Information Meeting

Wastewater Master Plan

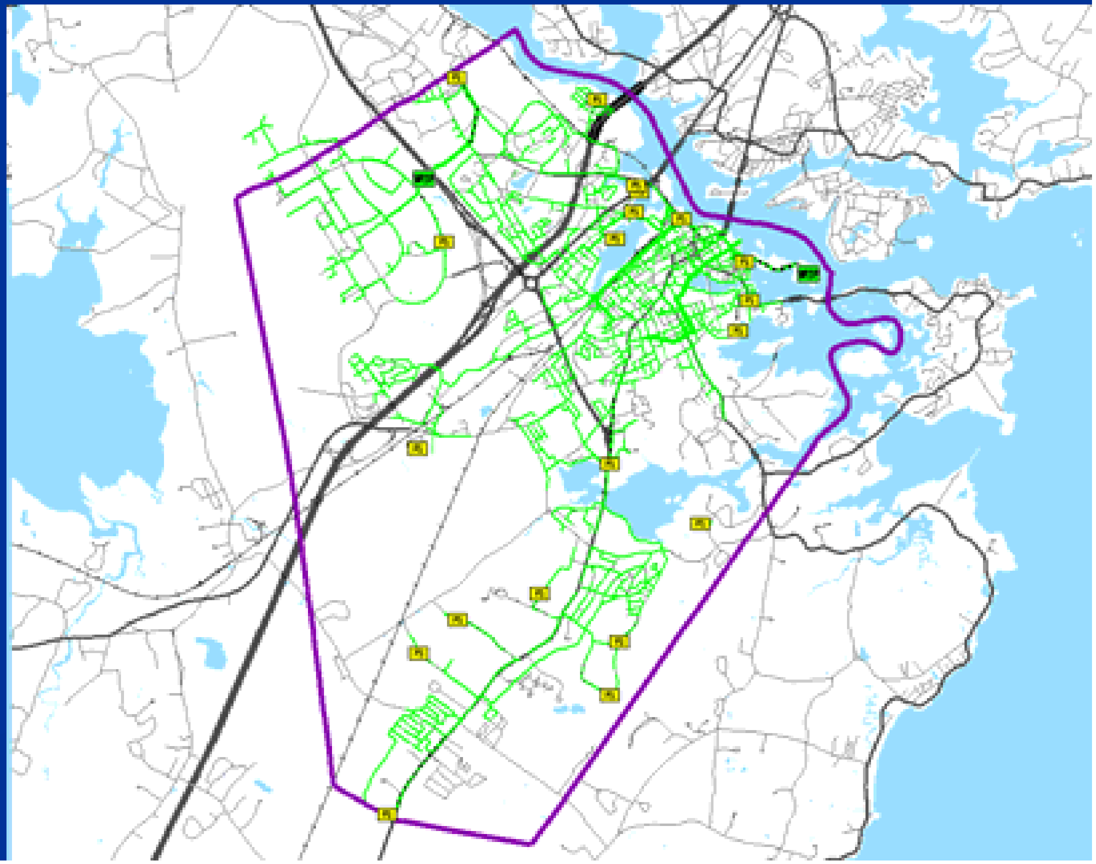
October 22, 2008

Presentation Outline

- Introduction
- Regulatory Framework
- Master Plan Background
- Project Status Update
- Wastewater 202
  - Wastewater Treatment
  - Secondary Treatment Technologies
  - Biosolids Treatment
- Summary and Questions

The Portsmouth Wastewater System

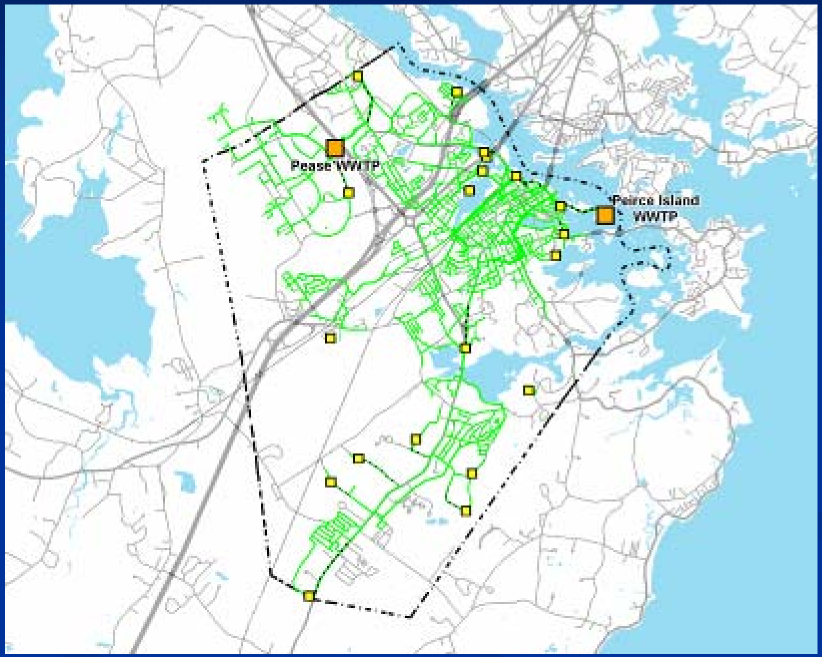
- ~ 115 miles of Collection System Approximately 60% is Combined Stormwater and Sanitary Flow
- 20 pumping Stations
- 3 Permitted Active Combined Sewer Overflows (CSOs)



City's Wastewater History

- 1964 - Peirce Island Primary Treatment Plant
- 1985 - Permit issued w/301(h) waiver
- 2007 NPDES permit issued requiring Secondary Treatment.

Projects Completed Since 1997 (over $25M)



- Peirce Island Bridge Forcemain
- Essex Sheffield Separation
- Thaxter Fells Separation
- Pannaway Manor Separation
- Brickbox Cleaning
- Brackett Road Sewer Extension
- Peirce Island WWTP Improvements
- Mechanic Street Pumping Station Upgrade
- Route One Sewer Improvements
- Upper Court Street (LTCP)
- South Mill Pond Area - Contract 1 (LTCP)

Projects Completed Since 1997 (con't)

- South Street Sewer Separation
- Pease Interceptor Upgrade
- Lafayette Road Pumping Station Upgrade
- SCADA System Upgrade
- Gosling Road Pumping Station Upgrade
- Dennett Street Sewer Separation
- Pleasant Point Sewer Extension
- Lower Court Street (LTCP)
- Deer Street Pumping Station (LTCP)
- Borthwick Avenue Sewer (LTCP)

Projects Concurrent with Master Plan

- Mechanic Street - Completed
- Bartlett Street – Design Completed
- Lincoln Area Contract 3 - Design On-going
- State Street – Design On-going
- Evaluating interim measures to control nitrogen and total suspended solids which can be implemented within the current NPDES Permit cycle – On-going

Permitting and Regulatory Framework

National Pollutant Discharge Elimination System Permits

- NPDES
- EPA issues five year permits with State concurrence
- The Permit regulates what is allowed out of a wastewater treatment plant into the river
- Permit Limits are based on
  - Technical Standards
  - State Issued Water Quality Standards

Regulatory Status

- 1990 Consent Decree
- Current Peirce Island NPDES permit
  - Issued in April 2007 for secondary treatment
- EPA issued Administrative Order August 2007

Future Regulatory Considerations

- EPA is considering a nitrogen limit for the next NPDES permit
- DES to publish estuary nitrogen criteria in December 2008 which will be the basis for new NPDES permit limits
  - Point Source vs Non-point Source
- Design must accommodate nitrogen limits
- Limits may vary depending on final location of outfall

Nutrient Impacts

- Phosphorus and Nitrogen
- Phosphorus is the limiting nutrient in freshwater systems.
- Nitrogen is the limiting nutrient in tidal systems.
- Excess nutrients can lead to Eutrophication
  - Algae blooms deplete oxygen, which can stress marine life.

Future Regulatory Considerations

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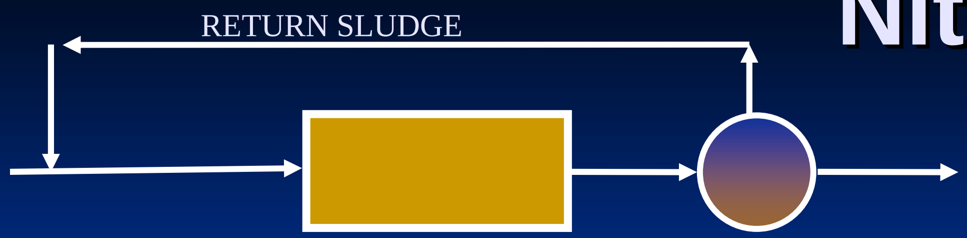
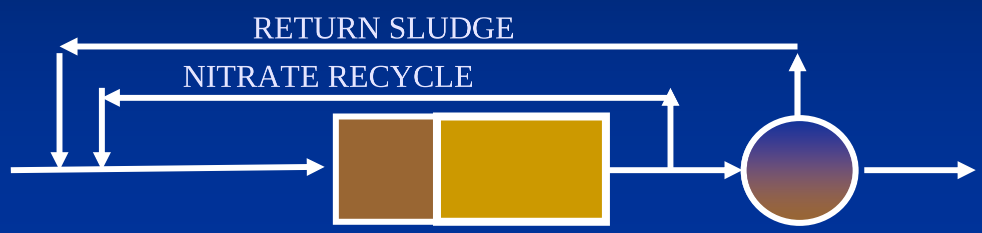
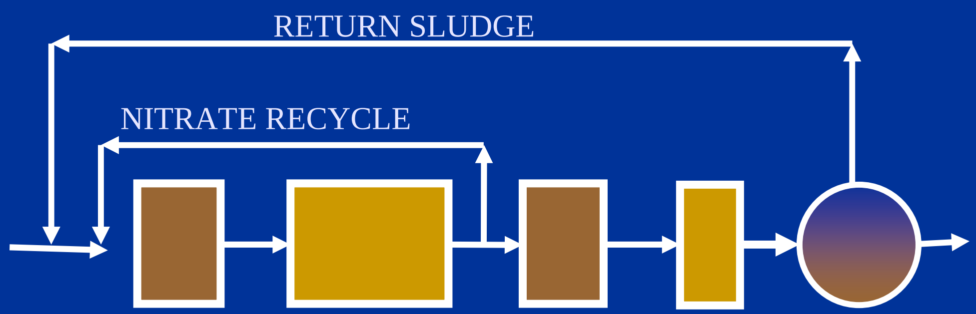
Nitrogen Reduction



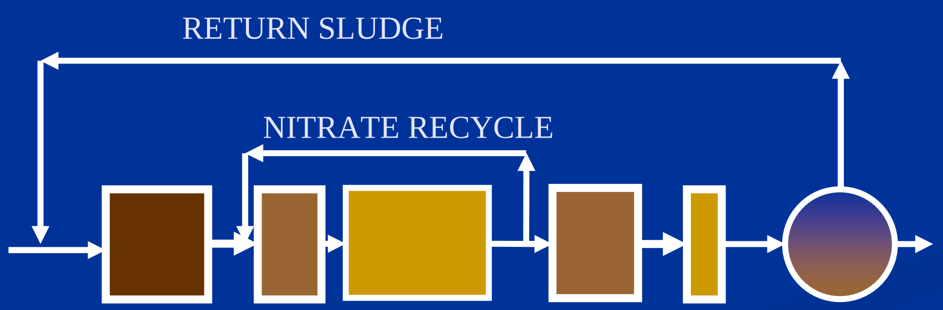
20 -30 mg/L Total Nitrogen



8 -10 mg/L Total Nitrogen



> 5 mg/L Total Nitrogen



> 3 mg/L Total Nitrogen

Permitting Summary

- Current Peirce Island NPDES permit is a standard secondary permit
- Permit does not have nutrient limits
- Nutrient levels in the river are being studied
- The City is working with the regulators and scientific community to assess the level of nutrient removal at a future WWTF
- As part of this wastewater master planning effort the City is including nutrient removal in all design alternatives

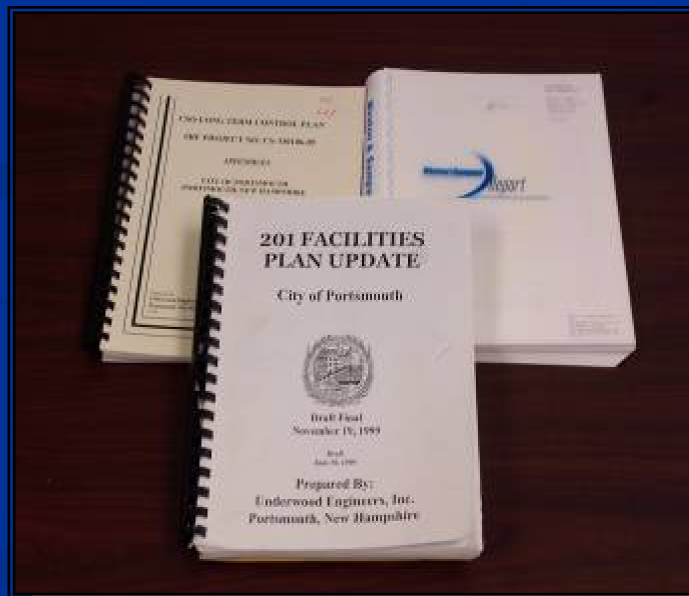
Wastewater Master Plan Components

Collection System
CSO LTCP

Wastewater Treatment Facilities

Master Planning Goal

- Master Planning effort will ensure the selected treatment plant and collection system CSO Long Term Control Plan alternatives are:
  - Sustainable
  - Cost Effective
  - Environmentally Sound
  - Fulfill Regulatory Requirements
  - Fulfill Funding Requirements



Progress To Date

- Scope of work
  - Developed at start of project
  - 14 Tasks
  - Approved by EPA and DES
- Project started in spring of 2007
- Completion in late summer of 2010

WMP Scope of Work

1. Define Study Parameters
2. Regulatory Requirements Review
3. Flow and Load Forecasting
4. Collection System Evaluation
5. Alternatives Evaluation
6. Develop Funding Strategies
7. Develop Implementation Schedule
8. Prepare the WMP Document
9. Update Wastewater Treatment Facilities Plan
10. Update CSO LTCP
11. Develop Public / Regulatory Participation Program
12. Project Management

14. Supplemental Work Plan-Interim Measures

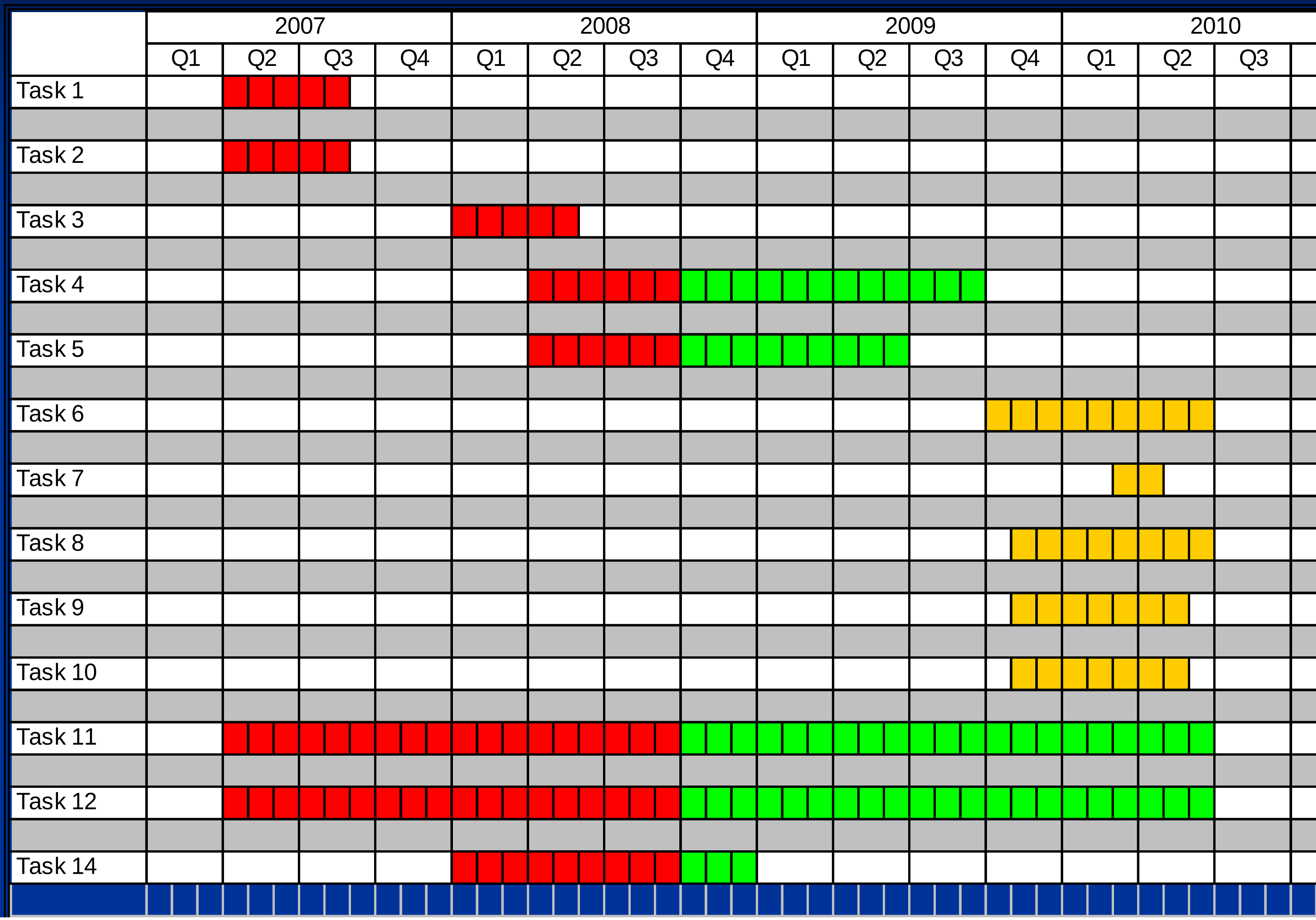
Completed (items 1–3)

On-going (items 4–5)

Future (items 6–10)

On-going (items 11–14)

Project Schedule



Future Wastewater Flows

- Population / Employment
  - Current 20,800 / 28,800
  - Year 2030 24,400 / 35,700
- Wastewater Flows
  - Current Max Month Flow 10 MGD
  - Future Max Month Design Flow 12 MGD (2030)
- Biosolids (sludge) and FOG Generation

Treatment Alternatives Assessment

- Develop WWTF Footprint Requirements
  - Treatment Capacities
  - Treatment Requirements
  - Treatment Technologies
    - Liquid Stream
    - Residuals/Biosolids
    - Fats/Oil/Grease
    - Septage
- Screen Potential Facility Sites

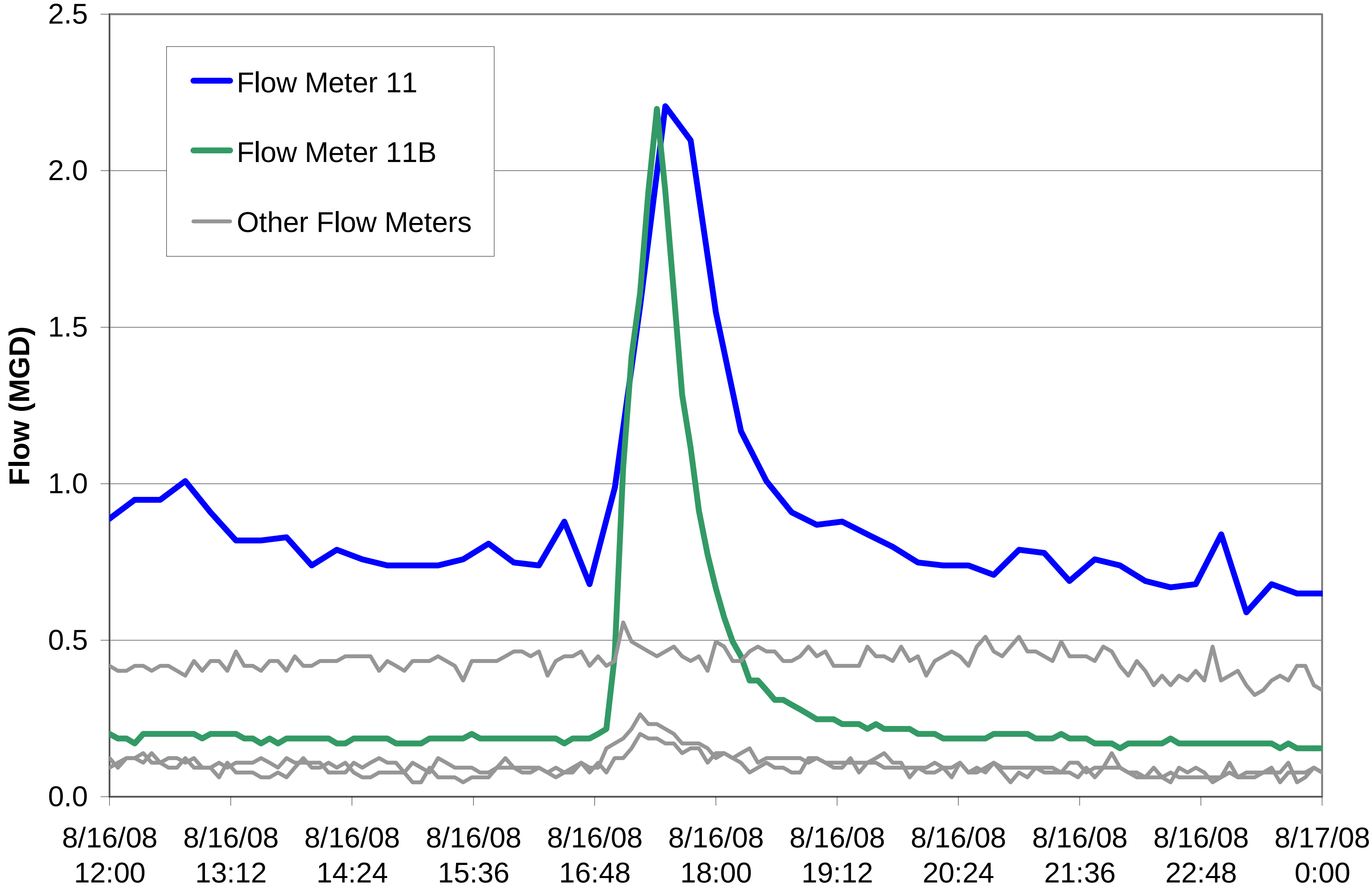
Collection System Evaluations

- Long Term Control Plan (LTCP)
- Determine peak flows within the collection system
  - Size wet weather treatment system(s)
- Evaluate additional separation potential
- Reduction in combined flows will reduce WWTF size

Flow Meter Locations

Flow Metering

Metering Site 11



Potential Plant Alternatives

- Treatment Plant Upgrade Alternatives
  - Expand the Peirce Island plant
  - Expand the Pease plant
  - Construct a new plant at a new location
  - Combination of redirecting flow and plant expansion/upgrade
- Each alternative impacts the collection system CSO LTCP and vice versa

Wastewater 202

Pease WWTF

1.2 MGD

Peirce Island WWTF

4.8 MGD

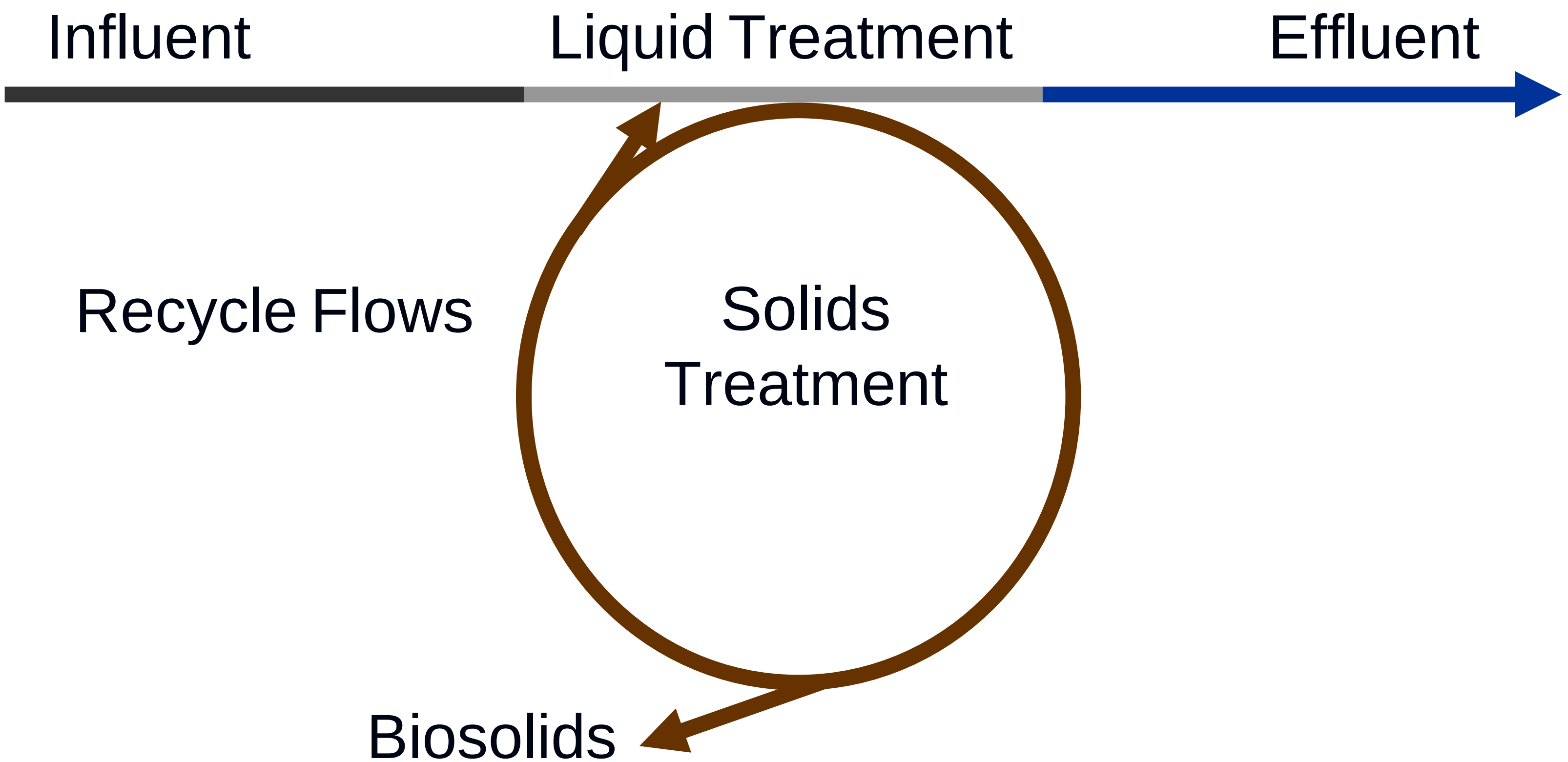
Pollutants of Concern

- Biochemical Oxygen Demand (BOD)
  - Measures the organics in a sample that are biodegradable under aerobic conditions
  - Reduces dissolved oxygen in receiving waters
  - 1 gallon of milk contains 1 lb of BOD
    - Requires 57 cubic feet of air
- Total Suspended Solids (TSS)
  - Visible pollutant
    - NOT dissolved (e.g. sugar)
    - Floaters, sinkers and lurkies
  - Imparts turbidity or color to water
  - Reduces transmission of light waves

More Pollutants of Concern

- pH
  - Changes acid-base balance of receiving water
  - Effluent is typically pH neutral
  - Nutrient reduction processes change pH
    - Chemical addition necessary to balance pH
- Nitrogen
  - Many forms
    - Ammonia
    - Nitrate
    - Nitrite
    - Nitrogen gas

A Manufacturing Facility



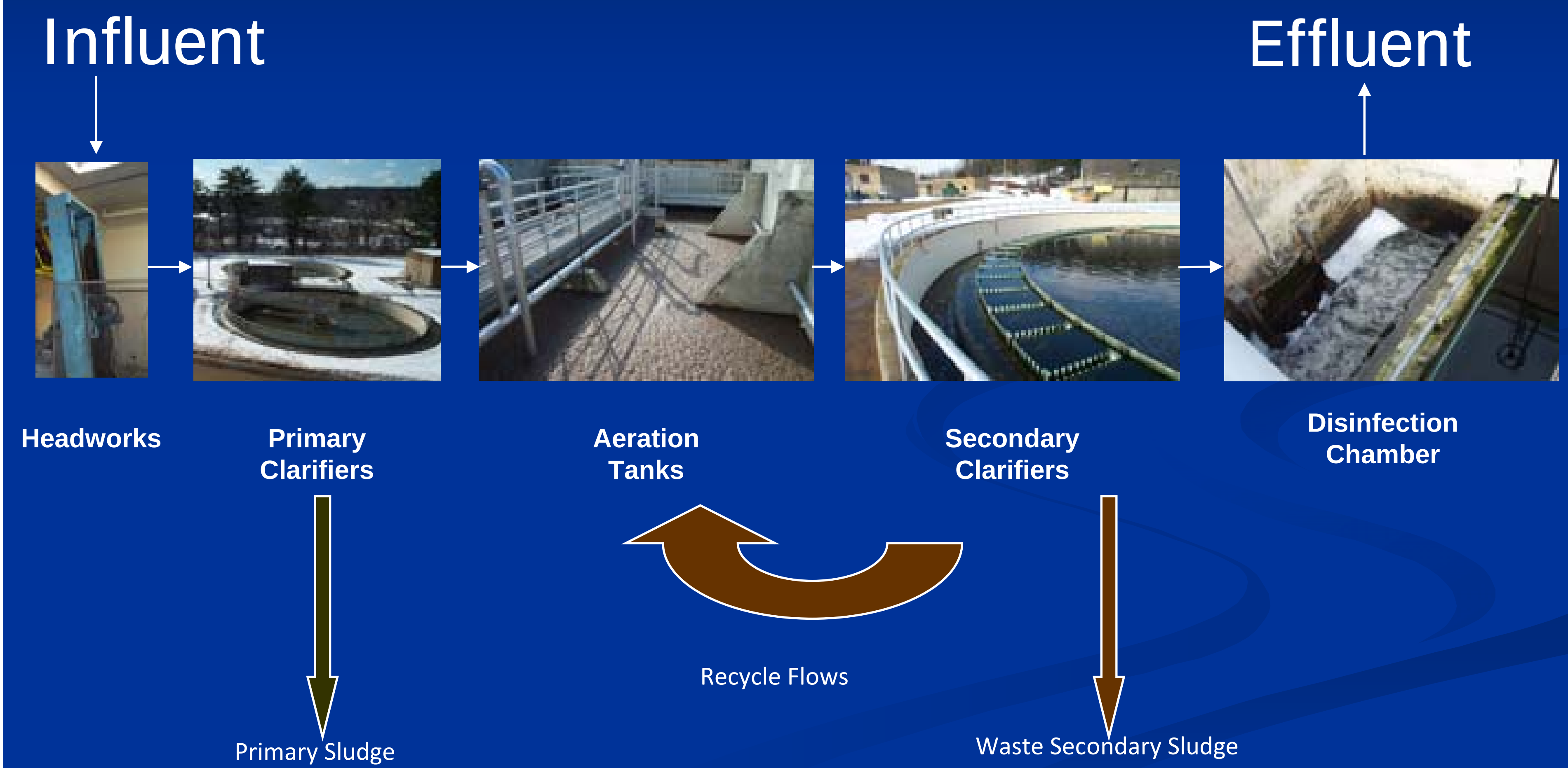
Basics of Wastewater Treatment

- BOD:
  - Aerobic bacteria consume organics
  - Must bring air to wastewater or wastewater to air
- TSS:
  - Non-organic and settlable organic removed in primary treatment
  - Non-settlable organic treated in secondary process (it is BOD)
  - May need to coagulate and filter lurkies

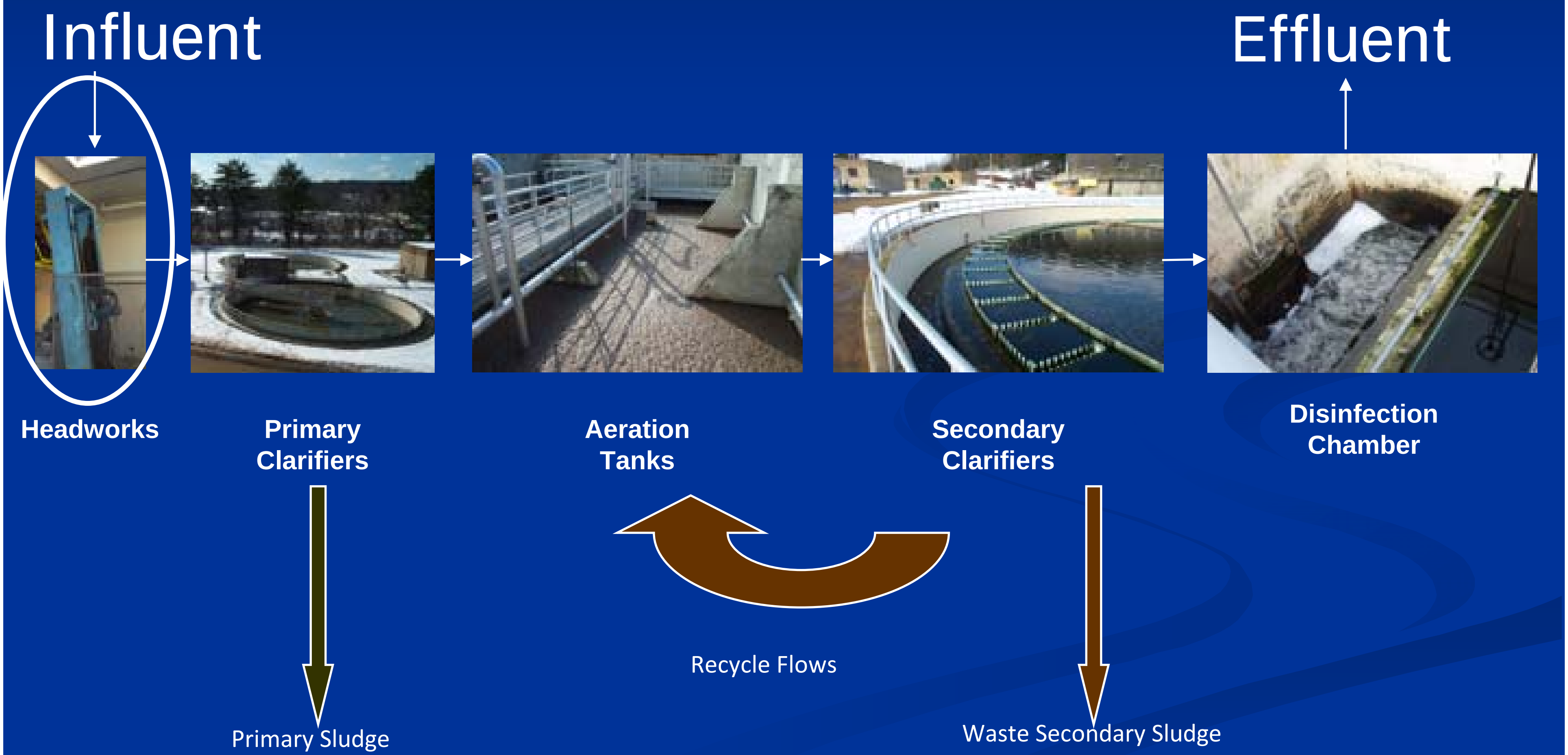
Basics of Wastewater Treatment

- pH
  - Adjust pH with chemical addition
  - Addition of base most common
    - Soda ash
    - Lime
- Nitrogen
  - A biological treatment process
    - BNR = Biological Nutrient Removal
  - Convert ammonia and organic nitrogen to nitrate
    - Must bring air to wastewater or wastewater to air
  - Convert nitrate to nitrogen gas
    - Anoxic conditions required
    - Must be done in process where oxygen is not present

Typical Secondary (BNR) Treatment Unit Processes

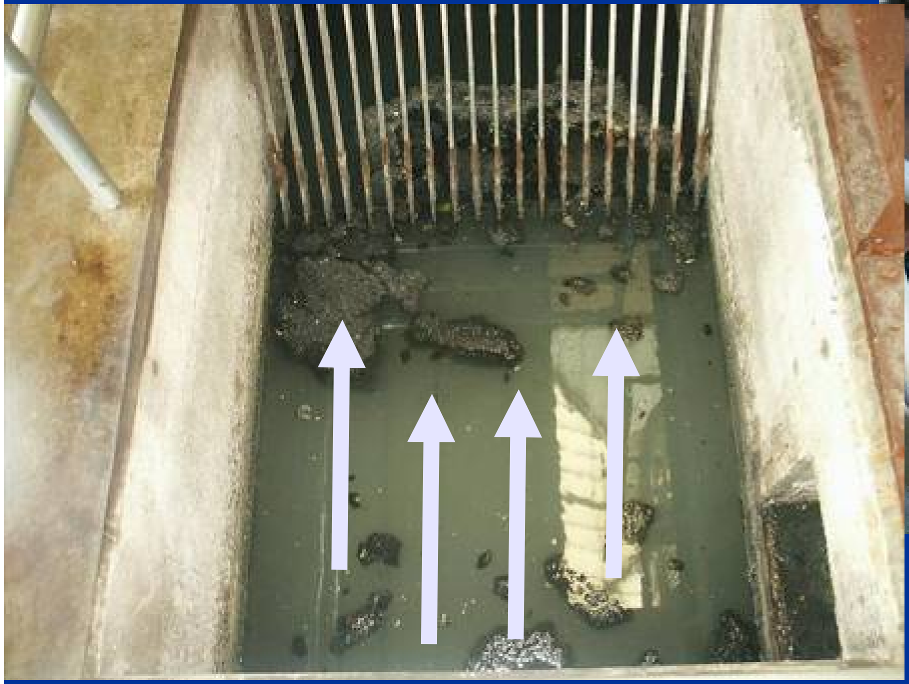


Typical Secondary Treatment Unit Processes



Headworks

- Screen out large solids and remove grit from influent

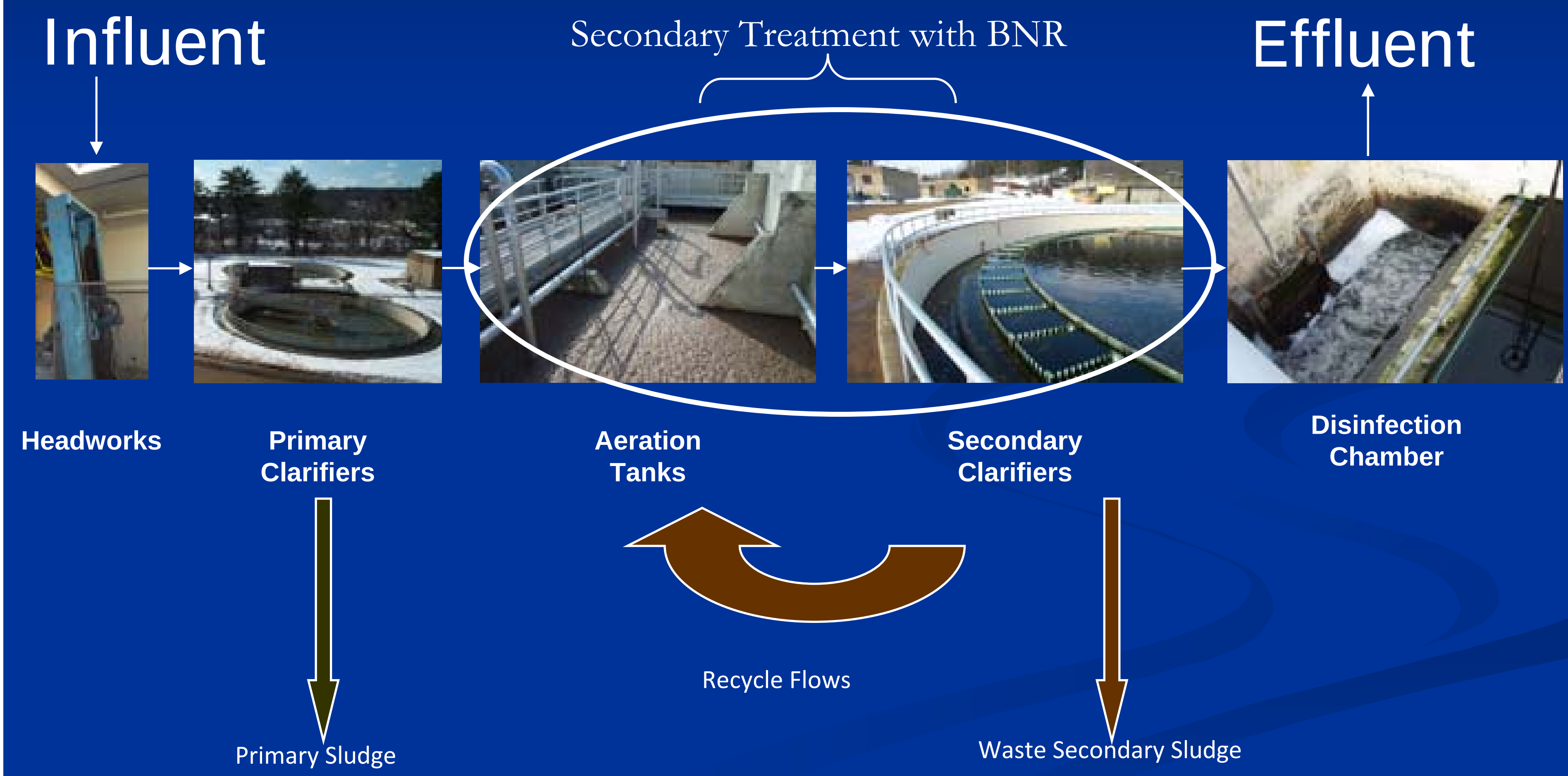


Typical Secondary Treatment Unit Processes

Primary Clarifiers

- Remove settleable solids

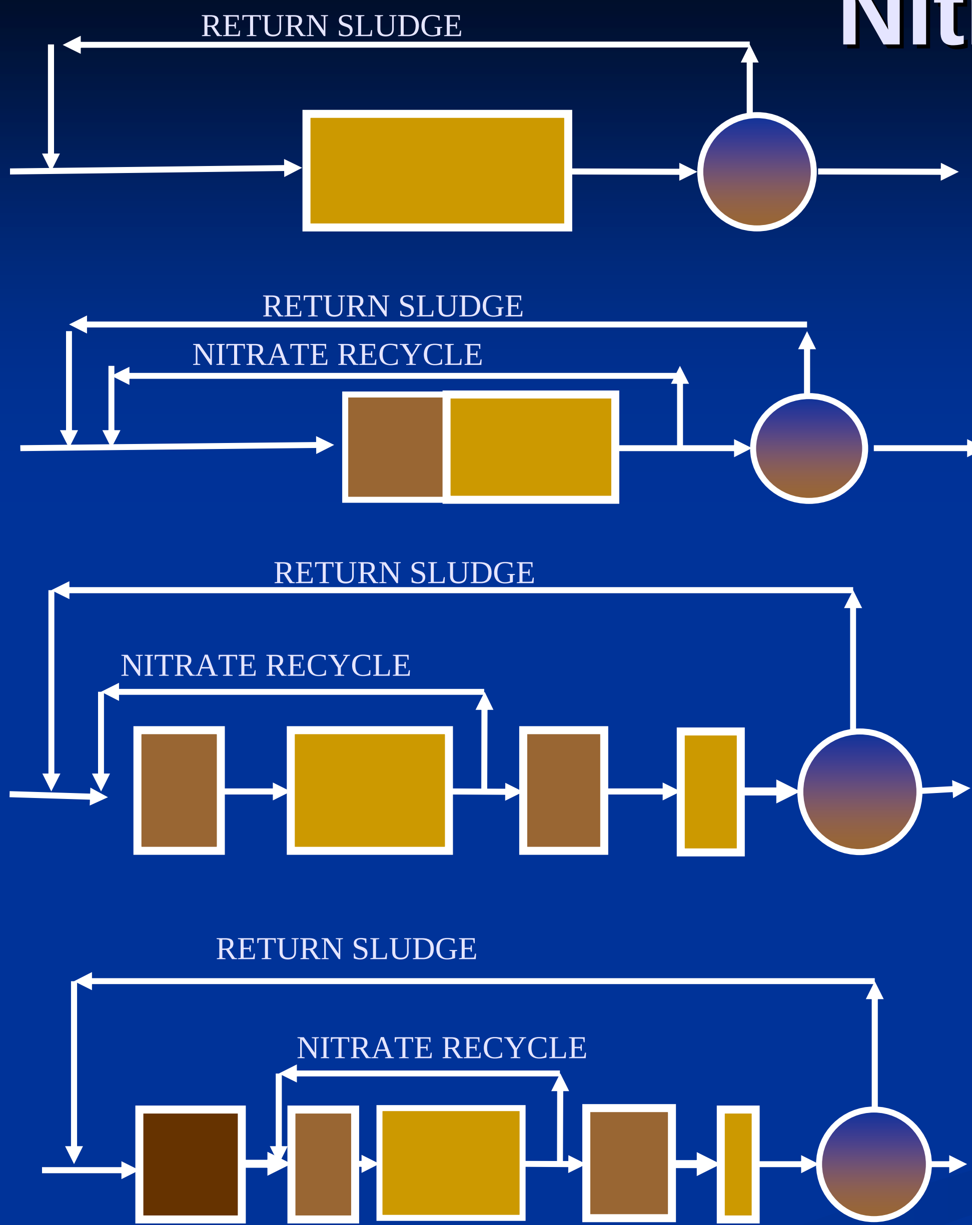
Typical Secondary Treatment Unit Processes



Aeration Tanks

- Secondary treatment is a biological process that converts solids and dissolved material into micro-organisms that are easily separated in a secondary clarifier.
- Compressed air is added in large volumes.
- Air is utilized by bacteria to break down organic waste (i.e. BOD).

Nitrogen Reduction



20 -30 mg/L Total Nitrogen

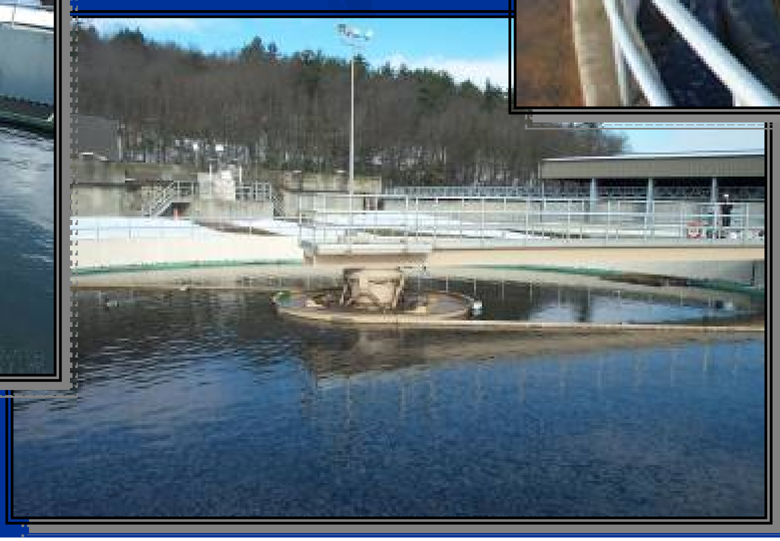
8 -10 mg/L Total Nitrogen

> 5 mg/L Total Nitrogen

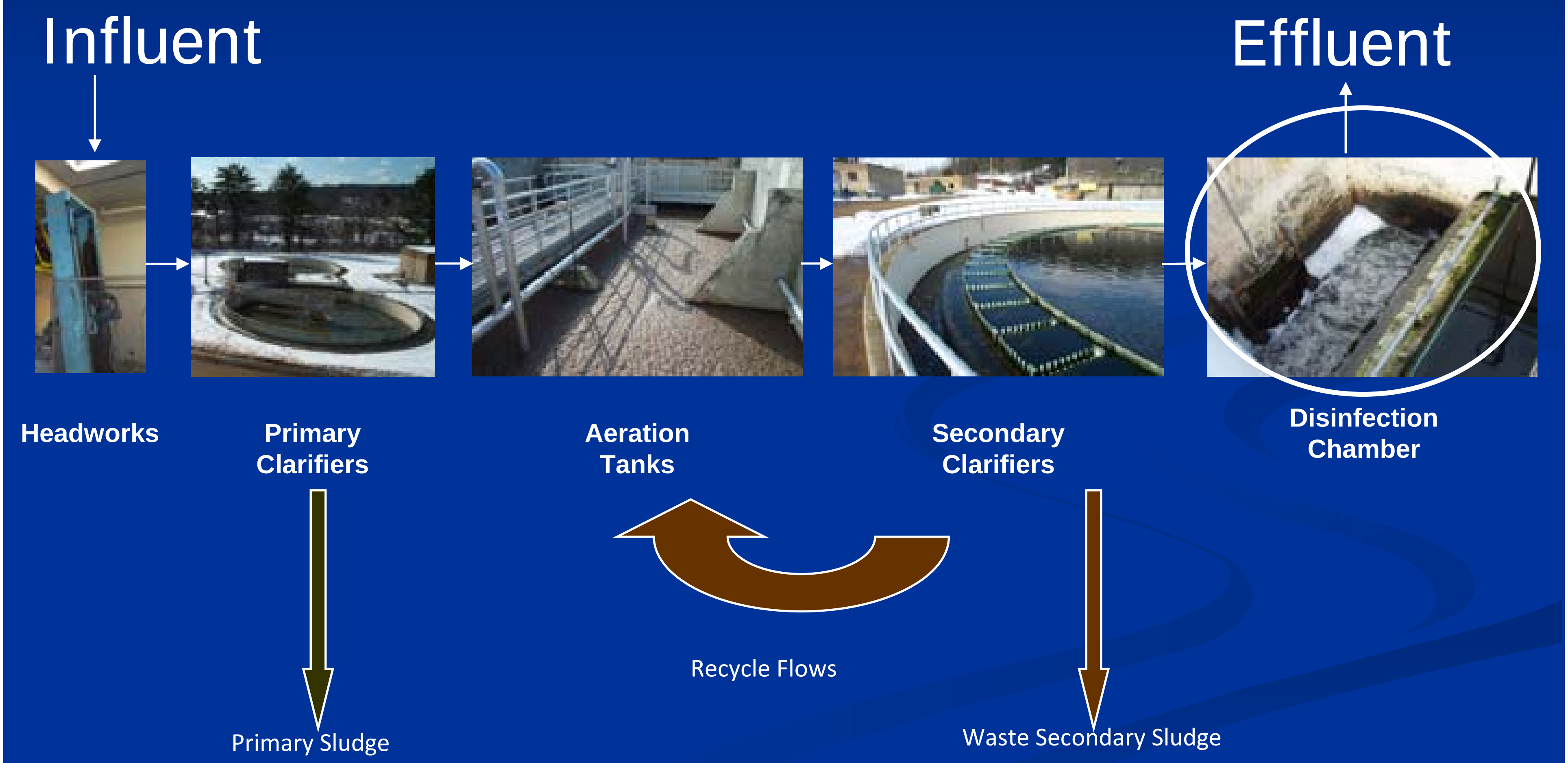
> 3 mg/L Total Nitrogen

Secondary Clarifiers

- Separate solids (micro-organisms) from treated wastewater
- Clear water exits at the top
- Solids exits at the bottom



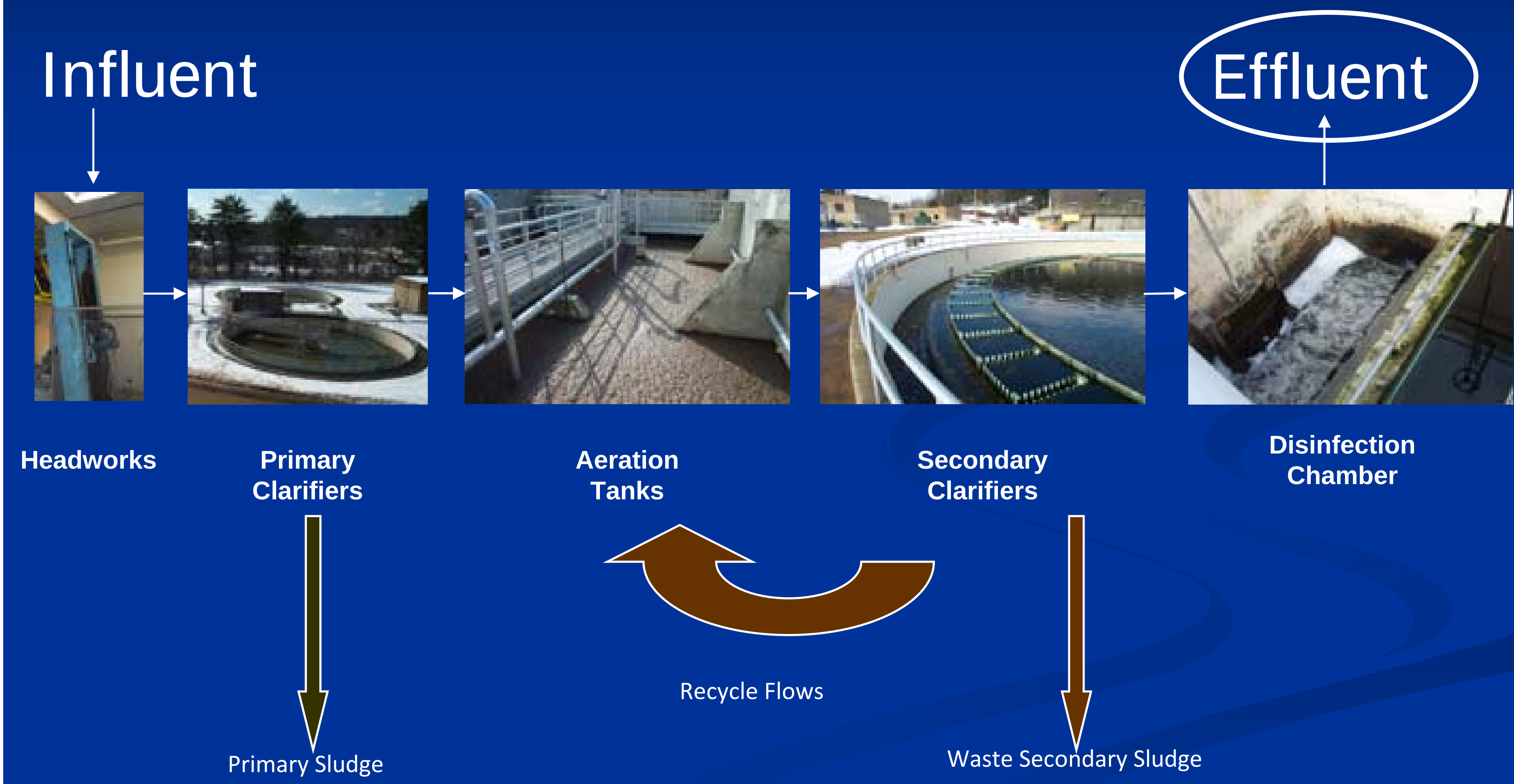
Typical Secondary Treatment Unit Processes



Disinfection Chamber

- Chlorine added to kill bacteria
- Final step prior to discharge to river

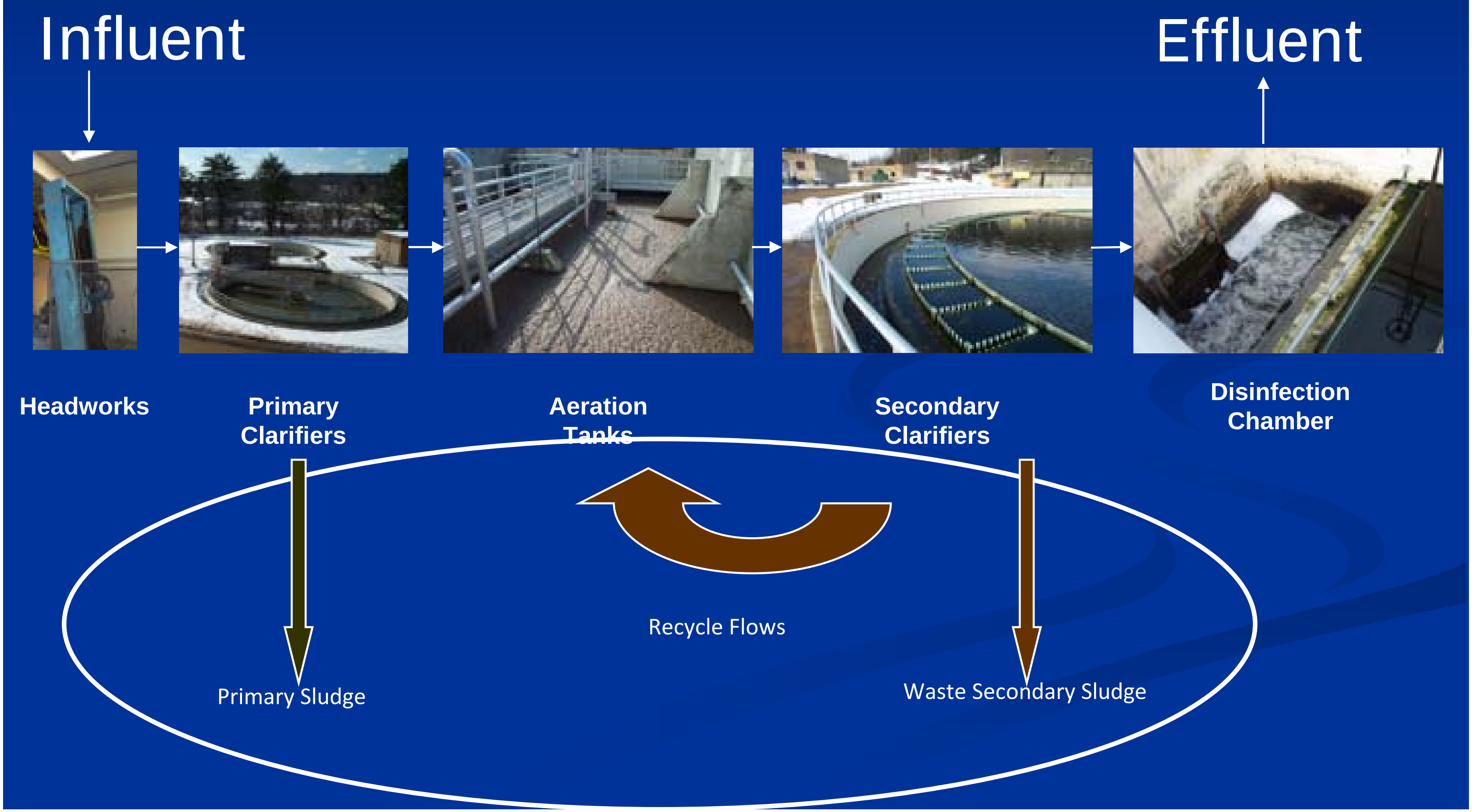
Typical Secondary Treatment Unit Processes



Final Discharge

- Final effluent from disinfection system flows to the receiving waters
- A diffuser under water disperses the final effluent
- Final outfall location may impact treatment limits

Typical Secondary Treatment Unit Processes



Recycle and Waste Flows

- Primary and secondary sludges are produced in the treatment process
- The greater level of treatment, the more sludge produced.
- Lifecycle costs are impacted by sludge production

What Are Sludges and Biosolids?

- Primary sludge
  - Solids settled in the primary clarifiers
- Secondary sludge
  - Excess micro-organisms settled in the secondary clarifiers
  - WAS
- Tertiary sludge
  - Typically chemical sludge (coagulants)
- Biosolids are sludges that have been stabilized

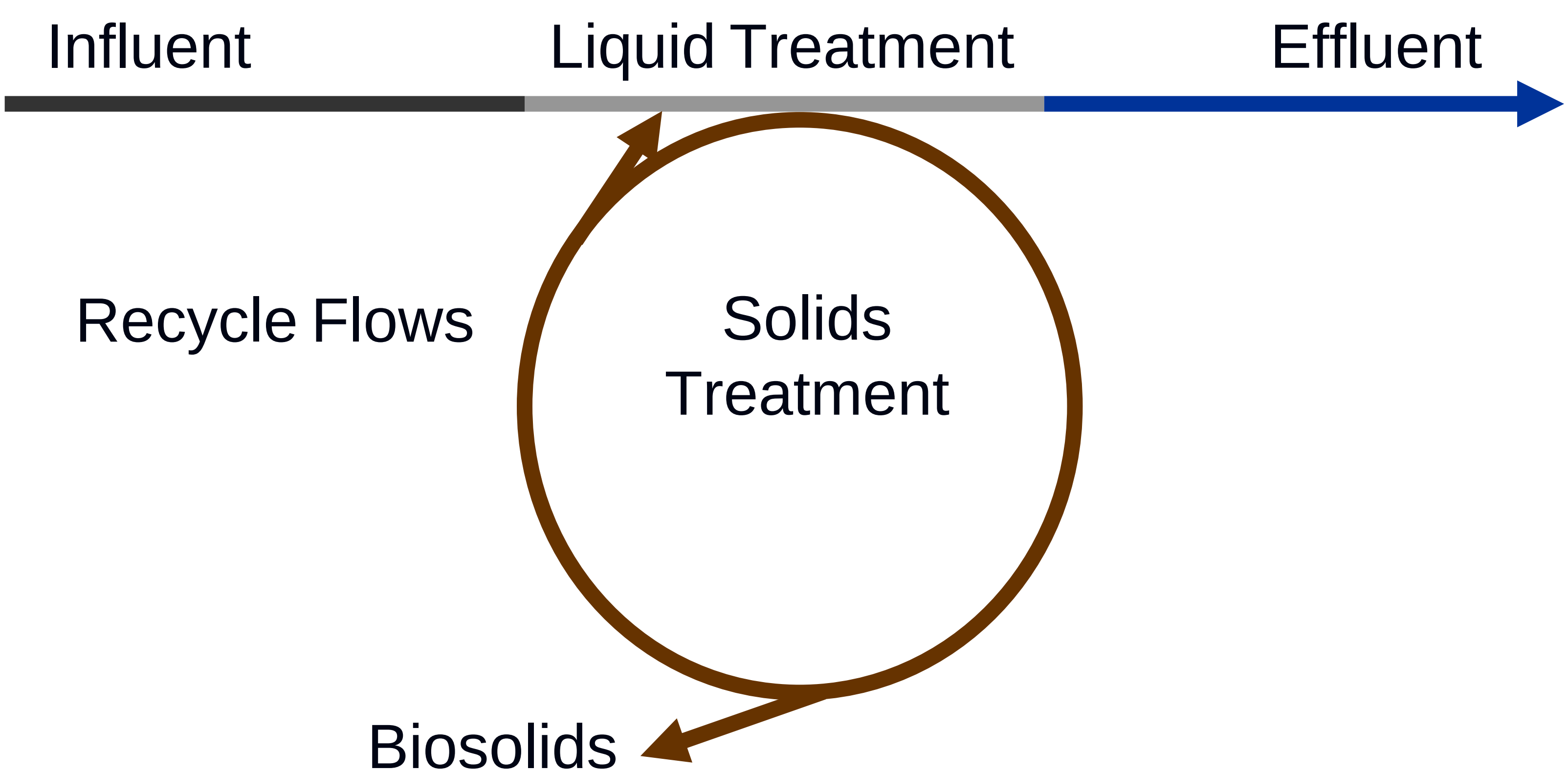
Biosolids Disposal/Reuse

- Disposal Options:
  - Land Apply
  - Landfill
- Reuse Options:
  - Land Apply
  - Fertilizer production
  - Combustion for renewable energy
- Disposal is regulated by EPA and DES

Break for Questions

Treatment Technologies

A Manufacturing Facility



Quick Recap

- Basis for design of WWTF
  - Regulator requirements set stage for NPDES permit
  - Flows and loads defined
- Basics of wastewater treatment
- Liquid stream technologies
- Solid stream technologies
- Discuss how treatment process is selected

Secondary (BNR) Treatment Technologies

- Activated Sludge/Suspended Growth
- Fixed Film/Hybrid
- Emerging Technologies

Nitrogen removal is considered for each of these technologies.

Activated Sludge/Suspended Growth

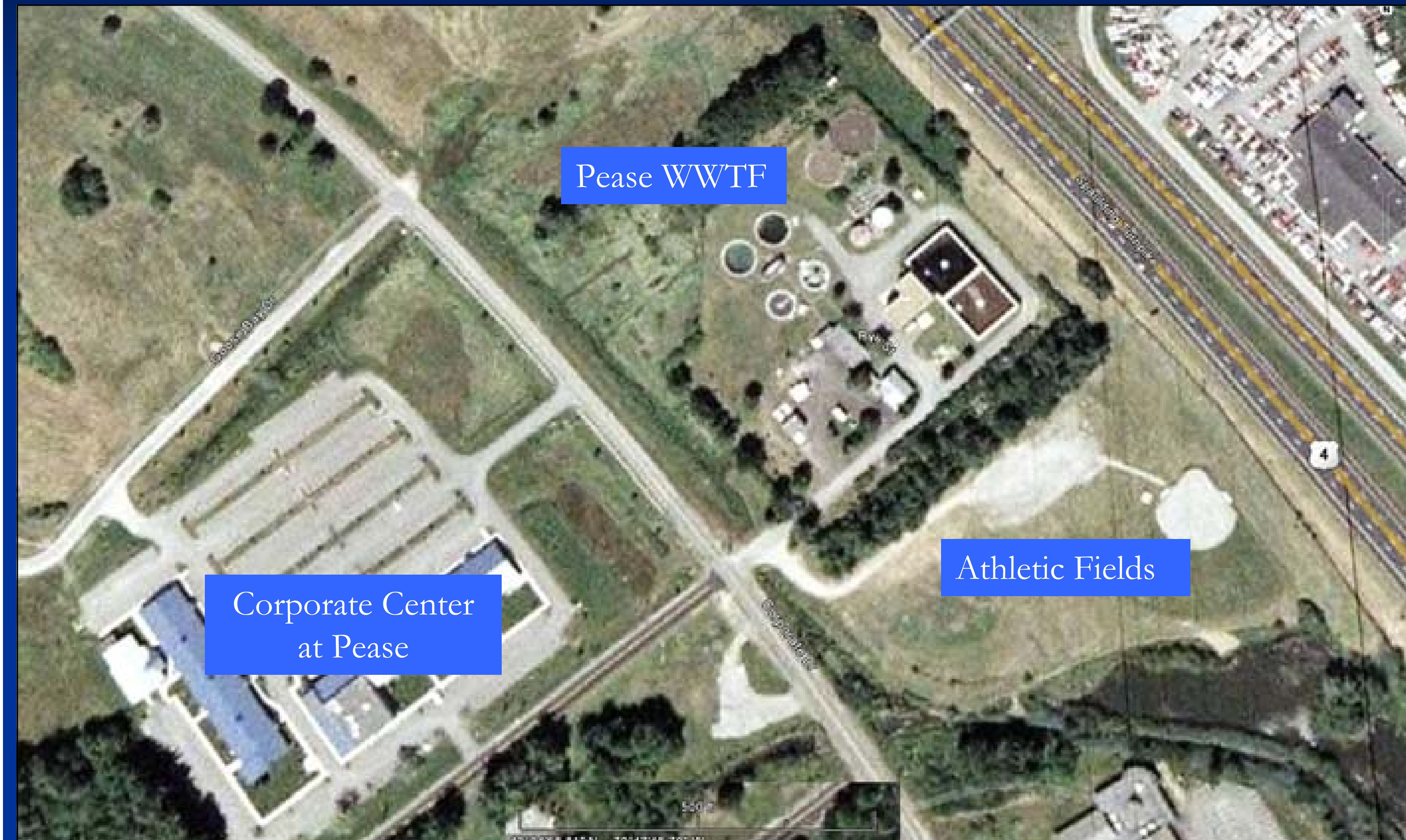
- Pease WWTF
- Mechanical air pumps (“blowers”) add dissolved oxygen to support biological growth.
- Different bacteria perform different tasks:
  - Reduce BOD
  - Transform nitrogen
  - Remove nitrogen

Activated Sludge/Suspended Growth

- Design considerations:
  - Temperature of water
  - Detention time
  - D.O. level
  - Organic loading
  - pH
- Anoxic zones (low D.O.) support biological growth for denitrifying organisms.
  - Final step in nitrogen reduction
- High energy consumption, but can have small footprint.

Activated Sludge/Suspended Growth

Pease Wastewater Treatment Facility



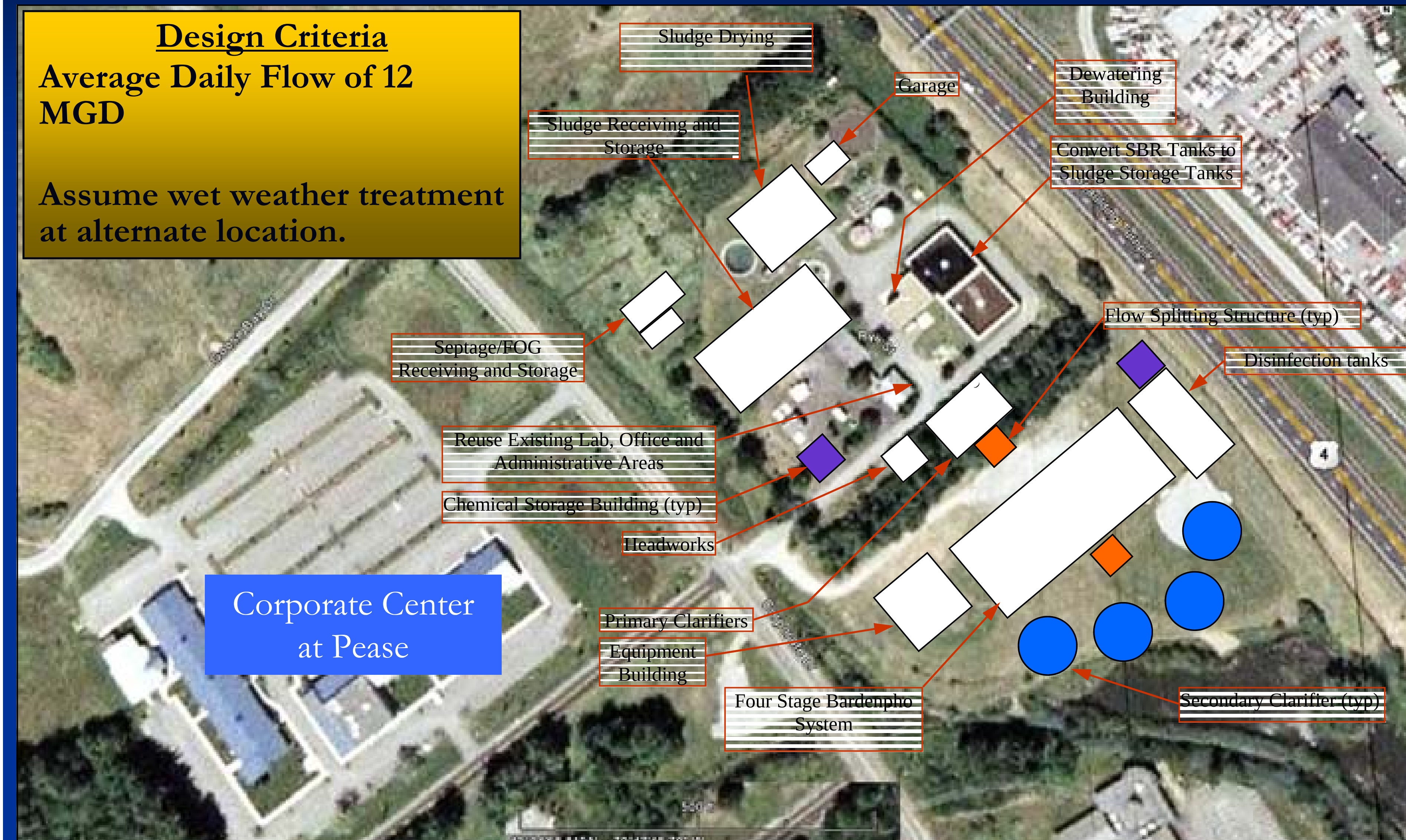
Modifications to Pease for 12 mgd WWTF

Modifications to Pease for 12 mgd WWTF

Design Criteria

Average Daily Flow of 12 MGD

Assume wet weather treatment at alternate location.



Peirce Island WWTF

Unbuildable Areas at Peirce Island

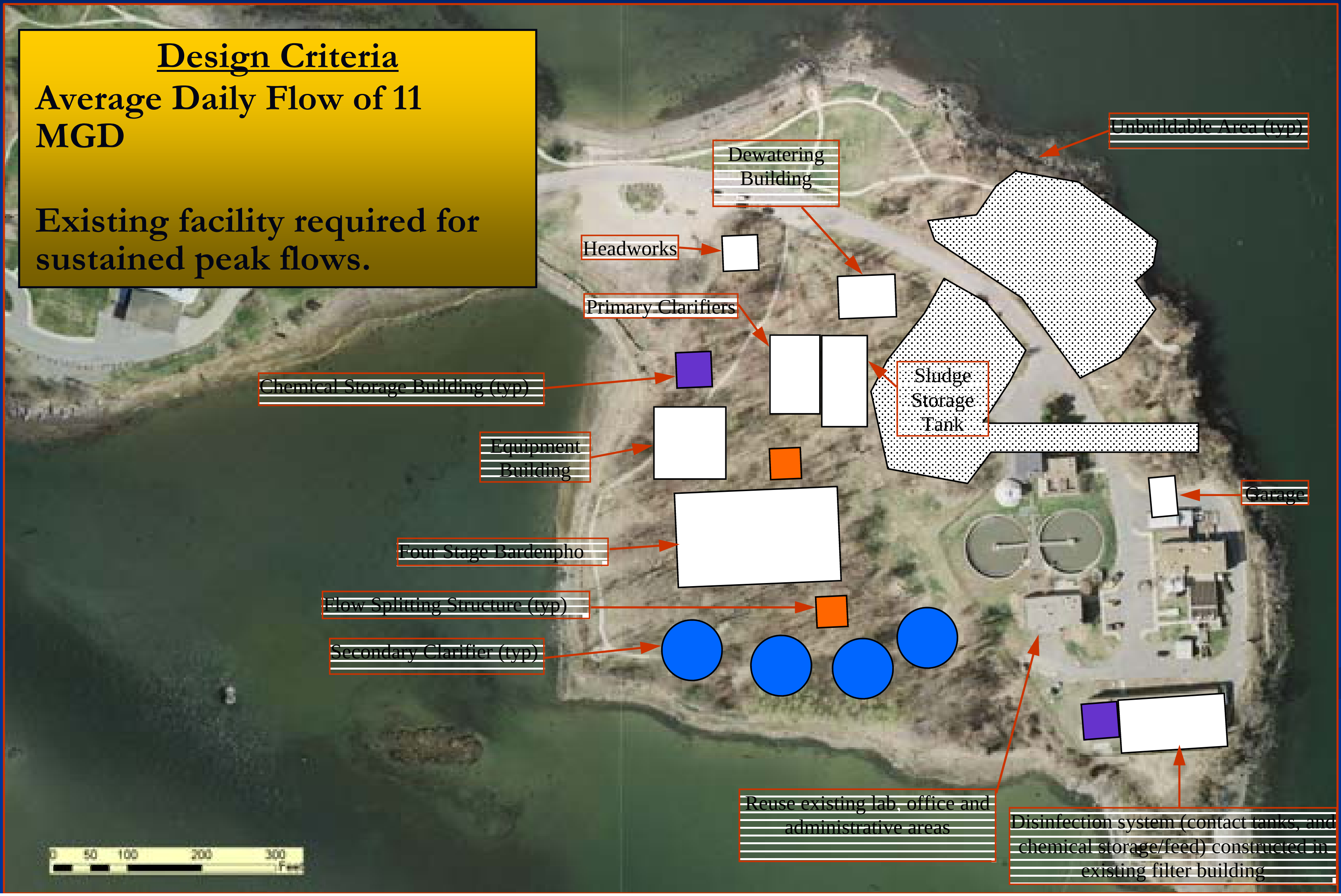
11 MGD WWTF at Peirce Island

11 MGD WWTF at Peirce Island

Design Criteria

Average Daily Flow of 11 MGD

Existing facility required for sustained peak flows.



Fixed Growth/Hybrid Processes

- Combination fixed growth and solids contact system.
- Fixed growth uses support media to for micro-organisms to growth
- Solids contact = active sludge process
- Different processes perform different tasks:
  - Reduce BOD – Fixed Growth
  - Reduce nitrogen – Solids Contact

Fixed Growth/Hybrid Processes

- Design considerations:
  - Temperature of water
  - Detention time
  - D.O. level
  - Organic loading
  - pH
- Denitrification filter may be required
- Fixed growth is low energy but large footprint

Fixed Growth/Hybrid Processes

Typical Processes

- Biological Aerated Filter (BAF) w/Denitrifying Filter
- Aerated Rotating Biological Contactors (RBC)
- Trickling Filter/Solids Contact (TF/SC)
- Integrated Fixed-Film Activated Sludge (IFFAS)
- Moving Bed Biological Reactor

TF/SC/NTF/Denite Filter

Littleton/Englewood, CO WWTP

Nitrifying TFs

CBOD TFs

Solids Contact Tanks

Emerging Technologies

- Many different categories:
  - Household appliance (composting toilet)
  - Neighborhood treatment systems (decentralized)
  - Small (< 1 mgd) treatment facilities
- Typical system status
  - Trial
  - Small scale implementation
- City met with EPA, DES and non-governmental groups to discuss treatment options

Emerging Technologies

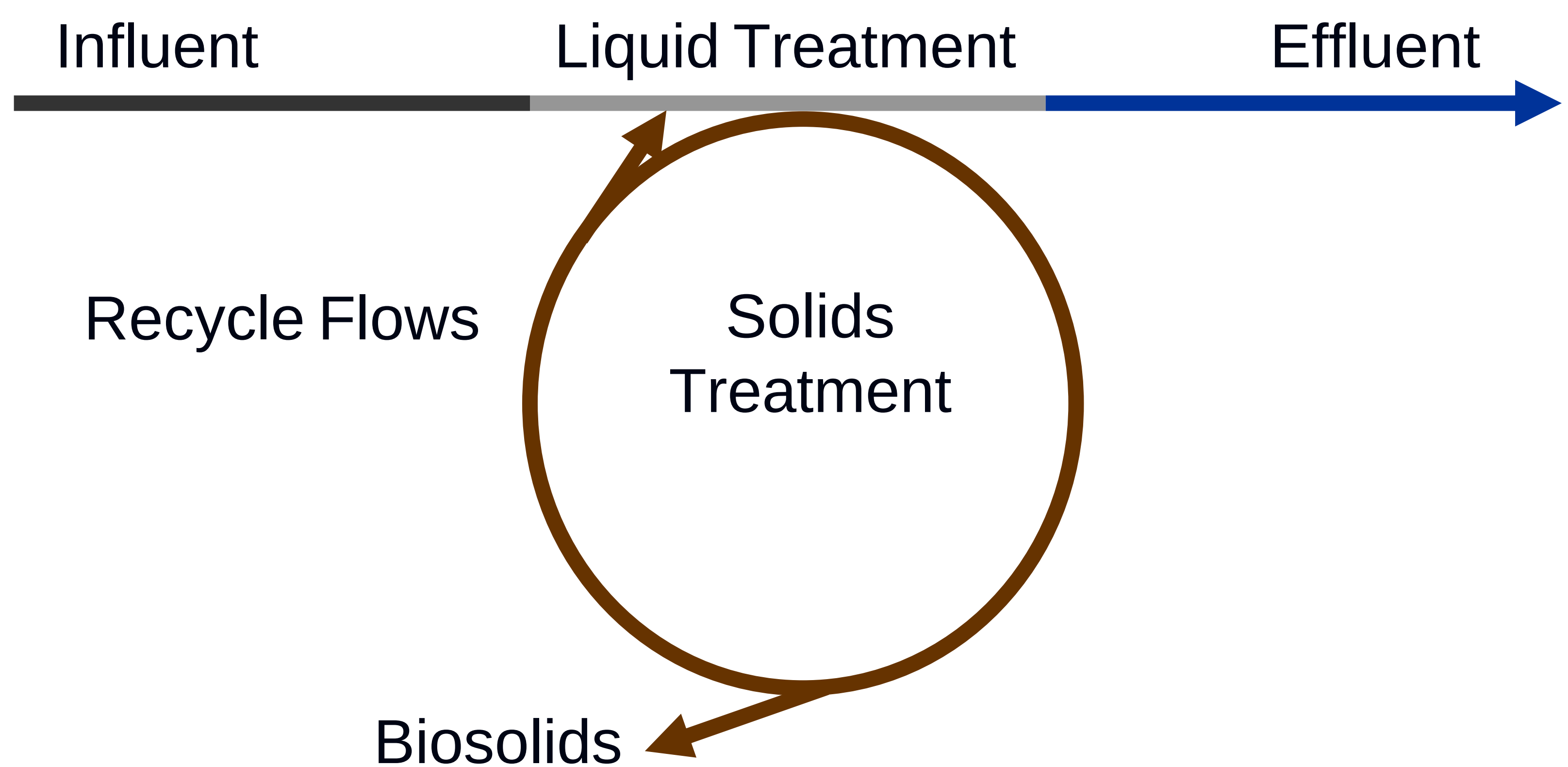
- Bio-Shelter
- Decentralized treatment systems
- Composting toilets
- Incinerating toilets
- Segregated waste streams
- BioMag treatment process
- Micromedia filtration
- Bio-augmentation

Emerging Technologies

- Design Considerations:
  - System flow
  - Ability to permit
  - Track record
  - Public acceptance
  - Cost to implement

Biosolids Technologies

A Manufacturing Facility



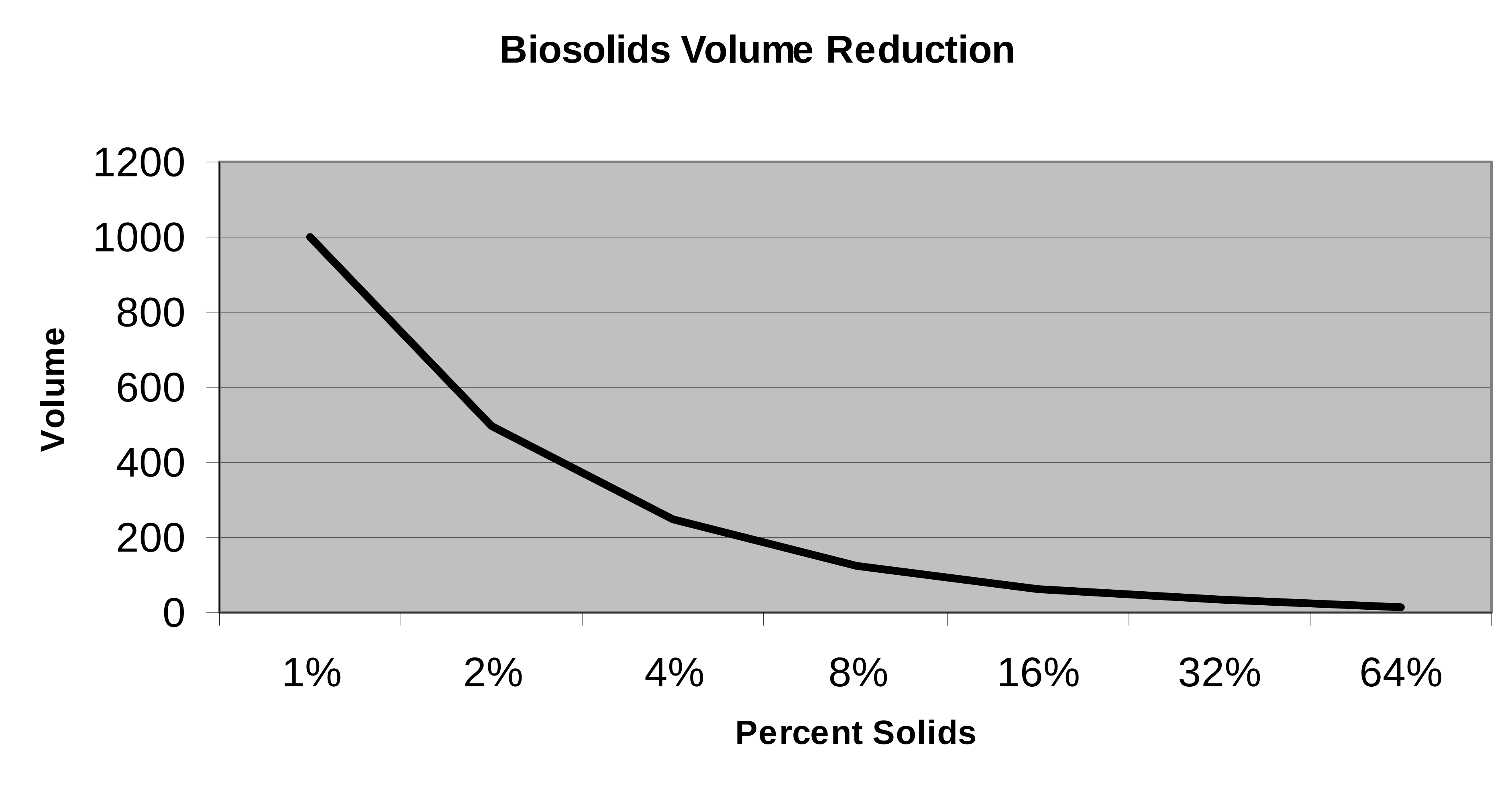
Importance of Biosolids Treatment

- Biosolids treatment and disposal are 50% - 60% of WWTF operating costs
- Disposal options are becoming more and more limited
- Type of wastewater treatment process impacts biosolids quantity and quality
- Treatment options must be flexible to meet changing regulations and market availability
- Management of nutrients (N) in recycle streams

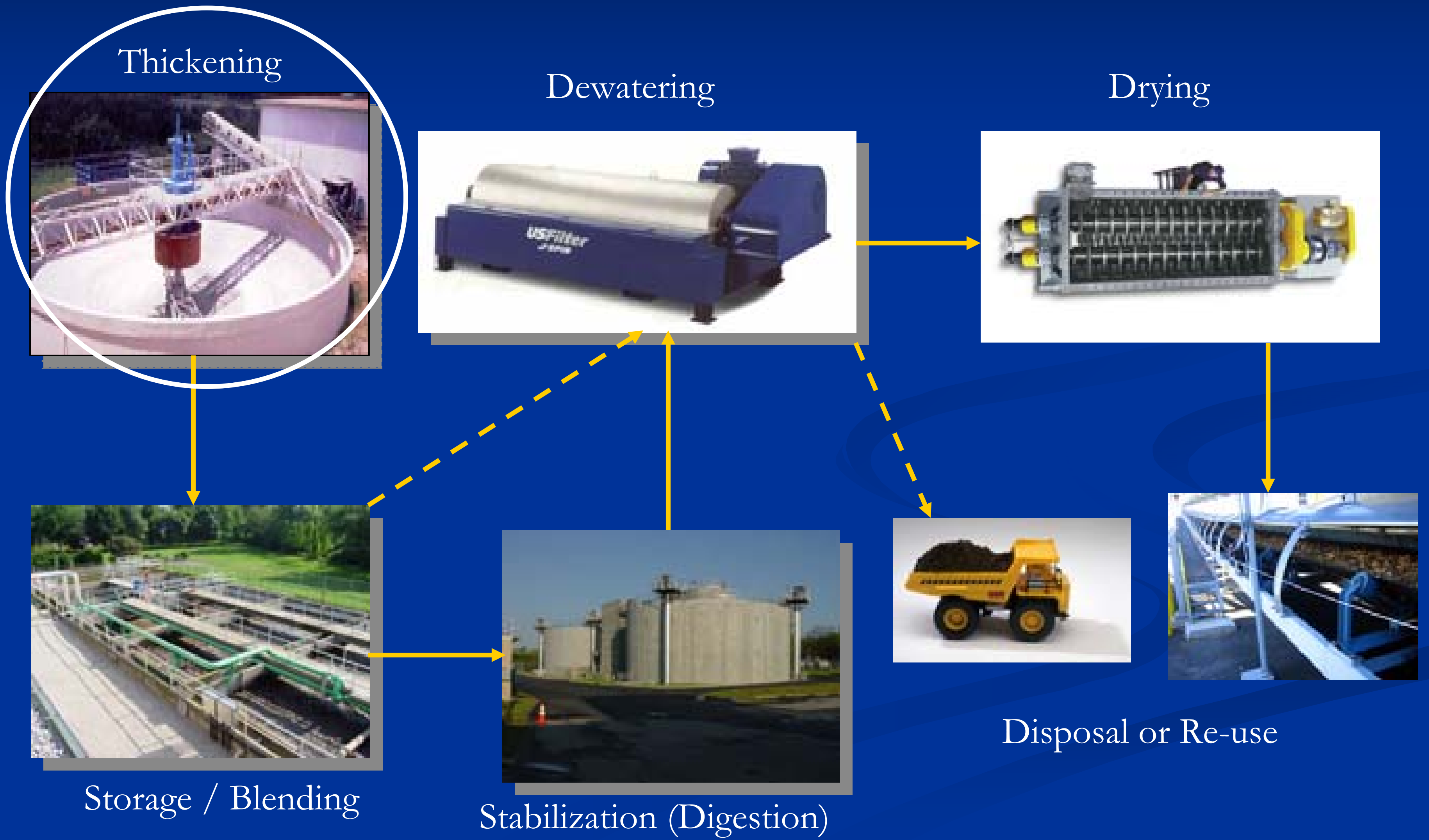
Biosolids Treatment

- Biosolids historically viewed as a waste product - Now considered a commodity
- Biosolids have energy value
  - Combustion heat value – similar to low grade coal, but much cleaner burning
  - Methane production from breakdown of organic matter captured for energy
  - Combined heat and power can offset WWTF energy costs
- Goal is a biosolids processing system that takes advantage of energy value

Why Thicken and Dewater?



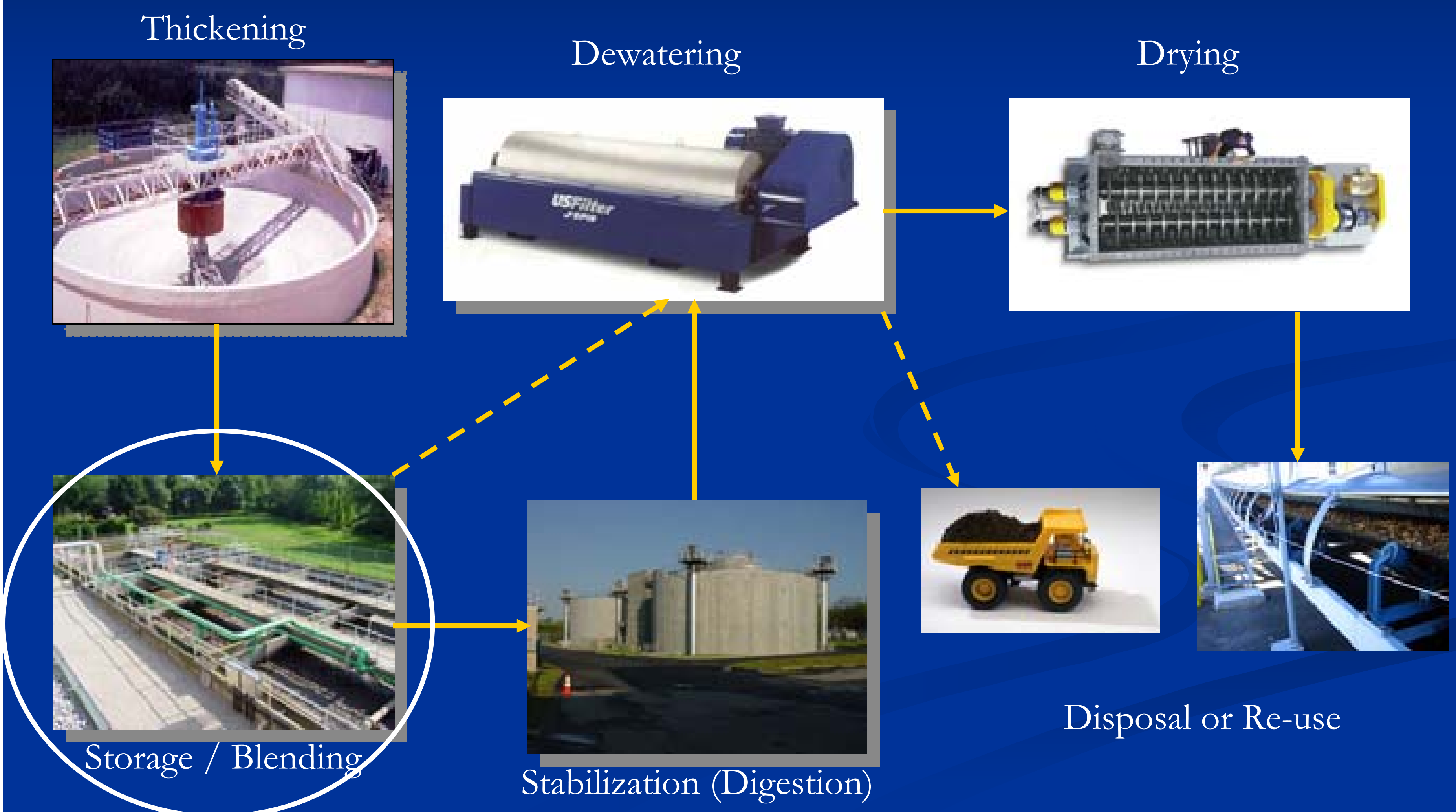
Biosolids Treatment Processes



Thickening

- Objectives:
  - Volume reduction through removal of water
  - Reduce hydraulic loading on downstream unit operations & processes
    - Process tank volumes and costs
- Recycle stream can have high nutrient concentration, must be managed

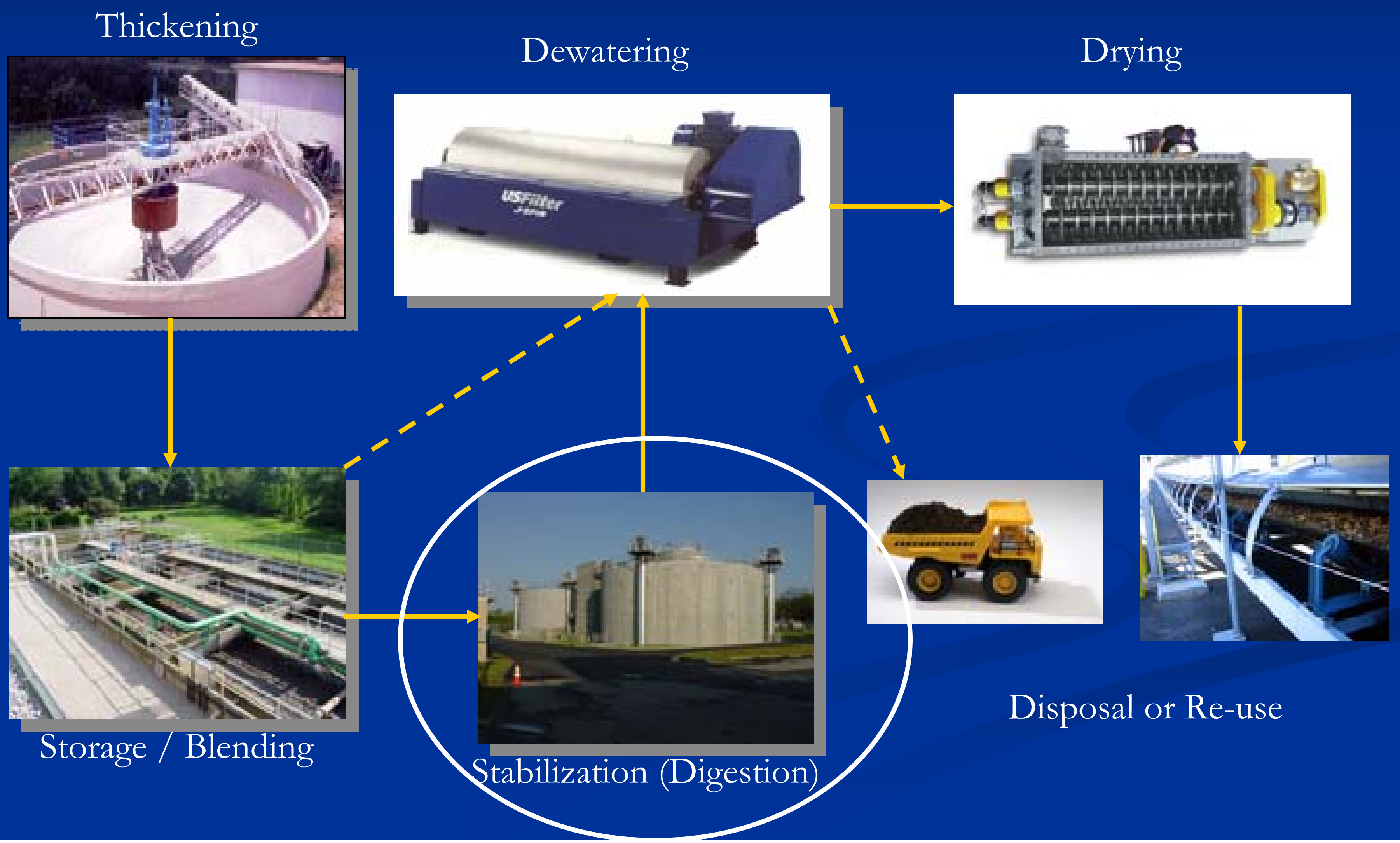
Biosolids Treatment Processes



Storage and Blending

- Objectives :
  - Create homogeneous feedstock
    - Different sludge types, received wastes
  - Store solids prior to next process, specifically non-continuous
  - Provide means to maintain solids throughput to other processes

Biosolids Treatment Processes



Stabilization and Vector Attraction Reduction

- Objectives:
  - Improve safety/quality of biosolids for reuse
    - Destroy pathogens, reduce odors (volatile solids) that can attract vectors
  - Volume reduction through solids breakdown
- Alternative energy potential
  - Anaerobic digestion: methane gas production from breakdown of organics
  - Combined heat and power (CHP)

Biosolids Treatment – Anaerobic Digestion

Synergy Between Anaerobic Digestion and Combined Heat and Power

CHP

Power

Biogas

Heat

Buildings & Processes

Storage & Blending

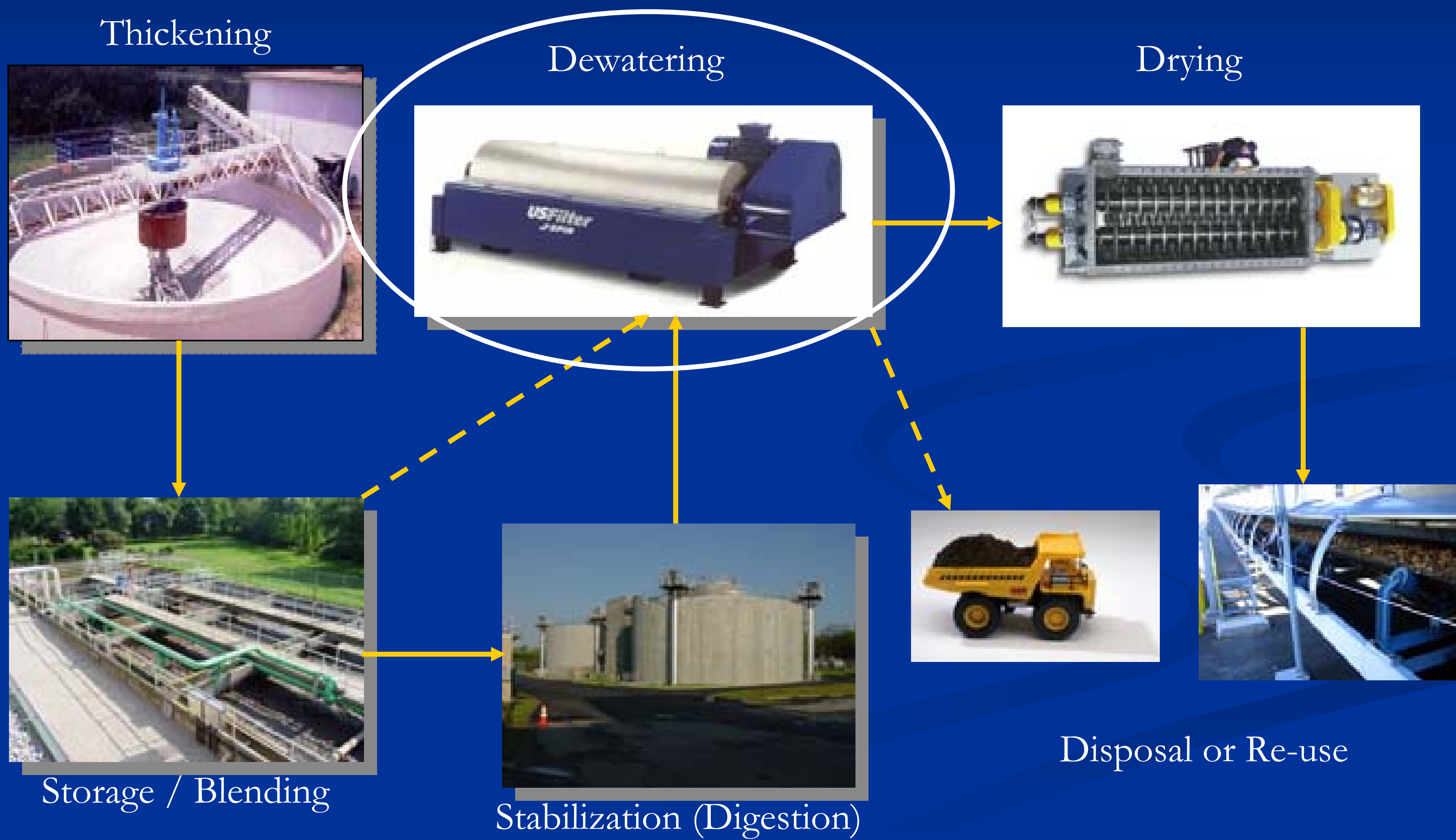
Feedstock

Anaerobic Digestion

Digested Biosolids

Thermal Treatment, Disposal or Reuse

Biosolids Treatment Processes

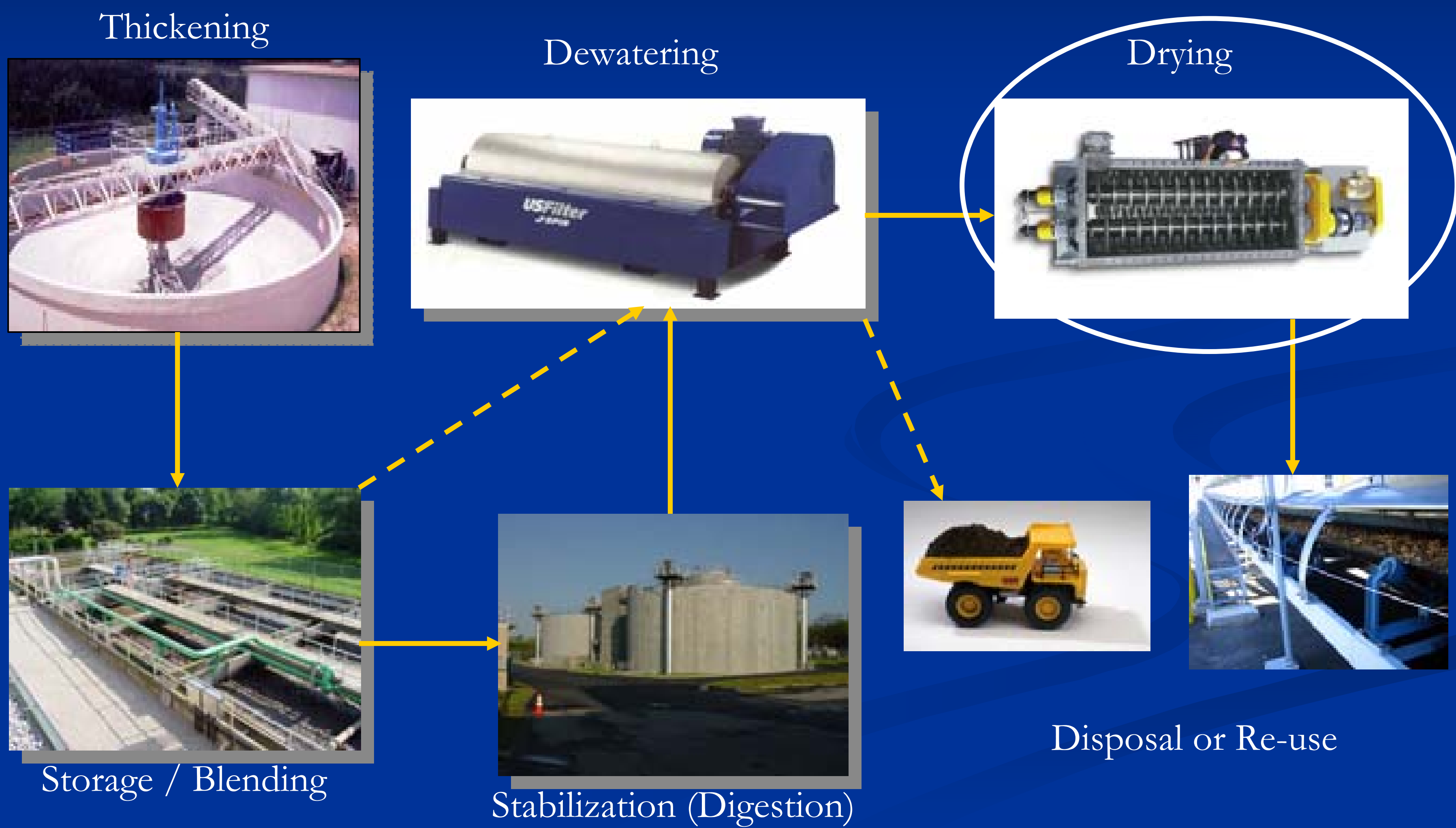


Dewatering

- Objectives:
  - Remove additional water to reduce:
    - Weight and volume
    - Load on downstream processes (drying)
    - Hauling and disposal costs

- Recycle stream can have high nutrient concentration, must be managed

Biosolids Treatment Processes



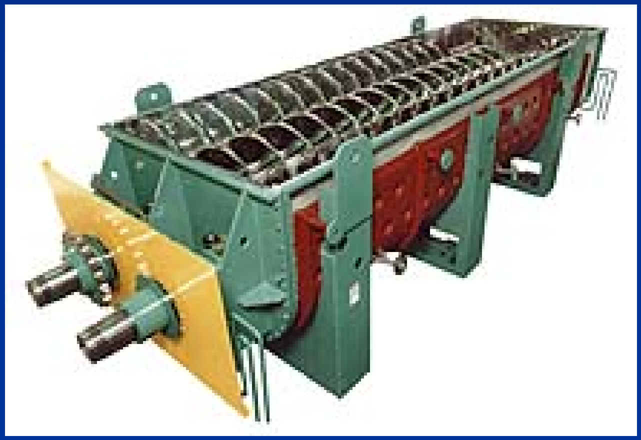
Thermal Drying

Objectives:

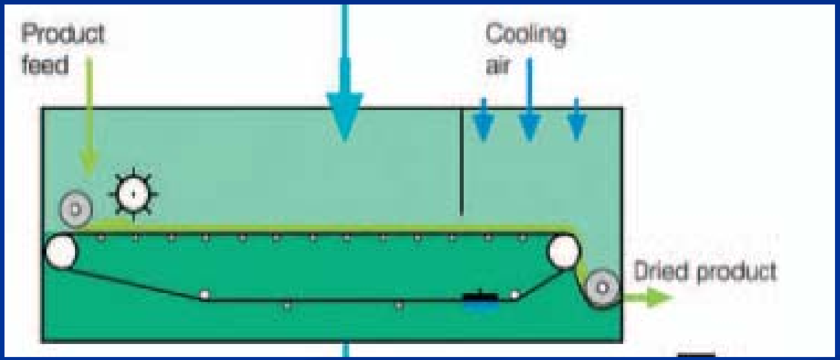
- Reduce water content (75-90% solids)
- Stabilization (high temperature)
- Pelletize biosolids
  - Produce granular material suitable for fertilizer or as QC for combustion
- Requires external fuel (NG, biogas) or heat source

Biosolids Treatment – Types of Drying

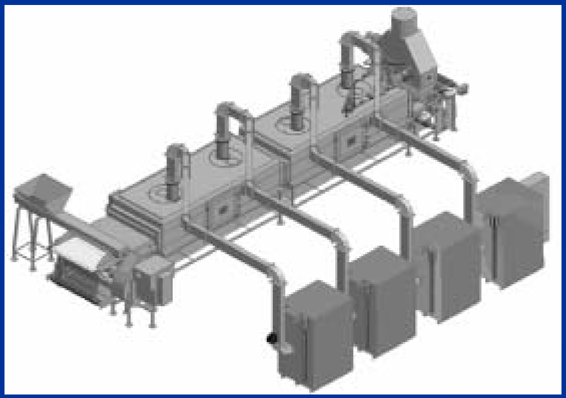
Indirect



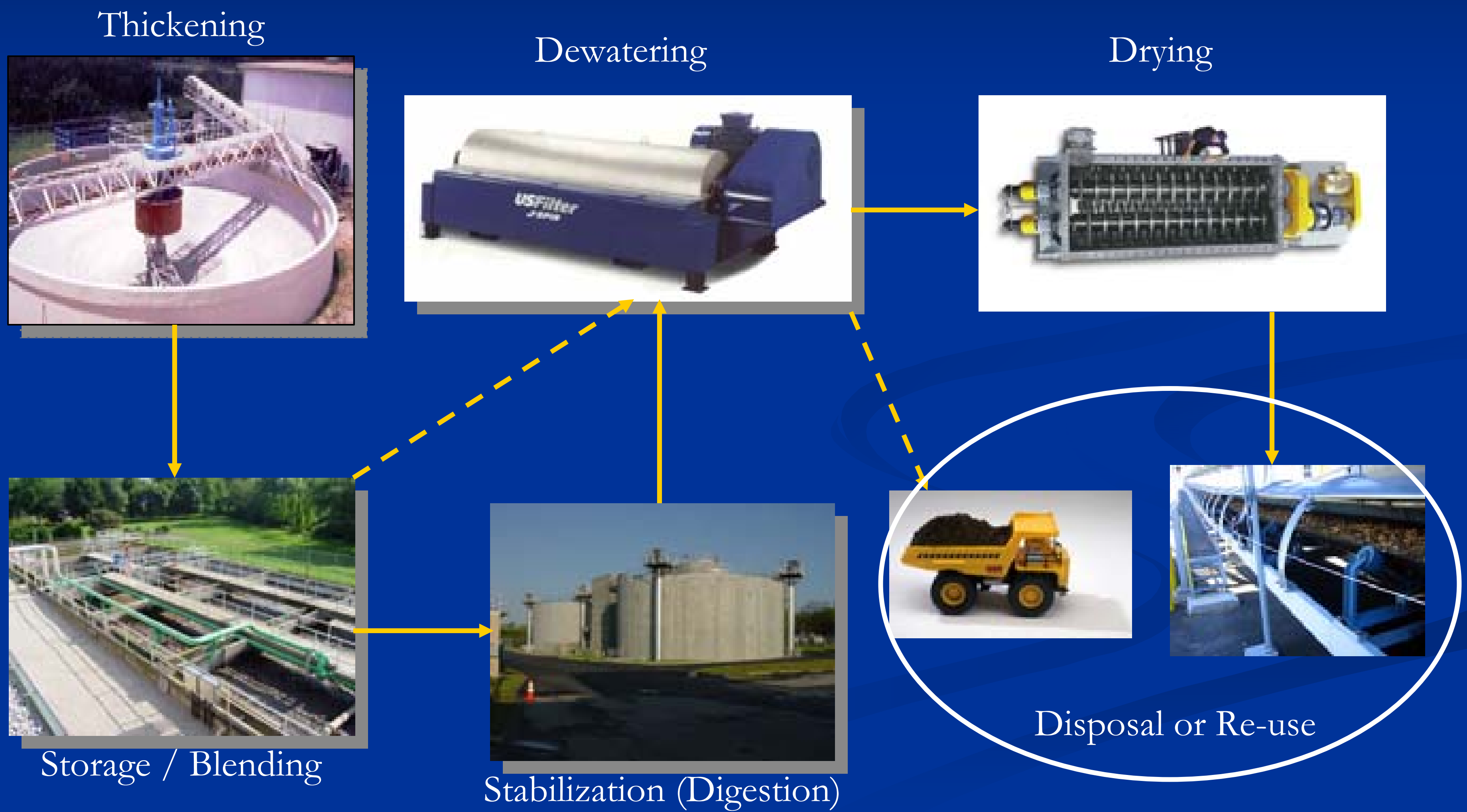
Direct



Microwave



Biosolids Treatment Processes



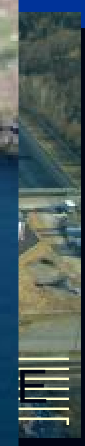
Biosolids Disposal/Reuse

- Traditional Disposal Options:
  - Land Apply
  - Landfill
- Re-use Options:
  - Land Apply
  - Fertilizer production
  - Combustion for renewable energy
- Disposal is regulated by EPA and DES

Design Considerations

- Disposal/reuse markets
- Balanced energy production and consumption
- Volume reduction
- Reuse and sustainability
- Recycle stream management - nutrients

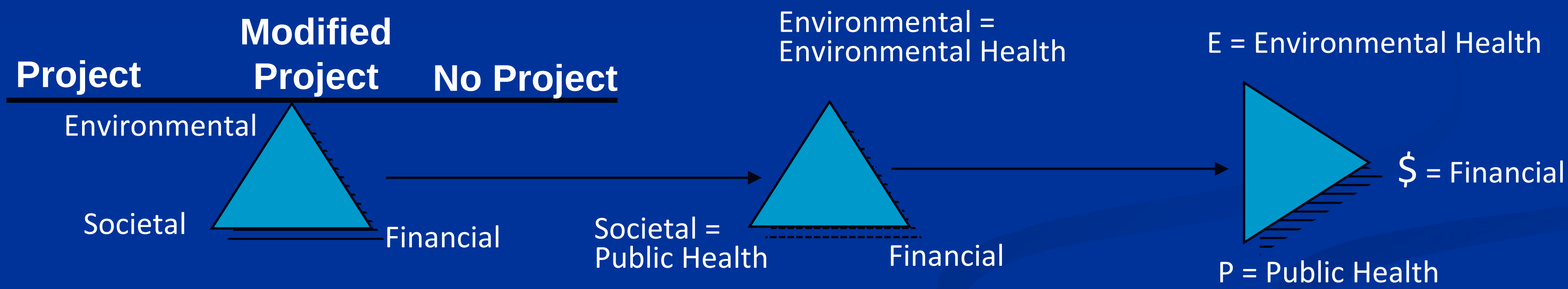
Wastewater Treatment Selection Process



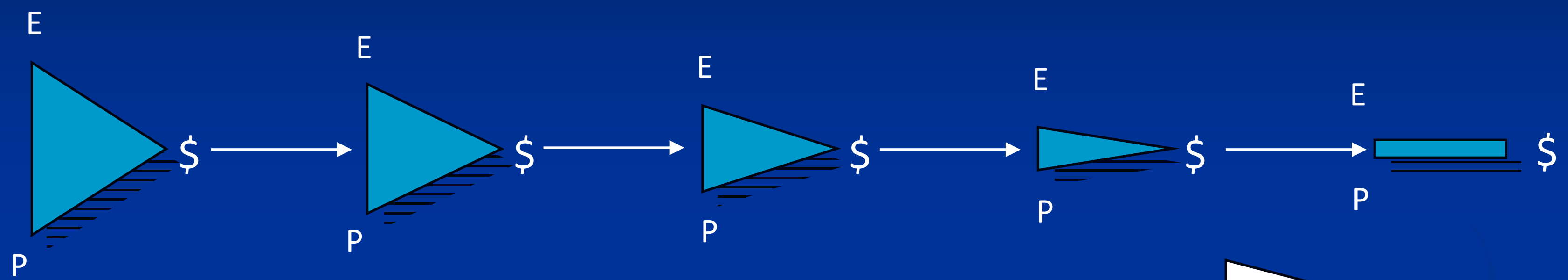
How is Treatment Process Selected?

- Evaluation of:
  - Land requirements
  - New construction requirements – reuse of existing
  - Labor requirements (complexity and reliability)
  - Energy (aeration, pumping)
  - Trucking (biosolids)
  - Chemicals
  - Recycle flows

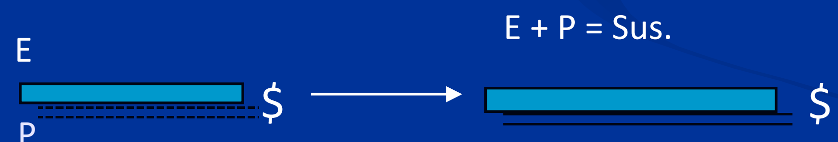
The Triple Bottom Line



The Triple Bottom Line



Increasing understanding that all things are interrelated.



Environmental health and public health are one in the same.

Sustainability

Balance of Capital, Lifecyle and Sustainability Costs

Next steps on the Master Plan

- EPA/DES approval of design criteria
- Finalize screening of site selections
- Complete treatment technology evaluations
- Complete LTCP update
- Continue quarterly updates to City Council
- Complete Master Plan and LTCP reports

Implementation Steps

- Environmental Impact Study
- Secure funding
- Design final recommendations
- Final EPA/DES approval
- Construct facilities

Questions