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AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS & SCIENTISTS®

American Academy of Environmental Engineers and Scientists
Webinar Series | Sept. 21, 2022

Converting Organic Waste Into Liquid Gold

Jay Brady, Principal Engineer, Stanley Consultants

Jon Koch, Director of the Water & Resource Recovery Facility, City of Muscatine, Iowa

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LOS ANGELES COUNTY SANITATION DISTRICTS
Converting Waste Into Resources

LA DWP Los Angeles Department of Water & Power

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Geosyntec consultants

OC SAN
ORANGE COUNTY SANITATION DISTRICT

DSWA
DELAWARE SOLID WASTE AUTHORITY

dc water is life®

We will begin our presentation in a few minutes…

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Improving Lives Since 1913. Stanley Consultants has been helping clients solve essential and complex energy and infrastructure challenges for over 100 years, successfully completing more than 50,000 engagements in 110 countries and all 50 states and U.S. territories. Values-based and purpose-driven, Stanley is an employee-owned company of engineers, scientists, technologists, innovators and client-service experts who are recognized for their commitment and passion to make a difference.

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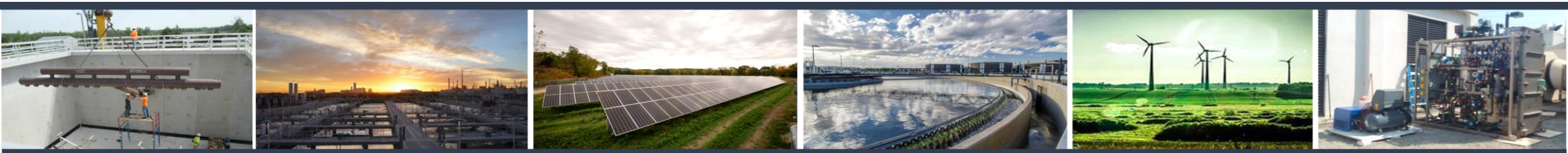

Leadership and Excellence in Environmental Engineering and Science

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Why did we want to work this hard?

Watching energy waste off into the air

Multiple tons/day to landfill from multiple industries

How many in 100-mile radius with the same issue?

Idea Formulation

Local Organic Wastes + Anaerobic Digestion =
RENEWABLE FUEL FOR VEHICLES

FOG Program + Spare Unused Tanks + Lightly Loaded Digesters
+ Continuously flaring unused Digester Gas = OPPORTUNITY

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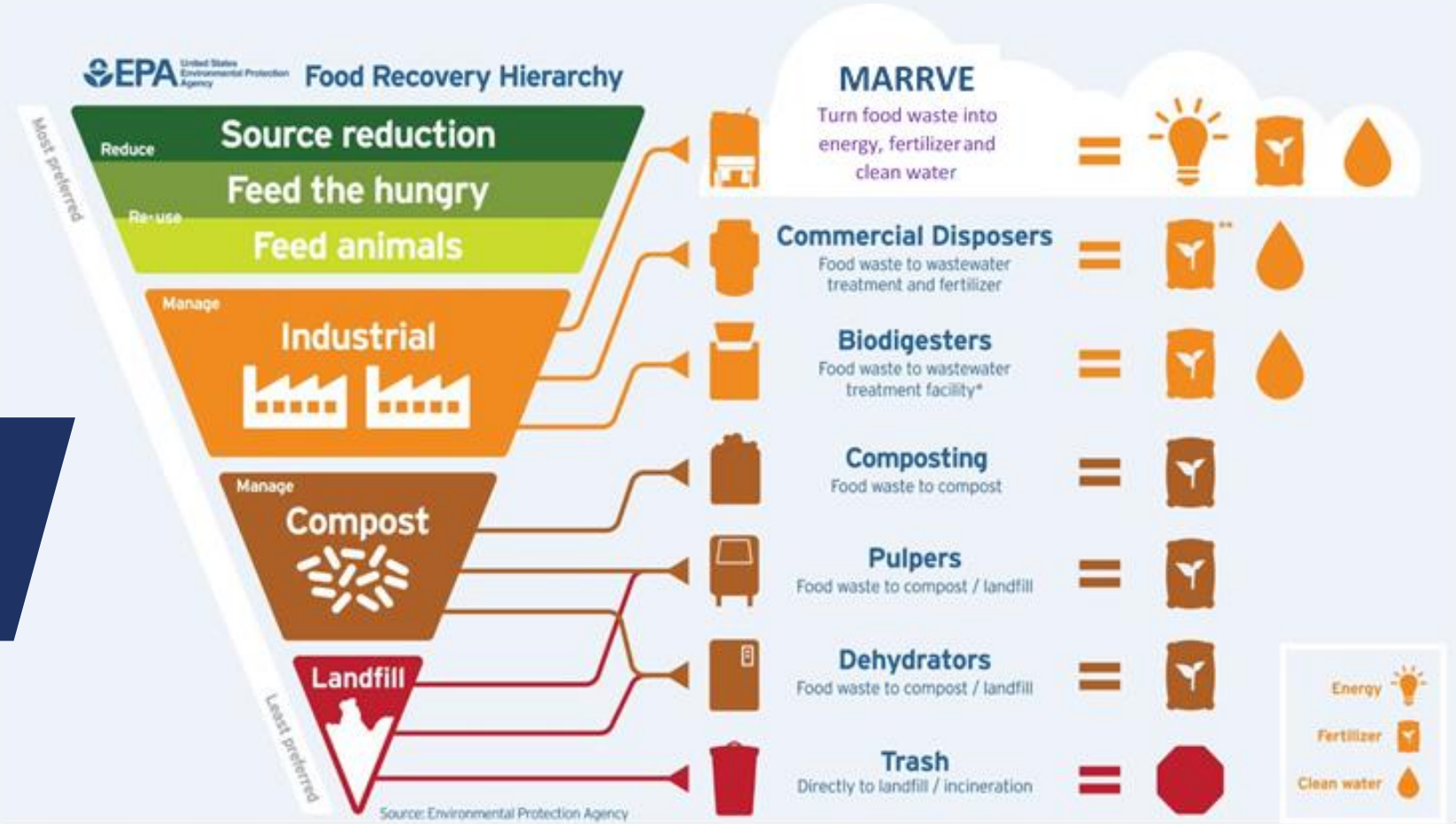
40% of food produced is not eaten

20% of landfill waste is organic and can be recycled

Our Philosophy

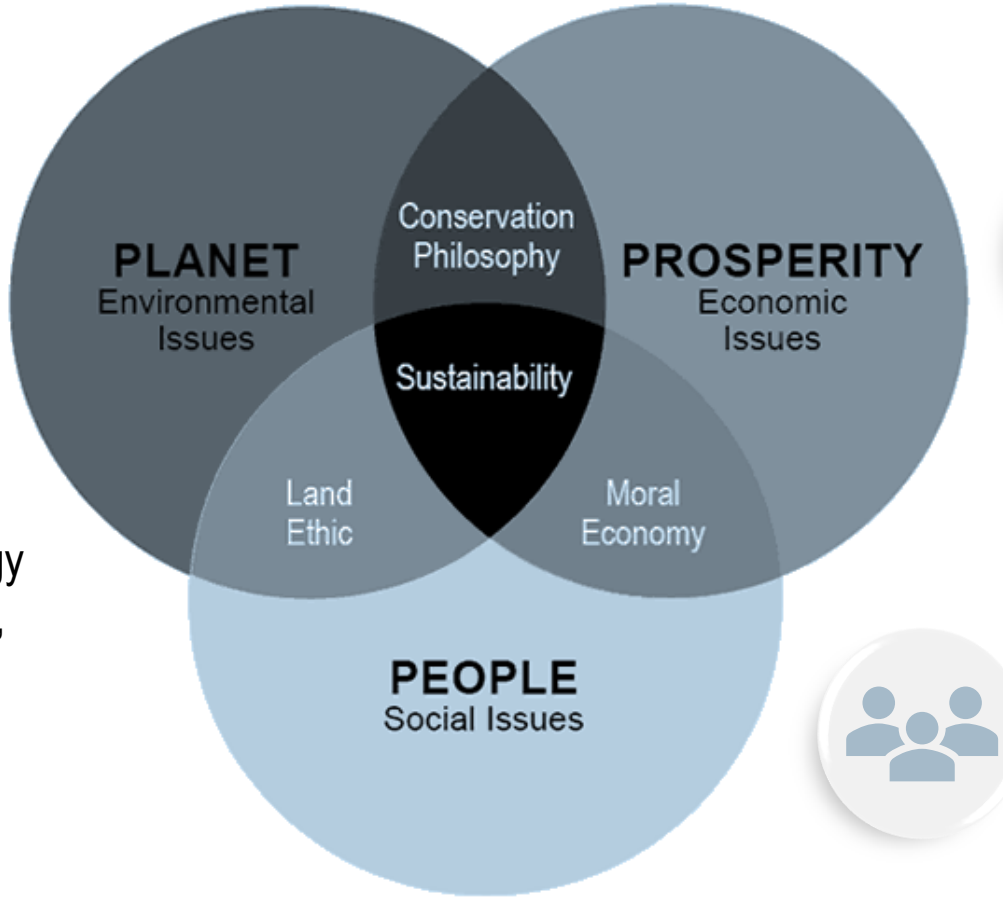
Why is it worth it?

<u>30% - 40%</u> of all food produced is not eaten!



Sustainability Drives Innovation, Directs Our Actions…

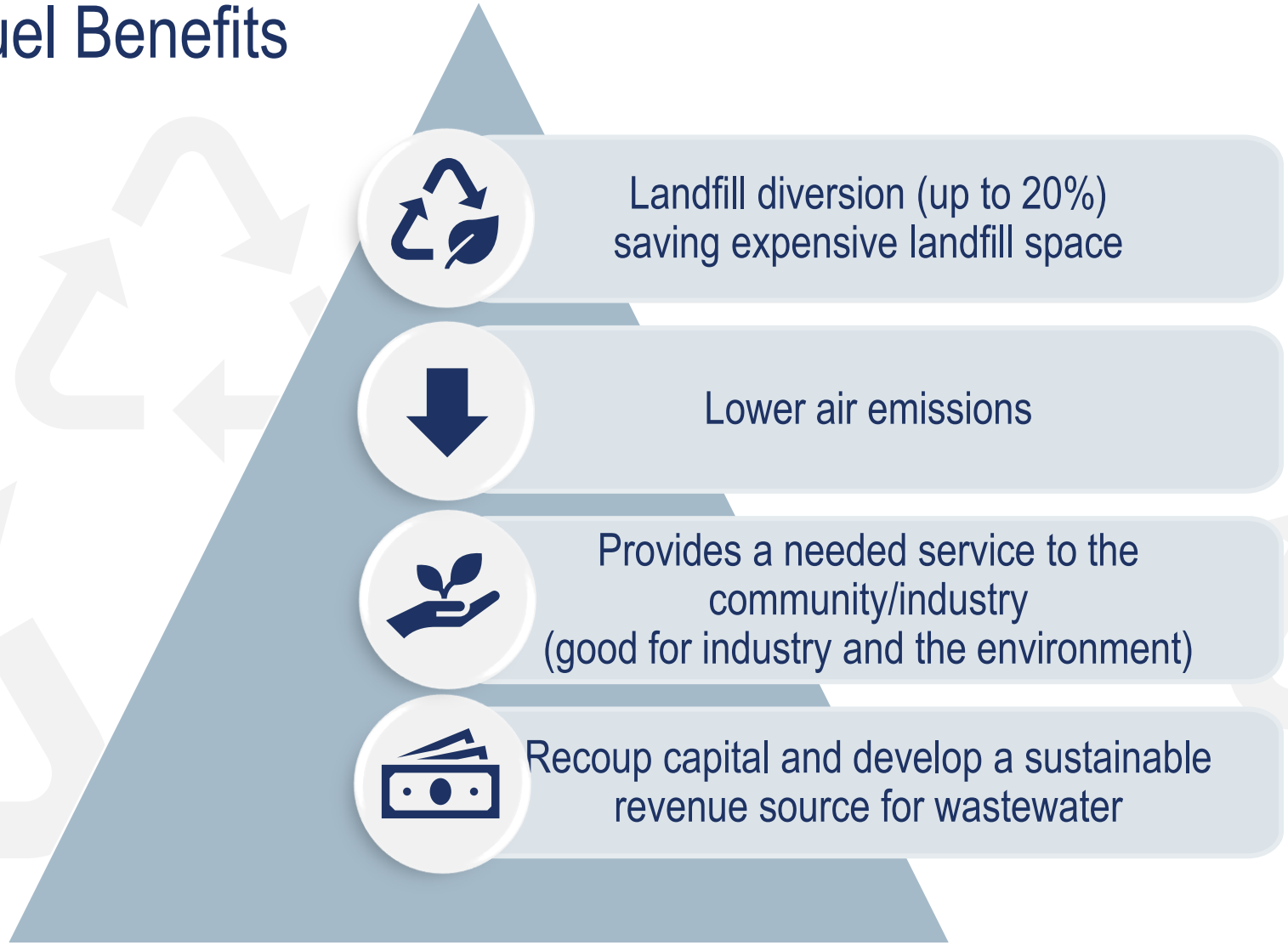
PLANET:
Water/Air Quality, Energy Conserving, Land Use, Resources



PROSPERITY:
Economic Opportunity, Profit, Employment, Property

PEOPLE:
Community, Health, Education, Equity, Quality of Life

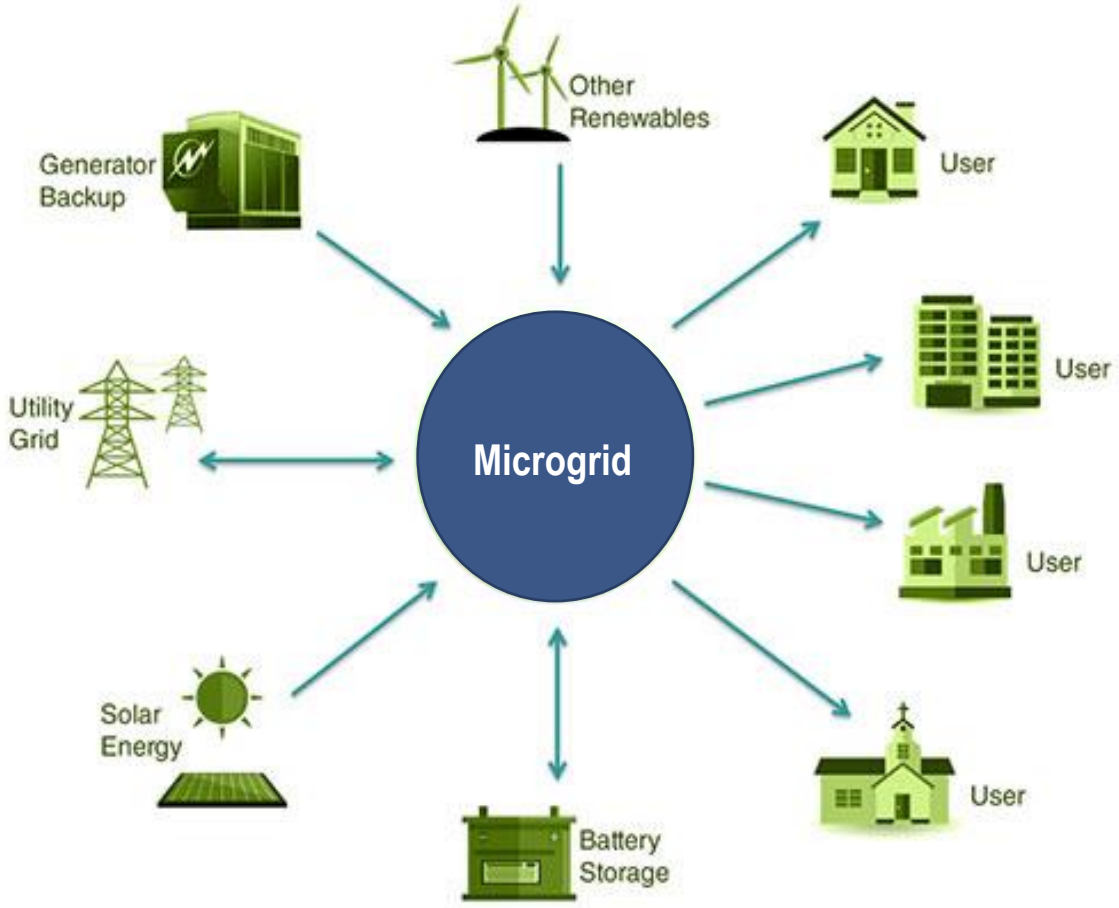
Waste to Fuel Benefits



Revenue and Clean Renewable Energy from Waste

MARR for Vehicles and Energy

Losing popularity, electric vehicles gaining



Connected microgrids can supplement power coming from traditional utilities, reduce demand charges and collect eRIN's for revenue.

Existing Digesters

- 2 Digesters
- 938,900 gallons total volume
- Design SRT: 22.8 days
- Current Primary/TWAS Sludge Volumes
  - 24,300 gpd average
  - 36,800 gpd maximum month
  - 5% solids

Existing Digesters

- FOG/HSW: 16,500 gpd average
- Gas Yield:
  - 56,300 CF/day average; Big range
  - ~14 CF/lb VS destroyed

Existing Digesters

- 4 old rectangular digesters
- Need rehabilitation
- Represent ~2,000,000 gallons capacity

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Plant Energy Use

BIOGAS

- ~30,000 CF/d average digester bldg. & process heating demand with peak of ~80,000 CF/d (477 Therms)
- Equivalent to heating 91 homes per year
- Winter/Summer usage swings

NATURAL GAS

- 3,650 therms average per month; 8,180 therms/month peak
- $3,300 per month in natural gas use for plant. ~$7,000 during peak winter months

ELECTRICITY

- 325,000 kWh per month electric use = $15,400

Waste Types (Feedstocks)

FOG = Fats, Oils, Greases – Restaurants

Liquid Organic Waste = high strength waste – liquid wastes with high organic content – often from food processors

Solid Organic Waste

- Packaged materials – i.e. bottled ketchup
- Past prime vegetables from grocer
- Cafeteria waste from schools

Local Potential

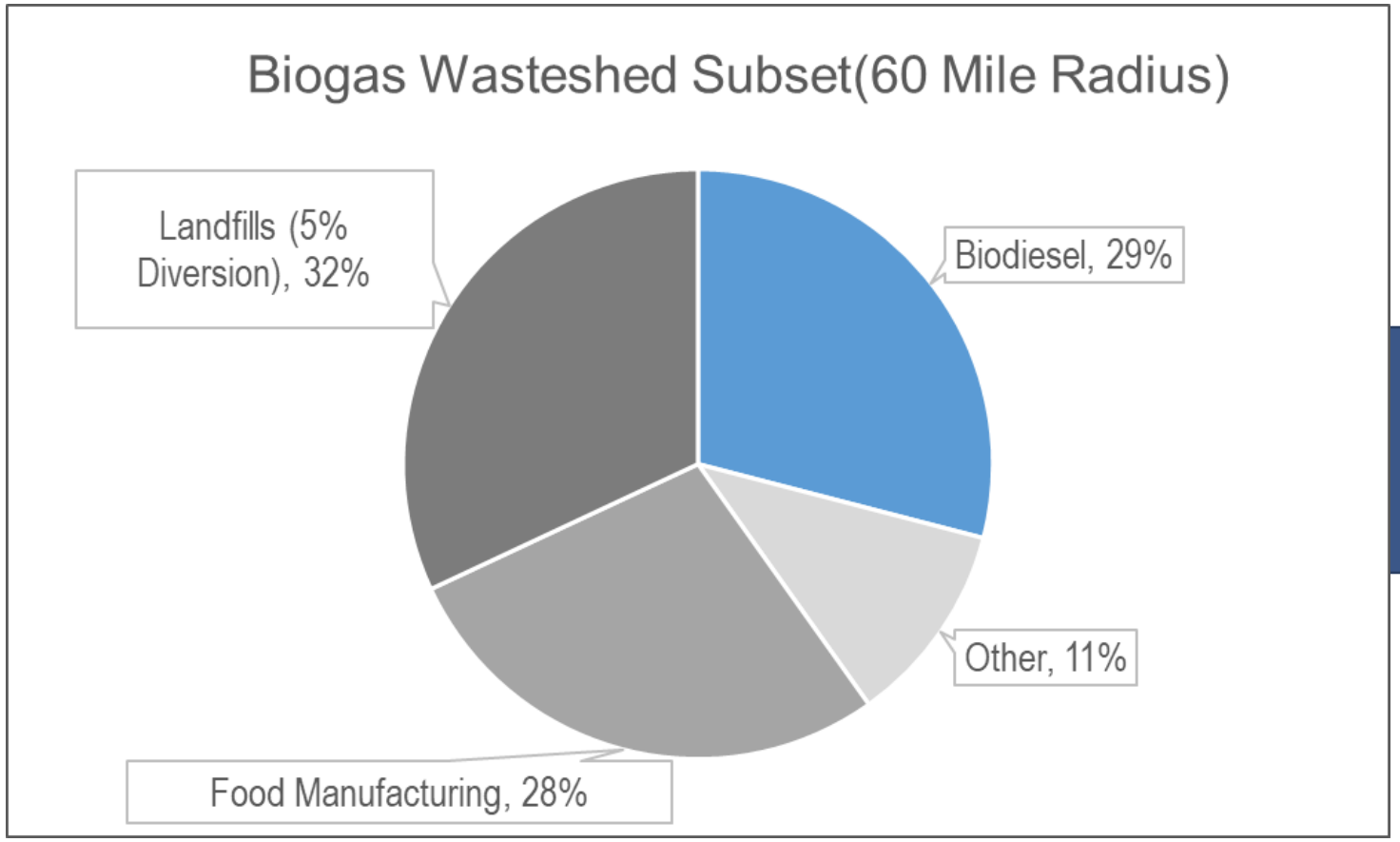
- FOG Haulers
- Local Industries such as Kraft Heinz
- Local Businesses such as HyVee Grocery
- Regional Industries
- Possible Fuel Purchase Partner (Ruan)

Local Potential

Feedstock Source	GPD
Treatment Sludge	36,778
Organic Solid Waste	2,646
Organic Liquid Waste	500
FOG/Available	22,670
Existing Digestion Capacity	62,594

In 60 mi radius, feedstock available for 4 million CF Biogas/day = 17,000 Diesel Gallons/Day

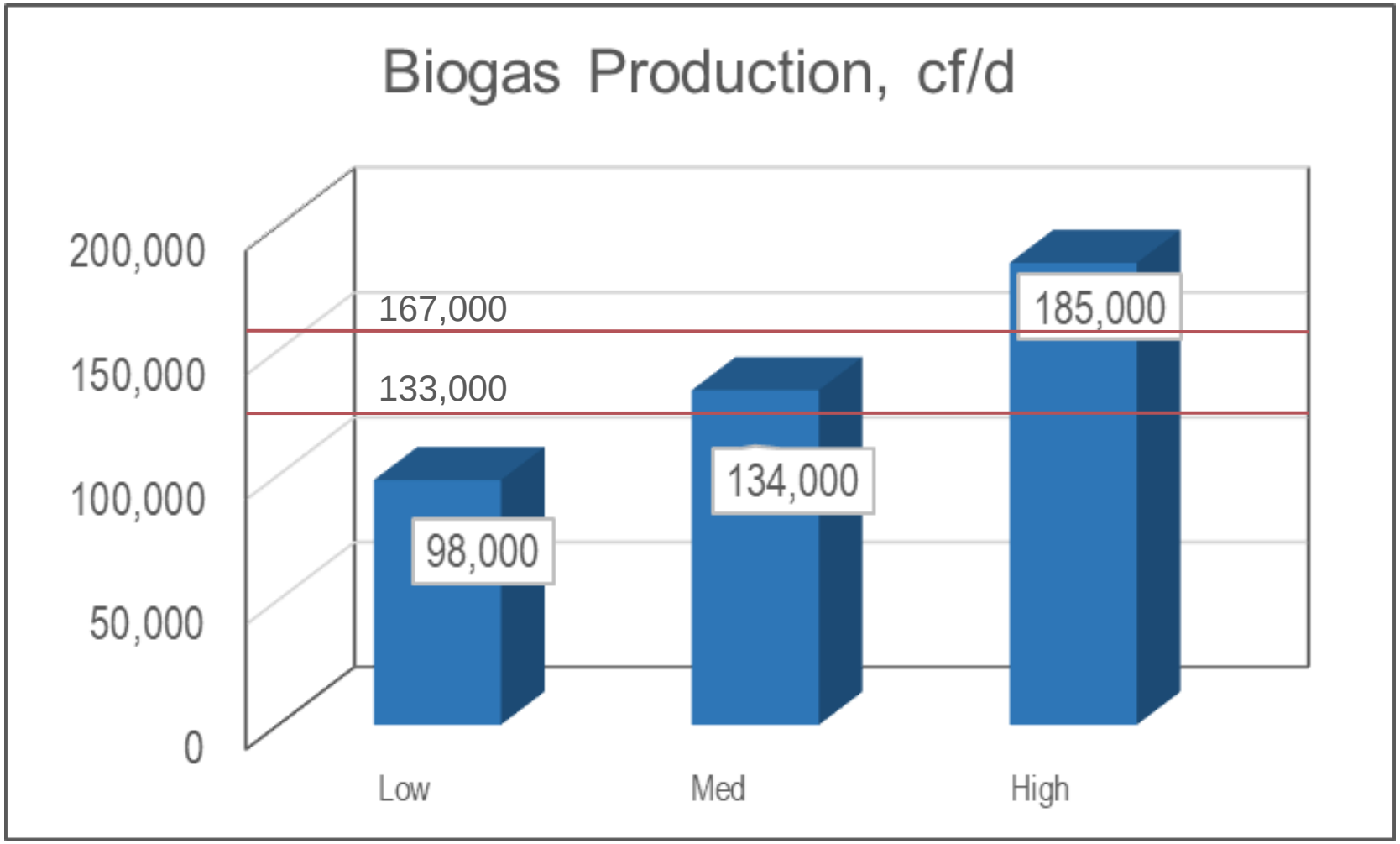
Local Potential



4 million CF Biogas/day
17,000 Diesel Gallons/Day

Source: EcoEngineers, Stanley Consultants

Biogas Production



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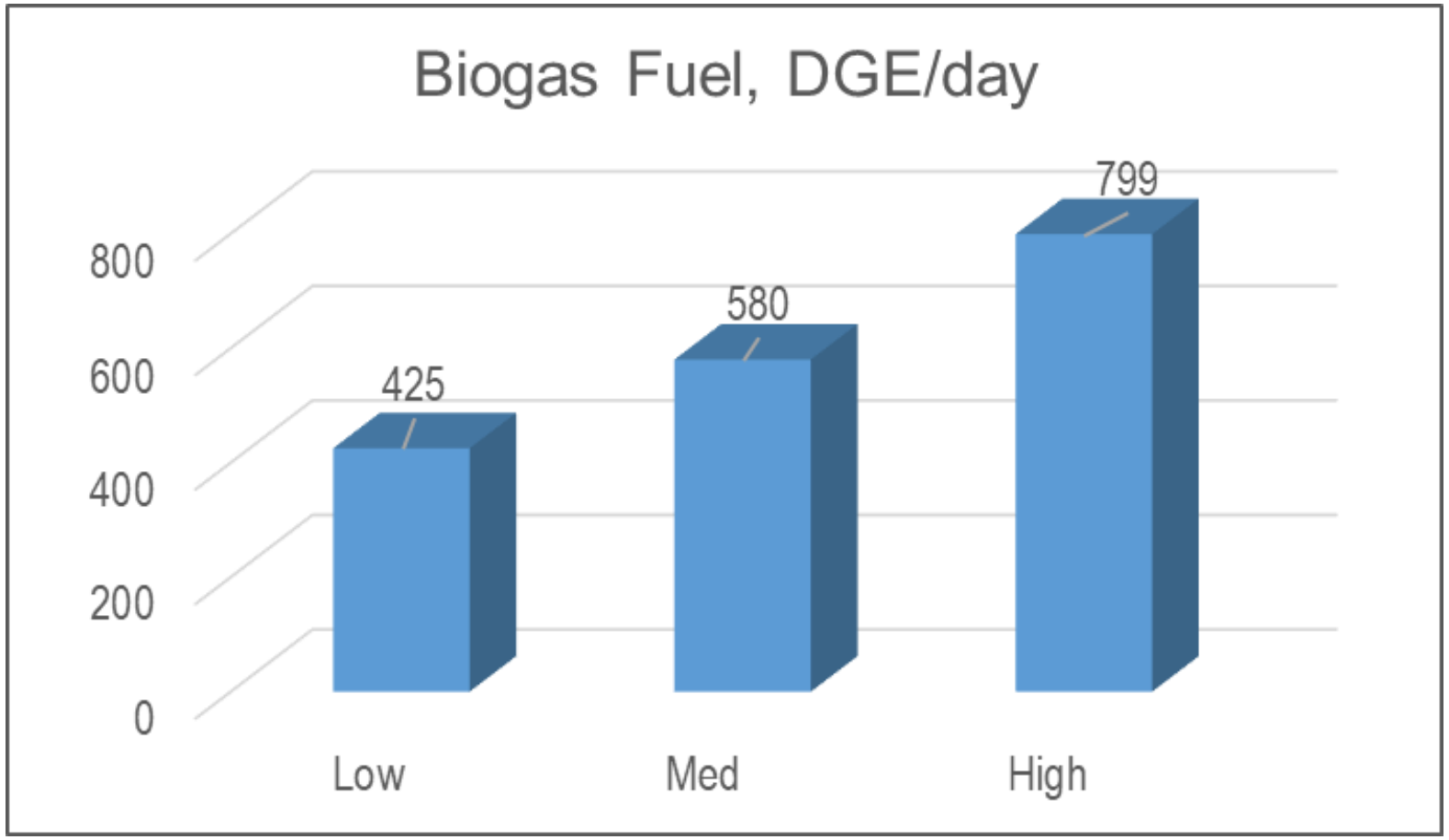
Biogas Fuel in Diesel Gallons



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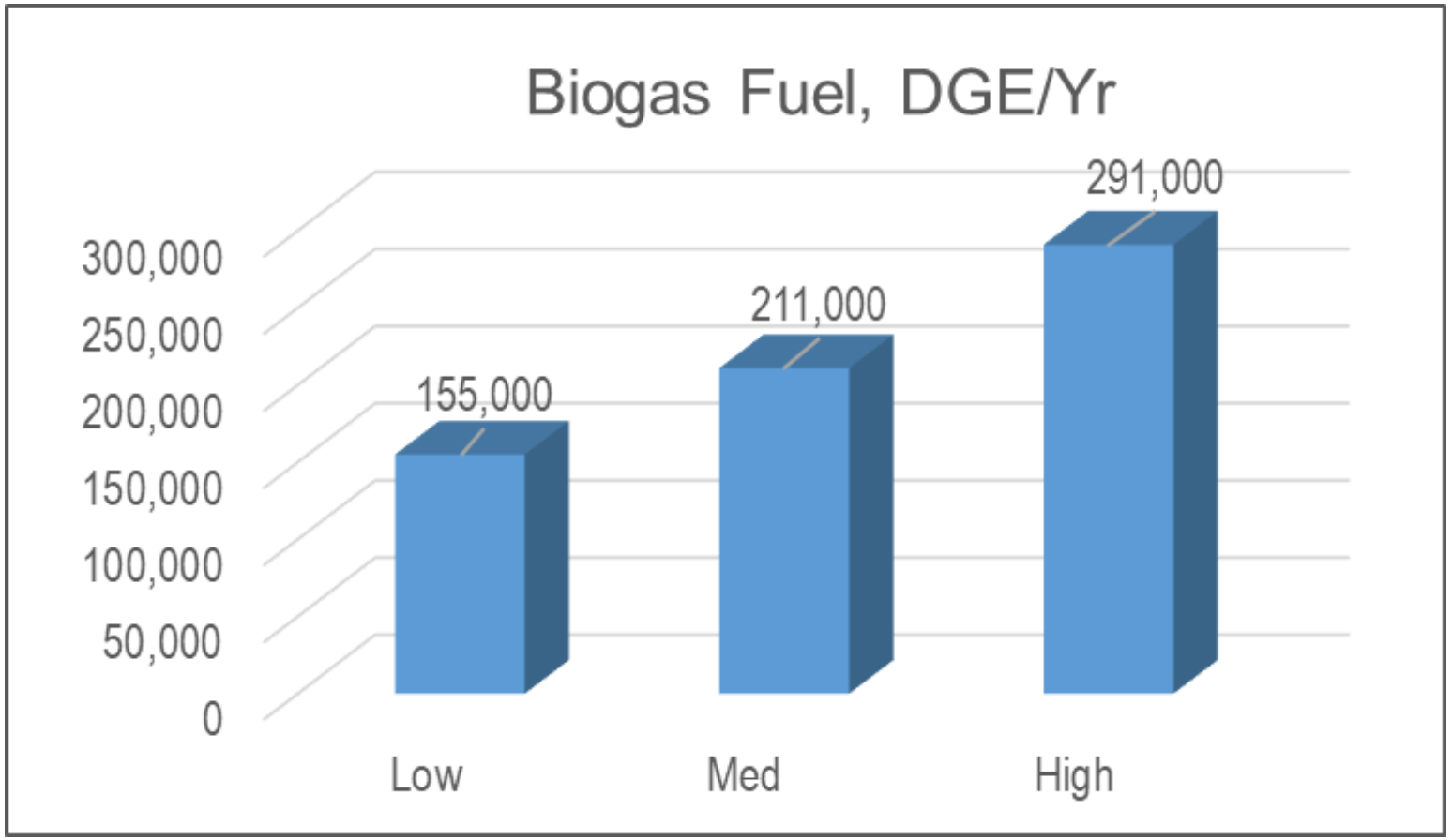
Annual Fuel


Biogas Fuel, DGE/Yr
300,000
250,000
200,000
150,000
100,000
50,000
0
155,000
211,000
291,000
Low
Med
High

Biogas Utilization Alternatives

1. Direct firing in building furnaces
   - Gas piping infrastructure
2. Cogeneration of heat and electric power
   - Traditional – Doesn't maximize renewable energy credits
   - New twist - microgrid management w/ e-RINs
3. Compressed natural gas for vehicle fuels
   - CNG Inventory Management
4. Treated biogas natural gas pipeline injection
   - Pipeline Connection Cost
   - Lack of utility gas specification

Utilization Alternatives

Alternative	Capital $1000	Annual Cost $	Annual Revenue/ Savings $	10 Yr PW $
Direct Fire	740	4,300	26,000	(500,000)
Cogen	2,380	22,400	115,000	(1,600,000)
BioCNG	3,770	105,000	394,000	(500,000) to 3,200,000
Pipeline	7,180	125,000	784,000	(1,600,000)

Estimated Project Cost

Phase	Estimated Study Cost
Phase 1 Receiving/Feed Facilities	$2.5- to $3 million
Phase 2 Digester Renovation	$1.6 million
Phase 3 BioCNG Vehicle Fueling Facility	$2.5- to $3 million

Projected Operational Costs

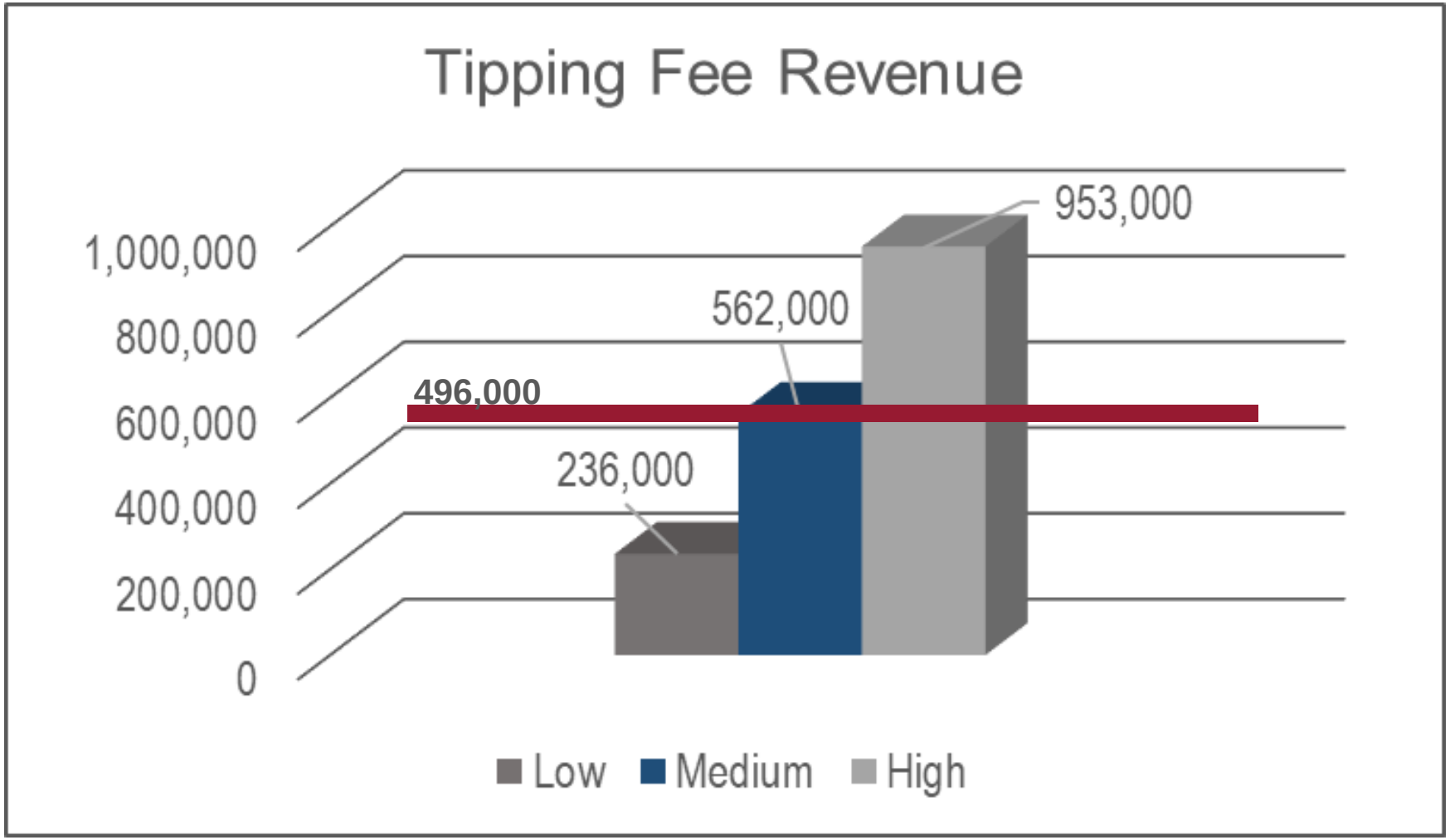
Phase 1 Receiving: $60,000 to $90,000

Phase 2 BioCNG: $95,000 to $120,000

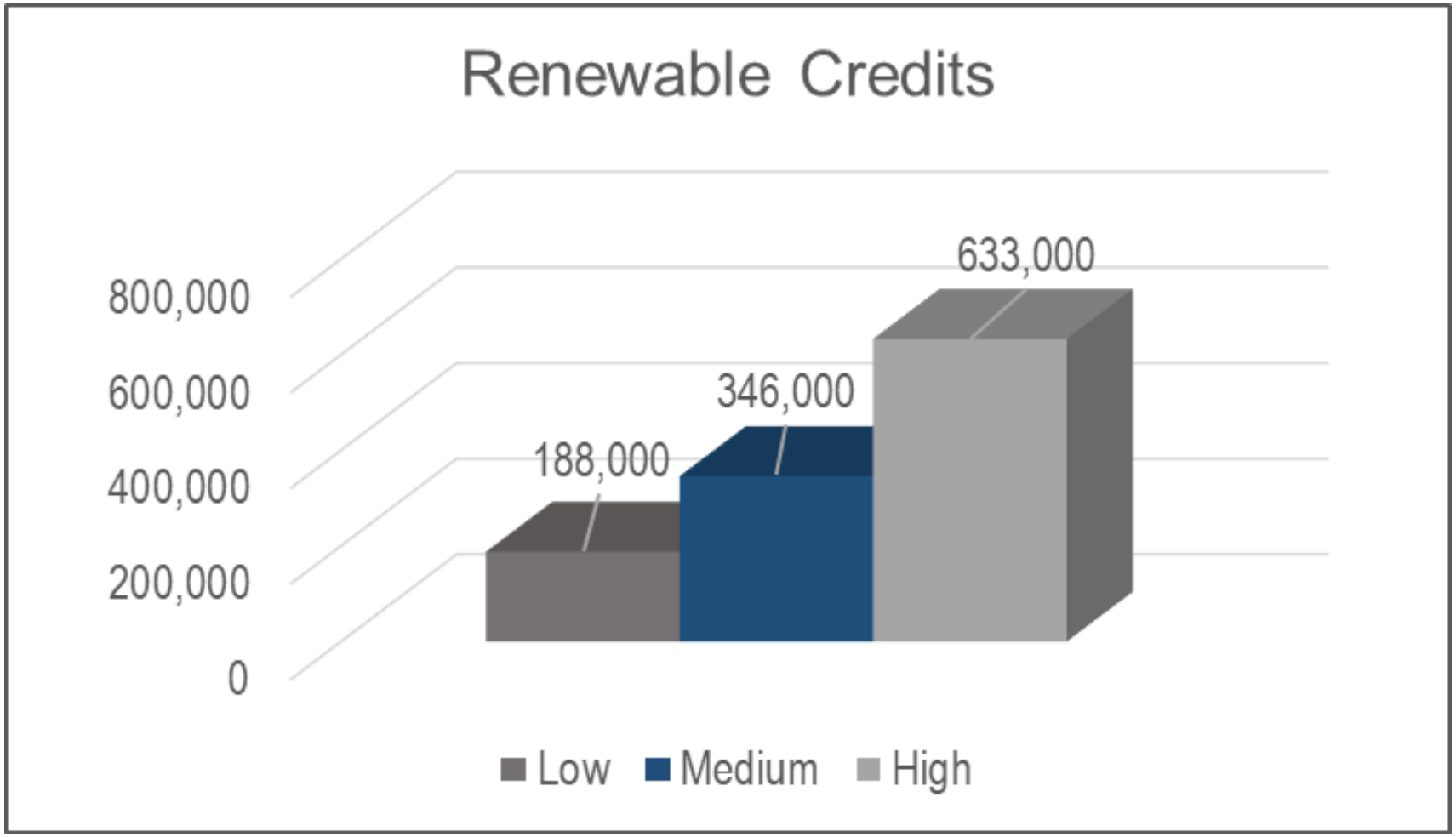
Potential Revenues

- Waste tipping fees
- Fuel Value
- Renewable Energy Credits
  - Petroleum producer $ paid to obtain offsetting renewable energy credits
  - Federal credits + for transportation related credits states such as CA, OR
  - Can be substantial revenue stream that can offset the capital investment

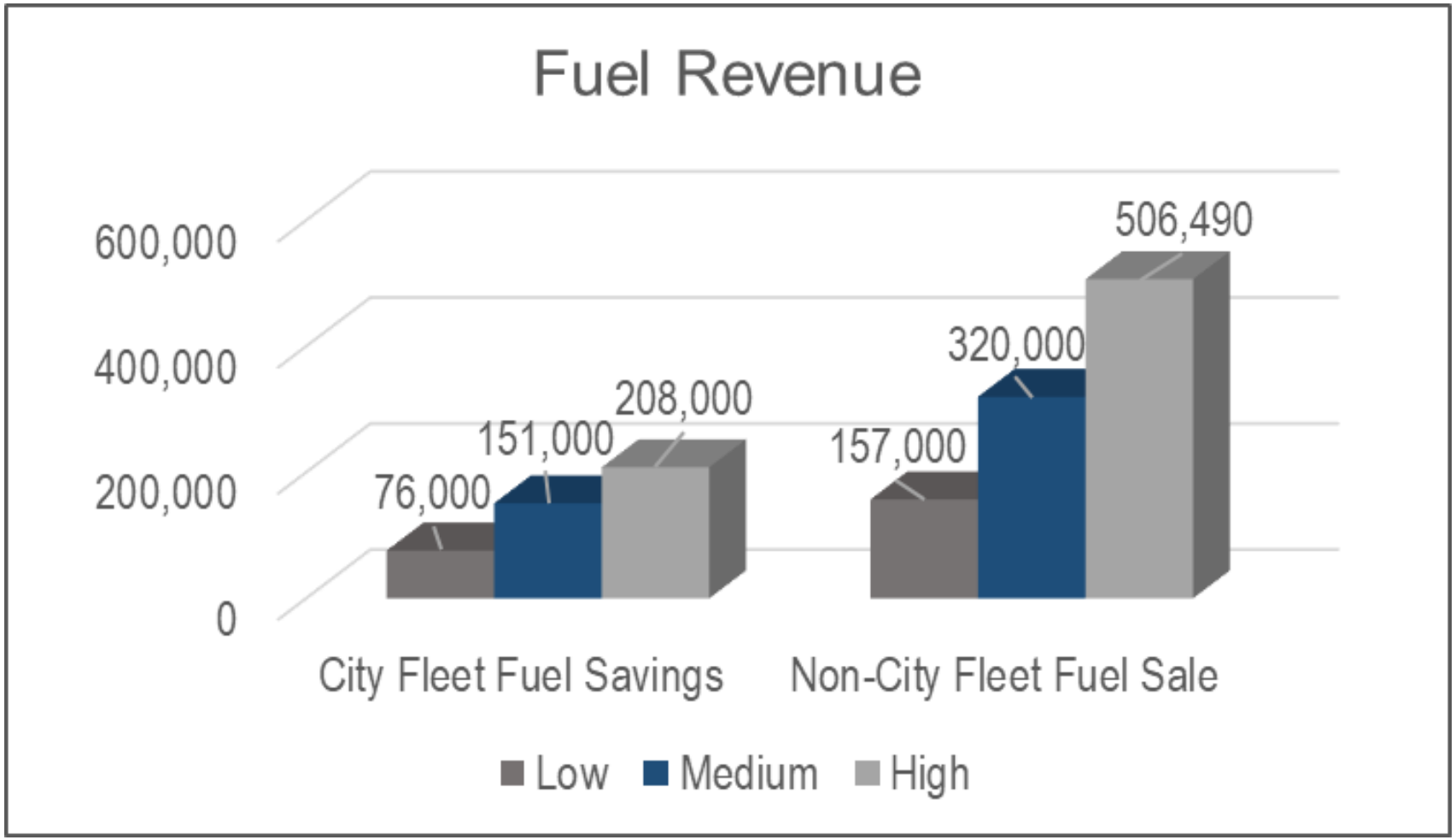
Potential Revenues



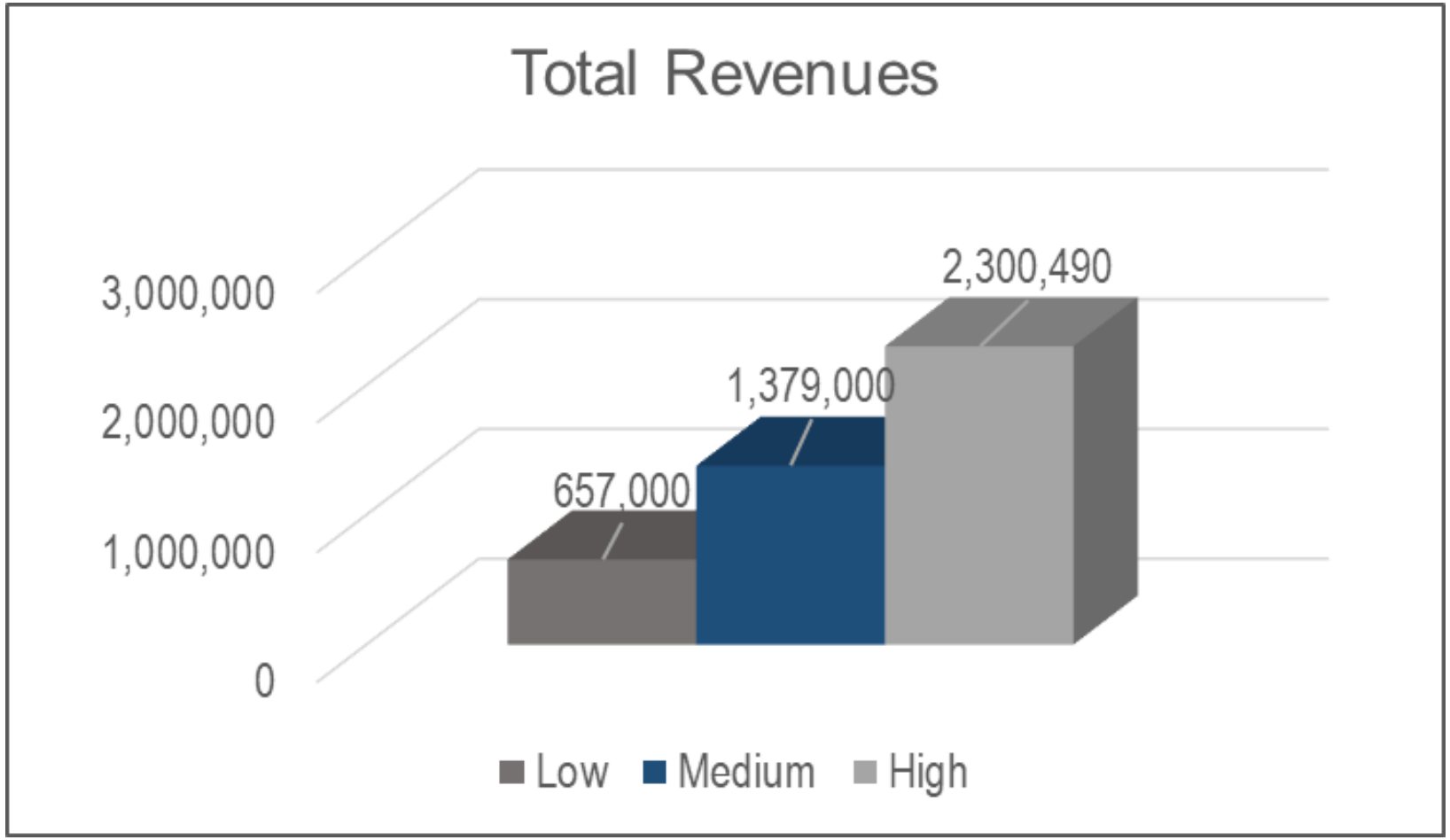
Potential Revenues



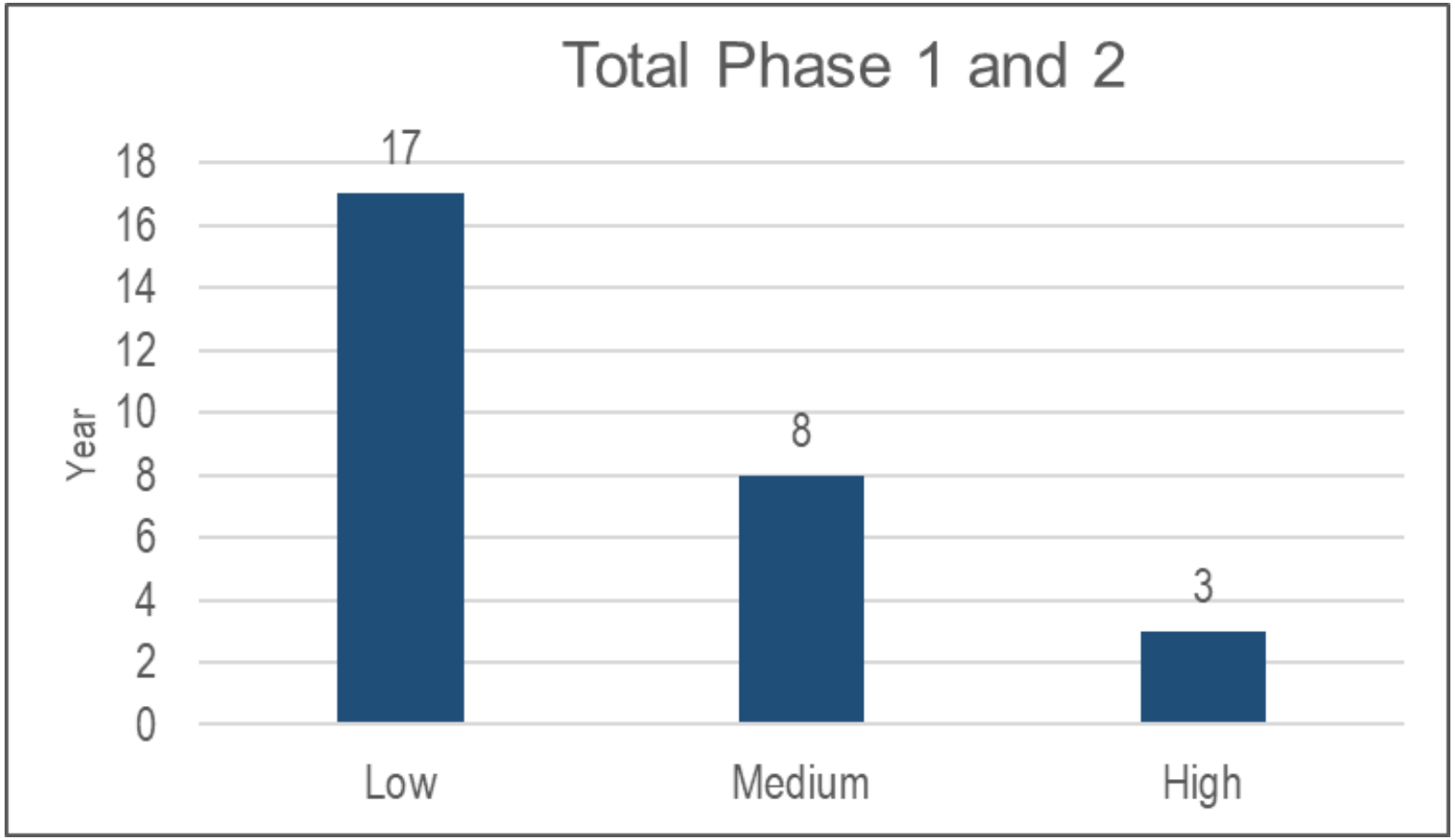
Potential Revenues



Potential Revenues



Rate of Return



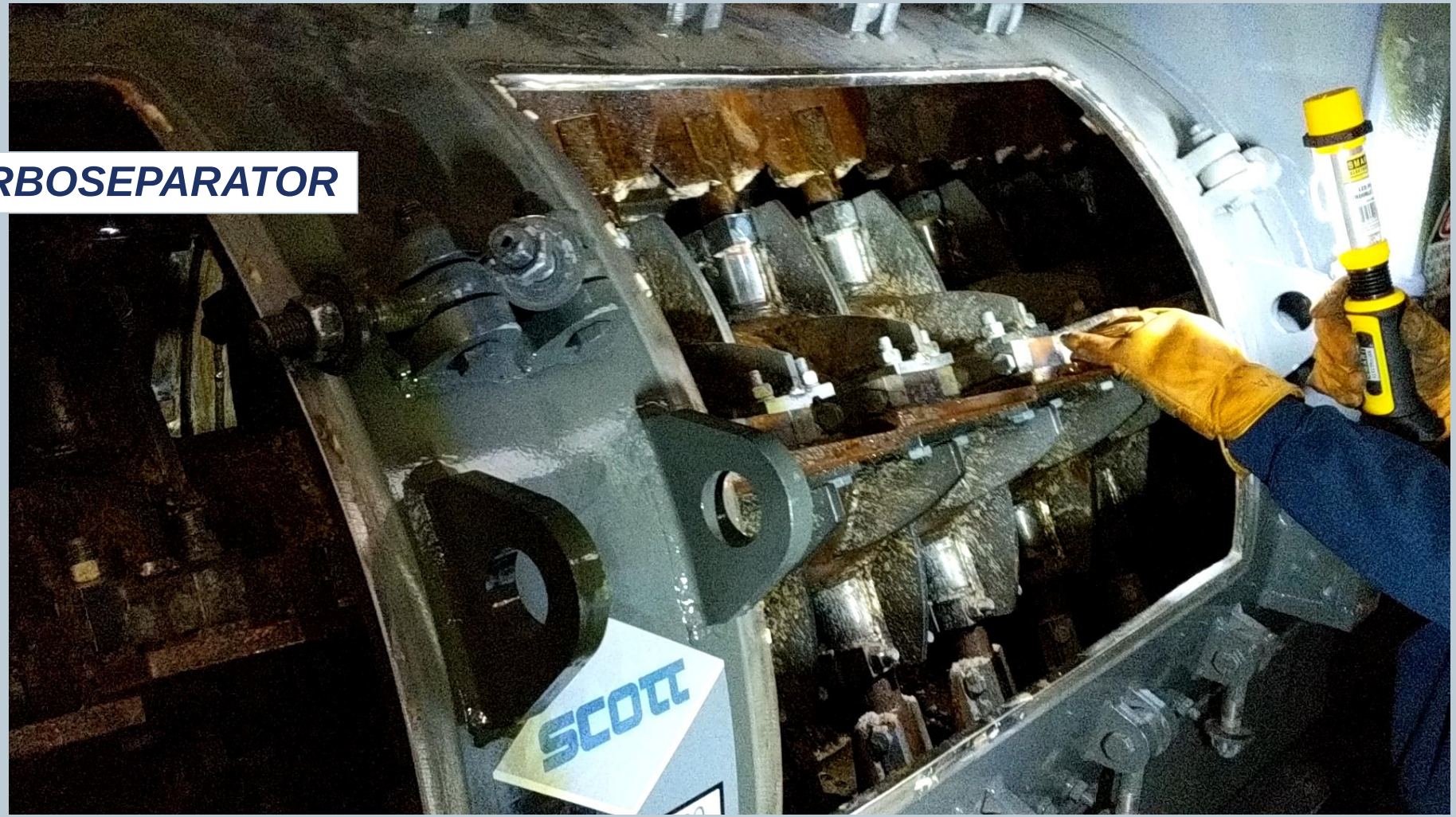
Risks

- Lower organic waste volumes
- Lower fuel usage and sales
- Lower tipping fee rates from competition
- Lower RIN values or phase out
- Higher operating costs

Scott Equipment Company

TURBOSEPARATOR

TURBOSEPARATOR

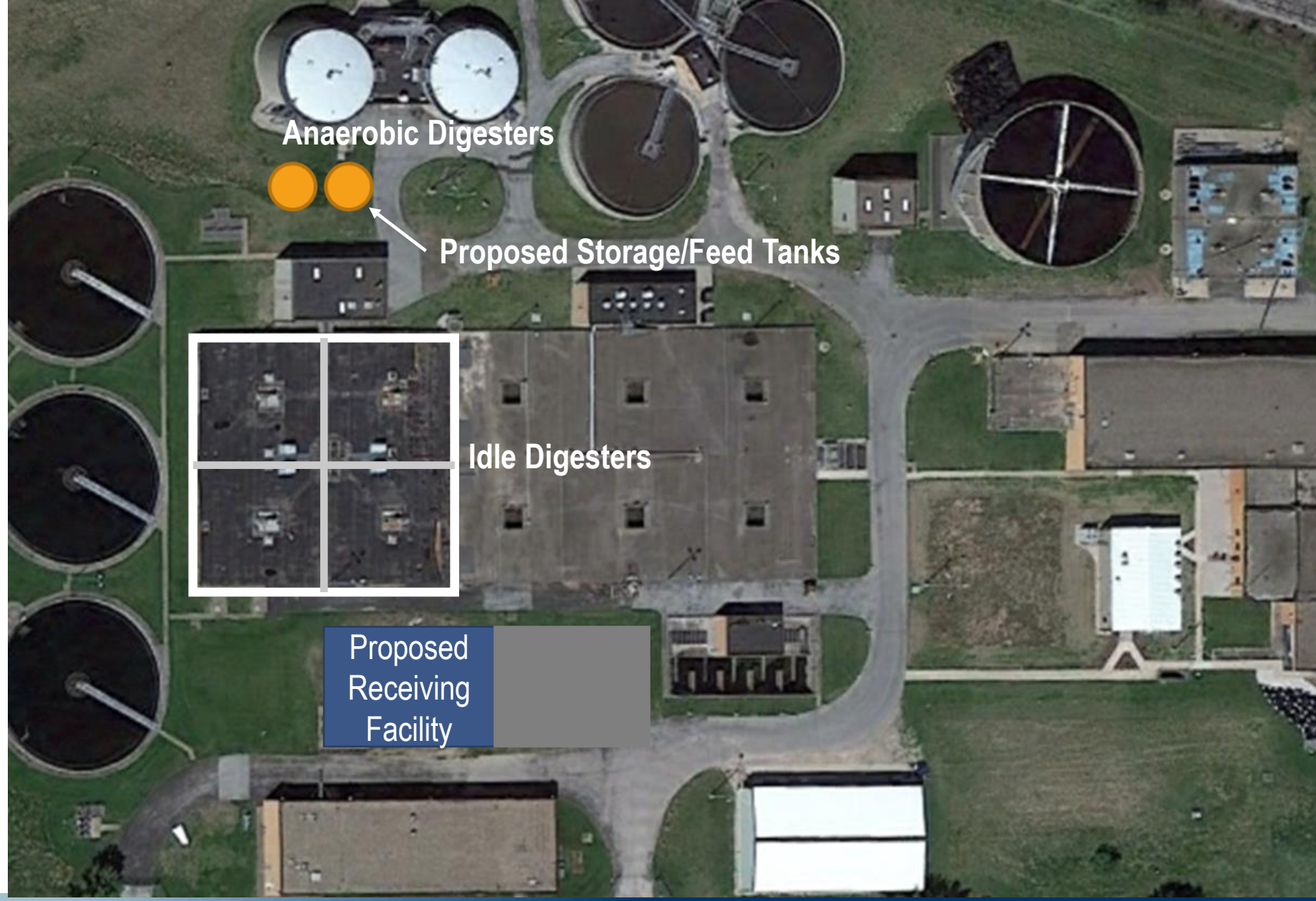


Courtesy Scott Equipment Company

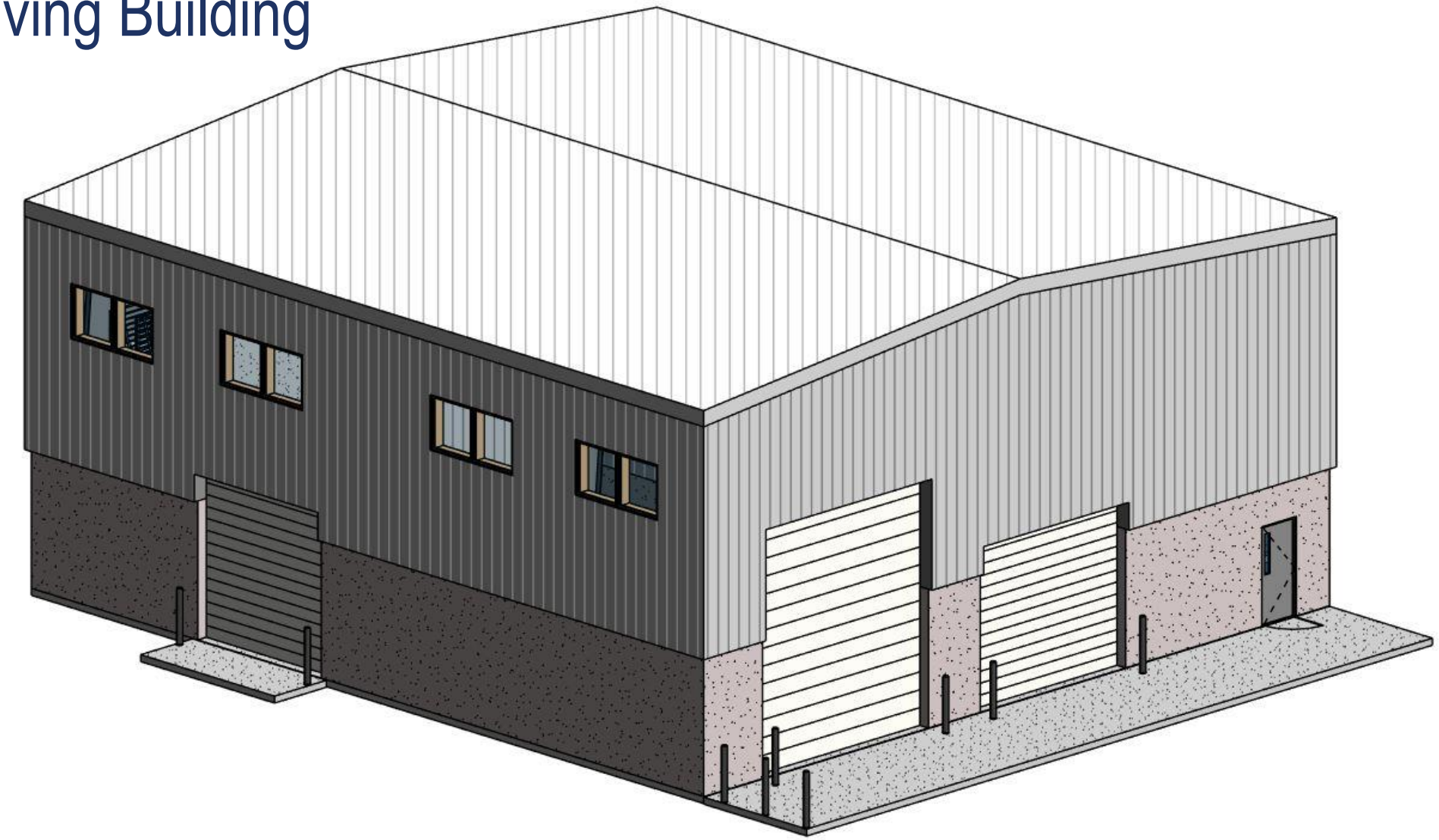
Plant Site


Digesters
DCB
Old Digesters
Aeration
Control Bldg
Thickening
Storage

Initial Project Location



Initial Receiving Building



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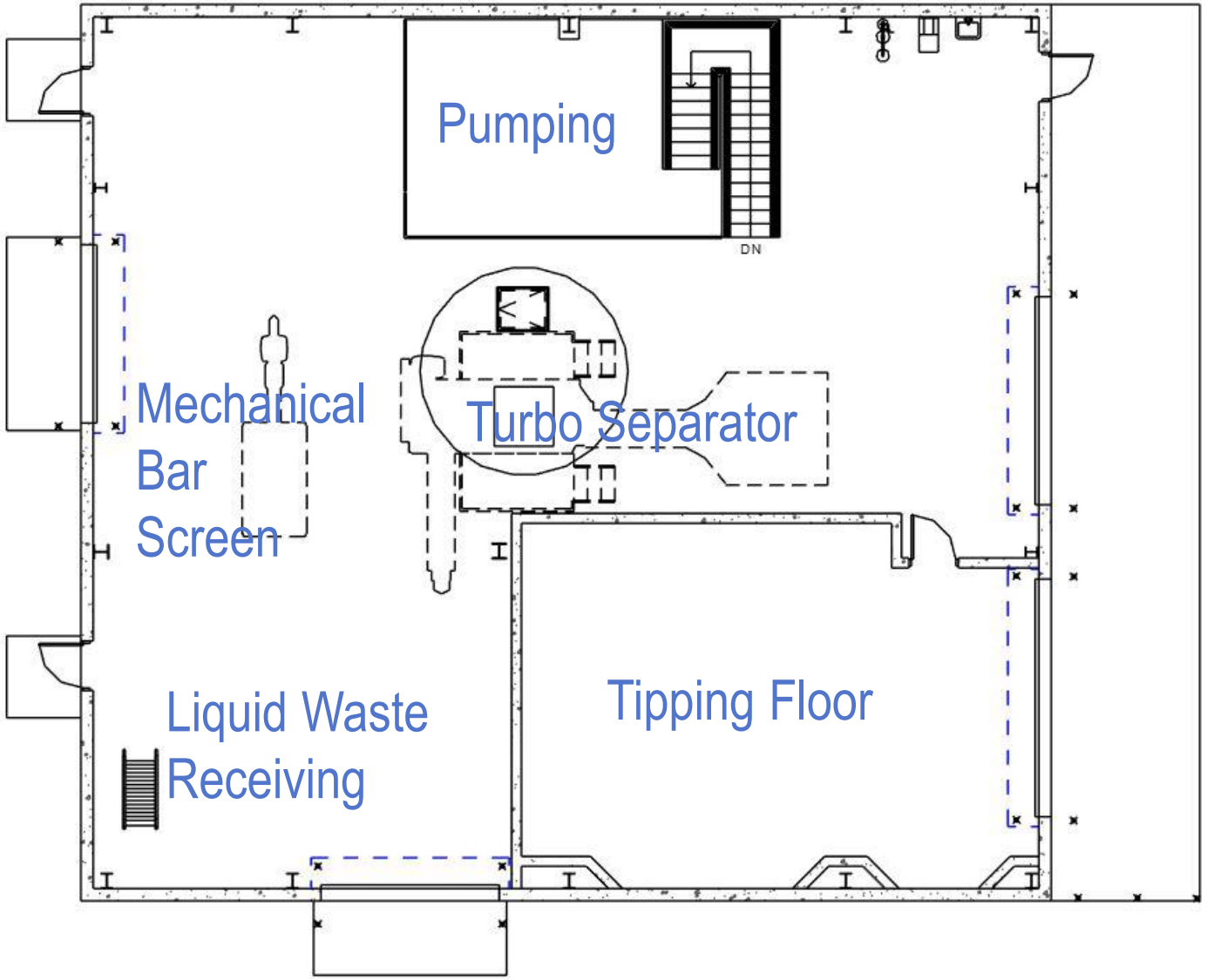
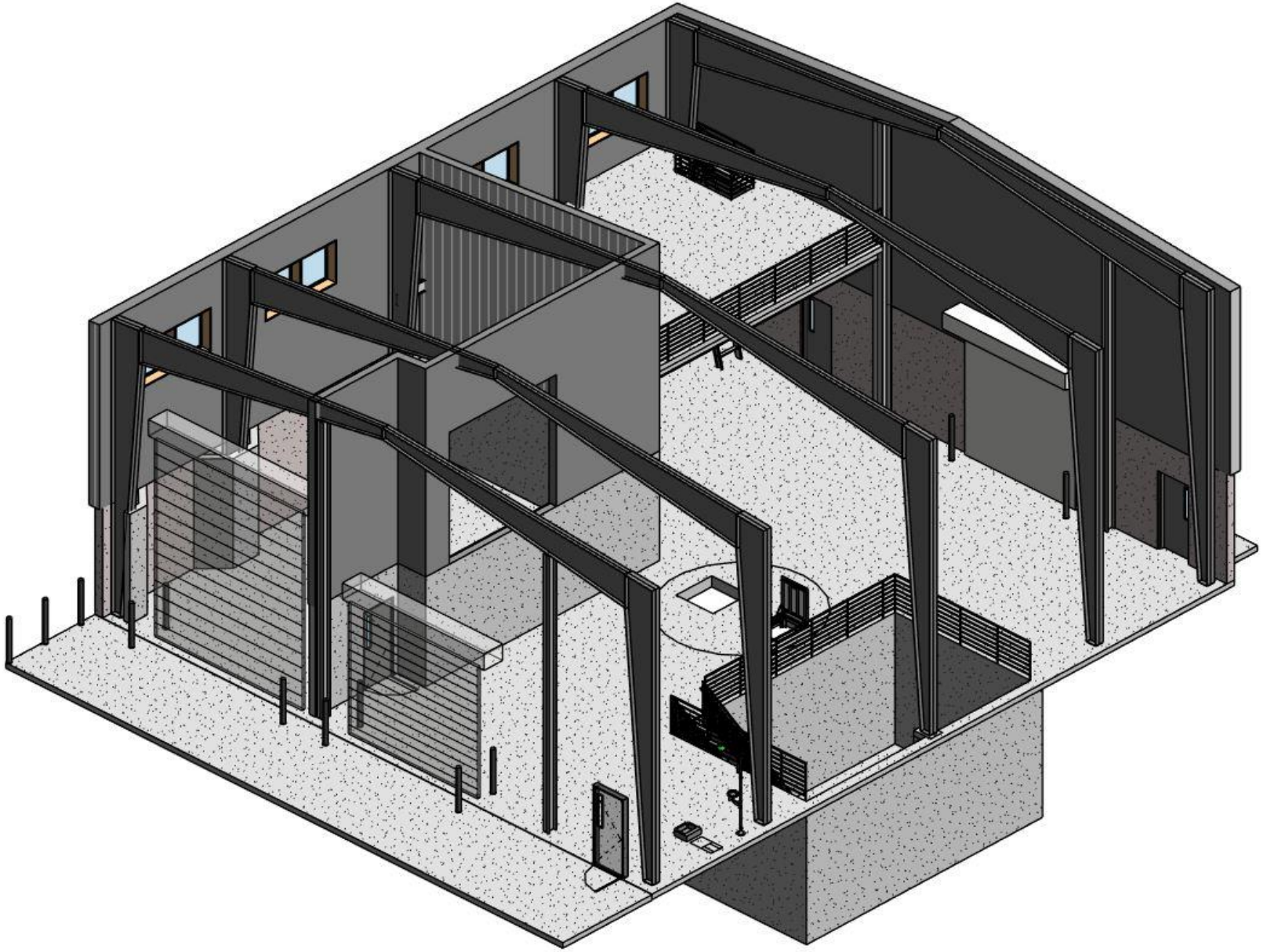
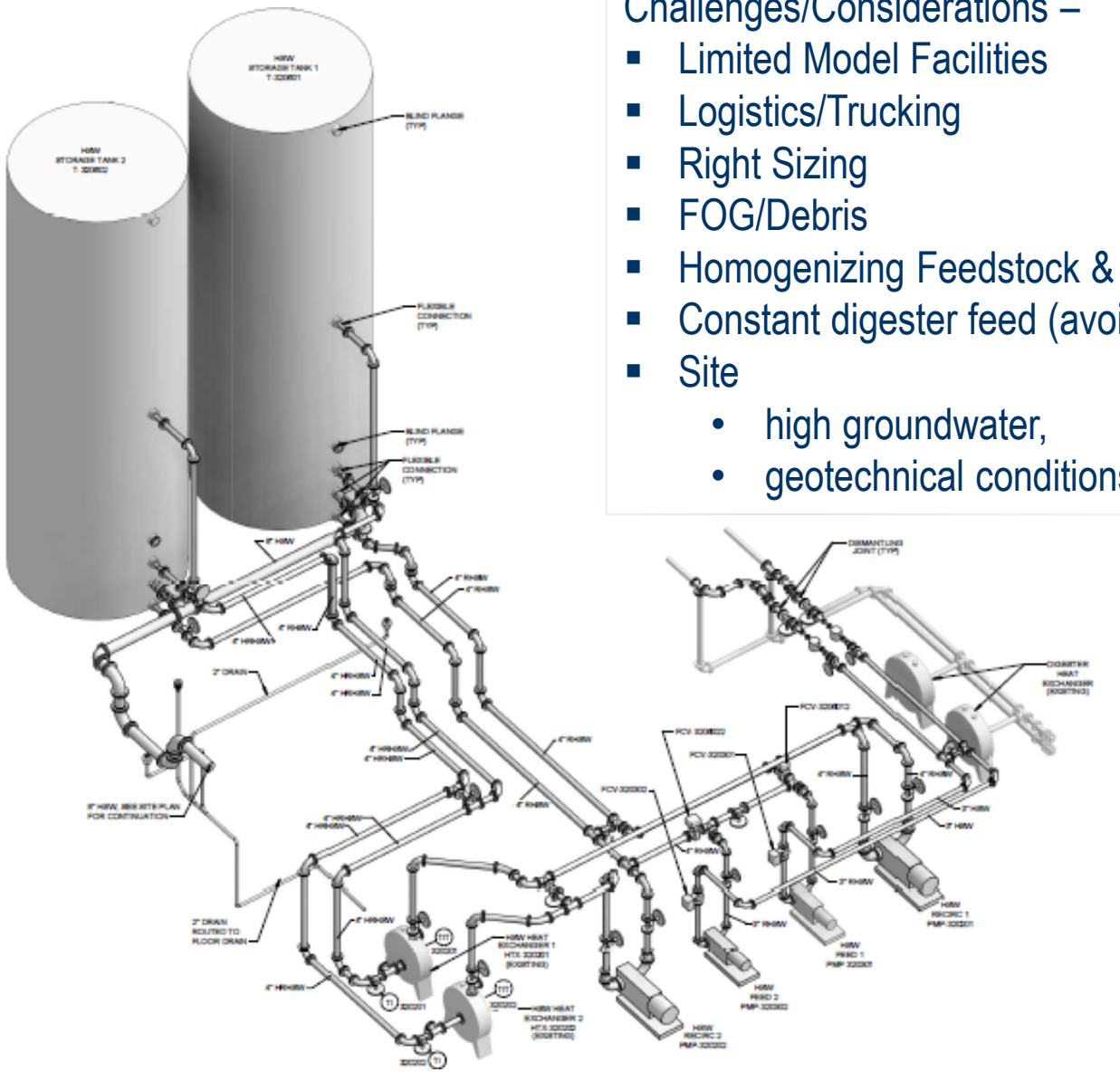


Initial Receiving Building Concept



Initial Project
HSW Storage



Challenges/Considerations –

- Limited Model Facilities
- Logistics/Trucking
- Right Sizing
- FOG/Debris
- Homogenizing Feedstock & Liquid Inventory
- Constant digester feed (avoid digester upset)
- Site
  - high groundwater,
  - geotechnical conditions

Change in Direction

High Estimated Cost

Concerns

- Limited Area for expansion
- Insufficient area for truck traffic
- Underground utilities

Outcomes

- Change Location
- Eliminate new HSW storage tanks; repurpose idle tank
- More room for truck queuing
- Use existing storage building

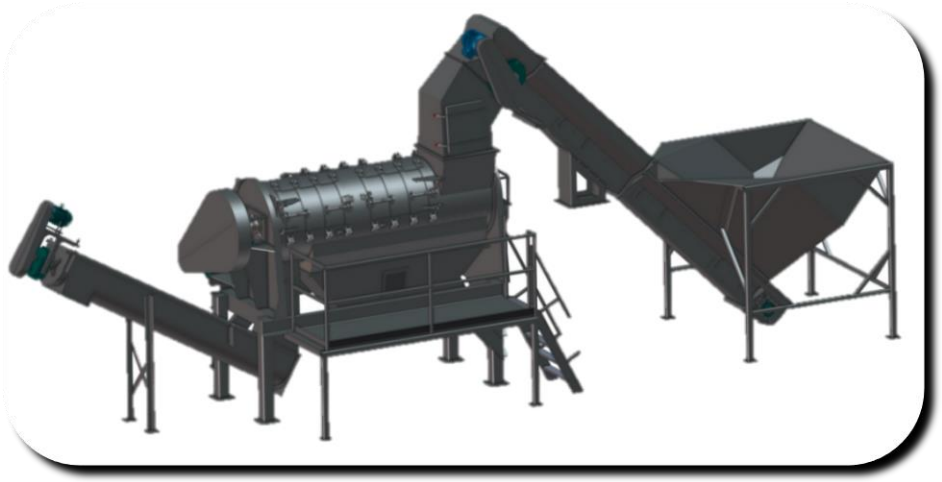
Reduced Scale

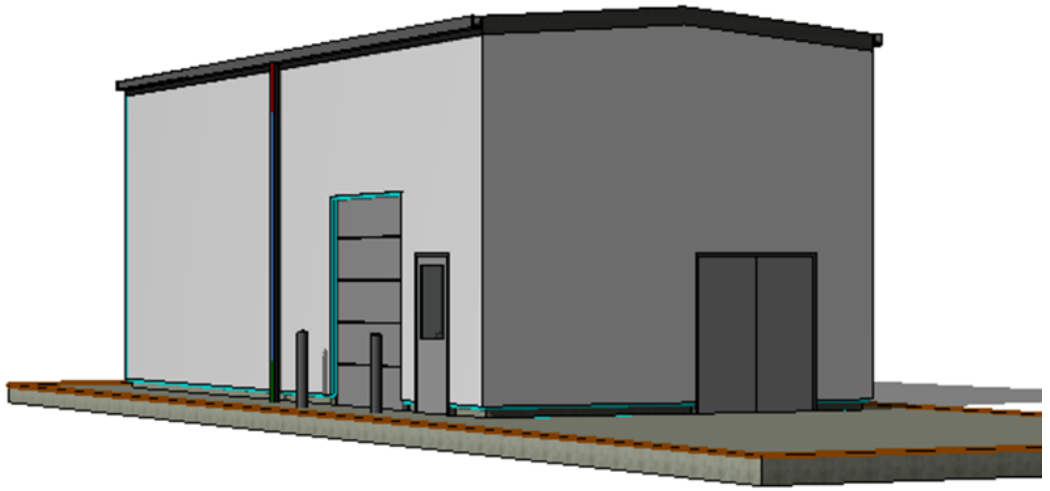
Manual Screening

Liquid Food Waste (LFW) Transfer Pumping

Use Renovated Concrete Tank

Use unused space at Solid Waste Transfer and Recycling Center

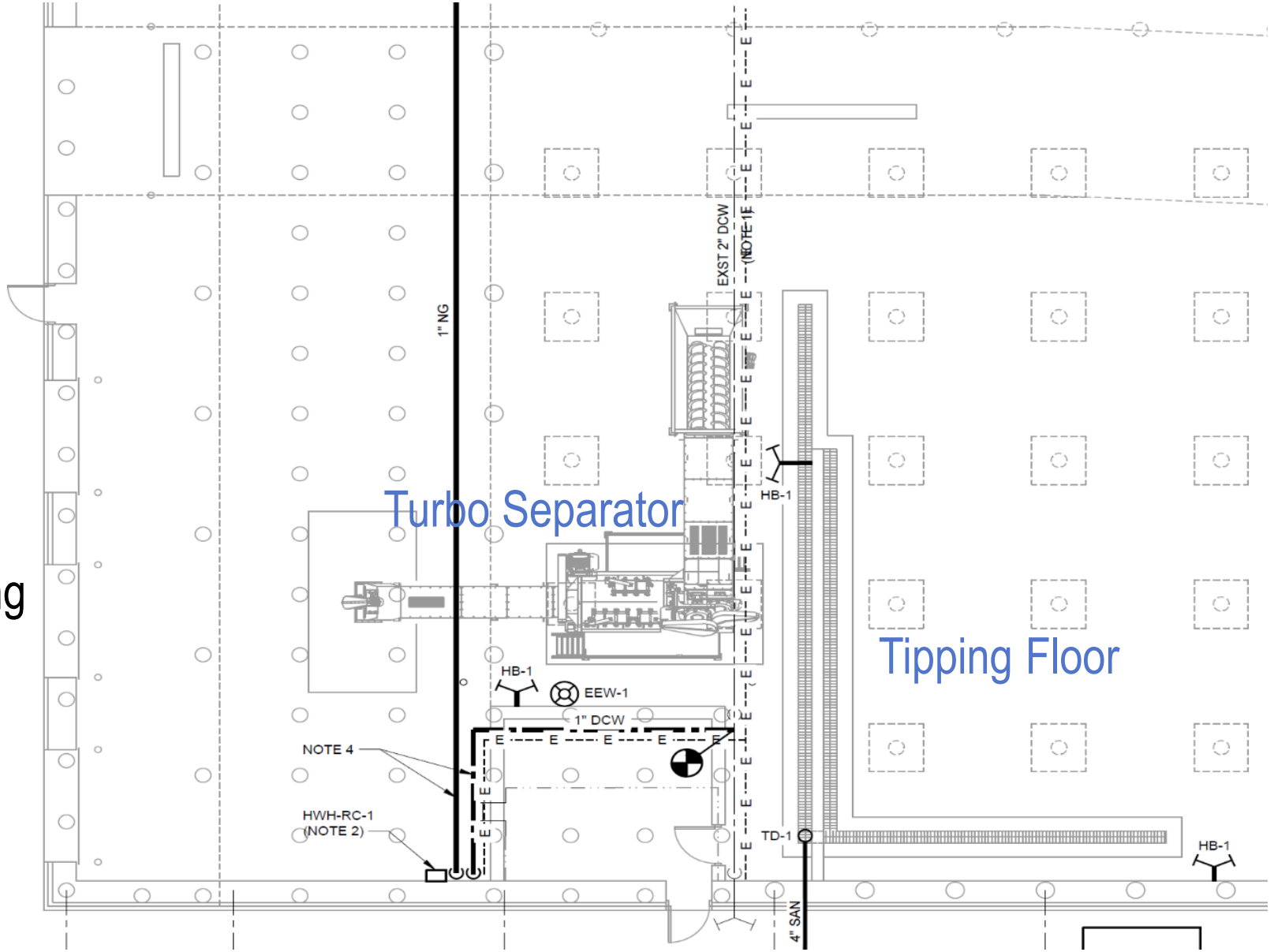




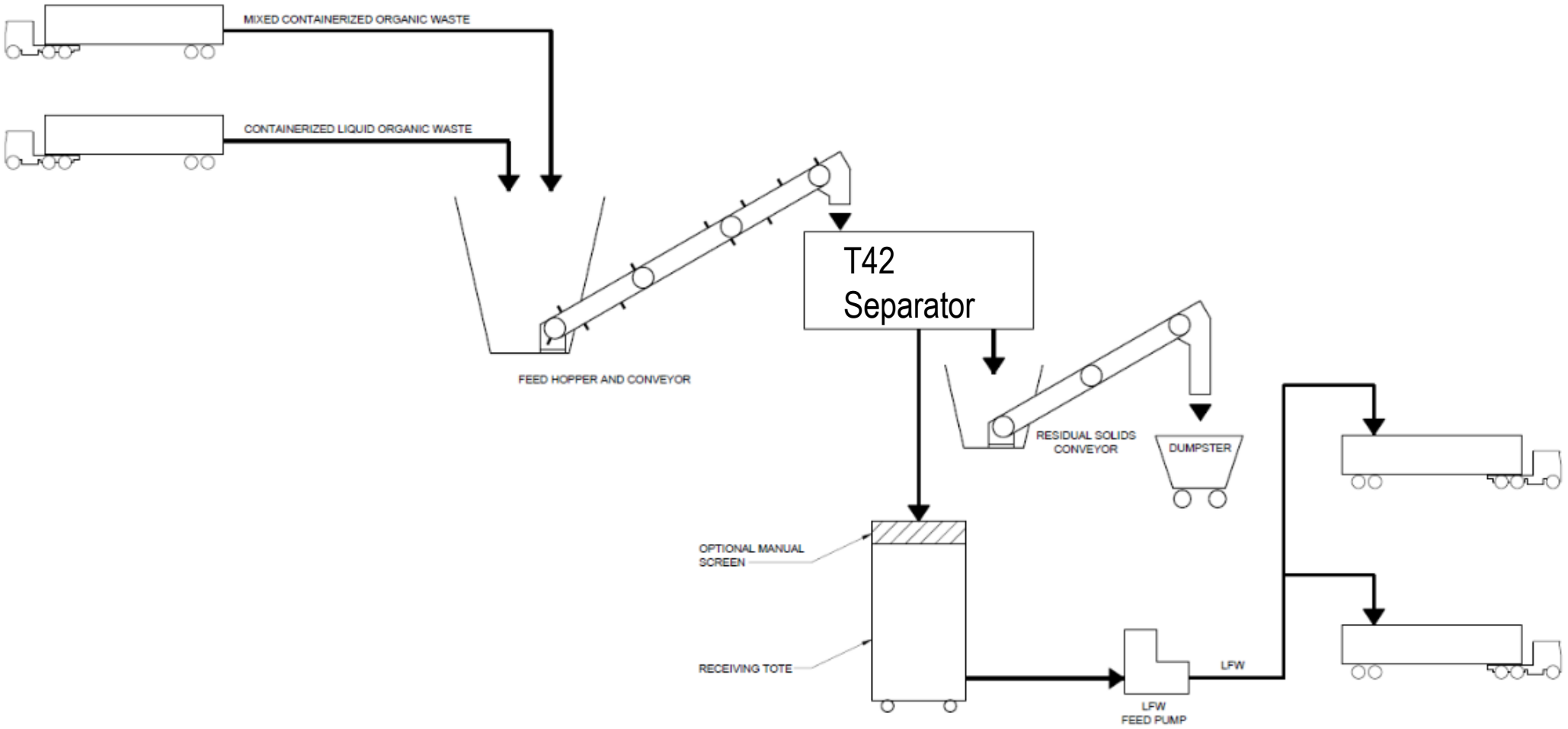
Recycling the Recycling Facility

The Project – Recycling Building

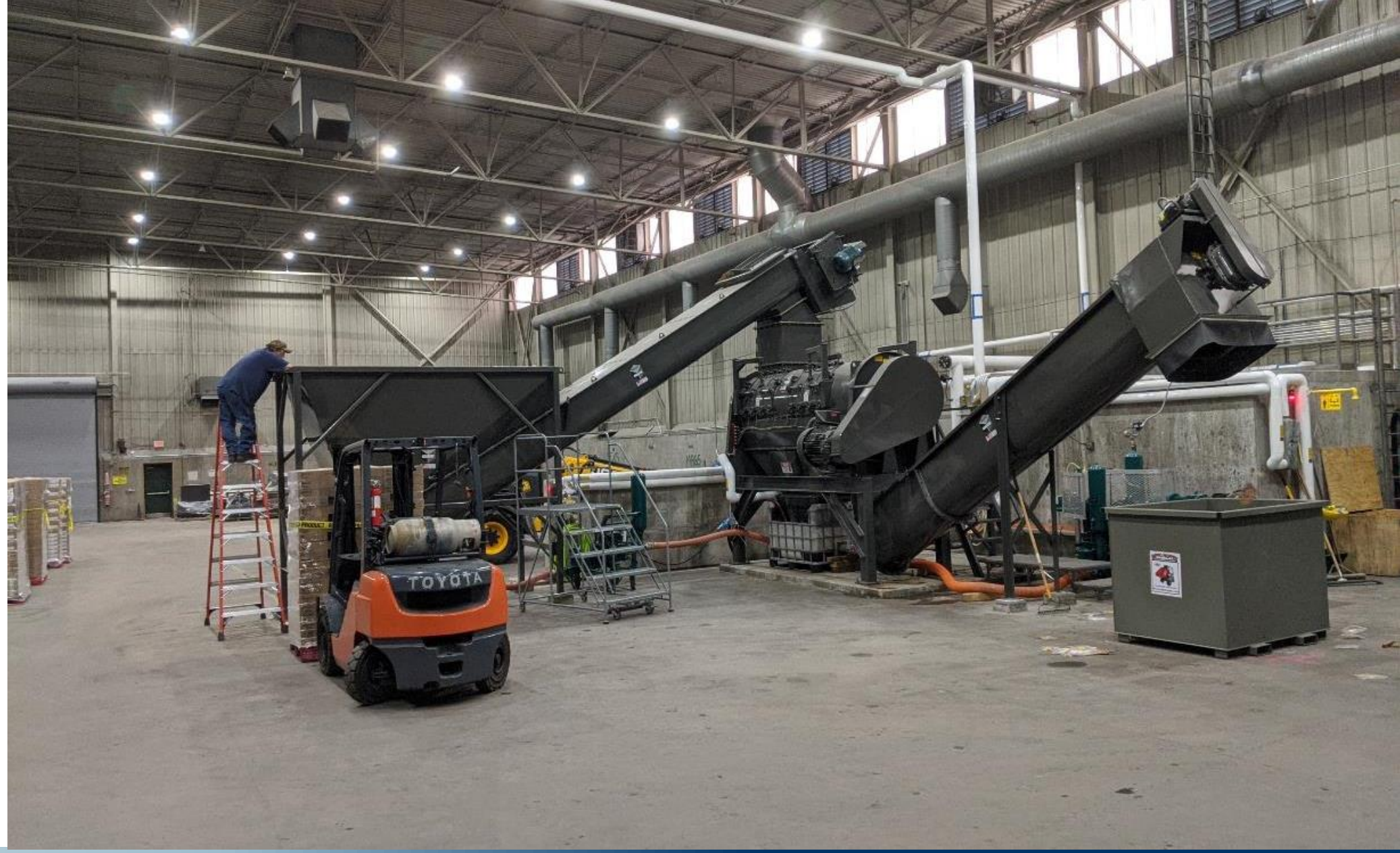
Loading Docks

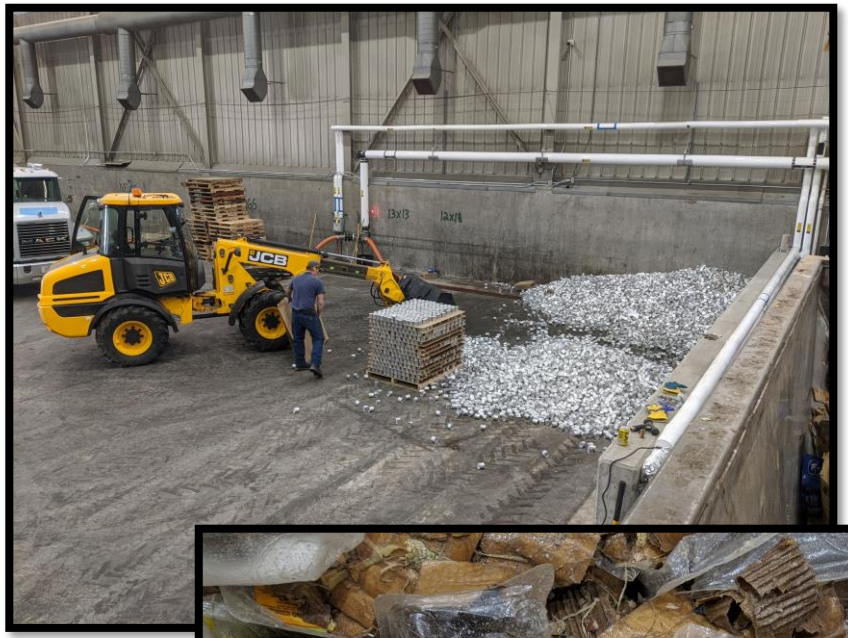


The Project – Process Schematic at Recycling Center

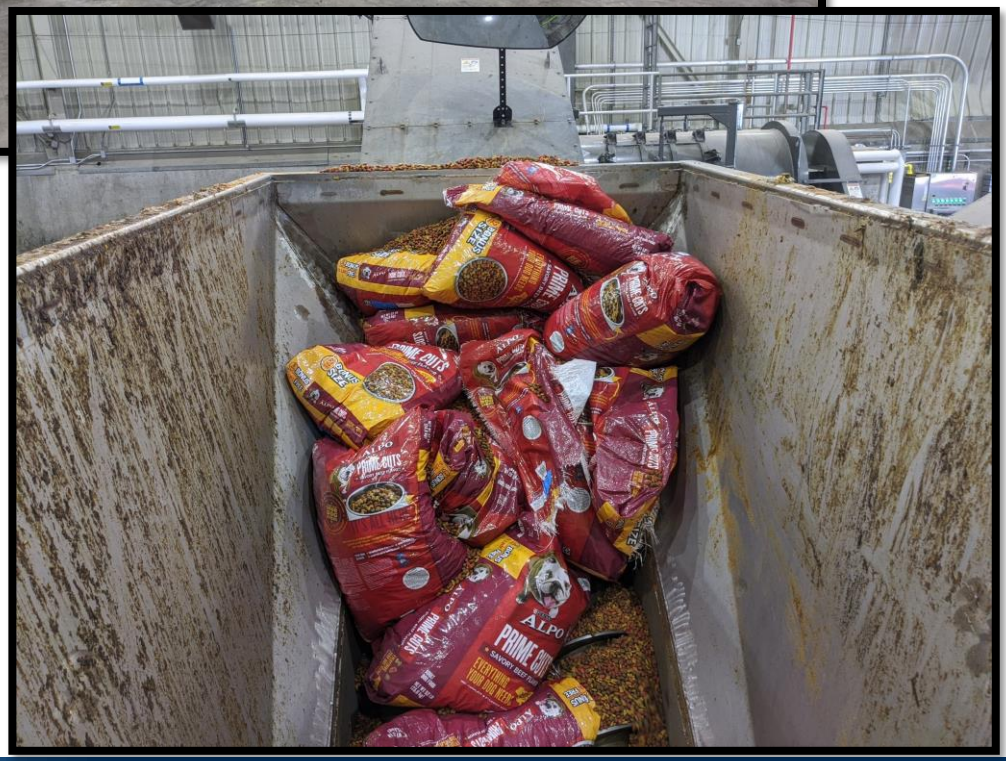


Turbo Separator



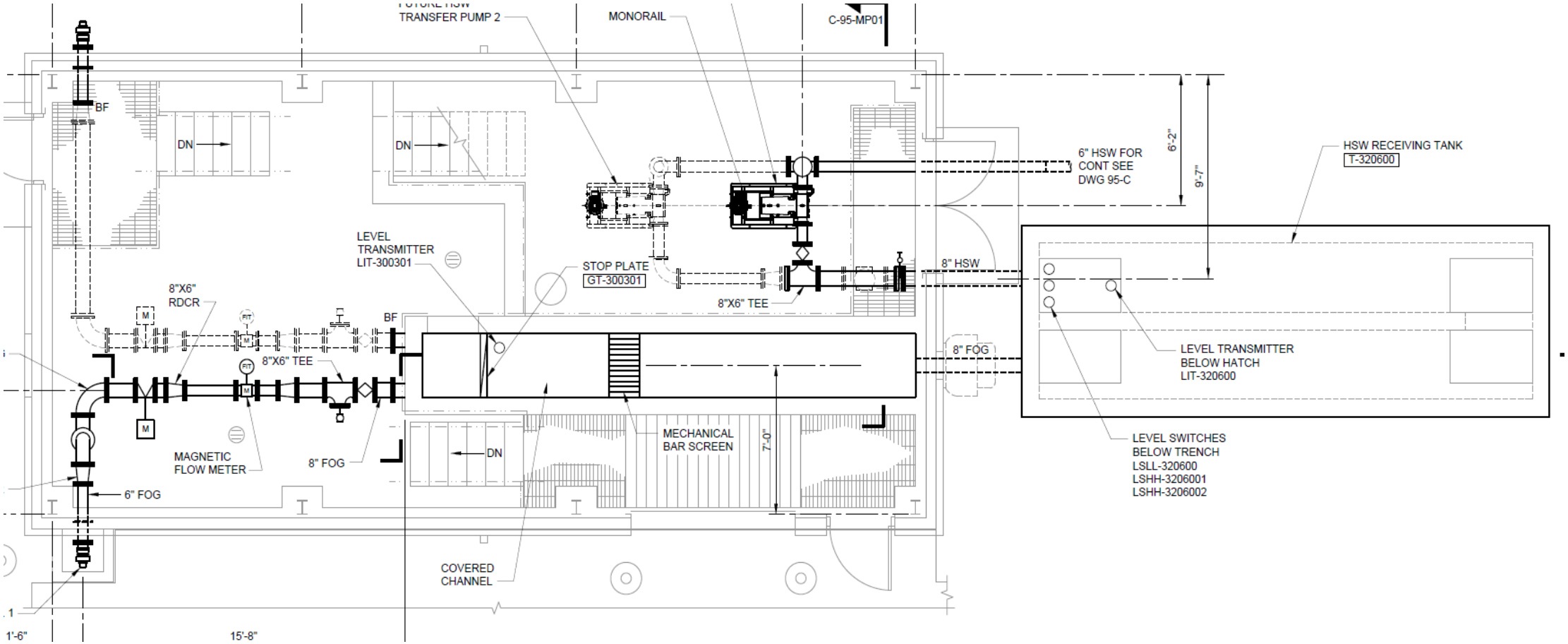

JCB


DeliFresh
OVEN ROASTED

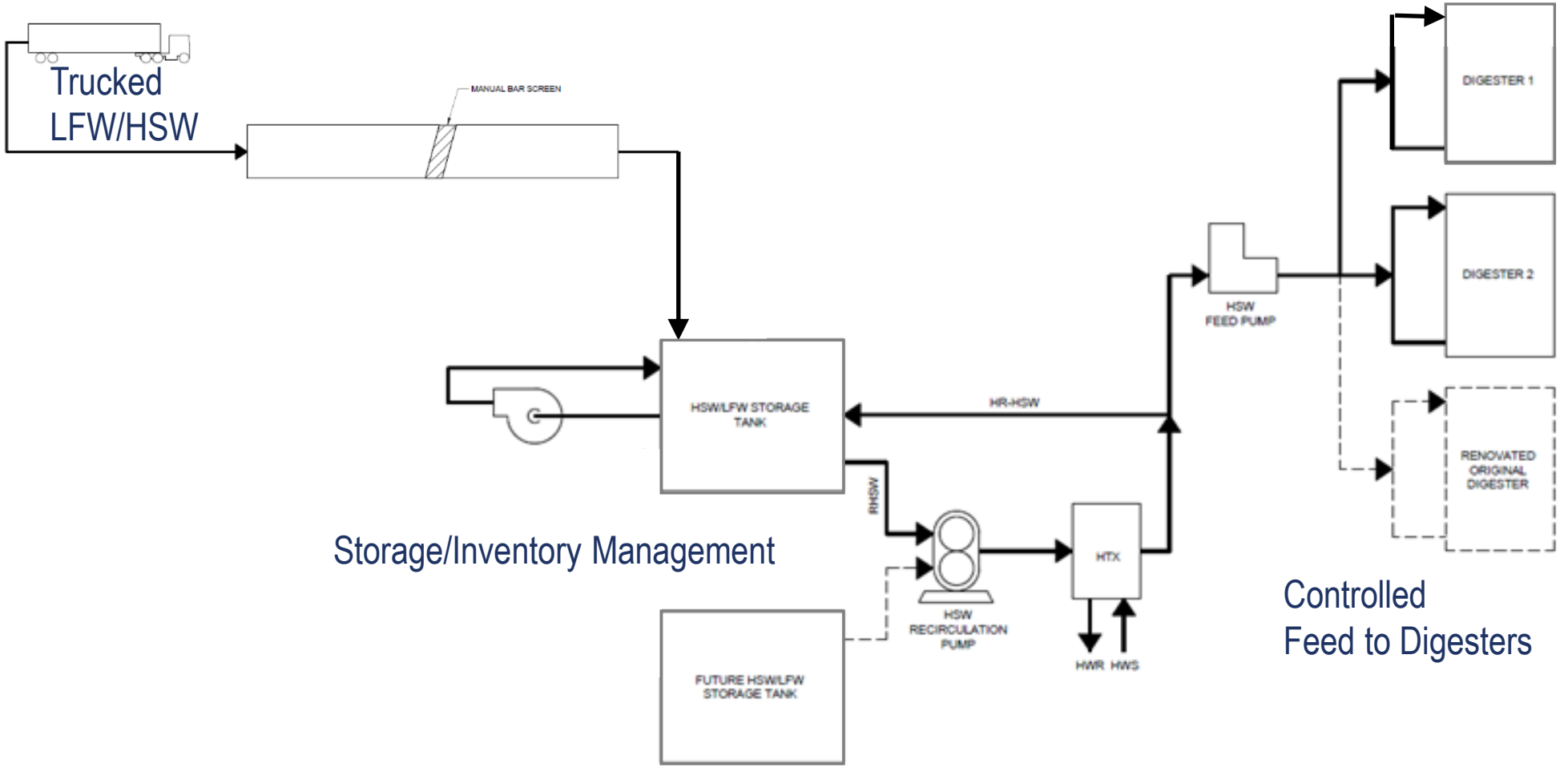

PRIME CUTS

Turbo Separator in Action

The Project – Receiving Building



The Project – Process Schematic



Receiving at WRRF

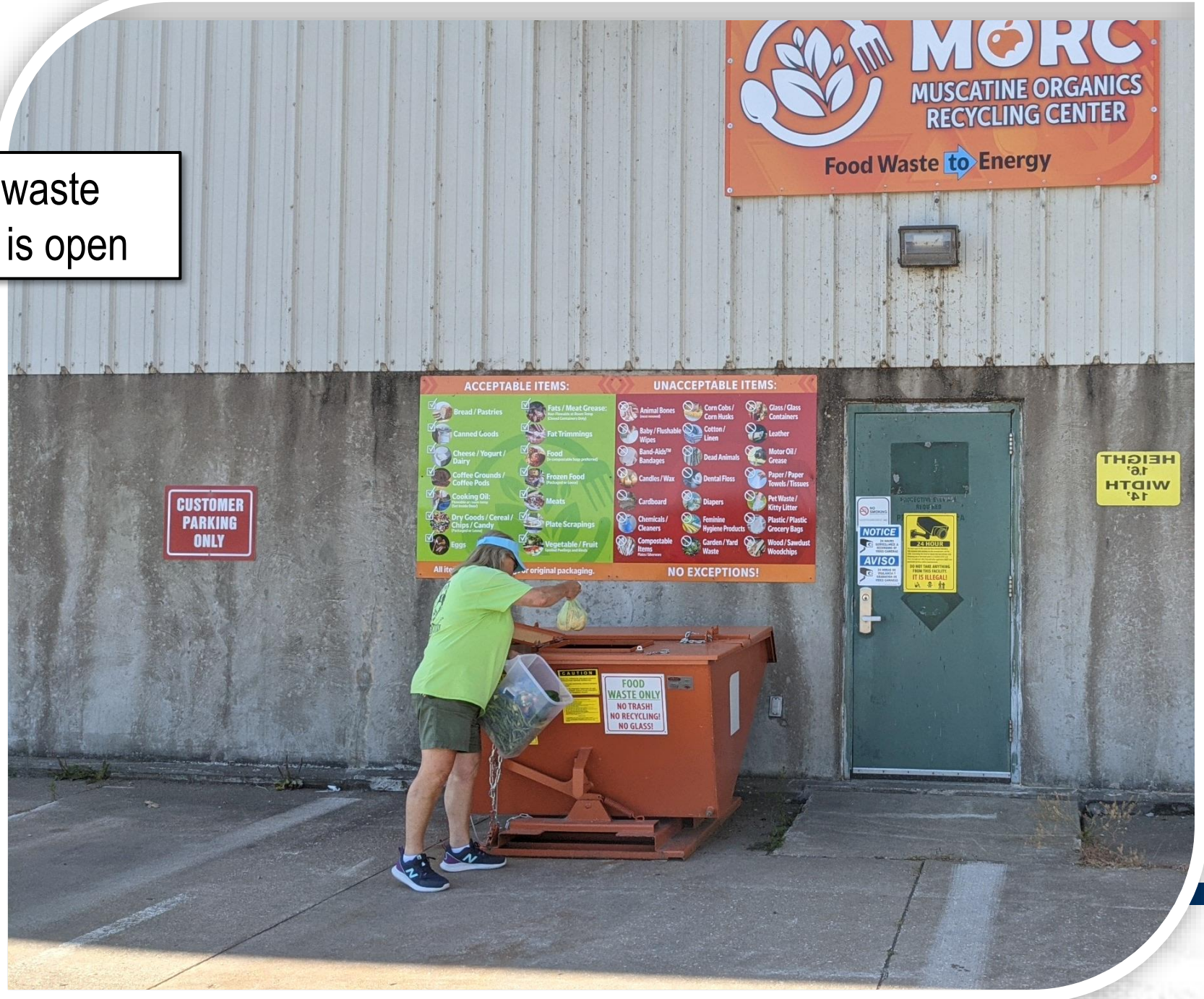
- Liquid and solids directly added to the storage tank.
- The second tank needs to be rehabilitated for proper dosing

HSW Tank Rehabilitation

Mixing & Pumping

- Tank Rehabilitation and Jet Mixing
- Tank #2 will receive the same in the Phase II project.
- Pumps installed
- New pumps will be installed for Phase II

Free Drop-off for food waste when Transfer Station is open



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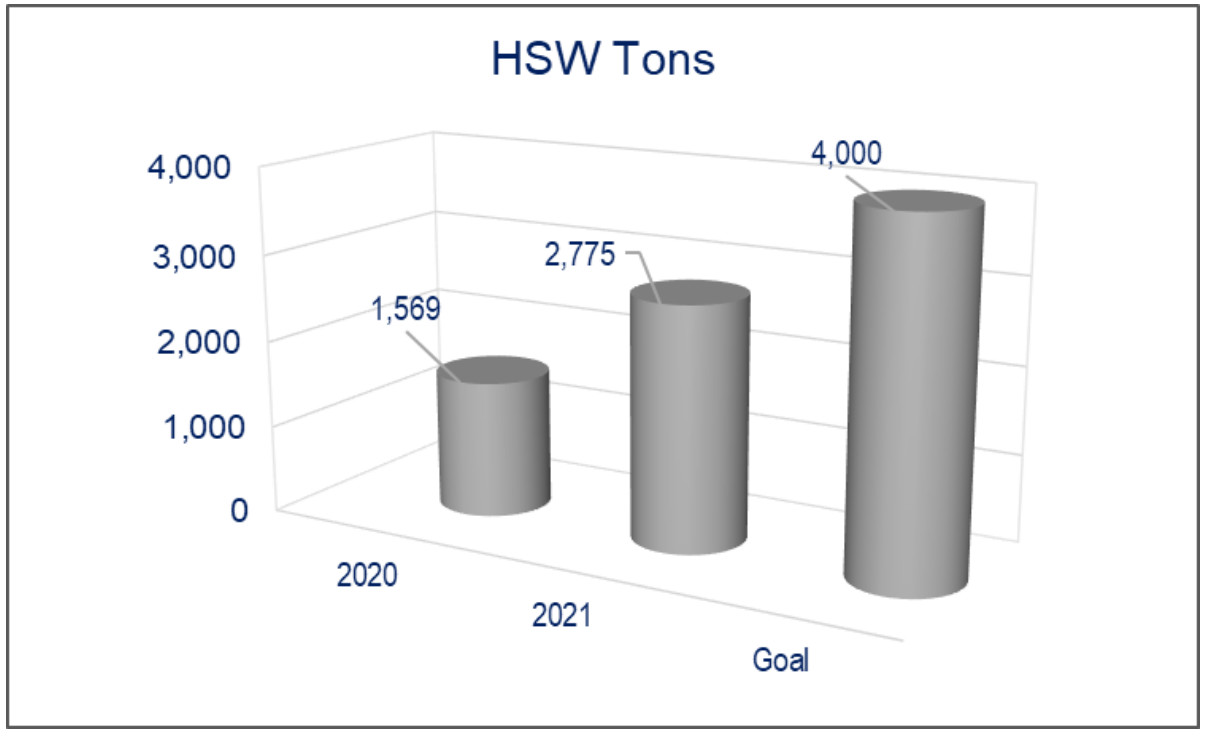
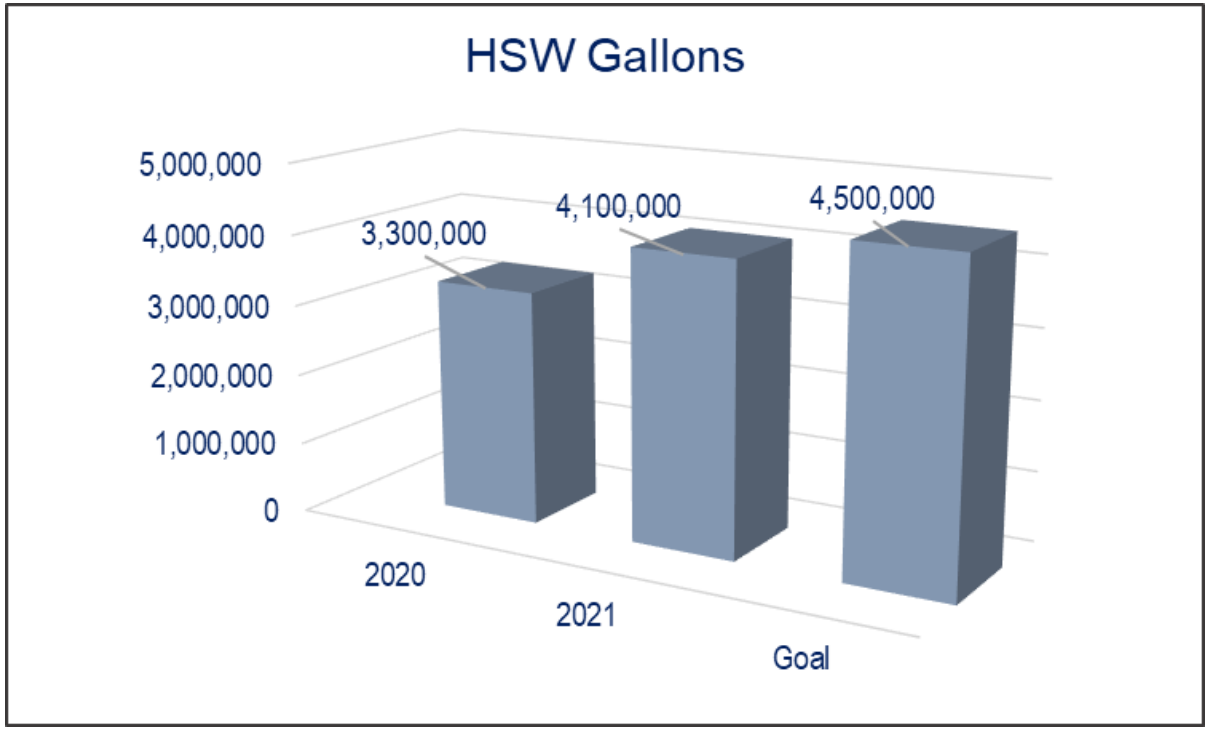
Project Update

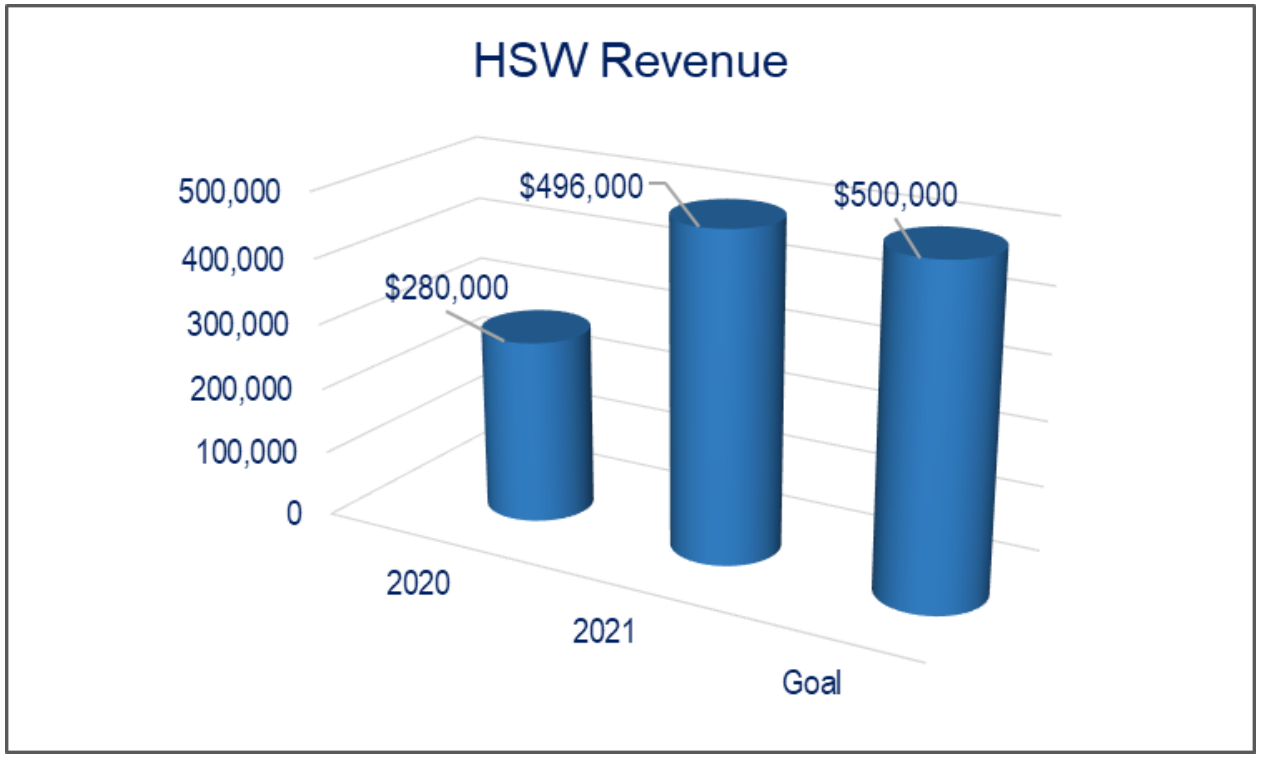
- Up to 10 new clients beyond original 5 expected
- Large management companies with multiple clients
- Both Muscatine Hy Vee stores instead of composting Also 6 stores in region

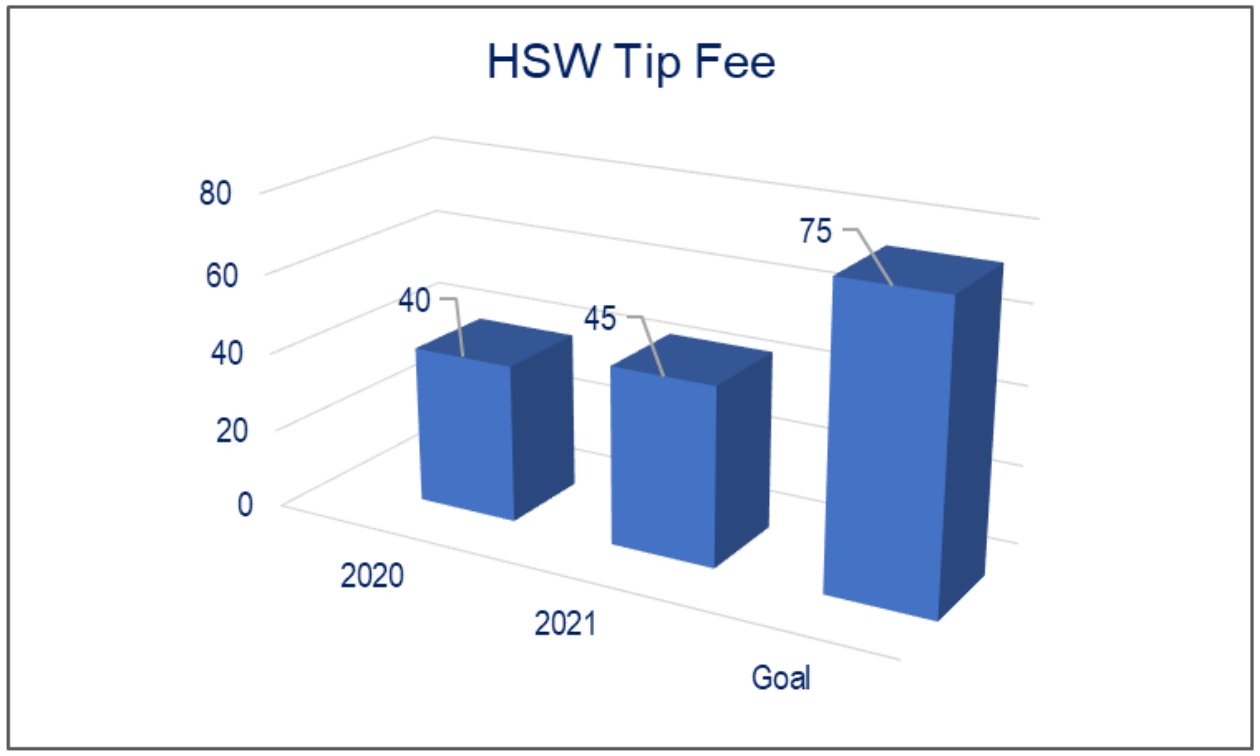
High Strength Waste Project Update





High Strength Waste Project Update





Operational Tidbits - Receiving

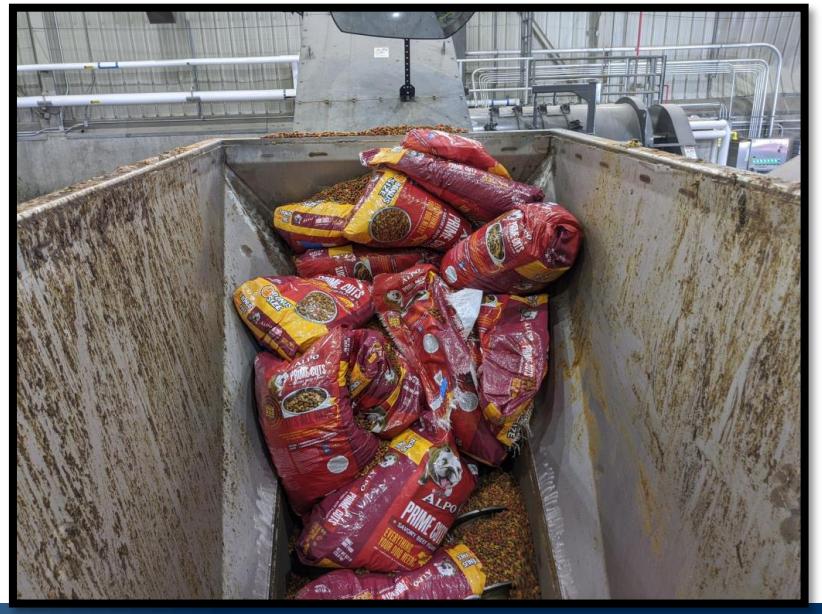
- ❖Truck queuing/circulation
- ❖Receiving volume
- ❖Debris removal
- ❖Hauler Interface/Billing
- ❖Liquid train vs Solids Train
- ❖Beware Antidegradation

Operational Tidbits - Depackaging

- Takes Labor
- Staging/Feedstock Storage
- Packaging Volume
- Auger & Pump Feeds
- Dry Product Challenges

Operational Tidbits - Processing

- Corrosive (low pH), abrasive = wear
- Balance feedstocks for digestibility
  - Proteins increase ammonia and phosphorus
  - FOG = rocket fuel = rapid bulk liquid expansion
- Homogenize the waste
- Steady feed digesters



Operational Tidbits - Processing

Food Waste/Co-Substrate	OLR gVS/L-d	Methane Yield mL/g VS-d
CFW – Chicken Manure	2.5	508
CFW – Chicken Manure	15	317
Kitchen Waste - Biowaste	10.9	420
CFW – Sewage Sludge	1	494
CFW – Rice Straw	5	392
Vegetables - None	1.4	250
Greasy Food Waste - Municipal	2	633
MSW Organic - FOG	4	318
Anaerobic Digestion of Food Waste with Unconventional Co-Substrates for Stable Biogas Production at High Organic Loading Rates, Hegde & Trabold; Sustainability Journal, July 2019		

Avoid Rapid Bulk Liquid Expansion

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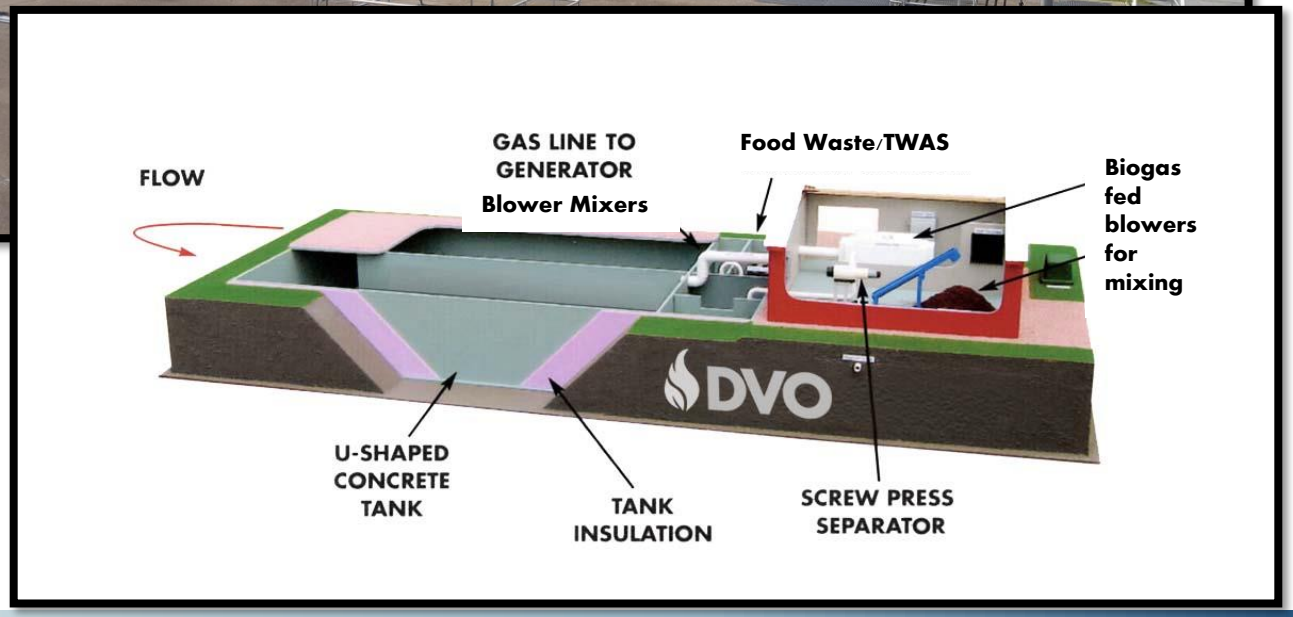
Muscatine Organics Recycling Center

MORC…It's Out Of This World!

The new facility was renamed the Muscatine Organics Recycling Center, or MORC, to identify it to the public and best reflect what is happening there.

Phase II: More Anaerobic Digesters



- $800,000 bonded to complete
- Engineering underway
- Needed for large quantities expected
- Needed for upsets

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Discussion

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Contact: BradyJay@stanleygroup.com
Jkoch@muscatineiowa.gov

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Join us Wednesday, October 5th for a webinar with Xing Xie, Ph.D., Assistant Professor at Georgia Institute of Technology, titled "Locally Enhanced Electric Field Treatment (LEEFT) for Disinfection" We have several other webinars scheduled as well.
Go to https://www.aaees.org/events to reserve your spot.

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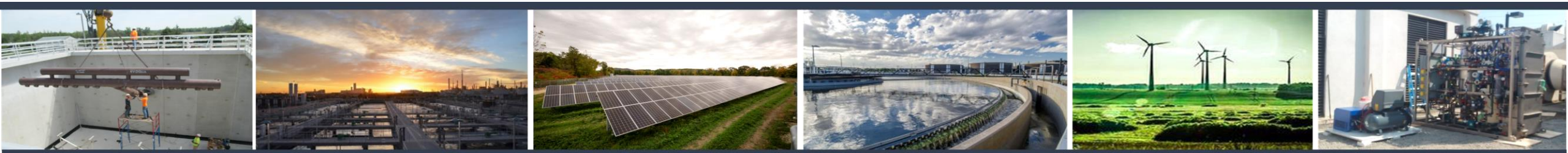
Questions? Email Marisa Waterman at mwaterman@aaees.org with any questions you may have.



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