Saskatchewan Water Action Network (SWAN)

in association with **University of Saskatchewan**

SWAN Project Kick-Off & Networking Event

February 10, 2016

Theme: WasteWater Recovery & Reuse

Innovative Sludge Management

Venkatesh Meda Ph.D., P.Eng.

Assoc. Professor, Chemical and Biological Engineering

University of Saskatchewan

Sludge treatment and management

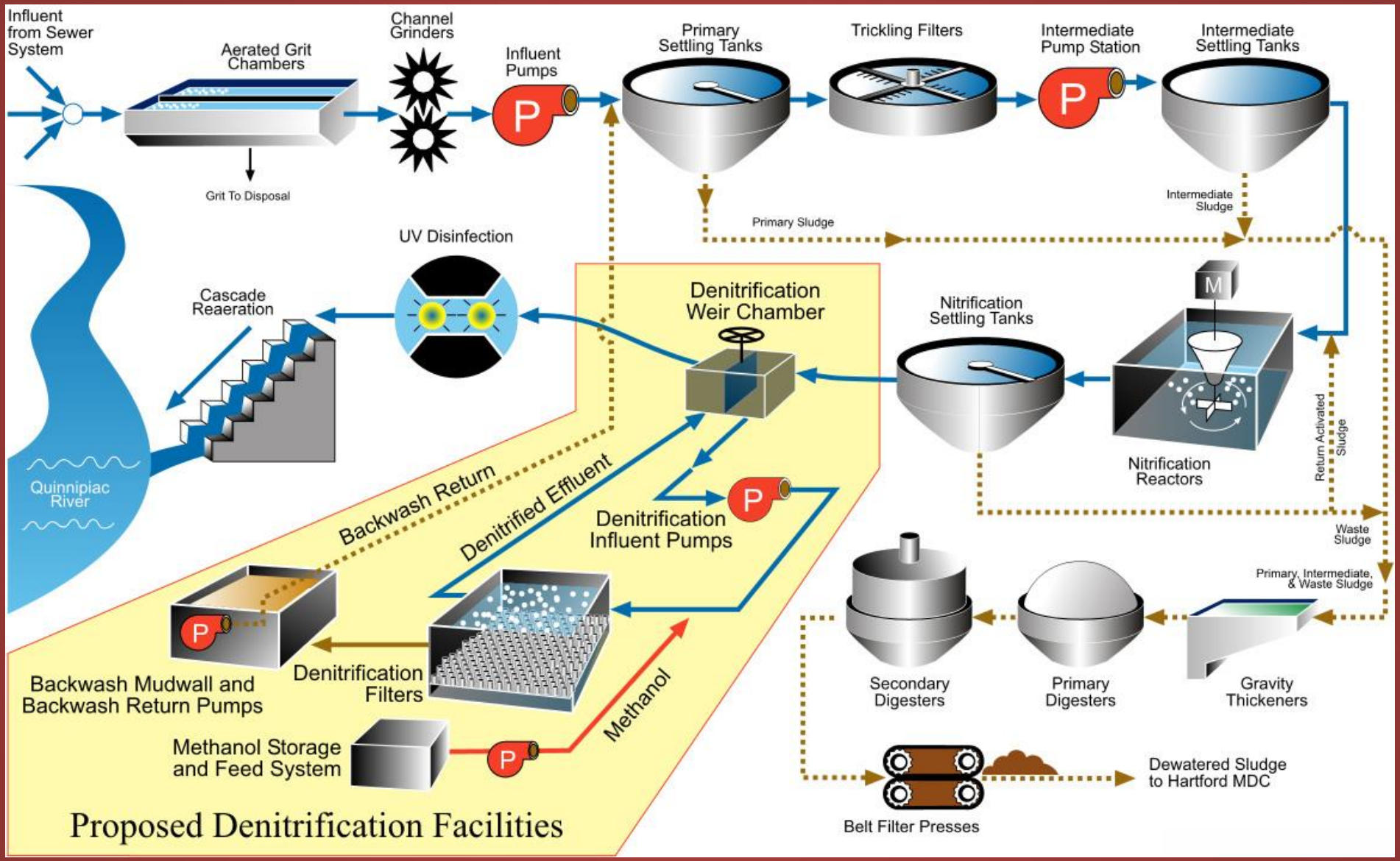
- Reduces organic ingredients
- Removes odour
- Reduces volume and weight
- Improves hygiene by removal of pathogenic organisms
- Prepares sludge for further utilization and/or disposal

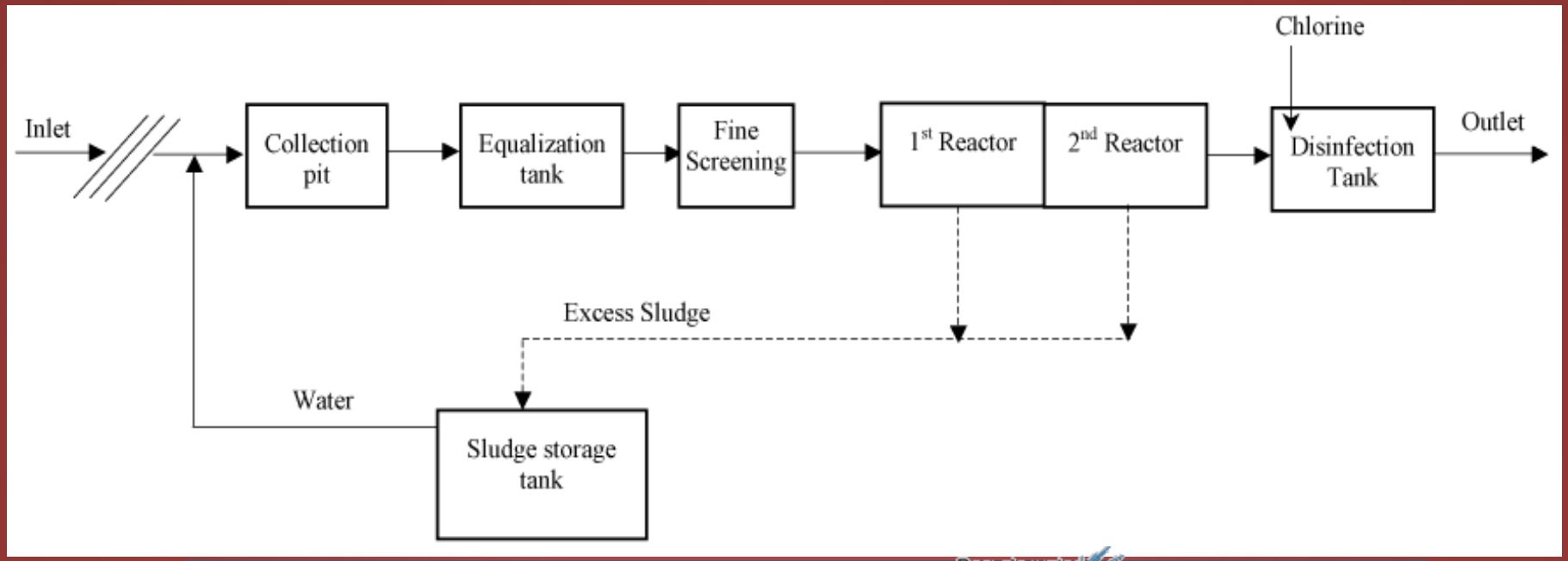
http://www.greennetfinland.fi/fi/images/4/4b/Nordic_sludge.pdf

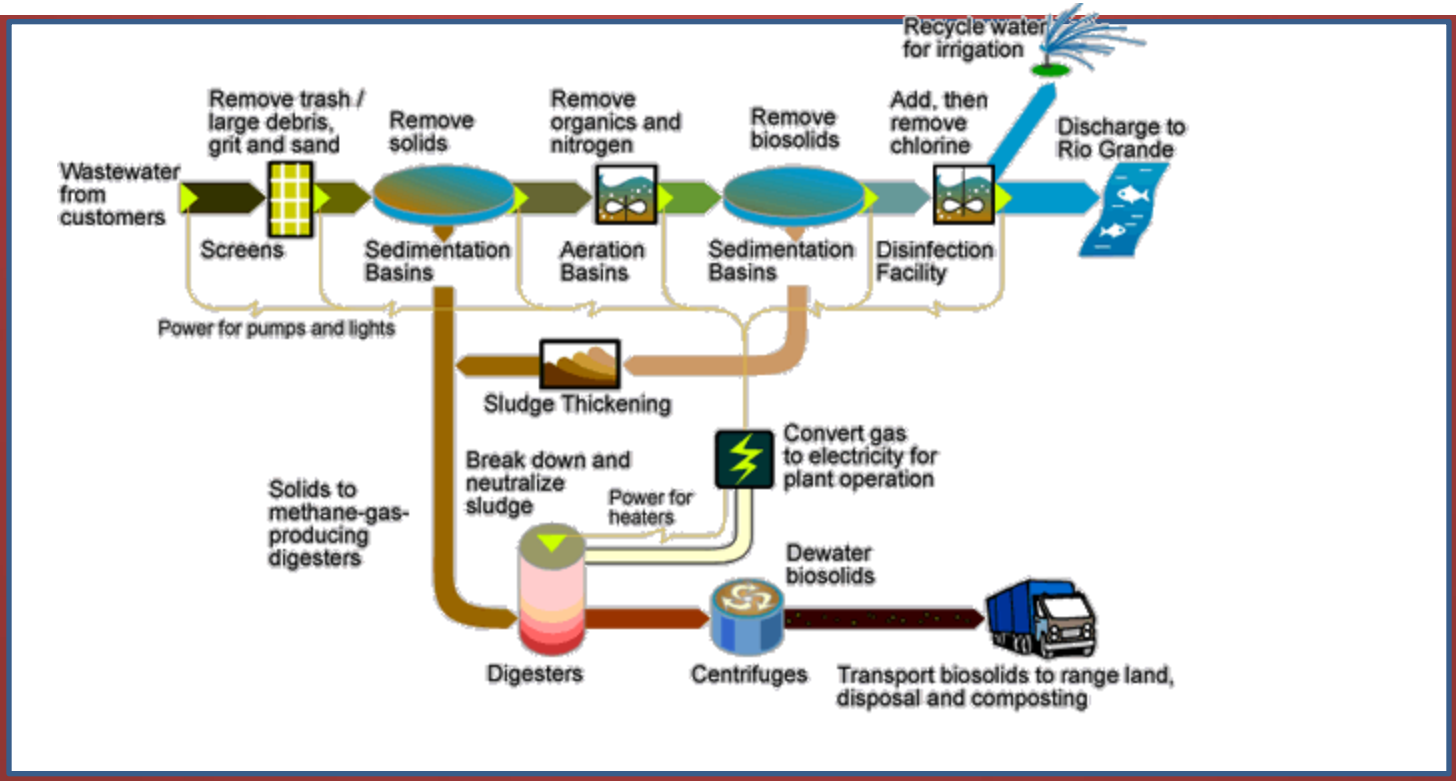
A] SLUDGE TREATMENT

- Thickening
- Digestion
- Conditioning
- Dewatering
- Drying
- Disposal (Incineration)

https://www.google.ca/search?q=sludge+management+technology


Influent from Sewer System
Aerated Grit Chambers
Grit To Disposal
Channel Grinders
Influent Pumps
Primary Settling Tanks
Trickling Filters
Intermediate Pump Station
Intermediate Settling Tanks
Intermediate Sludge
Primary Sludge
UV Disinfection
Cascade Reaeration
Quinnipiac River
Denitrification Weir Chamber
Nitrification Settling Tanks
Nitrification Reactors
Return Activated Sludge
Waste Sludge
Primary, Intermediate, & Waste Sludge
Backwash Return
Denitrified Effluent
Denitrification Influent Pumps
Backwash Mudwall and Backwash Return Pumps
Denitrification Filters
Methanol
Methanol Storage and Feed System
Secondary Digesters
Primary Digesters
Gravity Thickeners
Dewatered Sludge to Hartford MDC
Belt Filter Presses
Proposed Denitrification Facilities


Chlorine
Inlet
Collection pit
Equalization tank
Fine Screening
1st Reactor
2nd Reactor
Disinfection Tank
Outlet
Excess Sludge
Water
Sludge storage tank


Recycle water for irrigation
Remove trash / large debris, grit and sand
Remove solids
Remove organics and nitrogen
Remove biosolids
Add, then remove chlorine
Discharge to Rio Grande
Wastewater from customers
Screens
Sedimentation Basins
Aeration Basins
Sedimentation Basins
Disinfection Facility
Power for pumps and lights
Sludge Thickening
Convert gas to electricity for plant operation
Break down and neutralize sludge
Power for heaters
Solids to methane-gas-producing digesters
Dewater biosolids
Digesters
Centrifuges
Transport biosolids to range land, disposal and composting

- ✓ As a consequence of tightening water regulations, more and more difficult wastewater sludge are generated, which drives the development of new sludge handling and utilisation methods.

- ✓ Sludge could be considered as a valuable source for nutrient use, reuse of inorganic material, carbon upgrading processes,and energy production.

http://www.greennetfinland.fi/fi/images/4/4b/Nordic_sludge.pdf

Novel techno-approaches in Sludge Management

- Continuously operating pilot-scale filter belt press
- Computer controlled versatile pressure filter, special pumps
- Continuously operating membrane rigs
- Pilot-scale decanter centrifuge
- Pilot-scale flow through device for low temperature drying
- Pilot-scale continuously operating combustion equipment
- Flocculation/filtration rig for studying basic phenomena around sludge behaviour
- Large range of analytical equipment for sludge characterisation

http://www.greennetfinland.fi/fi/images/4/4b/Nordic_sludge.pdf

Novel techno-approaches in Sludge Management; a case study

- Watrec biorefinery design concept is an industrialized biogas plant solution where the waste is transformed into bioenergy and high quality fertilisers.

- Watrec offers both small- and large-scale co-digestion plants (20,000-360,000 tn/a) for the treatment of organic materials from agriculture, municipalities and industry.

- The first project was finalised in 2005, being the first large-scale co-digestion plant in Finland.

http://www.greennetfinland.fi/fi/images/4/4b/Nordic_sludge.pdf

Novel techno-approaches in Sludge Management; a case study

- Cambi-THP (Norway):
  - **Thermal Hydrolysis Process**
- Suitable for all types of waste water treatment sludge
- Particularly effective in treating biological sludge
- Both municipal and industrial waste water and biowaste prior to anaerobic digestion.

http://www.greennetfinland.fi/fi/images/4/4b/Nordic_sludge.pdf

Biorefinery Design Parameters

- ✓ Operational functionality
- ✓ Cost efficiency
- ✓ Maintenance friendly
- ✓ Clean and safe operation
- ✓ Hygienic process
- ✓ Nutrient management
- ✓ Process monitoring and control
- ✓ Operational chain management

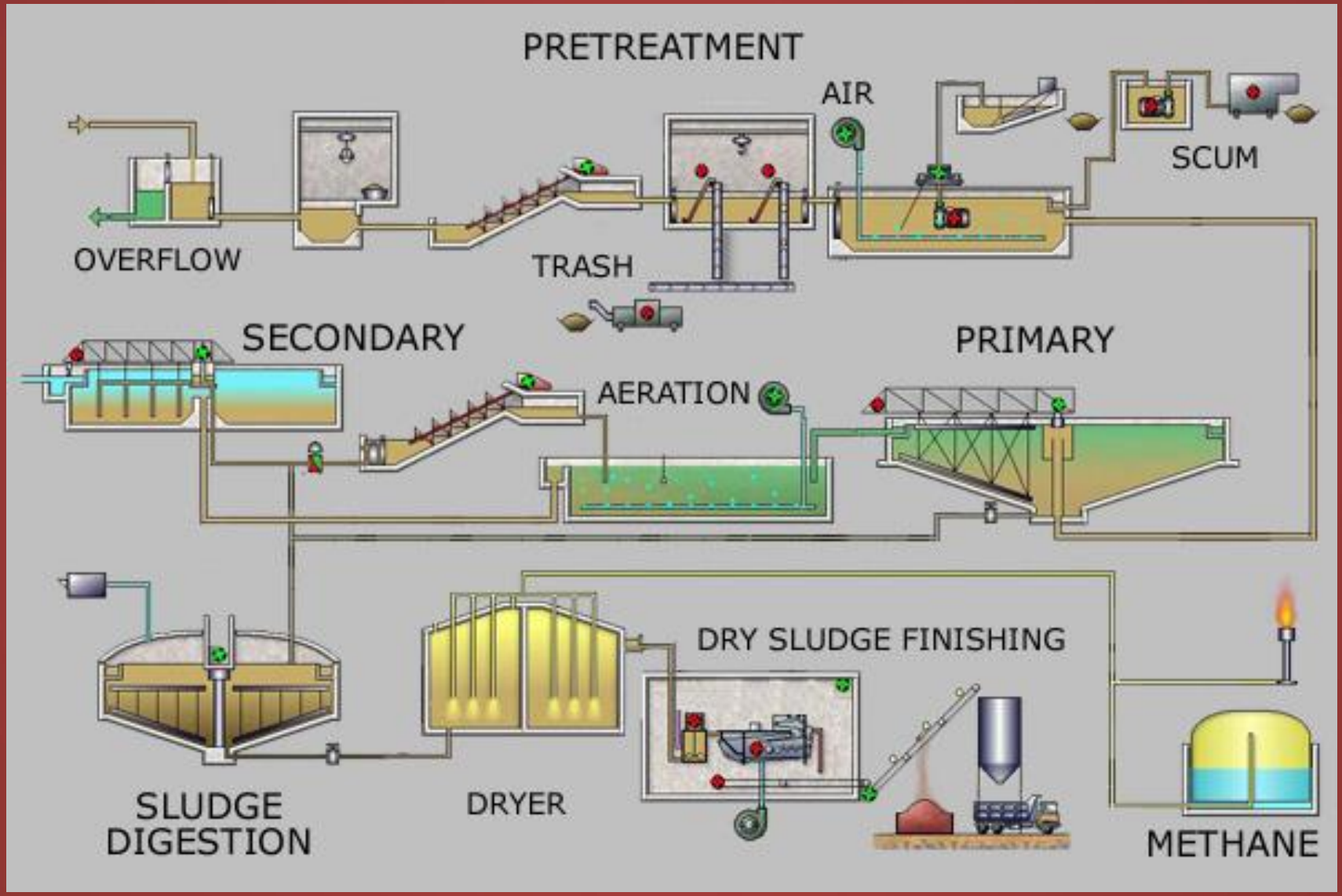
TRAINING AND CONSULTATION, PARTNERSHIP AND INTERNATIONAL COOPERATION

http://www.greennetfinland.fi/fi/images/4/4b/Nordic_sludge.pdf

Drum Composting beats conventional methods

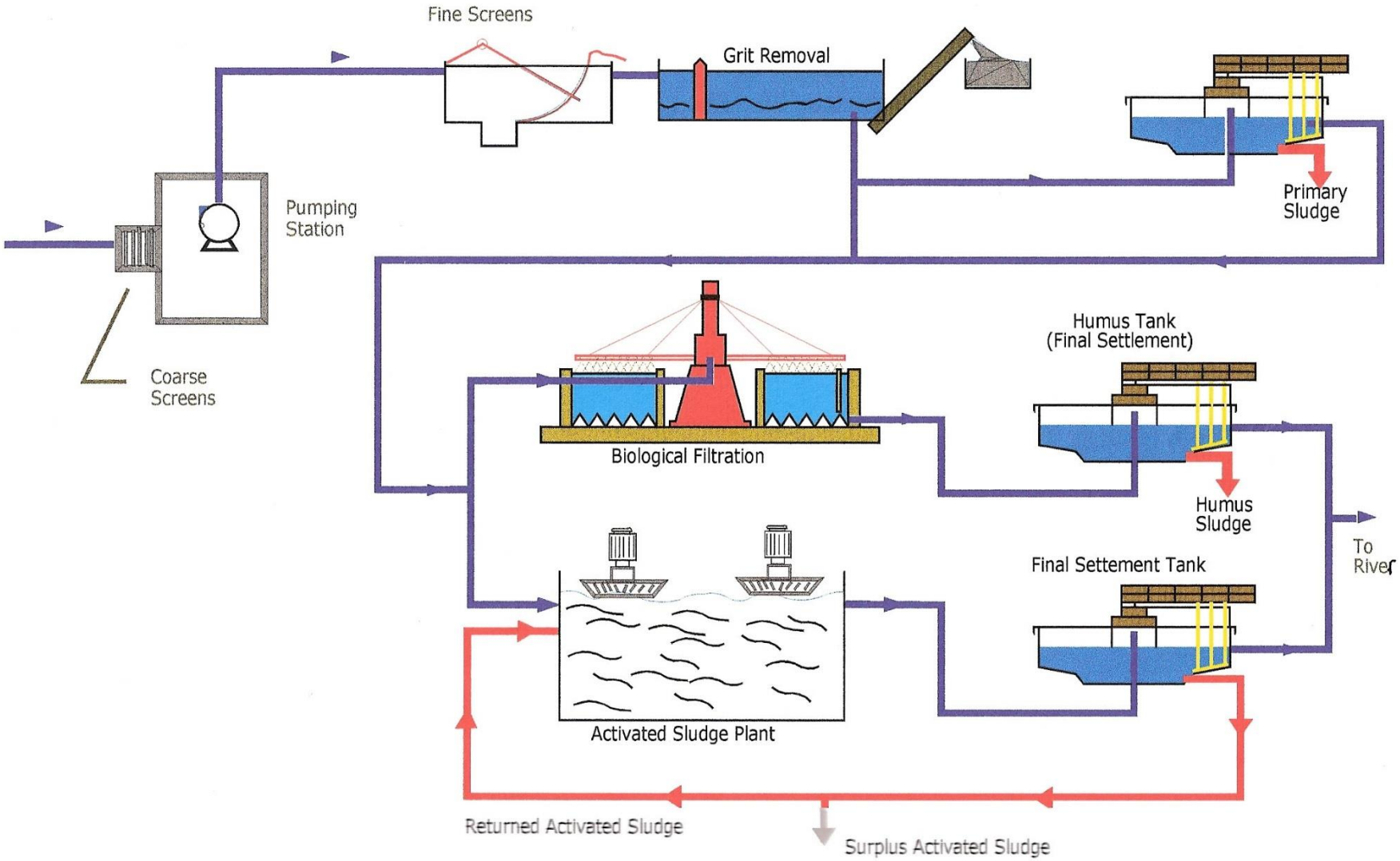
- One stop shop for waste and wastewater treatment
- The integrated waste solution – odourless, fulfils any requirements regarding safety and environment and can be used in residential community.
- A wide range of organic waste is suitable for drum composting; sludge from flotation or waste water treatment plant, manure, agro-food industry waste, green waste, separately collected biowaste from households etc.
- Ideally the waste would have 15 - 30 % dry material content, relatively small particle size and carbon-nitrogen ratio of 30:1.

http://www.greennetfinland.fi/fi/images/4/4b/Nordic_sludge.pdf

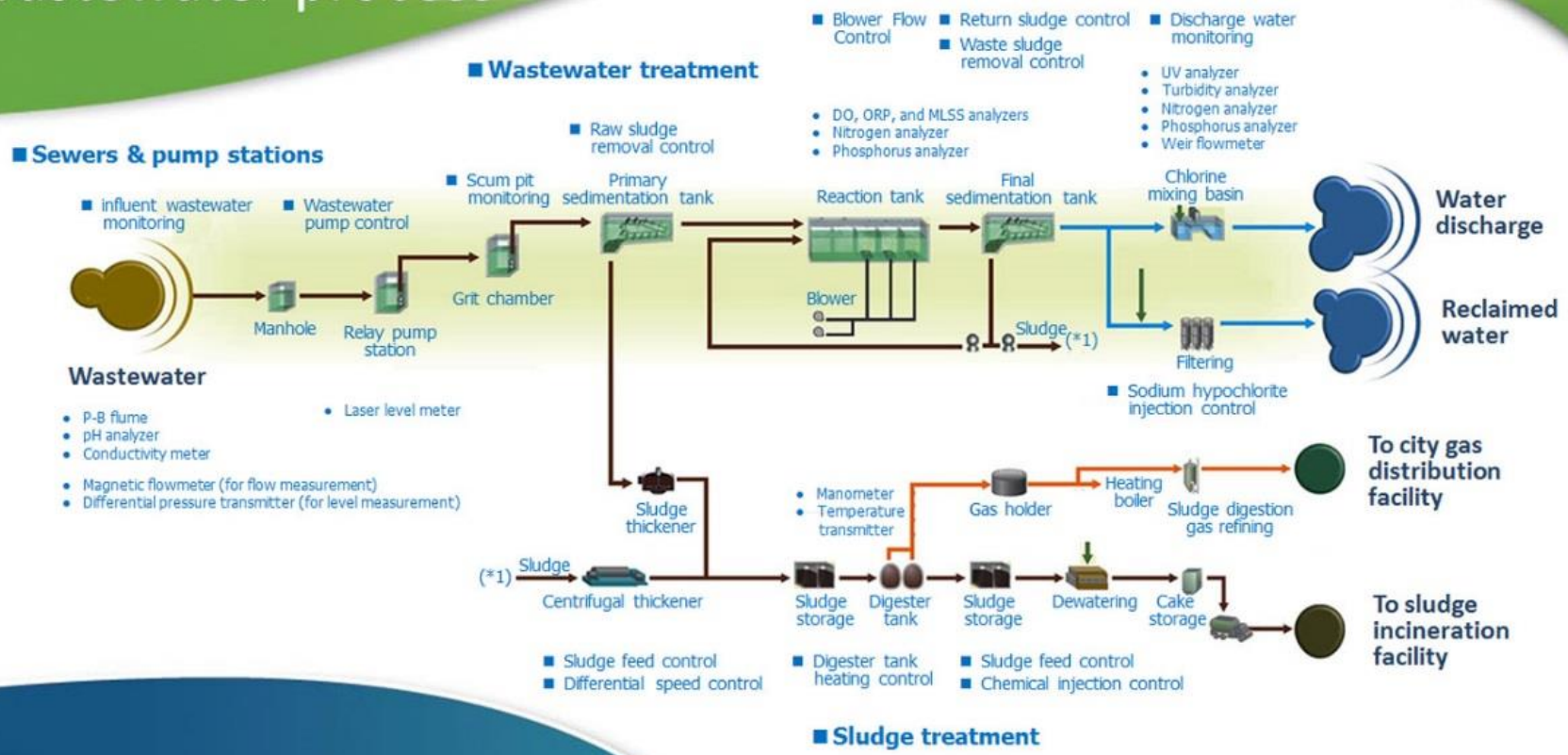


http://www.googlescholar.com

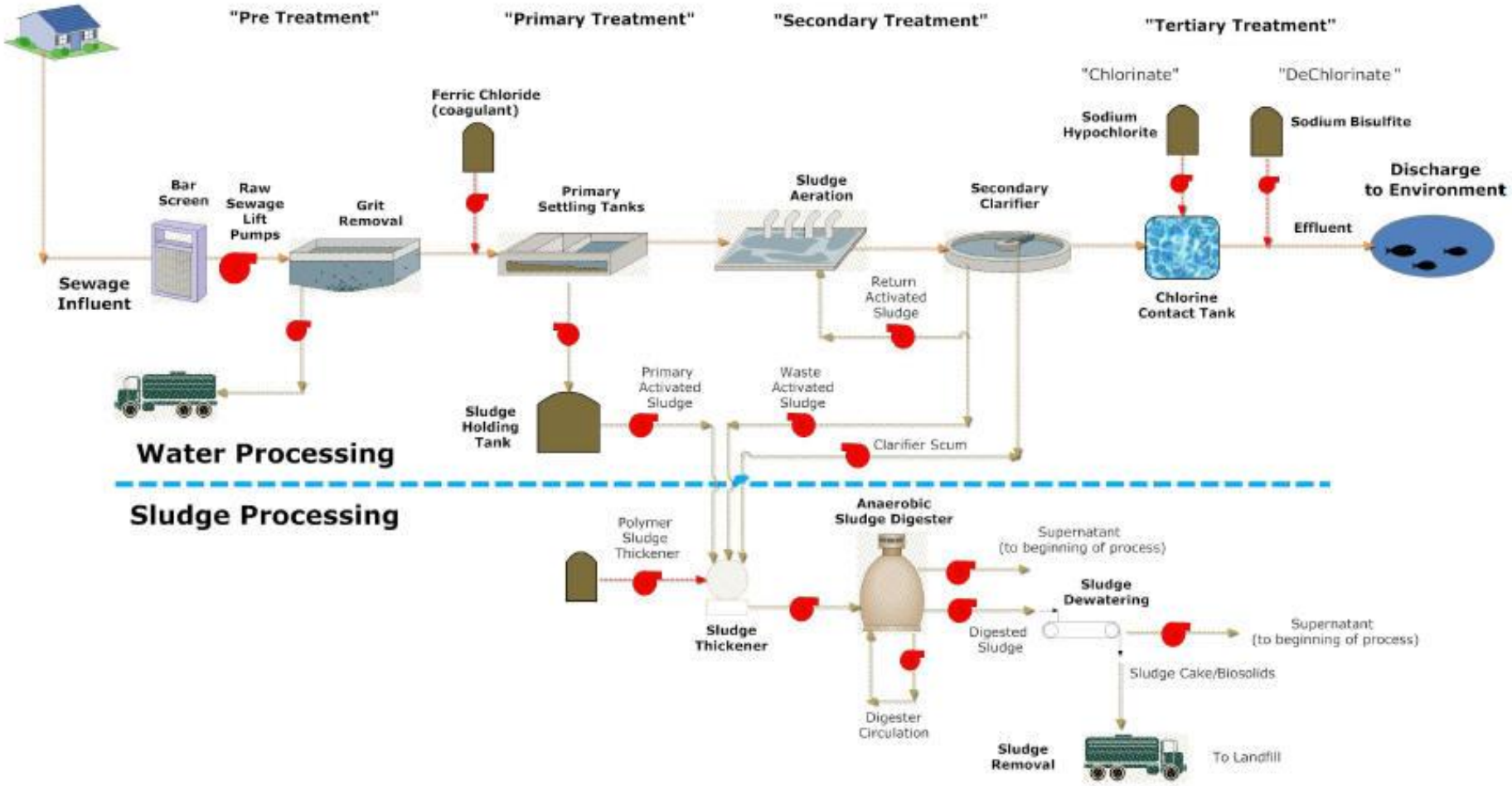
Sewage Treatment Processes

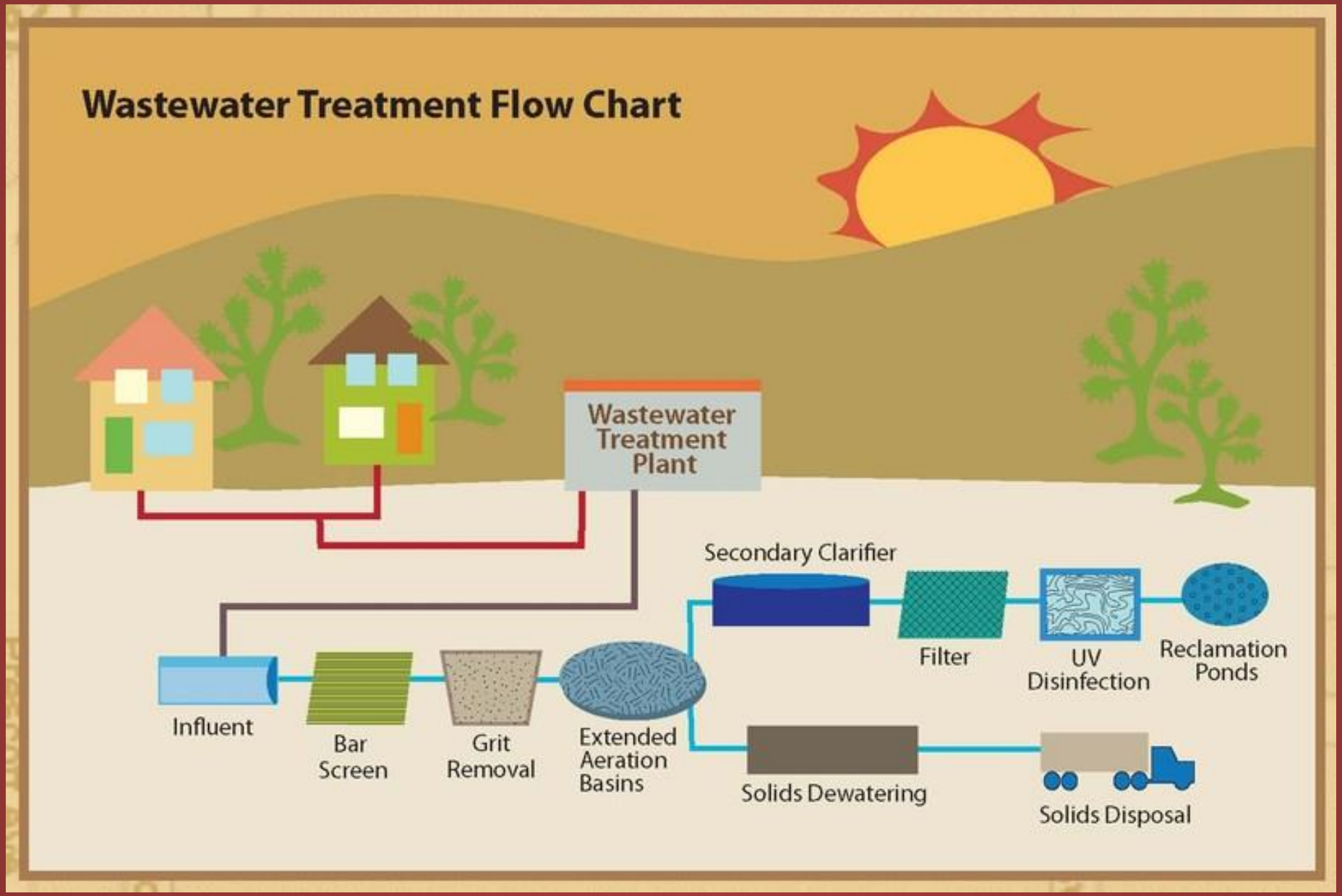


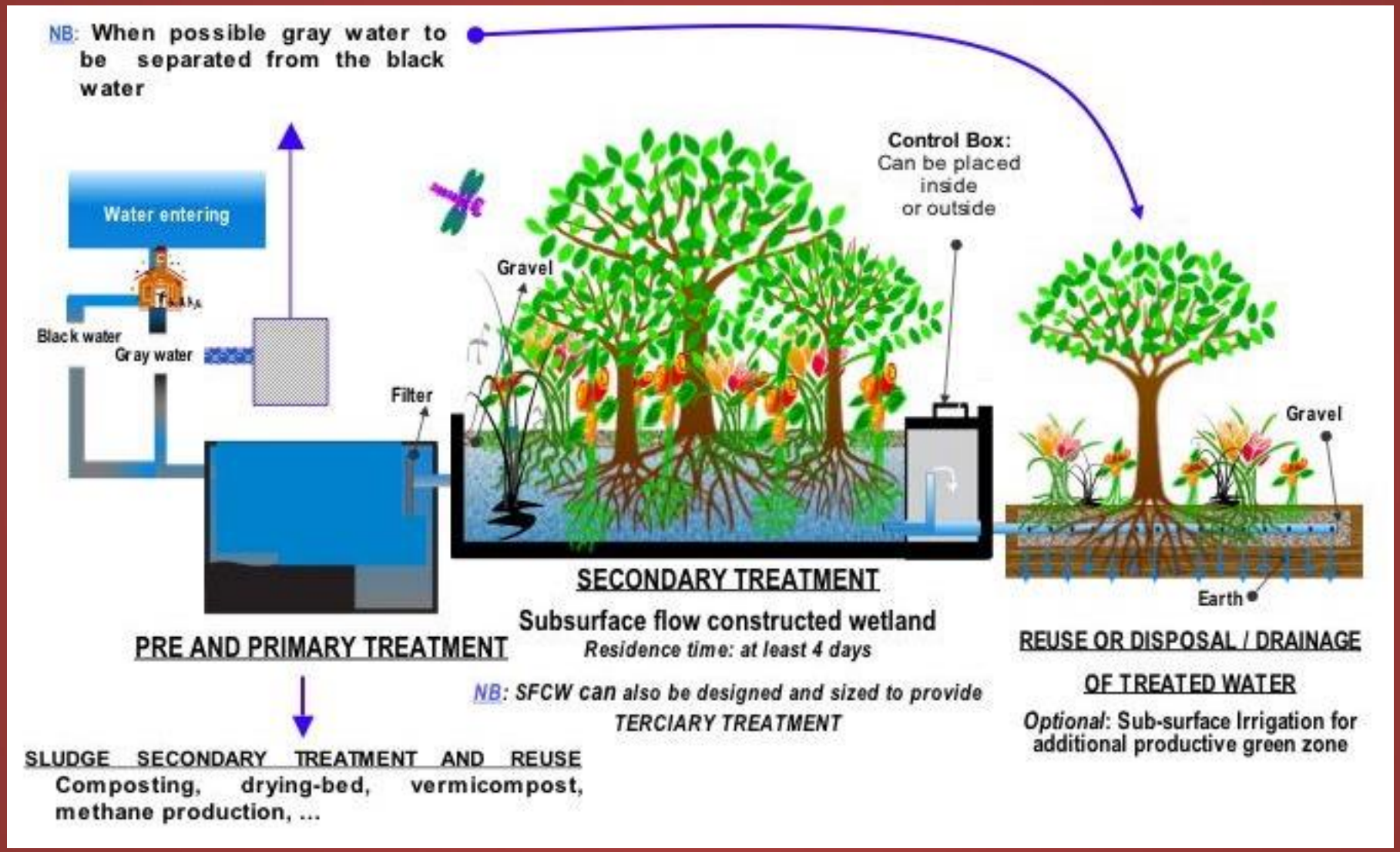
Wastewater process

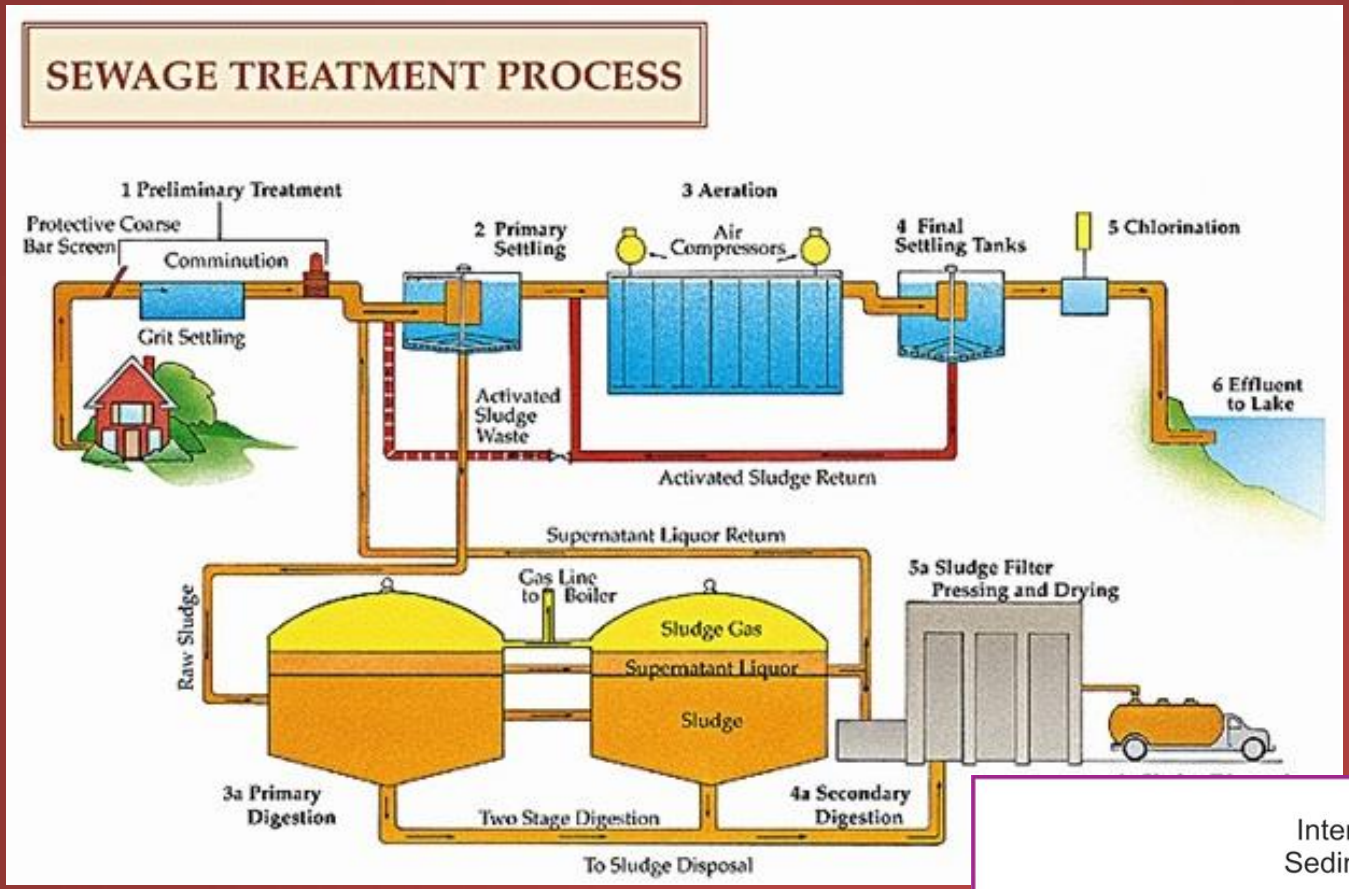


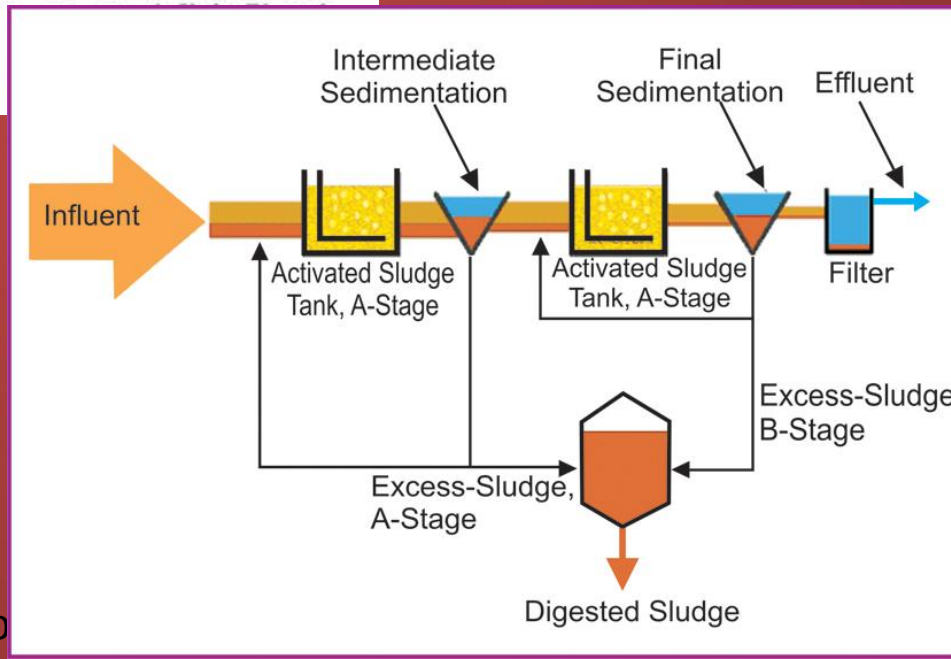
WASTEWATER PROCESS FLOW DIAGRAM





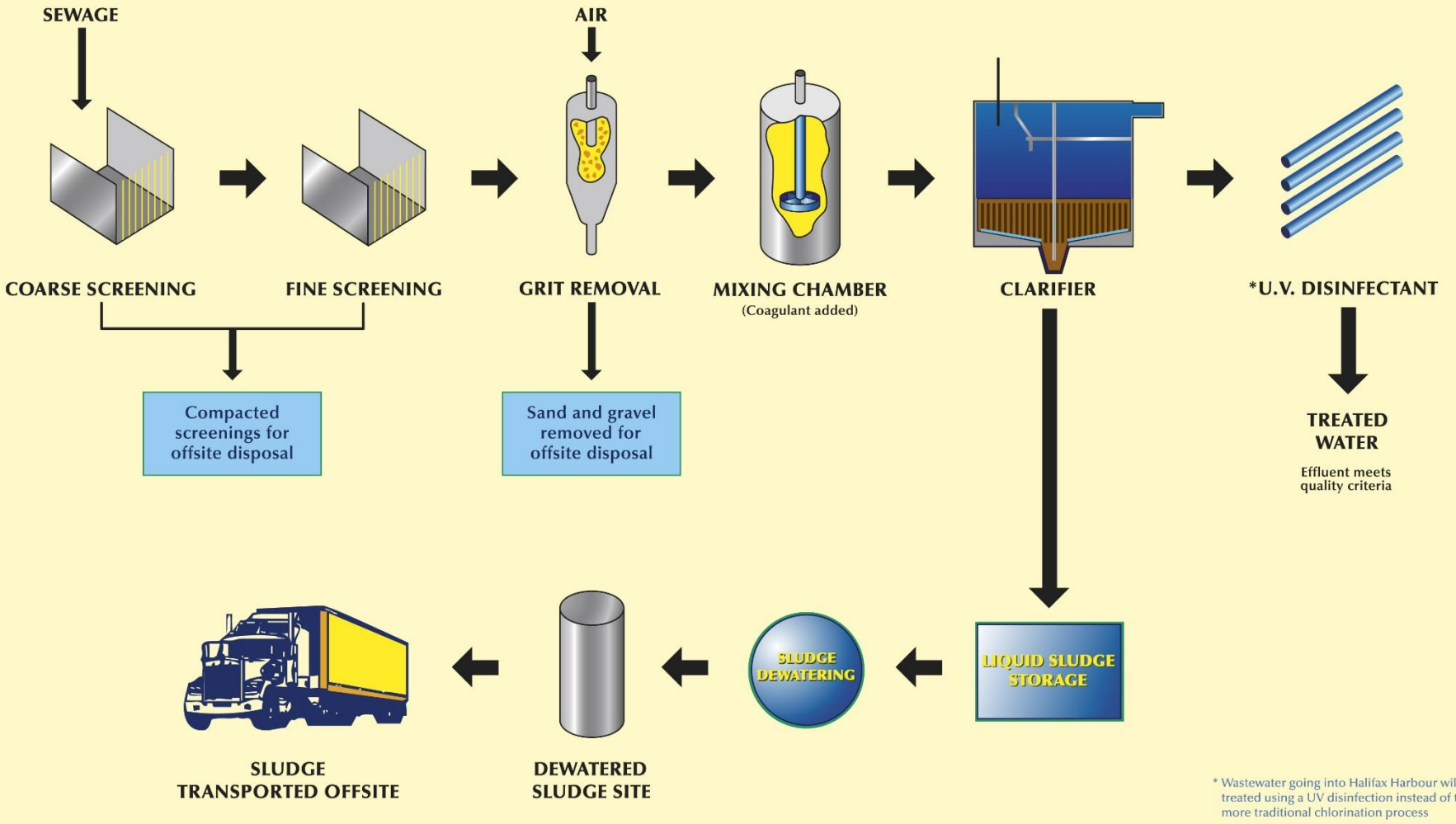


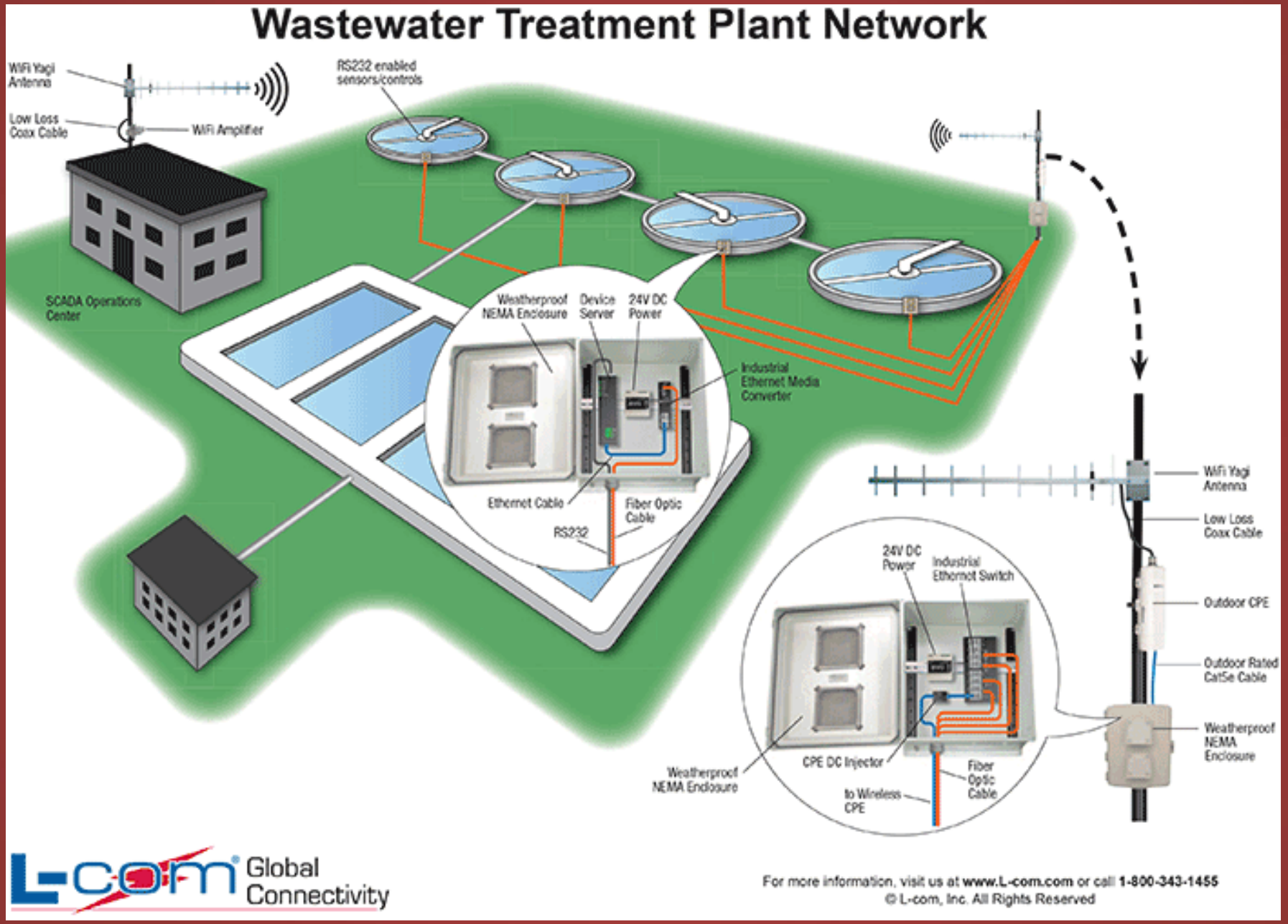

SEWAGE TREATMENT PROCESS
1 Preliminary Treatment
Protective Coarse Bar Screen
Comminution
Grit Settling
2 Primary Settling
3 Aeration
Air Compressors
4 Final Settling Tanks
5 Chlorination
6 Effluent to Lake
Activated Sludge Waste
Activated Sludge Return
Supernatant Liquor Return
Gas Line to Boiler
Raw Sludge
Sludge Gas
Supernatant Liquor
Sludge
5a Sludge Filter Pressing and Drying
3a Primary Digestion
Two Stage Digestion
4a Secondary Digestion
To Sludge Disposal

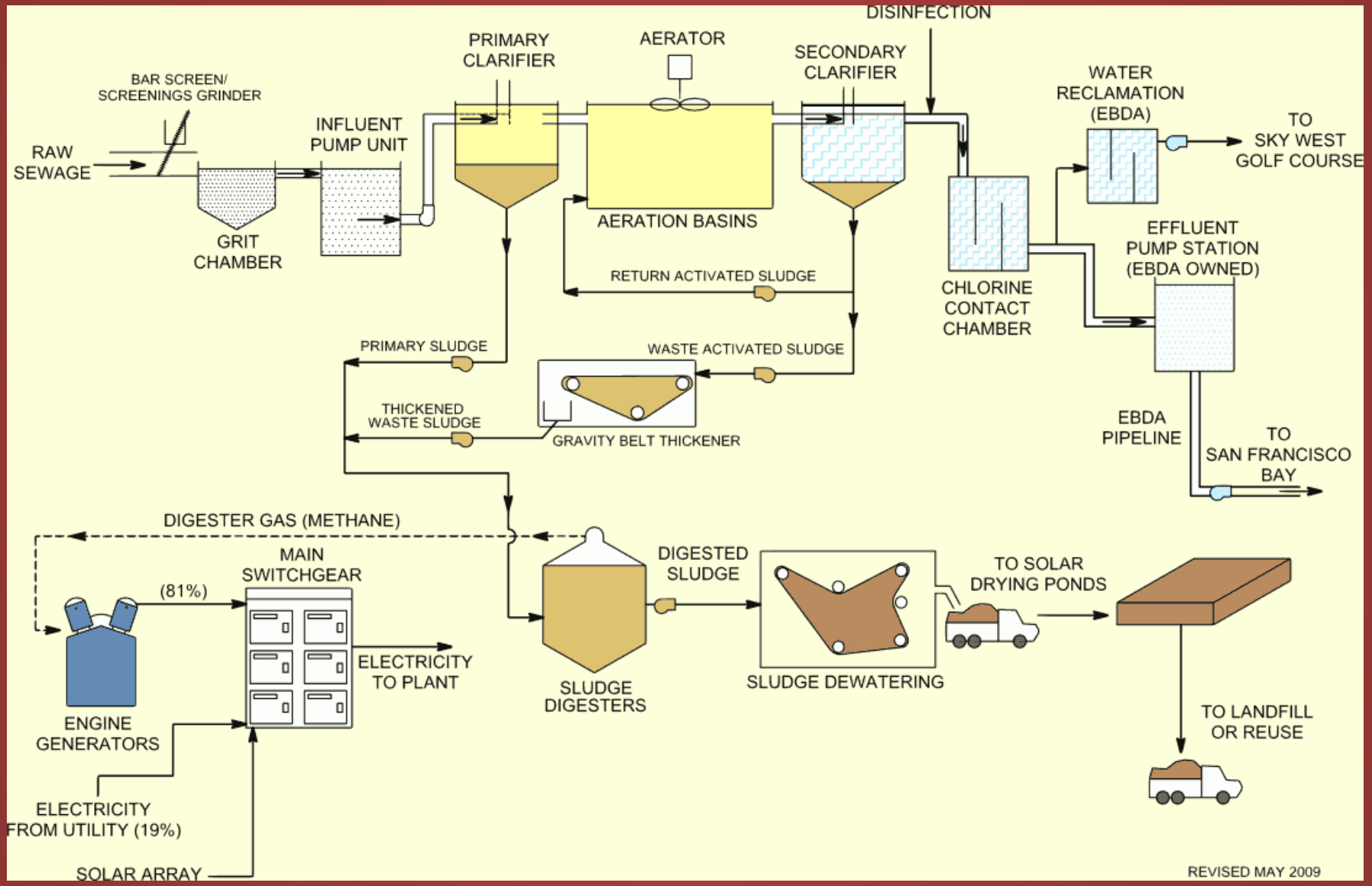

Intermediate Sedimentation
Final Sedimentation
Effluent
Influent
Activated Sludge Tank, A-Stage
Activated Sludge Tank, A-Stage
Filter
Excess-Sludge B-Stage
Excess-Sludge, A-Stage
Digested Sludge

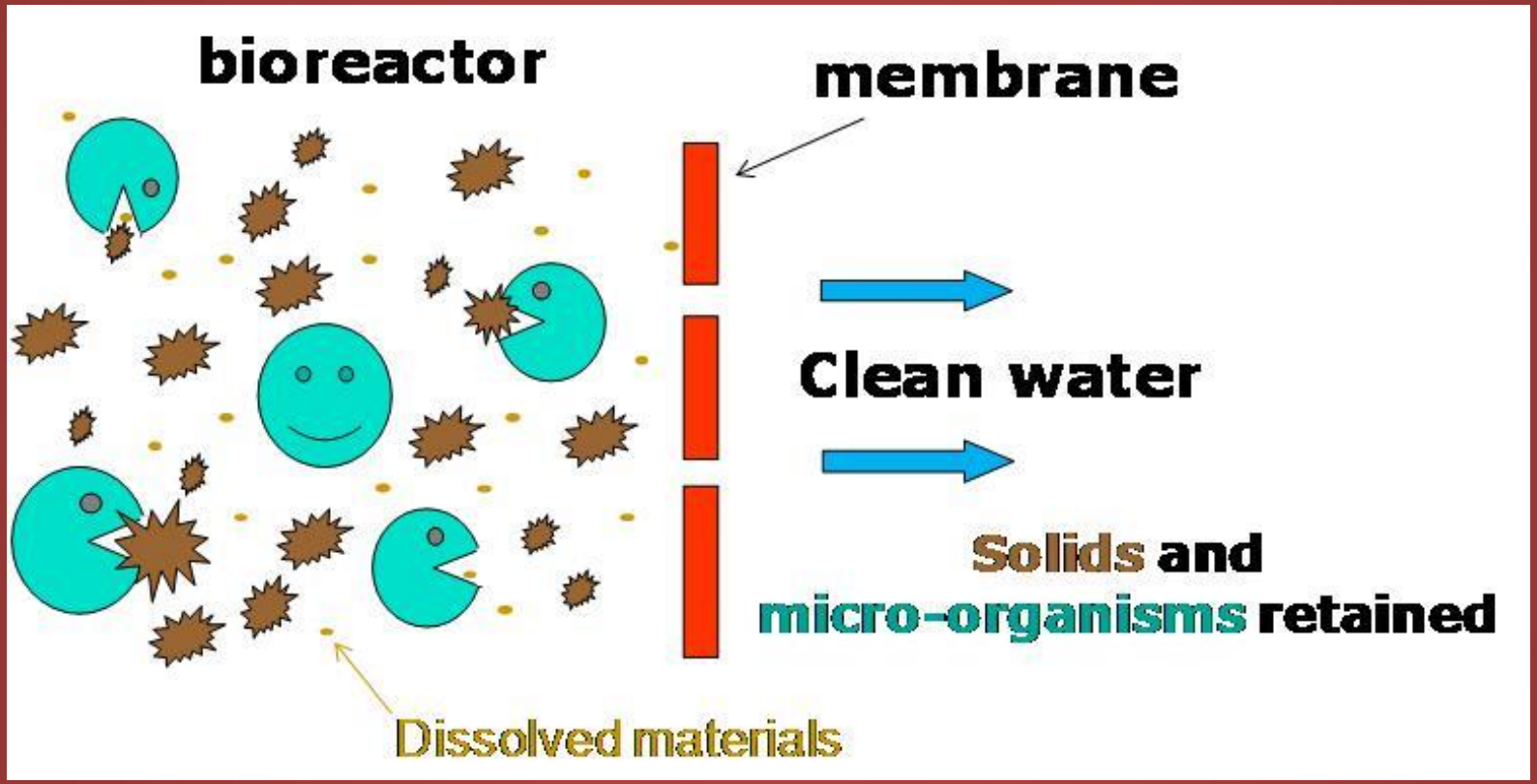
http://www.go

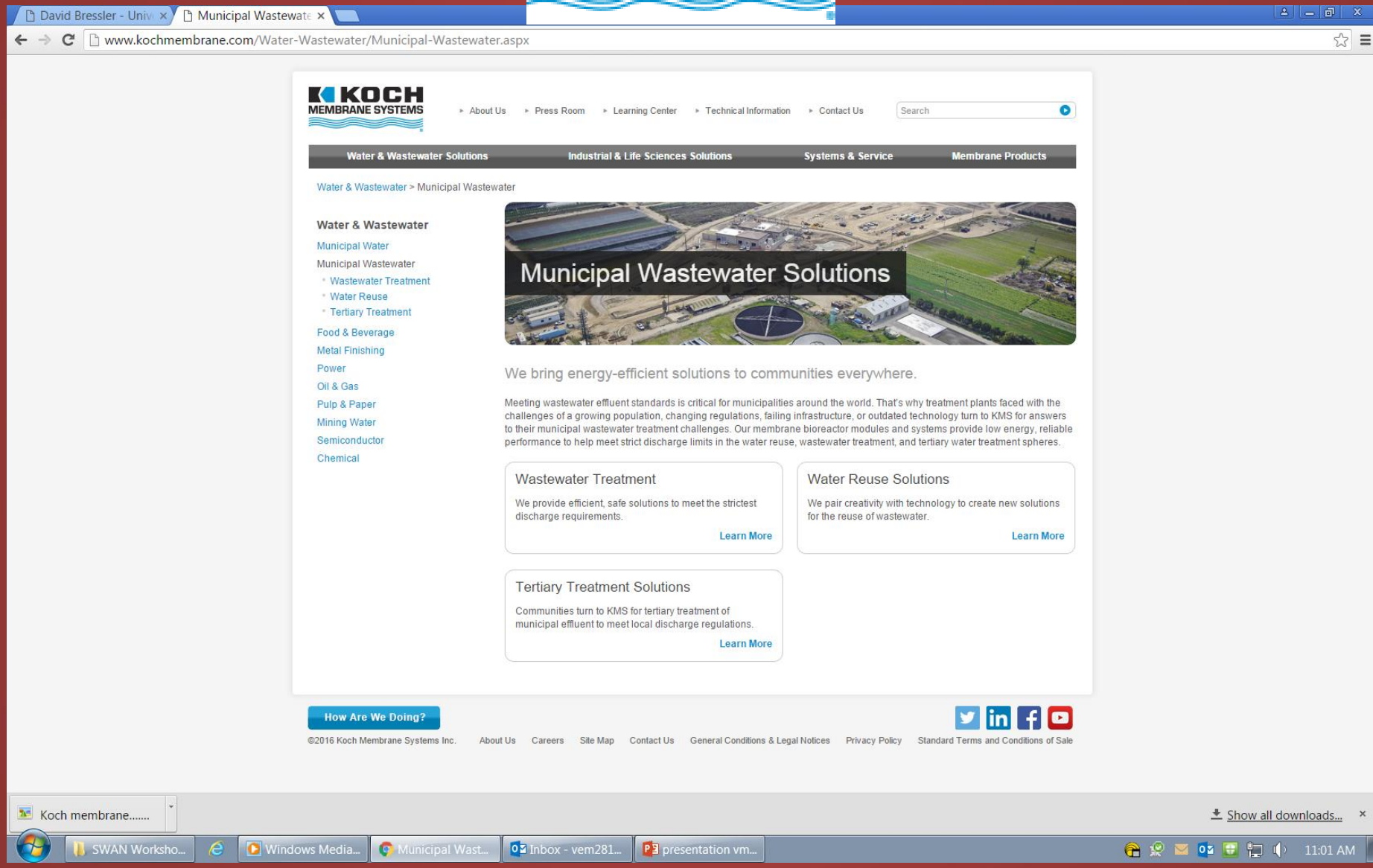
SEWAGE TREATMENT PROCESS



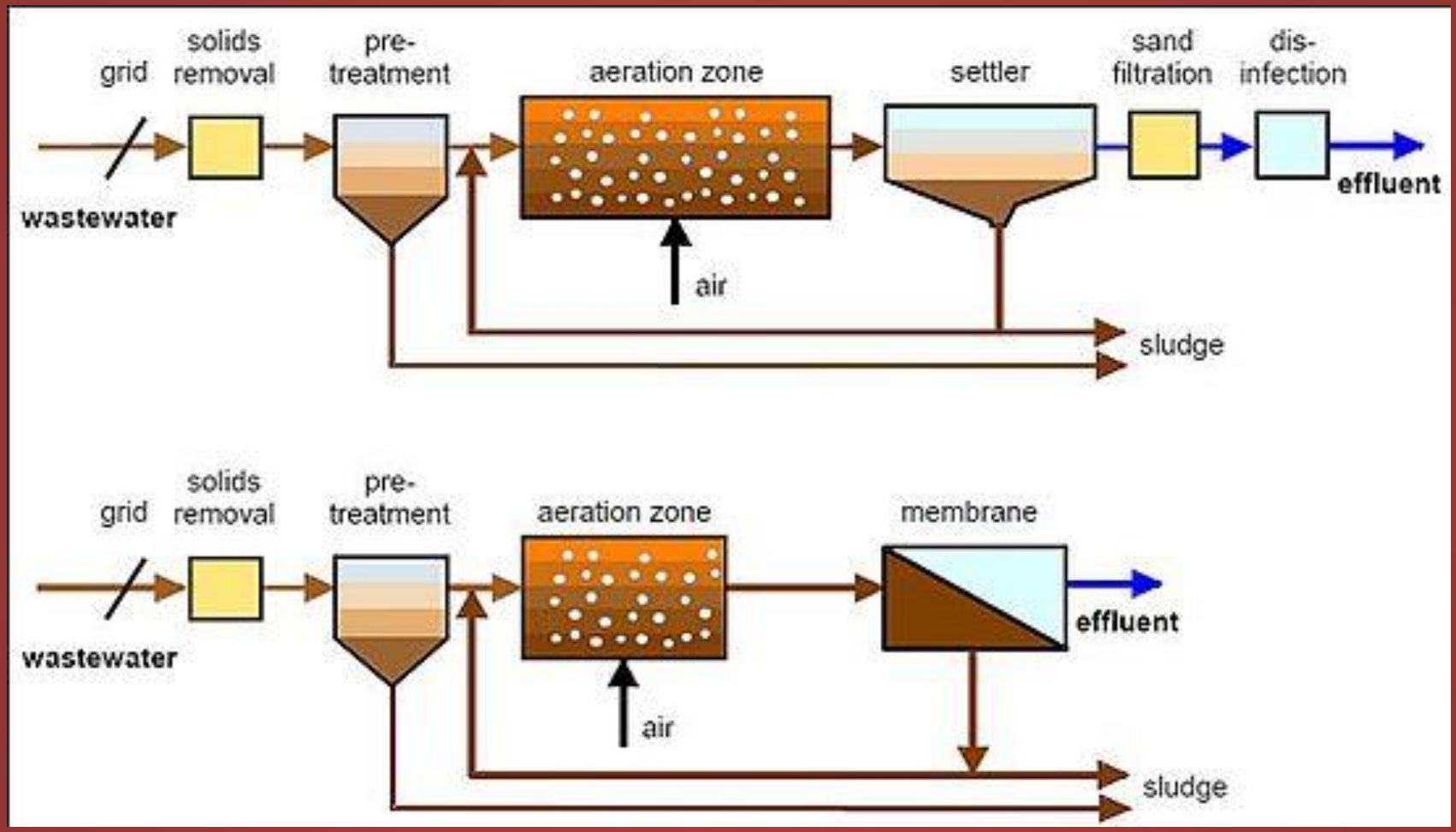




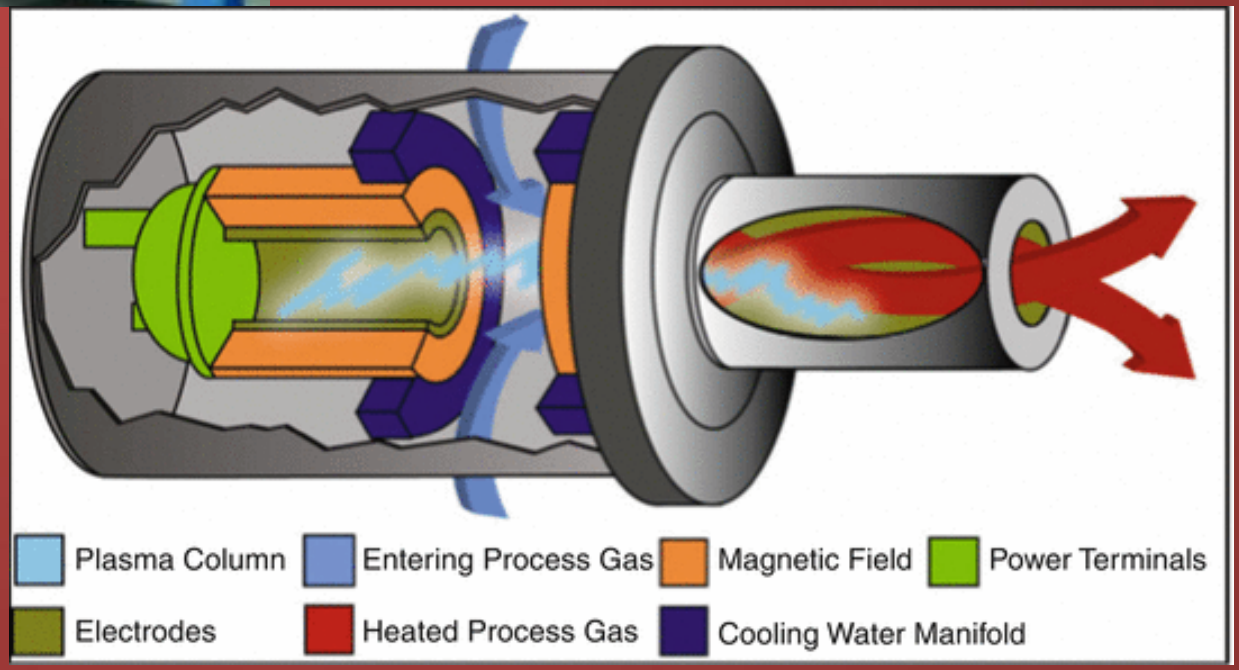




http://www.kochmembrane.com/Water-Wastewater/Municipal-Wastewater.aspx



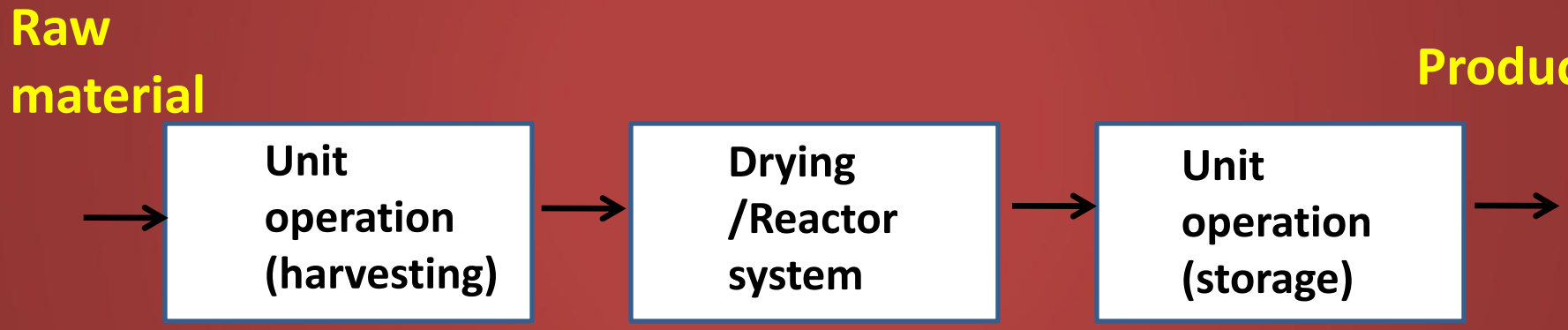
Plasma Assisted Sludge Oxidation (PASO)



http://www.googlescholar.com, HydroQuebec FAB Groups

Design Investigation basics

Majority of all chemical /biological engineering processes contains three operations;



What does a dryer /belt filter system design means ?

Drying fundamentals

- Removal of a liquid from a solid / semisolid/ liquid to produce solid product by thermal energy input causing phase change (sometimes converts solid moisture into vapor by sublimation eg. freeze drying with application of heat)
- Needed for the purposes of preservation and storage, reduction in cost of transportation, etc.
- Most common and diverse operation with over 100 types of dryers in industrial use
- Competes with distillation as the most energy-intensive operation

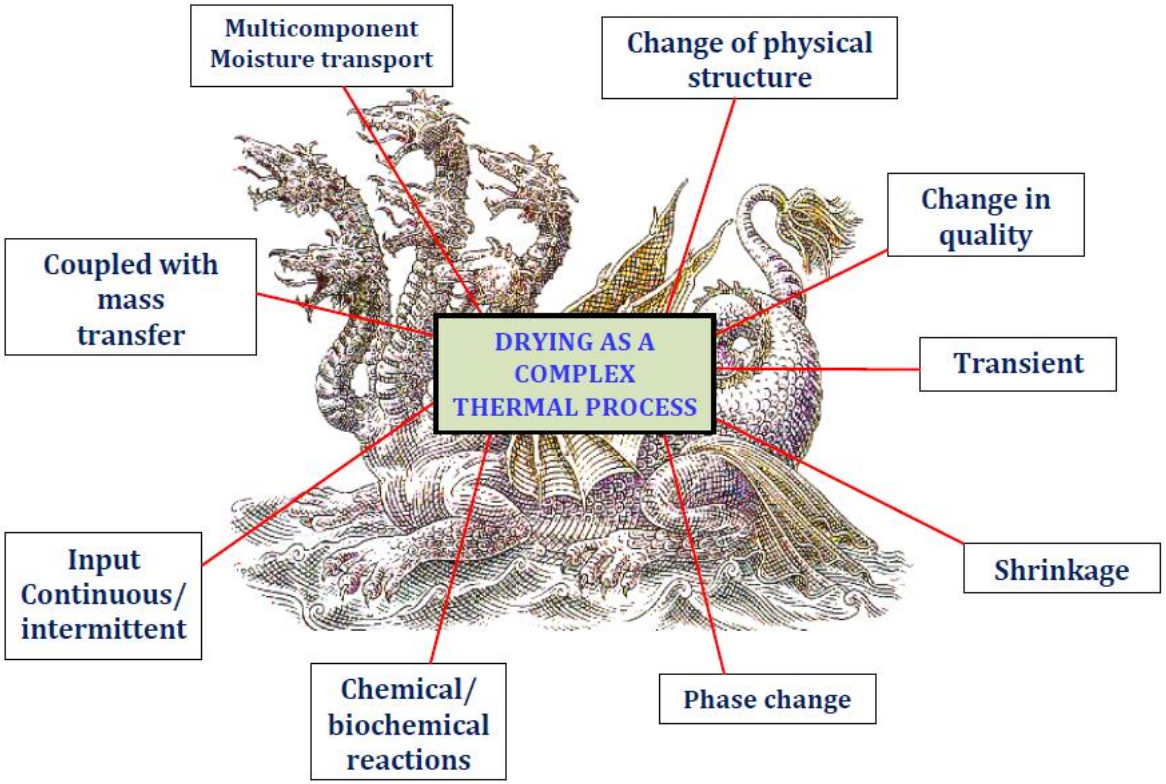
Drying fundamentals

(Mujumdar, A.S., NUS, 2011)

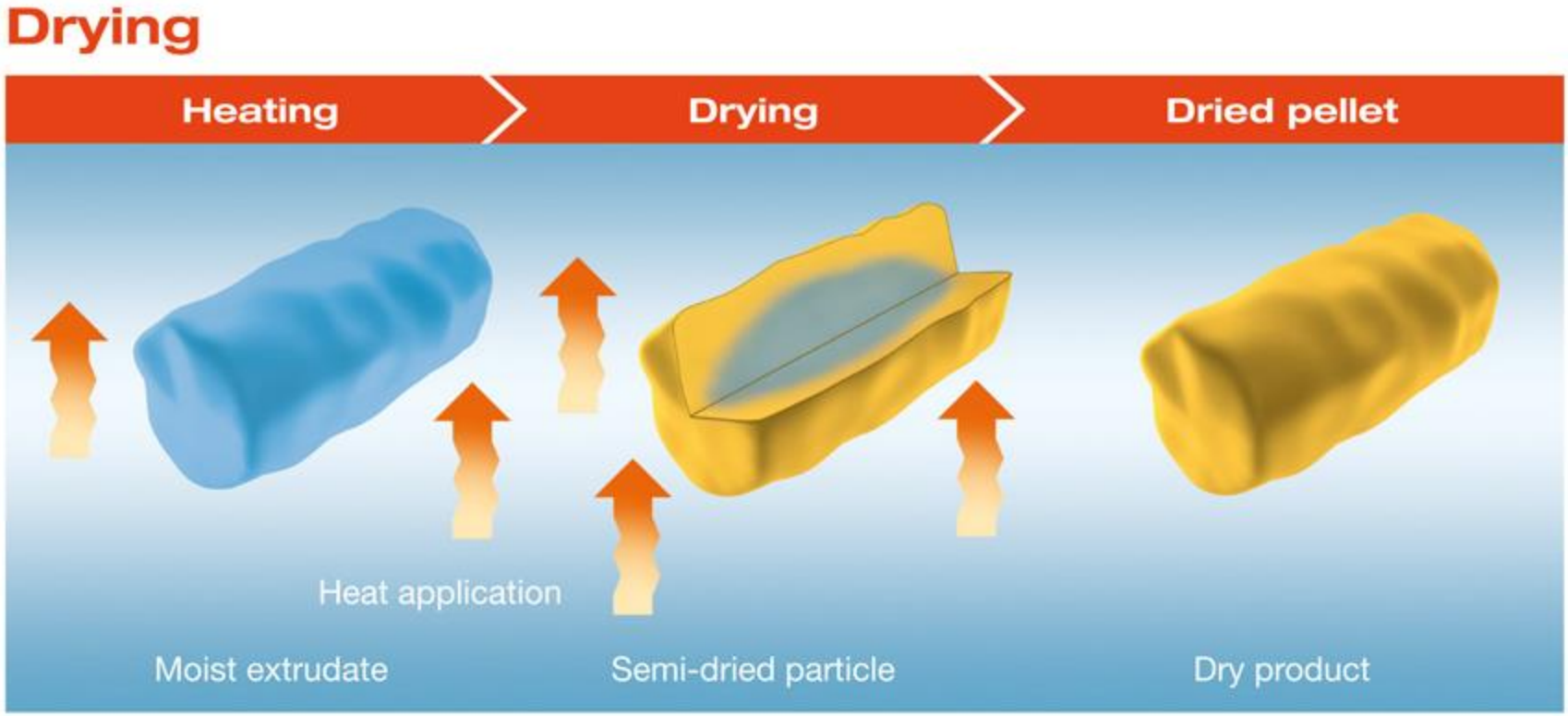
Drying_Principles and Practice.pdf - Adobe Reader

File Edit View Window Help

Drying a Complex Process



2:09 PM
8/7/2015

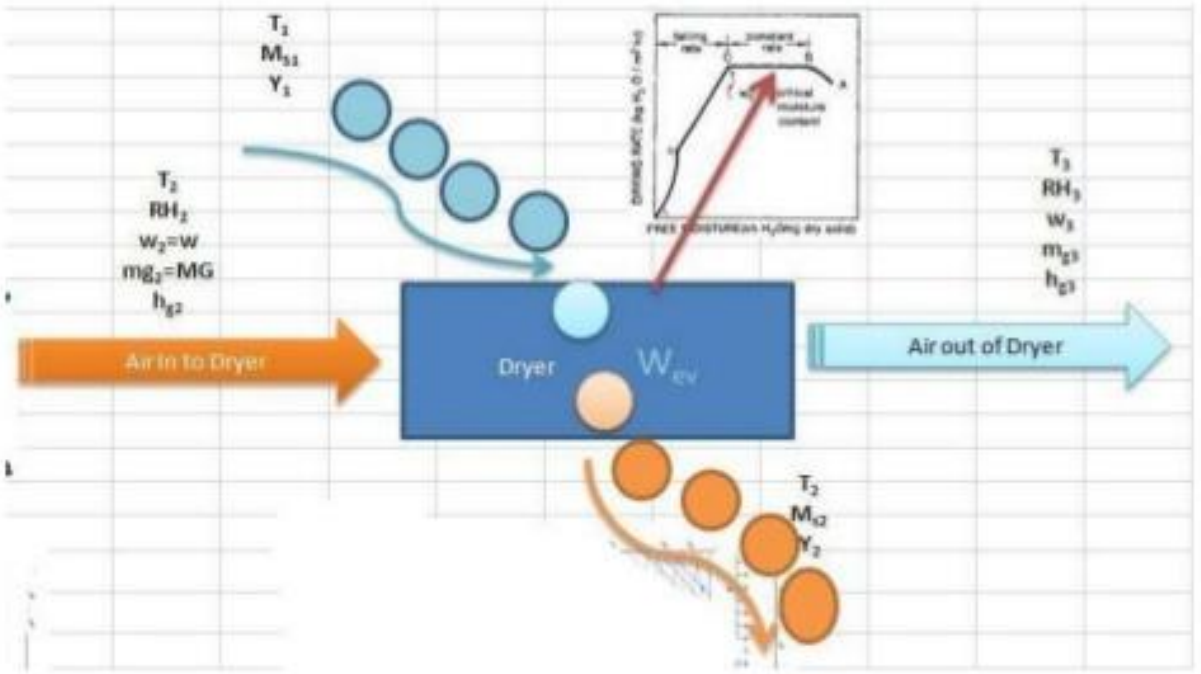


Advantages of fluidized bed drying

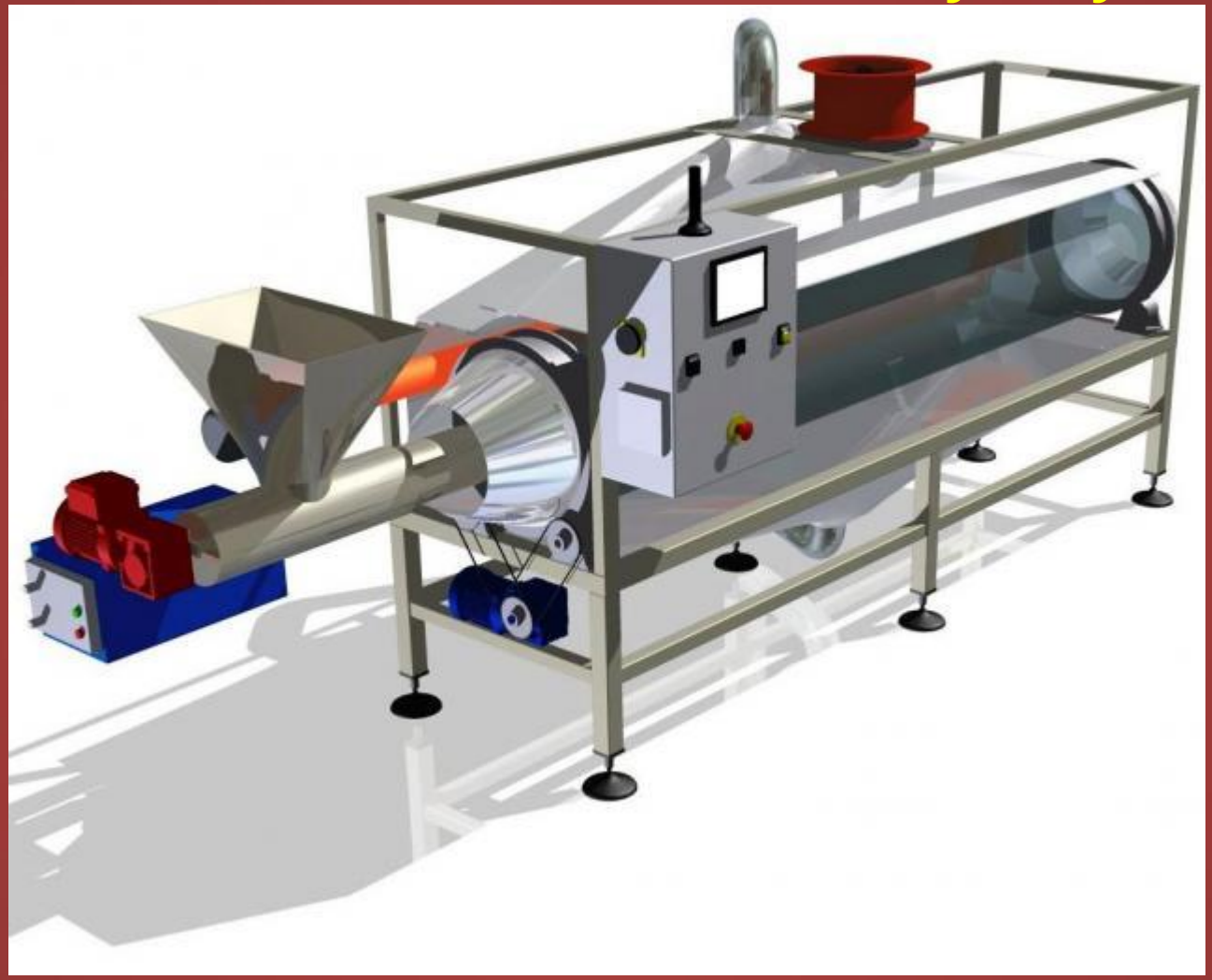
- Short drying times at freely selectable temperatures
- Conservation of the product
- Maintenance of functional properties
- Subsequent coating possible

Dryer

- For sizing the dryer as well as determining the level of the drying, it is important to obtain the drying kinetics of which the drying rate inside the dryer is calculated.

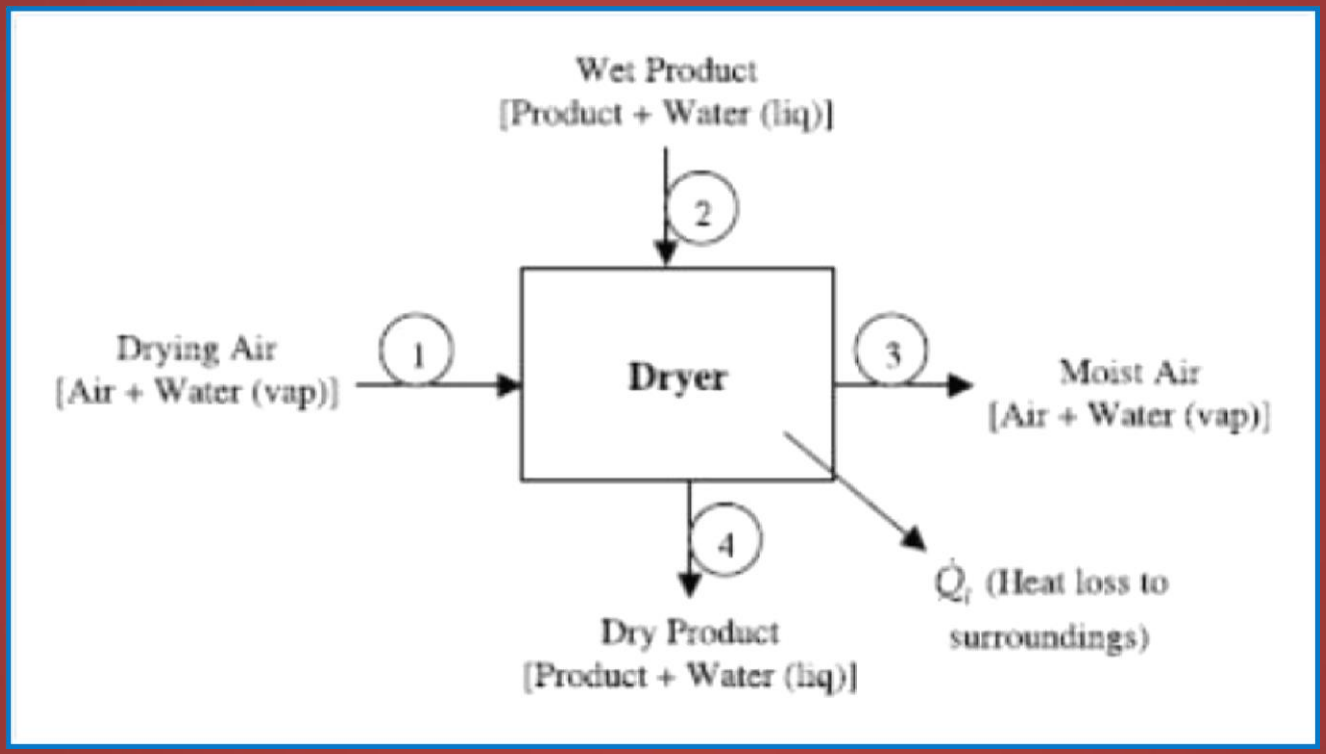


Radiant Convection Rotary Dryer



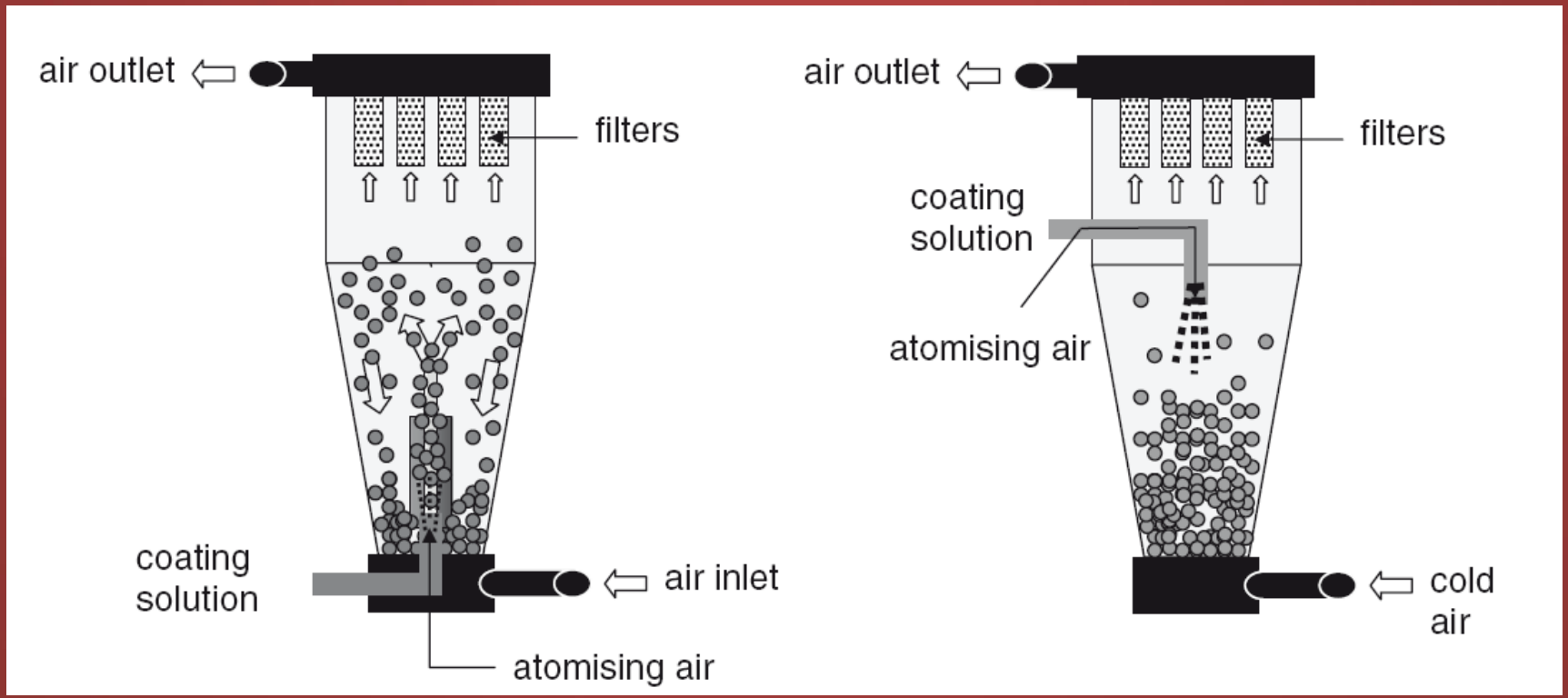
The drying process takes place during the movement of material in a perforated rotating drum and is conducted by infrared and convection heating.

Dryer system: mass and energy balance



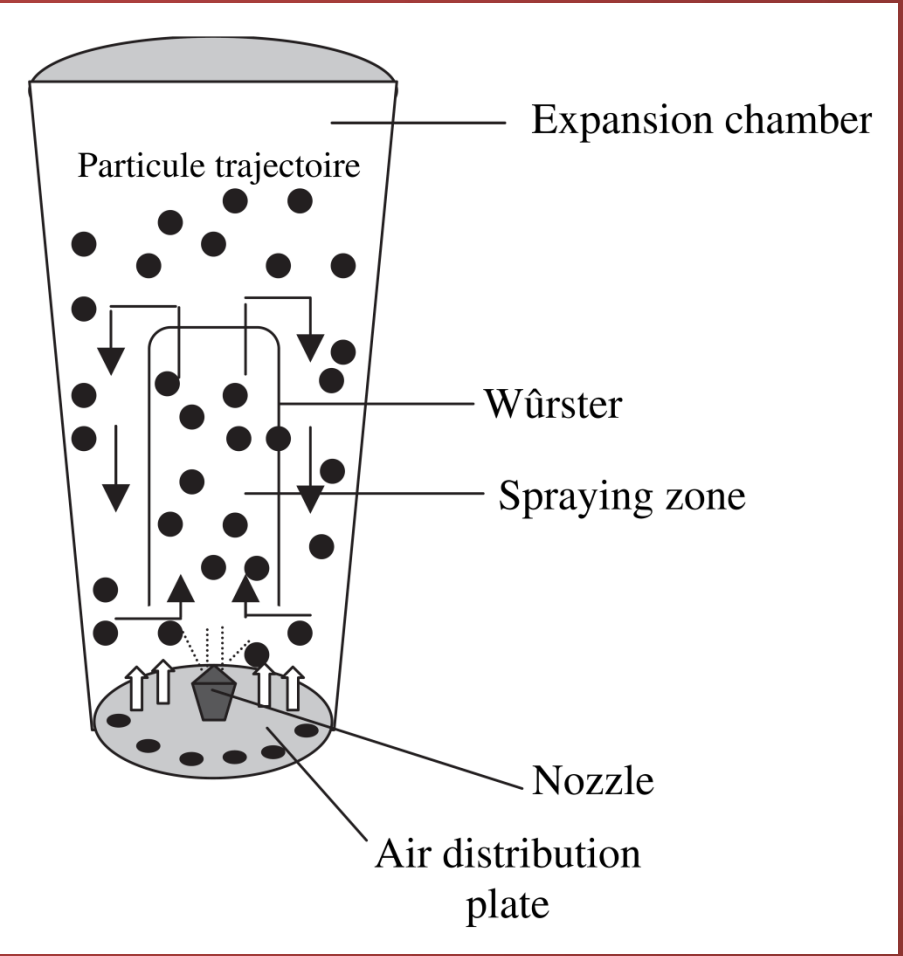
Fluid bed coating

- a coating is applied onto powder particles in a batch process or a continuous set-up.
- The powder particles are suspended by an air stream at a specific temperature and sprayed with an atomized, coating material.
- 5–50% of coating is applied, depending on the particle size of the core material and application of the encapsulate



Fluid bed drying

✓the coating is sprayed in an the bottom
✓The air flow rate is typically 80% in the center and 20% in the periphery
✓which brings the powder particles into circulation.
✓ This increases the drying rate and reduces agglomeration.
✓The bottom spray reduces the distance between the powder and the drops of coating solution, thereby reducing the risk of premature drying of the coating.



Büchi™ Reactors:

- Mass transfer
- Energy and Mass balance
- Heat transfer
- Chemical kinetics
- Thermodynamics

Concluding remarks

- Reduction of wastewater sludge is an important research and development target.
- Poor dewatering properties of sludge makes it very challenging task for sludge management.
- A wide range of dewatering methods is in use ($$).
- Sludge derivatives can be utilized as wet bulk material in agro-industrial applications (boilers, low grade soil amendment, reuse etc.).

Thank you

Questions/Comments?