SUEZ Advanced Solutions

Case Study: Optimizing Biosolids Management Cost and Circular Economy

James Willson, II, PE
Biosolids Project Manager

jwillson@utilityservice.com
Ph: 706-836-6565

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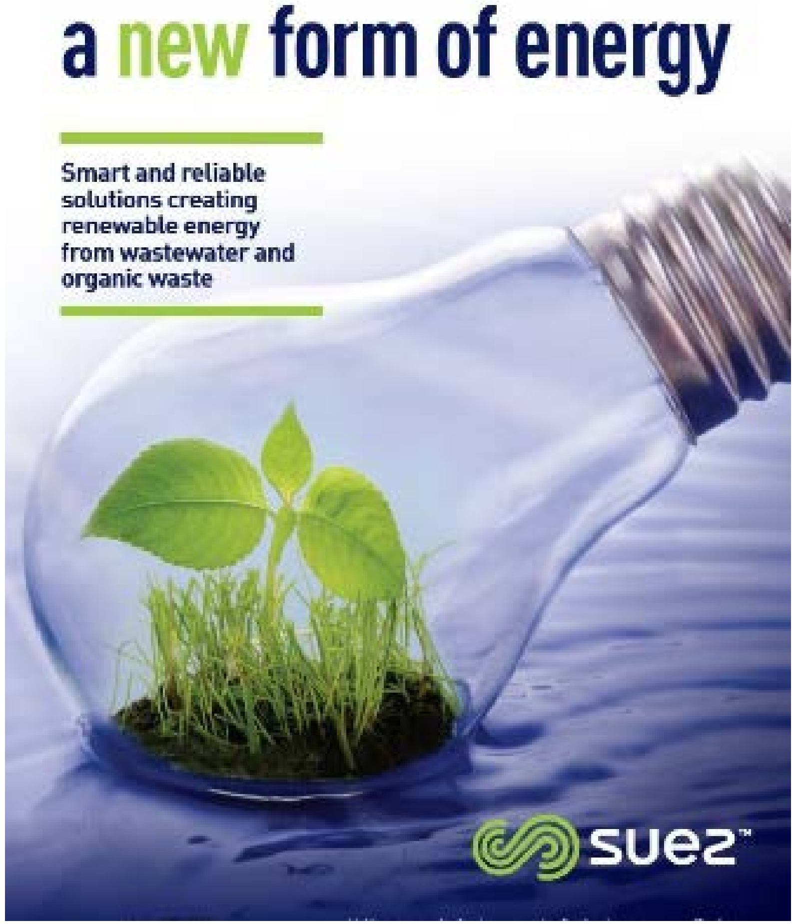
ready for the resource revolution

Energy Performance and Resource Recovery from Biosolids



a new form of energy

Smart and reliable solutions creating renewable energy from wastewater and organic waste

Circular Economy World

Old World:

WASTEWATER TREATMENT PLANTS

Landfills

Consent Decree

Incineration

Downtime

High Temperature

Emissions

H&S Risks

New World:

RESOURCE RECOVERY FACILITIES

LT Drying

Biological Hydrolysis

Hazards Free

Peace of Mind

Biosolids Marketing

Energy Recovery

Operational Performance

Sustainability

Revenue Stream

Reduced Cost

Environmental

Social

Introduction to a Circular Economy

- In 2012, approximately 75 million tons of dry sludge was generated, with anticipated growth of 83 million tons of dry sludge generated by 2017

5,138 GWh
energy produced every year from waste

44 million tonnes
of waste treated

14 million tonnes
of waste recovered

92 million people
supplied with drinking water

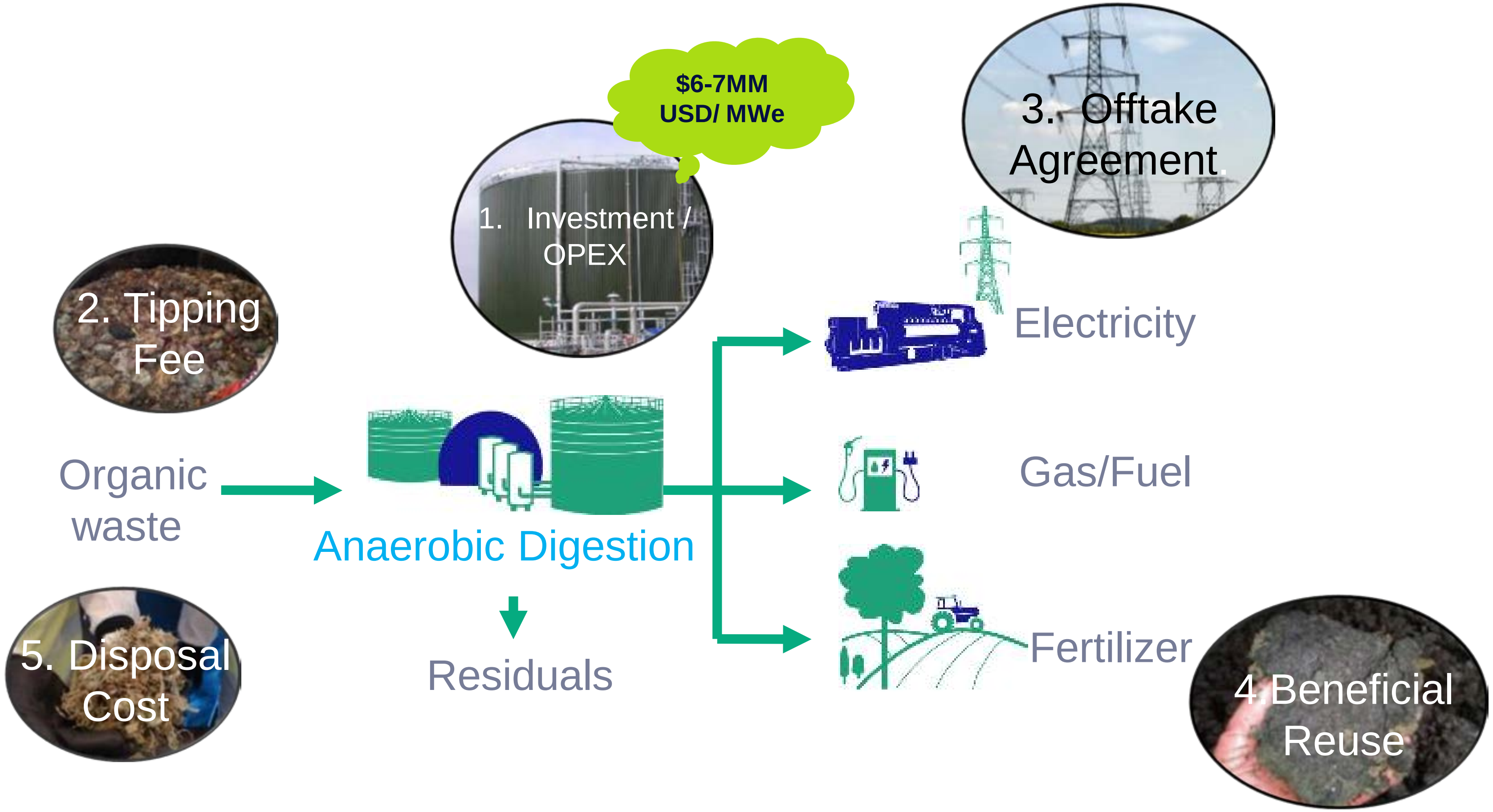
65 million people
benefiting from sanitation services

10 million people
supplied with desalinated drinking water

Resource Recovery

40% of all food never makes it to the table ($16 billion per year)

Food Waste makes up 20% of annual landfill contributions



$6-7MM USD/ MWe

1. Investment / OPEX

2. Tipping Fee

3. Offtake Agreement

4. Beneficial Reuse

5. Disposal Cost

Organic waste

Anaerobic Digestion

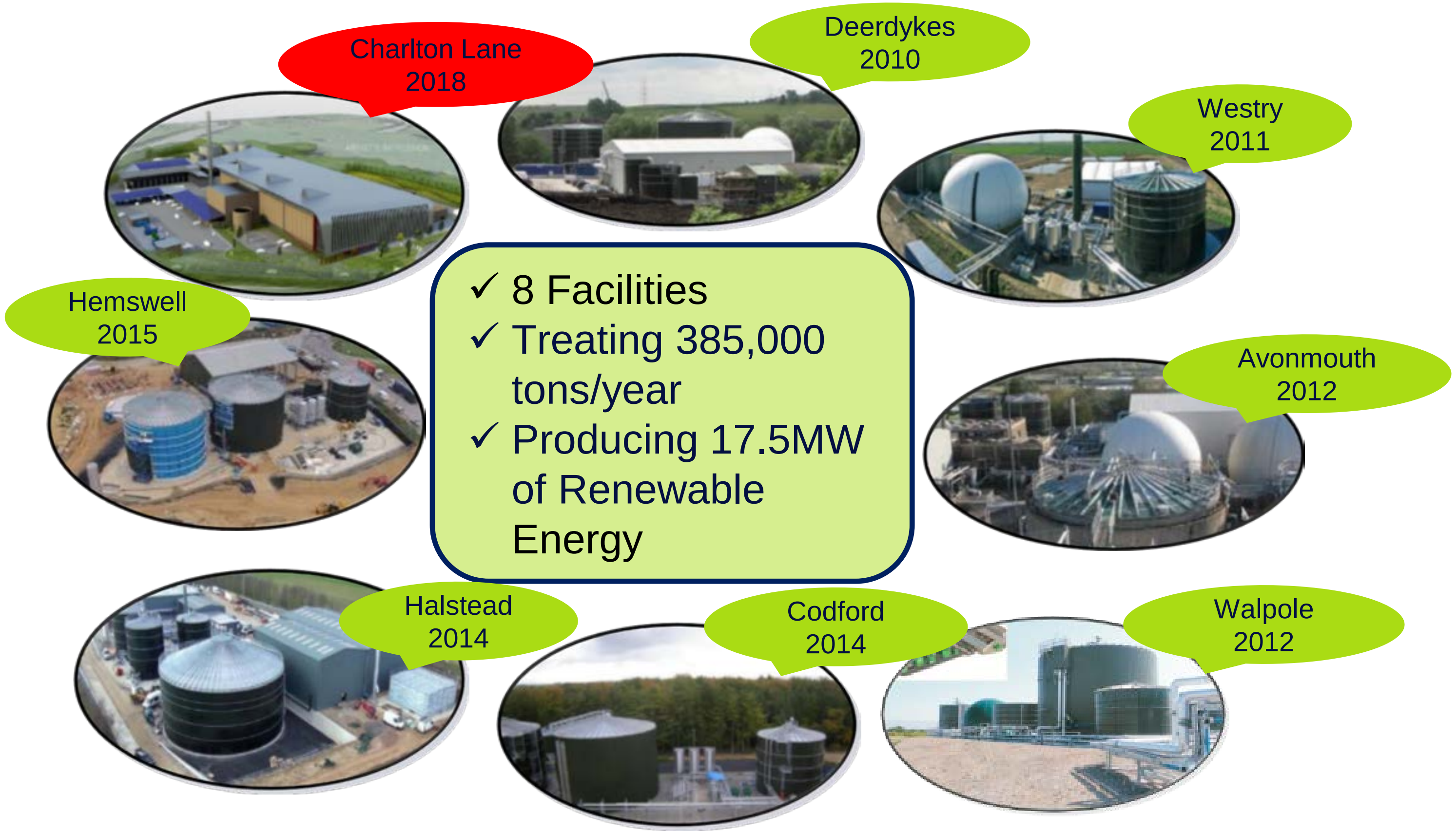
Residuals

Electricity

Gas/Fuel

Fertilizer

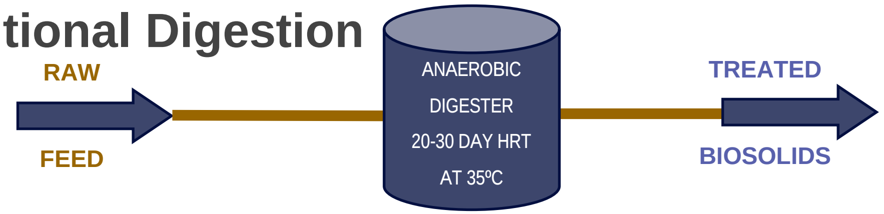
Success Stories



- ✓ 8 Facilities
- ✓ Treating 385,000 tons/year
- ✓ Producing 17.5MW of Renewable Energy

Emerging Technology
Advanced Digestion: Biological Hydrolysis

Conventional Digestion



RAW FEED

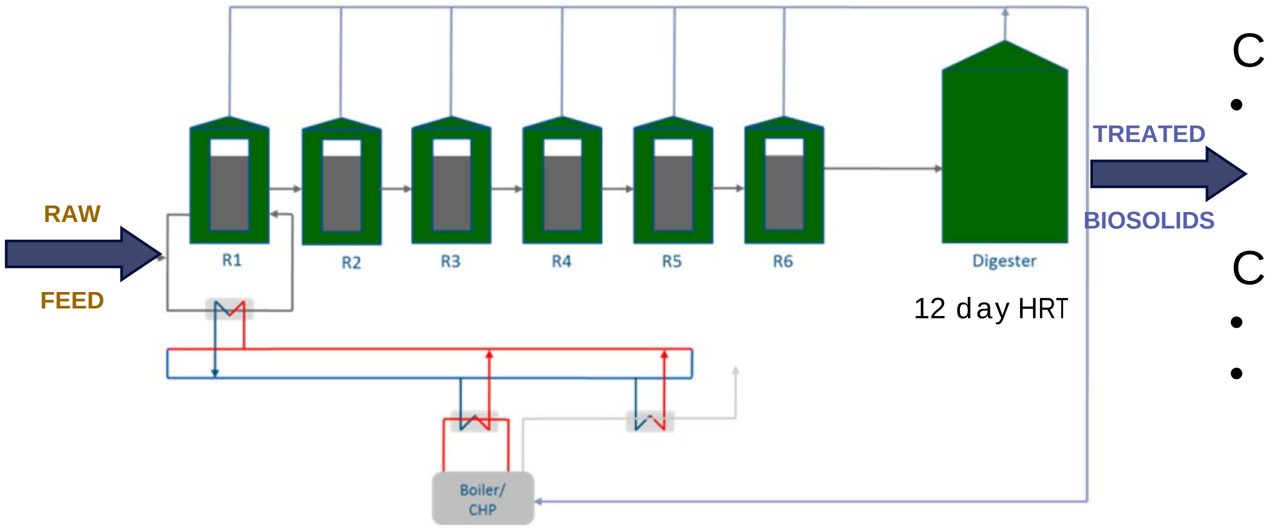
ANAEROBIC DIGESTER 20-30 DAY HRT AT 35ºC

TREATED BIOSOLIDS

Class B

Biological Hydrolysis Digestion

35ºC - 95ºF
42ºC - 107.5ºF
55ºC - 131ºF



RAW FEED

12 day HRT

TREATED BIOSOLIDS

Class B
- Tanks R1-R6: 3 days at 42°C

Class A
- Tanks R1-R3: 1.5 days at 42°C
- Tanks R4-R6: 24-36 hrs at 55°C

Case Study
Biological Hydrolysis

Great Billing Waste Recycling Center – Anglian Water Utility, UK

- WWTP servicing 300,000 pop. base
- ~ 20,000 m3 Digester Volume
- 12,000 tds / year Indigenous Sludge

Enter Biological Hydrolysis

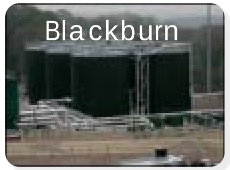
- Increased Biogas production over 300%
- Generate 4.2MWe with CHPs
- WWTP Electrically Self Sufficient
- Export electricity to grid for 4,000 homes

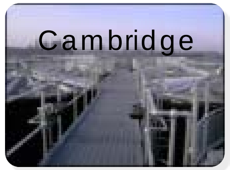
Proven Results
Biological Hydrolysis Technology


Macclesfield


Bromborough


Crewe


Blackburn


Cambridge


Avonmouth


Goddard's Green


Trowbridge


Eign


Lancaster


Great Billing

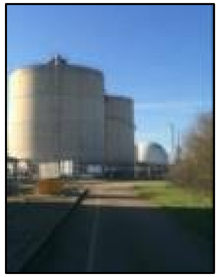
- 12 Plants Commissioned
- First Installation - 2002
- Sized from 4,500 – 40,000 Tonnes DS/yr
- Indigenous & Import Sludge
- Co-located digestion of sludge & food waste

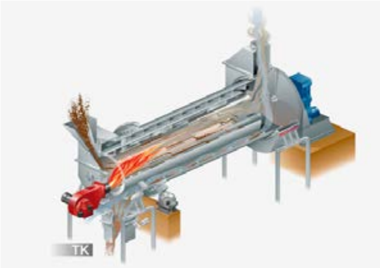

Kings Lynn

Proven Technology Operating for 15 Years

Emerging Biosolids Management Practices

- Advanced Digestion
  - Thermal Hydrolysis
  - Biological Hydrolysis
  - Maximize Digester Efficiency
- Thermal Drying
  - Low-temperature Drying
  - High-temperature Drying
- Composting
  - Bed Drying
  - Solar Drying



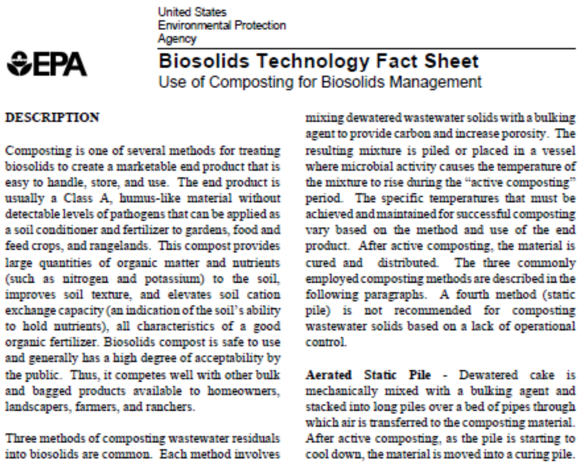


Emerging Biosolids Management Practices (Cont'd)

- Waste to Energy
  - Solids Waste to Energy through Advanced Digestion
  - Digester Gas
    - Heating Applications
    - Converting to CNG
  - Converting to Combined Heat and Power Generation
    - Mini-Grid
    - Back to the Grid
- Resource Recovery
  - Nutrient Recovery (Ammonia, Phosphorus, Struvite, etc.)

Researching Alternative Biosolids Management Systems

US EPA Biosolids Technology Fact Sheets



United States
Environmental Protection
Agency

Biosolids Technology Fact Sheet

Use of Composting for Biosolids Management

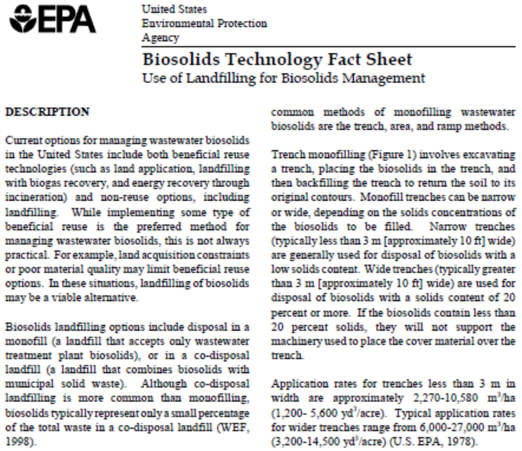
DESCRIPTION

Composting is one of several methods for treating biosolids to create a marketable end product that is easy to handle, store, and use. The end product is usually a Class A, humus-like material without detectable levels of pathogens that can be applied as a soil conditioner and fertilizer to gardens, food and feed crops, and rangelands. This compost provides large quantities of organic matter and nutrients (such as nitrogen and potassium) to the soil, improves soil texture, and elevates soil cation exchange capacity (an indication of the soil's ability to hold nutrients), all characteristics of a good organic fertilizer. Biosolids compost is safe to use and generally has a high degree of acceptability by the public. Thus, it competes well with other bulk and bagged products available to homeowners, landscapers, farmers, and ranchers.

Three methods of composting wastewater residuals into biosolids are common. Each method involves mixing dewatered wastewater solids with a bulking agent to provide carbon and increase porosity. The resulting mixture is piled or placed in a vessel where microbial activity causes the temperature of the mixture to rise during the "active composting" period. The specific temperatures that must be achieved and maintained for successful composting vary based on the method and use of the end product. After active composting, the material is cured and distributed. The three commonly employed composting methods are described in the following paragraphs. A fourth method (static pile) is not recommended for composting wastewater solids based on a lack of operational control.

Aerated Static Pile - Dewatered cake is mechanically mixed with a bulking agent and stacked into long piles over a bed of pipes through which air is transferred to the composting material. After active composting, as the pile is starting to cool down, the material is moved into a curing pile.

Composting



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Biosolids Technology Fact Sheet

Use of Landfilling for Biosolids Management

DESCRIPTION

Current options for managing wastewater biosolids in the United States include both beneficial reuse technologies (such as land application, landfilling with biogas recovery, and energy recovery through incineration) and non-reuse options, including landfilling. While implementing some type of beneficial reuse is the preferred method for managing wastewater biosolids, this is not always practical. For example, land acquisition constraints or poor material quality may limit beneficial reuse options. In these situations, landfilling of biosolids may be a viable alternative.

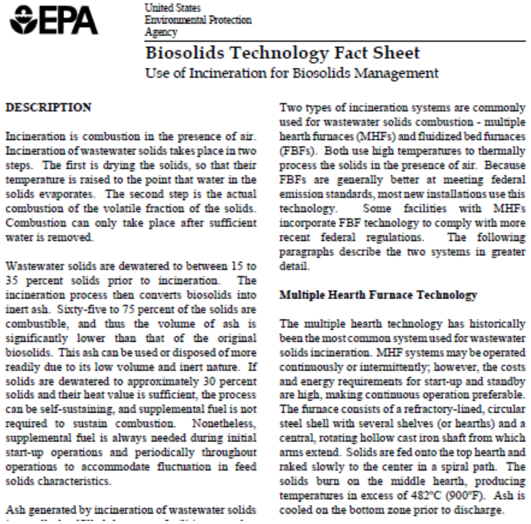
Biosolids landfilling options include disposal in a monofill (a landfill that accepts only wastewater treatment plant biosolids), or in a co-disposal landfill (a landfill that combines biosolids with municipal solid waste). Although co-disposal landfilling is more common than monofilling, biosolids typically represent only a small percentage of the total waste in a co-disposal landfill (WEF, 1998).

common methods of monofilling wastewater biosolids are the trench, area, and ramp methods.

Trench monofilling (Figure 1) involves excavating a trench, placing the biosolids in the trench, and then backfilling the trench to return the soil to its original contours. Monofill trenches can be narrow or wide, depending on the solids concentrations of the biosolids to be filled. Narrow trenches (typically less than 3 m [approximately 10 ft] wide) are generally used for disposal of biosolids with a low solids content. Wide trenches (typically greater than 3 m [approximately 10 ft] wide) are used for disposal of biosolids with a solids content of 20 percent or more. If the biosolids contain less than 20 percent solids, they will not support the machinery used to place the cover material over the trench.

Application rates for trenches less than 3 m in width are approximately 2,270-10,580 m^3/ha (1,200- 5,600 yd^3/acre). Typical application rates for wider trenches range from 6,000-27,000 m^3/ha (3,200-14,500 yd^3/acre) (U.S. EPA, 1978).

Landfilling



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Biosolids Technology Fact Sheet

Use of Incineration for Biosolids Management

DESCRIPTION

Incineration is combustion in the presence of air. Incineration of wastewater solids takes place in two steps. The first is drying the solids, so that their temperature is raised to the point that water in the solids evaporates. The second step is the actual combustion of the volatile fraction of the solids. Combustion can only take place after sufficient water is removed.

Wastewater solids are dewatered to between 15 to 35 percent solids prior to incineration. The incineration process then converts biosolids into inert ash. Sixty-five to 75 percent of the solids are combustible, and thus the volume of ash is significantly lower than that of the original biosolids. This ash can be used or disposed of more readily due to its low volume and inert nature. If solids are dewatered to approximately 30 percent solids and their heat value is sufficient, the process can be self-sustaining, and supplemental fuel is not required to sustain combustion. Nonetheless, supplemental fuel is always needed during initial start-up operations and periodically throughout operations to accommodate fluctuation in feed solids characteristics.

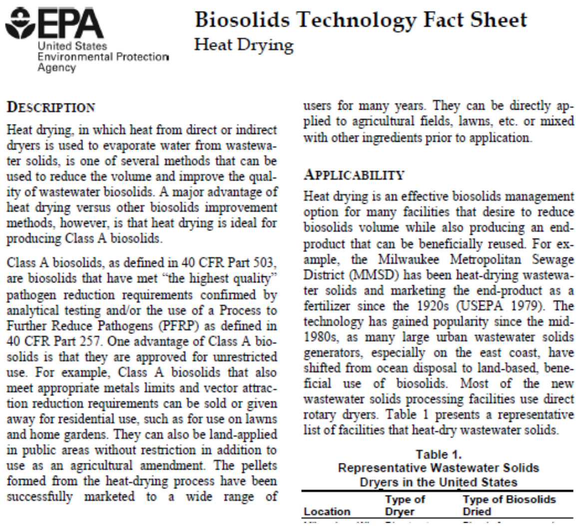
Ash generated by incineration of wastewater solids

Two types of incineration systems are commonly used for wastewater solids combustion - multiple hearth furnaces (MHFs) and fluidized bed furnaces (FBFs). Both use high temperatures to thermally process the solids in the presence of air. Because FBFs are generally better at meeting federal emission standards, most new installations use this technology. Some facilities with MHFs incorporate FBF technology to comply with more recent federal regulations. The following paragraphs describe the two systems in greater detail.

Multiple Hearth Furnace Technology

The multiple hearth technology has historically been the most common system used for wastewater solids incineration. MHF systems may be operated continuously or intermittently; however, the costs and energy requirements for start-up and standby are high, making continuous operation preferable. The furnace consists of a refractory-lined, circular steel shell with several shelves (or hearths) and a central, rotating hollow cast iron shaft from which arms extend. Solids are fed onto the top hearth and raked slowly to the center in a spiral path. The solids burn on the middle hearth, producing temperatures in excess of 482°C (900°F). Ash is cooled on the bottom zone prior to discharge.

Incineration



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Biosolids Technology Fact Sheet

Heat Drying

DESCRIPTION

Heat drying, in which heat from direct or indirect dryers is used to evaporate water from wastewater solids, is one of several methods that can be used to reduce the volume and improve the quality of wastewater biosolids. A major advantage of heat drying versus other biosolids improvement methods, however, is that heat drying is ideal for producing Class A biosolids.

Class A biosolids, as defined in 40 CFR Part 503, are biosolids that have met "the highest quality" pathogen reduction requirements confirmed by analytical testing and/or the use of a Process to Further Reduce Pathogens (PFRP) as defined in 40 CFR Part 257. One advantage of Class A biosolids is that they are approved for unrestricted use. For example, Class A biosolids that also meet appropriate metals limits and vector attraction reduction requirements can be sold or given away for residential use, such as for use on lawns and home gardens. They can also be land-applied in public areas without restriction in addition to use as an agricultural amendment. The pellets formed from the heat-drying process have been successfully marketed to a wide range of users for many years. They can be directly applied to agricultural fields, lawns, etc. or mixed with other ingredients prior to application.

APPLICABILITY

Heat drying is an effective biosolids management option for many facilities that desire to reduce biosolids volume while also producing an end-product that can be beneficially reused. For example, the Milwaukee Metropolitan Sewage District (MMSD) has been heat-drying wastewater solids and marketing the end-product as a fertilizer since the 1920s (USEPA 1979). The technology has gained popularity since the mid-1980s, as many large urban wastewater solids generators, especially on the east coast, have shifted from ocean disposal to land-based, beneficial use of biosolids. Most of the new wastewater solids processing facilities use direct rotary dryers. Table 1 presents a representative list of facilities that heat-dry wastewater solids.

Table 1.
Representative Wastewater Solids
Dryers in the United States

Location	Type of Dryer	Type of Biosolids Dried

Heat Drying

Market Overview: Composting/Solar Drying

Pros

- Helps the Environment
- Low Initial Cost
- Conserves Resources

Cons

- Creates Odors
- Lots of manpower
- Space requirements
- Dryness of about 60%
- Issues during humid season
- Bulking agent may be required

Market Overview: Lime Stabilization

Pros

- Helps the Environment
- Low Initial Cost
- Conserves Resources

Cons

- Creates Odors
- Lots of manpower
- Chemicals use/additional operational costs
- Larger volume produced
- Higher hauling & transportation costs
- More social impact
- Lower value of the final product

Market Overview: Landfilling

Pros

- Low Initial Cost
- Suitable for biosolids with high concentrations of metals/toxics
- Improves packing of solid waste and increases biogas production

Cons

- Eliminates reuse potential
- Dependent on subcontractors for hauling
- Extensive planning and selection/management of landfill site
- Landfill operations are labor intensive
- Potential for groundwater contamination at the landfill site
- Higher hauling & transportation costs
- Odor generation
- Landfills are closing getting further away from facilities

Market Overview: Land Application

Pros

- Helps the Environment
- Low Initial Cost
- Conserves Resources

Cons

- Odors control measures
- Lots of manpower
- Limited to certain times of year (especially in colder climates)
- Weather can interfere with the applications
- Large storage capacity
- Higher hauling & transportation costs

Cons

- Application sites/farms getting further from facilities
- Restrictions on land use after application
- Potential bans at state, county or local level
- Potential public opposition
- Negative impacts to soil if not practiced properly

Market Overview: Incineration

Pros

- Volume reduction
- Generation of stable material. Ash is also sterile, effectively eliminating storage and handling problems
- Potential energy recovery
- Minimal land area required

Cons

- High capital investment
- Annual operating costs depend on fuel costs
- Consumption of non-renewable resources (oil and/or gas
- Limited feasibility in nonattainment areas
- Operating problems. Significant down time requiring backup or storage
- High technology instrumentation
- Regulatory compliance with air pollution control permits
- Potential for public opposition

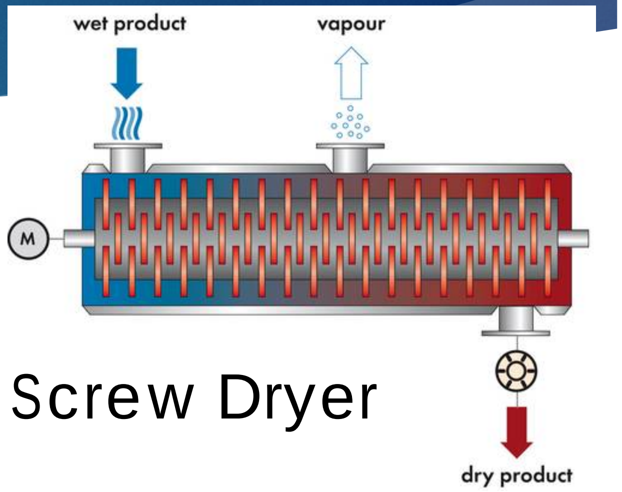
Market Overview: High Temperature Dryer

Pros

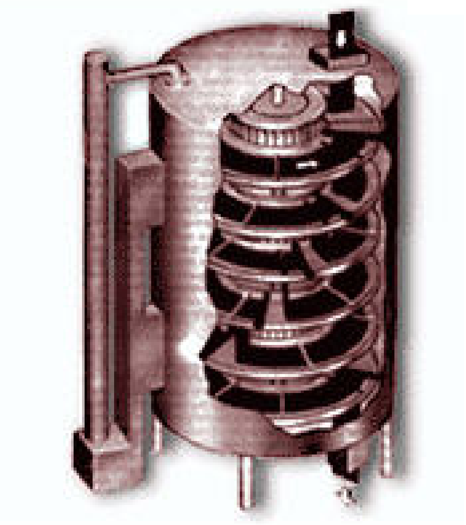
- Small footprint
- Variety of feed material characteristics
- Reduces volume of material
- Generates a marketable product

Cons

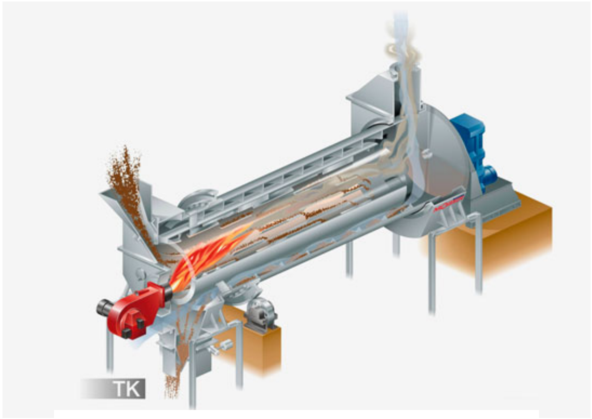
- Substantial capital investment
- Large amount of energy
- Generates dust
- Creates an explosive hazard
- Complex system and need for skilled workers
- May cause nuisance odors



Screw Dryer



Tray dryer

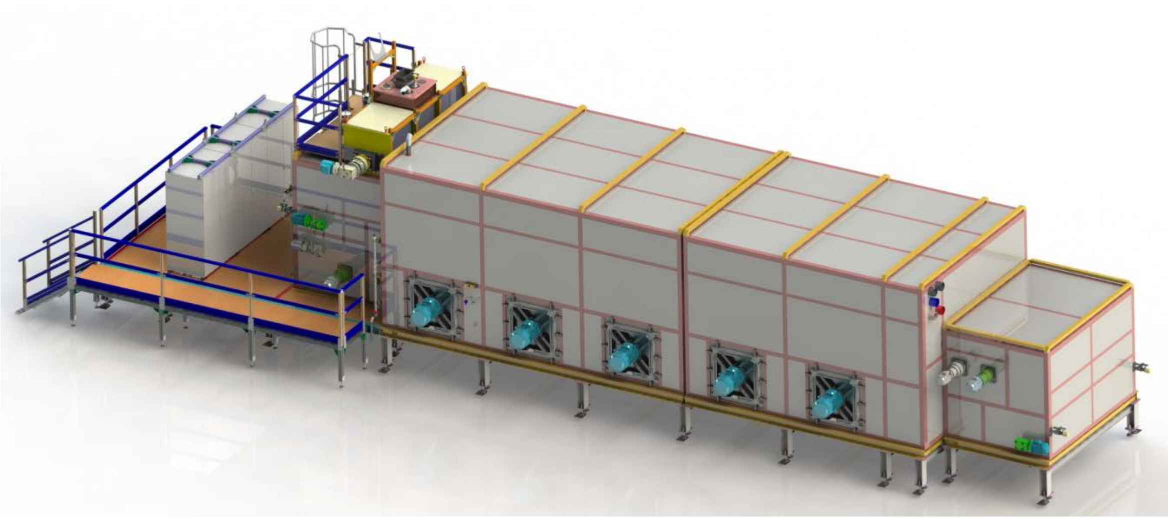


Drum Dryer

Market Overview: Low-Temperature Belt Dryer

Pros

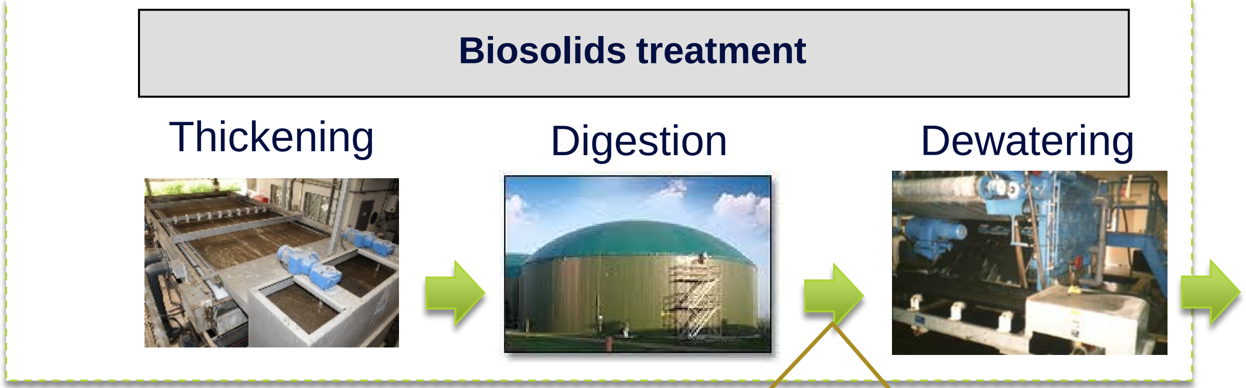
- Small Plant footprint (Modular)
- Variety of feed material characteristics
- Reduces volume of material
- Generates a marketable product
- Relatively no dust generation
- ATEX study no explosive hazards
- Lower energy requirements compared to High Temperature Dryer system
- Heat recovery systems
  - Combined Heat and Power Systems
  - Exhaust Gases
- Simple system operation/maintenance



Cons

- Substantial capital investment
- Large amount of energy
- May cause nuisance odors

Emerging Technology
FlocFormer: Dewatering Optimization



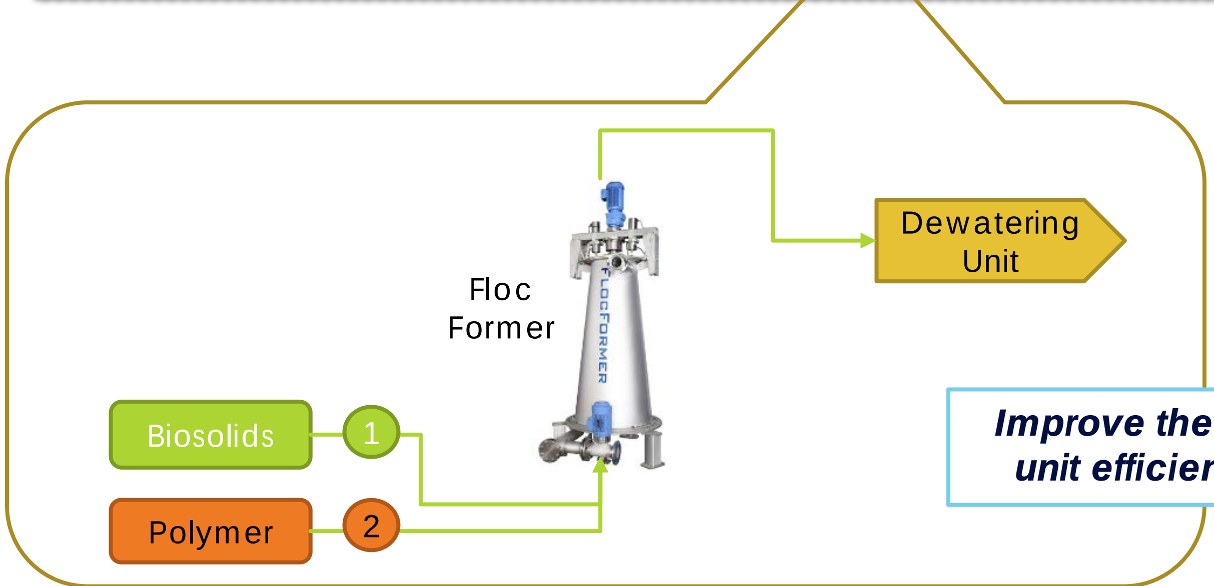
Biosolids treatment

Thickening

Digestion

Dewatering

15-25% DS



Floc Former

Dewatering Unit

Biosolids

1

Polymer

2

Improve the dewatering unit efficiency by 25%

Dewatering Optimization

Any type of dewatering unit

Belt Filter Presses

Centrifuges

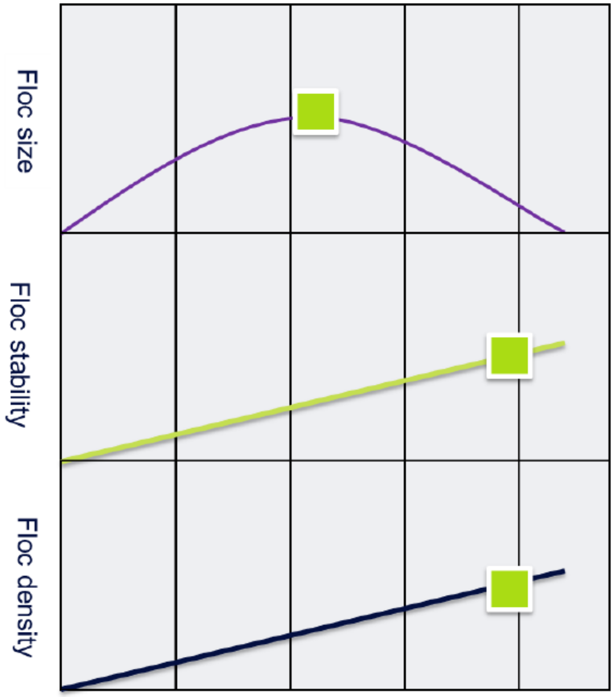
Screw Presses

...

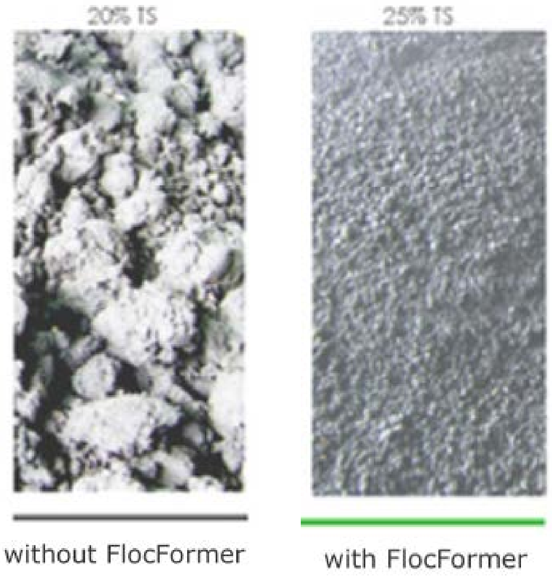
Key to Dewatering

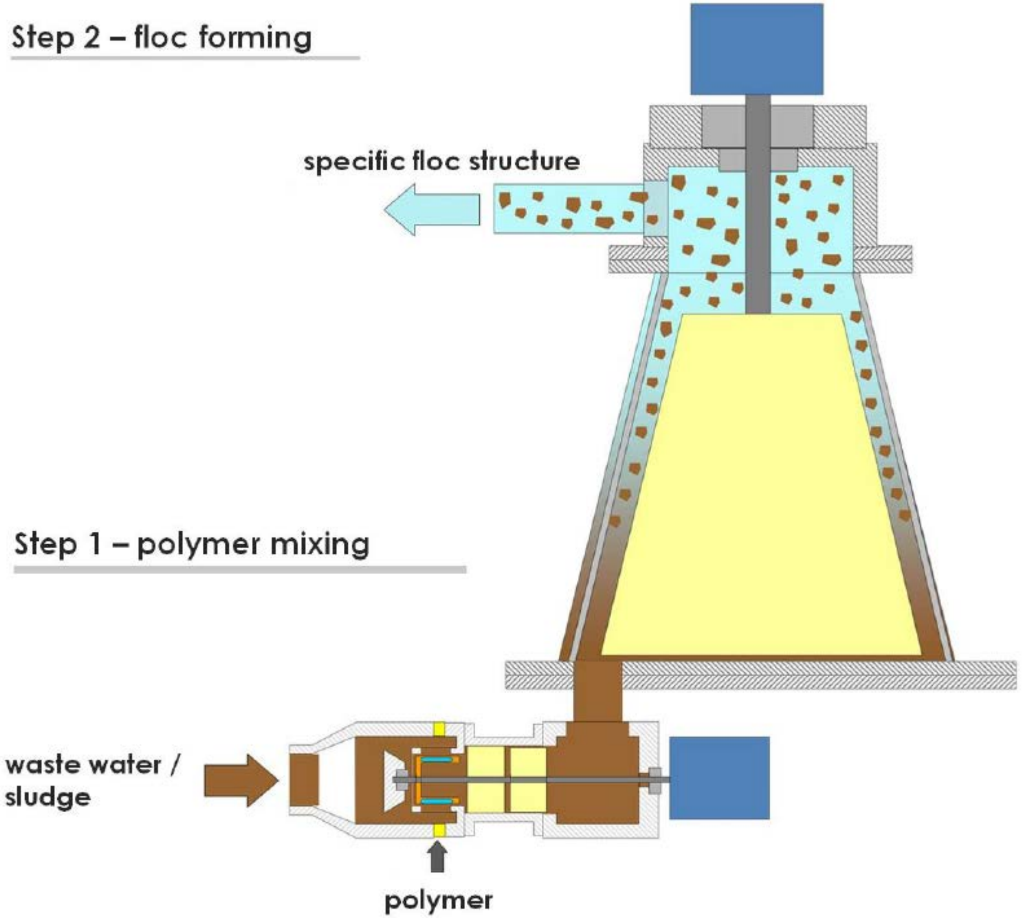
Key to efficient dewatering: the floc structure (headache)

It is generally not possible to generate a specific floc structure by using **one** mixing device.



Floc Former: How it Works





FlocFormer: Proven Results

KA Köln-Wahn

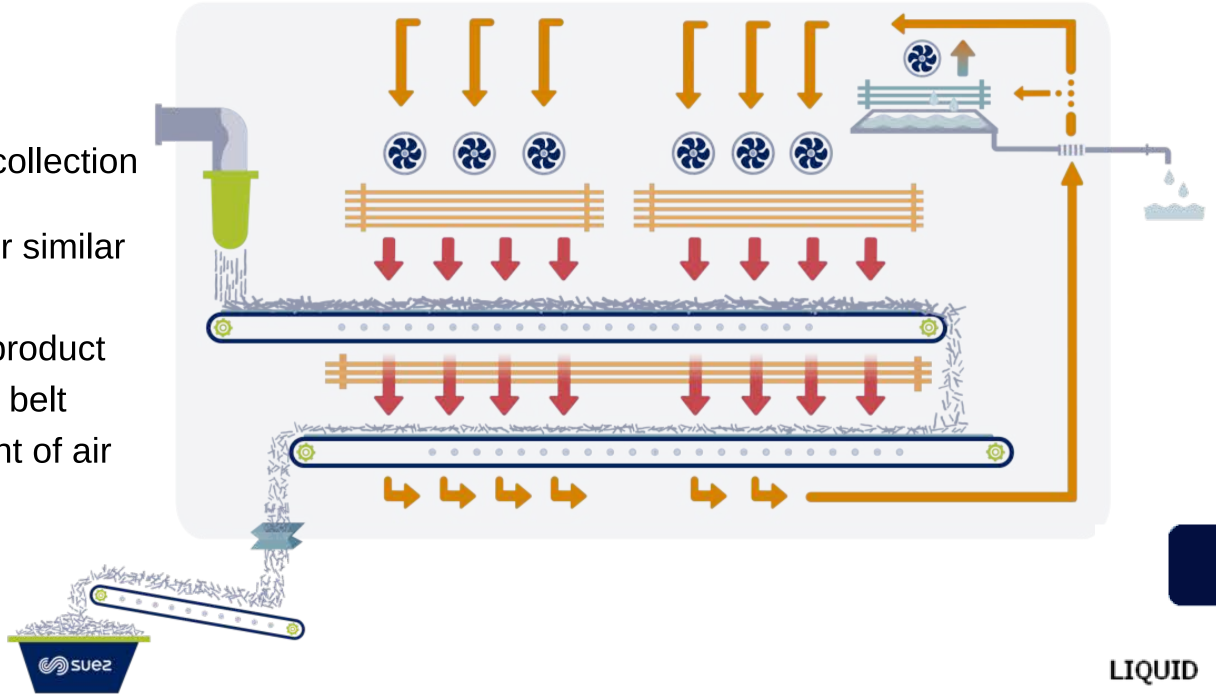
KA Rüsselsheim

Suez Technology
Low-Temperature Thermal Drying

Reception and extrusion

The product is deposited in a collection hopper, where it moves to the conformation system (sludge or similar materials)

- The system distributes the product along the entire width of the belt
- This facilitates the movement of air through the product



Belts

- They run through the tunnel loaded with sludge without moving it, thereby avoiding the generation of dust and the possibility of jams.

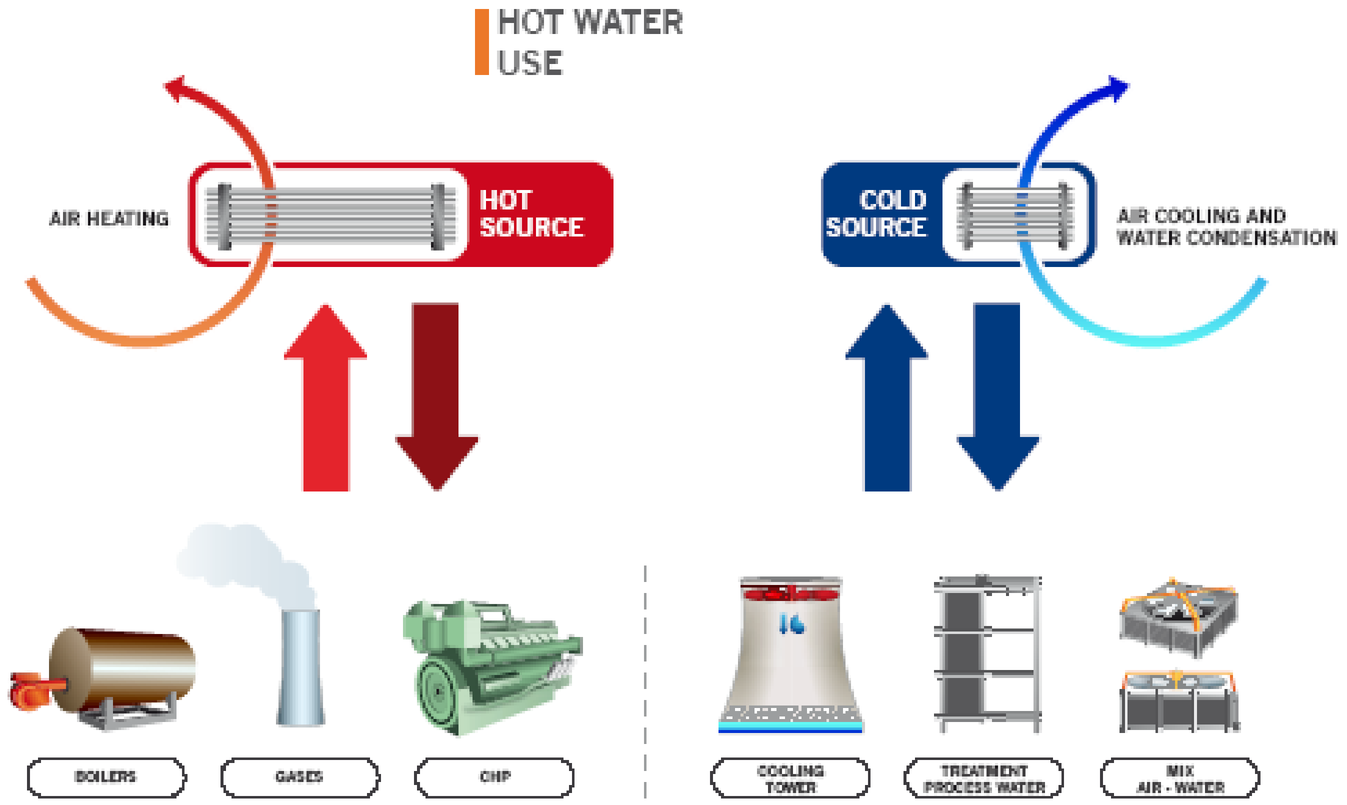
Fans

They generate the movement of hot, dry air from 65 to 80ºC in a closed circuit. The direction of the air is perpendicular to the belts, extracting water from the product due to the hygrometric balance.

- Convection drying (Air T < 80ºC)
- Closed air circuit
- Internal condensation
- Final dryness greater than 90%

VAPORIZATION vs EVAPORATION

STC – Low Temperature Drying



Hot source (water 90/75ºC):

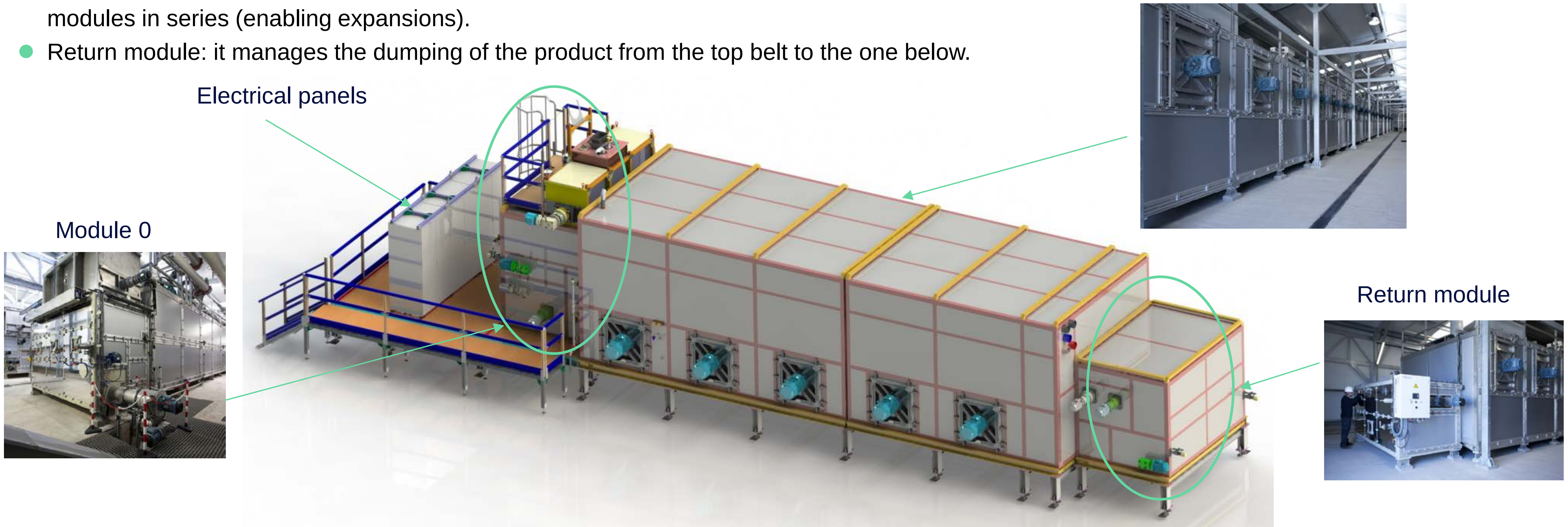
Cold source (water 30/40ºC):

The STC Biosolids Dryer

Equipment Components

The equipment is made up of the following elements:

- Module 0: where the product feeding, conforming and unloading process takes place.
- Drying modules: where the drying process takes place. The system is made up of one or various modules in series (enabling expansions).
- Return module: it manages the dumping of the product from the top belt to the one below.



Drying modules

Electrical panels

Module 0

Return module

- Modular systems assembled in factory and fully tested. Easily expandable plants
- Independent module running
- Partial maintenance without process interruption
- Easy operation
- Easy access to all equipment

Case Study
Low-Temp Drying to Alternative Fuel

Biosolids Management at Cement Kiln (CEMEX)

▶ **INVESTOR**

EMARASA – managed by SUEZ

▶ **VOLUME:** $16.5 million

(Agreement signed on 2004)

▶ **TECHNOLOGY**

STC Low temperature drying

Residual heat (150ºC) → hot water (84ºC)

Dried sludge combustion

▶ **MAIN ORDERS**

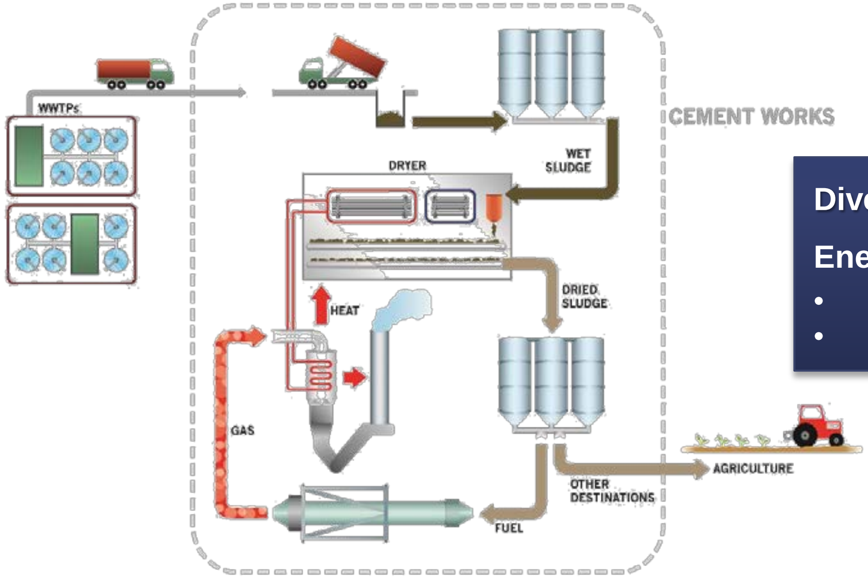
57,000 tones/year

Agreement duration: 15 years

Project duration: 2 years

▶ **LOCATION**

Alicante (Spain)



Diversified biosolids management

Energy savings for all:

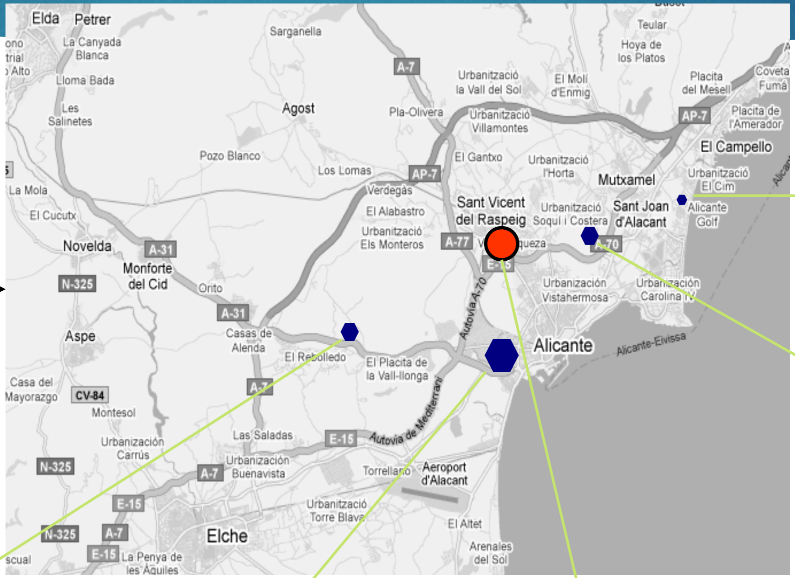
- **Utility: $ 2,564,000 /year (Nat gas)**
- **CEMEX: $ 801,000/year (Carbon)**

Case Study

Case Study: EMARASA - CEMEX
Thermal Drying at Low Temperature in a Cement Plant

▶ GEOGRAPHICAL SITUATION OF THE INSTALLATIONS

WWTPs location in relation to the Cement Plant



Alacantí Norte WWTP
≈ 5.000 ton/year
≈ 14 Km.

Monte Orgegia WWTP
11.000 tones/year
227.023 he
≈ 8 Km.

Alacantí Sur WWTP
≈ 10.000 tones/year
≈ 14 Km.

Rincón de León WWTP
27.000 tones/year
429.141 he
≈ 14 Km.

CEMEX Cement Plant

Biosolids Management at Cement Kiln (CEMEX)

Site overview. The drying building is placed on the left whereas the cement plant is displayed on the right

Heat exchanger

Dried sludge silos and transport to cement kiln

View of the drying tunnel inside the building

City of Atlanta, GA - NORESCO

NORESCO – City of Atlanta Watershed Bio-Solids Drying Project

City of Atlanta GA
RM Clayton Facility
Largest of Four Facilities
Serving City of Atlanta

NORESCO Project is part of an overall Energy Savings Contract with the City of Atlanta. Allows the City to:

- Decommission existing incinerator
- Reduce landfill impact
- Reduce carbon footprint
- Create approx. 40K metric tons of carbon credits annually
- Save approx. $90M in biosolids management fees over next 15 years

- WWTP Size: 122 MGD; with peak flows exceeding 320 MGD
- Biosolids Process: Anaerobic Digestion followed by centrifuges (class B)
  - 8.06 wet-tons/hr (90,000 wet-tons/yr) @ 24%DS
- Goal: Convert into EPA-rated Class A EQ biosolids, which will be used sustainably as an agricultural soil amendment or fertilizer product
- Dryer Size:
  - Two parallel dryers with total capacity of 3.87 dry tons/hr (29,000 dry tons/yr)
  - Each dryer will remove 11,815 pph evaporation capacity
- Scope of Services:
  - Equipment Supply and Engineering – Dryer Technology
  - Installation Support and Commissioning
  - Warranty
- Project Status:
  - Notice to Proceed: Received January 19, 2018
  - Design Documents: Anticipated mid-March 2018
  - Shipment to Site: Anticipated Start October, 2019
  - Commissioning: Anticipated May, 2020

KINSTON, NC
RECOVERING ORGANICS & TURNING WASTE INTO A FERTILIZER PRODUCT

City of Kinston
North Carolina
Population Served
21,677 hab.

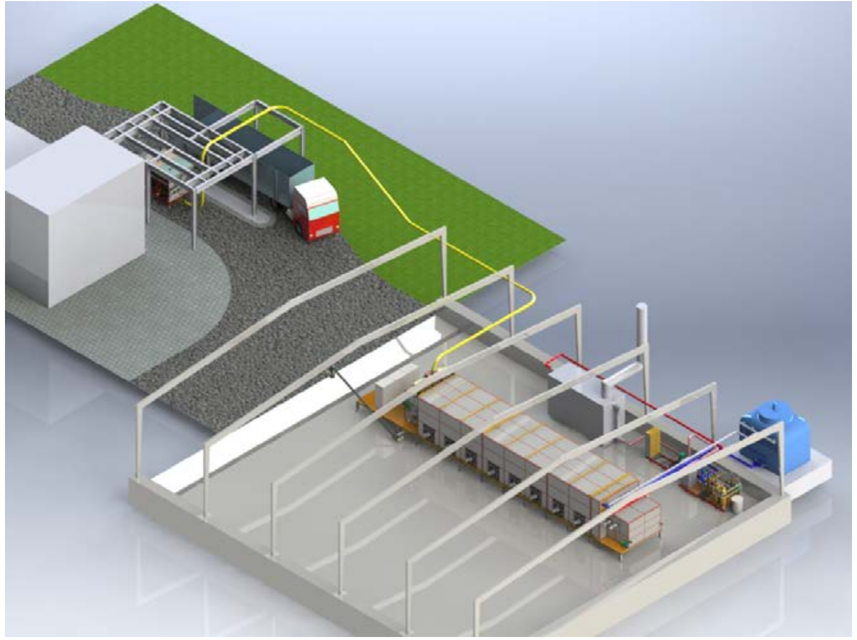
SUEZ has been serving the City of Kinston for more than 20 years delivering an Asset Management Program for their water tanks through our local service center located in Madison, North Carolina

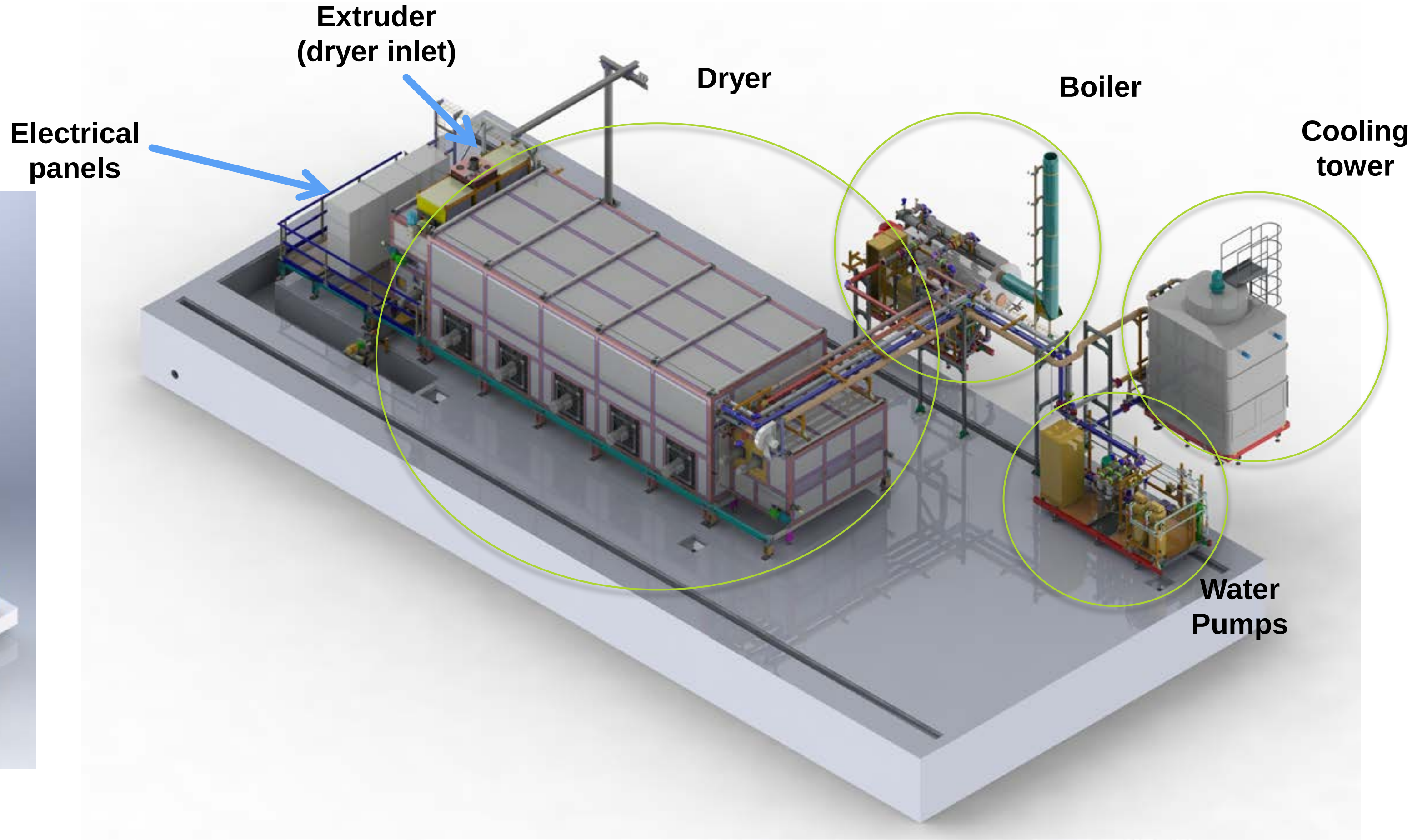
- WWTP Size: Permitted Flow 11.85 MGD; Average 5 MGD; Peak 21 MGD
- Biosolids Process: Aerobic Digestion followed by belt filter press (class B)
- Goal: Turn into class A production and market final product as fertilizer to local farms
- Local Partners for Biosolids Marketing, Engineering and Permit
  - Biosolids will be sold at $15-20/ton as fertilizer
- Dryer Size: 10 dry tons/day (4,282 pph evaporation capacity)
- Scope of Services:
  - Design services
  - Environmental Permit
  - Equipment Supply (Dryer, boiler, cooling tower, water softener, pumping system)
  - Installation and Commissioning
  - Warranty Extension & Service Support
  - Integration with dewatering process (BFP)
- Project Status:
  - Currently under design/fabrication
  - Project Commissioned: mid-October, 2018

Kinston NC - Concept

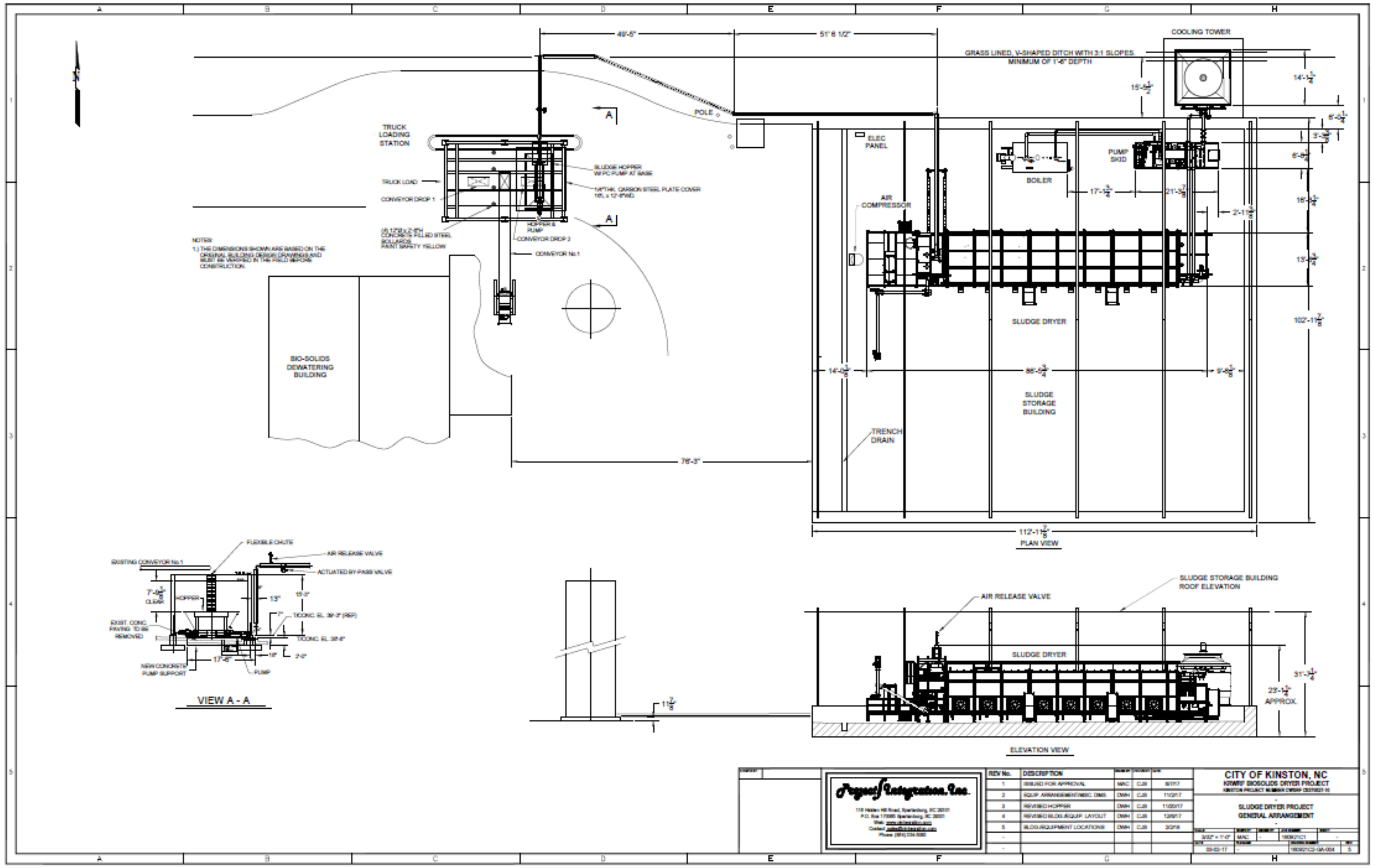
Kinston NC – Pilot Study

Kinston NC – Preliminary Design Layout





Kinston NC – Final Design Layout



What Kinston Looks Like Today

Proven Results
Low-Temp Thermal Drying

suez

- More than 20 years in thermal drying
  - Wood: since 1991
  - Sludge: since 1997
  - Biomass: since 2011

Thank you for your participation

Additional Questions/Concerns

James Willson
Biosolids Project Manager

jwillson@utilityservice.com
Ph: 706-836-6565

Jessica Morrison
Water Sales Consultant

jmorrison@utilityservice.com
Ph: 414-791-7496

October 18, 2018

ready for the resource revolution suez