Water Environment
Association

WWTP Sustainable Design Opportunities
A Case Study in Dubuque, Iowa

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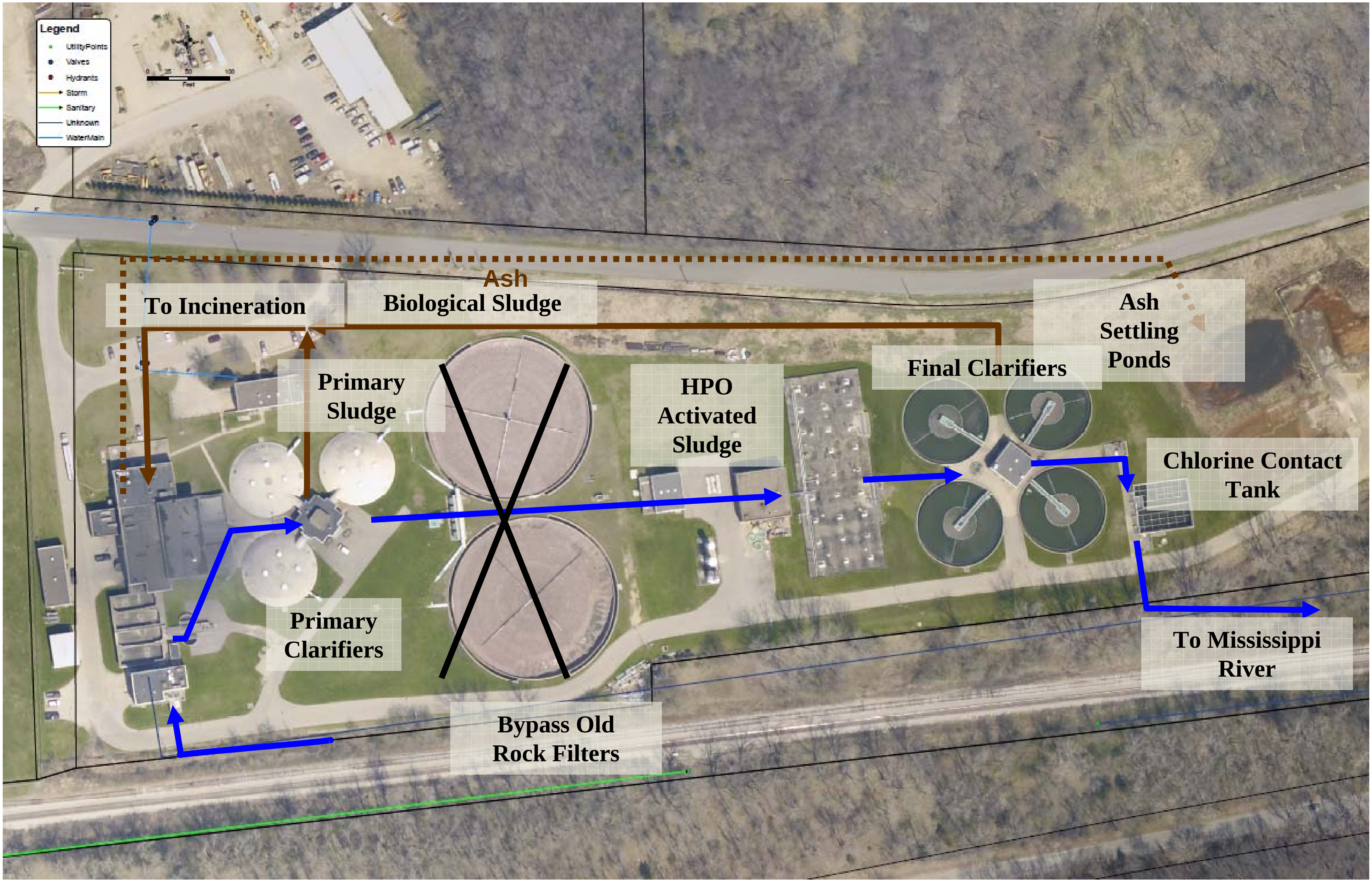
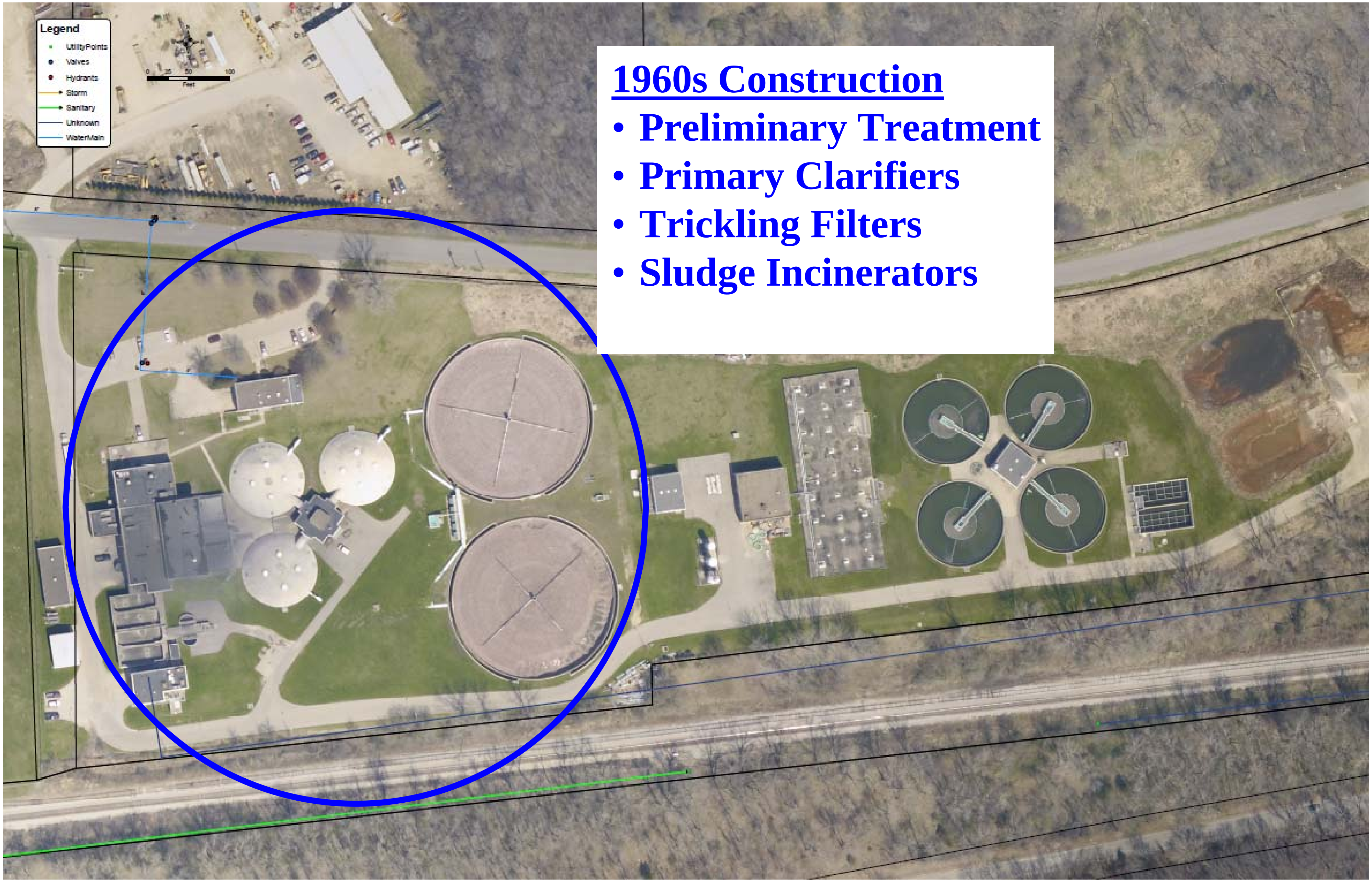
Presentation Outline

- Background & History
- Project Drivers
- Major Project Elements
- Sustainability Drivers in Dubuque
- Sustainable Project Elements

Overview of the Water Pollution Control Plant



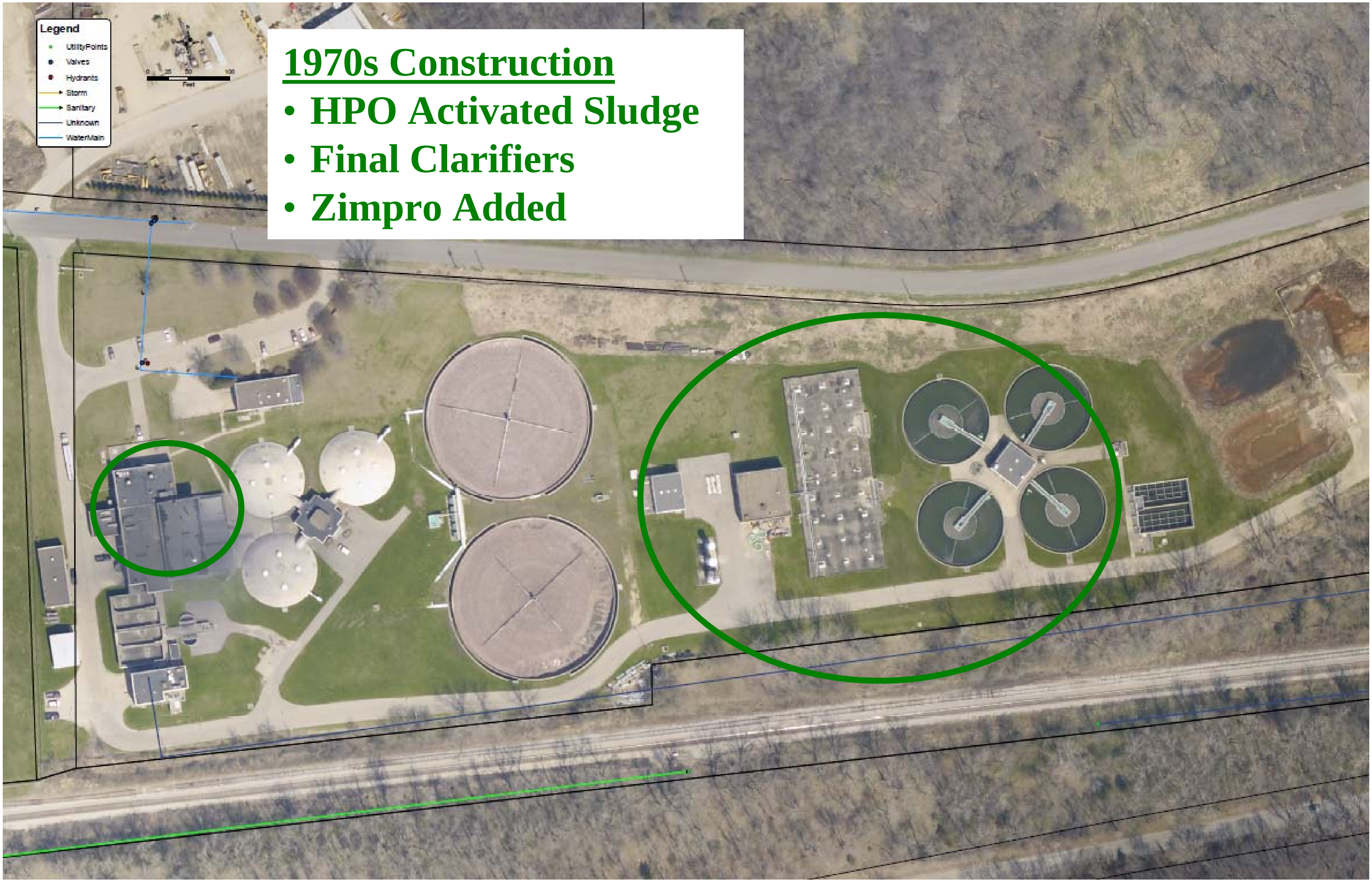
History of the Water Pollution Control Plant



<u>1960s Construction</u>

- **Preliminary Treatment**
- **Primary Clarifiers**
- **Trickling Filters**
- **Sludge Incinerators**

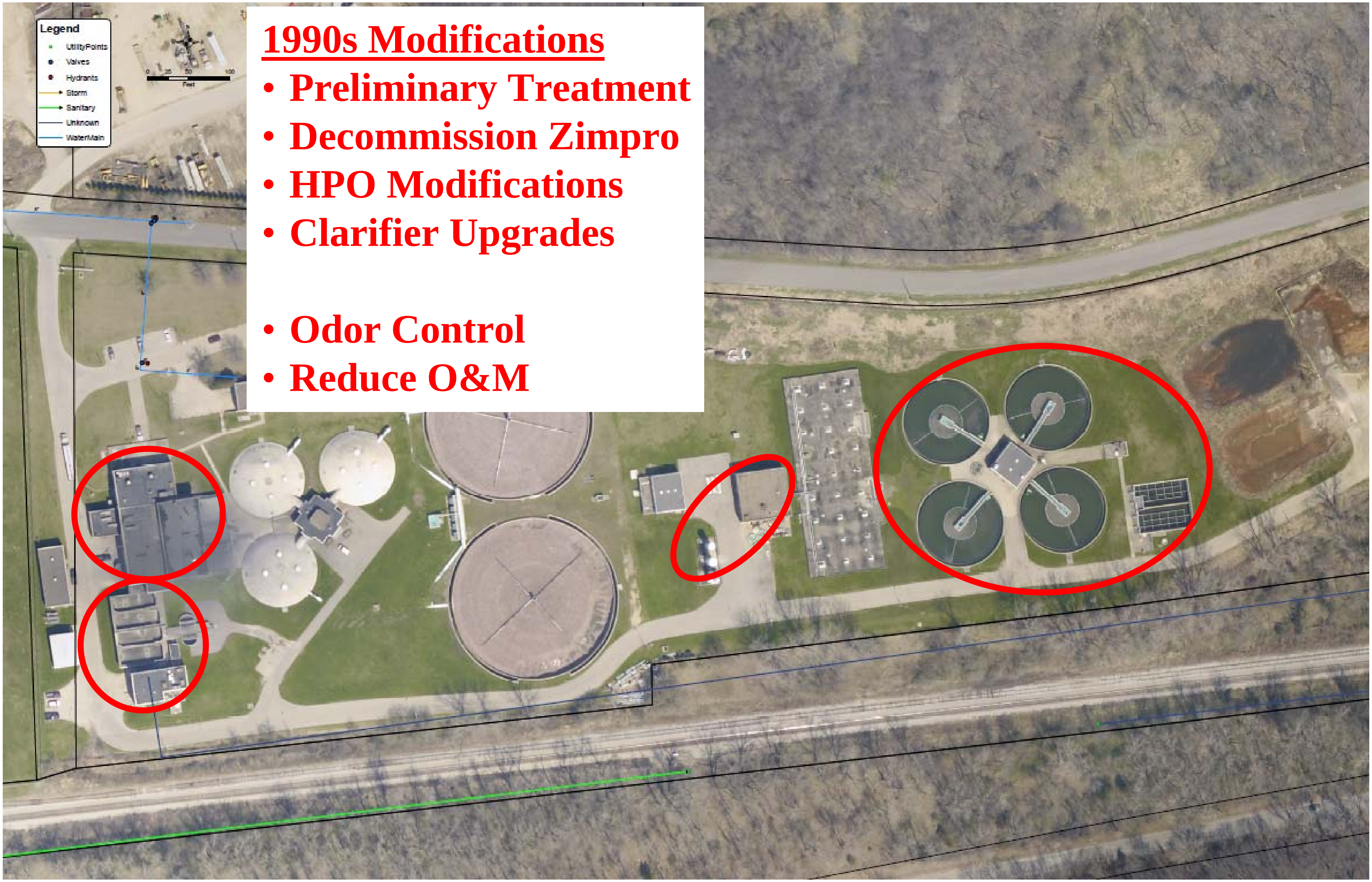
History of the Water Pollution Control Plant



<u>1970s Construction</u>

- HPO Activated Sludge
- Final Clarifiers
- Zimpro Added

History of the Water Pollution Control Plant



1990s Modifications

- Preliminary Treatment
- Decommission Zimpro
- HPO Modifications
- Clarifier Upgrades

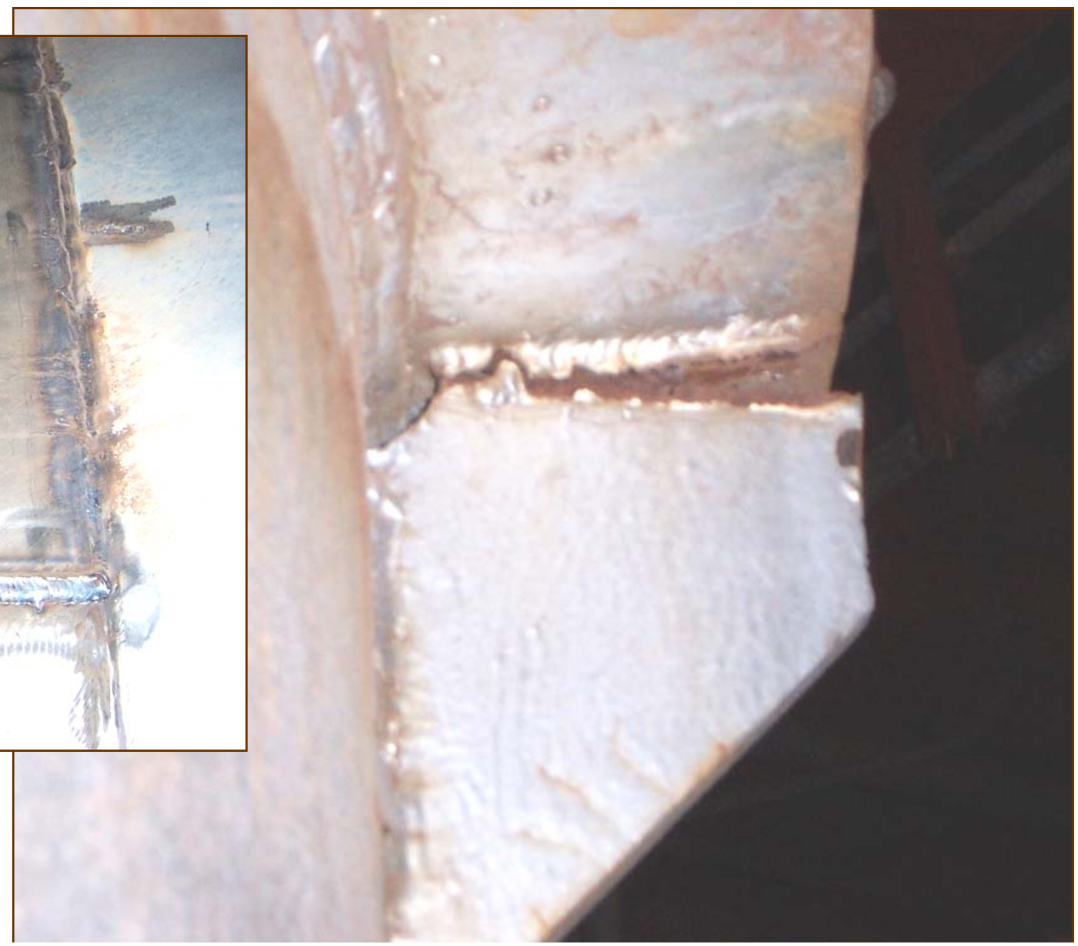
- Odor Control
- Reduce O&M

Project Drivers - Concerns & Issues

1. Plant Age
2. Performance
3. Capacity/City Growth
4. Regulatory Changes

Project Drivers – Plant Age

- Systems and equipment 30-40 years old
- Reduced efficiencies; high maintenance
- Especially critical for incinerators

Dubuque WPCP Upgrade Project

1. Planning started in 2007
2. Facilities Plan approved December 2008
3. Design complete March 2010
4. Bid date May 20, 2010
5. Bid Amount: $50 million
6. Construction Completion: 2013

Major Project Elements

Sustainability Drivers

2006 program to establish Dubuque as a “Sustainable City”

2009 announcement to make Dubuque one of the first “smarter cities”

Energy Star rating for buildings, lighting, HVAC; possibly entire project/plant

Sustainable Dubuque

SUSTAINABLE DUBUQUE
viable • livable • equitable

<u>11 Sustainable Principles</u>

- **Regional Economy**
- **Smart Energy Use**
- **Resource Management**
- **Community Design**
- **Green Buildings**
- **Healthy Local Food**
- **Community Knowledge**
- **Reasonable Mobility**
- **Healthy Air**
- **Clean Water**
- **Native Plants & Animals**

IBM Smart City

- “Dubuque will be a living lab…to develop an international smarter sustainable city model and a set of reusable assets…”
  - Transit & Transportation
  - Energy
  - Housing & Urban Development
  - Social Engagement - Public Awareness
  - Health & Wellness
  - Parking - Transit optimization

Smart City

- Enhance the city's and citizens' understanding of energy consumption and water management
- Reduce costs and overall carbon footprint
- Implement an IBM platform for real-time integrated "sustainability monitoring"
- Energy management and energy use tracking within the electric grid - water system, WPCP, etc.

Energy Efficiency

- **Portfolio Manager for WWTPs**
  - **Benchmark against other WWTPs**
- **Specific Incentives for Energy Efficiency Improvements and Elements**

Sustainable Project Elements
Planning Phase

- **Previous Planning in the 1980s (20 years ago):**
  - **Focused on incinerators**
  - **Air pollution was primary concern**
  - **“Protest” type opposition to incineration**

Sustainable Project Elements
Planning Phase

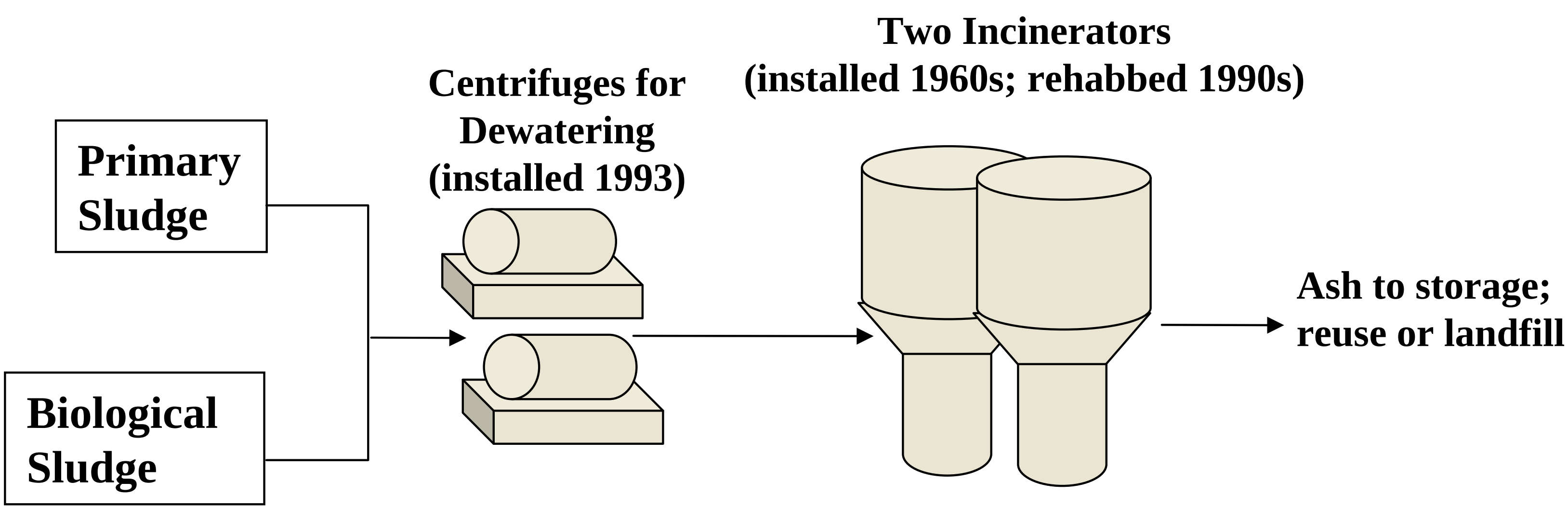
- **2007-2008 Planning:**
  - **Air pollution still primary concern**
  - **Engaged public and interest groups**
  - **<u>Discussion</u> vs. <u>protests</u>**

  - **Two public informational meetings/workshops**
  - **Industrial/commercial presentation and outreach**
  - **City council workshops**
  - **Additional presentations by WPCP staff to interested groups**

Sustainable Project Elements
Planning Phase

- **Residuals Management Example**

Example
Current Solids Management
Sludge Incineration



Example
Solids Management Alternatives

RM1	**Refurbish both incinerators**
RM2a	**Refurbish one incinerator; use lime system for backup**
RM2b	**One new incinerator; use lime system for backup**
RM3	**Redundant lime stabilization systems; land application**
RM4	**Anaerobic digestion; land application**
RM5	**Anaerobic digestion and composting**
RM6	**Anaerobic digestion and drying; land application**
RM7	**Drying; land application**

Example

Capital Costs

		Opinion of Capital Costs
Alt. RM1	Rehab Both Inc.	$ 26,928,000
Alt. RM2a	Rehab. 1 Inc.; Lime Backup	$ 17,781,000
Alt. RM2b	One new Inc.; Lime Backup	$ 33,232,000
Alt. RM3	Lime Stabilization	$ 12,173,000
Alt. RM4	Digestion & Land App.	$ 26,788,000
Alt. RM5	Digestion & Composting	$ 26,788,000
Alt. RM6	Digestion, Drying, and Land App.	$ 42,790,000
Alt. RM7	Drying and Land App.	$ 26,306,000

Example
O&M Costs

		Opinion of Annual O&M
Alt. RM1	Rehab Both Inc.	$ 862,000
Alt. RM2a	Rehab. 1 Inc.; Lime Backup	$ 914,000
Alt. RM2b	One new Inc.; Lime Backup	$ 914,000
Alt. RM3	Lime Stabilization	$ 1,669,000
Alt. RM4	Digestion & Land App.	$ 754,000
Alt. RM5	Digestion & Composting	$ 790,000
Alt. RM6	Digestion, Drying, and Land App.	$ 1,062,000
Alt. RM7	Drying and Land App.	$ 1,391,000

Example

20-Year Present Worth

		Opinion of Present Worth	% of Lowest (Present Worth)
Alt. RM1	Rehab Both Inc.	$ 37,624,000	126%
Alt. RM2a	Rehab. 1 Inc.; Lime Backup	$ 29,941,000	100%
Alt. RM2b	One new Inc.; Lime Backup	$ 45,469,000	152%
Alt. RM3	Lime Stabilization	$ 33,530,000	112%
Alt. RM4	Digestion & Land App.	$ 35,601,000	119%
Alt. RM5	Digestion & Composting	$ 36,054,000	120%
Alt. RM6	Digestion, Drying, and Land App.	$ 55,453,000	185%
Alt. RM7	Drying and Land App.	$ 43,838,000	146%

Example

40-Year Present Worth Costs

- **City wished to look beyond the typical 20-year planning window to establish direction and evaluate long-term sustainability**

- **Anaerobic digestion alternatives had lowest 40-year present worth values**

Example
Carbon Footprint

Category	RM1	RM2	RM3	RM4	RM5	RM6	RM7
	Incin.	Incin.	Lime	AD	AD	AD + Dry	Drying
Electricity, MWH/yr	1,614	1,614	834	686	686	1,289	603
Nat. Gas, MBTU/yr	0	0	0	0	0	24,500	45,900
Fuel Oil, gal/yr	18,300	18,300	6,000	1,280	1,280	230	430
GHG Emissions, Tons of CO_{2e}/yr	**1,300**	**1,300**	**640**	**480**	**480**	**2,300**	**3,100**

Notes:

Carbon equivalents from electrical generation = 1.37 lbs CO_2/kWH.

Carbon equivalents of natural gas use = 117 lbs CO_2/MBTU.

Carbon equivalents of fuel oil use = 22.29 lbs CO_2/gallon.

Source: EPA Climate Change Website

Dubuque All-America City 2007

STRAND ASSOCIATES, INC.® ENGINEERS

Example
Sludge Processing Direction

- **Anaerobic Digestion Selected**
  - **Lowest annual O&M cost**
  - **Lowest energy use**
  - **Potential for energy generation**
  - **Reasonable 20-year present worth cost**
  - **Lowest 40-year (and beyond) present worth**
  - **Most “Sustainable” solution**

Sustainable Project Elements
Anaerobic Digestion

- **High-strength industrial wastes/FOG wastes**
  - **Digestion facilities are designed to accommodate**
  - **Receiving station included**

- **Food residuals (commercial, institutional)**
  - **Preliminary design complete**

Sustainable Project Elements
Renewable Energy

- **<u>Thorough</u> evaluation of renewable energy opportunities:**
  - **Solar**
  - **Wind**
  - **Geothermal**
  - **Effluent heat recovery**
  - **Biogas**
  - **Food residuals**
  - **Micro Hydropower**

- **Include effluent heat recovery and biogas reuse; plan for others**

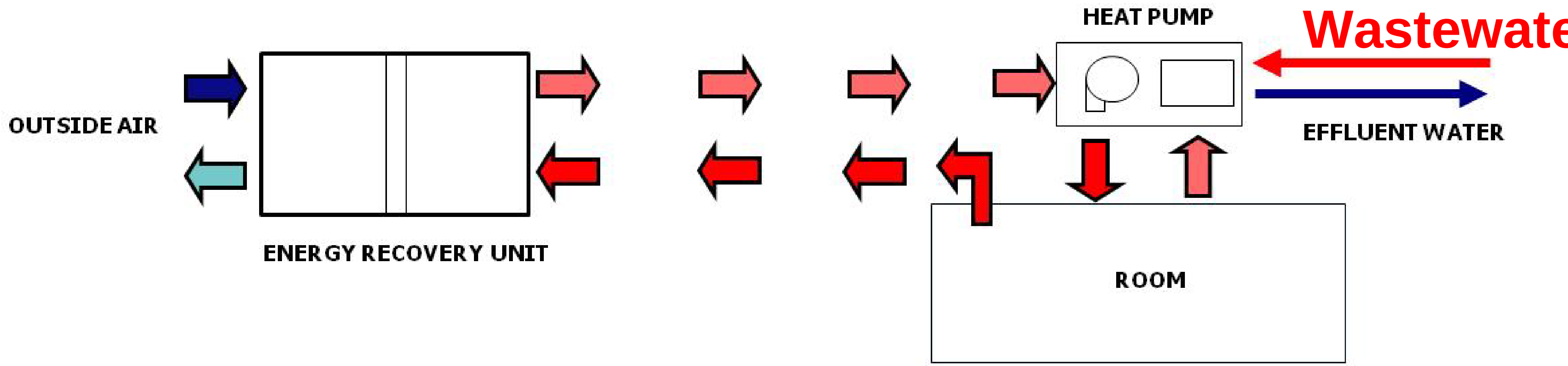
Sustainable Project Elements
Cogeneration

Biogas Production at Design Conditions	**260,000 ft^3/day**
Total Energy Content of Biogas	**156 MMBTU/day**
Electrical Generation Potential (kW) **(kWH/day)**	**400** **9,600**
Net Electrical Generation Value @ $0.08/kWH	**$768/day** **$280,000/yr**
GHG Emission Reduction Credit ***(Biogas used to generate electricity)***	**4,800,000 lbs CO_2/yr**** **~ 2,400 tons/yr**

***** 1 kWH ~ 1.37 lbs CO_2 equivalent.***

Sustainable Project Elements
Effluent Heat Recovery

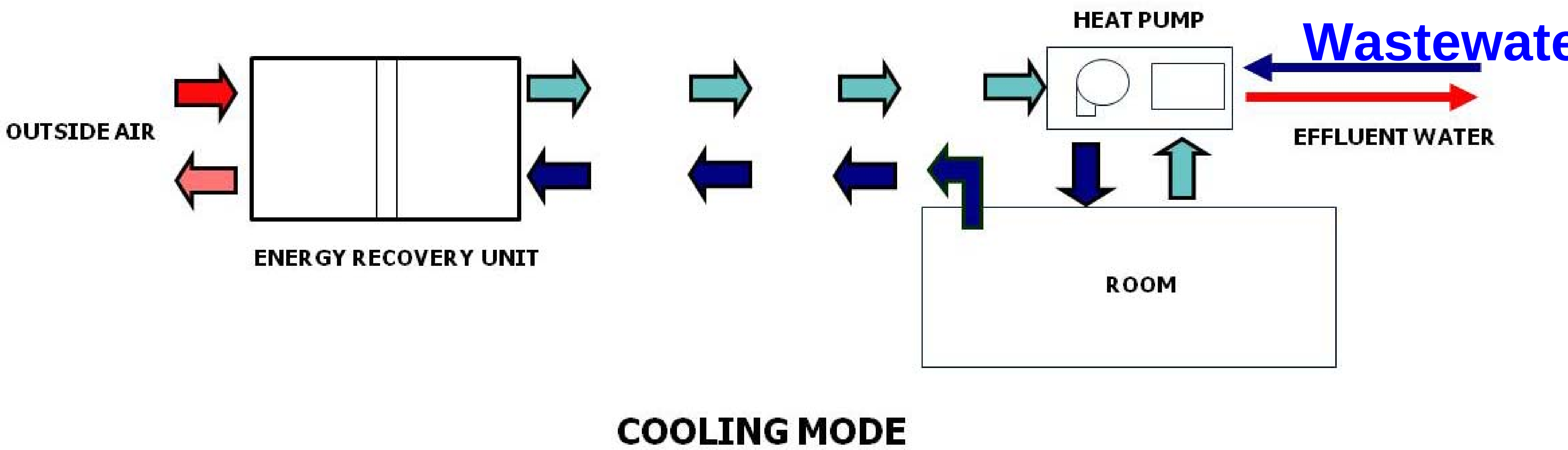
Winter



HEATING MODE

Sustainable Project Elements
Effluent Heat Recovery

Summer



Sustainable Project Elements
Building Design

- **Energy Star rating for the Administration Building**
- **Energy Star credits for process buildings**
- **Energy Star rating for plant?**

Energy Efficiency (Thermal)

- **Building Shell R Values (non-process)**
  - **R = 50 for roofs (typical design ~ 24)**
  - **R = 24 for walls (typical design ~ 14)**
  - **Specified wall panel system in lieu of standard infill**

- **Available credits of $0.60/sq. ft. for thermal efficiency (occupied spaces)**
  - **$6,000 for Admin. Bldg.**

Energy Efficiency (HVAC/Mechanical)

- HVAC Modeling
  - TRACE 700 modeling of all occupied spaces
  - Identify thermal bridging
- Mechanical/thermal efficiency > ~93% (equipment)
- Available credits of $0.60/sq. ft. for mechanical efficiency
  - Includes process buildings too

Energy Efficiency (Lighting)

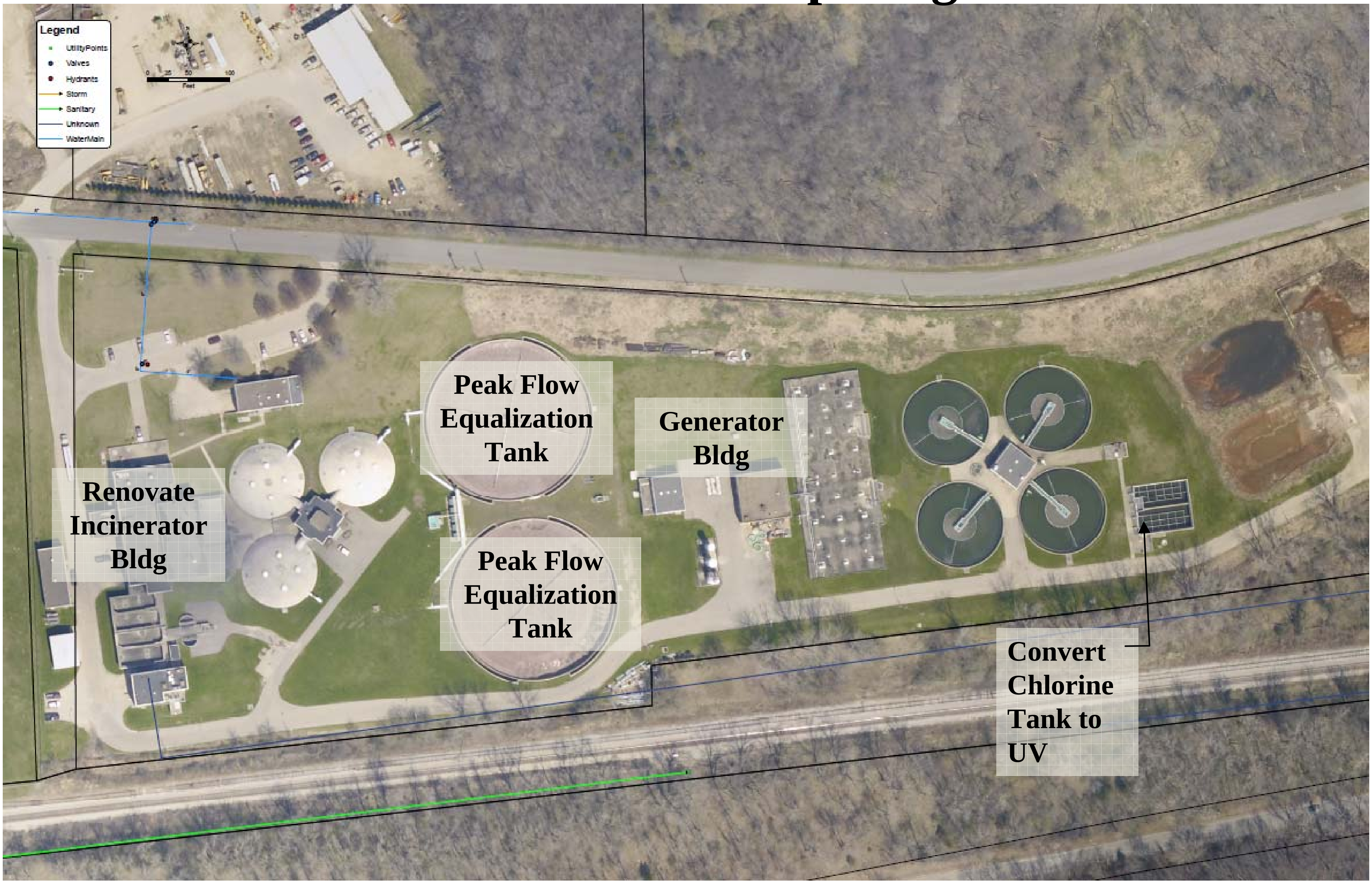
- **AGI32 Modeling of All Spaces**
  - **Interior and exterior lighting efficiency**

- **Available credits of $0.60/sq. ft. for lighting efficiency**
  - **Includes process buildings too**

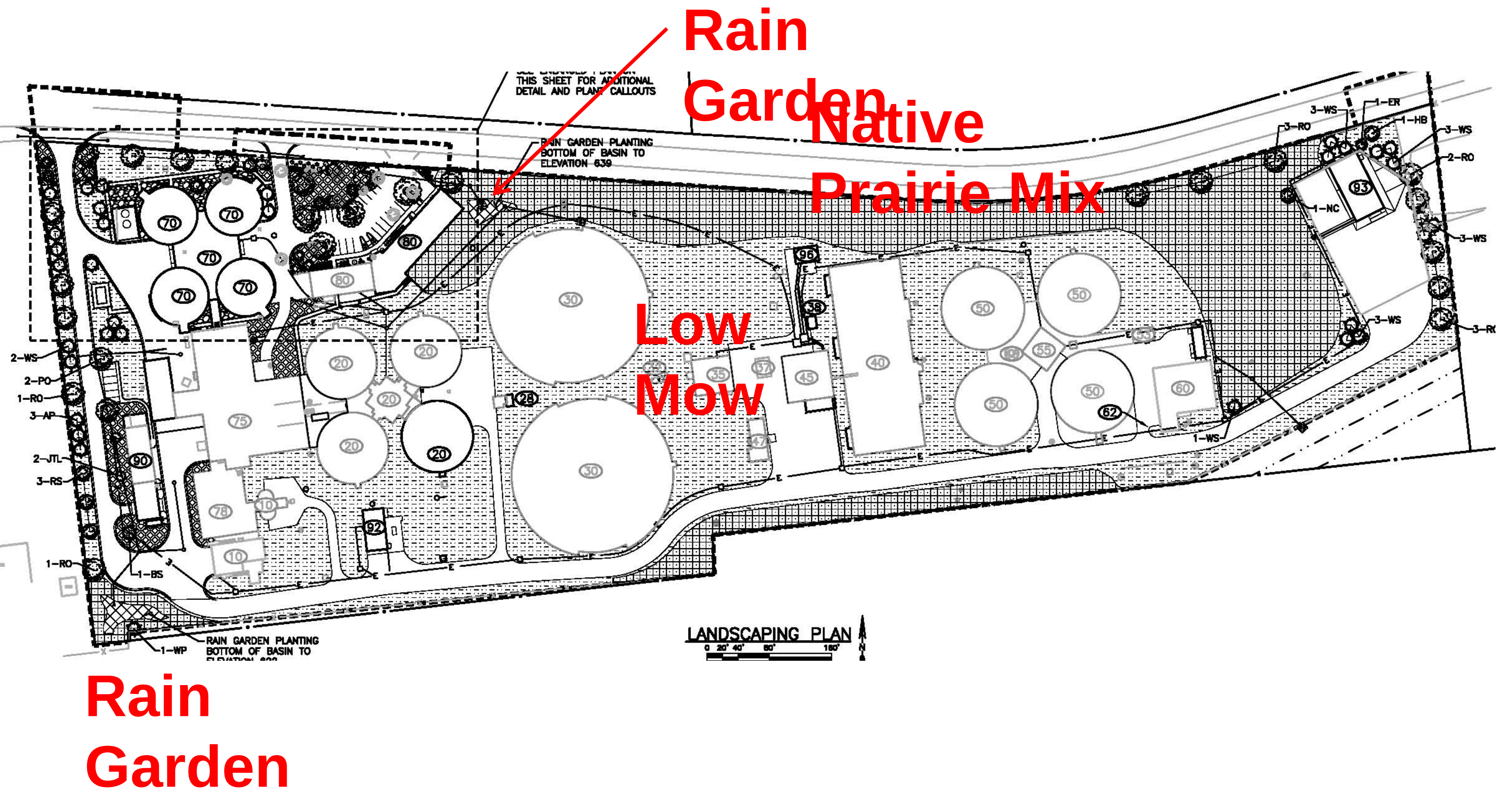
Sustainable Project Elements
Building Design

- **Utility rebates - materials, appliances, etc. (~$250,000)**
- **Very Significant Design Effort**
- **Design Verification After Construction**

Sustainable Project Elements
Structure Re-Purposing



Sustainable Project Elements
Site Design



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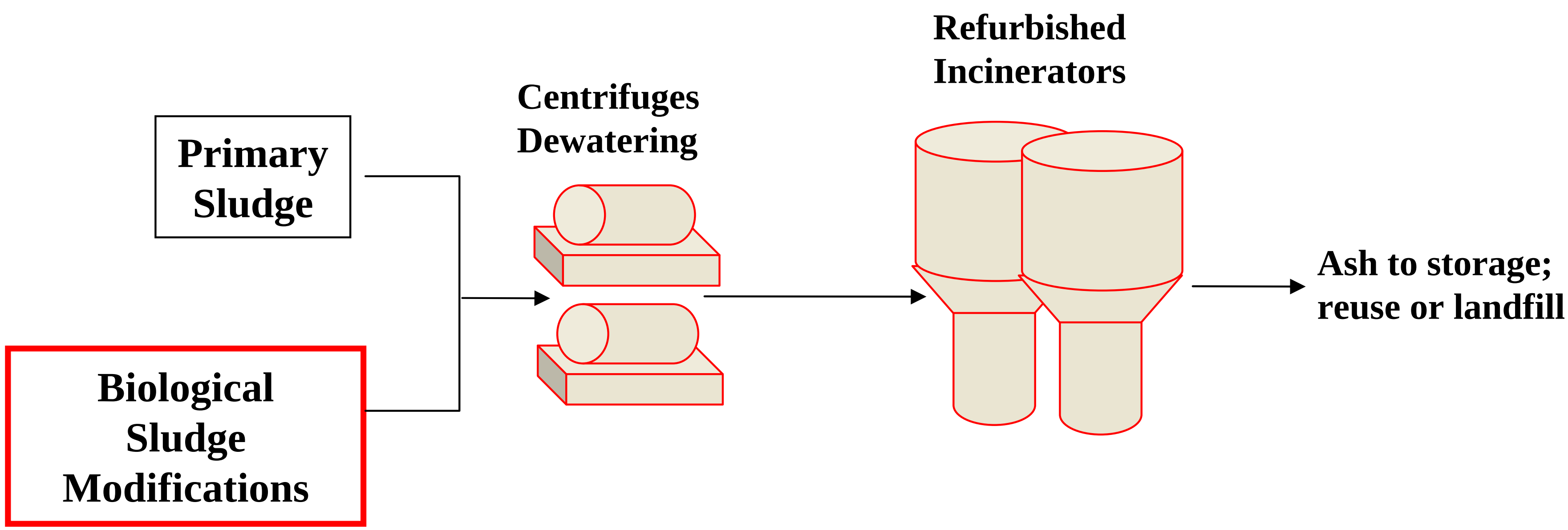
Sustainable Project Elements
Public Sharing/Education

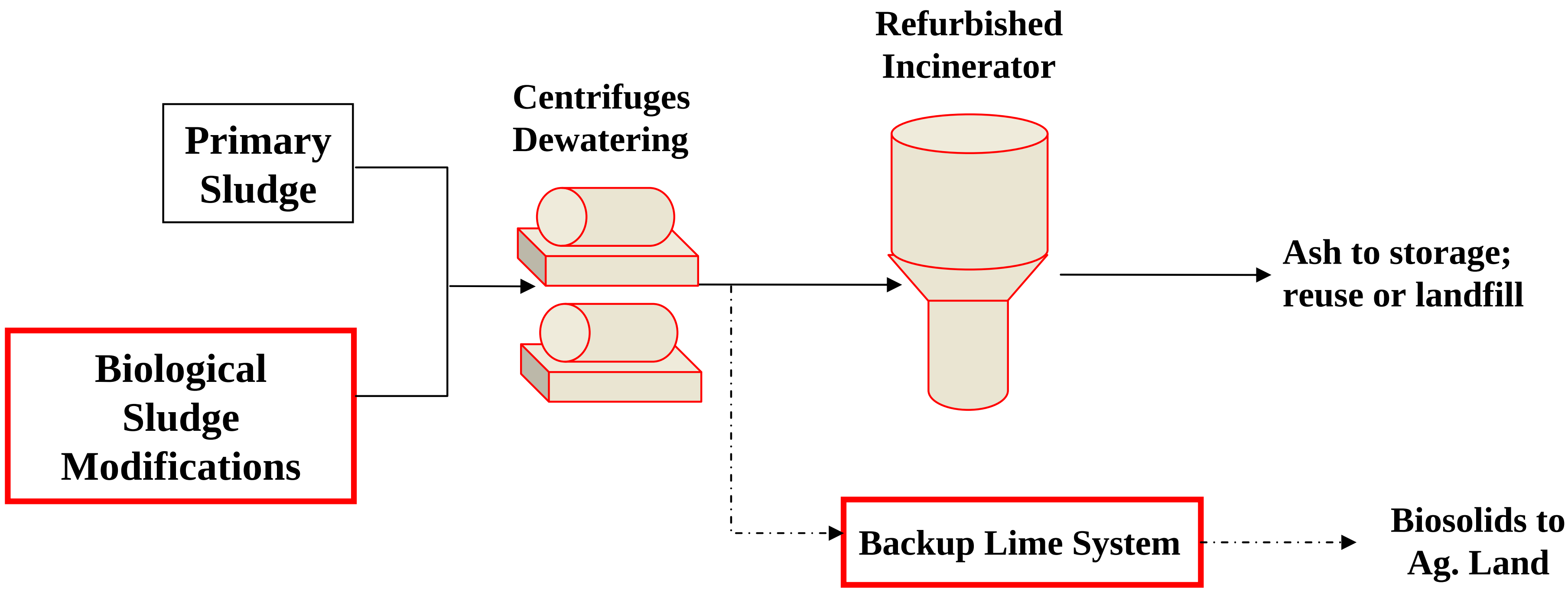
- **Plant operating data and energy use data sharing via the Internet.**

Major Project Elements

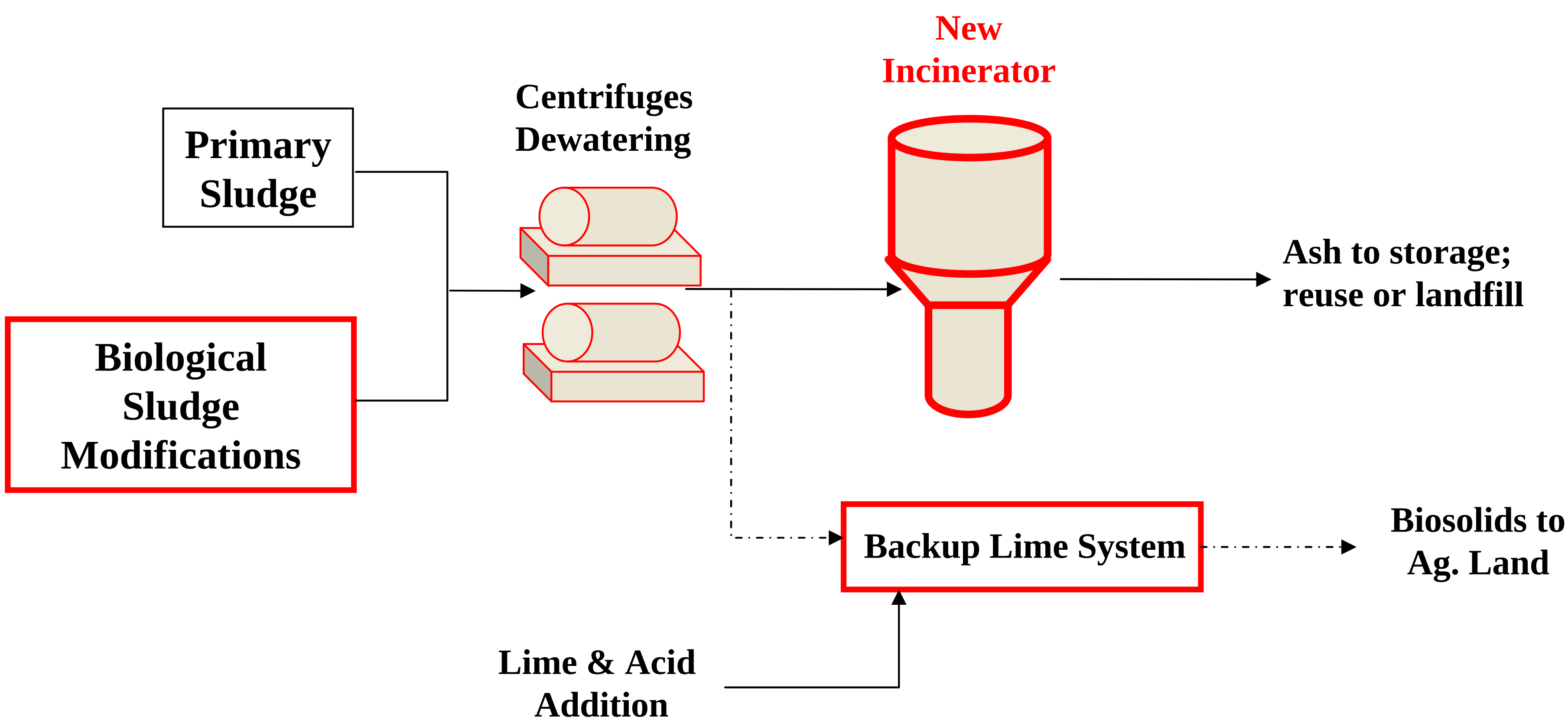
Alt. RM1 – Refurbish Both Incinerators



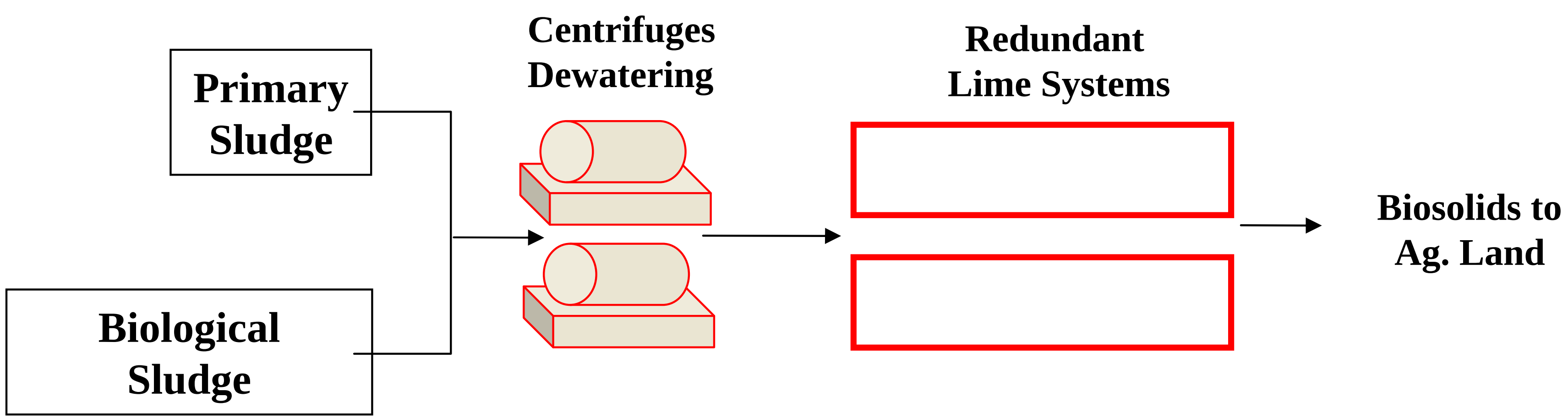
Alt. RM2a – Refurbish One Incinerator Use Lime as Backup



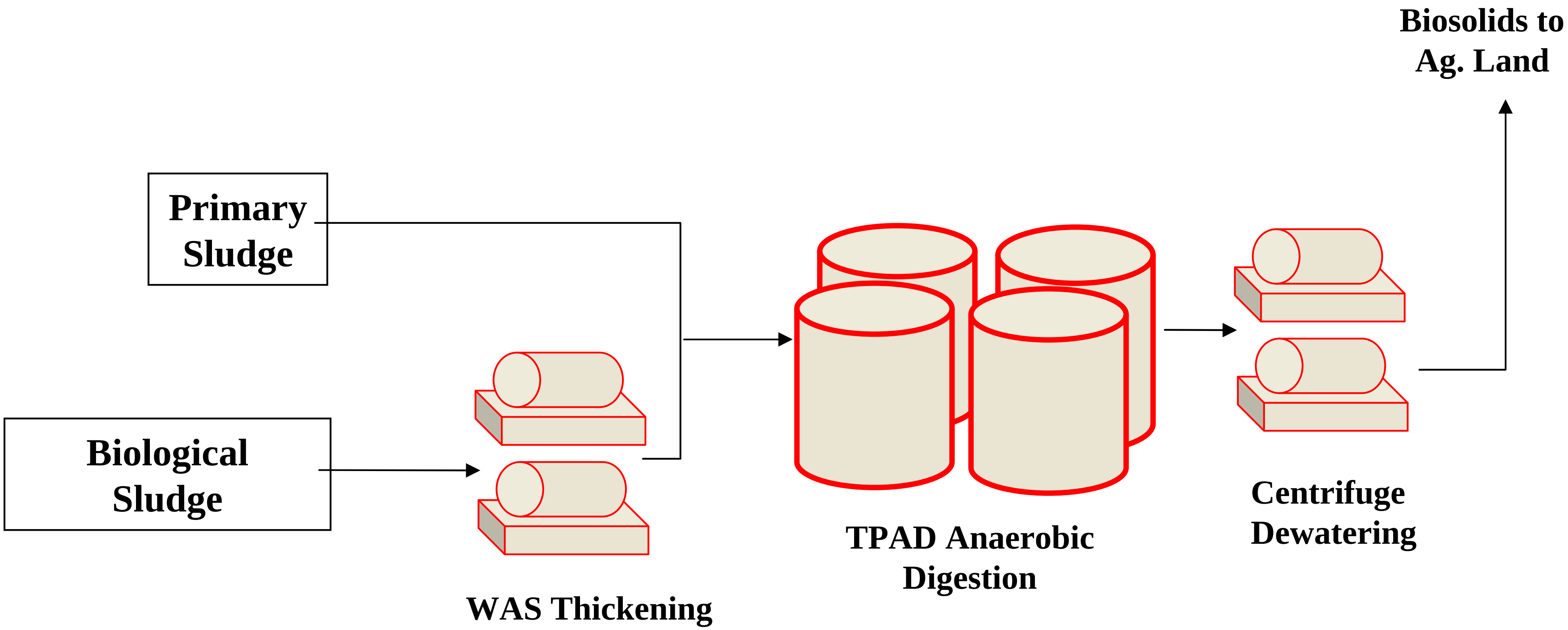
Alt. RM2b – One New Incinerator
Use Lime as Backup



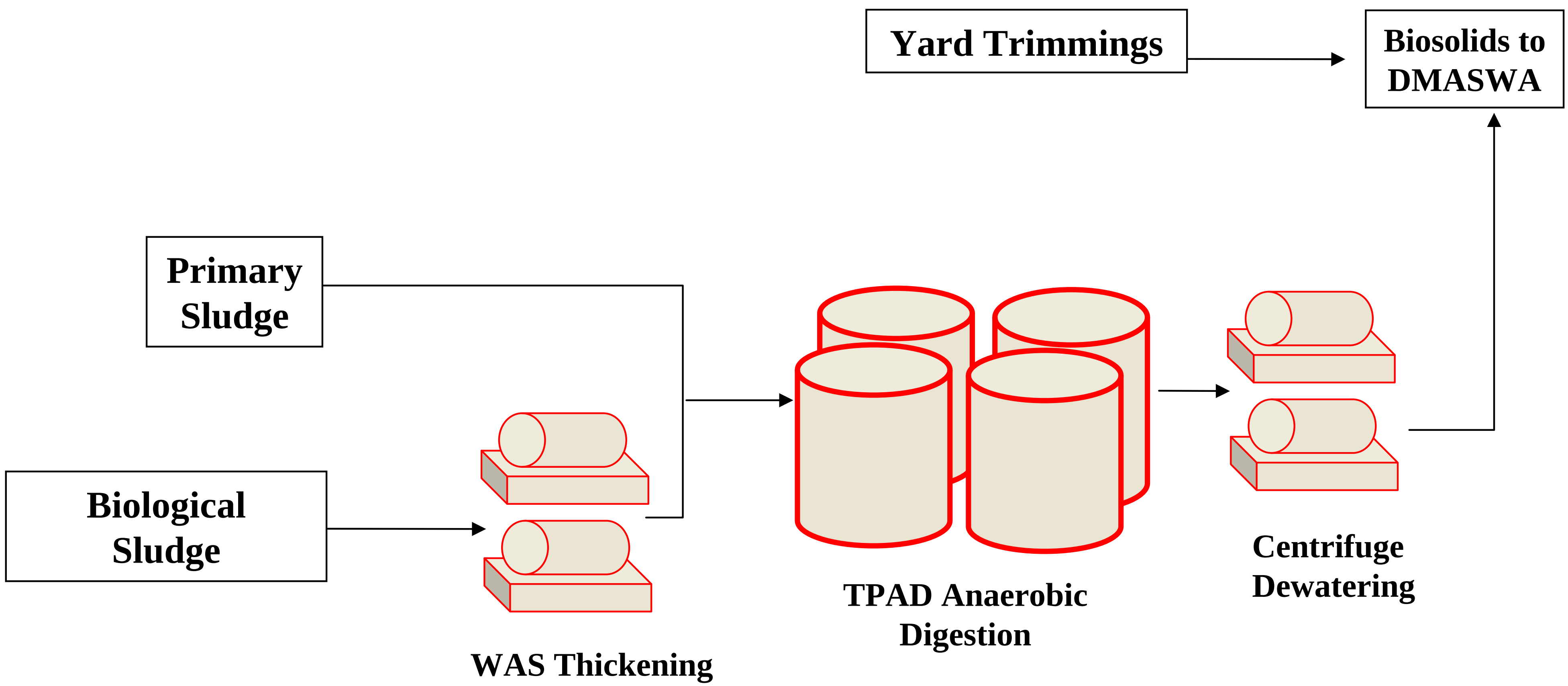
Alt. RM3 – Lime Stabilization and Land Application



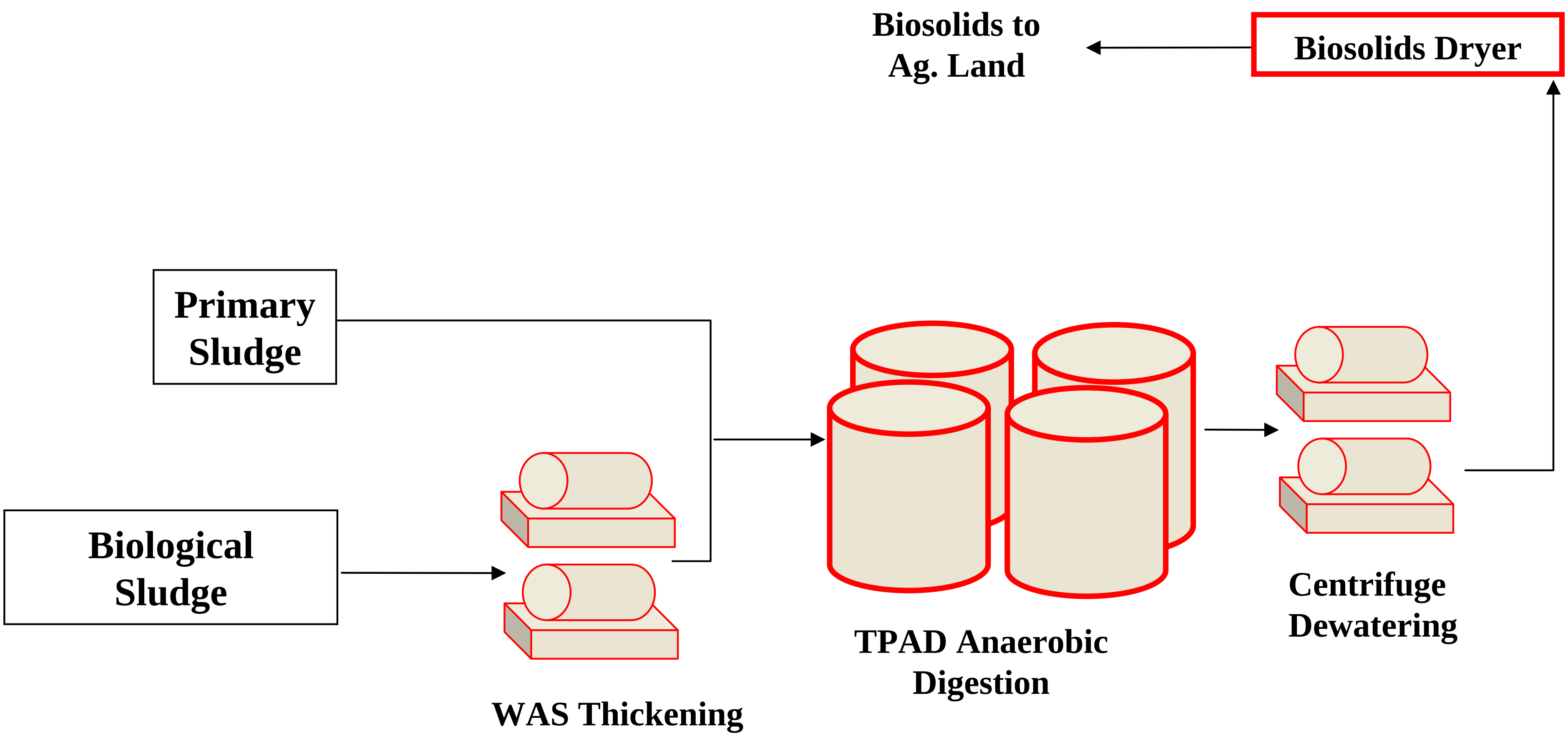
Alt. RM4 – Anaerobic Digestion with Land Application



Alt. RM5 – Anaerobic Digestion with Composting



Alt. RM6 – Anaerobic Digestion and Drying with Land Application



Alt. RM7 – Drying and Land Application