Technical Analysis Study

Biosolids Dryer

Presented to:

City of Cottage Grove Sewer District
1800 N Douglas Ave
Cottage Grove, OR 97424

EnergyTrust of Oregon

Analysis Contractor:

RHT ENERGY

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Disclaimer

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The intent of this energy analysis study is to estimate energy savings associated with recommended energy efficiency upgrades. This report is not intended to serve as a detailed engineering design document, any description of proposed improvements that may be diagrammatic in nature are for the purpose of documenting the basis of cost and savings estimates for potential energy efficiency measures only. Detailed design efforts may be required by participant in order to implement potential measures reviewed as part of this energy analysis.

While the recommendations in this report have been reviewed for technical accuracy and are believed to be reasonably accurate, all findings listed are estimates only, as actual savings and incentives may vary based on final installed measures and costs, actual operating hours, energy rates and usage.

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1.0 EXECUTIVE SUMMARY

1.1 Introduction

Background

The City of Cottage Grove Sewer District (SD) was originally constructed in 1959 and was upgraded with secondary treatment in 1967. In 1984, the site was further modified and expanded. In 2006, the plant upgraded to an aerobic digestion and activated sludge treatment process. The plant processes influent using an oxidation ditch, digesters, a polymerization system, and a mechanical press. The reclaimed water is treated through filtration and a chlorine contact basin. The water is discharged to the river, or to holding ponds for irrigation use. Solids are reduced to approximately 15% solids (85% water) and transported offsite for composting.

The plant is designed for an average influent of 1.8MGD for dry weather season and 3.5MGD for wet-weather season. Typical influent flow for dry season is 1MGD and 3MGD during the wet-weather season. In 2018, the plant transported an average of 19 tons per week of 15% solids.

The SD plans to increase their solids output from 15% to 90%, by further reducing the liquid content. The upgrade will reduce energy costs and will also reduce annual transportation costs of approximately $47k per year.

System Overview

The SD sends the influent thru an oxidation ditch that uses orbital discs to aerate thru circulation. Once the influent is oxidized it is sent to clarifying ponds where the water is gravity-separated from the sludge. The sludge is sent to the aeration basins for processing and the reclaimed water is sent through filtration and chemical treatment. See appendix for a process flow diagram (PFD) of their existing operation.

The sludge is pumped from the aeration basins to a polymerization system. A mechanical auger is used to inject polymer while also reducing the liquid content in the sludge. Post polymerization the sludge is sent to a mechanical belt press where the sludge is further dewatered to achieve approximately 15% solids and 85% liquid. The sludge accumulates onsite in a storage shed until it is hauled offsite approximately two times per week for disposal.

The plant is interested in a biosolids dryer to increase the solids output by weight from 15% to 90%. This retrofit study looks at the energy savings with the addition of a biosolids dryer to their current sludge treatment process. The addition of the new dryer allows the plant to remove several operations in the plant. See appendix for a process flow diagram of the SD's proposed operation.

The oxidation ditch, digester blowers, and clarifiers run 8,760 hours per year. The polymerization system, including the waste activated sludge (WAS) pump and the total waste activated sludge (TWAS) pump, run 2,902 hours per year. The mechanical press runs approximately 4.5 hours per day 6 days per week, for a total of 1,404 hours per year. Personnel indicate the loading on the equipment is consistent year long, independent of influent flow or seasons.

Plant personnel provided an overview of the plant operations and hours of operation.

1.2 EEM Summary

- EEM 1: Biosolids Dryer

  As shown in the existing PFD, the baseline system for sludge treatment consists of aeration digesters, a polymerization system, and a mechanical press. Solids are transported offsite 1-2 times per week for final disposal. EEM 1 consists of upgrading the sludge-treatment process with drying capability to decrease the water content in the final solids. The addition of a new dryer removes the need for the aeration digesters and the polymerization system while also reducing transportation costs.

- EEM 2: Insulate Dryer

  The new biosolids dryer operates at a temperature of 350°F. Insulating the dryer will reduce conductive, convective, and radiant heat losses from the surface of the dryer to ambient air. EEM 2 energy savings is based on a rolling baseline from EEM 1.

1.3 Economic Summary

Table 1: Estimated Savings and Cost Summary

Electric Utility Rate Schedule:	PAC 30
Cost of Electricity:	$0.0540 /kWh
Cost of Demand:	$7.97 /kW/mo
Natural Gas Utility Rate Schedule:	03C
Cost of Natural Gas:	$0.7761 /Therm

EEM No.	Description	Included in Package?	On-Peak Demand Reduction (kW/mo)	Demand Charges ($)	Annual Electrical Energy Savings (kWh/yr)	Annual Natural Gas Energy Savings (Therms/yr)	Total Annual Electric Savings ($)	Total Annual Gas Savings ($)	Installed Cost ($)	Pre-Incentive Payback (Years)
1	Biosolids Dryer	Yes	0.0	$0	197,042	0	$10,640	$0	$760,000	71
2	Insulate Dryer	Yes	0.0	$0	0	10,628	$0	$8,248	$22,000	2.7
Total for Recommended Measures:			0.0	$0	197,042	10,628	$10,640	$8,248	$782,000	41

Note: Pre-incentive payback = Installed cost/Total Annual Savings. Demand savings are not included in the payback calculation since the peak power of the system may not always coincide with the peak demand of the facility during each billing cycle.

Table 2: Estimated Incentive Summary

Eligible Project Cost Cap:	50%			
Capital Electric Savings Cap:	$0.32	/kWh (>1yr pre)	$0.02	/kWh (<1yr pre)
Capital Natural Gas Savings Cap:	$2.00	/Therm (>1yr pre)	$0.20	/Therm (<1yr pre)

EEM No.	Description	Measure Type	Measure Life (Years)	Eligible Project Cost Cap (50%)	Electric and Gas Savings Cap ($)	Estimated Total Incentive ($)	Customer Cost After Incentive	Payback With Incentive (Years)
1	Biosolids Dryer	Capital	20	$380,000	$63,053	$63,053	$696,947	66
2	Insulate Dryer	Capital	20	$11,000	$21,256	$11,000	$11,000	1.3
Total for Recommended Measures:						$74,053	$707,947	37

Note: Final Incentive is the lesser of Eligible Project Cost Cap and Electric Savings cap.

Fraction of Package Cost Covered by Energy Trust Incentive: 9%

1.4 Potential Additional Benefits

The biosolids dryer will effectively remove liquid content from the final outgoing solids. The decrease in total liquid content is anticipated to remove the need for offsite disposal. Previous annual records indicate the City of Cottage Grove could save approximately $47K per year in transportation costs. See appendix for details on transportation costs.

Other benefits are reduced costs for the maintenance of the polymerization system and a reduction in chemical costs for sludge treatment.

The dryer is equipped to circulate more than 90% of the air stream, which controls odors and reduces or eliminates the need for air permitting.

1.5 Recommendations

We recommend the installation of EEMs 1 and 2. These measures provide a simple payback of 37 years with Energy Trust incentives, as shown in Tables 1 and 2.

1.6 Implementation Summary

Review this report and make an implementation decision

Your staff has assisted with the development of this report. Because equipment and operational changes are recommended, your organization needs to be comfortable with the data, the analysis and the proposed EEMs for the project to be a success. Please independently evaluate the information contained in this report as you normally would for other projects of this scope. Contact vendors to firm up bids. Do your normal diligence and make a decision.

Sign an Energy Trust incentive application (Form 420C) prior to signing any Purchase Orders

Contact your PDC with your decision, and request and sign an incentive application prior to signing purchase orders or making other financial commitments to proceed with the project.

Implement the project

Finalize the design in a manner consistent with equipment, set-points, and algorithms described in Section 2 of this report. Any significant differences should be discussed with your PDC and Technical Lead to confirm that they do not have a negative impact on energy efficiency performance. Sign purchase orders and contracts with contractors. Complete the installation.

Commission the project

Commission the project according to guidelines in Section 5 of this report.

Project closeout

Send your PDC written notification of project installation completion, commissioning submittals, and documentation of costs by energy efficiency measure. Your PDC will make a site visit to inspect the equipment and prepare a verification report. Your incentive will be paid after Energy Trust approves the verification report.

2.0 DETAILED DESCRIPTION OF PROPOSED EQUIPMENT AND OPERATION

2.1 EEM 1 –Biosolids Dryer

2.1.1 EEM 1 – Source of Energy Savings

The addition of the biosolids dryer in the sludge treatment process allows for complete removal of the digesters and the polymerization system from the process. This change removes the need for the digester blowers (75HP), the polymerization system (~1/2HP), the auger motor (3HP) and the TWAS pump (5HP). The WAS pump (7.5HP) operating hours are anticipated to be reduced by approximately 48%.

The new dryer is equipped with variable frequency drives (VFD) on its motors including: the belt drive, in-feed sifter, and the blowers. It is also equipped with a programmable computer that simultaneously controls the system to maximize throughput while still meeting percent by weight moisture specifications.

2.1.2 EEM 1 – Specific Equipment Recommendations

- Install a 0520U Gryphon Dryer complete with VFDs on the blower, belt, and in-feed sifter motors and programmable control for process monitoring and control.

2.1.3 EEM 1 – Set-points and Algorithms Recommended to Achieve Energy Performance

The recommended drying system is equipped with several energy-saving features that do not require adjustments. This study used a setpoint for the air in the dryer of 350°F. All other features are controlled within the dryer's programmable logic control (PLC). For example, the PLC controls the VFD settings for the belt speed, blower motors, and in-feed sifter. The dryer is also equipped to recycle more than 90% of the air stream thereby reducing the volume of incoming air to preheat.

- The dryer is set to an air temperature of 350°F
- The weekly drying time is approximately 41 hours
- The dryer runs for 10 hours/day
- Incoming solids are a temperature of 65°F or higher

2.2 EEM 2 – Insulate Dryer

2.2.1 EEM 2 – Source of Energy Savings

The operating system of the dryer is 350°F. Addition of insulation will reduce the radiant and convective heat losses from the exterior of the dryer and subsequently will save natural gas.

2.2.2 EEM 2 – Specific Equipment Recommendations

- Install a ½", insulation blanket on the surface of the dryer, Type II, ASTM C553-13 or equivalent

2.2.3 EEM 2 – Set-points and Algorithms Recommended to Achieve Energy Performance

Insulation is a passive heat recovery system and requires no setpoint or controls. It is recommended that the insulation is inspected periodically, to ensure there is no damage that could reduce its effectiveness.

3.0 EEM COSTS

The estimated costs for the dryer and insulation are included in Tables 3 and 4. The cost of the dryer includes: freight, installation, commissioning, and a small dry scrubber for the exhaust emissions.

Table 3: Estimated EEM 1 Costs

EEM 1: Biosolids Dryer						
Item	Description	E or Q	Vendor	Qty	Unit	Total
1	Gryphon Biosolids Dryer 0520U	Q	JBI Water & WW	1	$760,000	$ 760,000
Subtotal						$ 760,000
Contingency 0%						$ -
Total Cost EEM 1:						$ 760,000

Table 4: Estimated EEM 2 Costs

EEM 2: Insulate Dryer						
Item	Description	E or Q	Vendor	Qty	Unit	Total
1	1/2" - 450F Insulation Blanket	Q	JBI Water & WW	1	$ 20,000	$ 20,000
Subtotal						$ 20,000
Contingency 10%						$ 2,000
Total Cost EEM 2:						$ 22,000

4.0 BASELINE AND ANALYSIS OVERVIEW

4.1 Baseline Description

The City of Cottage Grove SD treats incoming influent using an oxidation ditch and activated sludge treatment. The SD sends the influent thru an oxidation ditch that uses orbital discs to aerate thru circulation. Once the influent is oxidized it is sent to clarifying ponds where the water is gravity-separated from the sludge. The sludge is sent to the aeration basins known as digesters, and the reclaimed water is sent through further treatment. The aeration system is equipped with two blowers, one delivers enough oxygen for both digesters, while the other serves as redundant.

The sludge is pumped from the digesters to a polymerization system through the WAS pump. A mechanical auger is used to inject polymer and reduce the liquid content in the sludge. The plant has two polymerization machines, one serves as redundant. Post polymerization the sludge is sent to a mechanical belt press using the TWAS pump. The sludge is dewatered further in the mechanical belt press to achieve approximately 15% solids and 85% liquid. The sludge accumulates onsite in a storage shed. The sludge is hauled offsite approximately two times per week for disposal. See the appendix for a process flow diagram of the existing operation.

The oxidation ditch, digester blowers, and clarifiers run 8,760 hours per year. The polymerization system, including the WAS pump and the TWAS pump, run 2,902 hours per year. The mechanical press runs approximately 4.5 hours per day 6 days per week, for a total of 1,404 hours per year. Personnel indicate the loading on the equipment is consistent year long, independent of influent flow or seasons. See the baseline equipment summary in Table 5.

Table 5: Baseline Equipment Summary

Equipment	Manufacturer	Model Number	Year	Count	HP	VFD
Digester Blowers	Kaeser	FB 620 C	2011	2	75	Y
WAS Pump	Techtop	GR3-CI-TF-254T-6-BR-D-7.5	2006	1	7.5	Y
Polymerizer Skid	PolyBlend	SP60102102	2006	2	0.5	N
Auger Motor	Baldor	EM3768T	2006	1	5	Y
TWAS Pump	Baldor	EM3704T	2006	1	3	Y
Mechanical Press	Ashbrook Co	Custom Skid	2006	1	10	N

Plant personnel provided an overview of the plant operations and hours of operation. The proposed equipment subject to be removed for the EEM upgrade was data logged for power usage and operating hours per day.

4.2 Overview of Technical Approach

This section describes the technical approach in broad terms. Readers interested in more analytical detail should refer to the Appendix.

4.2.1 Data Logging

To better understand the operation of the facility, baseline monitoring was conducted for the following equipment:

- Digester Blower #1 (kW)
- WAS Pump (kW)
- Auger Motor (kW)
- TWAS Pump (kW)

These motors are of interest for data logging since they are proposed to be taken offline, or in the case of the WAS pump, the hours will be reduced. Data logging was done in 1-minute intervals for 2 weeks except for the auger motor, which gathered a 15-minute snapshot of the power usage. Time-of-use for the auger is the same as the TWAS pump operating hours. See the appendix for data logging results.

4.2.2 Baseline Analysis

A yearly model was created using the baseline equipment and estimated operational hours provided by plant personnel. The system was modeled based on the performance found through data logging. Energy usage for equipment downstream to the data-logged equipment was based on motor load of 75%, individual motor efficiency, and VFD efficiency if applicable.

Site personnel indicate that there is no seasonal fluctuation in hours of operation or total loading on the equipment. The calculated and data-logged energy usage was considered to be the same year-round and was used for the annual energy model.

4.2.3 EEM Analysis

EEM 1

The addition of the biosolids dryer removes the need for the digester blowers and the polymerization system. The EEM energy model was updated to reflect the process, including a reduction in the operating time of the WAS pump. Energy usage for equipment upstream to the EEM upgrade was based on motor load of 75% and individual motor efficiency and VFD efficiency if applicable.

The biosolids dryer energy usage was calculated using vendor specifications and the current average solids hauled offsite, 19 tons per week. According to vendor specifications, the dryer has an evaporative rate of 0.42 ton per hour, which was used to determine total energy and operational hours.

EEM 2

3EPlus software was used to determine the heat loss of the dryer for the process temperature of 350°F and varying ambient temperatures. An uninsulated dryer loses, on average, 550k BTU/hr, whereas a dryer with ½" of 450°F insulation, loses on average, 136k BTU/hr. EEM 2 was calculated using the operating hours and a rolling baseline determined from EEM 1.

See Table 6 for a summary of the total annual energy usage for the baseline and EEM upgrades.

4.3 Key Assumptions

This section describes the key assumptions used in the baseline and EEM analysis.

4.3.1 Key Assumptions for Baseline Analysis

- Equipment not data logged and equipped with VFDs was calculated to use 75% of nameplate power.
- Site indicates the equipment runs similar hours year-round independent of influent flow rates or seasons.
- Data logged time-of-use was considered to be the same as year-round operating hours.

4.3.2 Key Assumptions for EEM Analysis

- Equipment not data logged and equipped with VFDs was calculated to use 75% of nameplate power.
- Site indicates the equipment runs similar hours year-round independent of influent flow rates or seasons.
- WAS pump feeds the mechanical press only.
- Upstream processing times are not affected by the EEM upgrade, e.g., oxidation ditch, clarifiers, and mechanical press will continue to run the same hours as baseline.
- Operating hours are based on the manufacturer's specified evaporative rate of 0.42 ton/hr.
- Cottage Grove solids are an average temperature of 65°F.
- The average ambient temperature is the monthly average high temperature (for insulation heat loss).
- The required energy to run the dryer is to heat and evaporate water only.
- Setpoint of the dryer is 350°F.
- The plant processes an average of 19 tons per week of 15% solids.
- The dryer output is 90% solids.
- The burner has a combustion efficiency of 80.4%.
- The surface area of dryer is a rectangular shape and the dryer ducting was treated as a circular shape.
- The sludge cake is loaded with a front loader and no additional pumping is required.
- The incoming liquid is superheated to 350°F then vaporized.

4.4 Summary of EEM Analysis

Table 6: Modeling Summary

EEM	Model	Include in Package?	Baseline Annual Energy Usage (kWh/yr)	EEM Annual Energy Usage (kWh/yr)	Annual Energy Savings (kW/yr)	Demand Savings (kW/mo)	Baseline Annual Energy Usage (Therms/yr)	EEM Annual Energy Usage (Therms/yr)	Annual Energy Savings (Therms/yr)
--	Baseline	--	277,163	--	--	--	--	--	--
1	Biosolids Dryer	Yes	--	80,121	197,042	0	38,909	--	0
2	Insulate Dryer	Yes	--		0	0	--	28,281	10,628
Total for Recommended Measures:				80,121	197,042	0		28,281	10,628

5.0 COMMISSIONING REQUIREMENTS

5.1 Purpose of Commissioning

The purpose of commissioning is to ensure that the EEMs are properly installed, working as intended, and delivering energy savings. Some simple EEMs, such as motor replacements, do not need to be commissioned. Although Energy Trust of Oregon does not have a requirement for commissioning, doing so for some measures makes very good business sense.

5.2 Logistical Requirements and Customer Assistance

Commissioning should be conducted during typical plant operation. Ideally the dryer is running to a specification of 90% dry solid waste.

Commissioning is a cooperative effort between your staff and the contractor. Of course, it is your equipment and you will have the final decision regarding how it is operated. Generally, the contractor will spend a day on site for an initial commissioning visit (with periodic assistance from your staff). Some projects require and iterative process of changing set-points/algorithms and observing performance to achieve optimum performance. Your staff will be involved in these steps as well.

5.3 Settings to be Observed/Confirmed/Recorded

Refer to Section 2 for the recommendations by specific EEM(s) of the set-points and algorithms to achieve energy performance. Section 2 is meant for use by facility operators to ensure that settings have been implemented to achieve energy savings. Note that these settings may be modified during the commissioning process.

5.4 Performance Verification Plan

Table 7 describes the procedure recommended for the PDC Account Manager to verify that the system achieves the estimated energy savings. Note that these settings could be modified during the commissioning process and savings should be re-calculated if significant changes were made.

Table 7: Verification Plan

Verification Type	Item #	Verification Item	Method
Physical Inspection	1	EEM 1: Verify Biosolid Dryer Upgrade	Visually inspect and confirm the Gryphon 0520U dryer is installed.
	2	EEM 1: Verify Decommissioned Equipment	Verify digester blowers, polymerization system: polymerizer skid, auger motor, and TWAS pump, are no longer used in the solid-treating process.
	3	EEM 1: Verify WAS Pump Configuration	Visually inspect the WAS pump is feeding the mechanical press.
	4	EEM 1: Air Temperature	Visually confirm the dryer is set for an air temperature of 350°F.
	5	EEM 1: Sludge Feed	Verify no additional electric energy is being used for sludge delivery to the biosolid dryer, e.g. pumping, conveyance, etc.
	6	EEM 2: Verify Insulation is Installed	Visually inspect for insulation on the body and dryer ducting.
Data Logging	1	EEM 1: Verify Total Power	Data log the dryer's motors at steady state, in 15min increments, to determine the total average operating power of 30kW.
	2	EEM 1: WAS Pump	Confirm time-of-use has been reduced thru data logging. One-week, including a weekend, is recommended. EEM hours are approximately 4.5 hrs/day, 6days/wk, 52wks/yr
	3	EEM 1: Combustion Efficiency	Confirm the combustion efficiency is 80.4% or greater.
	4	EEM 2: Insulation Efficiency	Confirm the insulation surface temperature is <140°F while the dryer is set to 350°F.
Confirm with Personnel	1	EEM 1: Upstream Equipment	Verify equipment operating hours remain unchanged for the mechanical press.
	2	EEM 1: Dryer Feed Rate	Verify dryer runs for approximately 41 hours per week for approximately 19 tons of 15% solids (0.4 ton/hr).

6.0 APPENDIX

A. Energy Calculations
B. Vendor Quotes
C. Equipment Specifications and Drawings
D. Data Logging Results
E. Process Flow Diagrams
F. Email Communications and Supporting Documentation
G. Photographs

A. Energy Calculations

BASELINE ENERGY MODEL					Design		Calculated	Measured	Baseline
Current Process	Description	Year	Hrs/year[2]	Count	HP	VFD	kW[1]	kW	kW-hrs /year
Digesters	Aerobic; custom design for: anaerobic			2					
Blower #1	Kaeser FB 620 C	2011	8,760	1	75	Y		29	252,288
Blower #2	Kaeser FB 620 C one blower is redundant	2011	-	1	75	Y		0	-
WAS Pump	Techtop GR3 (to screw press)	2006	2,902	1	7.5	Y		1.5	4,352
Polymer Pumps	small pumps <1/2hp	2006	2,902	1	0.5	N	0.44		1,277
Auger Motor	Baldor (screw press)	2006	2,902	1	5	Y		0.29	841
TWAS Pump	Baldor (screw press to mech press)	2006	2,902	1	3	Y		2.0	5,937
Mechanical Press	Custom, several motors no VFDs	2006	1,404	1	10	N	8.9		12,468
Total									**277,163**

1. If equipped with VFD and no snapshot data is available, assume 75% powerand 84% VFD efficiency for motors <= 10hp, and 88% for motors >10hp.
2. Site indicates the equipment runs similar hours year-round independent of influent flow rates.

EEM ENERGY MODEL					Design		Op. Energy		EEM 1		EEM 2	
Current Process	Description	Year	Op Hours /Year[2]	Count	HP	VFD	kW[1]	MMBTU/ hr	kW-hrs /year	Therms /year	kW-hrs /year	Therms /year
WAS Pump[3]	Techtop GR3 (to mechanical press)	2006	1,404	1	7.5	Y	1.5		2,106		2,106	
Mechanical Press	Custom, several motors no VFDs	2006	1,404	1	10	N	10		14,040		14,040	
Biosolids Dryer[4,5]	0520U (5' x 20')		2,147	1	113	Y	30	1.8	63,975	38,909	63,975	28,281
Total									**80,121**	**38,909**	**80,121**	**28,281**

1. If equipped with VFD and no snapshot data is available, assume 75% power usage and 90% efficiency.
2. Site indicates the equipment runs similar hours year-round independent of influent flow rates.
3. Assume EEM upgrade requires WAS pump to feed mechanical press only; power usage from data logging.
4. Operating hours and electric energy usage are based on manufacturer's specification of a 0.42 ton/hr evap rate, NG usage calculated.
5. Assumed sludge cake is loaded via front loader and there's no additional pumping required.

NG Usage - Enthalpy Calculations	Feed Rate Dry Solids (tons/week)	Water Evap 90% DS (tons/week)	Water Evap 90% DS (lbs/week)	h_l (BTU/lb) 65F	h_l (BTU/lb) 350F	h_{vap} (BTU /lb) 350F	Op. Sched (hrs/week)	H (BTU/week)	EEM 1 Average H (MMBTU /hr)	EEM 2 Average H (MMBTU /hr)
dryer start up	<< assume less than 15 min start up, max BTU 2.5MMBTU						1	2,517,361		
sensible heat in	2.9	16	32,222	33	321			9,271,719		
evaporative heat in	2.9		32,222			870		28,046,222		
Process Requirement							40	39,835,302	0.96	0.96
rad and conv heat loss									0.55	0.14
System Requirement									1.5	1.1
comb. eff loss									0.30	0.22
Total Energy Required									**1.8**	**1.3**

1. Input feed is average annual temp of 65F
2. Solids are negligent for heating, all energy goes to driving off water
3. The combustion efficiency for the burner is 80.4% - excess oxygen at 3%
4. The water is assumed to be superheated quickly to 350F before vaporizing, due to Gryphon's differential pressure system
5. Dryer runs on average, 10 hours per day.

H, Water Enthalpy = enthalpy of vaporization + sensible heat

sensible heat = mass flow rate x (specific enthalpy out – specific enthalpy in)

evaporative heat = mass flow rate x enthalpy of vaporization

operating hours = mass flow rate required / dryer capacity

Dryer Dimensions (Approximated)		
Length	20	ft
Width	7	ft
Height	2	ft
Surface Area	**388**	ft2
Surface Area = 2*WH+2*LH+2*LW		

Dryer Round Dimensions			
qty	D (ft)	L (ft)	SA ft2
16	0.5	2	50
1	1	15	47
1	2	29	182
1	3	2	19
Total			**298**
Surface Area = 2*pi*r*L			

Month	Average Air Temp (F)	Op Days Month	Op Hours / Month	Heat Loss BTU/hr-ft2	Radiant Heat Loss BTU/hr	Heat Loss BTU/hr-ft2	Radiant Heat Loss BTU/hr
	High			EEM1		EEM2	
January	48	18	182	840	576,348	207	141,681
February	52	16	165	831	569,786	205	140,382
March	57	18	182	819	561,583	202	138,758
April	61	17	176	809	555,021	200	137,458
May	68	18	182	792	543,537	197	135,185
June	74	17	176	778	533,694	194	133,236
July	82	18	182	759	520,569	190	130,637
August	83	18	182	756	518,928	190	130,312
September	76	17	176	773	530,412	193	132,586
October	65	18	182	800	548,459	198	136,159
November	53	17	176	828	568,146	204	140,057
December	46	18	182	845	579,630	207	142,331
Average	**64**				**550,509**		**136,565**

Reported: usclimatedata.com

Baseline Additional Costs - Solids Removal Fee *Heard Farms Payments from City of Cottage Grove SD*		
Service Month	Invoice Date	Invoice Amount
Feb	3/1/2018	$ 4,568
Mar	4/2/2018	$ 3,702
Apr	5/1/2018	$ 4,767
May	6/1/2018	$ 2,203
Jun	7/2/2018	$ 2,878
Jul	8/1/2018	$ 2,058
Aug	9/4/2018	$ 6,015
Sep	10/3/2018	$ 2,932
Oct	11/1/2018	$ 2,811
Nov	12/3/2018	$ 1,051
Dec	1/2/2019	$ 5,659
Jan	2/1/2019	$ 8,375
Total (Feb to Jan)		**$47,020**

Vendor specifications detail a surface termperature <140°F. 1/2" insulation is recommended for ease of installation around the ducting.

NAIMA 3EPlus V4.1

Item ID = 1
Item Description = Biosolids Dryer
System Application = Tank Shell - Horizontal
Dimensional Standard = ASTM C 585 Rigid
Calculation Type = Heat Loss Per Hour Report
Process Temperature = 350
Ambient Temperature = 25.0
Wind Speed = 0.0

Bare Metal = Steel
Bare Surface Emittance = 0.8
Insulation Layer 1 = 450F MF BLANKET, Type II, C553-13

Outer Jacket Material = All Service Jacket
Outer Surface Emittance = 0.9

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft^2)	Efficiency (%)
Bare	349.4	894.90	
0.5	137.8	217.20	75.73
1.0	96.9	122.80	86.28
1.5	78.8	85.76	90.42
2.0	68.4	65.97	92.63
2.5	61.5	53.63	94.01
3.0	56.6	45.19	94.95
3.5	53.0	39.06	95.64
4.0	50.1	34.39	96.16
4.5	47.8	30.73	96.57
5.0	45.9	27.77	96.90
5.5	44.3	25.33	97.17
6.0	43.0	23.29	97.40
6.5	41.8	21.55	97.59
7.0	40.8	20.06	97.76
7.5	39.9	18.75	97.90
8.0	39.1	17.61	98.03
8.5	38.4	16.60	98.14
9.0	37.8	15.70	98.25
9.5	37.2	14.89	98.34
10.0	36.7	14.16	98.42

DISCLAIMER OF WARRANTY - NO WARRANTIES. THIS SOFTWARE PRODUCT IS PROVIDED AS IS WITHOUT WARRANTY OF ANY KIND. Refer to the full disclaimer of warranty under the "help" menu in the toolbar at top of the program for details.

NAIMA 3EPlus V4.1

Item ID = 1
Item Description = Biosolids Dryer
System Application = Tank Shell - Horizontal
Dimensional Standard = ASTM C 585 Rigid
Calculation Type = Heat Loss Per Hour Report
Process Temperature = 350
Ambient Temperature = 45.0
Wind Speed = 0.0

Bare Metal = Steel
Bare Surface Emittance = 0.8
Insulation Layer 1 = 450F MF BLANKET, Type II, C553-13

Outer Jacket Material = All Service Jacket
Outer Surface Emittance = 0.9

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft^2)	Efficiency (%)
Bare	349.5	847.50	
0.5	150.2	208.10	75.45
1.0	111.9	117.80	86.10
1.5	94.9	82.30	90.29
2.0	85.1	63.32	92.53
2.5	78.7	51.48	93.93
3.0	74.2	43.38	94.88
3.5	70.7	37.49	95.58
4.0	68.1	33.01	96.10
4.5	66.0	29.49	96.52
5.0	64.2	26.65	96.86
5.5	62.7	24.31	97.13
6.0	61.5	22.35	97.36
6.5	60.4	20.68	97.56
7.0	59.5	19.25	97.73
7.5	58.6	18.00	97.88
8.0	57.9	16.90	98.01
8.5	57.3	15.93	98.12
9.0	56.7	15.06	98.22
9.5	56.1	14.29	98.31
10.0	55.7	13.59	98.40

NAIMA 3EPlus V4.1

Item ID = 1
Item Description = Biosolids Dryer
System Application = Tank Shell - Horizontal
Dimensional Standard = ASTM C 585 Rigid
Calculation Type = Heat Loss Per Hour Report
Process Temperature = 350
Ambient Temperature = 55.0
Wind Speed = 0.0

Bare Metal = Steel
Bare Surface Emittance = 0.8
Insulation Layer 1 = 450F MF BLANKET, Type II, C553-13

Outer Jacket Material = All Service Jacket
Outer Surface Emittance = 0.9

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft^2)	Efficiency (%)
Bare	349.5	823.60	
0.5	156.4	203.40	75.31
1.0	119.3	115.20	86.01
1.5	102.9	80.53	90.22
2.0	93.5	61.96	92.48
2.5	87.3	50.37	93.88
3.0	82.9	42.45	94.85
3.5	79.6	36.69	95.55
4.0	77.1	32.30	96.08
4.5	75.0	28.86	96.50
5.0	73.3	26.08	96.83
5.5	71.9	23.79	97.11
6.0	70.7	21.87	97.34
6.5	69.7	20.24	97.54
7.0	68.8	18.83	97.71
7.5	68.0	17.61	97.86
8.0	67.3	16.54	97.99
8.5	66.7	15.59	98.11
9.0	66.1	14.74	98.21
9.5	65.6	13.98	98.30
10.0	65.1	13.30	98.39

Item ID = 1
Item Description = Biosolids Dryer
System Application = Tank Shell - Horizontal
Dimensional Standard = ASTM C 585 Rigid
Calculation Type = Heat Loss Per Hour Report
Process Temperature = 350
Ambient Temperature = 65.0
Wind Speed = 0.0

Bare Metal = Steel
Bare Surface Emittance = 0.8
Insulation Layer 1 = 450F MF BLANKET, Type II, C553-13

Outer Jacket Material = All Service Jacket
Outer Surface Emittance = 0.9

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft^2)	Efficiency (%)
Bare	349.5	799.70	
0.5	162.6	198.60	75.16
1.0	126.8	112.60	85.92
1.5	110.9	78.73	90.16
2.0	101.9	60.58	92.42
2.5	95.9	49.25	93.84
3.0	91.7	41.50	94.81
3.5	88.5	35.87	95.51
4.0	86.1	31.58	96.05
4.5	84.1	28.22	96.47
5.0	82.5	25.50	96.81
5.5	81.1	23.26	97.09
6.0	80.0	21.38	97.33
6.5	79.0	19.79	97.53
7.0	78.1	18.41	97.70
7.5	77.4	17.22	97.85
8.0	76.7	16.17	97.98
8.5	76.1	15.24	98.09
9.0	75.6	14.41	98.20
9.5	75.1	13.67	98.29
10.0	74.6	13.00	98.37

NAIMA 3EPlus V4.1

Item ID = 1
Item Description = Biosolids Dryer
System Application = Tank Shell - Horizontal
Dimensional Standard = ASTM C 585 Rigid
Calculation Type = Heat Loss Per Hour Report
Process Temperature = 350
Ambient Temperature = 85.0
Wind Speed = 0.0

Bare Metal = Steel
Bare Surface Emittance = 0.8
Insulation Layer 1 = 450F MF BLANKET, Type II, C553-13

Outer Jacket Material = All Service Jacket
Outer Surface Emittance = 0.9

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft^2)	Efficiency (%)
Bare	349.5	751.40	
0.5	174.9	188.80	74.87
1.0	141.7	107.20	85.73
1.5	127.1	75.01	90.02
2.0	118.7	57.73	92.32
2.5	113.2	46.94	93.75
3.0	109.3	39.56	94.74
3.5	106.4	34.19	95.45
4.0	104.1	30.10	95.99
4.5	102.3	26.89	96.42
5.0	100.8	24.30	96.77
5.5	99.6	22.17	97.05
6.0	98.5	20.38	97.29
6.5	97.6	18.86	97.49
7.0	96.8	17.55	97.66
7.5	96.2	16.41	97.82
8.0	95.5	15.41	97.95
8.5	95.0	14.52	98.07
9.0	94.5	13.73	98.17
9.5	94.1	13.03	98.27
10.0	93.7	12.39	98.35

B. Vendor Quotes

RE: Gryphon 0520U and 0530U Estimate Request

jimcoskey@jbiwater.com

Wed 2/13/2019 2:02 PM

To: Gretchen Joyce - RHT Energy <Gretchen@rhtenergy.com>;

EEM 1 total cost, includes: freight, installation, supervision, commissioning, and training from the vendor. It also includes a dry carbon scrubber for the small amount of exhaust emissions.

Gretchen,

The machine costs: EEM 2 Cost

0520 U complete is $780,000 minus insulation of $20,000 = $760,000

0530 U complete is $880,000 minus insulation of $25,000 = $855,000

JIM COSKEY
JBI Water & Wastewater Equipment
Philomath, OR

Cell: 541 609 1367
jimcoskey@jbiwater.com
www.jbiwater.com

From: Gretchen Joyce - RHT Energy <Gretchen@rhtenergy.com>
Sent: Wednesday, February 13, 2019 12:15 PM
To: jimcoskey@jbiwater.com
Subject: RE: Gryphon 0520U and 0530U Estimate Request

Hi Jim,

This is great.

For my records, what is the cost of the 0520U and 0530U prior to the insulation upgrade?

Gretchen Joyce
Energy Analyst
Production Efficiency

Working with Energy Trust of Oregon

RHT Energy
Program Delivery Contractor
1215 Stowe Ave., Medford, Oregon 97501

541.770.5884 OFFICE
541.414.8421 CELL
energytrust.org

From: jimcoskey@jbiwater.com <jimcoskey@jbiwater.com>
Sent: Tuesday, February 12, 2019 2:12 PM

C. Equipment Specifications and Drawings

Gryphon dryer system information provided by vendor

Gryphon Environmental, LLC
2920 Fairview Drive
Owensboro, KY 42303

Financial Analysis

Cottage Grove WWTP

Estimates For Budgeting Purposes Only

Date 11/1/18

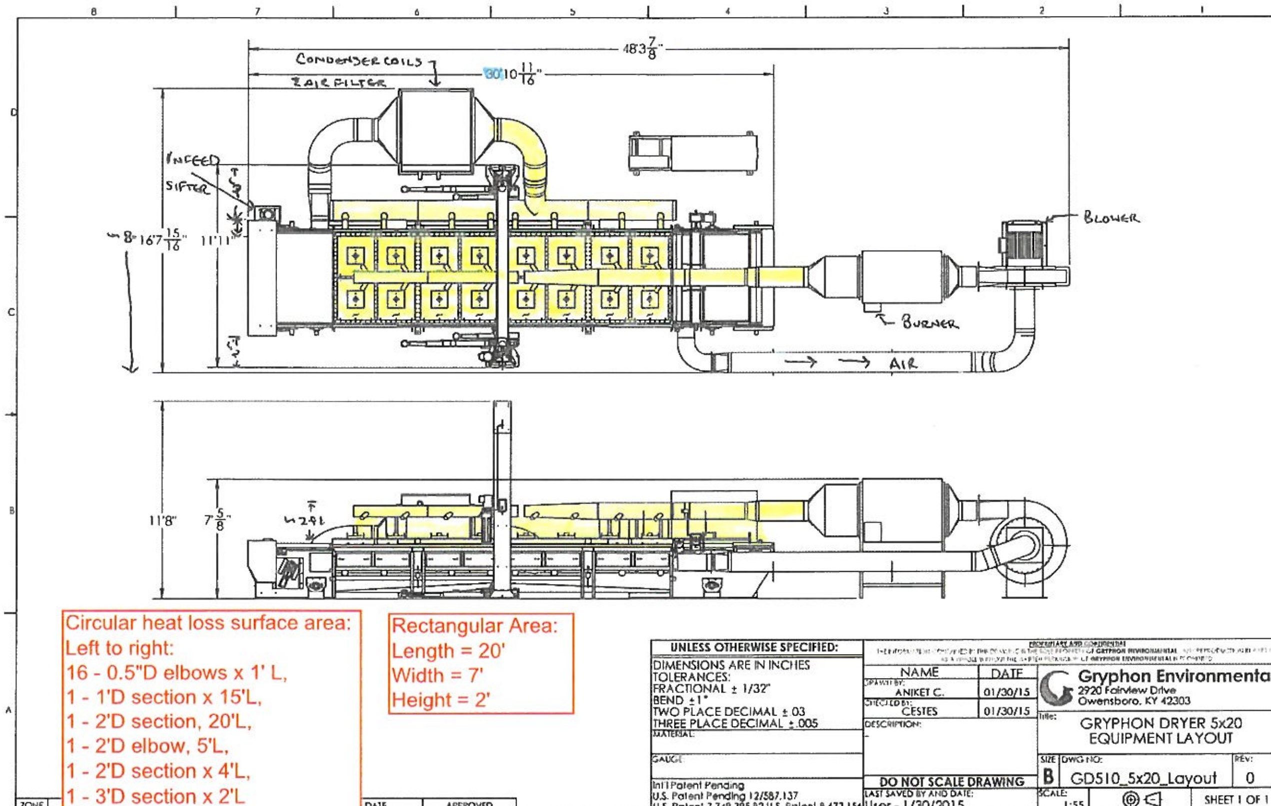
Dryer Operating Schedule										Energy		Op Ex			Exhaust Air Estimates		
% TS Pre / Post	Operating Schedule Hrs / Days	Feed Rate to Dryer (tons/day)	Water Removal (tons/day)	Water Removal (tons/hr)	Dry Product (tons/day)	Gryphon Model	# Dryers	Nominal Evap Capacity (t/hr/ea)	Budgetary Cap Ex (Installed / Operational)	Thermal MMBTU/hr	Electric KW/hr	Annual Nat. Gas $	Annual Electric $	Annual Maint Budget	Exhaust Air Volume (SCFM)	Filtration Level	Exhaust Air Temp
15% 90%	10 5	6.67	5.56	0.56	1.11	0530 U	1	0.63	$880,000	1.167	41.7	$12,133	$8,667	$ 30,800	375	49 um	121 F
15% 90%	10 7	4.76	3.97	0.40	0.79	0520 U	1	0.42	$780,000	0.833	29.8	$12,133	$8,667	$ 27,300	250	49 um	121 F

Assumes:
$0.080 Per kW of Electricity
$4.000 Per MMBTU (or decatherm) of natural gas

Equipment electrical required is 29.8 kW/hr for 4.76 tons/day
Hourly evaporative rate is 0.42ton/hr
Natural Gas usage calculated separately

Note: Cost also included here.

Gryphon 0520U Dryer



Circular heat loss surface area:
Left to right:
16 - 0.5"D elbows x 1' L,
1 - 1'D section x 15'L,
1 - 2'D section, 20'L,
1 - 2'D elbow, 5'L,
1 - 2'D section x 4'L,
1 - 3'D section x 2'L

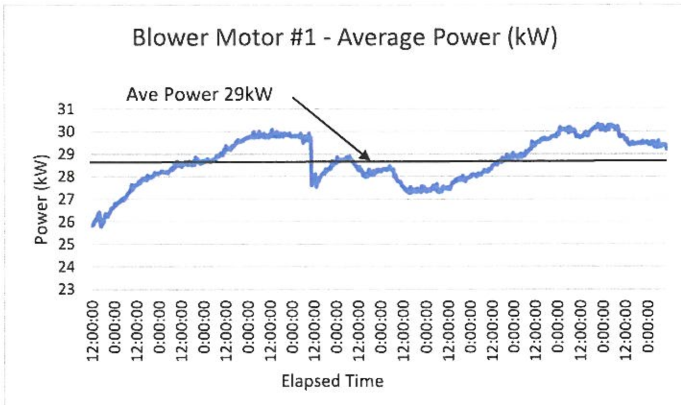
Rectangular Area:
Length = 20'
Width = 7'
Height = 2'

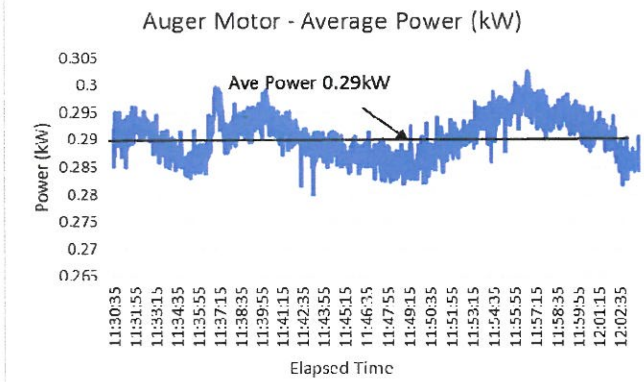
HEATED / SURFACE AREA

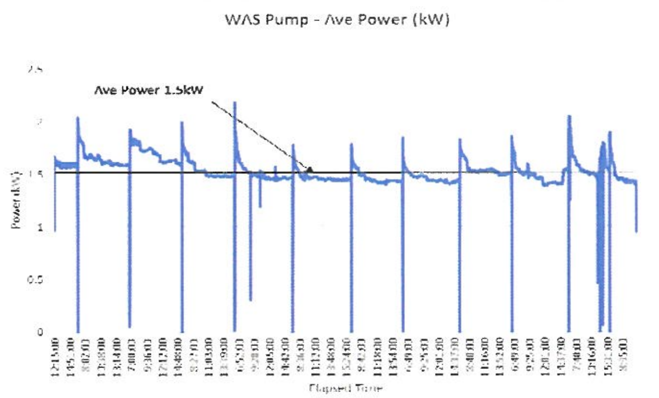
	RECTANGLE
L	30 ft
W	7 ft
H	2 ft

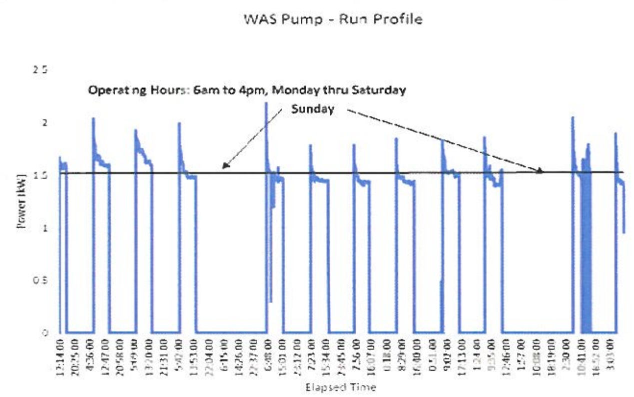
D. Data Logging Results

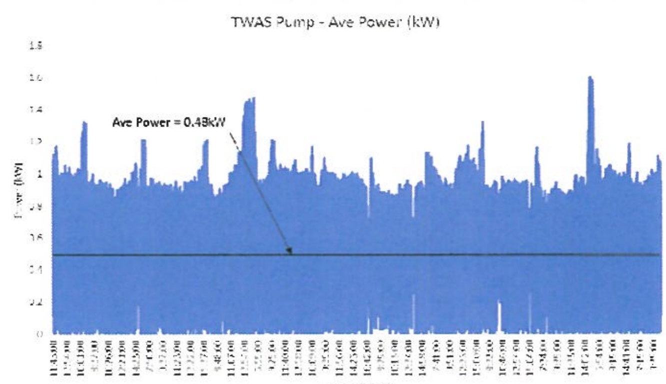
	Design Criteria							Data Logging and Results					
	Power (HP)	Power (kW)	Volts	FLA (amps)	RPM	Nom Eff	VFD	Data Logging Interval	Average Power (kW)	Max Current (amps)	Motor Op. %	Op Hours	kW-hrs
Blower #1	75	55.9	460	84	3600	91.0	Y	2 weeks	29	40	47%	8,760	252,288
WAS Pump	7.5	5.6	460	10.6	1170	91.0	Y	2 weeks	1.5	2.1	20%	2,902	4,352
Auger Motor	5	3.7	460	8	1150	89.5	Y	15 min	0.29	0.48	6%	2,902	841
TWAS Pump	3	2.2	460	5	1160	89.5	Y	2 weeks	0.48	2.0	41%	2,902	1,398
Total													**258,879**

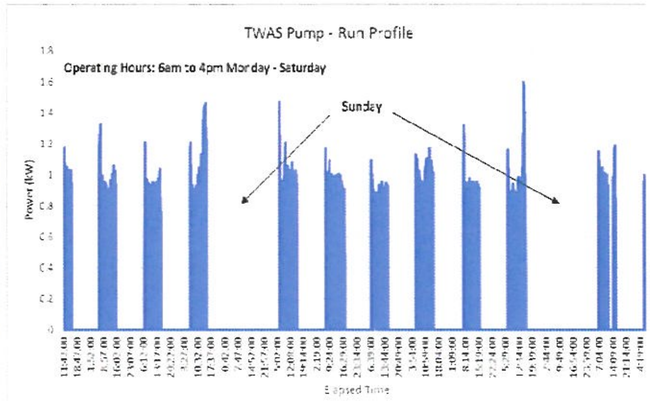






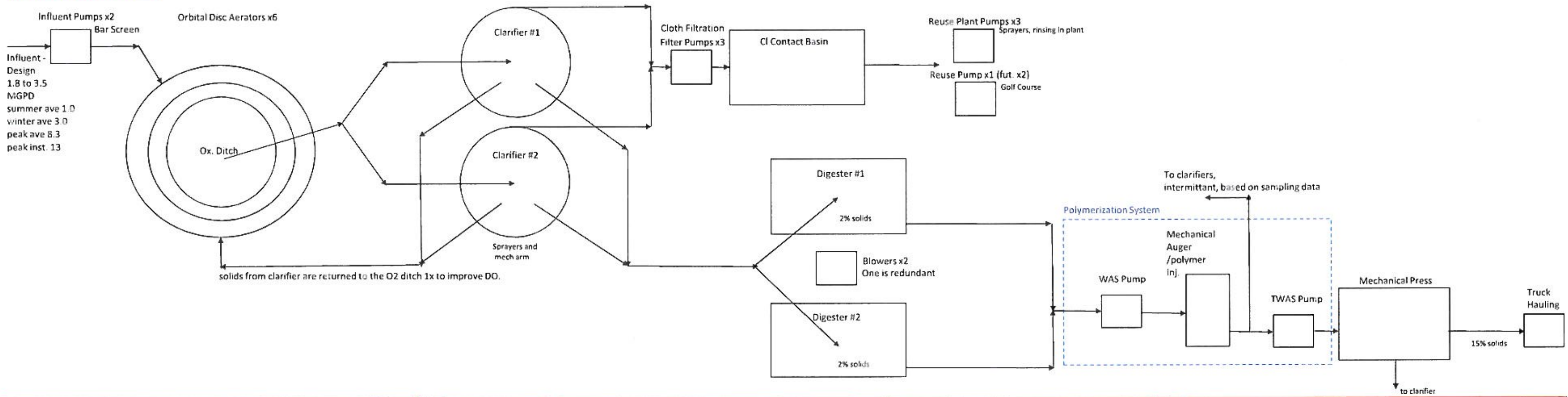




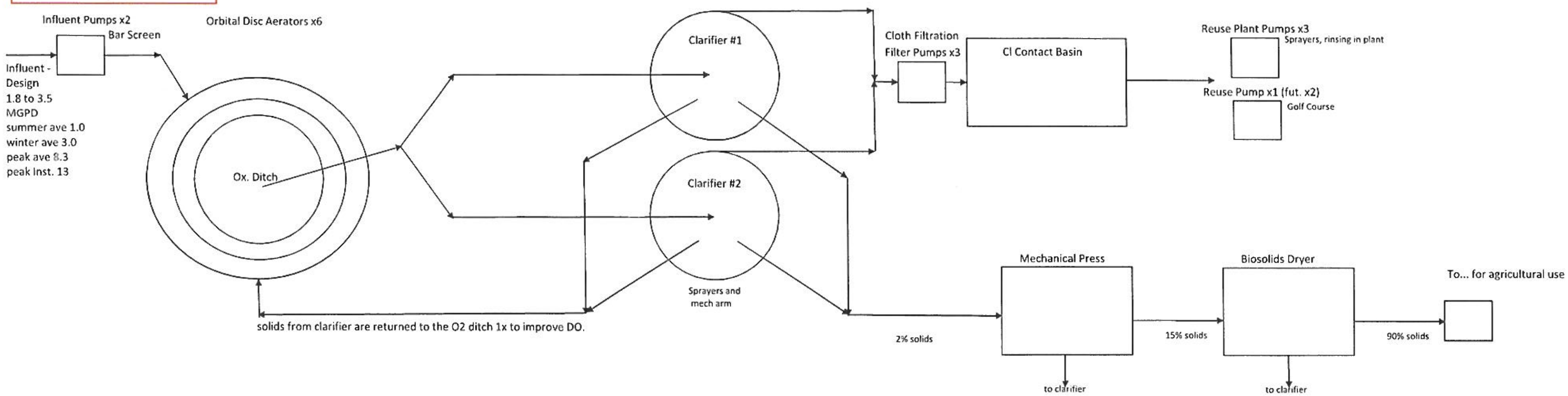


E. Process Flow Diagrams

Current Process



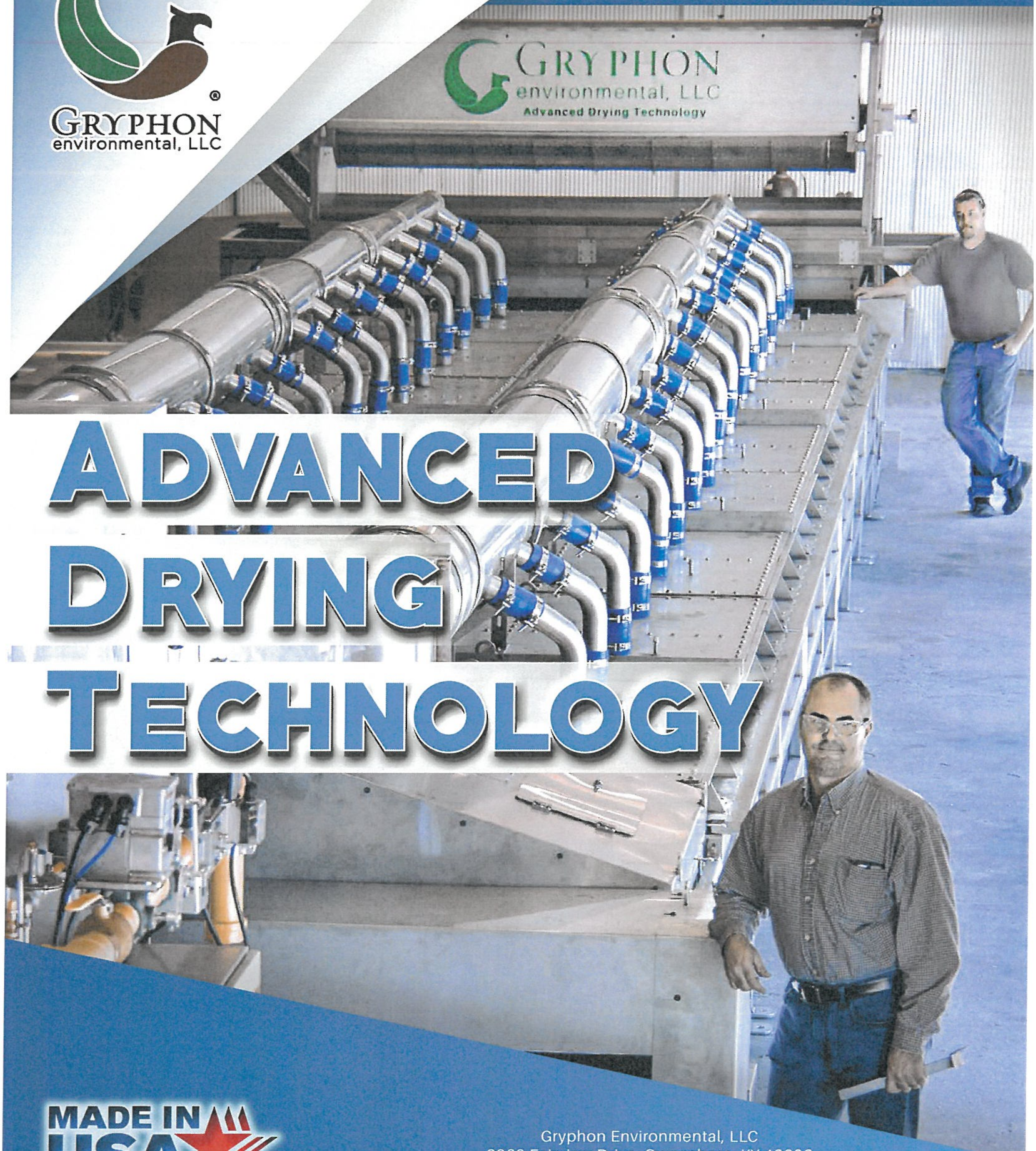
Biosolids Drying Process



F. Email Communications and Supporting Documentation

GRYPHON
environmental, LLC

AUTOMATED DRYING TECHNOLOGY FOR
APPLICATIONS OF ANY SIZE



ADVANCED DRYING TECHNOLOGY

MADE IN USA

Gryphon Environmental, LLC
2920 Fairview Drive, Owensboro, KY 42303
www.2gryphon.com info@2gryphon.com (270) 485-2680

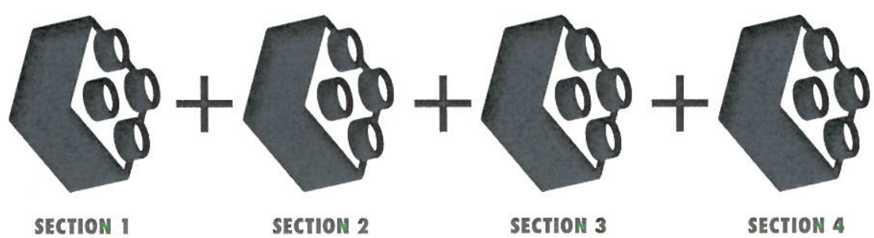
MANUFACTURING

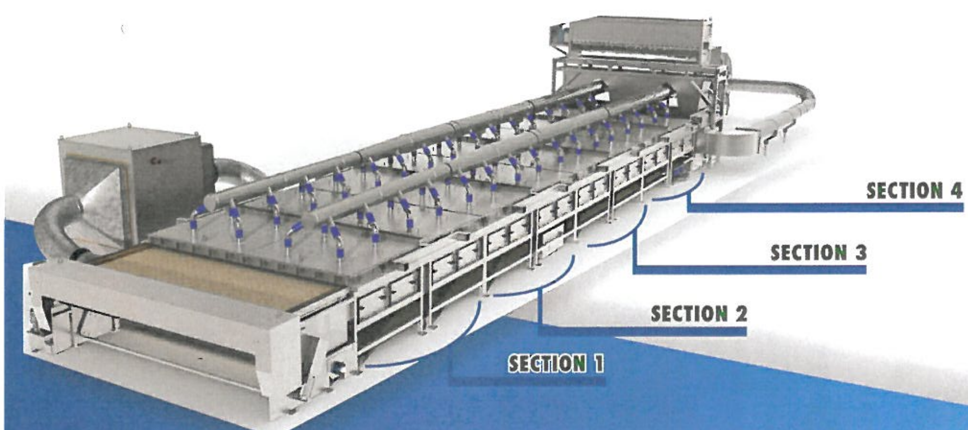
Gryphon's sectional dryer design provides major benefits in manufacturing, shipment, installation and functional expandability.

This innovative design reduces capital costs, speeds lead time, simplifies freight methods, reduces installation time and cost and provides flexibility for the future.

REPEATABLE EXPANDABLE DESIGN

SAVES MONEY





MODELS

MODEL 03-SERIES

3 ft. by 6 ft.

Sections are assembled in a series to produce models 0312 and 0318 dryers.

For municipal plants ranging from 0.5 to 5 MGD. Evaporative capacities range from 2.5 to 5.5 tons of water per day.

MODEL 05-SERIES

5 ft. by 10 ft.

Sections are assembled in a series to produce models 0510, 0520, and 0530 dryers.

For municipal plants ranging from 3 to 15 MGD. Evaporative capacities range from 5 to 15 tons of water per day.

MODEL 10-SERIES

10 ft. by 10 ft.

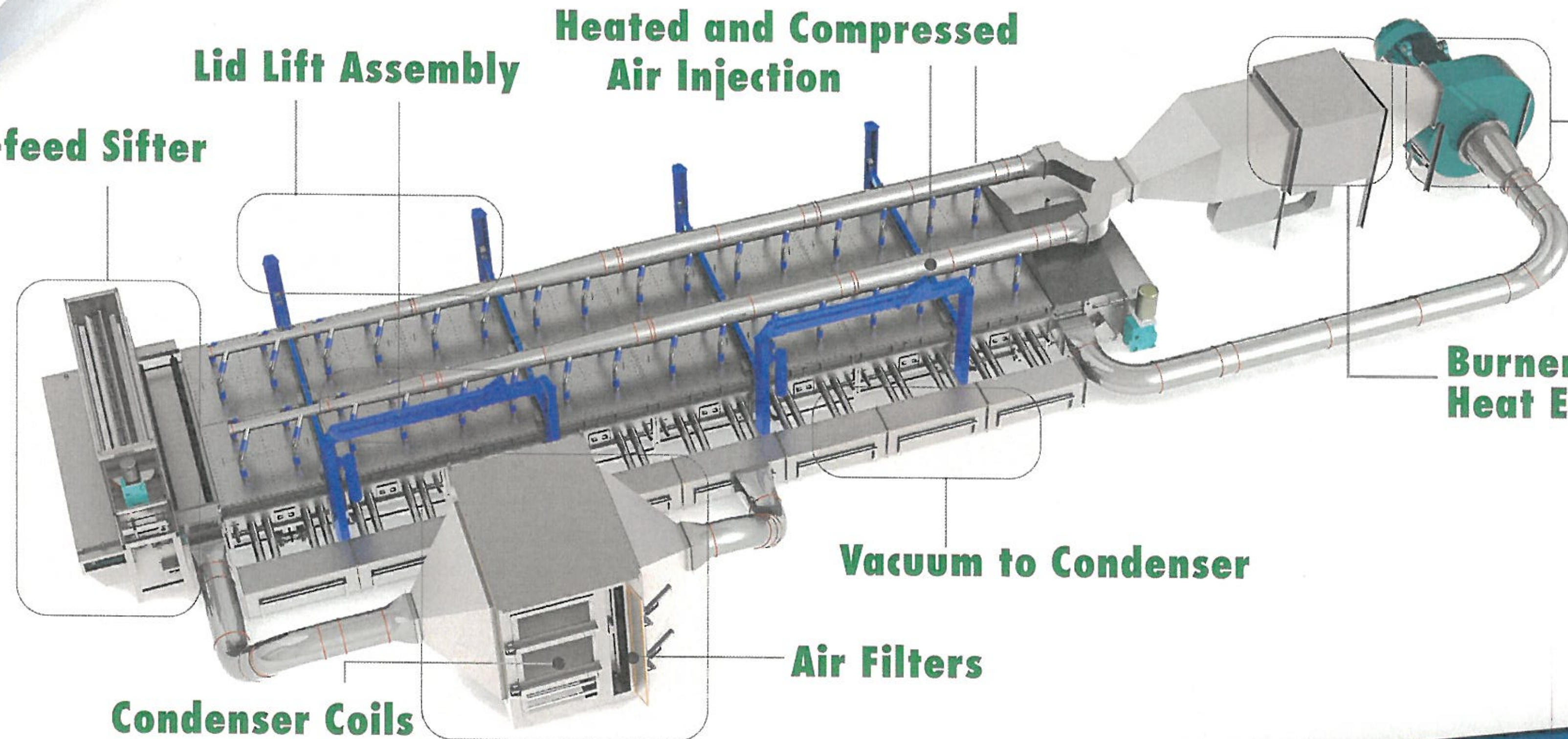
Sections are assembled in a series to produce models 1020, 1030, 1040 and 1050 dryers. Dual unit designs are also available to enable single point of control for large applications.

For municipal plants ranging from 10 to 100 MGD. Evaporative capacities range from 5 to 150 tons of water per day.

COST-EFFECTIVE DRYERS FOR ANY SIZE PLANT

GRYPHON environmental, LLC

ADVANCED DRYING TECHNOLOGY



- Less than 15-minute Start-up and Shut-down time.
- Full Automation. Software/PLC controlled air volume, temperature and cycle time.
- Remote diagnostics capability and 3-level alarming.
- Automated washing of chambers, air filter and belt.
- Low chamber temperature enhances drying safety.
- Advanced thermodynamics reduces energy demands.
- Eliminates the needs for bag-houses, scrubbers or exhaust stacks.
- Re-circulating air stream reduces/ eliminates exhaust released to atmosphere.

FEW MOVING PARTS AND REDUCED MAINTENANCE.

FLEXIBLE DESIGNS FOR APPLICATIONS OF ANY SIZE

RAPID PRODUCTION & INSTALLATION

TECHNOLOGY BENEFITS

Gryphon's closed loop design re-circulates more than 90% of the air stream. In addition to unprecedented energy efficiency, air re-circulation controls odors and reduces or eliminates the need for air permitting.

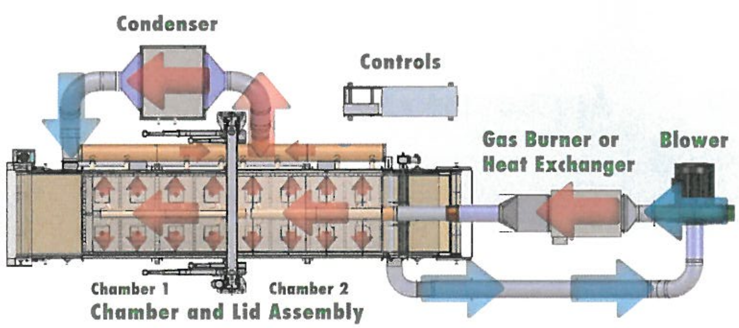
Heating of the air stream can be achieved by using the most economical energy source. Options include natural gas, biogas, waste heat, steam or electricity.

RE-CIRCULATING AIR STREAM

AIR

REDUCES THE DEMANDS OF AIR PERMITTING

- Lower capital costs
- Reduced power consumption
- Rapid lead time
- Quick and simple installation
- Less ancillary equipment
- Reduced solids handling
- Class A, EQ validation and trend monitoring
- Potential tax incentives



Energy Trust of Oregon
Production Efficiency Program

MAINTENANCE

Fewer moving parts means lower maintenance costs and maximum safety. Dryers are engineered for accessibility and built with standard off-the-shelf motors, pumps, drives, controls and instrumentation.

The innovative design ensures ease of maintenance, increases reliability and maximizes up-time.

MAINTENANCE MADE EASY

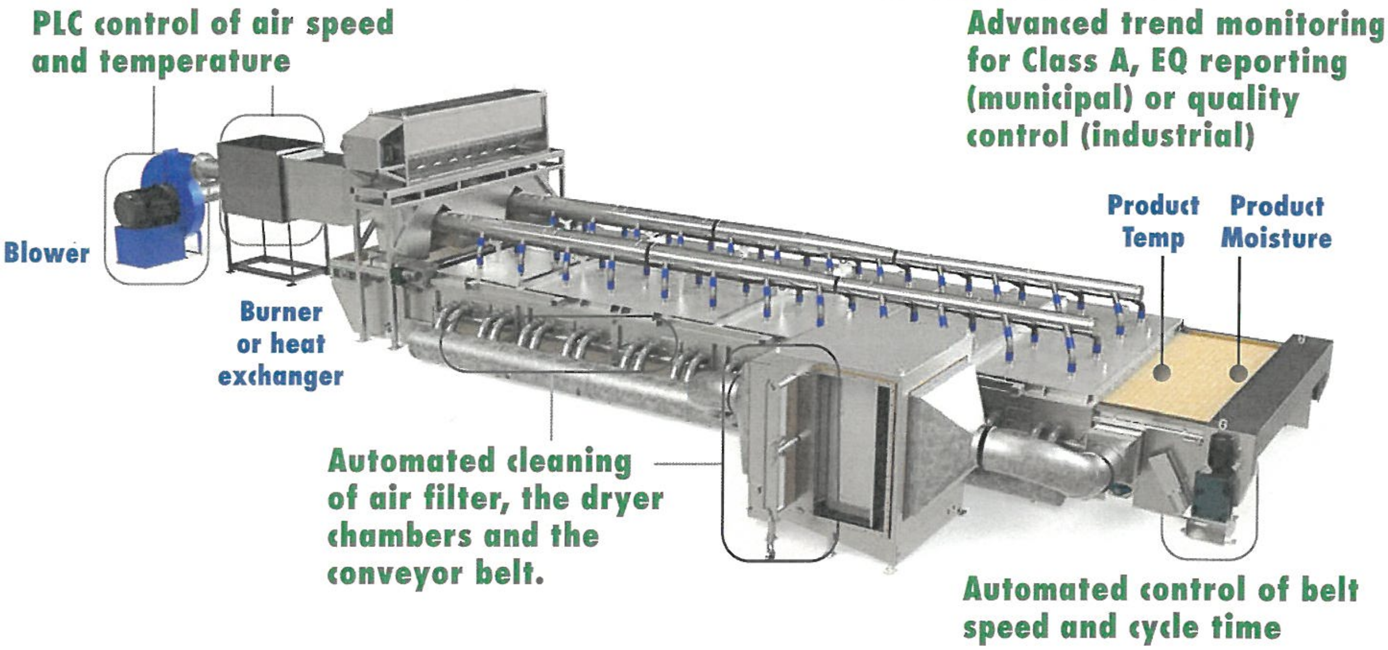
... system allows full access.

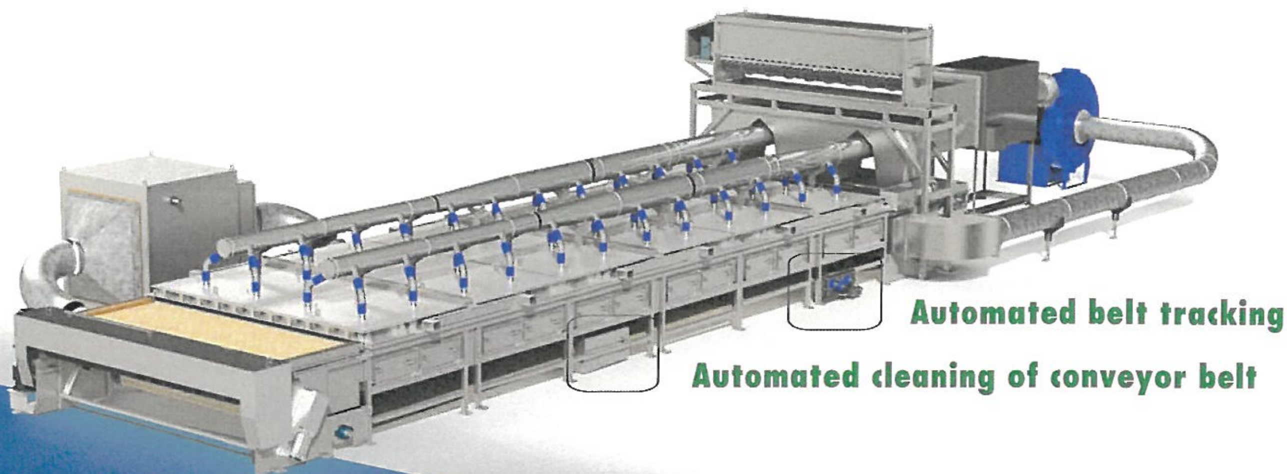
Roll-in, roll-out condenser coil and filter.

Biosolids Dryer

- City of Cottage Grove (Sewer District)
Technical Analysis Study (TAS)

COMPREHENSIVE TREND MONITORING





While advanced PLC software actively monitors and adjusts the drying process in real-time to maintain Class A, EQ bio-solids quality, trend monitoring software also records all critical process variables for complete historical data compliance. Gryphon's triple redundancy approach ensures simplified, worry-free reporting to satisfy US EPA 503 requirements and other regulatory demands.

First method: Specialized sensors measure moisture content of the dried material as discharged from the dryer. Historical data is automatically recorded and available for reporting.

Second method: Temperature sensors measure the dried material at multiple intervals as discharged from the dryer. In addition to moisture content, temperature data serves as a redundant verification that Class A, EQ requirements are met.

Third method: Measurement and recording of product residence time, along with process air mass flow and temperature, provides a third verification of time versus temperature exposure.

Gryphon Environmental, LLC
2920 Fairview Drive, Owensboro, KY 42303
www.2gryphon.com info@2gryphon.com (270) 485-2680

Re: Operations' Runtime

Erich Schroeder <wwsuper@cottagegrove.org>

Mon 2/11/2019 12:05 PM

To: Gretchen Joyce - RHT Energy <Gretchen@rhtenergy.com>;

Gretchen, the summertime is the same amount as the winter since we produce about the same amount of solids...Erich

On Mon, Feb 11, 2019 at 11:26 AM Gretchen Joyce - RHT Energy <Gretchen@rhtenergy.com> wrote:

> Hi Erich,
>
> I need to get a sense of the seasonal operation in the plant. Based on the information you provided, the summertime influent rate is approximately 1 MGPD and wintertime is 3 MGPD.
>
> Since we're data logging during the winter months, I will make assumptions for the summertime operations. Would you say the unit operations, e.g., digesters, polymerization system, etc., work 3x as much in the winter as they do in the summer? If the summertime hours aren't reduced by 1/3, can you provide me with an idea how much the equipment runs in the summer compared to the winter?
>
> Thanks,
>
> **Gretchen Joyce**
>
> *Energy Analyst*
>
> *Production Efficiency*
>
> Working with Energy Trust of Oregon
>
> RHT Energy
>
> Program Delivery Contractor
>
> 1215 Stowe Ave., Medford, Oregon 97501
>
> 541.770.5884 OFFICE
>
> 541.414.8421 CELL
>
> energytrust.org

HEARD FARMS PAYMENTS

Date	Invoice No	Check Number	Amount
2/1/2018	11941	113755	$6,223.04
3/1/2018	11979	113909	$4,567.88
4/2/2018	12021	114166	$3,701.93
5/1/2018	12061	114363	$4,767.03
6/1/2018	12107	114592	$2,203.41
7/2/2018	12153	114858	$2,878.32
8/1/2018	12198	115118	$2,057.88
9/4/2018	12240	115424	$6,014.89
10/3/2018	12302	115628	$2,932.47
11/1/2018	12333	115838	$2,810.58
12/3/2018	12374	116100	$1,051.34
1/2/2019	12417	116283	$5,658.91
2/1/2019	12467		$8,375.30
		Average Annual Cost: $47,020	**$53,242.98**

Transportation cost summary from City of Cottage Grove SD to Heard Farms for solids removal.

Fw: Gryphon Dryer Budget Estimates - Sludge Drying

Gretchen Joyce - RHT Energy

Fri 2/22/2019 4:14 PM

To: Gretchen Joyce - RHT Energy <Gretchen@rhtenergy.com>;

Gretchen,

Here is the information from Gryphon that you requested for the 520U dryer unit under consideration for Cottage Grove WWTP.

Burner, 10 to 1 turndown, **0.833 MMBTU steady state operation rate,** 2.5 MMBTU Max. – Air Temp leaving burner 350 – 375 degree F

Insulation is certified for placement on surfaces with temperatures up to 450 degree F and not to exceed 140 degrees F at outer surface of insulation.

I am available to discuss any questions.

Kind regards,

JIM COSKEY
JBI Water & Wastewater Equipment
Philomath, OR

Cell: 541 609 1367
jimcoskey@jbiwater.com
www.jbiwater.com

From: jimcoskey@jbiwater.com <jimcoskey@jbiwater.com>
Sent: Tuesday, January 22, 2019 4:11 PM
To: 'Gretchen Joyce - RHT Energy' <Gretchen@rhtenergy.com>
Subject: RE: Gryphon Dryer Budget Estimates - Sludge Drying

Gretchen,

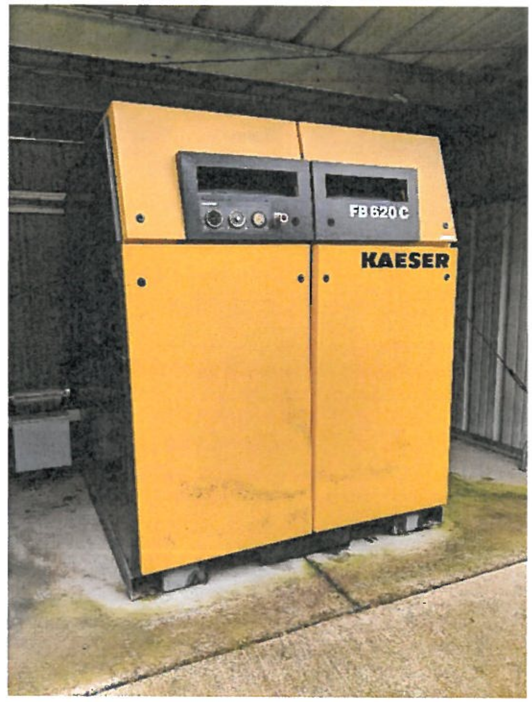
Thanks for the clarification and additional information, shared today during our call. I contacted Gryphon after the call and we will try to have the requested information back to you on Thursday.

Kind regards,

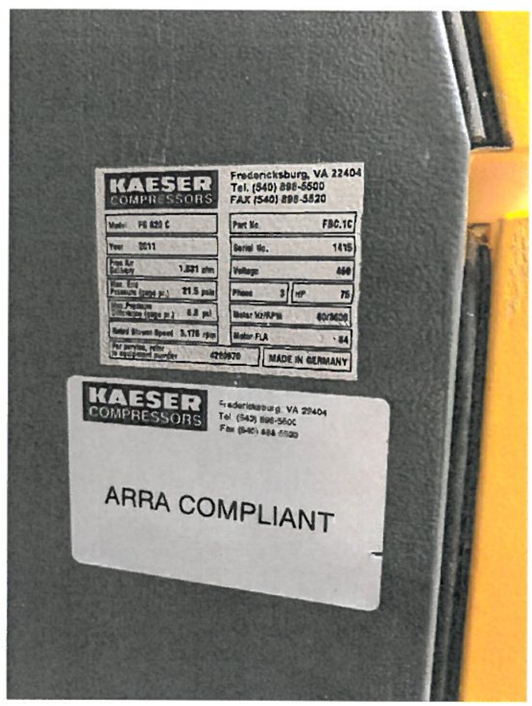
JIM COSKEY
JBI Water & Wastewater Equipment
Philomath, OR

Cell: 541 609 1367
jimcoskey@jbiwater.com

G. Photographs



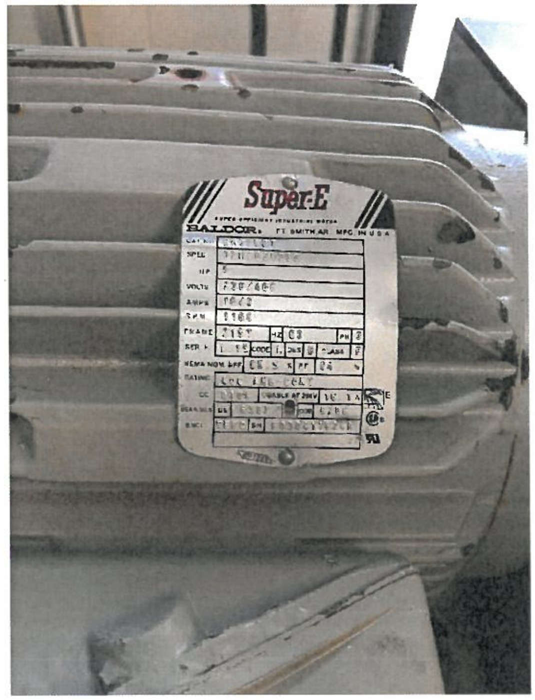
Blowers #1 and #2



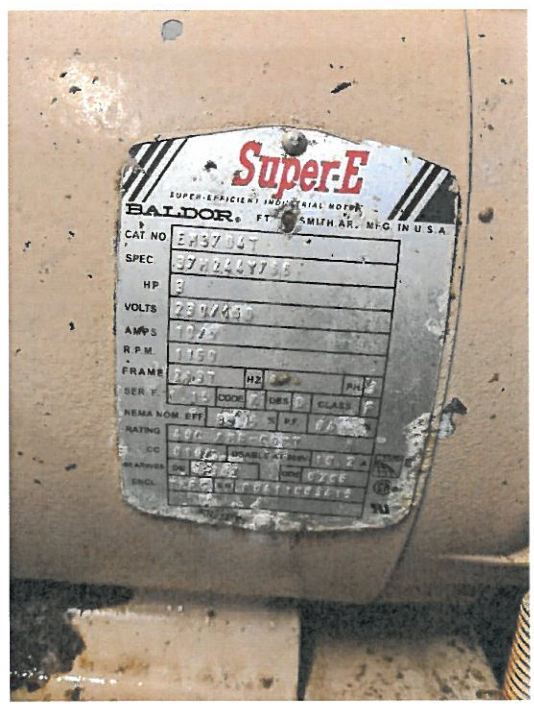
Nameplates for Blowers #1 and #2

Waste Activated Sludge (WAS) Pump and Nameplate

Polymerization System (1 of 2) and Motor Nameplate



Auger (Screw Press) and Motor Nameplate



Total Waste Activated Sludge (TWAS) Pump and Nameplate