Generating Energy Through Co-Digestion

City of Fort Worth
Village Creek Water Reclamation Facility

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Metropolitan Water Reclamation District of Greater Chicago

Outline

- VCWRF Description
- Journey to Achieve Energy Independence
  - Gas Turbines
  - JCI Energy Performance Contract
- Co-Digestion Phases
  - Planning
  - Implementation
  - Operation
- Lessons Learned

Water Reclamation Facility
Treatment, Recovery and Reuse

Service to over 1 million customers in 23 communities

Wastewater

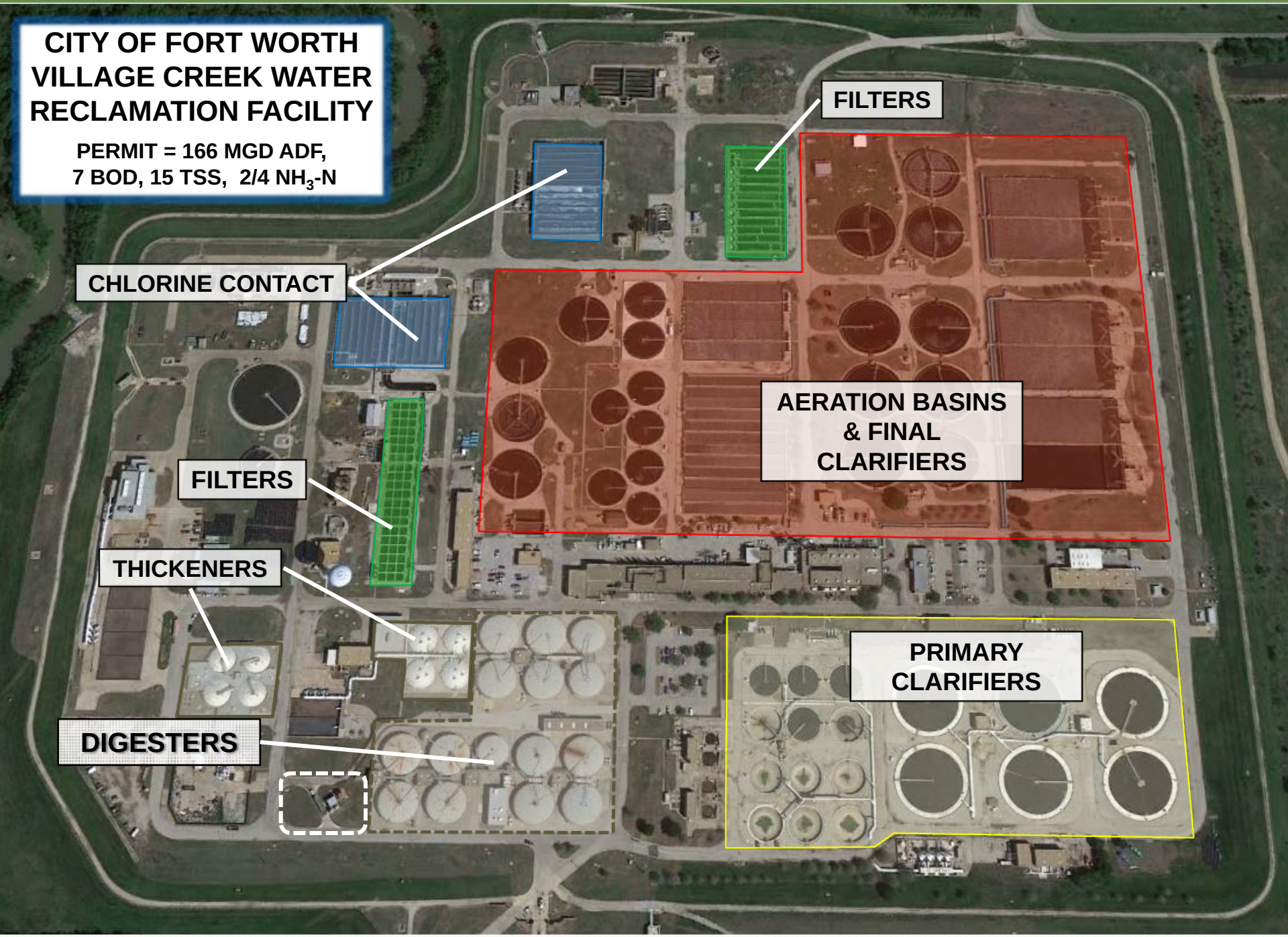
Village Creek WRF

Trinity River

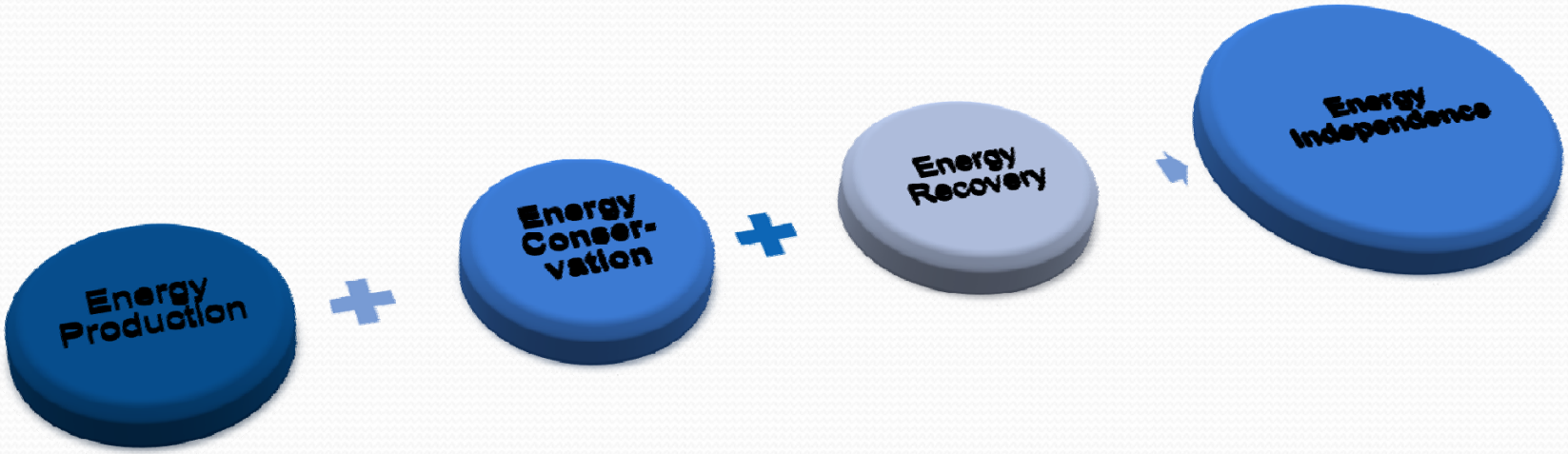
Reuse Water

Biosolids

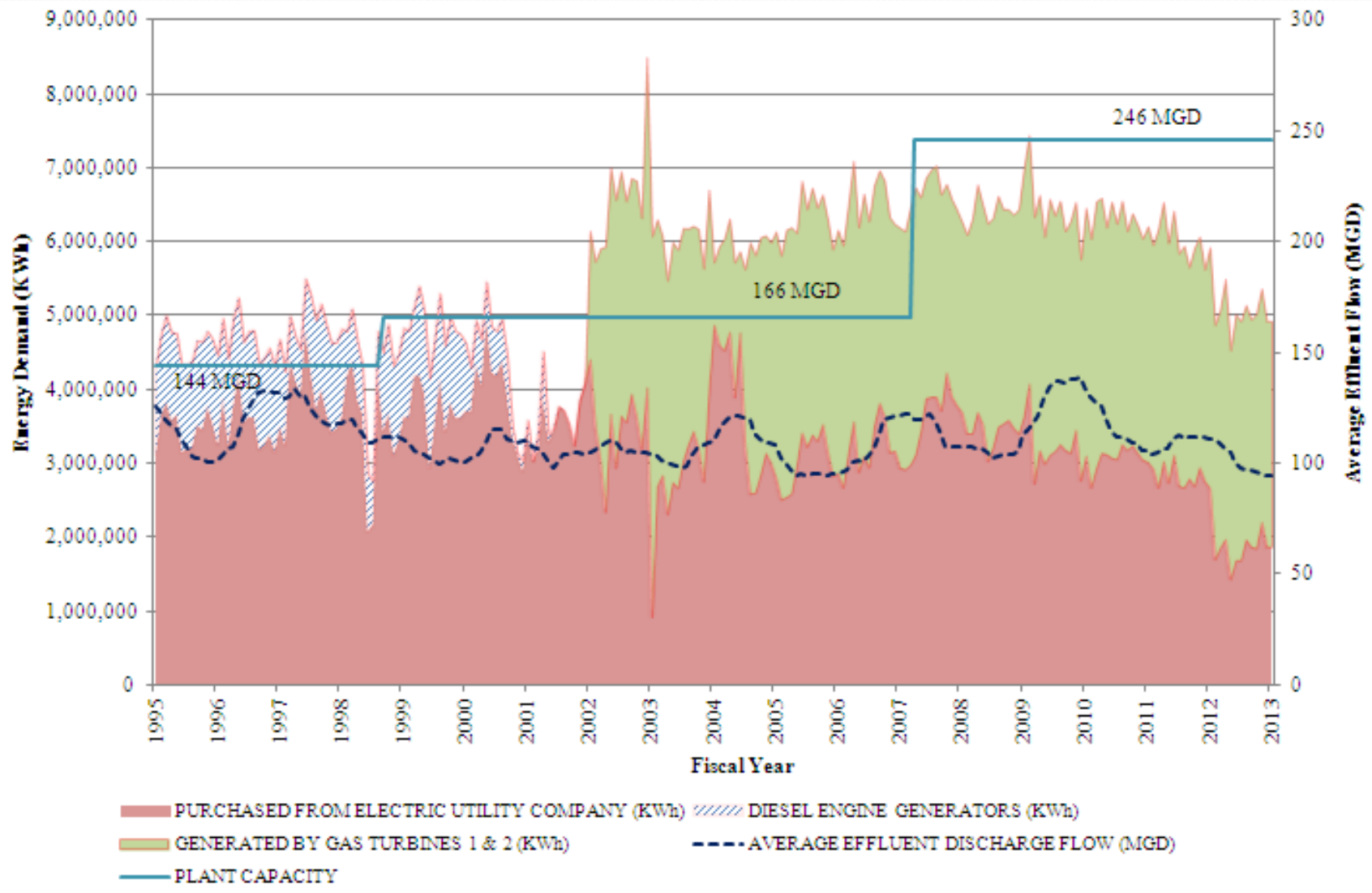
Energy


CITY OF FORT WORTH
VILLAGE CREEK WATER
RECLAMATION FACILITY
PERMIT = 166 MGD ADF,
7 BOD, 15 TSS, 2/4 NH_3-N
FILTERS
CHLORINE CONTACT
AERATION BASINS
& FINAL
CLARIFIERS
FILTERS
THICKENERS
PRIMARY
CLARIFIERS
DIGESTERS

Journey to Achieve Energy Independence

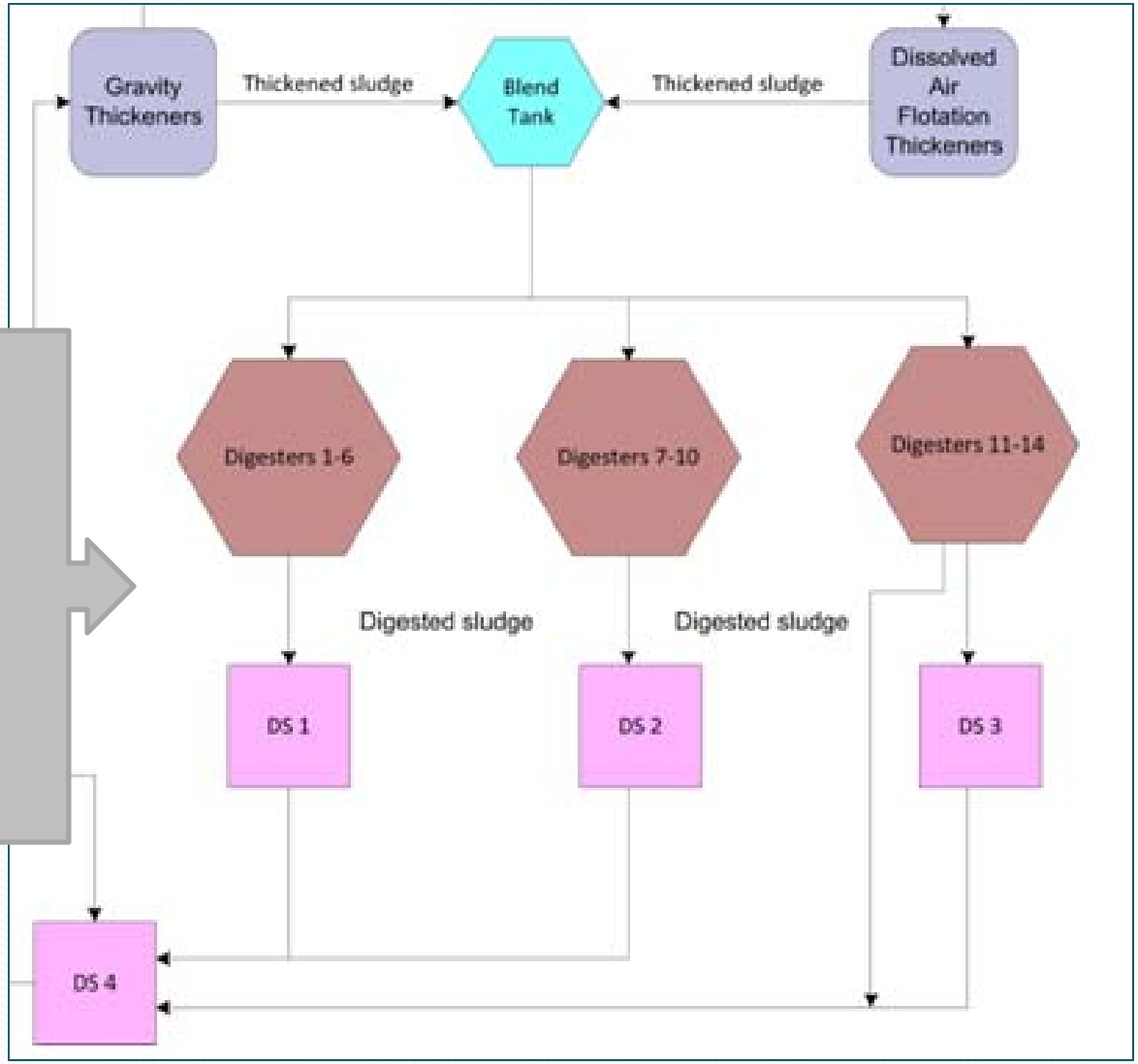


Electrical Utilization



Energy Production…

Starts at the 14 Anaerobic Digesters



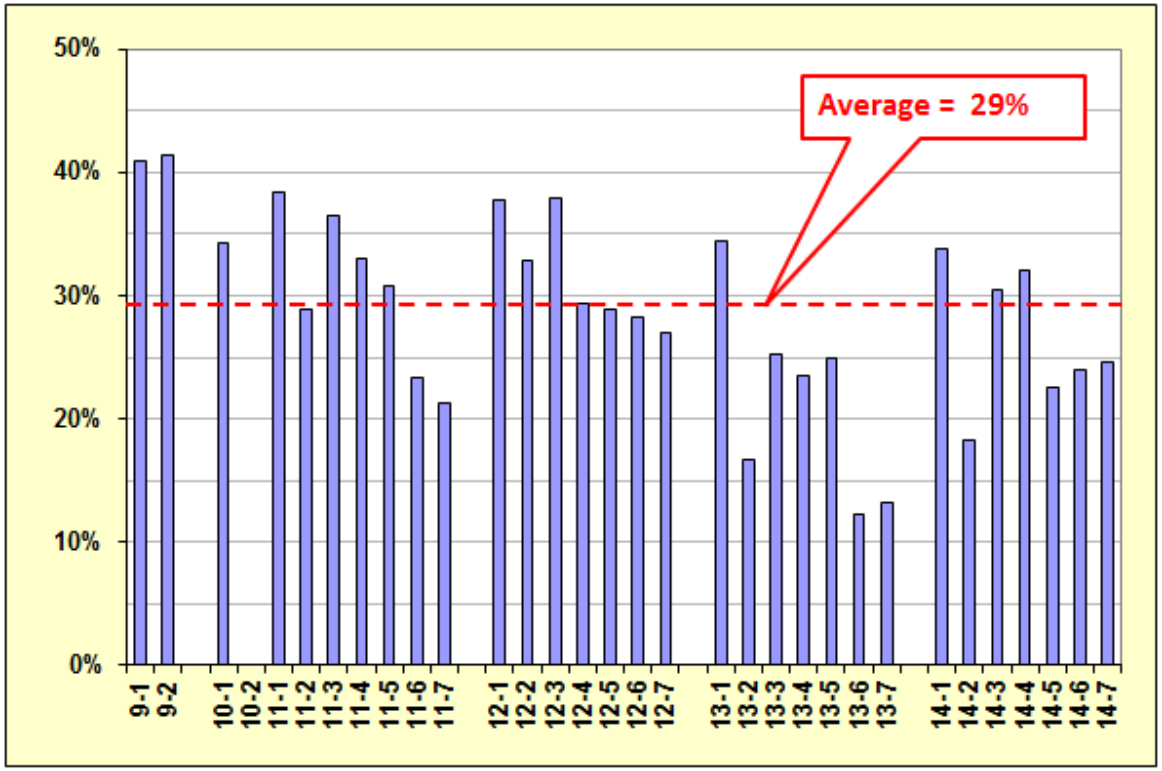
Operational Parameters

PARAMETER	RANGE OR TARGET
pH Range	6.8 – 7.4
Temperature	95^{o} – 99^{o}
Detention Time	≥15 Days
Volatile Acids	<500 mg/L
Alkalinity	~3000 mg/L
Feed Total Solids %	>2.5%
% Volatile Solids Destruction	≥38%

Operational Challenges

No efficient mixing with gas compression

Operational Challenges



Grit accumulation & loss of treatment volume

Energy Conservation & Recovery

Achieved with the JCI Energy Savings Performance Contract which goals were:

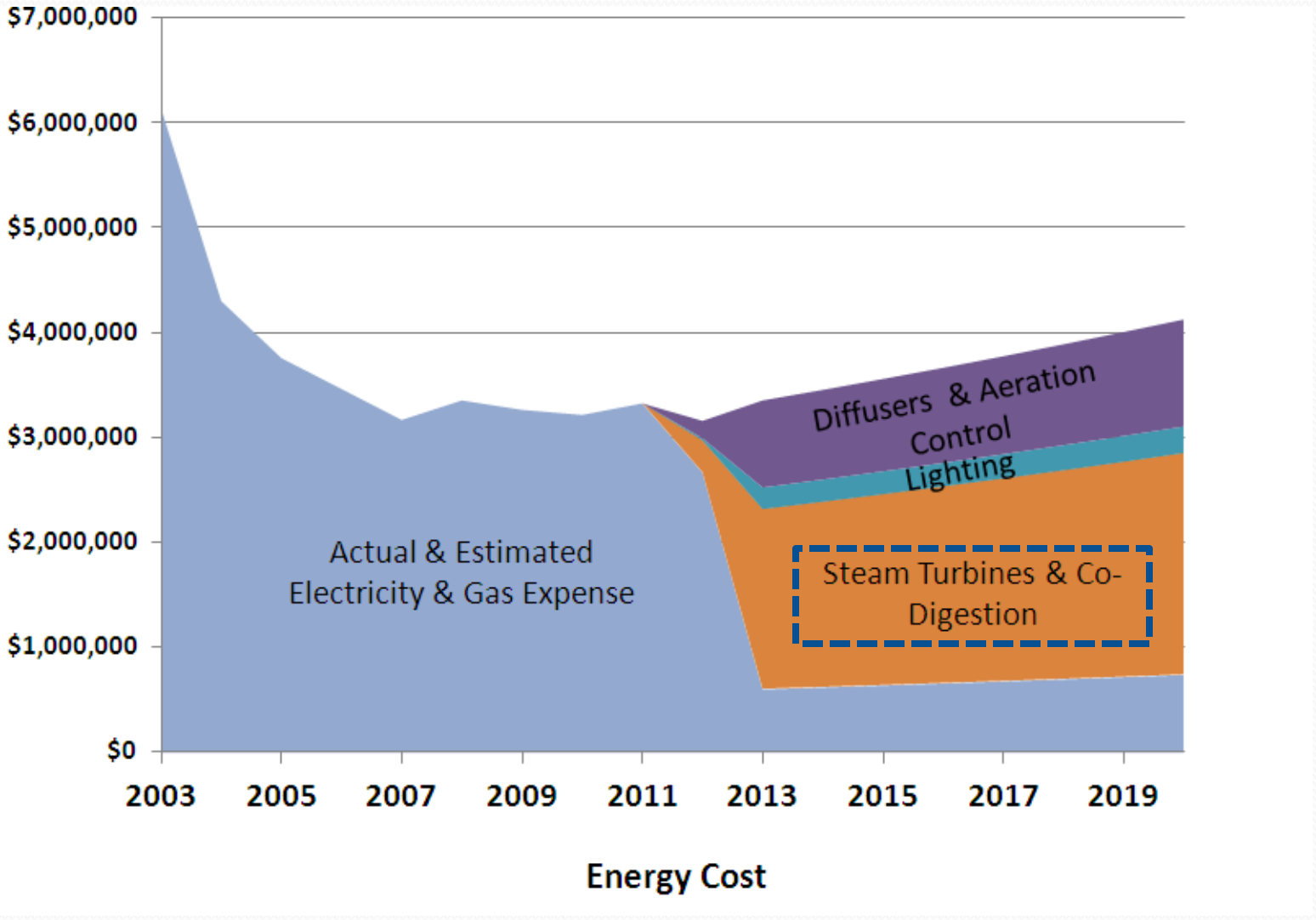
- To improve energy efficiency and enhance energy reduction
- Total project cost of $36,756,399
- Guarantees an annual O&M and electrical savings of $3,184,757
- 12 year payback
- No rate impact

JCI Energy Savings Performance Contract Projects

Facility Improvement Measures (FIMs):

1. Diffuser Replacement
2. Heat Recovery Steam Generation
3. Digester Mixing & Co-Generation Facility
4. SCADA replacement
5. Anoxic zones
6. HVAC, Power Factor Correction, pump efficiency

Estimated Electrical Savings



Energy Recovery & Production Schematic

Flares

Waste Heat to Atmosphere

Anaerobic Digesters

Biogas

Gas Turbine Generator

Energy

5 MW

Air

Hot Fuel Gas

Steam Blowers

Air

Electric Blowers

Heat Recovery Steam Generator

Steam

Electricity

Planning Phase

1. Why consider it?
2. Type of substrate
3. Screening sources
4. Financial and contract considerations

Leveraging The Opportunity

Numerous industries in or near Fort Worth with High Strength Wastes (HSW)

- Batter dumps & DAF float from food processors
- Expired / damaged product from soft drink bottler
- Glycerin and organic acids from biodiesel facility

City's Objective

- City's main objective was to assure reliable, long-term, low-risk supply of HSW to increase biogas production.

- Potential HSW suppliers identified through pretreatment program
  - Contacted with waste characterization surveys
  - Evaluated/accepted on a case by case basis

HSW Hauler's Requirements

- COD > 50,000 mg/L, prefer > 100,000 mg/L
- Pumpable at ambient temperature
- Minimal suspended solids, especially inert solids
- High volatile solids
- No pH adjustment necessary
- No pollutants that threaten digester performance or sludge quality (i.e. heavy metals, sanitizers, sulfates)

HSW Contracting Process

- Conducted by Pre-treatment Services
- Solicit interest from interested parties
- Receive/evaluate potential waste streams
- Procure agreements
  - Accountability, key contact info
  - Contract period
  - Fees
  - Indemnification/liability
  - Delivery mechanisms and time frames (customers arrange for delivery – at their expense – and at prescribed schedule)

Implementation Phase

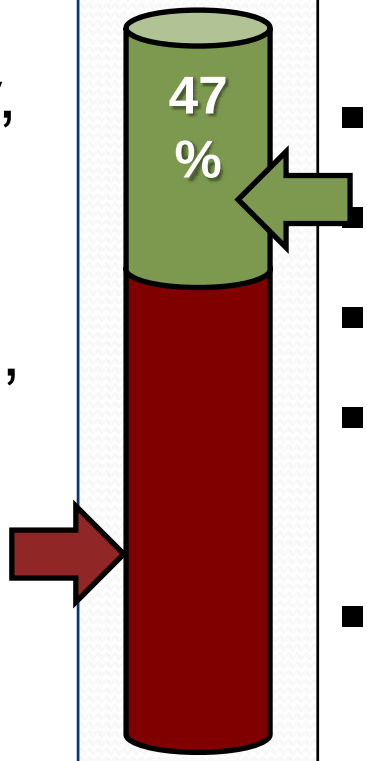
1. HSW fed to six digesters
2. Improvements to mixing systems
3. Design considerations
4. Design build type project

Based on Dr. Leonard Ripley's Slides

Why Implement Co-Digestion?

1 MG sludge digester:

- 200 lb VSS/kft^3-day,
- 75% VSS destruction,
- 10 ft^3 CH_4 /lb ΔVSS,
- Methane yield =
  - 8,360 SCF/hr
- Energy yield =
  - 8.0 MM BTU/hr

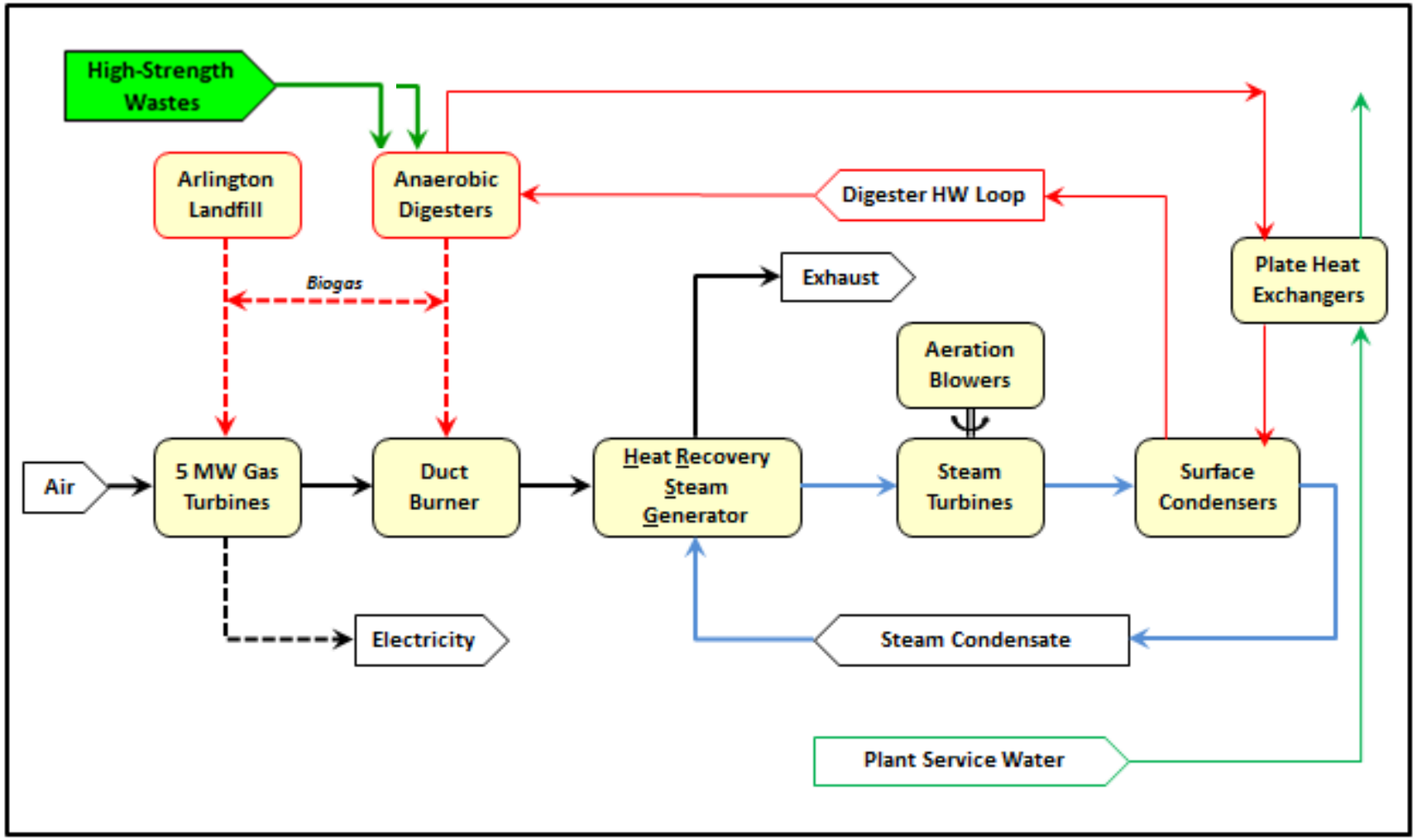


1 MG co-digestion:

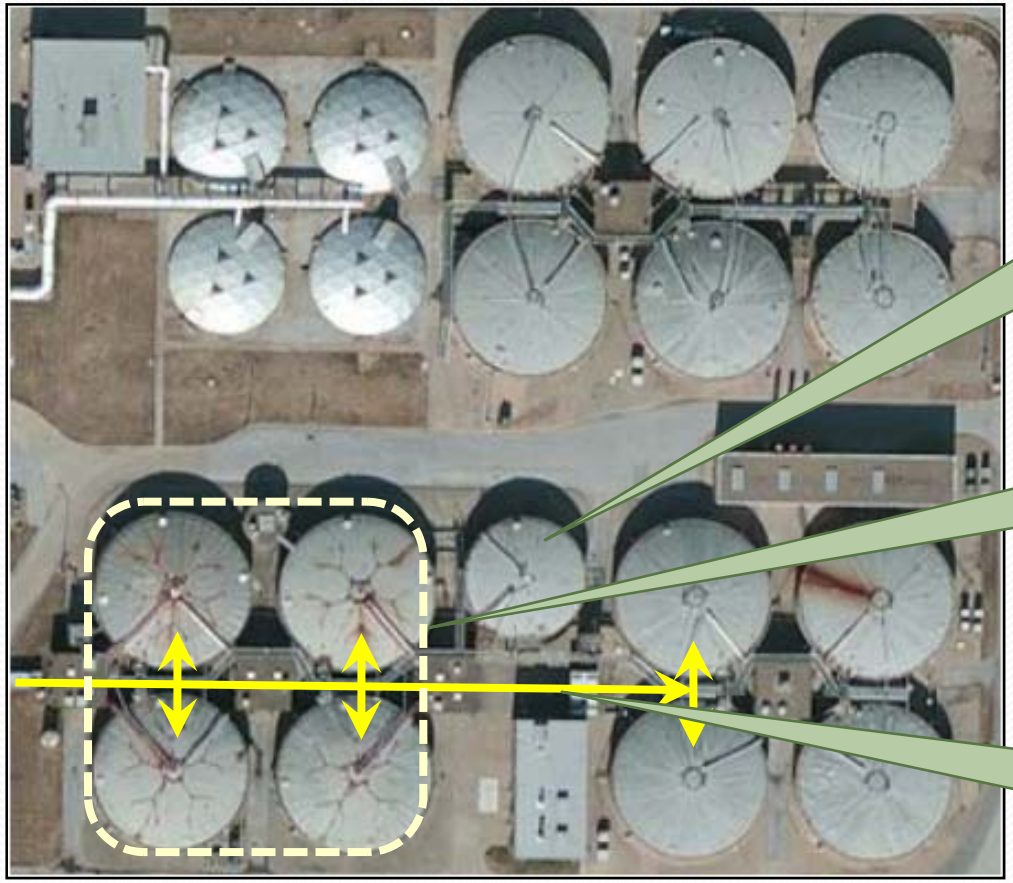
- 2.0 kg COD/m^3-day,
- 90% COD destruction
- 6.3 ft^3 CH_4 /lb ΔCOD,
- CH_4 yield =
  - 3,940 SCF/hr
- Energy yield =

  3.8 MM BTU/hr

Energy Recovery & Production Chart



Feed Distribution Options

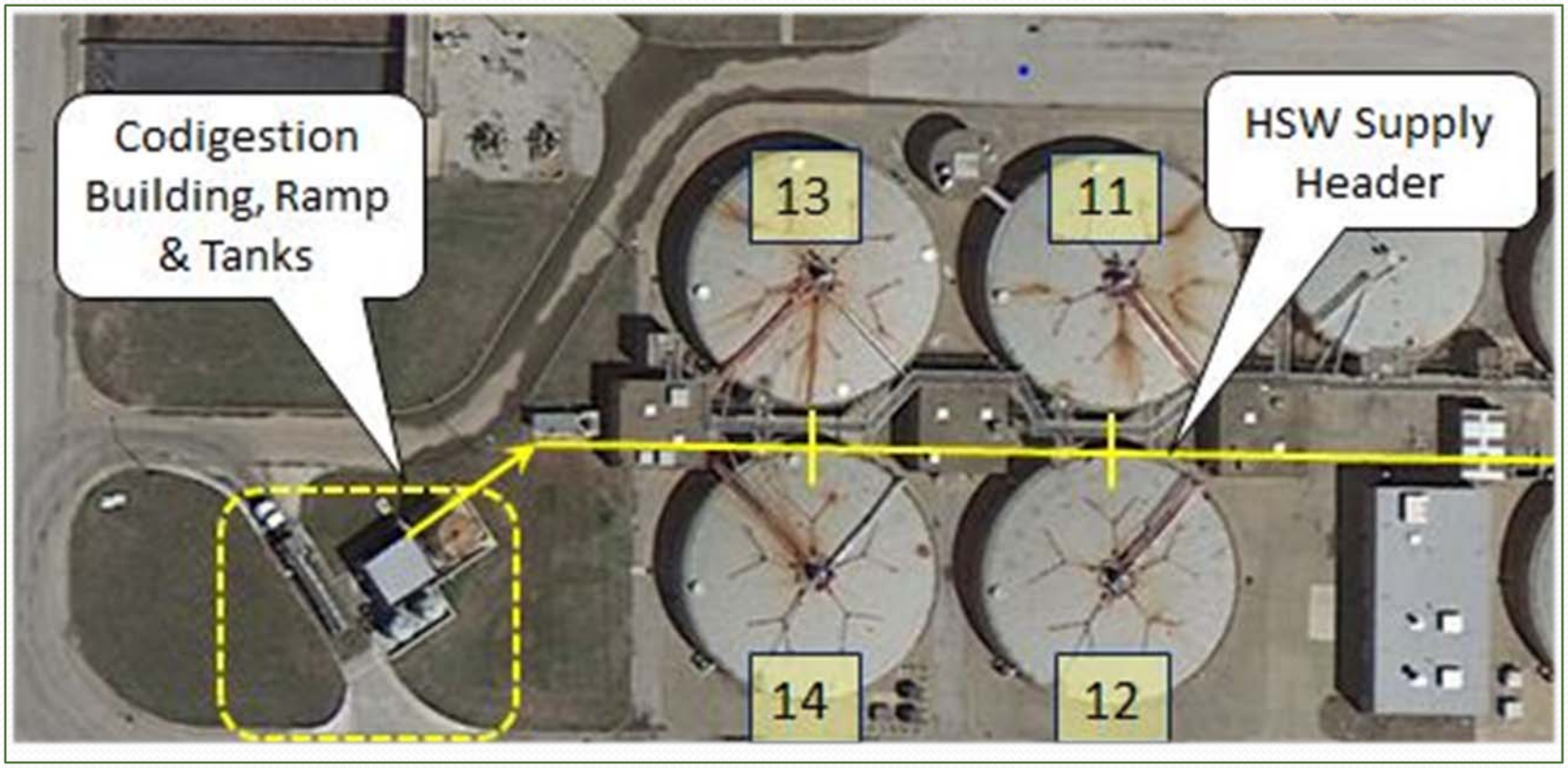


Send all HSW to the sludge blend tank

Feed digesters in a “pod” to limit pipe length

Feed codigesters through a new HSW header

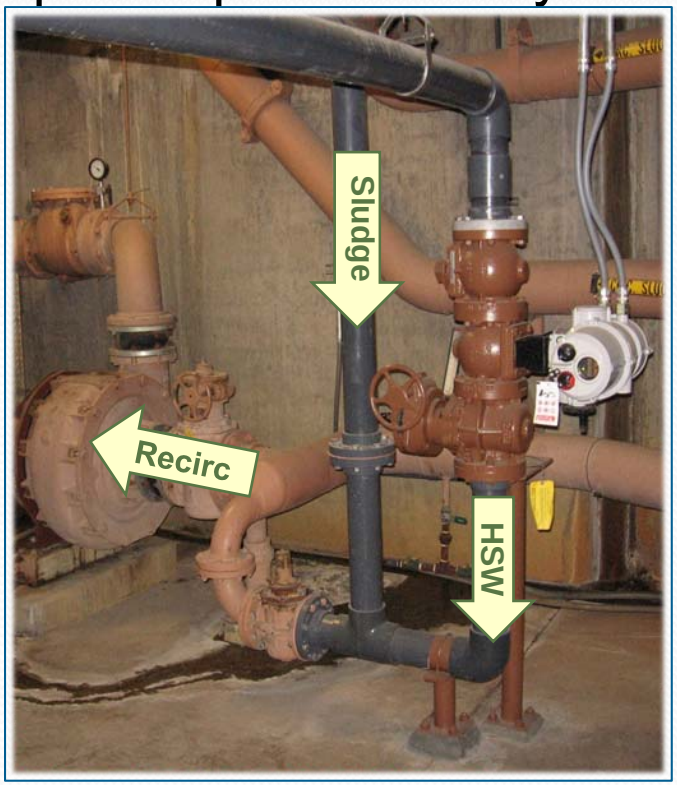
Feed Selected Option



Digester Modifications

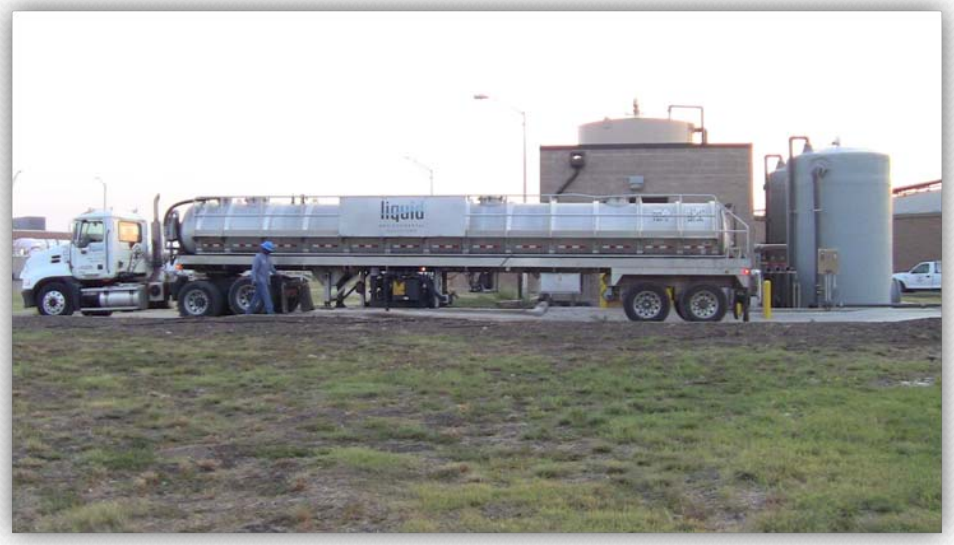
Mixing: Linear Motion Mixers

Feed: PVC header and valves, open to pulse-feed cycles



Receiving Station

- Dedicated truck ramp, with containment curbs, drain, and wash-down sump
- 30,000-gal mix tank, with chopper pumps, jet mixing and heat exchanger



Metering System

- Two 6,000-gal batch tanks, each with recirculation mixer, and heat exchanger
- PLC to feed operator-specified volume to digesters in pulses.

Mix tank on right, two batch tanks on left

Operational Phase

1. Receiving station
2. Scheduling deliveries
3. Monitor gas production
4. Monitor performance

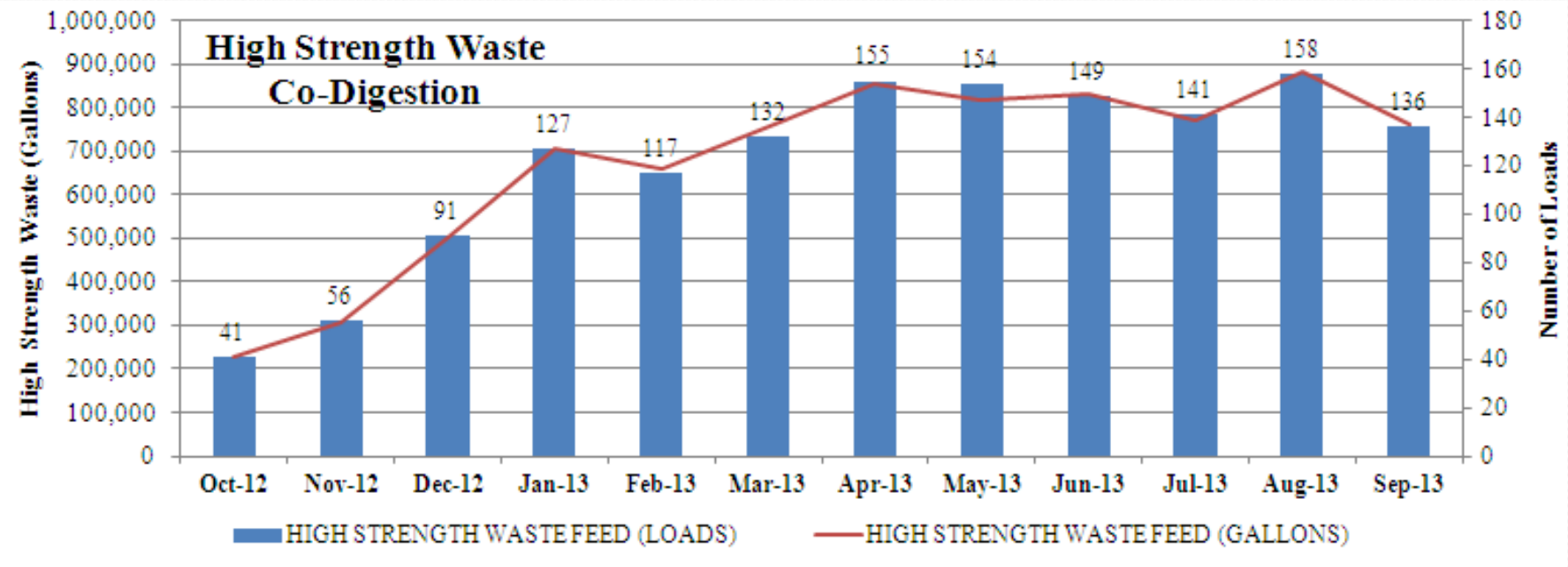
Receiving HSW

- Clear through security
- Installation of cameras and good lighting
- Operator/supplier offload to complete manifests
- Offloading takes approximately 30 minutes
- Limited storage (ensure tank capacity to offload)

Scheduling Deliveries

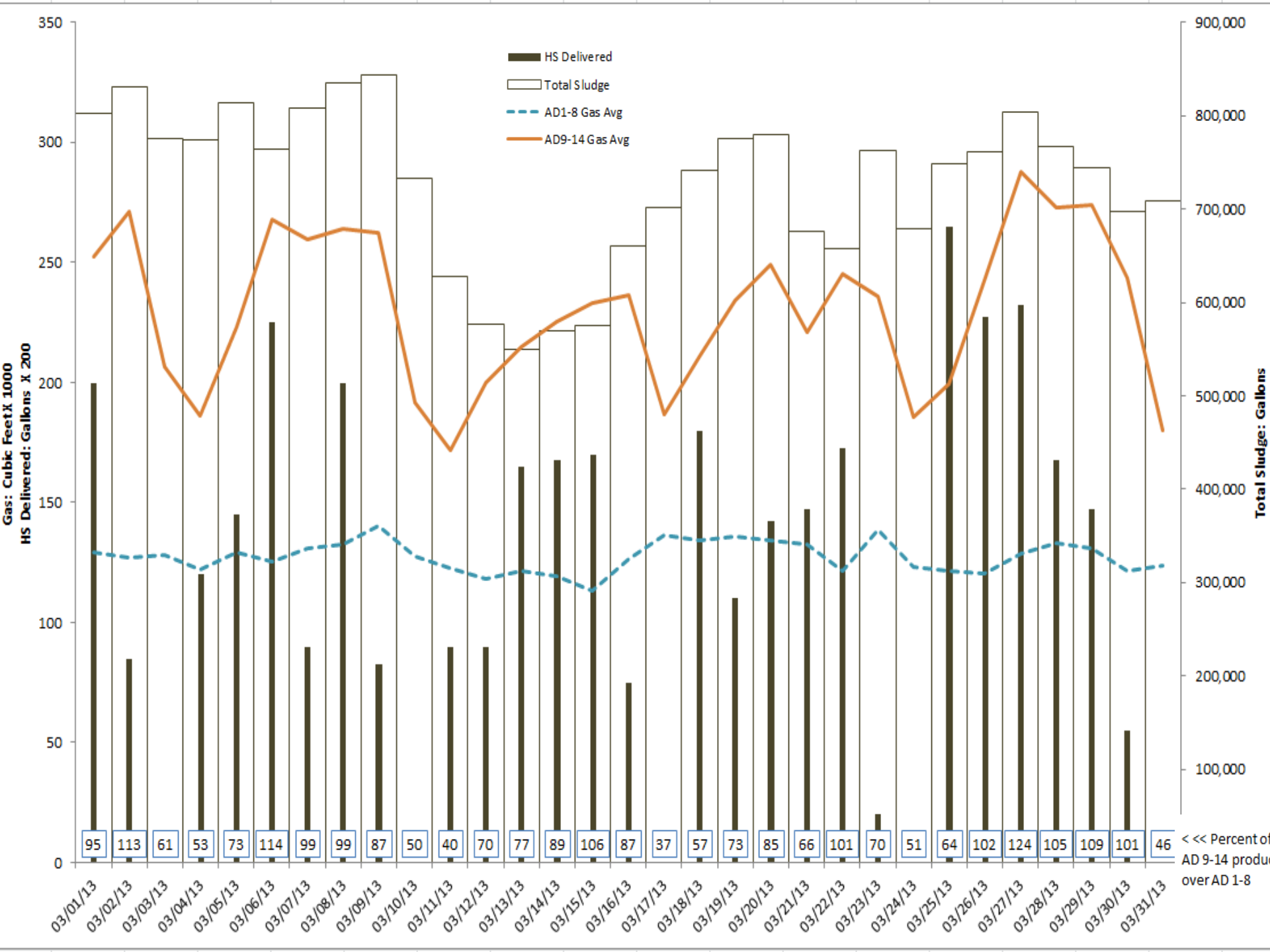
- Started slowly in Sept 2012, with filtrate from Liquid Environmental System's grease processing facility
- Gradually added other wastes:
  - South Waste
  - Delek biodiesel
  - Coca-Cola
- Others pending

Gradually Increase of Deliveries



Monitor Performance

- Set feed-rate to match expected deliveries (for consistent, effective gas production)
- Sufficient waste to get through the night/weekend
- Monitor (feed rates, waste characteristics, temperature, digester performance, etc.)


HS Delivered
Total Sludge
AD1-8 Gas Avg
AD9-14 Gas Avg
Gas: Cubic Feet X 1000
HS Delivered: Gallons X 200
Total Sludge: Gallons
350
300
250
200
150
100
50
0
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
95 113 61 53 73 114 99 99 87 50 40 70 77 89 106 87 37 57 73 85 66 101 70 51 64 102 124 105 109 101 46
< << Percent of
AD 9-14 produc
over AD 1-8
03/01/13
03/02/13
03/03/13
03/04/13
03/05/13
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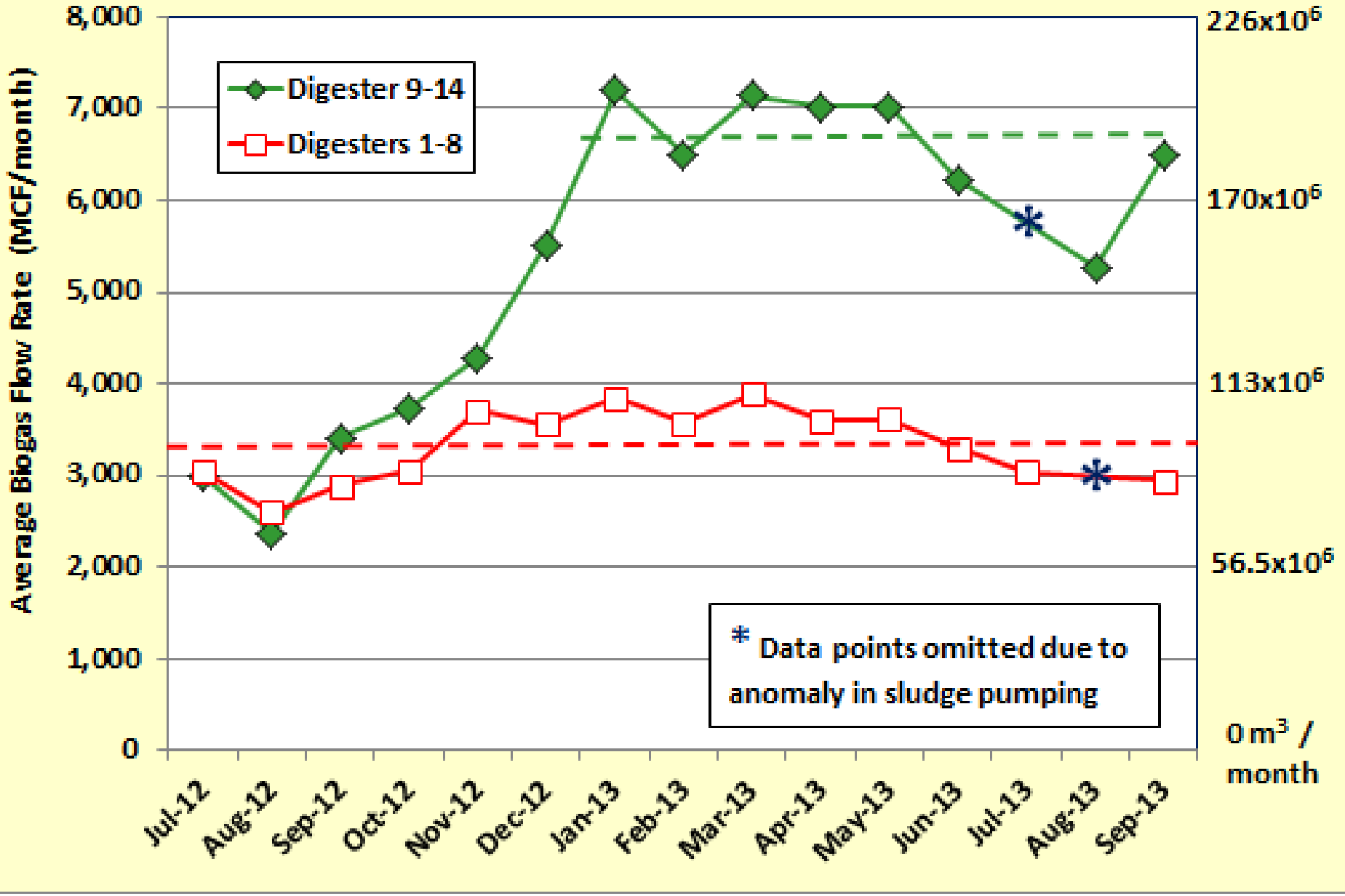
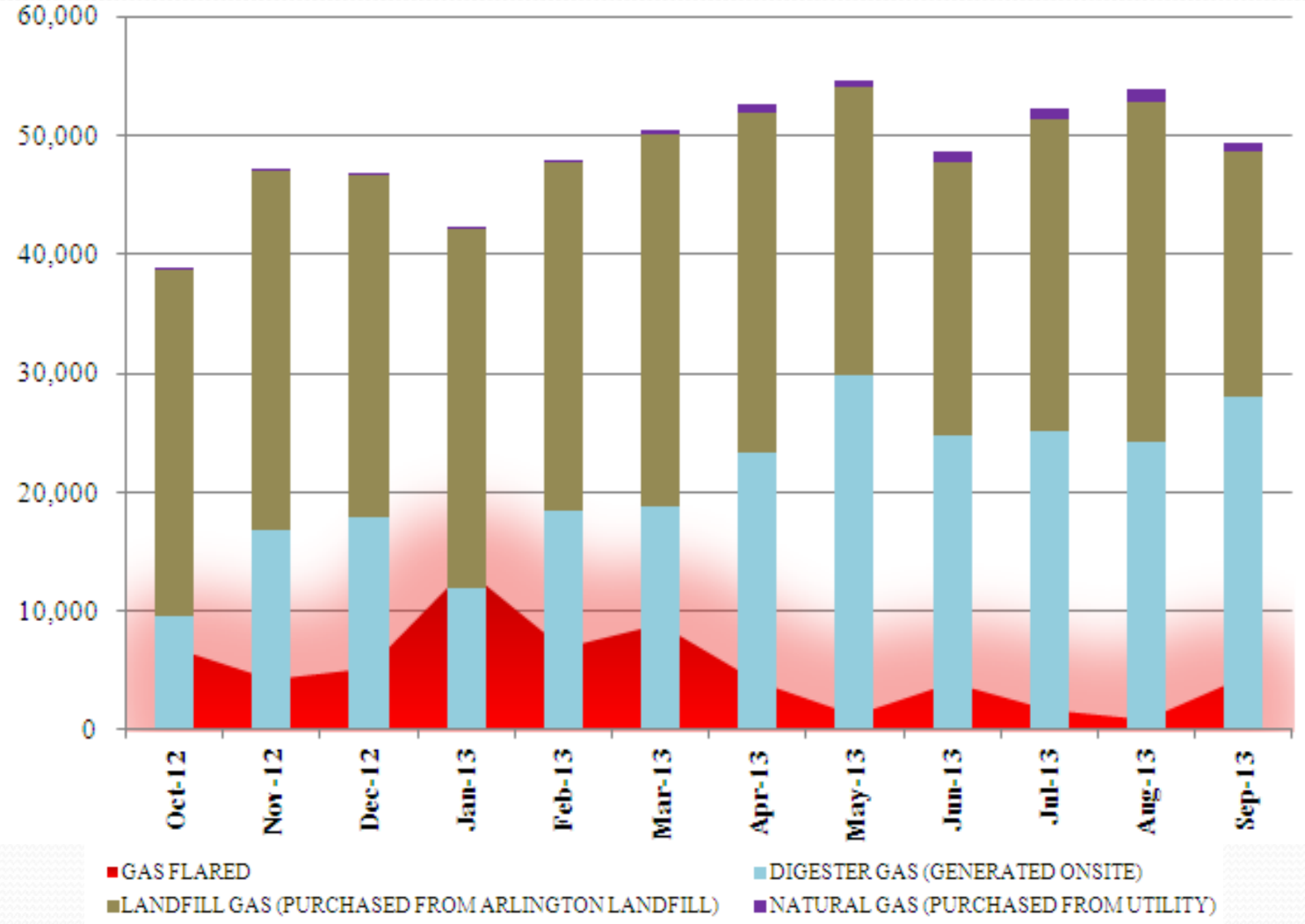
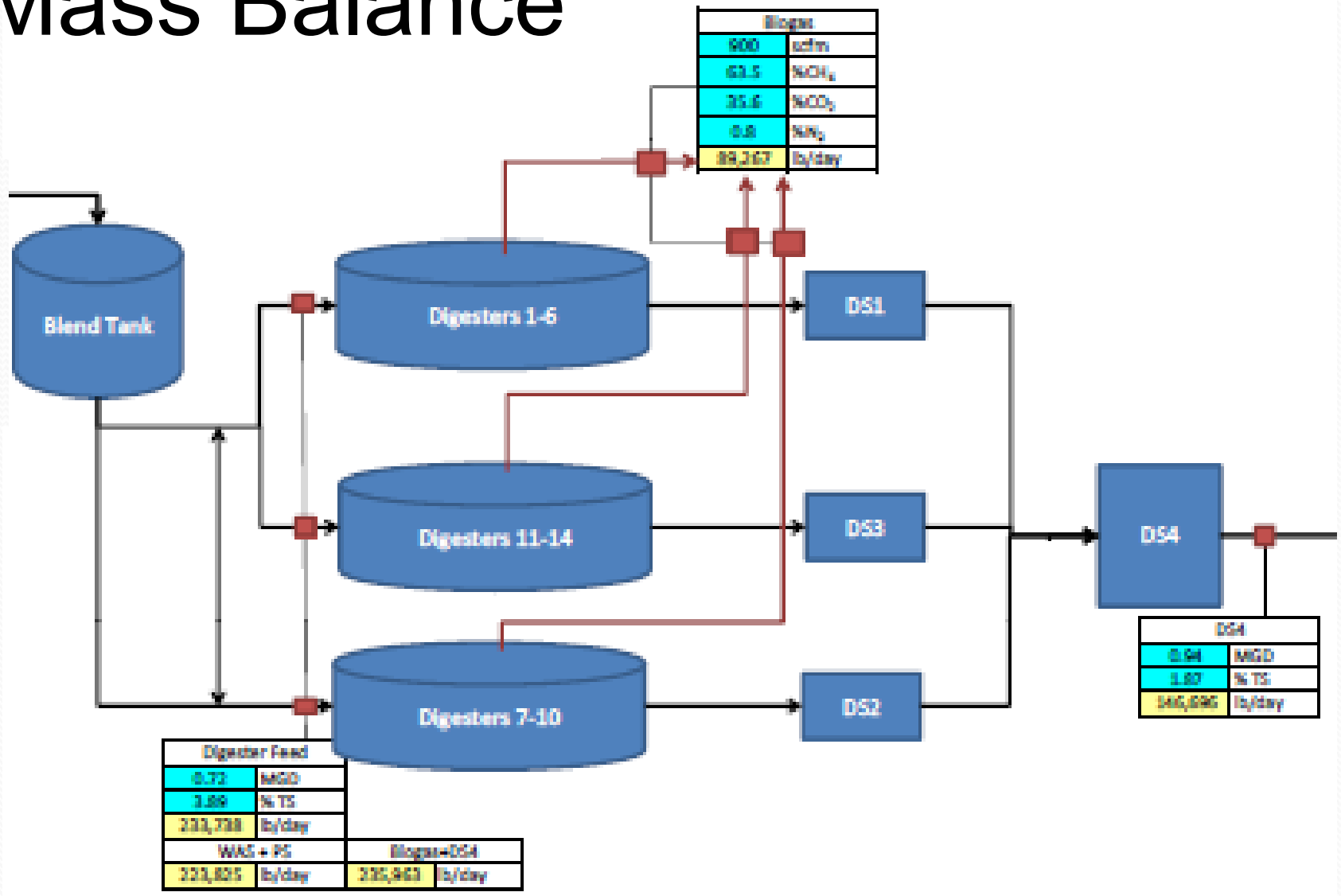


Courtesy of Dr. Leonard Ripley

Overall Gas Utilization



Mass Balance



Performance Monitoring

DIG#	TEMP.	TS%	TS %VOL	PH	TOT.ALK.	VOL. ACID	VA/ALK ratio
1	96	2.60	58.04	7.093	125	887	0.28
2	93	2.36	57.84	7.102	950	717	0.24
3	97	2.46	56.05	7.143	125	687	0.22
4	96	2.28	56.69	7.248	000	729	0.24
5	98	2.69	55.58	7.112	950	620	0.21
6	95	2.42	55.01	7.143	100	711	0.23
7	95	2.33	55.26	7.248	150	848	0.27
8	97	2.59	57.10	7.213	175	790	0.25
9	98	2.34	57.48	7.233	300	826	0.25
10	97	2.34	56.41	7.213	350	665	0.20
11	97	2.56	54.49	7.283	425	975	0.28
12	99	2.78	54.41	7.233	375	814	0.24
13	99	3.05	57.34	7.253	600	845	0.23
14	98	3.05	55.91	7.293	500	668	0.19

	TSS(MG/L)	%Vol.
BLEND TANK	34525	64.2
DS1 (1-6)	22425	55.3
DS2 (7-10)	26625	56.3
DS3 (11-14)		
DS4 (ALL)	22800	53.7

Lessons Learned

1. Planning is critical
2. Efficient mixing system
3. Balancing sink/sources

Lessons Learned

- HSW planning is critical … know what you're getting. Village Creek has chosen to be very "picky" about its suppliers to reduce risk of upsets
- Efficient mixing is critical for Co-Digestion
- Balancing financial drivers:
  - Steady, reliable biogas production
  - Divert organic loading from liquid treatment
  - Tipping fee revenue

Challenges

- Equalizing HSW loading from weekdays to weekends
- High temperature of HSW from grease processors greater than 130^0F
- Odors from truck unloading
- Balancing heat sink/sources

VCWRF Flying Towards Energy Neutrality… The Sky's the Limit