Lesson Learned – 23 Years of Food Waste Acceptance

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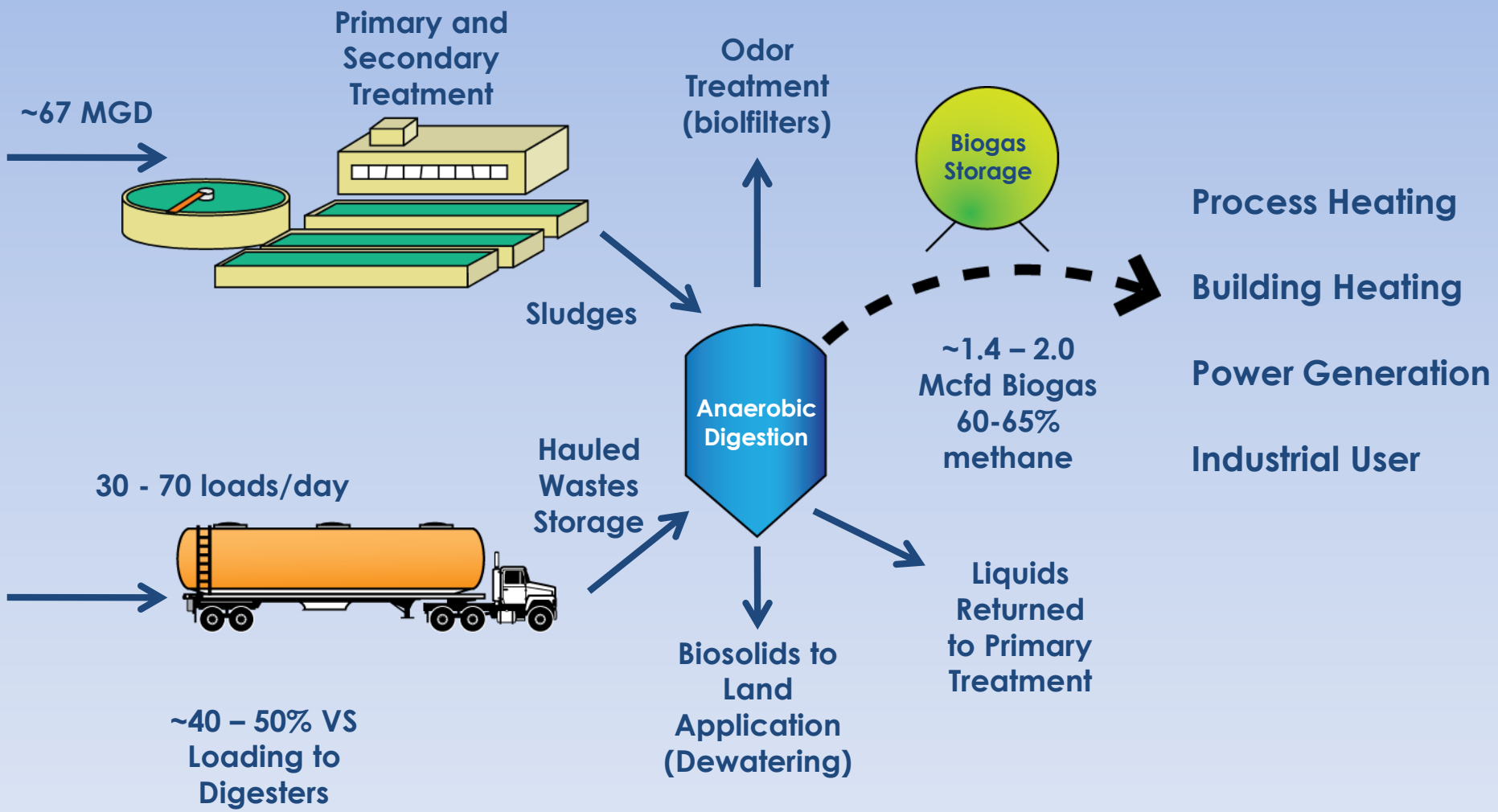
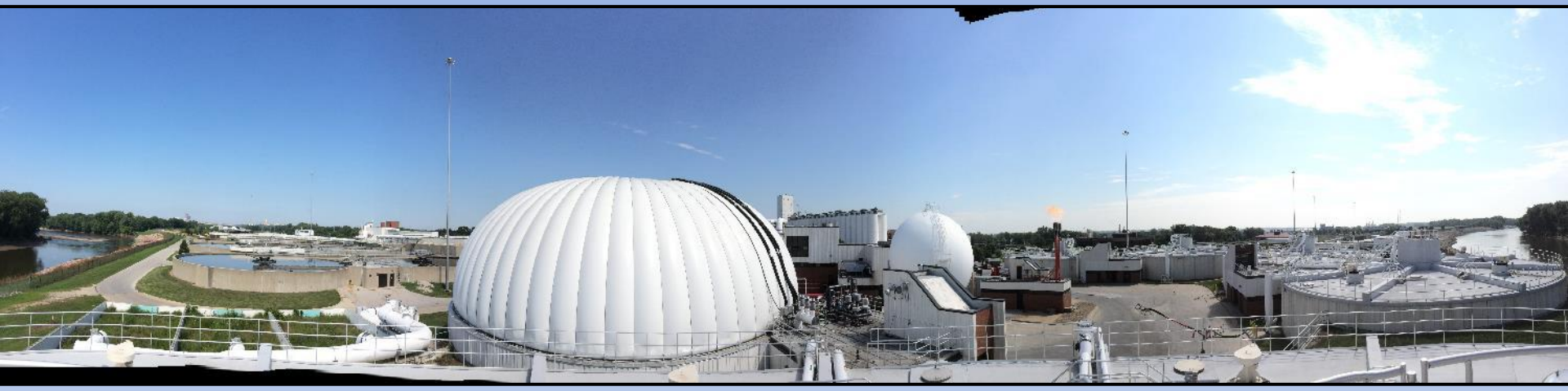
Des Moines Wastewater Reclamation Authority (WRA)

- WRA Serves 17 member agencies in three counties
- City of Des Moines is the contract operator of the WRA's wastewater reclamation facility (WRF)
- Average dry-weather flows of ~67 million gallons per day (MGD)
- Serves ~500,000 residents in greater metro Des Moines area
- *Mission Statement - Preferred hauled waste facility for Iowa and surrounding areas*

Wastewater Reclamation Facility (WRF)

Des Moines WRF Flow Schematic:

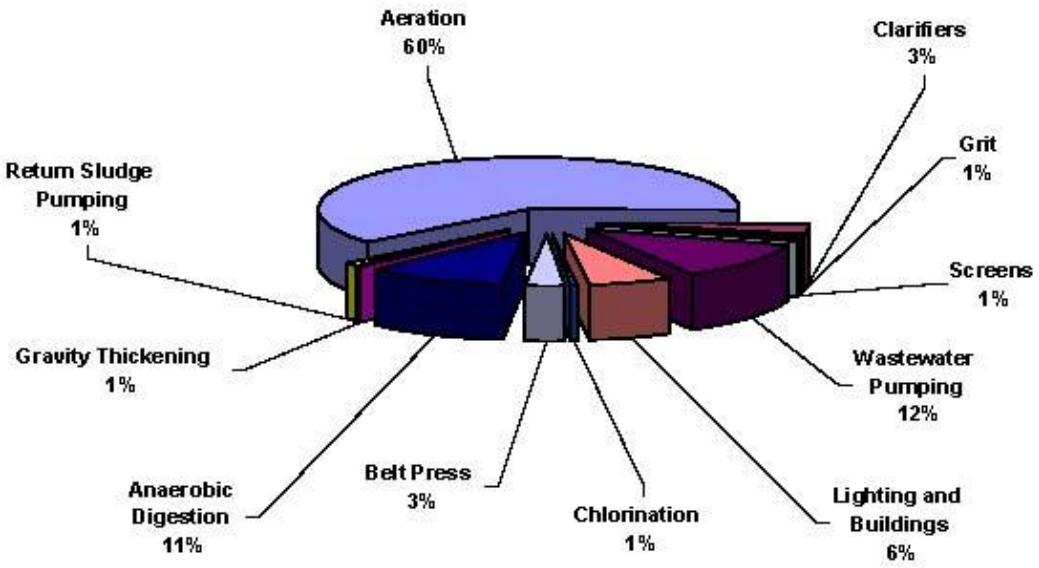




HIGH STRENGTH ORGANIC WASTE [HSOW]

Understand Your Need For Energy (Heat and Power)

Electricity Requirement for Typical Activated Sludge Facilities (WEF, 2007)



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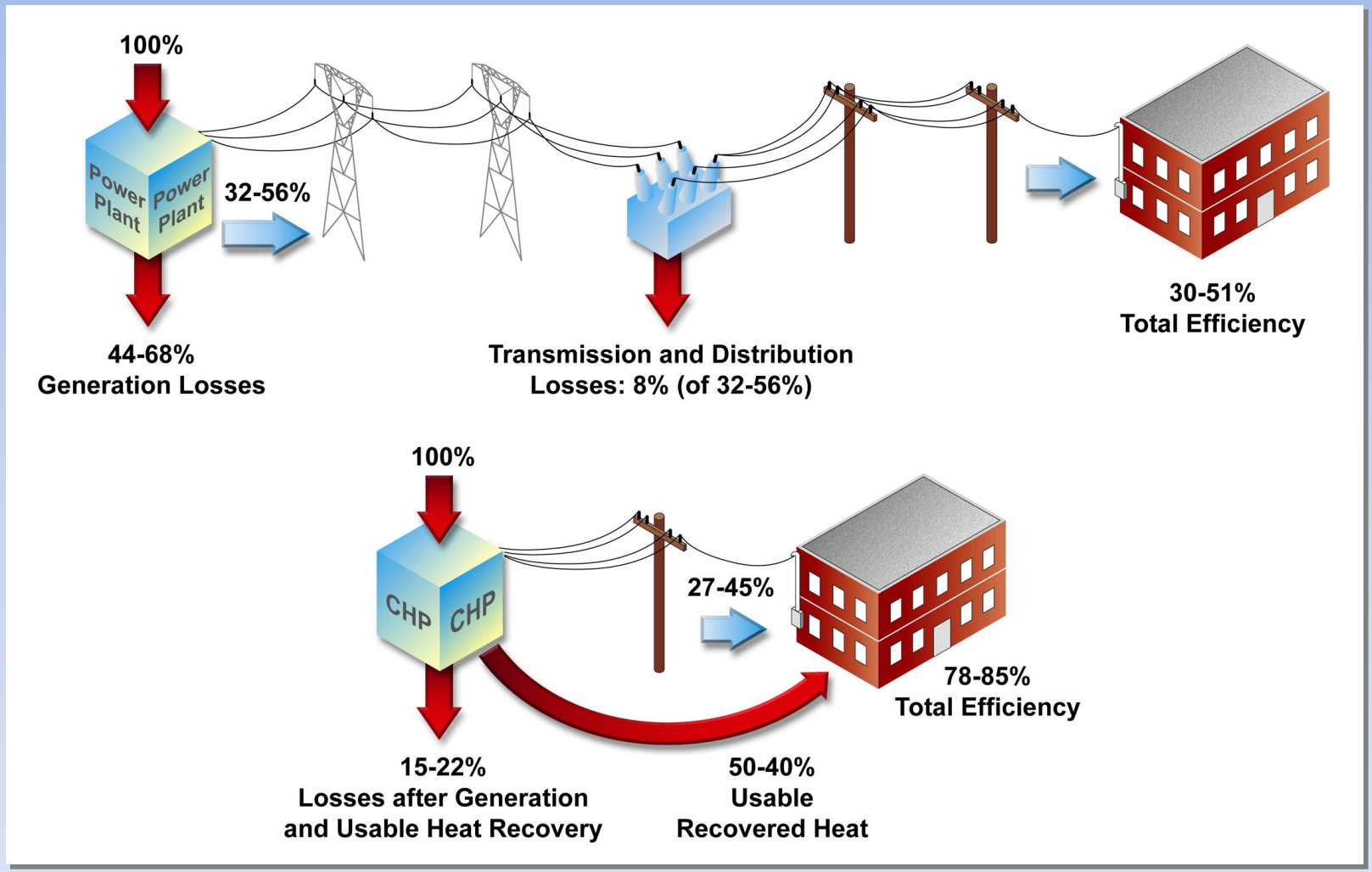
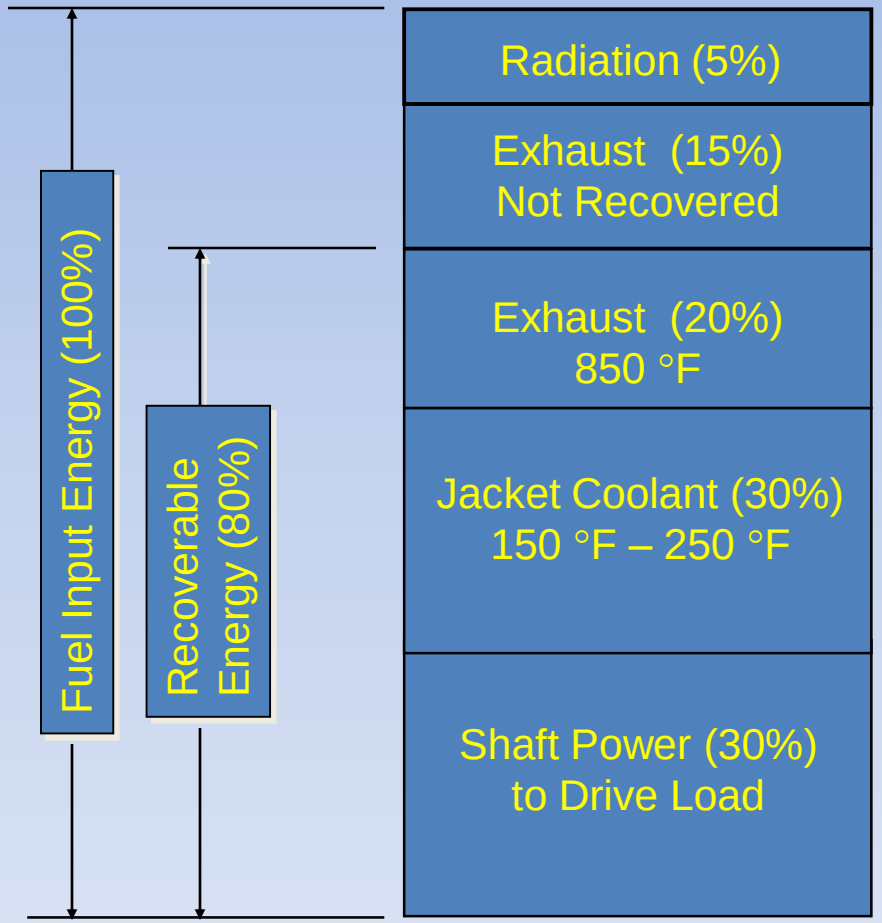
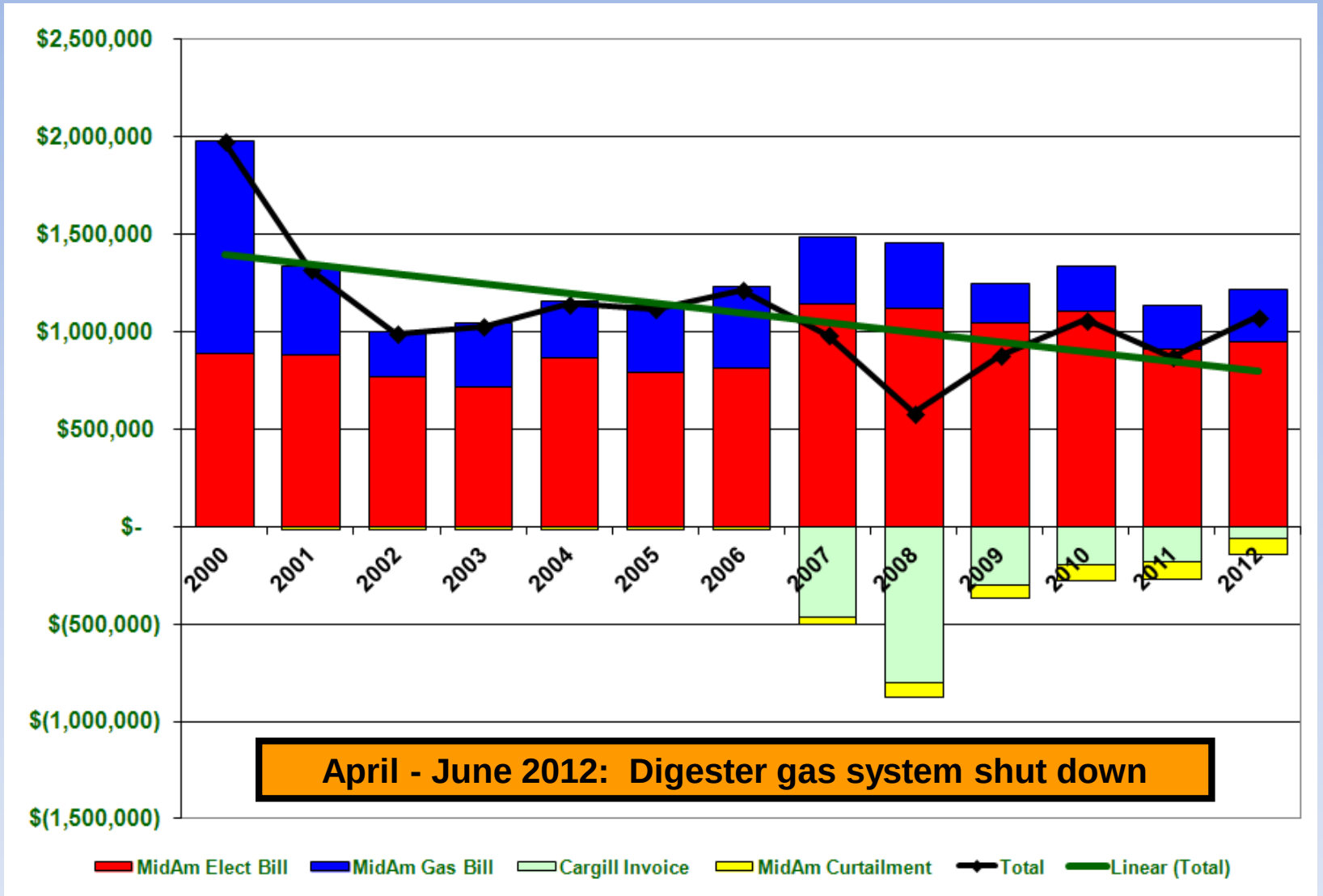
How CHP Saves Energy



Reciprocating Engine - Heat Balance



WRF Net Energy Cost



Reciprocating Engines
Rules - of - Thumb

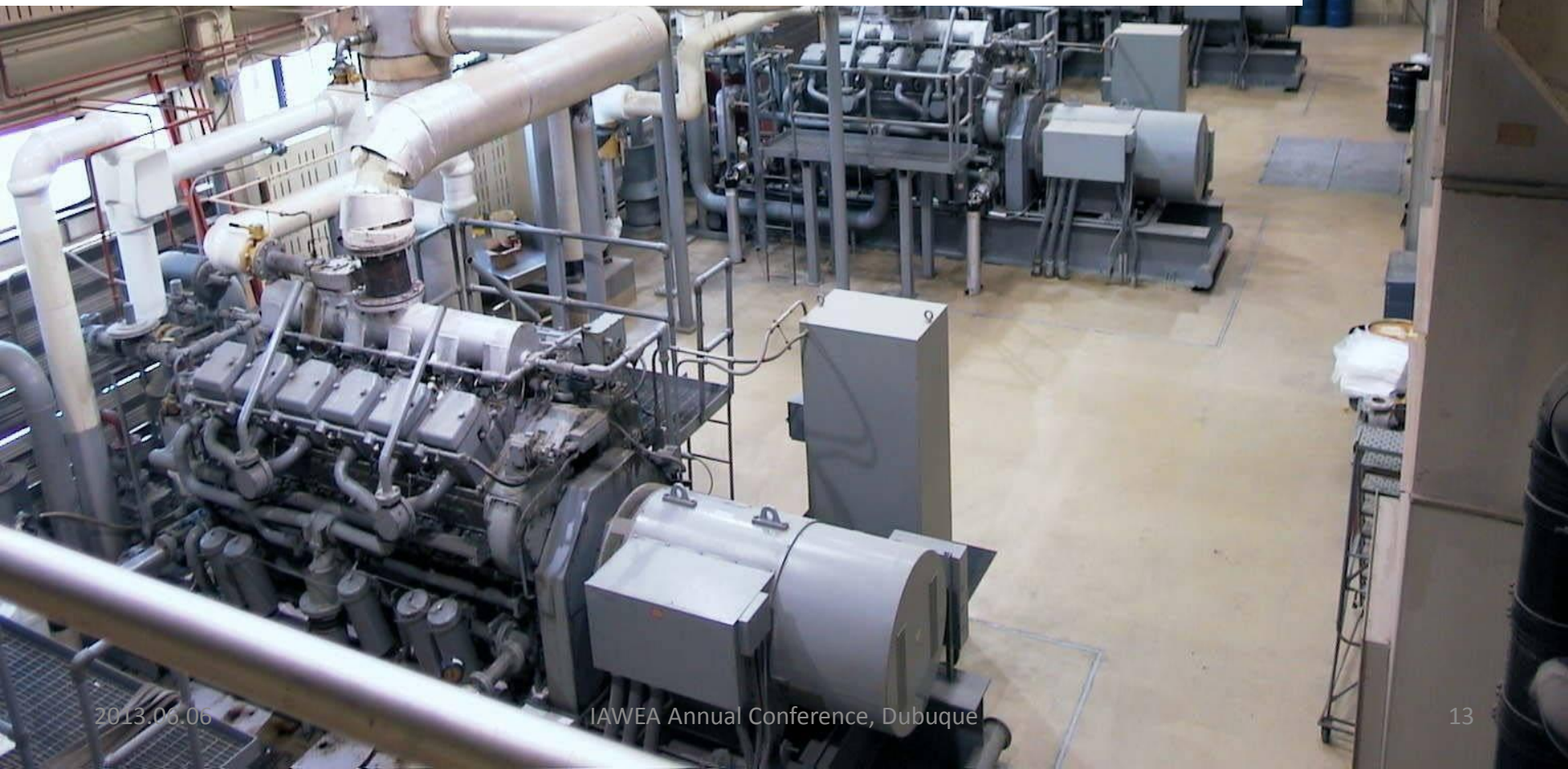
Capacity Rage *(kW)*	100 – 500	500 – 2,000
Electric Generation Efficiency LHV of Fuel *(%)* Heat Rate *(BTU/kWh)*	 24 – 28 14,000 – 12,000	 28 – 38+ 12,000 – 9,000
Recoverable Useful Heat Hot Water *(BTU/h per kW)* Steam *(lbs/h per kW)*	 4,000 – 5,000 4 - 5	 4,000 – 5,000 4-5
Installed Cost *($/kW)* *(with Heat Recovery)*	1,800 – 1,400	1,400 – 1,000
O & M Costs *($/kWh)*	0.015 – 0.012	0.012 – 0.010

Gas / Combustion Turbines
(Rules - of - Thumb)

Capacity Rage *(kW)*	1,000 – 10,000	10,000 – 50,000
Electric Generation Efficiency LHV of Fuel *(%)* Heat Rate *(BTU/kWh)*	 24 – 28 14,000 – 12,000	 31 – 36 11,000 – 9,500
Recoverable Useful Heat Hot Water *(BTU/h per kW)* Steam *(lbs/h per kW)*	 5,000 – 6,000 5 - 6	 5,000 – 6,000 5 - 6
Installed Cost *($/kW)* *(with Heat Recovery)*	1,500 – 1,000	1,000 – 800
O & M Costs *($/kWh)*	0.015 –0.012	0.012 – 0.010
Emission Levels *(ppm)* NOx (Dry Low NOx) NOx (SCR)	 < 25 < 9	 < 25 < 9


90
DIGESTION COMPLEX

- Combined heat and power (CHP)
- 3 engine generator sets, each ~600 kW
- Used over **175 million cubic feet of digester biogas** to generate **10.9 million kWh of electricity** in 2012



Biofuels Co-Digestion
Des Moines WRF

- ~67 MGD Primary & Secondary WWTP w/ Anaerobic Digestion
- Receives ~500,000 gal / week of "Hauled-In Waste" for Co-Digestion High Volatile Solids, which makes up > 40-50% of Digester Loading

  - FOG (Brown grease from grease traps)
  - Corn syrup mash from Ethanol Production
  - Glycerin from Biodiesel Production
  - Soybean Oil
  - Sugar Waste
  - Dairy Waste
  - Rendering gelatin
  - Lutein (marigold extract)

Hauled Waste Receiving Upgrades (2007)

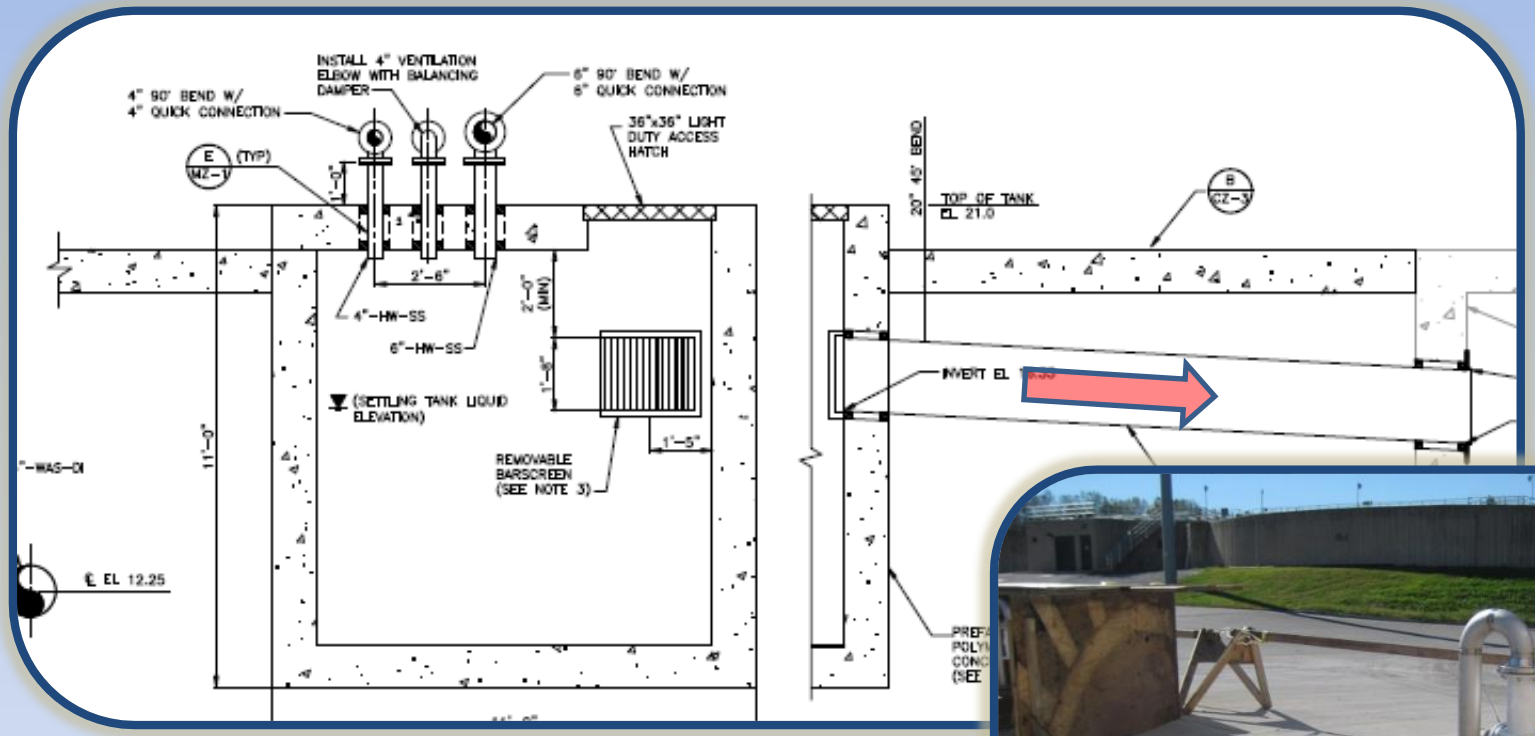
Hauled Waste Unloading Facility
~1994

Hauled Waste Unloading Facility
Upgraded ~2007

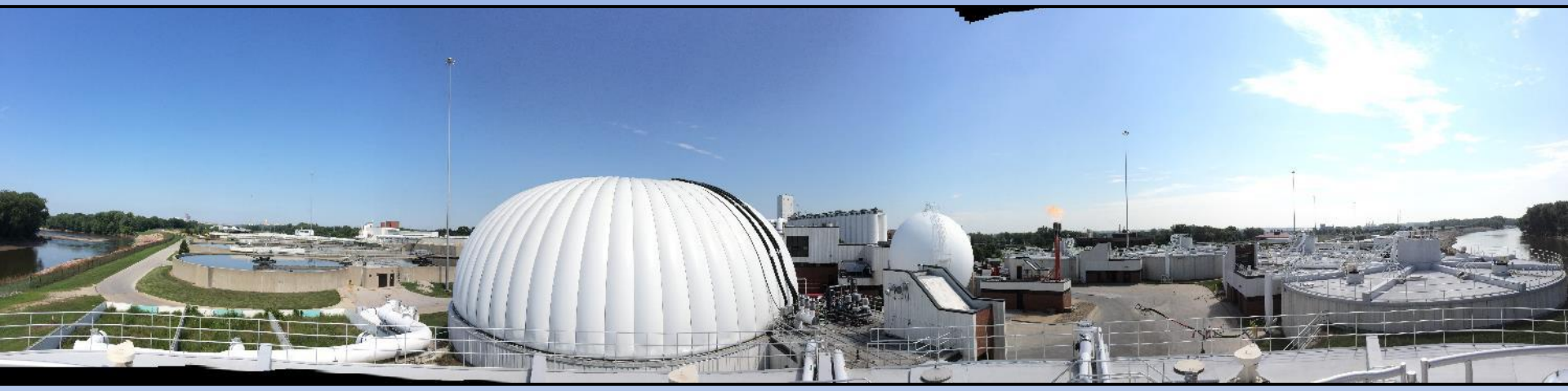
Managing Corrosive & High-Strength Materials

- Corrosive conditions
  - pH, 3.5 to 12
  - VS, 32 – 99%, Avg. = 81-percent
  - Temp, 50 – 200 °F
  - Oil and Grease, <1,000 – 125,000 mg/L, Avg. 8,600 mg/L
- Highly variable characteristics from each hauled waste load

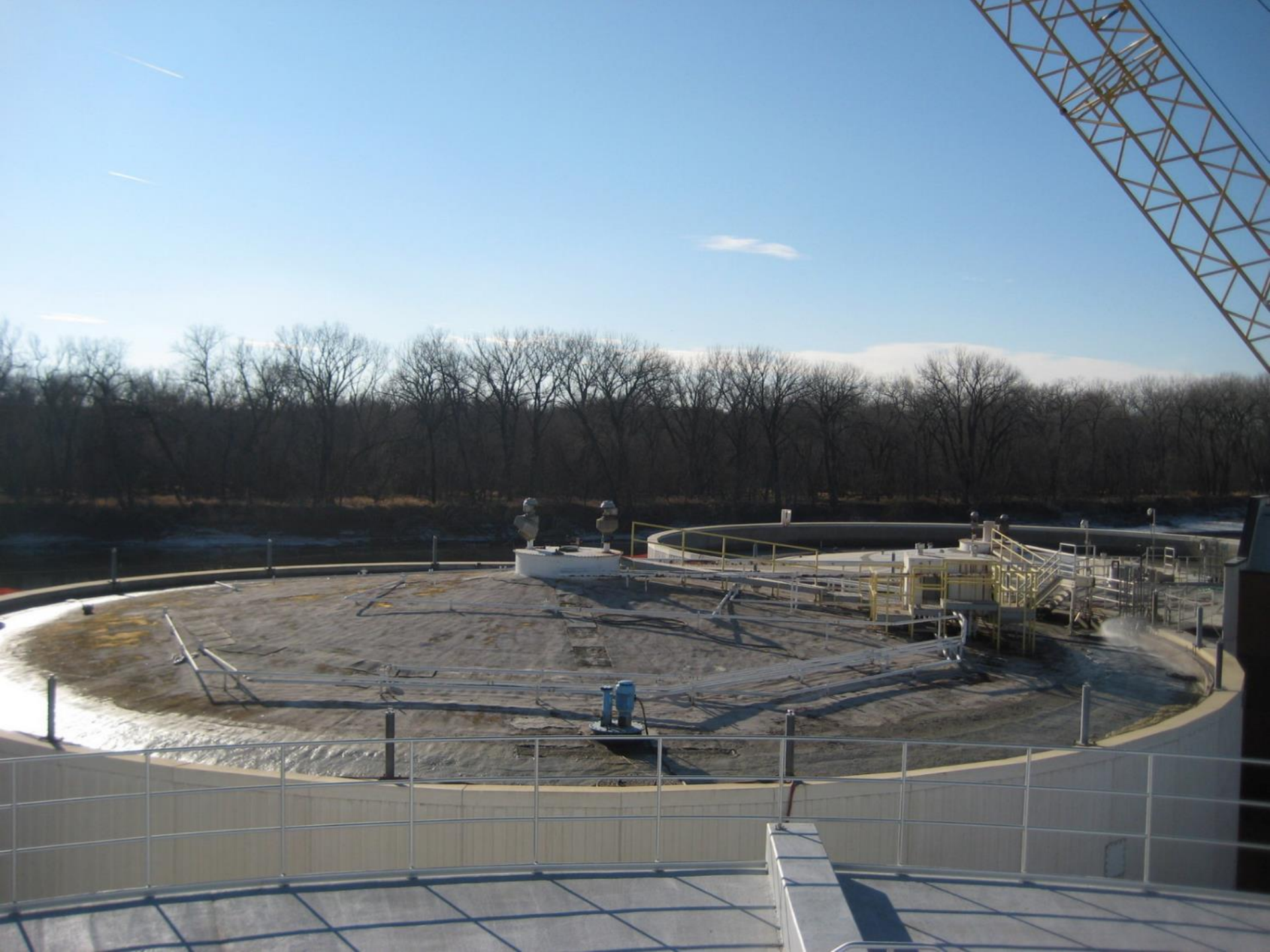
Hauled Waste Receiving Upgrades (2009)



A Wastewater and Hauled Organic Waste Treatment Center

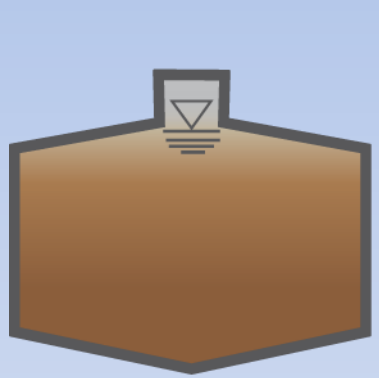


FACILITY IMPROVEMENTS

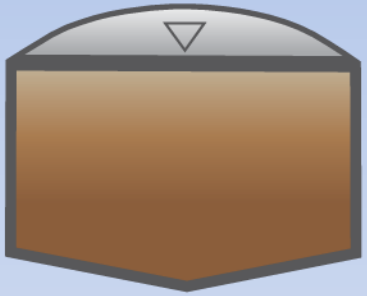


WRF Digester Improvements

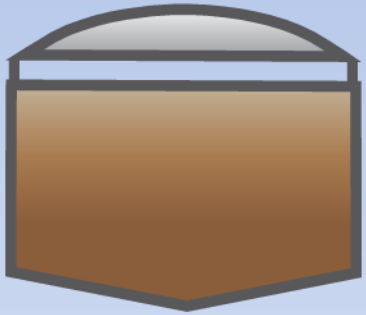
- Digester Covers Evaluated



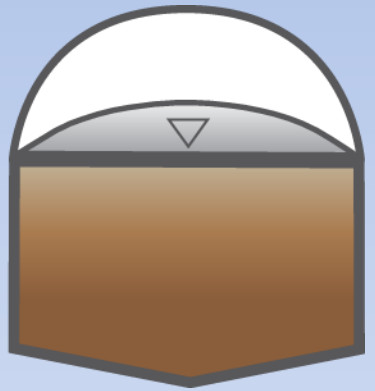
Submerged Fixed Concrete



Fixed Steel



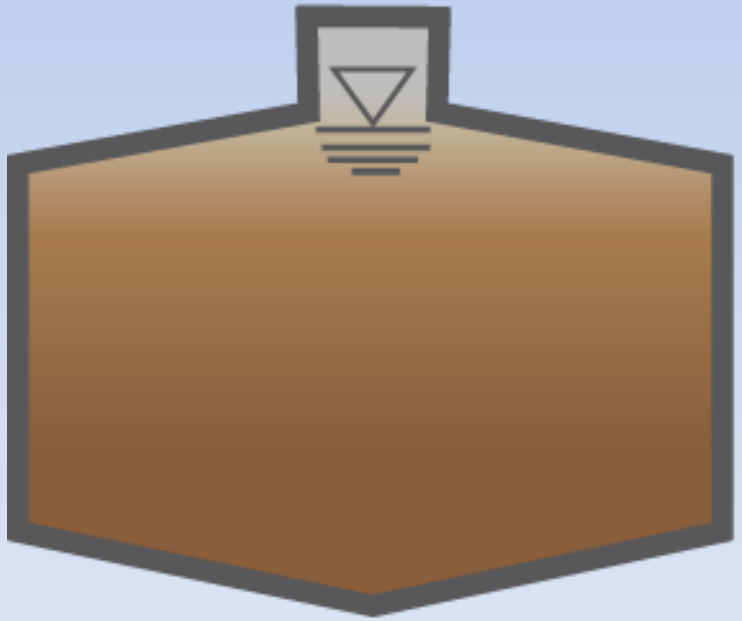
Floating



Gas Membrane

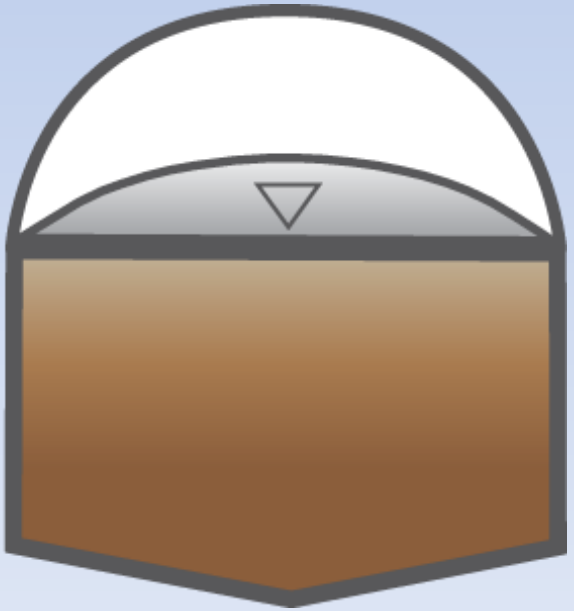
Submerged Fixed Concrete Covers Selected for Primary Digesters

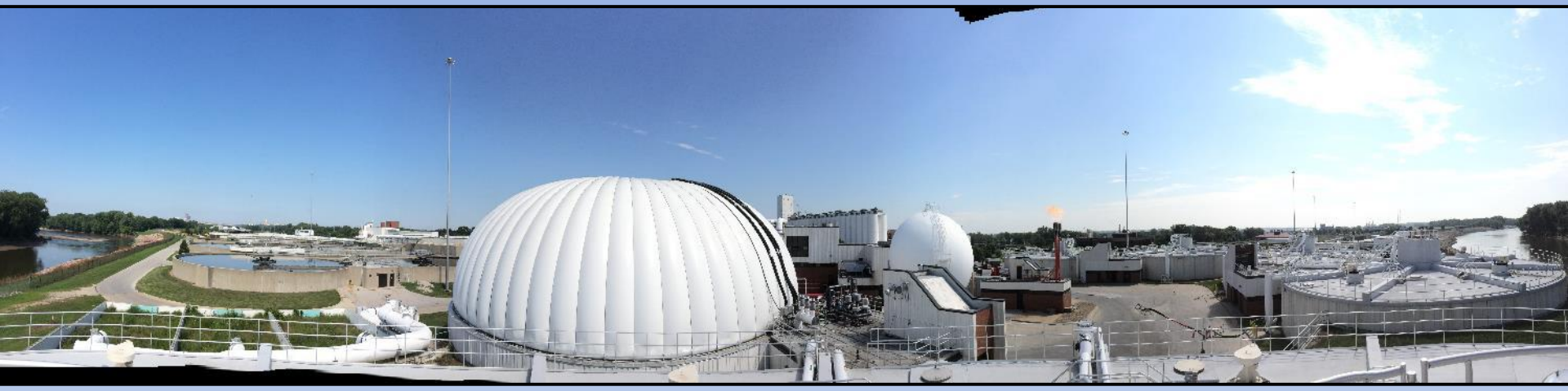
- Concentrate scum and foam at central point
  - *Allows spray suppression to be more effective*
  - *Large diameter draw-off for rapid removal*
- Additional benefits
  - *Ease of maintenance*
  - *Increases tank capacity 8%*



Gas Membrane Covers Selected for Secondary Digester

- Allows for variable sludge levels for flexibility in dewatering operational schedule
- Provides biogas storage dampening
- Designed with capability to continue to operate as primary digester





FACILITY CONSTRUCTION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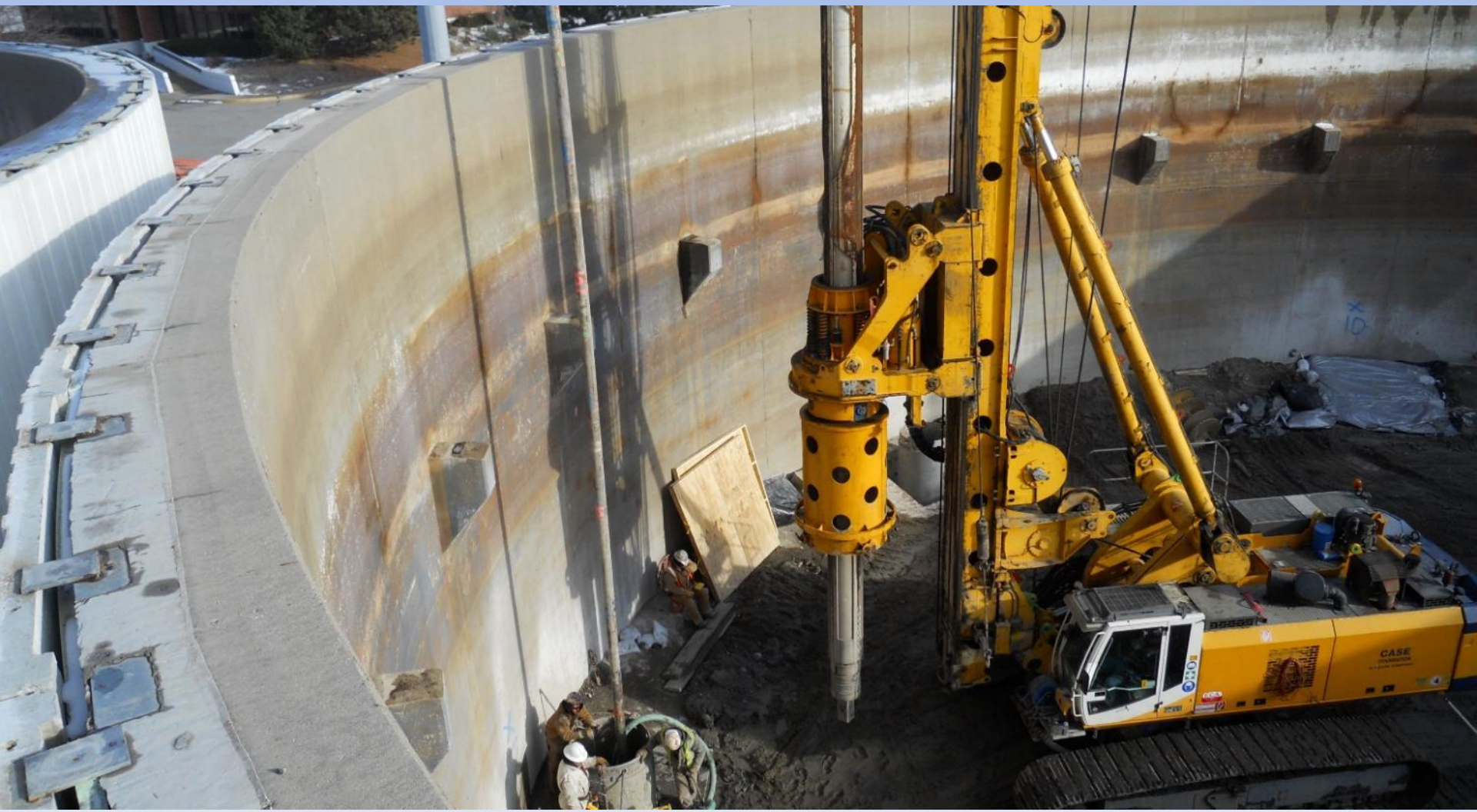
West view of Digestor Complex

New Submerged Fixed Concrete Covers Required Extensive Support System

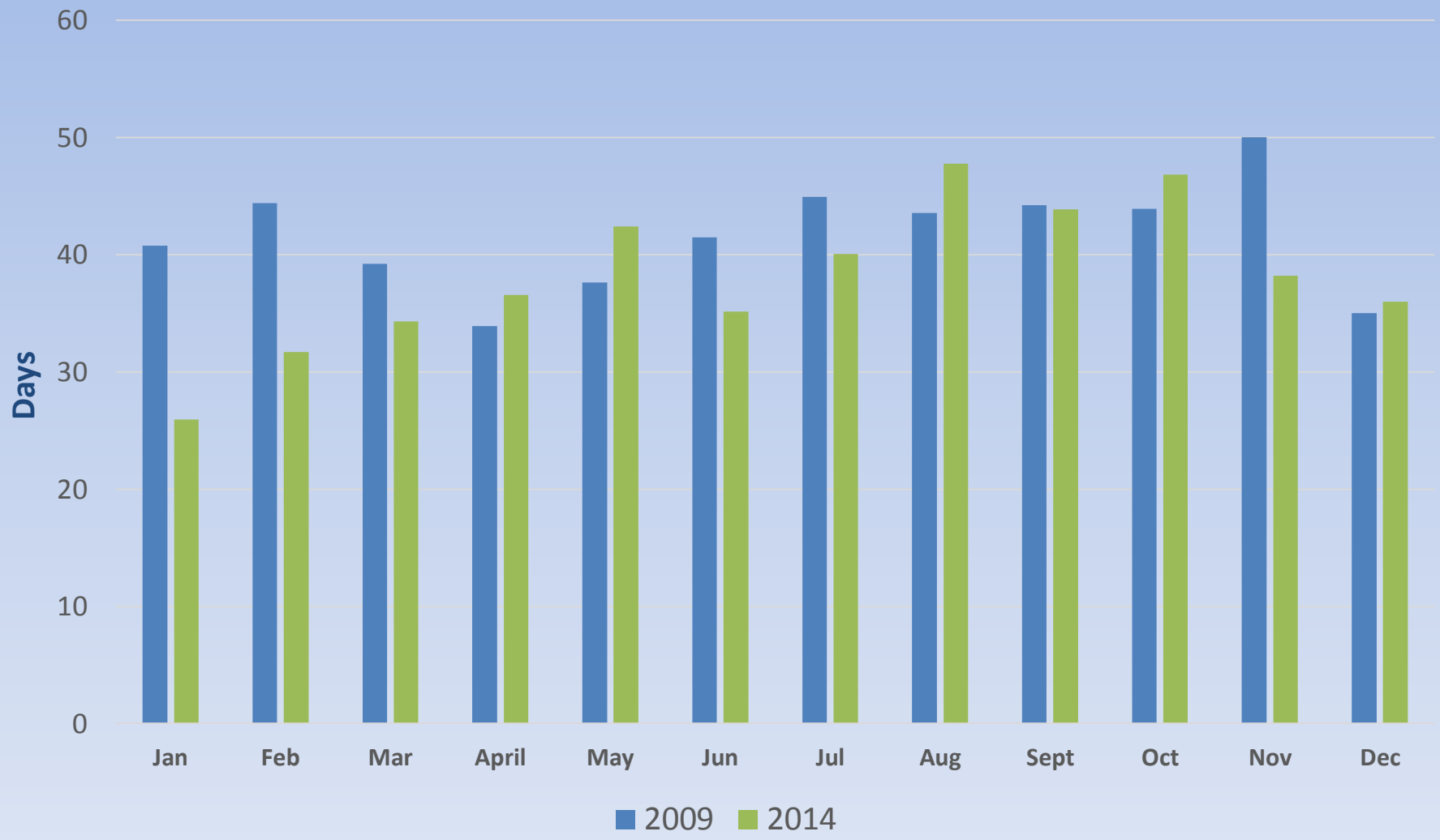


Interior Tank Columns Used to Support the Concrete Cover

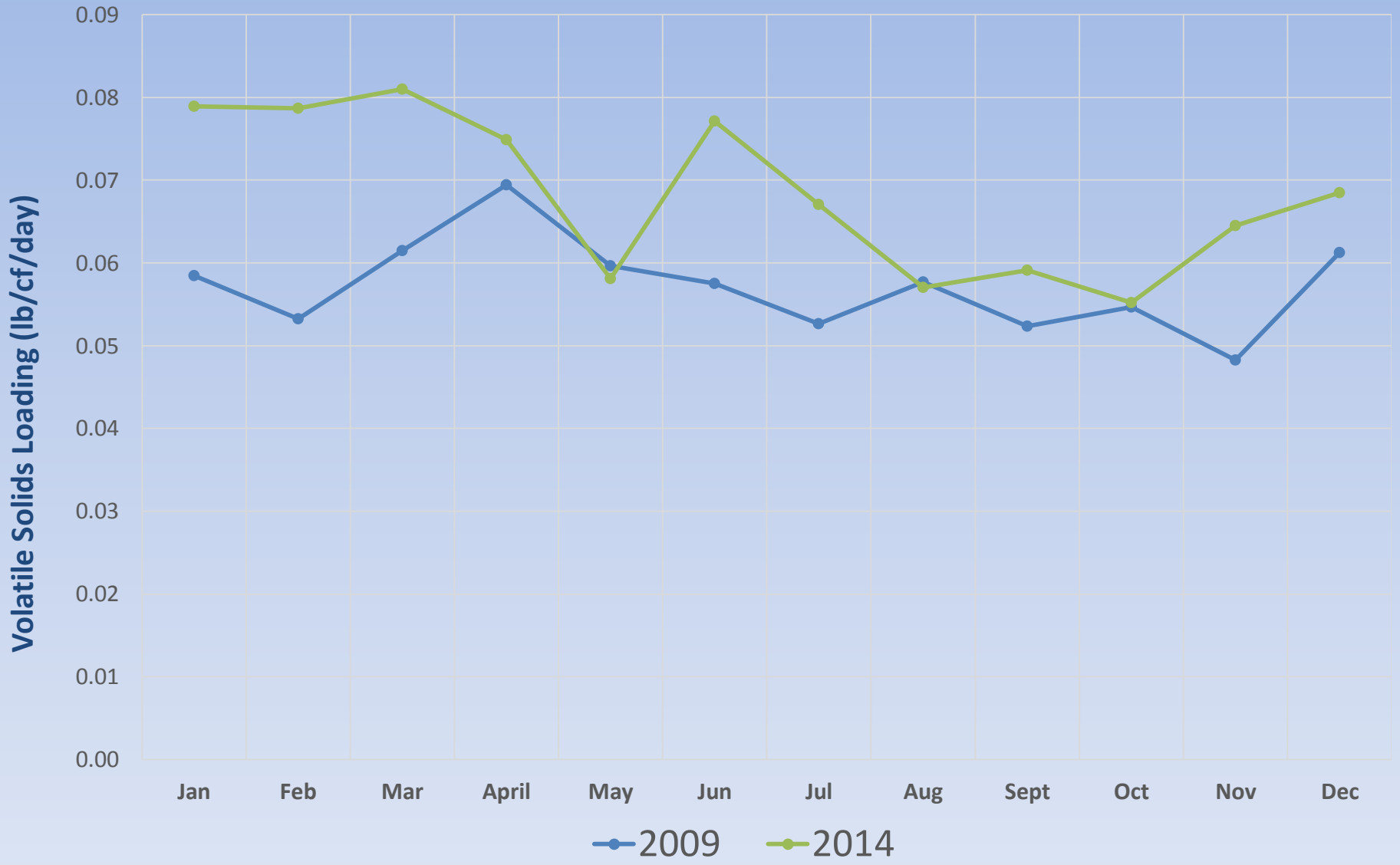

80-2

PERFORMANCE METRICS

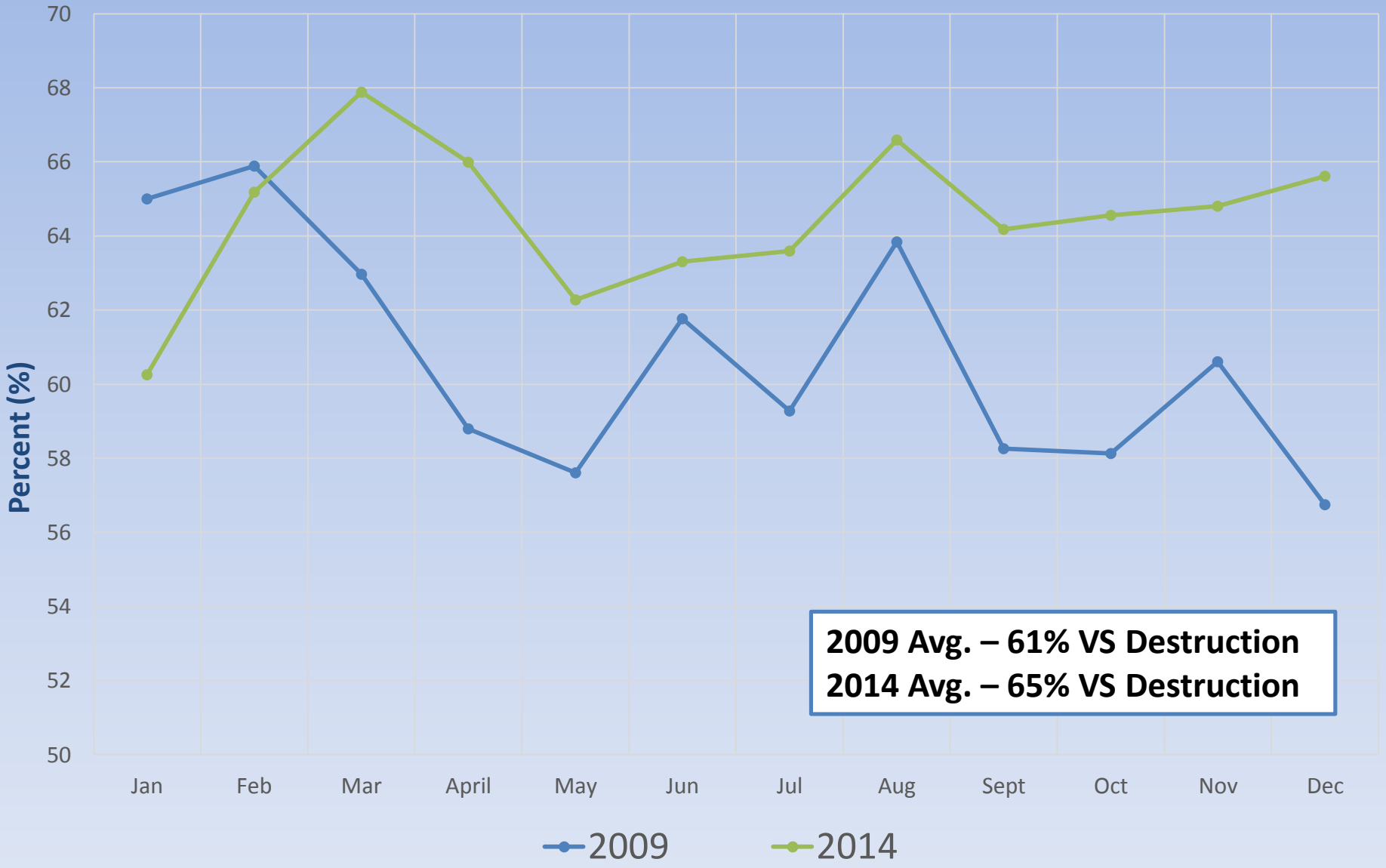
Anaerobic Digester
Hydraulic Residence Time (HRT)



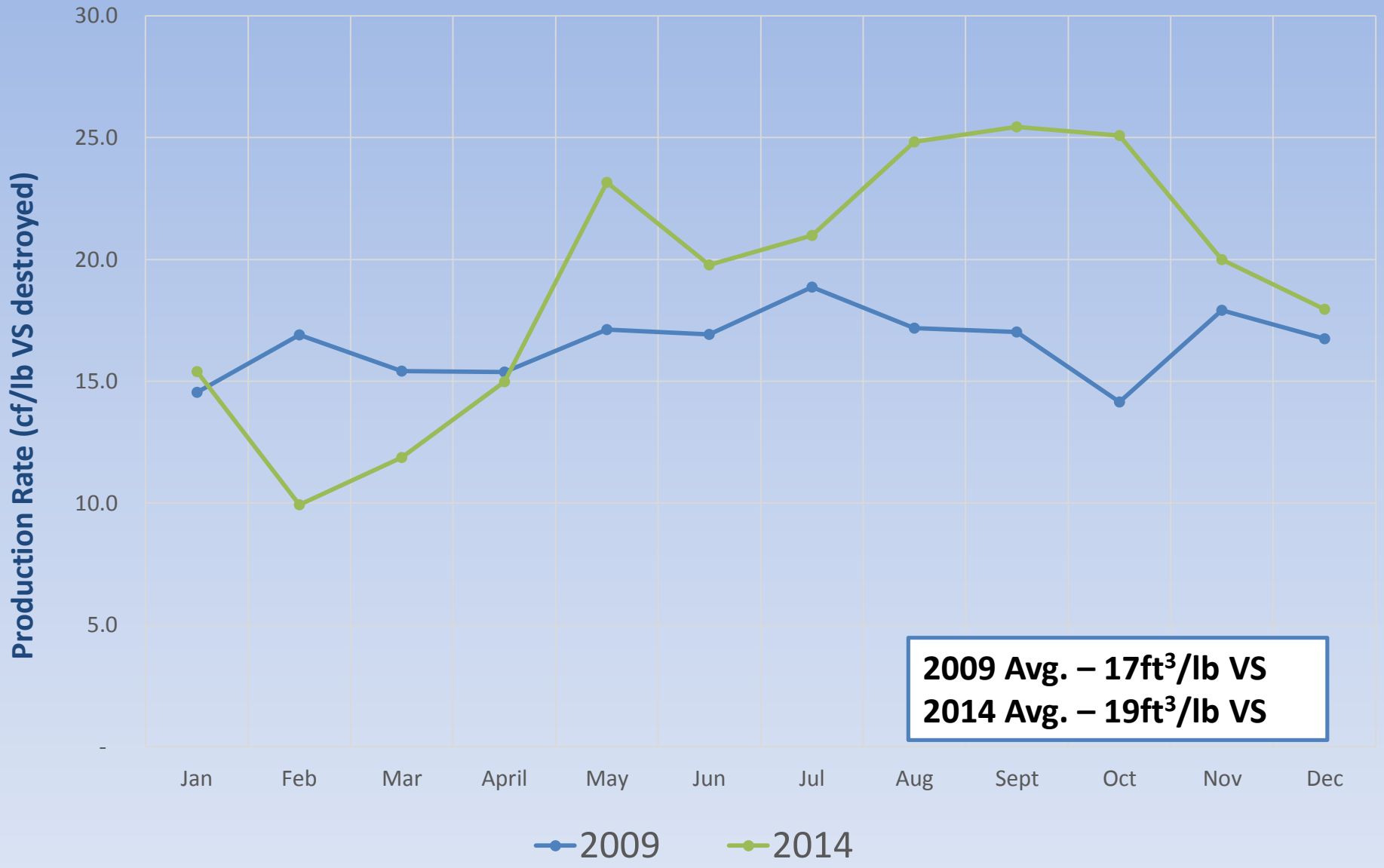
Blended Sludge Feed – Volatile Solids Loading



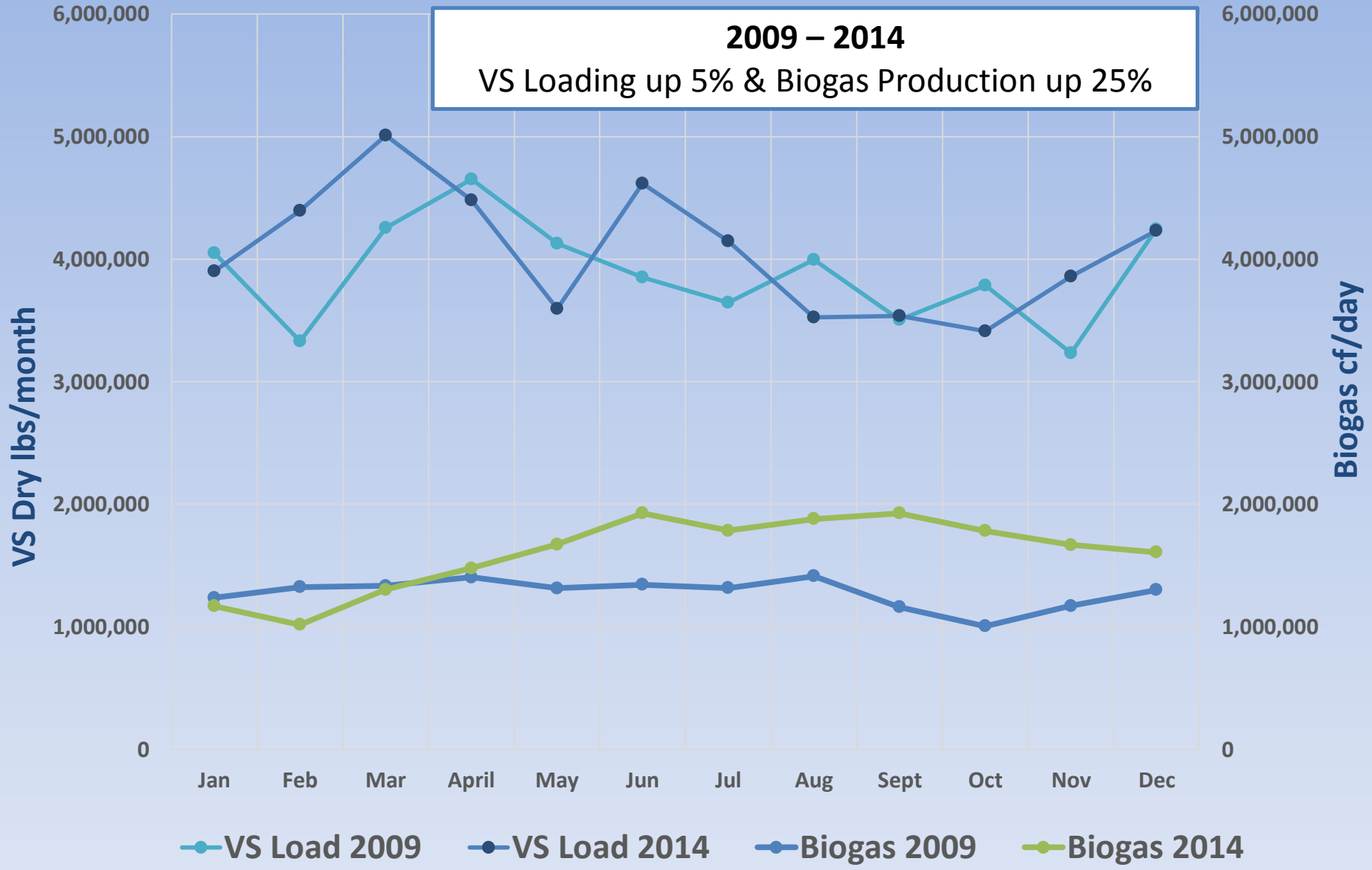
Volatile Solids Reduction



Average Biogas Production Rate



2009 vs. 2014: VS Loading & Biogas Production



CONCLUSIONS

Conclusions

- Collect data, flow, temperature, waste characteristics, etc.
- Food wastes are an excellent digester feedstock
- Co-digestion of food wastes is a proven way to increase energy production
  - 5% increase in VS Loading and a 25% increase in biogas production
- Know your energy needs and energy production potential. Recognize that these are rarely in balance
- Utilize existing infrastructure where possible
- Plan for change – keep a list of prioritized improvements

For More Information

WERF

Water Environment Research Foundation

Collaboration. Innovation. Results.

Co-Digestion of Organic Waste Products with Wastewater Solids

INTERIM REPORT

WERF

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Table 2-6. Gas Production and Yield as a Function of COD Removal.

	Feed	Volume (ml)	COD (mg/ml)	COD Fed (mg)	Digested Sludge COD (mg/ml)	Digested Sludge COD (mg)	COD Removed (mg)	Biogas Volume Increase (ml)	Yield (ml Gas/mg COD_t)	% of Theoretical Biogas Production
Round 1	Co-thickened Sludge	5	95	475	34	170	305	110	0.36	58%
	Canola Oil	0.053	1790	570	34	172	398	165	0.41	67%
	Restaurant Grease	0.205	463	570	33.2	172	398	223	0.56	90%

Acknowledgements

- Larry Hare, Jim Buck, James Beck, Scott Hutchens, and all WRA operations and maintenance staff

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- Scott Carr, P.E., Black & Veatch

QUESTIONS / DISCUSSION

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