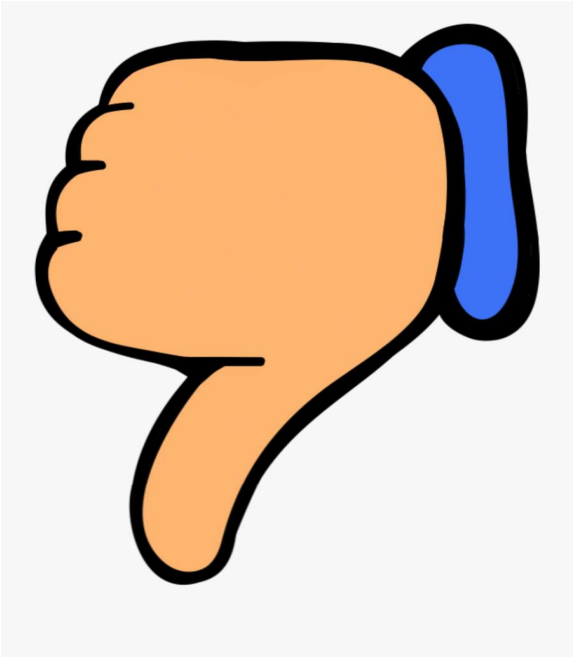
Advantages

- Controlled seasonal discharge
- Lower construction and operation costs
- Accepts surge flows more easily
- Low chemical and energy usage
- No sludge disposal during first 20 years
- Increased design life
- Lower mechanical failure
- Adaptable to land application of final effluent



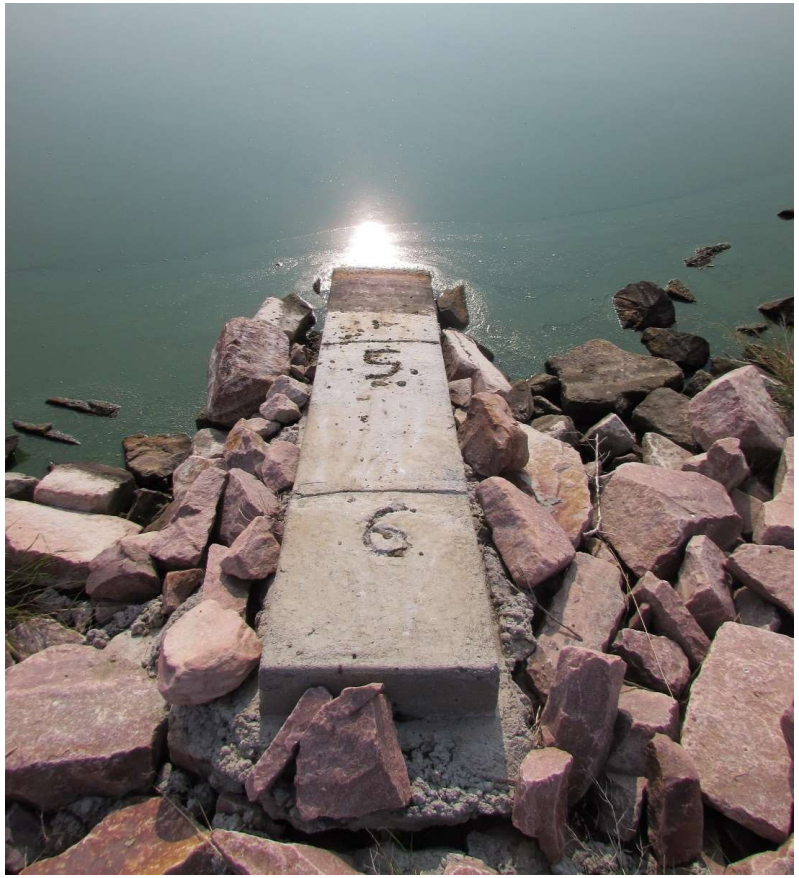
Disadvantages

- Spring odors
- Large land usage
- Operations dependent on climate conditions
- Possible groundwater contamination
- Potential for higher suspended solids



Natural Influences

- Solar Radiation
- Temperature
- Wind Speed
- Precipitation
- Evaporation
- Ice Cover
- Bacteria & Algae



Physical Influences

- Pond Configuration
- Pond Hydraulics
- Retention Time
- Seepage
- Inflow & Infiltration
- Pond Dimensions
- Aeration & Mixing



Chemical Influences

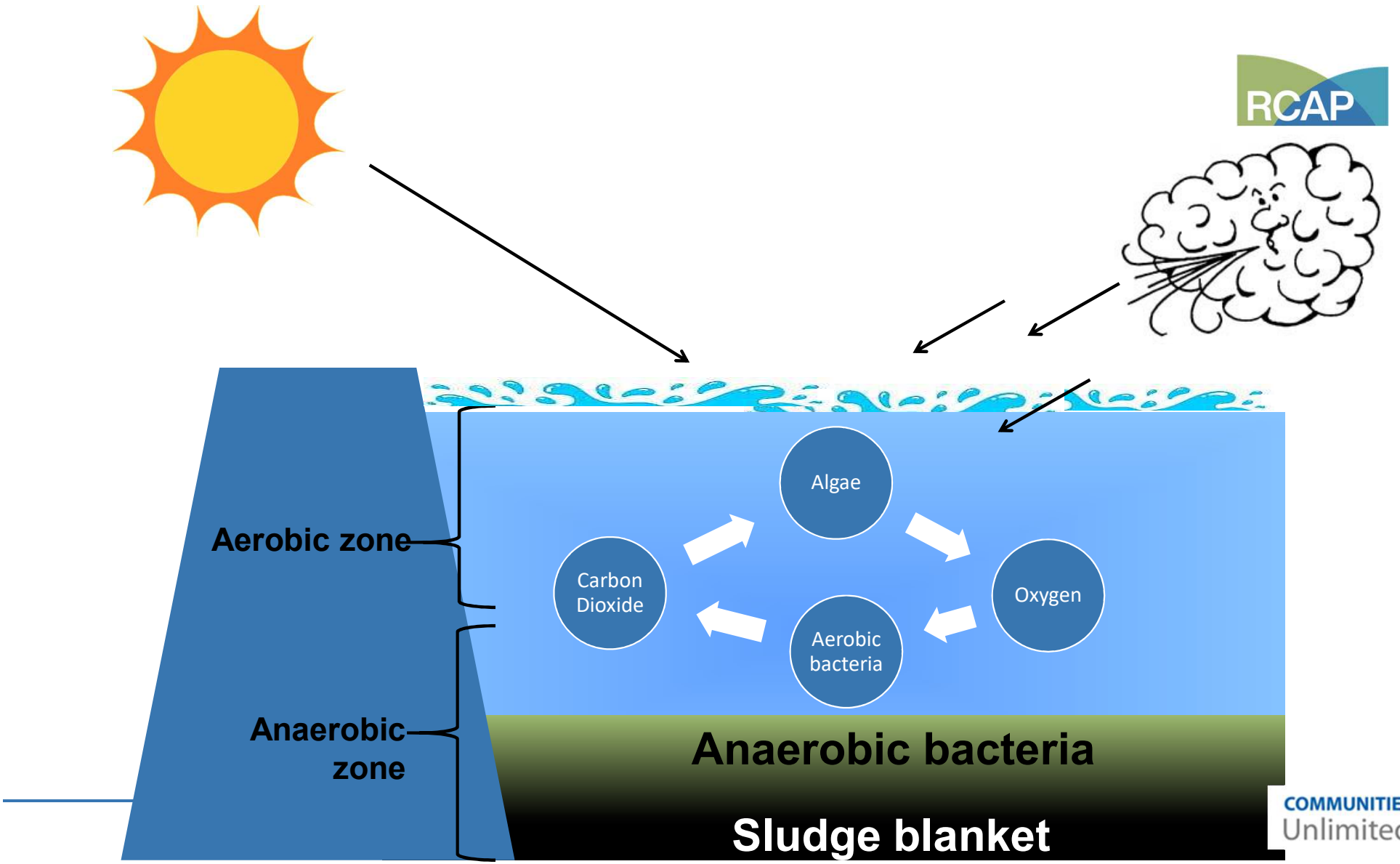
- Loading
- Alkalinity
- pH
- Salinity
- Toxicity
- Composition of Liner/Dikes



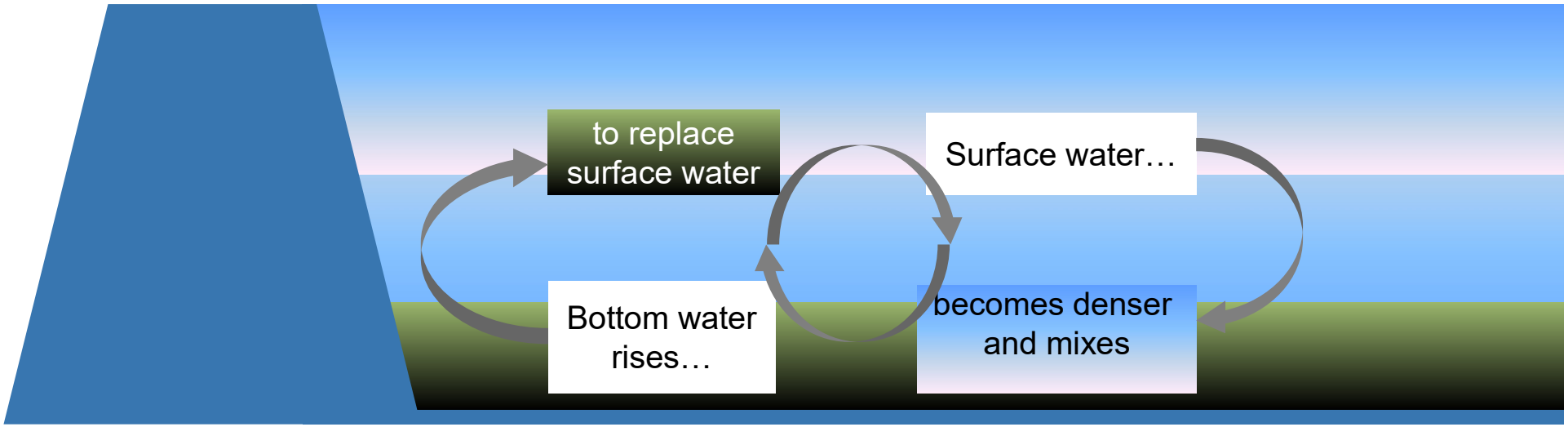
Lagoon Types Based on Bacteria Type

- Anaerobic
- Facultative
- Aerobic

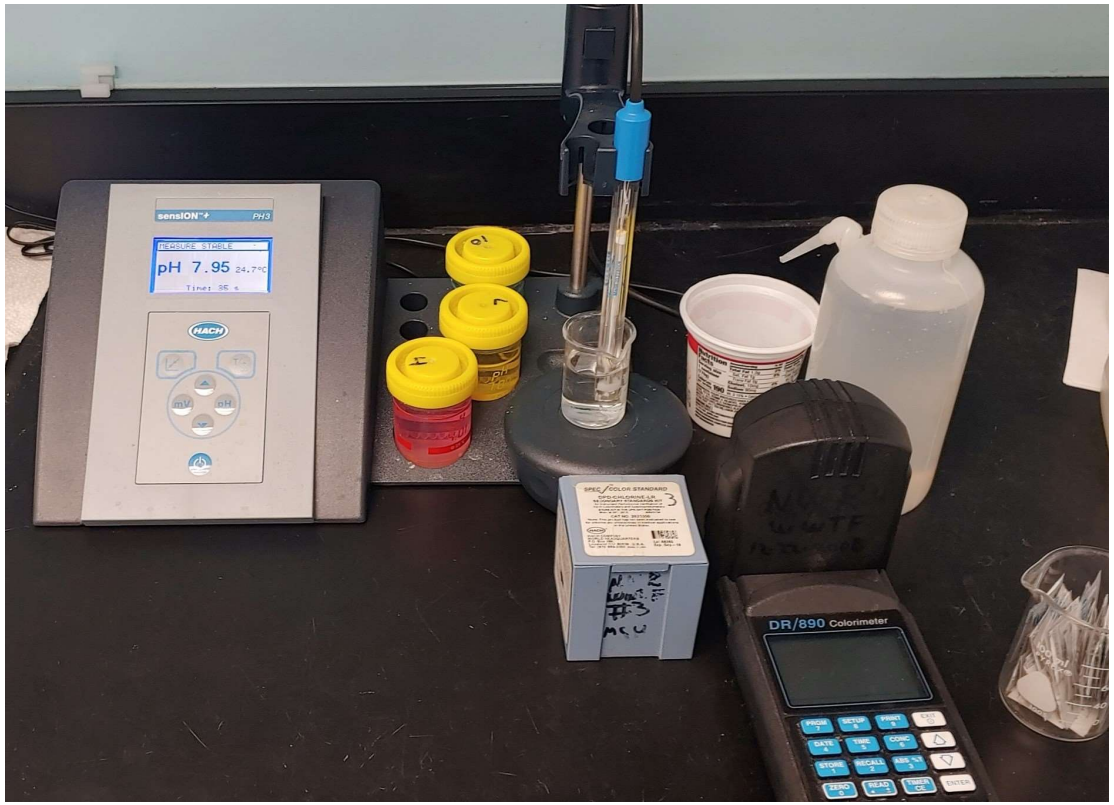


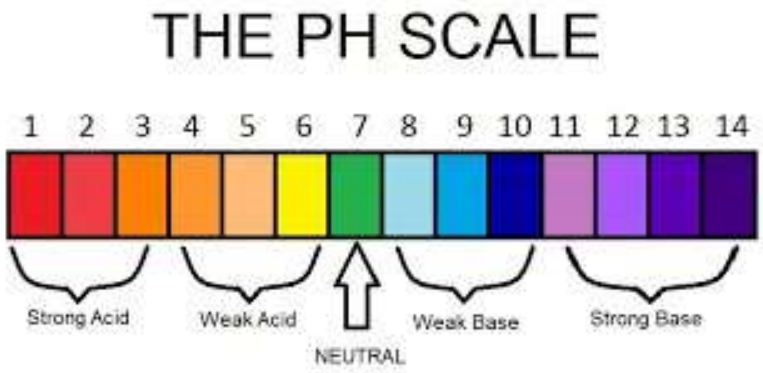

RCAP
Aerobic zone
Anaerobic zone
Algae
Carbon Dioxide
Oxygen
Aerobic bacteria
Anaerobic bacteria
Sludge blanket
COMMUNITIES Unlimited

Thermal Turnover



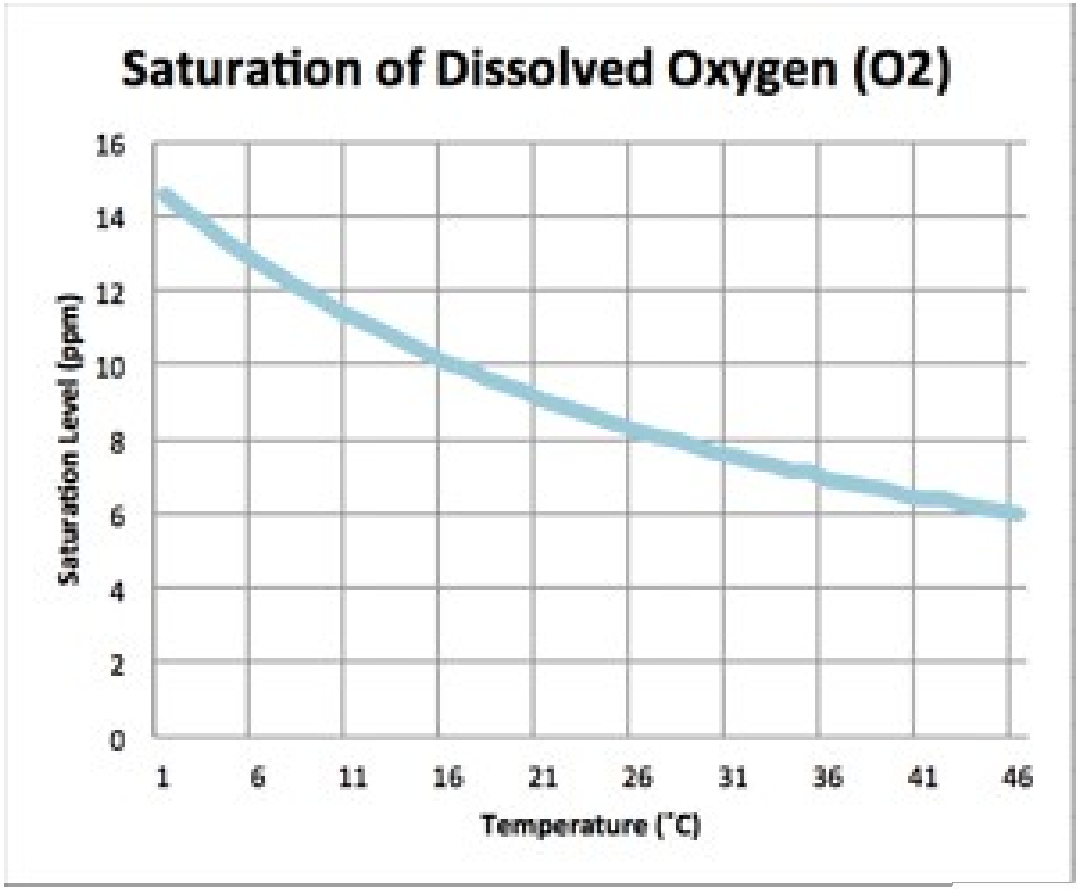
pH


sensION+ PH3
pH 7.95
HACH
DR/890 Colorimeter


THE PH SCALE
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Strong Acid
Weak Acid
NEUTRAL
Weak Base
Strong Base

Dissolved Oxygen

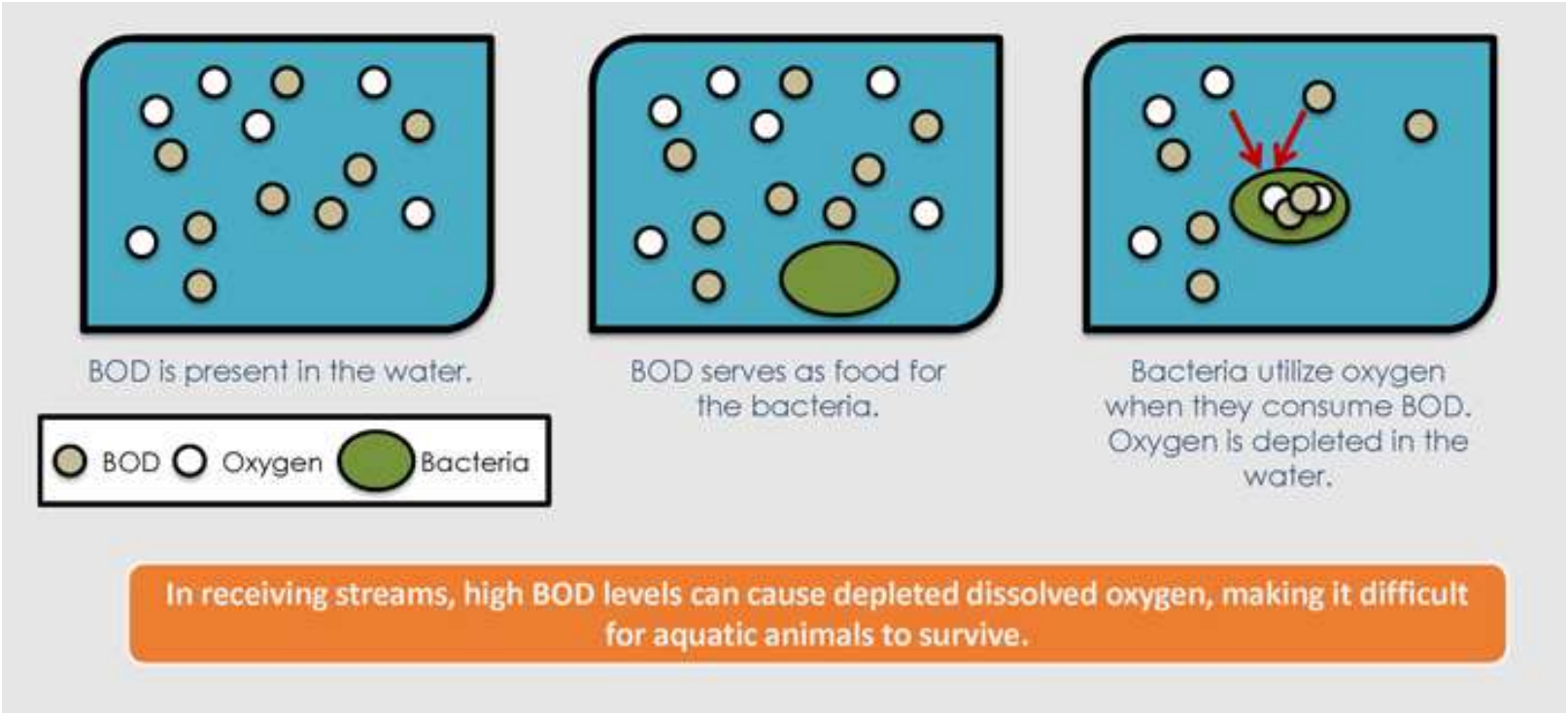




Temperature



BOD

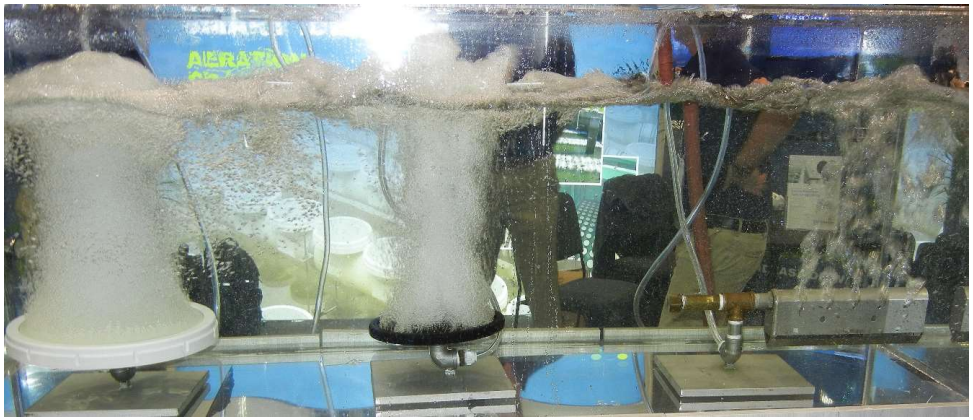

BOD is present in the water.
BOD serves as food for the bacteria.
Bacteria utilize oxygen when they consume BOD. Oxygen is depleted in the water.
BOD
Oxygen
Bacteria
In receiving streams, high BOD levels can cause depleted dissolved oxygen, making it difficult for aquatic animals to survive.

DO Measurement





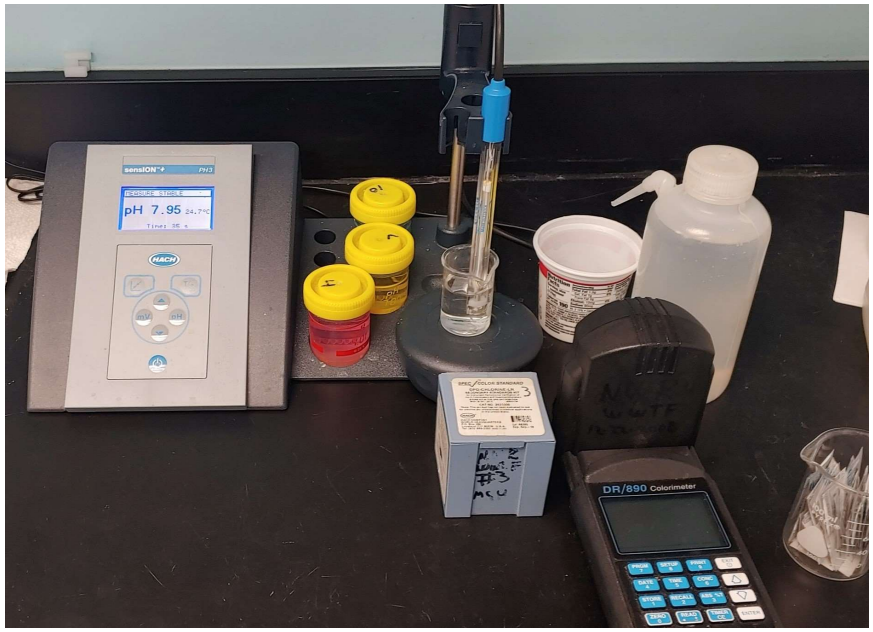
Diffused Aeration





Source: © http://northcowichan.bc.ca

pH / Temp Measurement

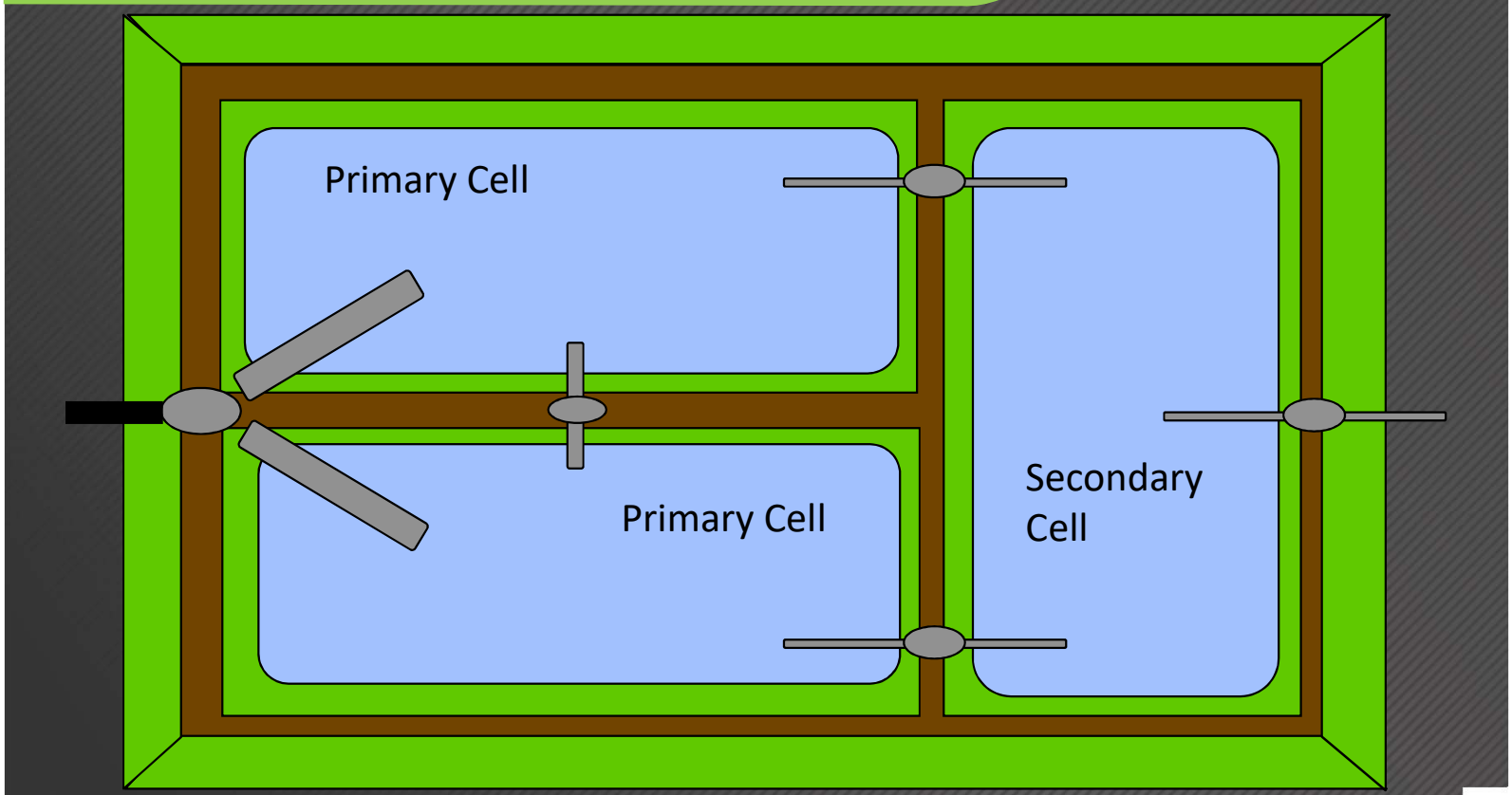




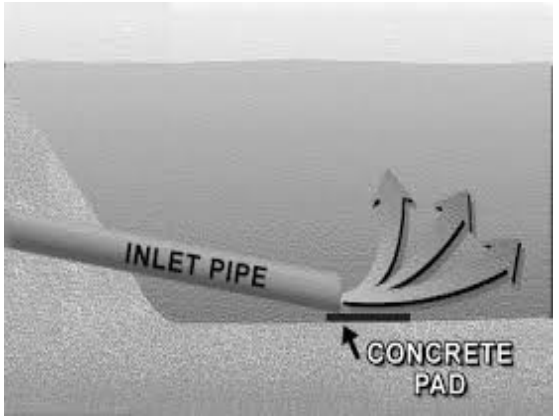
Source: © Hach

Typical Lagoon Three Cell System

Three Cell – can be run in Series or Parallel



Inlet/Outlet Structures







Valve Covers



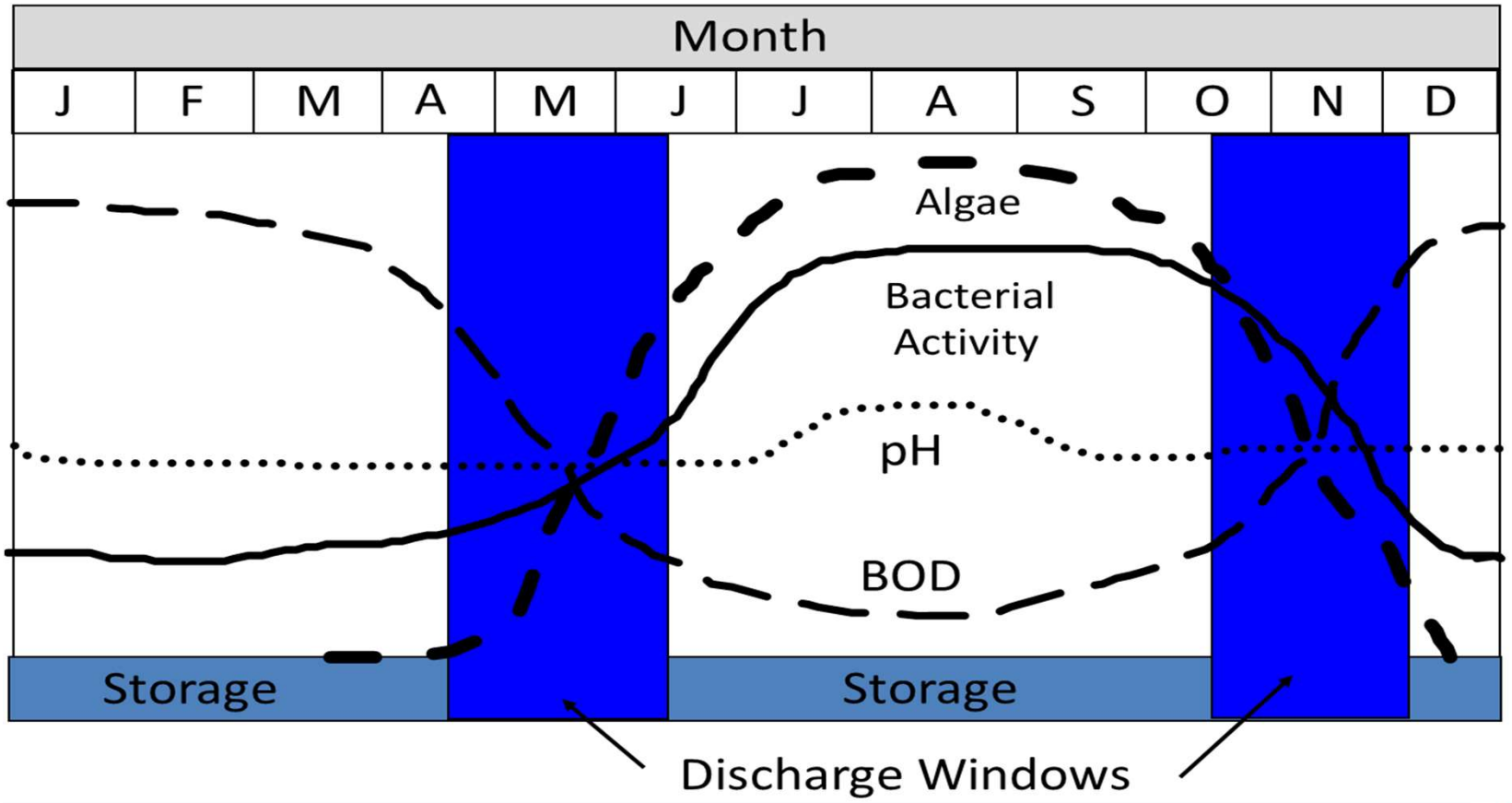
Effluent Transfer Pump



Effluent Structure

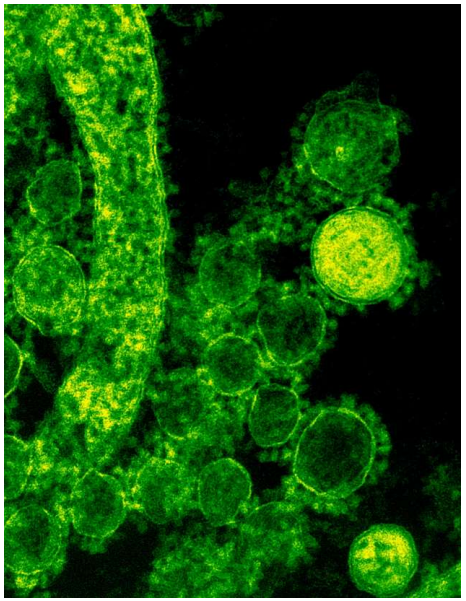


Annual Changes in the Pond

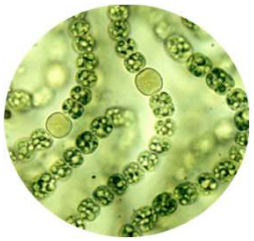


RCAP

Algae

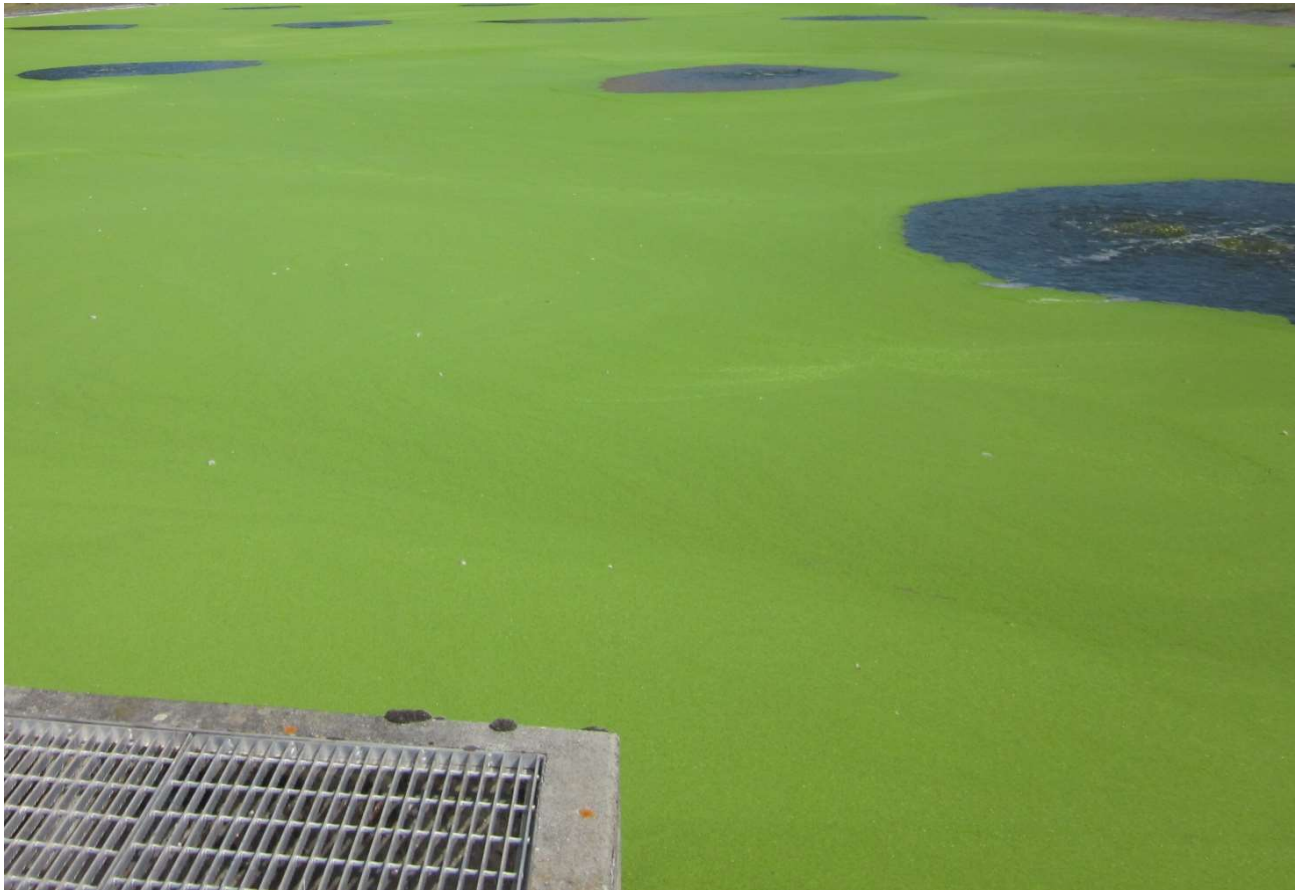




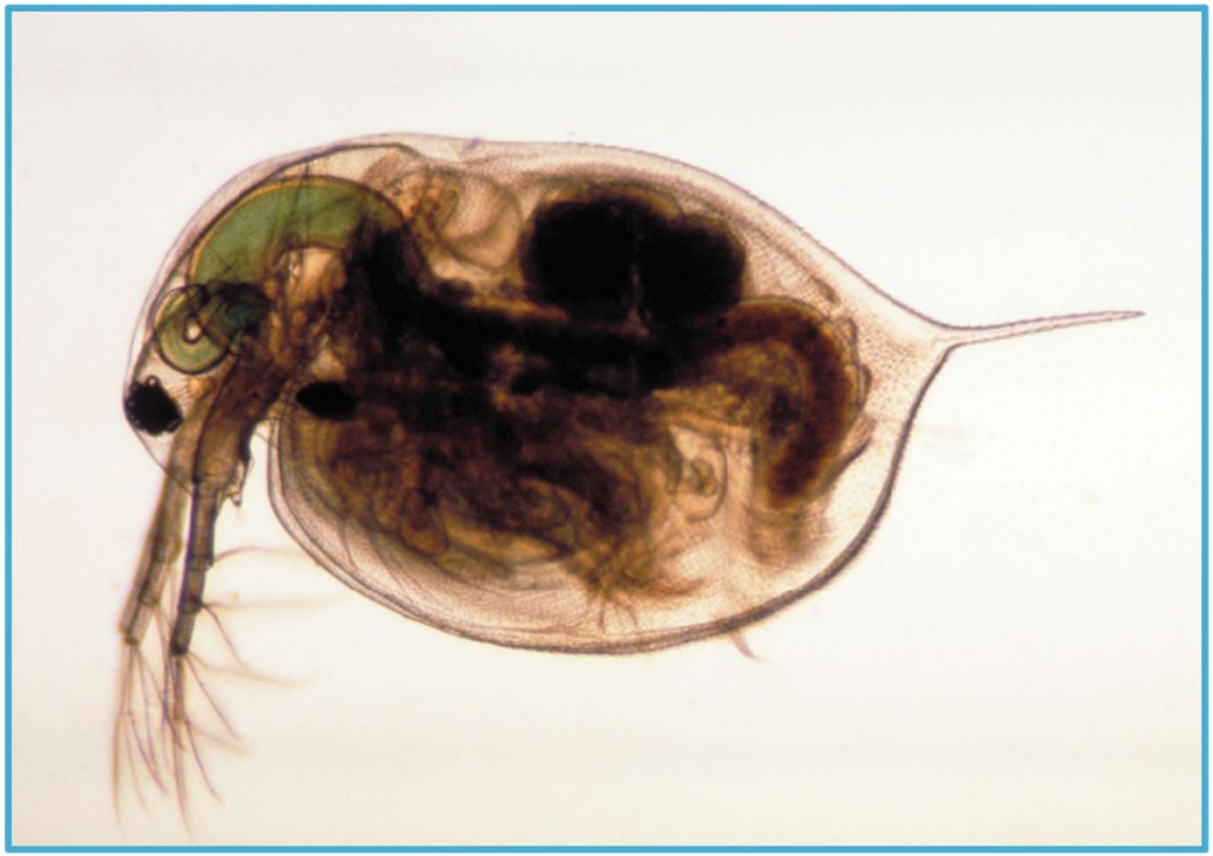




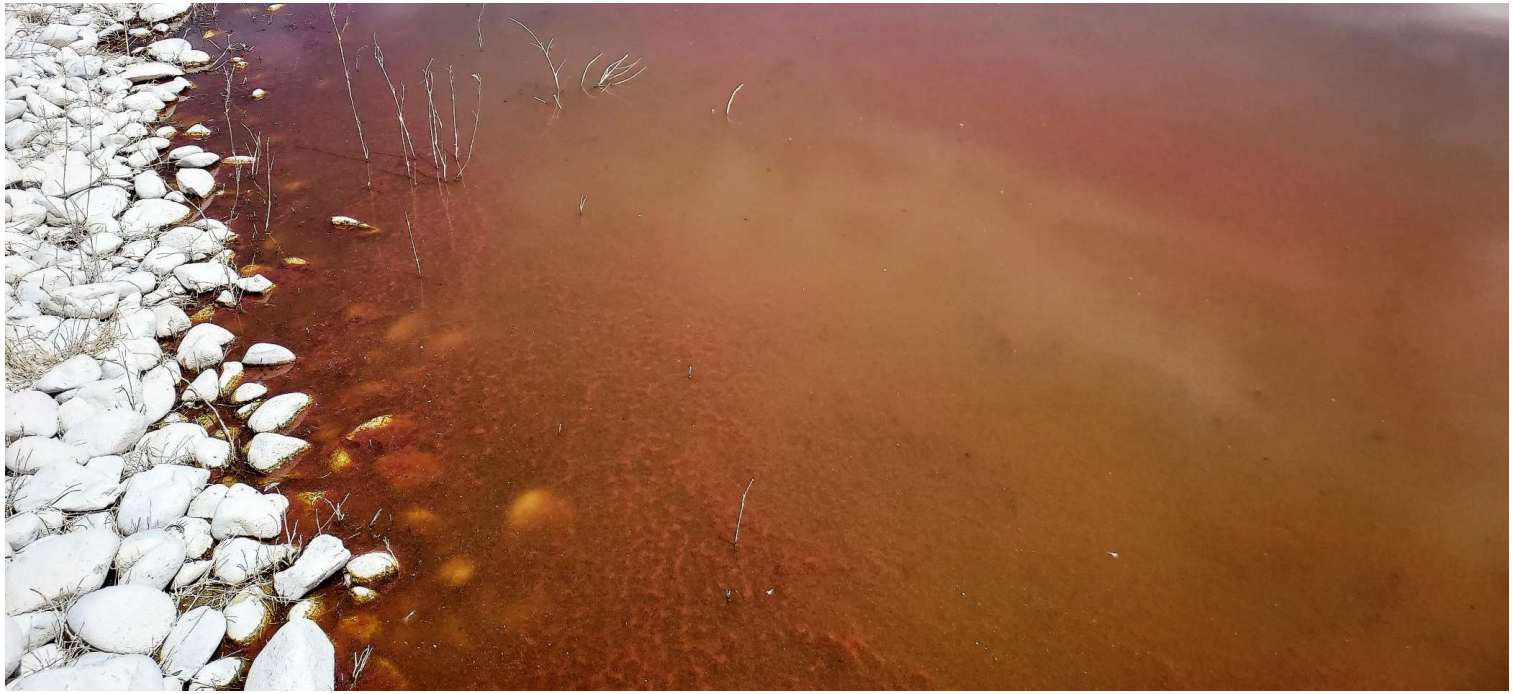
Algae's Role in Lagoon Treatment



Daphnia (water flea)



Daphnia Bloom



Shallow Rooted Grass Bank



Rip Rap the Clay Dike Wall



Control Vegetation Growth Along Dike Wall



Create Old Water





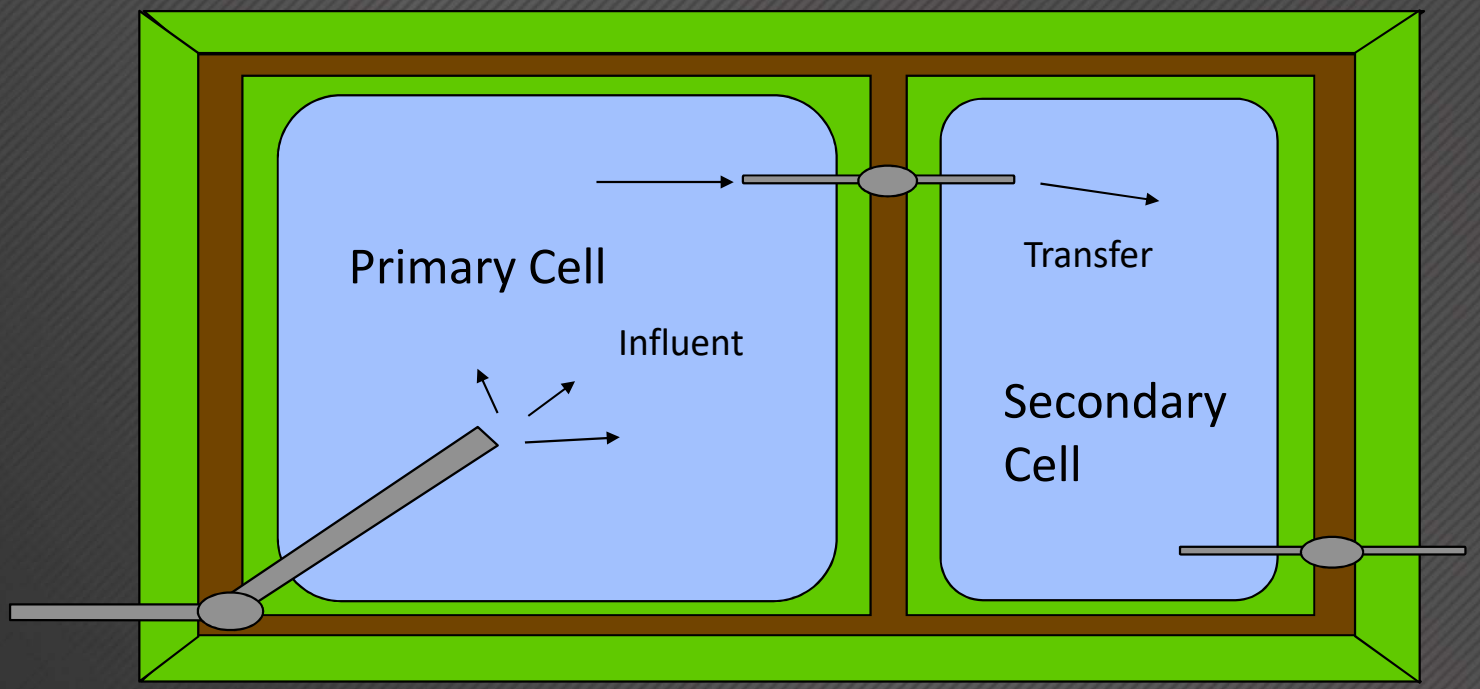
Manage Sludge Depth



RCAP

Operational - Seasons

Two Cell - Series

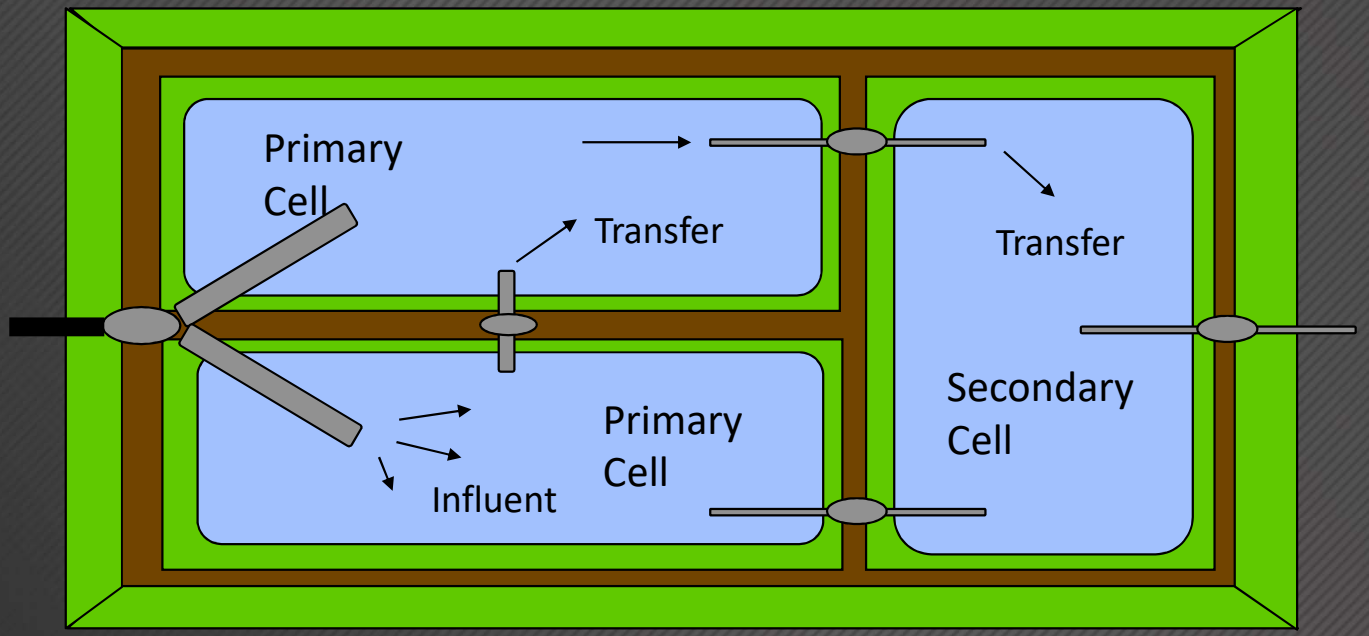


1. Influent into Primary
2. Create old water
3. Transfer into Secondary

COMMUNITIES Unlimited

Operational - Seasons

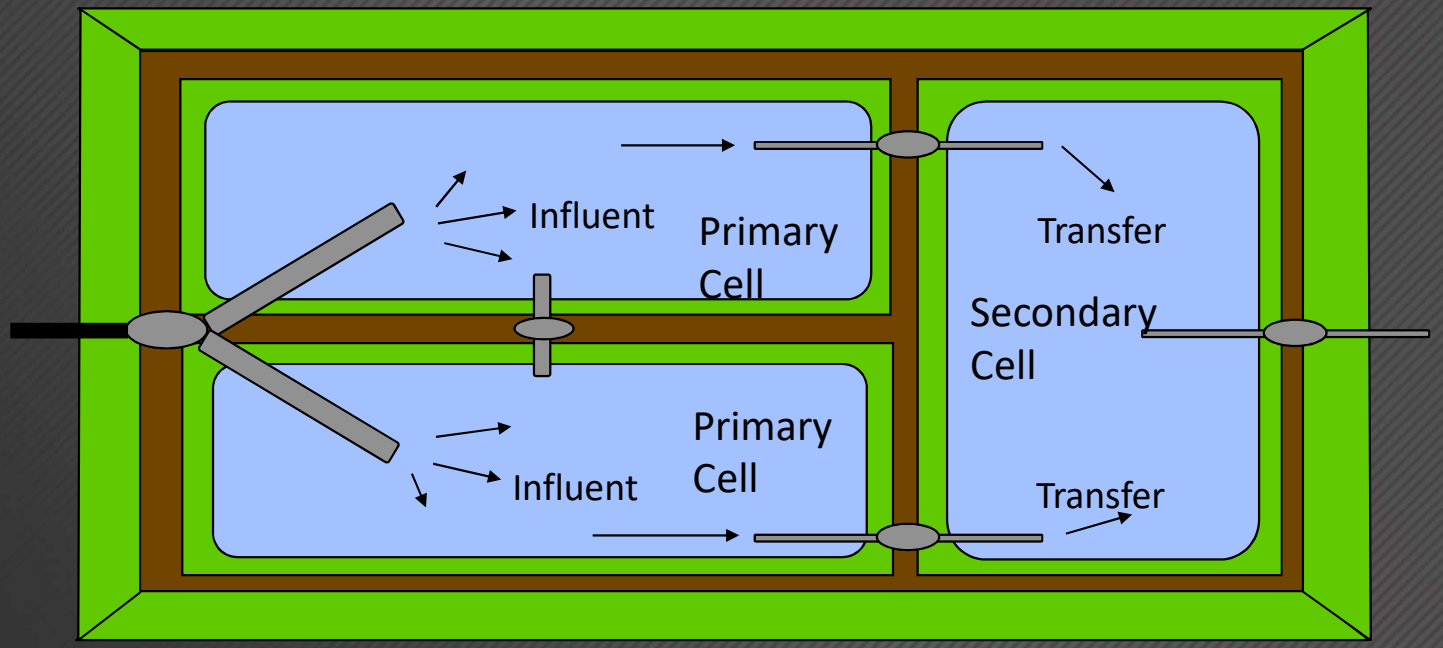
Three Cell – Series (Summer, During Discharge)



1. Influent into Primary A (or Primary B)
2. Create old water
3. Transfer to other Primary
4. Create old Water
5. Transfer to Secondary

Operational - Seasons

Three Cell – Parallel (Winter, High Loading)



1. Equal split into both Primary Cells
2. Create old water
3. Transfer into Secondary

Color

- Dark Green (normal primary pond)
- Light Green (normal secondary pond)
- Dark Pea Soup (Sometimes primary pond in the summer)
- Dark Brown (organic overload or too much mixing)
- Black or Grey (Just after ice out, or organic overload)
- Blackish Green (Blue green algae)
- Red streaks or pink (Daphnia under stress low DO)

Effluent Discharge

- Determine if a discharge is necessary
- Collect representative samples 2 weeks before discharge
- Notify Primacy of your intent to discharge
- Discharge at a rate of 6 inches per day or less
- Discharge only enough to provide enough storage capacity
- Collect samples during discharge if your permit requires it
- Complete discharge report and submit as required by permit

Fall Discharge



Effluent Samples

- CBOD
- TSS
- Fecal Coliform
- E. Coli (EPA permits)
- DO
- pH
- Ammonia, Total Nitrogen, TKN
- Total Phosphorus
- or whatever else your permit requires

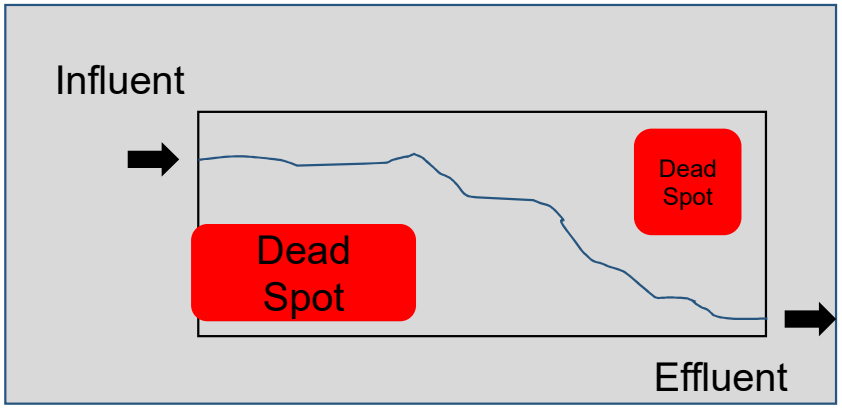
Maintenance goals

- Protect the seal or liner
- Reduce odor and insect problems
- Prevent short circuiting
- Increase sunlight penetration



Short-Circuiting





Source: RCAC

Clay Liners







Plastic Liners









Building a Splash Pad



Plastic Liner Repair



Signage


NO ADMITTANCE
WASTEWATER
TREATMENT FACILITIES
RIDGE SOUTH DAKOTA
04/17/2007

Cattails & Bulrushes



Small Trees



Low Water Level





Duck Weed



Badger and Muskrat Holes





Solids Build-up at End of Influent Pipe



Solids Build-up at End of Effluent Pipe



Erosion



Cattle



Septage



FOG





Do You Have Your Ponds Fenced In?



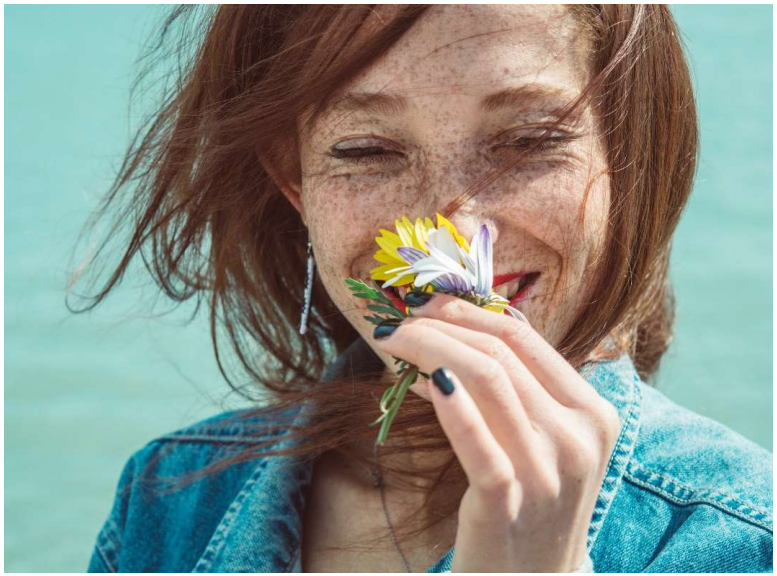
Broken Fence



Broken Gate

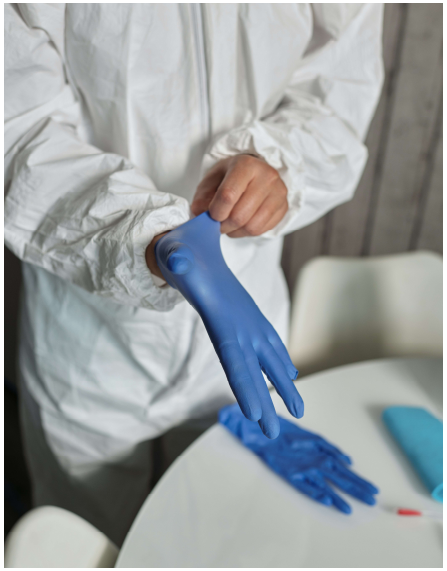


Odors



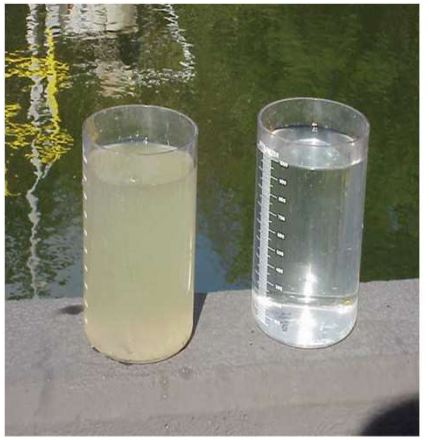


Operator's Responsibilities









COMMUNITIES Unlimited

Process Control Tests

- pH
- Dissolved Oxygen (DO)
- Ammonia
- Nitrate
- Alkalinity
- Temperature
- Chemical Oxygen Demand (COD)
- Biological Oxygen Demand (BOD5)
- Total Suspended Solids (TSS)
- Sludge Blanket Profile

Taking Wastewater Samples

- Immediate Grab samples:

pH, Dissolved Oxygen (DO), Temperature



- 24-Hour Composite samples:

Ammonia, Nitrate, Alkalinity, COD, BOD5

Total Suspended Solids (TSS)

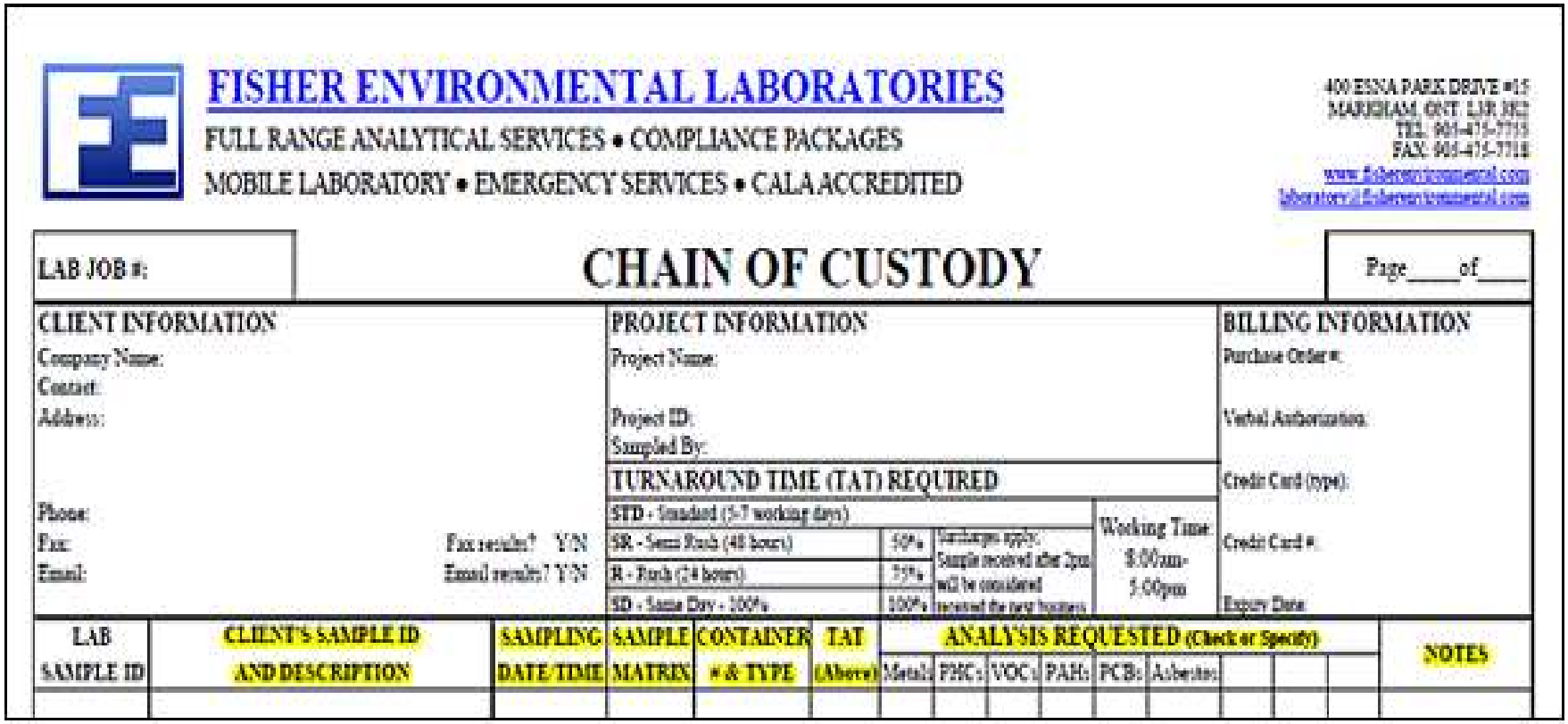


Automatic Sampler and Rain Gage





Chain of Custody



FISHER ENVIRONMENTAL LABORATORIES

FULL RANGE ANALYTICAL SERVICES • COMPLIANCE PACKAGES

MOBILE LABORATORY • EMERGENCY SERVICES • CALA ACCREDITED

400 ESNA PARK DRIVE #15
MARKHAM, ONT. L3R 3K2
TEL: 905-475-7755
FAX: 905-475-7718
www.fisherenvironmental.com
laboratory@fisherenvironmental.com

LAB JOB #:

CHAIN OF CUSTODY

Page____of____

CLIENT INFORMATION

Company Name:
Contact:
Address:

Phone:
Fax: Fax results? Y/N
Email: Email results? Y/N

PROJECT INFORMATION

Project Name:
Project ID:
Sampled By:

TURNAROUND TIME (TAT) REQUIRED

STD - Standard (5-7 working days)
SR - Same Rush (48 hours) 50%
R - Rush (24 hours) 75%
SD - Same Day - 100%

Surcharges apply. Sample received after 2pm will be considered received the next business

Working Time: 8:00am-5:00pm

BILLING INFORMATION

Purchase Order #:
Verbal Authorization:
Credit Card (type):
Credit Card #:
Expiry Date:

LAB SAMPLE ID	CLIENT'S SAMPLE ID AND DESCRIPTION	SAMPLING DATE/TIME	SAMPLE MATRIX	CONTAINER # & TYPE	TAT (Above)	ANALYSIS REQUESTED (Check or Specify)									NOTES
						Metals	PHC's	VOC's	PAH's	PCB's	Asbestos				

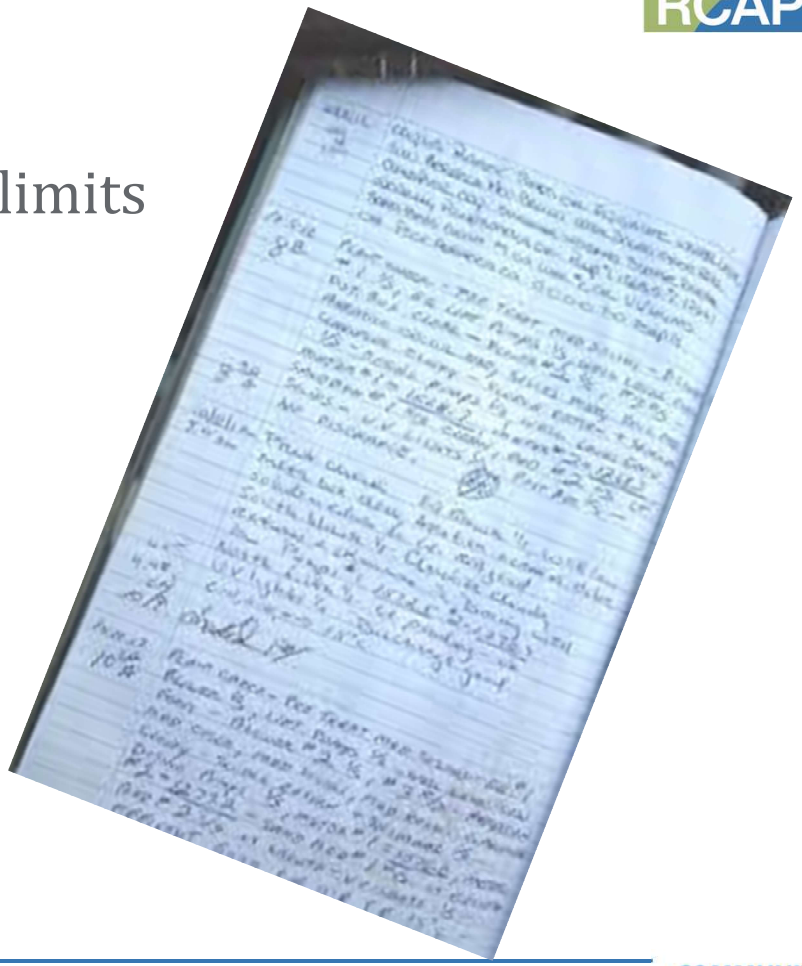
Bottle Labels

- Every sample bottle is labeled. Tied back to the Chain of Custody COC



Recordkeeping

- Create a baseline
- Ensure you meet your permit limits
- Proves you are doing your job
- Historical record

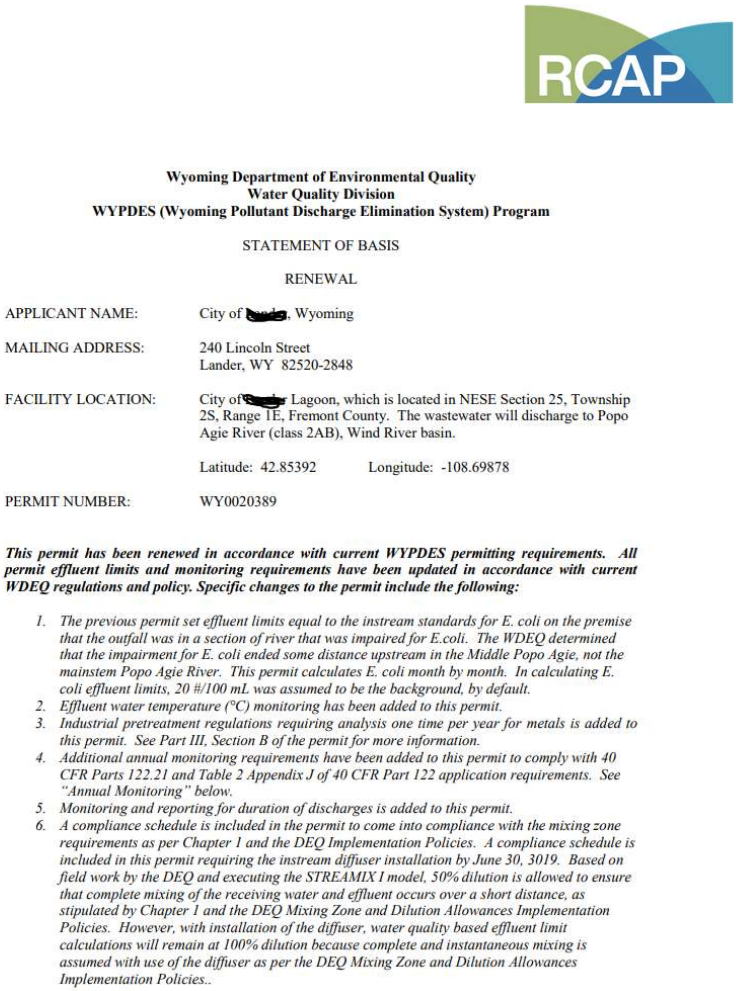


Records

- Preventive maintenance records for each piece of equipment
- Preventive maintenance schedule
- Service report cards
- Spare parts inventory
- List where spare parts come from
- O and M instructions
- Specifications on equipment from suppliers

Know Your Permit

- Unique to your system
- It is how you are judged
- Has everything required listed



Wyoming Department of Environmental Quality
Water Quality Division
WYPDES (Wyoming Pollutant Discharge Elimination System) Program

STATEMENT OF BASIS

RENEWAL

APPLICANT NAME: City of [redacted], Wyoming

MAILING ADDRESS: 240 Lincoln Street
Lander, WY 82520-2848

FACILITY LOCATION: City of [redacted] Lagoon, which is located in NESE Section 25, Township 2S, Range 1E, Fremont County. The wastewater will discharge to Popo Agie River (class 2AB), Wind River basin.

Latitude: 42.85392 Longitude: -108.69878

PERMIT NUMBER: WY0020389

This permit has been renewed in accordance with current WYPDES permitting requirements. All permit effluent limits and monitoring requirements have been updated in accordance with current WDEQ regulations and policy. Specific changes to the permit include the following:

1. *The previous permit set effluent limits equal to the instream standards for E. coli on the premise that the outfall was in a section of river that was impaired for E.coli. The WDEQ determined that the impairment for E. coli ended some distance upstream in the Middle Popo Agie, not the mainstem Popo Agie River. This permit calculates E. coli month by month. In calculating E. coli effluent limits, 20 #/100 mL was assumed to be the background, by default.*
2. *Effluent water temperature (°C) monitoring has been added to this permit.*
3. *Industrial pretreatment regulations requiring analysis one time per year for metals is added to this permit. See Part III, Section B of the permit for more information.*
4. *Additional annual monitoring requirements have been added to this permit to comply with 40 CFR Parts 122.21 and Table 2 Appendix J of 40 CFR Part 122 application requirements. See "Annual Monitoring" below.*
5. *Monitoring and reporting for duration of discharges is added to this permit.*
6. *A compliance schedule is included in the permit to come into compliance with the mixing zone requirements as per Chapter 1 and the DEQ Implementation Policies. A compliance schedule is included in this permit requiring the instream diffuser installation by June 30, 3019. Based on field work by the DEQ and executing the STREAMIX I model, 50% dilution is allowed to ensure that complete mixing of the receiving water and effluent occurs over a short distance, as stipulated by Chapter 1 and the DEQ Mixing Zone and Dilution Allowances Implementation Policies. However, with installation of the diffuser, water quality based effluent limit calculations will remain at 100% dilution because complete and instantaneous mixing is assumed with use of the diffuser as per the DEQ Mixing Zone and Dilution Allowances Implementation Policies..*

NPDES

National Pollution Discharge Elimination System

Electronic Discharge Monitoring Reporting (eDMR) System



Standard Operating Procedures



REMINDER TO GET OFF AUTO PILOT

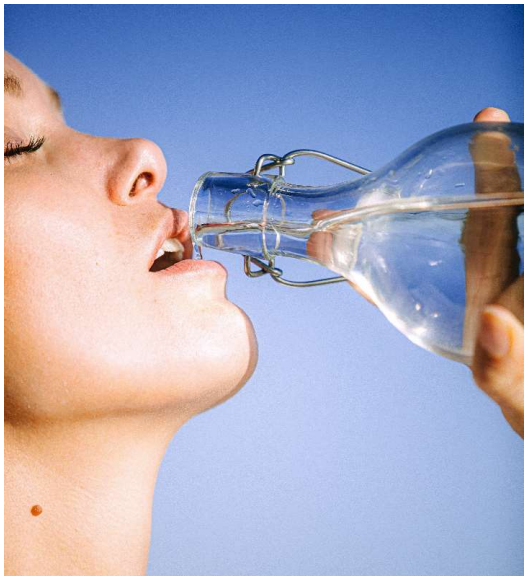


- Turn that brain back on…
- Do not just “do” rounds, be an Operator
- Turn your data to knowledge

A GOOD OPERATOR…

- **GOOD OPERATORS:** Use all their senses

- **NOTE:** You do not have to use your sense of taste…Just saying





Contact Information:
Lucas Guinn
Lucas.Guinn@CommunitiesU.org
(479) 313-4982
www.CommunitiesU.org