Anoxic selector, single stage nitrification process

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City of Waco
Water Utility Services

Presentation

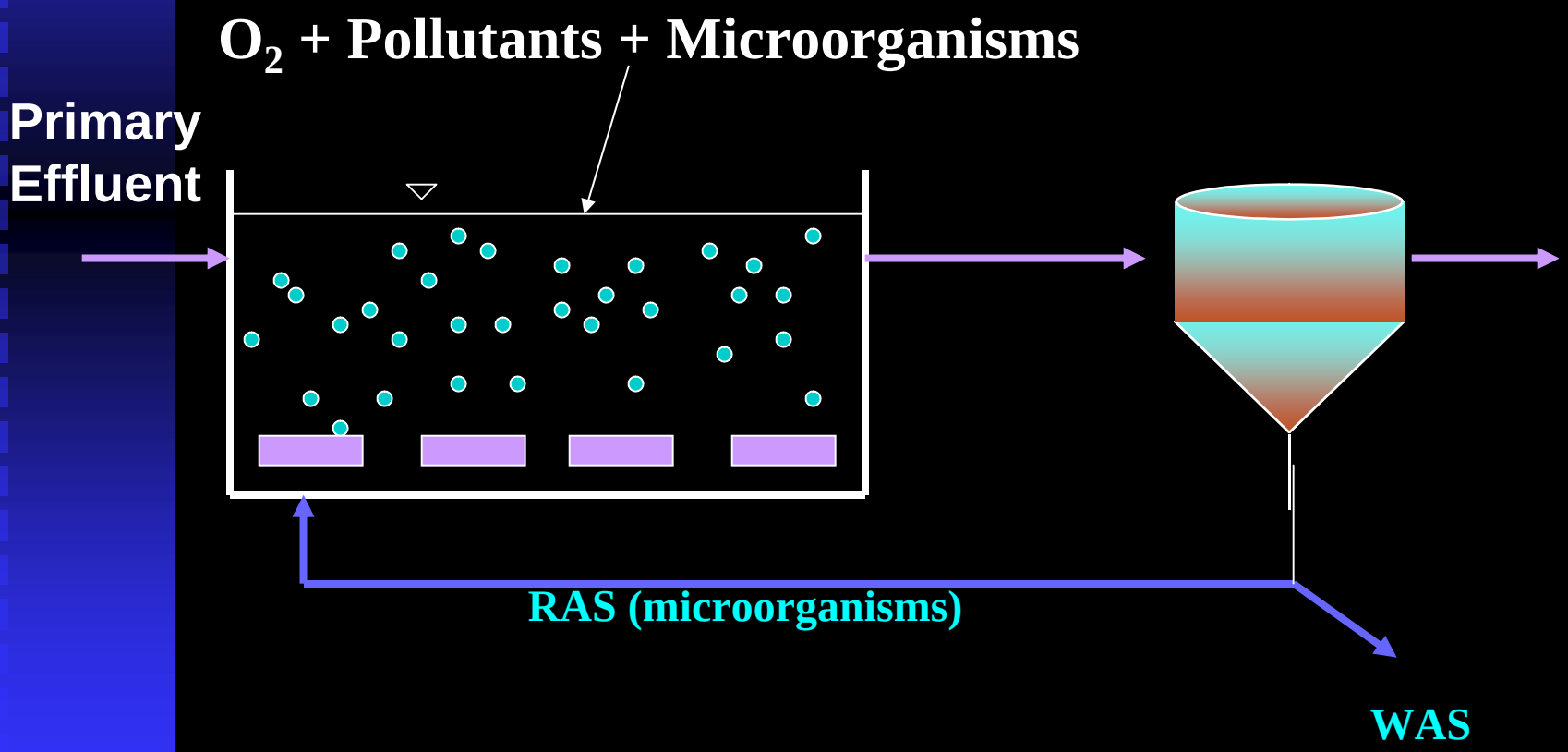
- Review of Theory
  - Nitrification
  - Denitrification
- Characteristics of bioreactors
  - Aerated or Oxic
  - Un-aerated or Anoxic
- Nitrification Optimization
- Denitrification Optimization

- PRACTICAL APPLICATIONS @ WMARSS

Nitrification

- Oxidation of ammonia to nitrite in oxic conditions by nitrosamonas group (Optimum pH 8.0):
  - $2NH_3^+ + 3O_2 \longrightarrow 2H^+ + 2H_2O + 2NO_2^-$
- Oxidation of nitrite by nitrobactor group:
  - $2NO_2^- + O_2 \longrightarrow 2NO_3^-$ (nitrates)
- Oxygen mechanically provided by blowers
- Oxygen Consumption: 4.6 lbs of oxygen per lb of ammonia oxidized to nitrates (energy intensive!)
- Recover Nitrification Cost: **De-nitrification**
- **Nitrobes that Nitrify are facultative (oxic or anoxic). In anoxic they can use NO_3 in lieu of direct O_2 for cellular respiration and denitrify**

Aerated (Oxic) Bioreactor



Denitrification

Using biomass in wastewater as carbon source for bacteria:

$$C_5H_7NO_2 + 4.6\ NO_3^- \longrightarrow 2.8\ N_2 + 5\ CO_2 + 1.2\ H_2O + 4.6\ OH^-$$

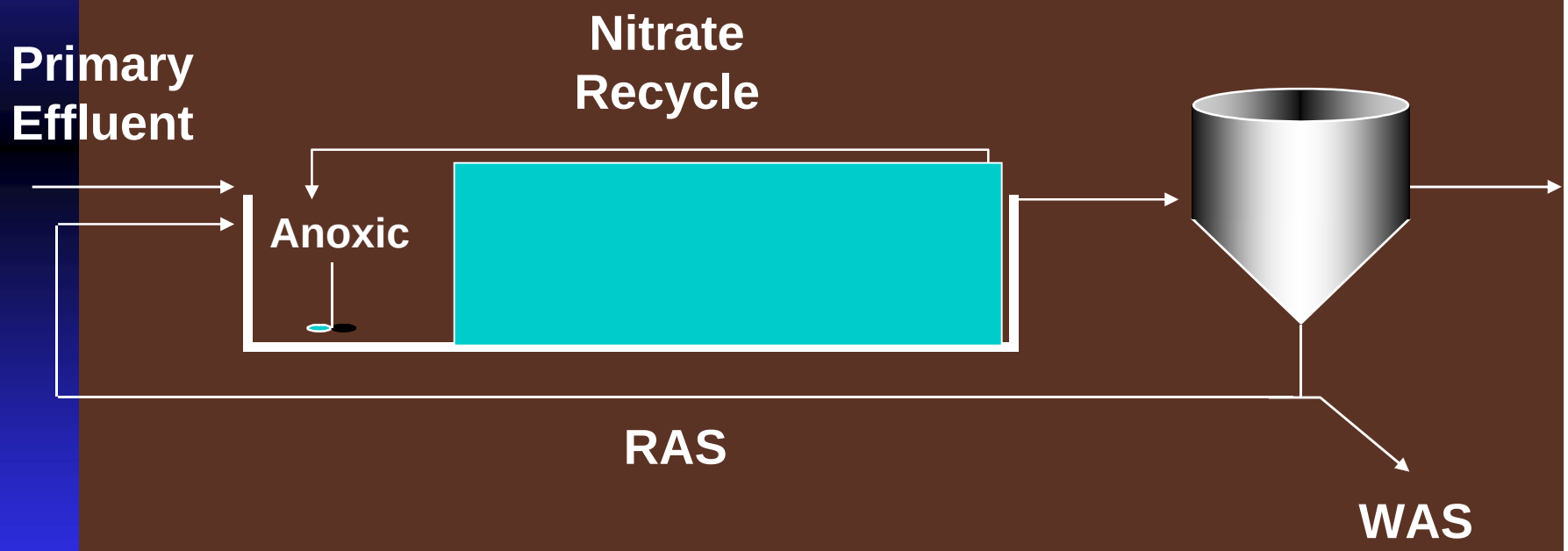
(biomass) (nitrates)

- Because within the anoxic reactor no dissolved oxygen is supplied bacteria strip the oxygen molecule from the nitrates and consume the BOD present.

ADVANTAGES OF DENITRIFICATION

- Nitrate is reduced to nitrogen: $NO_3 \longrightarrow N_2$
- BOD is consumed
- Alkalinity is replenished saving the buffer for subsequent pH sensitive biological reactions

Un-aerated Bioreactor (Anoxic Zone)



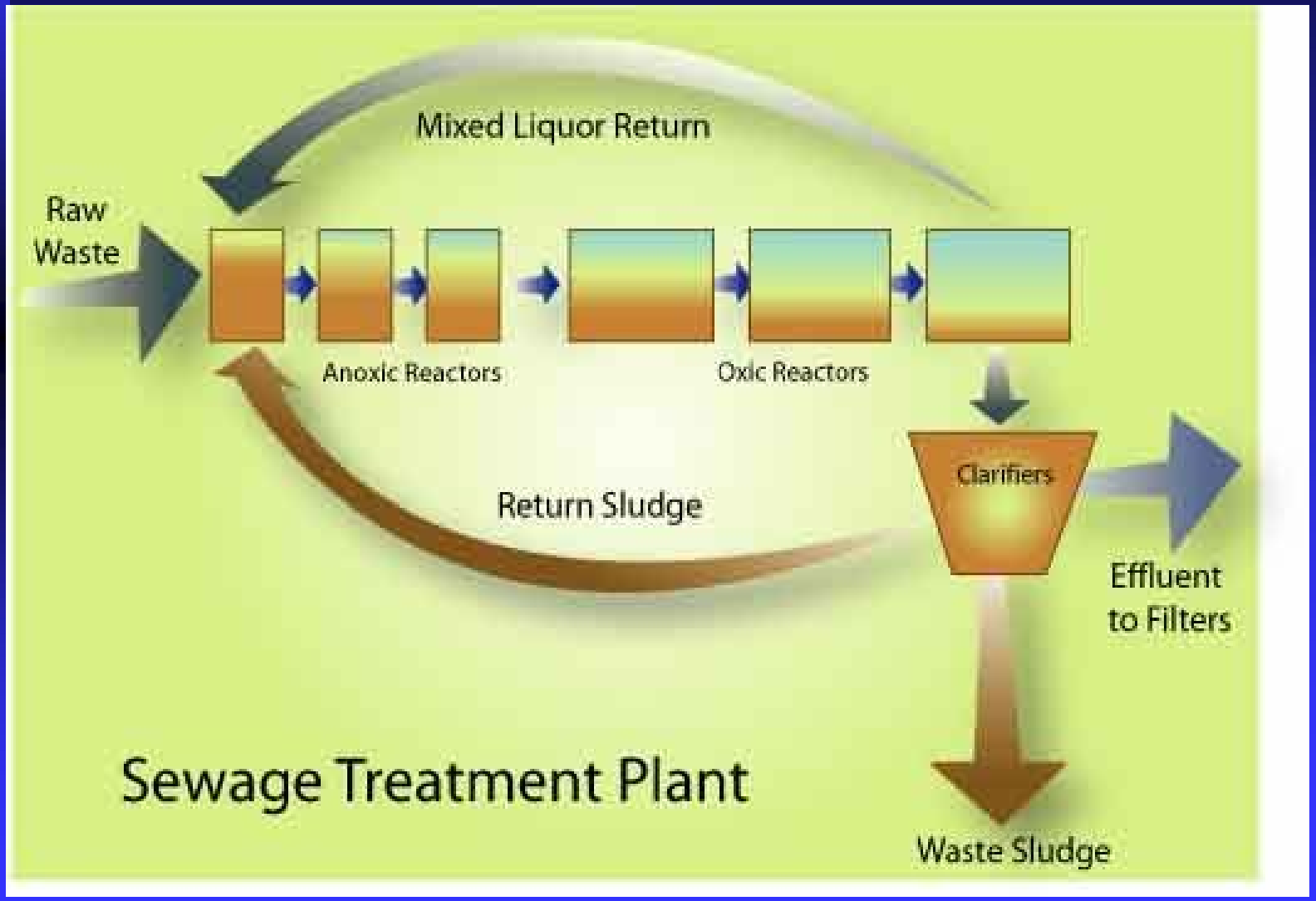
Nitrification Optimization Summary

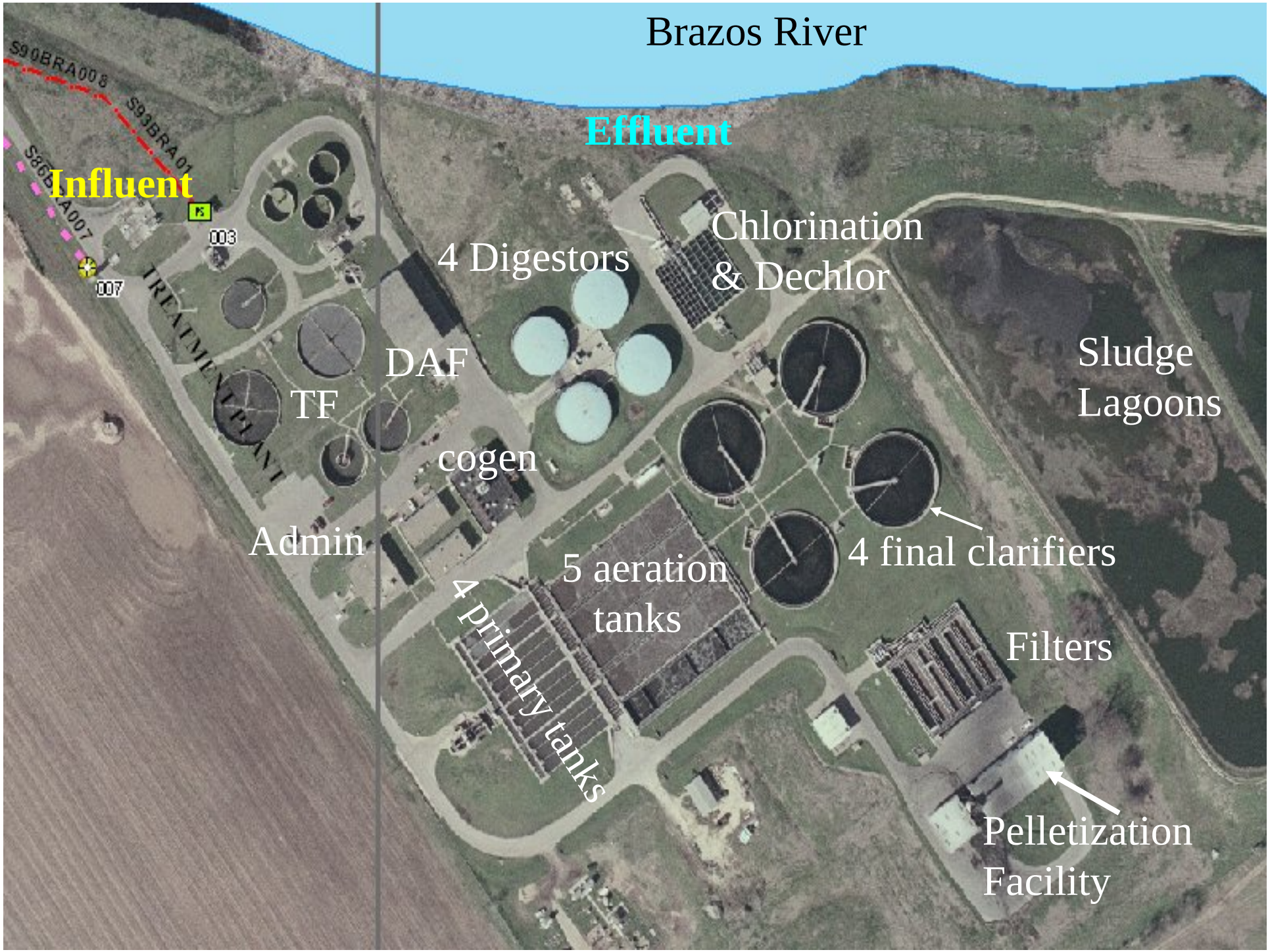
- Test nitrification rate occasionally
- Select appropriate SRT
- Keep DO at min 2 mg/l @ peak conditions
- Keep pH about neutral (optimal 7.5 to 8.5)
- Provide sufficient alkalinity
- Replenish a portion of the alkalinity consumed during the nitrification process by denitrification

Denitrification Optimization Summary

- Minimize DO in anoxic zone (< 0.2 mg/l)
- Maximize recycle capabilities
- Provide sufficient carbon source

Ludzak - Ettinger Process




Brazos River
Effluent
Influent
S90BRA008
S93BRA01
S86BRA007
003
007
TREATMENT PLANT
4 Digestors
Chlorination
& Dechlor
DAF
TF
cogen
Admin
Sludge
Lagoons
4 final clarifiers
5 aeration
tanks
4 primary tanks
Filters
Pelletization
Facility