

Technical Memorandum

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Technical Memorandum

Subject:	Class A Biosolids Technology Evaluation
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Limitations:

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Section 1: Introduction

The purpose of this technical memorandum (TM) is to document the supporting materials and results of the Class A biosolids technology evaluation prepared for King County (County). This TM was developed to assist the County in preparing their response to Council Proviso 2019-0148.P3 Version 2. The proviso calls for the identification of Class A alternatives to the current Class B biosolids application in forest and farm environments. The County is interested in diversifying the biosolids products to increase resiliency. This evaluation built upon the King County Treatment Plant Flows and Loadings Study. The previous evaluation identified and screened solids treatment technologies for each of the County's three regional treatment plants. Other earlier studies conducted for the County on Class A biosolids treatment alternatives were also used as background materials for this study.

This TM documents the following subtasks performed for this evaluation:

- Class A technology screening
- Overview descriptions of the short-listed technologies, including a more detailed description of the gasification/pyrolysis technology
- Development of biosolids treatment and reuse scenarios
- Conceptual modeling of each scenario to evaluate solids production, energy usage, and greenhouse gas (GHG) emissions.
- Development of conceptual capital and operating and maintenance (O&M) cost estimates
- Evaluation of the scenarios based on triple bottom line (TBL) criteria.

Preliminary results of the TBL evaluation were discussed in a review workshop with the County. This TM incorporates feedback from the County received at that workshop.

Section 2: Technology Screening

The first task for this study was to pre-screen potential Class A technologies to identify those that could produce a Class A biosolids product. The approach used was to first synthesize previous studies on biosolids processing technologies and perform an initial screening for Class A technologies; this resulted in a comprehensive list of relevant Class A technologies. Screening criteria were developed to further reduce the selection of Class A technologies to those potentially suitable for County biosolids management.

The following documents were used as references:

- King County Treatment Plant Flows and Loadings Study King County Biosolids Strategic Plan 2016 2037
- King County 2005 Class A Biosolids Workplan

The draft biosolids technology evaluation from the King County Treatment Plant Flows and Loadings Study, was used as the starting point for this evaluation with some modifications as described in the following sections below.



2.1 Biosolids Technology Screening Criteria

Four categories of screening criteria were developed and include:

- Technology maturity
- Improved process
- Resource recovery
- Environmental impacts

Details of each category are described below.

2.1.1 Technology Maturity

Technology maturity relates to the state of development and implementation of a given technology and is directly related to the risk/reliability of its adoption. The use of non-established technologies typically has a high degree of risk related to failure in the successful application of the technology and in meeting the required performance. Given these risks, non-established technologies were screened from the evaluation.

The implementation of international technologies in the U.S. poses challenges that are related to differences in regulations, materials and feedstocks, design standards, and market drivers. International technologies require adaption to U.S. standards and environment, which generally correlates to additional costs. A steeper learning curve may also result from being the first/early adopter of international technologies. Due to the increase in the risk of failure in meeting performance, international technologies that have no U.S. implementations were screened from the evaluation.

This analysis is based on the most current available information. The technology market for biosolids is constantly changing and adapting to new technology developments, maturation of technologies, and the discontinuation of others. Reassessing current non-established and non-U.S. implemented technologies in the future may result in these technologies advancing for further consideration. The three tiers of technology maturity used in this evaluation include:

- **Established:** This tier represents technology that has been well-established in the industry for solids processing applications; these technologies have broad usages with long records of performance.
- Non-established: This tier represents technologies that fall within the two following categories:
 - Embryonic: This first tier represents technology in its early development state or that has been demonstrated at bench or small pilot scales in a laboratory environment. In some cases, an embryonic technology may be proven at full scale with a different feedstock, but not with wastewater sludge. It may be in operation at one or two full-scale plants for a short duration but has not achieved a long-term proven status; therefore, technologies deemed embryonic were eliminated from further consideration.
 - Innovative: Innovative technology is commercially viable and has been proven at full scale in one or more installations. Innovative technologies have a shorter track record of reliable operation than established technologies (e.g., typically less than 5 years).
- U.S. Implementation: Many wastewater technologies have a global presence and the exchange of technologies internationally is common practice. When foreign technologies established in other markets enter the U.S. market, critical technical challenges can arise as well as issues with navigating and receiving approval from U.S. regulatory agencies. This presents a potential risk that can have negative and costly consequences for implementation.

2.1.2 Improved Processes and Existing Technology Enhancement

Improved processes and existing technology enhancement are summarized as follows:

- Improved processes: Technologies categorized as improved processes include those that will improve current solids treatment performance. For example, improvements can include increased process efficiency, increased digester gas production, reduced power and polymer consumption, resource recovery, improved biosolids product quality, and a reduced required quantity of solids. Current solids treatment technologies at each WWTP have been proven acceptable under current conditions and are designated as the baseline case (existing) scenario technology. Any technology that will likely degrade performance from the baseline case was eliminated from further consideration.
- Existing technology enhancement: Technologies in this category are optimization strategies that can improve overall process performance while using existing infrastructure. These require minor infrastructure modifications or minor new component additions without adding major new process tankage.

2.1.3 Resource Recovery

Resource recovery relates to the beneficial use of biosolids and digester gas:

- Class A biosolids: This comprises technologies that produce Class A biosolids with one of U.S. Environmental Protection Agency's (EPA) Process to Significantly Reduce Pathogens processes or that have achieved Class A equivalency. This does not include technologies that can potentially produce biosolids products meeting Class A requirements but require site-specific equivalency determination and/or daily pathogen monitoring/reporting to prove compliance on each biosolids batch.
- New biosolids product: These technologies produce biosolids products other than dewatered Class B cake, which is currently produced at the County's WWTPs.
- More gas production: These technologies increase digester gas production over conventional mesophilic digestion. All major County plants currently produce and beneficially use digester gas. Increased digester gas production can be achieved by digester pretreatment and/or advanced digestion processes. Technologies that reduce or eliminate gas production were eliminated from further consideration.

2.1.4 Environmental Impacts

Environmental impacts include the impact on GHG emissions from the solids treatment processes. GHG emissions reductions can be achieved by reducing power and chemical consumption, increasing digester gas production, increasing or providing a higher level of beneficial use for digester gas, or reducing vehicle fuel consumption. BC eliminated technologies that significantly increase GHG emissions from further consideration.

2.2 Biosolids Technology Screening Results

The criteria established in **Section 2.1** were used to perform a technology screening. **Table 1** shows the preliminary technology screening results. This screening table originated from work completed for the King County Treatment Plant Flows and Loadings Study and was adapted for this study as described below. Technologies with acceptable maturity (or will have beneficial impacts over existing processes) were given a "✓" mark on that criterion. Technologies with detrimental impacts (as described above) are given an "X" mark on that criterion. Table cells were left blank where the technology was neutral or not applicable with respect to the criterion. Any technology with an "X" in any criterion was eliminated from further evaluation and shown as shaded cells in **Table 1** below.

	Table 1. Class A Technology S	creeni	ng						
	Solids Processing Technologies								
		Technology Improve		Improved Process					Environmental Impacts
Parameter	Technology	Established	U.S. Installations	Improved Process	Existing Enhancements	Class A Biosolids	New Biosolids Product	More Gas Production	GHG Emissions Reduction
	Conventional Mesophilic Anaerobic Digestion (CMAD) (baseline case South Plant, West Point, Brightwater)	~	~			x			
	Conventional TAD or TPAD with Batch Tanks	1	✓	✓	✓	~	✓	✓	✓
Anaerobic	Acid/Gas Anaerobic Digestion (AGAD)	1	✓	1		X		✓	✓
Digestion	Post Aerobic Digestion (PAD)	X	✓	×		X			X
	Dual digestion (ATAD plus thermophilic anaerobic)	1	✓	X	X	✓	✓	X	X
	Recuperative thickening (e.g., OMNIVORE™)	X	✓	×	✓	Х			
	Thermal hydrolysis (Cambi)	×	✓	√		✓	✓	✓	
	Thermal hydrolysis (Biothelys™, Exelys™, LysoTherm®, Haarslev™)	X	X	✓		✓	✓		
	Thermal-chemical hydrolysis (PONDUS)	X	 Image: A second s	✓		X		<	
Digestion Pretreatment	Enzymatic hydrolysis (Monsal)	X	X	✓		X		✓	✓
Tretreatment	Mechanical (Crown)	X	X	✓		X		✓	
	Ultrasonic (sonix™, Sonolyzer®)	X	X	~		X		✓	
	Electrokinetic (BioCrack)	X	X	✓		X		✓	
	Alkaline stabilization	×	~	X		✓	✓	X	X
	Incineration with power generation	×	~	X		X		X	X
Other	Compositing (raw sludge)	×	 Image: A second s	X		✓	✓	X	X
Stabilization	Thermal drying (raw sludge)	×	 Image: A second s	X		√	✓	X	X
Technologies	Gasification/pyrolysis	X	 Image: A second s			_2	✓	X	_3
	Hydrothermal oxidation (AquaCritox®)	X	X				✓	X	1
	Hydrothermal liquefaction-gasification (Genifuel Corporation)	X	X				✓	X	1
	Thermal drying	1	×	X		×	✓	X	X
Product	Solar Drying	 Image: A second s	 Image: A second s	<mark>X</mark> 1		✓	✓		
Enhancement Post-Digestion	Thermal-chemical hydrolysis (Lystek)	X	×	X		✓	✓		
and Dewatering	Composting	1	√	✓		×	✓		
	Soil blending, Post Class A Digestion	×	√	✓		✓	✓		

¹ Solar drying is only feasible in eastern Washington due to the lower solar radiation of the region. Auxiliary heating in terms of natural gas would be needed to supplement drying requirements.

² The Washington Department of Ecology (Ecology) does not have a policy that covers pyrolysis and will require a review of Class A designation for these systems on a case by case bases.

³ Some gasification and pyrolysis systems can become energy neutral or positive based on the dry solids content of the dewatered cake entering the system. The Bioforcetech system evaluated was paired with a belt dryer rather than a biodryer based on the manufacturer's recommendation. This pairing resulted in the system requiring external energy input.

Several changes were made to the draft biosolids technology evaluation prepared during theKing County Treatment Plant Flows and Loadings Study and are noted below:

- 1. Added Class A solar drying to the list based on its inclusion in the evaluation from the KC Strategic Plan 2018-2037
- 2. TAD and TPAD alternatives were combined with batch tanks as one alternative.
- 3. The ATAD component of Dual Digestion does not produce gas and requires significant additional energy to digest. TAD/TPAD with batch tanks represents a better alternative for enhanced Class A digestion for County plants.
- 4. Cambi thermal hydrolysis process (THP) is the only THP technology with a U.S. Installation. Cambi will be the representative technology for THP.
- 5. Class A Biosolids was updated to be a screening criterion
- 6. U.S. Installations was added as a screening criterion
- 7. PAD was updated with an X for GHG due to energy use for aeration
- 8. Thermal drying was updated with an X for improved process due to increase in energy use
- Thermal-Chemical Hydrolysis (Lystek) was updated with an X for improved process due to the creation of a liquid product that would require additional trucking and application, not consistent with County product goals
- 10. Off-site and on-site designations were removed to be more generic for soil blending and composting

A short-list of the technologies remaining after this screening process is shown in **Table 2**. All technologies that received negative marks in any criterion were removed from further consideration. Pyrolysis did not meet the specified criteria for screening but was included in the evaluation due to interest from the County Council.

	Table 2. Class A Technology	Short L	ist							
	Solids Processing Technologies									
			ology ation	Improved Process	Resource Recovery		very	Environmental Impacts		
Parameter	Technology	Established	U.S. Installations	Improved Process	Existing Enhancements	Class A Biosolids	New Biosolids Product	More Gas Production	GHG Emissions Reduction	
Anaerobic Digestion	Conventional Mesophilic Anaerobic Digestion (CMAD) (baseline case South Plant, West Point, Brightwater)	✓	~			x				
	Conventional TAD or TPAD with Batch Tanks	√	×	 ✓ 	✓	1	×	1	✓	
Digestion Pretreatment	Thermal hydrolysis (Cambi)	√	1	 ✓ 		×	 Image: A start of the start of			
Other Stabilization Technologies	Gasification/pyrolysis	X	~			_1	~	x	2	
Product Enhancement Post-	Composting	√	 Image: A second s	 ✓ 		 Image: A start of the start of	 Image: A start of the start of			
Digestion and Dewatering	Soil blending, Post Class A Digestion	✓	×	✓		 Image: A start of the start of	√			

¹ Ecology does not have a policy that covers pyrolysis and will require a review of Class A designation for these systems on a case by case bases.

² Some gasification and pyrolysis systems can become energy neutral or positive based on the dry solids content of the dewatered cake entering the system. The Bioforcetech system evaluated was paired with a belt dryer rather than a biodryer based on the manufacturer's recommendation. This pairing resulted in the system requiring external energy input.



Section 3: Biosolids Technologies

This section provides a brief overview of the short-listed technologies. A longer discussion on pyrolysis technologies is included and covers the status of the technology and the biochar market. This discussion was not included in the previous evaluation under Task 450 as it had not passed the technology screening.

3.1 Anaerobic Digestion

3.1.1 Mesophilic Anaerobic Digestion

Mesophilic anaerobic digestion (MAD) is the most commonly used anaerobic digestion process in the U.S. Mesophilic digesters are operated within the mesophilic temperature range, 95 to 102 degrees Fahrenheit (°F), at solids retention times (SRTs) exceeding 15 days. Typically, loading criteria range from 100 to 160 pounds of volatile solids (Ib-VS) per 1,000 cubic feet (ft³) per day (d) with limiting loadings rates of 200 Ib-VS/1,000 ft³/d. The process produces substantial methane-rich digester gas that has high thermal value and is commonly used as a renewable fuel.

Mesophilic digestion produces a Class B biosolids as defined by the U.S. Environmental Protection Agency's (USEPA) Part 503 regulations and is suitable for most large-scale agricultural, forest, and mine reclamation applications. Class B biosolids have some application restrictions to protect public health and safety.

3.1.2 Thermophilic Anaerobic Digestion

Thermophilic anaerobic digestion (TAD) occurs at temperatures between 120 and 135 °F, at conditions suitable for thermophilic microorganisms. Biochemical reactions increase with temperature; therefore, microbial reactions in TAD are much faster than mesophilic digestion. The advantages of TAD include increased solids destruction capability, improved dewatering, increased gas production, and increased pathogen destruction. Because of the increased biochemical reaction rate, loadings to a TAD have been reported as high as 500 lb-VS/1,000-ft³/d, significantly higher than those of MAD.

Disadvantages of TAD include higher energy requirements for heating, poorer supernatant quality, and higher dewatering odor requiring treatment. In addition, thermophilic dewatered cake has slightly higher initial end product odor due to higher ammonia that dissipates relatively quickly. Higher solids destruction rates in a thermophilic digester release greater concentrations of ammonia which contributes to the poorer supernatant quality, potentially impacting the plant's liquids steam processes. TAD also requires additional heat exchangers and heat resources relative to MAD to heat the digester to higher temperatures; however, heat recovery systems can greatly reduce heating costs. **Figure 1** is a photograph of the TAD operated by Metro Vancouver at the Annacis Island Wastewater Treatment Plant (WWTP) in Delta, British Columbia.



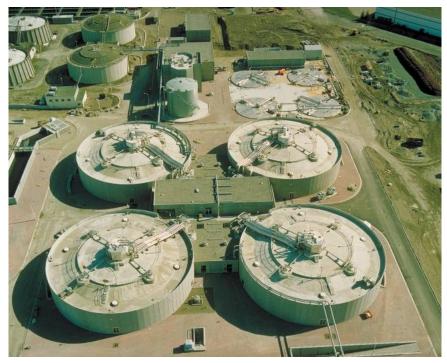


Figure 1. Thermophilic anaerobic digesters at Annacis Island WWTP

If properly configured, TAD can produce Class A biosolids. To prevent the potential for short-circuiting and increased pathogen levels above the Class A criterion in the biosolids, batch tanks are often used. The wastewater solids are held in a batch tank for a set period of time (24 hours hold time required for Class A at 131°F) to prevent the opportunity for any solids to pass through the entire digestion process in a shorter time period than required (i.e., short-circuiting the process). To meet USEPA requirements for Class A biosolids, separate batch tanks (or batch operation of the digesters) would need to be included with a TAD process. Without batch operation, the biosolids from the TAD process operated at higher temperatures and configured properly can potentially produce biosolids that meet Class A requirements for pathogen reduction, but would require testing of each biosolids batch.

3.1.3 Temperature-Phased Anaerobic Digestion

Temperature-phased anaerobic digestion (TPAD) incorporates the advantages of TAD and mitigates some of the disadvantages through the incorporation of MAD to improve performance. TPAD uses digesters in series, where the first stage is thermophilic followed by a mesophilic stage. The high biochemical reaction rate in the thermophilic phase improves solids destruction capability, improves dewaterability of the sludge, increases gas production, and increases pathogen destruction rates. The following mesophilic stage(s) improves the performance of the overall digestion system and helps mitigate the disadvantages of TAD (specifically, poorer supernatant quality and odors). The higher temperature of the thermophilic stage and configuration's ability to minimize short-circuiting contributes to greater pathogen destruction. As with TAD, TPAD can be configured with batch tanks to produce Class A biosolids. Also similar to TAD, a greater number of heat exchangers and heat resources are required to heat the wastewater solids to thermophilic temperatures and then cool the solids to mesophilic temperatures. **Figure 2** is a photograph of the TPAD system at Western Lake Superior Sanitary District's WWTP in Duluth, Minnesota.



Figure 2. TPAD at Western Lake Superior Sanitary District WWTP

3.2 Digestion Pretreatment

3.2.1 Thermal Hydrolysis Process (THP)

Class A THP is a mature technology in Europe and worldwide with full-scale facilities in service since 1995; the first installation in the U.S. (Blue Plains plant in Washington, DC) has been operating since late 2014 and other U.S. installations are in the planning, design, and construction phases. THP is a pretreatment process prior to anaerobic digestion. There are two primary manufacturers of Class A THP – Cambi and Veolia. Class A THP uses medium-pressure steam to create high temperature and pressure conditions, which lyse (break open) bacterial cells and promote the release and solubilization of particulate organic material, making the feed solids more amenable to digestion. **Figure 3** depicts a typical process flow of the Cambi Class A THP system for pretreatment of wastewater solids before digestion.

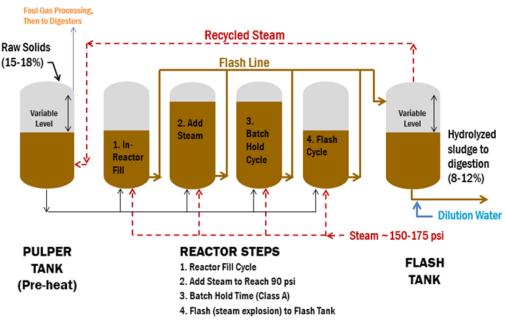


Figure 3. Cambi thermal hydrolysis process

THP systems can approximately double conventional MAD organic loading rates because of the modified characteristic of the feedstocks. This more efficient use of digester volume reduces the number of digesters required. Ancillary buildings and equipment are required to operate a THP system, including steam boilers, solids screening, pre-dewatering, raw cake storage and pumping, and solids dilution and cooling systems. While THP systems can reduce the required digester volume, the ancillary systems impact total system cost, complexity, and footprint.

The vast majority of Class A THP systems have been implemented by Cambi. However, competitor THP systems (Biothelys[™], Exelys[™], LysoTherm[®], Haarslev[™]) have been installed in Europe, and Veolia's Biothelys system has been installed in the United Kingdom. Due to the lack of U.S. installations from THP manufacturers, this evaluation will use Cambi's THP system as the representative technology for THP systems alternatives.

3.3 Product Enhancement Post-Digestion and Dewatering

3.3.1 Composting

Composting is the most common method used to produce Class A biosolids in the U.S. To meet the criteria for Class A, composted biosolids must meet regulated metals, pathogen and vector attraction reduction limits, comply with required sampling and analysis protocols, maintain compost temperature and retention time records, and meet product labeling requirements.

Digested biosolids dewatered cake can be composted with sawdust, wood chips, yard clippings, storm debris, food waste, manure or crop residues, and food processing wastes. The final composted product provides nutrients and organic matter and sequesters carbon, thereby conserving resources, restoring soils, and combating climate change. Additionally, composting has been a long used process to reduce environmental contamintants. Research and composting applications have shown that aerobic composting can be effective at reducing antimicrobial resistant genes/bacteria and organic pollutants (Semple et al., 2001; Youngquist et al., 2016; Ozaki et al., 2017).

Composted biosolids are used in agriculture, horticulture, and landscaping just like any other retail soil product. Professional landscapers and master gardeners use composted biosolids for landscaping new homes and businesses. Home gardeners also find composted biosolids to be an excellent alternative to typical fertilizer.

Many composting technologies are available in the market and can vary from low-tech with limited process control to high-tech with precise process control. Many of these technologies can improve the composting process by providing better control of environmental factors, aeration rates, temperature, etc. In-vessel composting is one such method that uses silos, structures, plastic material, or other physical barriers to improve the composting process. Generally, these technologies provide the best composting process with the most efficient use of space and overall best product quality. Windrow composting is the most simplistic and widely used composting method. Windrow composting uses long rows and short piles of mixed biosolids and organic material that are mechanically aerated with a front-end loader or a windrow turner. This method is typically less controlled, uses a significant amount of space, and requires greater manual labor. Aerated static pile (ASP) composting is a high-rate composting method that sits between windrow and in-vessel composting. It is more compact and can be covered or uncovered. Piles or windrows are placed on top of porous bulking agents like wood chips with channels or pipes that provided negative or positive forced aeration through the piles while removing process water. ASPs are the second most widely used composting system and commonly used for biosolids composting.

3.3.2 Soil Blending and Manufactured Soils

Soil blending can be used to improve overall product quality or to change the product characteristics by blending biosolids with other organic and inorganic materials. However, the feedstock to any soil blending operation must be a Class A biosolids cake. These manufactured soils can be formulated to provide specific characteristics for unique applications and to reach a wider market through product diversification. Soil blended products can be publicly distributed in bag or bulk form. Generally, public reception of blended products tends to be positive due to similarities with existing non-biosolids soil conditioning products and reduced odors. The City of Tacoma produces several blended products including their most popular product, TAGRO Classic, which is comprised of two parts Class A dewatered cake, two parts sawdust, and one-part sand. Other blended products that are offered include mulch products that contain 80 percent woodchips and 20 percent biosolids and a potting soil mix of 20 percent biosolids, 20 percent maple sawdust, and 60 percent clean, aged bark. TAGRO has been largely successful with their blended products with demand often exceeding supply.

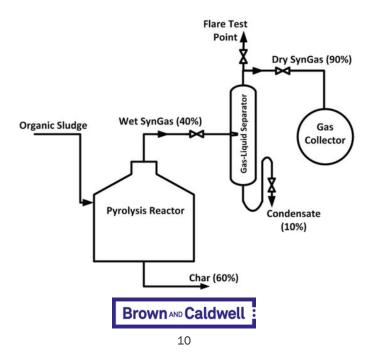
3.4 Other Stabilization Technologies

3.4.1 Gasification and Pyrolysis

Gasification and pyrolysis are technologies that have been widely used in other industries, principally using wood waste as a carbon source, but with very limited applications in the wastewater/biosolids industry. The following sections provide a description of the technologies and a discussion of the status of their development.

3.4.1.1 Technology Description

Pyrolysis is the thermal decomposition and partial mineralization of carbonaceous materials occurring in an anaerobic environment. Thermal decomposition typically occurs at temperatures in excess of 300°C. The anaerobic environment can promote the breakdown of carbon-rich feedstocks into an energetically favorable endpoint (e.g. methane) to generate a modest amount of combustible gas called syngas or pygas. The condensable fraction of the syngas can be stored and used as a liquid fuel and is often referred to as bio-oil. The remaining solid residue is a high-value product called biochar. Biochar has a thermal value similar to coal, functions as an adsorbent like activated carbon, and can also be used as a soil conditioner to improve overall soil health. A basic configuration of a pyrolysis unit and its major components is provided below in **Figure 4**.

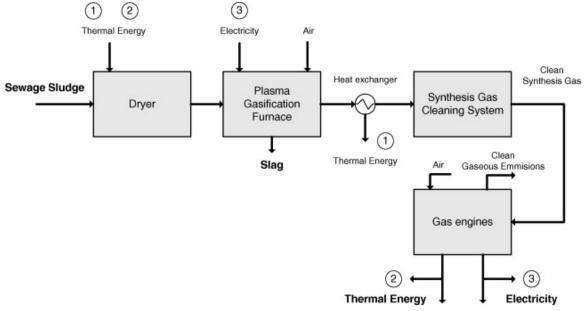


151084_Class A Biosolids Tech Eval TM_final_4-20-20

Figure 4. Basic configuration of a pyrolysis unit

The advantages of pyrolysis include residuals volume reduction, the potential for net energy production, carbon fixing into a stable form in biochar, and generation of a value-added product in biochar. In addition to the various end uses for biochar, research has also demonstrated the removal of contaminants of emerging concern such as triclosan and nonylphenol to non-detect levels during pyrolysis (Lee et al., 2018; Paz-Ferreiro et al., 2018; Ross et al., 2016). While pyrolysis itself can be energy positive, it requires prior biosolids drying to 60 to 90 percent total solids, requiring a substantial increase in energy input and representing a substantial additional investment in capital outlay and operational and maintenance costs for the biosolids dryer. As described further below, biochar management contracts are now commercially available at no cost to the generator with opportunities for revenue sharing.

Pyrolysis is often linked with gasification, which is another thermal process that combines the thermal decomposition step of pyrolysis with a controlled oxidation zone where limited air, oxygen, or steam is added to partially oxidize the volatilized organics. In gasification, the oxidation zone is consequently followed by a reductive zone where further cracking and reforming of the gases takes place to produce a syngas made up of lighter hydrocarbons compared to that of pyrolysis, with a smaller condensable fraction. While the condensable fraction of pygas has an energetic value and has been successfully processed into a usable liquid fuel with various feedstocks, it is highly acidic and unstable when heated making it difficult to handle. A basic configuration of a gasification unit and its major components is provided below in **Figure 5**.





3.4.1.2 State of Technology

Applications of biosolids-based pyrolysis and gasification systems have been extremely limited due to the high technical risks, large capital cost, and the additional research and process adaption that is required when transferring technologies from other industries. The non-homogenous characteristics of biosolids, which can fluctuate in the amount of organic and inorganic content, can result in operational challenges. These challenges include impacts to the energy balance of the system requiring external natural gas or the addition of wood feedstocks to prevent interruption in the pyrolysis process. These conditions could dramatically increase operational costs and reduce the overall reliability of the system. The variations in the characteristics of biosolids may also change final product quality and increase the corrosion of the systems



which would require additional maintenance. These factors can impact the long-term success of programs and can result in failure which is further discussed in **Section 3.4.1.6**.

Only three biosolids pyrolysis/gasification facilities are operational in the U.S. with the largest facility processing 7,000 wet tons per year. This facility represents only 6 percent of the biosolids produced from the County's biosolids management program. This is out of a total of 33 U.S. gasification and pyrolysis facilities, where the other 30 plants process other feedstocks such as wood waste into syngas and biochar The limited number of facilities suggests that the technology remains an emerging technology with needs for a longer operation history, more research, and additional installations.

Table 3 below lists identified projects currently in operation, taken out of service, or are under planning, design, or construction.

Table 3. Biosolids Pyrolysis and Gasification Projects										
Company	Facility	Location	Feedstock	Туре	Scale	Status	Biosolids Capacity (WT/Yr)			
Aries Clean Energy	Linden Roselle Sewerage Authority complex	Linden, New Jersey	Biosolids	Gasification/ Pyrolysis	Full-scale	Q4 2020	130,000			
Aries Clean Energy	Lebanon Waste-to- Energy Plant	Lebanon, Tennessee	Woodwaste and biosolids	Gasification/ Pyrolysis	Full-scale	2016 - present	1,095			
Aries Clean Energy	City of Covington	Covington, Tennessee	Woodwaste and biosolids	Gasification/ Pyrolysis	Full-scale	2014 - present	730			
Aries Clean Energy	Aries-Holloway Bioenergy Facility	Lost Hills, California	Agricultural biomass	Gasification/ Pyrolysis	Full-scale	Q3 2021	60,225			
Max West	Sanford Utility Department	Sanford, Florida	Biosolids	Gasification/ Pyrolysis	Full-scale	2009-2014 decommissioned	14235			
Bioforcetech	Silicon Valley Clean Water	Redwood City, California	Biosolids	Pyrolysis	Full-scale	2017 - present	7000			
Bioforcetech	Edmonds Wastewater Treatment plant	Edmonds, Washington	Biosolids	Pyrolysis	Full-scale	2021	-			
Anaergia	Rialto Bioenergy Facility	San Bernardino, California	Biosolids and foodwaste (70%)	Pyrolysis	Full-scale	2020	109,500			
Anaergia	Encina Wastewater Authority	Carlsbad, California	Biosolids	Pyrolysis	Pilot/ demonstration	2014	-			
KORE Infrastructure	LACSD joint Water Pollution Control Plant	Carson, California	Biosolids	Pyrolysis	Pilot/ demonstration	2008-2015	1000			

The chemical, material, and energy industries have shown a growing demand for investments in pyrolysis and gasification plants as a means for the development of alternative fuels and carbon products. Approximately 272 gasification plants are in operation worldwide and 74 additional plants are under construction based on a 2014 update of the gasification facilities database by Global Syngas Technologies Council. According to some research studies, the global market for biochar is expected to increase to the range of \$653M-\$3,100M by 2027 (TechSci Research, 2019; Research Nester, 2018). The largest growth in pyrolysis/gasification applications can be seen in the use of agriculture waste, biomass, organics, plastic/tire, and coal to produce renewable natural gas production, biochar, and bio-oil. Recent bans in international recycling outlets for plastics has also seen an increase in investment in plastics-to-oil solutions. In the last decade, the aviation industry has begun a campaign to decarbonize air travel by using sources for renewable aviation fuel (IRENA, 2017). All of these market drivers have spurred the rapid development of the pyrolysis and gasification industry.

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3.4.1.3 European and International Applications

The adoption of pyrolysis and gasification technologies in Europe has advanced more rapidly than the U.S. No other international applications could be found outside of Europe and the U.S. In Europe, the use of pyrolysis and gasification technologies has been limited to the energy, materials, and forestry industry. Similar to the U.S., there are limited applications of pyrolysis and gasification of biosolids. Less than a dozen facilities use biosolids as a feedstock and are primarily small scale facilities. Europe's application of biosolids pyrolysis and gasification can be classified as emerging and likely faces similar risks and regulatory development requirements as the U.S.

3.4.1.4 United States Applications

Gasification has been evaluated with different feedstocks over the past few decades and has faced a number of historical operational challenges including concerns for dioxin formation in oxygenated pockets, difficulty in scaling reactors, and deformation or slag formation from residual product within the reactor. The most recent example of full-scale biosolids gasification occurred at the Maxwest Sanford Florida facility that operated from 2009 to 2014. The system operated as a 20-dry ton per day regional biosolids receiving and processing facility; however, the system was never able to achieve the targeted operational efficiency or reliability and was decommissioned. The technology has since been sold to a new company, Aries Clean Energy, who successfully operates two full-scale gasifiers that run on a combined feedstock of wood waste and biosolids. These facilities process only a fraction of biosolids compared to wood-waste and more details can be seen in **Table 3**. Aries Clean Energy recently obtained funding and has started construction of a regional biosolids gasification facility in Linden, New Jersey.

Pyrolysis has been evaluated at a number of facilities at pilot scale, including Los Angeles, California by Kore Infrastructure and Encina, California by Anaergia. The first full-scale biosolids pyrolysis unit was commissioned in June 2017 at the Silicon Valley Clean Water Authority in Redwood, California. The unit was supplied by Bioforcetech, an Italy-based technology provider, and is capable of processing 1,300 pounds of dry biosolids product per hour. The unit was approved by EPA as a non-incineration process and permitted by the Bay Area Air Quality Management District as a process heater. Regulations for biosolids biochar are currently undefined. Washington state approval for a Class A biosolids product will be on a case by case basis until additional research or updates to regulations occur.

3.4.1.5 Biochar Market

In 2018, a survey of the U.S. biochar industry was conducted in North America. The survey was sent to both biochar producers and consumers (Draper et al., 2018). Out of an estimated 135 U.S. biochar producers, 61 producers (18 percent resellers) responded. These producers reported that their primary pyrolysis feedstock was woody biomass but could also include other organic materials such as manure, grass, agricultural waste, construction waste, fiber, and food waste. Data from the survey suggested that the annual production of biochar in the U.S. was 35,000 to 70,000 tons. End-uses for biochar were primarily in agricultural application, draining, cannabis production, and odor control. This is consistent with biochar potential uses in compost, soil amendment, gardening, livestock bedding, and land and water reclamation projects (Draper et al., 2018). The average price from all producers was \$129 per cubic yard or approximately \$763 per ton assuming a bulk density of 338 pounds per cubic yard.

The largest expected market growth for biochar is for crop application and then for use for water purification and filtration (Draper et al., 2018). In the Pacific Northwest region, several producers of biochar currently provide a variety of products.

Table 4 below summarizes biochar producers and prices in the Pacific Northwest.



Table 4. Summary of Biochar Producers in the Pacific Northwest									
Producer State Feedstock Product		Product	Bagged Price (\$/CY) ¹	Bulk Price (\$/CY) ¹	Bulk Price (\$/DT) ²				
Pacific Biochar	California/Oregon	Forestry Residues	Blacklite Mix #6	\$164	\$135	\$521			
Sonoma Biochar	California	Wood waste	Sonoma Biochar	\$470	\$240	\$1420			
Oregon Biochar Solutions	Oregon	Wood Waste Residues	Rogue Biochar	\$150	\$110	\$799			
Sunriver Biochar	Oregon	Wood	Sunriver Biochar	\$500	-	-			
Biochar Supreme	Washington	Forestry Residues	Black Owl Premium Biochar	\$1054	\$350	\$2071			
Olympic Biochar	Washington	Paper Mill Byproduct	Olympic Biochar	\$135	\$105	\$621			

¹ Prices reflect November 2019 values from respective websites.

² Assumes an average dry bulk density of 338 lbs per cubic yard.

Although biochar has a potentially high value, market studies have suggested that the demand for the product does not currently meet the supply. The high price of biochar is cost prohibited for wider adoption of the product by more general consumers such as conventional agriculture, home garden, lawn care, and commercial nurseries. The high price point of biochar in general agriculture would require unrealistic increases in crop productivity to break even with cost. Biochar is more likely to be used as a small faction additive to blended products for wider distribution.

The recent growth in biochar suppliers is likely reflective of early adopters who are positioning for potential future demand. This occurrence is typical in emerging markets. However, a search for biochar producers indicated that the market is still in its infancy. Approximately half of the producers documented in a 2015 survey are no longer in business.

Biosolids-based biochar has not been tested in the biochar market and its market acceptance is unknown. Considering that applications for biochar currently are in high value and niche products, biosolids biochar is unlikely to portray similar positive associations when compared to virgin wood-based biochar. Bioforcetech has suggested a price per ton in the range of \$250, which is approximately 15 to 25 percent of the market price for other biochar products. Biosolids biochar may find more success in mixed/blended products compared to pure products.

3.4.1.6 Risks and Challenges

Implementation of technologies with high capital requirements, limited applications, and advanced or complex processes presents a challenge of high technical and financial risk. A recent report from Waste Gasification and Pyrosis Technology Risk Assessment by the environmental-leaning company GAIA estimated that billions have been lost in the development of failed pyrolysis and gasification projects. The report cites \$2 billion lost from just four UK projects (GAIA, 2017). Failure of gasification and pyrolysis systems have largely been associated with restrictive capital costs, technical and system failures, and limitations in the market demand of end products.

Due to the slow traction and implementation of pyrolysis and gasification technologies, significant consolidation of independent and "start-up" companies has occurred over the last decade. This shift has seen larger companies purchasing and absorbing pyrolysis and gasification technologies to bolster their product lines. However, this change in the vendor market indicates that some companies have financial vulnerabilities and the precarious financial nature of startup companies in sustaining long-term operation. The acquisition of smaller pyrolysis and gasification companies by larger conglomerates does allow for a reduction in the risk of investing in new technologies which have the financial backing.

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Table 5 lists gasification and pyrolysis companies that have conducted business ventures in North Americain the past decade but have undergone bankruptcy or acquisition.

Table 5. Pyrolysis and Gasification Company Consolidation and Bankruptcy						
Company	Status					
MaxWest Environmental Systems	Declared Bankruptcy. Acquired by Aries Clean Energy					
Oneida Seven Generations Corp	Defunct					
Navitus Sustainable Industries	Defunct					
Lehigh Technologies	Acquired by Michelin					
GE Gasification Division	Acquired by Air Products					
U.S. Linc Energy Ltd	Declared Bankruptcy					
Solena Fuels	Declared Bankruptcy					
Lima Energy	Declared Bankruptcy					
KiOR (Inaeris Technologies)	Declared Bankruptcy					
Plasco Energy Group	Declared Bankruptcy, Acquired RMB Advisory					
RWE (Germany), Uhde,	Acquired ThyssenKrupp Uhde					
Carbon Resources Recovery GmbH	Acquired by Klean Industries					
Thermogenicx	Defunct					

3.4.2 Bioforcetech

Bioforcetech was founded in 2012 and is part of the is the Presezzi Extrusion Group based in Italy. Their first U.S.-based pyrolysis system came online in June 2017 at the Silicon Valley Clean Water Authority in Redwood, California.

Figure 6 below shows the biodryer and pyrolysis unit located in Silicon Valley. Bioforcetech has since supplied two biosolids pyrolysis units in Italy and is in the planning phase at the City of Edmonds, Washington for a pyrolysis system that is coupled with solids belt dryers to replace the city's incinerator. Their European partner PYREG GmbH, has 16 operating plants with two biosolids facilities in Europe. Because Bioforcetech is the only company currently using pyrolysis on biosolids alone in the U.S., it was selected as the representative pyrolysis technology for this study.

Their pyrolysis technology is a 24/7 autonomous system that operates at temperatures between 450 to 750°C. The pyrolysis process is coupled with a biodryer that uses biogenic heat to supplement the energy required for drying before pyrolysis. This allows for a low-energy and high-efficiency system that can potentially be energy self-sufficient. For the biodyer to work, it operates at a low capacity and may not suitable for all projects. Bioforcetech has partnered with Centrisys to offer a higher capacity compact low-temperature belt dryer. For this study, Bioforcetech recommended the use of the belt-dryer with the pyrolysis system.

The pyrolysis process works by first thermal drying the biosolids to greater than 70 percent dry solids through the use of a belt dryer. The dried biosolids are then fed to the pyrolysis unit where natural gas is used to start-up the process to reach the pyrolysis temperatures. The high temperatures volatilize the organic carbon to produce pygas. The pyrgas is combusted in a separate chamber and used to heat the outer casing of the reactor allowing the process to be self-sustained without natural gas at that point.

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Bioforcetech provides a variety of different contracts and funding options to utilities. Bioforcetech's implementation at Silicon Valley Clean Water Authority is currently though a 10-year biosolids management contract where Bioforcetech owns and operates the system. However, Bioforcetech now offers multiple pyrolysis supply contracts where they can operate the system under short and long-term agreements or offer training and startup support to plant staff.



Figure 6. Silicon Valley Clean Water Authority biosolids drying and pyrolysis system

3.4.3 Mass and Energy Balance

BC performed a mass and energy balance analysis for biosolids pyrolysis to evaluate vendor-supplied performance data and develop expected operating criteria for input into BC's SWEET model for estimating overall system energy and greenhouse gas profiles. At the time of this report, there is limited data published related to mass and energy yield assessments for biosolids pyrolysis. Two mass and energy studies perform laboratory scale pyrolysis reactions with a similar experimental setup and temperature range. The first study conducted by Yuan et al. (2013), operated bench-scale pyrolysis reactions until gas production ceased and did not present the residence time of the reaction. This study presented substantially higher yields of biochar than the second, conducted by McNamara et al. (2016), which performed all pyrolysis experiments for a duration of at least 40 minutes. The reported duration of the second study more closely matches the target retention time of the Bioforcetech system (30 min.) evaluated for this project and the reported biochar mass yield. It is likely that the 2013 experiment performed the pyrolysis experiments at shorter retention times than the Bioforcetech system, thus the 2016 study was used to evaluate the mass and energy yields for this project.

The 2016 study collected mass and energy content data from a digested and dried biosolids pyrolysis feed product generated from the Milorganite production facility in Milwaukee, Wis., and the resulting volatilized and biochar fractions from pyrolysis. The gas from the system was run through an impinger to collect the oil (or tar) fraction and the data for the oil and non-condensable gas is presented separately. A summary of the mass and energy yield data presented as a percentage of the mass and energy content of the feed biosolids

at a range of temperatures is provided below in **Table 6**. The original mass data reported for the pyrolysis products was within 8 percent of the feed mass and was normalized below to project the full mass yield for the SWEET model. The difference in the sum of the energy yield percentage data for the products from 100 percent represents the enthalpy of the reaction. If the sum of the energy yields is less than 100 percent, that means that the process was exothermic and did not require additional heat input to sustain the operation. Where the energy yield content sum is higher, that difference represents the cost of energy for pyrolysis.

Table 6. Mass and Energy Yield Data									
Nominal Temp	Biochar		Oil		Syr	igas			
(°C)	Mass	Energy	Mass	Mass Energy		Energy			
300	71%	81%	25%	8.2%	4.1%	0.1%			
400	57%	55%	37%	26%	5.3%	1.1%			
500	46%	33%	46%	68%	8.3%	5.8%			
600	44%	31%	46%	37%	10%	10%			
700	41%	30%	47%	37%	12%	11%			
800	39%	26%	43%	55%	17%	19%			

Source: Summarized from McNamara et. al. (2016)

An example schematic of the mass and energy yield data is provided below in **Figure 7** to provide a diagram of the experimental setup and products generated from a pyrolysis run at 500 °C.

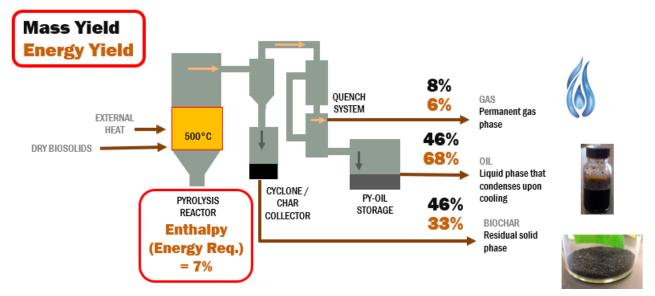


Figure 7. Diagram of mass and energy yield data at 500 °C

The mass and energy yield data summarized from the study by McNamara et. al. was compared to the performance data for the commercial pyrolysis units proposed by Bioforcetech for this project. Bioforcetech supplies two pyrolysis units called the P-Five and P-Three that are operated at a temperature range of 350 °C to 720 °C.



The major difference between the laboratory scale study and the Bioforcetech proposal is that the Bioforcetech system immediately combusts the pyrolysis volatile fraction before condensation can take place, circulates the hot exhaust gas through the pyrolysis reactor jacket to provide thermal energy to the reaction (if required), and then transfers the thermal energy through an air-to-water heat exchanger to potable or filtered process water to supply useful thermal energy in the form of the hot water. Thus the energy yield projected by Bioforcetech represents the useful thermal energy in the form of hot water and accounts for the inefficiencies of heat transfer throughout the process. A process schematic of the Bioforcetech system with exhaust heat recovery is presented below in **Figure 8**.

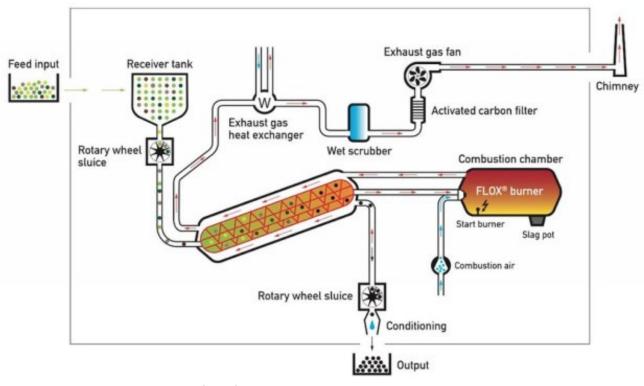


Figure 8. Bioforcetech pyrolysis system process schematic

(Source: Bioforcetech)

A summary of the capacity data for each pyrolysis unit, along with the anticipated mass and energy yield for each system based on the proposal provided by Bioforcetech is provided below in **Table 7**.

Table 7. Mass and Energy Yield Data Summarized from Bioforcetech Proposal				
Parameters	Source	P-Three	P-Five	
Max Throughput (Ib-total solids/hour)	Reported 264		792	
Min. Feed (% total solids)	Reported	60%		
Max Biochar Production (lb/hour)	Reported	orted 106 3		
Biochar Mass Yield	Calculated	40%		
Max Energy Production (MMBtu/hr)	Reported	0.5 1.5		
Useful Thermal Energy Yield ¹	Calculated	27%		

¹ Useful thermal energy recovered in hot water assuming energy content of 7,000 Btu/lb of digested biosolids feed.

The calculated biochar mass yield of 40 percent most closely resembles the 41 percent mass yield observed at 600 °C and is within 5 percent of the mass yield observed at 700 °C in the study summarized above, showing good agreement. At 600 °C, the energy yield of the combined oil and gas fraction was 48 percent in the lab study. When compared to the reported useful thermal energy yield of the Bioforcetech system of 27 percent, this represents a thermal efficiency of 58 percent through the combustion and heat exchangers systems assuming no energy is required by the reactor. This is within a reasonable range assuming each component has a thermal efficiency of 75 percent to 80 percent and also shows good agreement with the lab-scale study.

Based on the results of this analysis, the SWEET model was updated with the lab-scale mass and energy yield parameters for 600 °C. The useful thermal energy generation was calculated based on the thermal efficiency of 58 percent calculated from the Bioforcetech proposal assuming an energy content of 7,000 Btu/lb in the digested biosolids feed. The useful thermal energy was assumed to be at temperatures suitable for heating a belt dryer and was used to offset the natural gas demand required for fueling the hot water dryer heating boiler.

3.4.4 Biochar

Limited research exists on the GHG emissions impacts of biochar's application on agriculture and soils. Biochar has been stated to impact emissions by limiting biogenic carbon mineralization by carbon fixation, improving soil health and thereby reducing natural GHG emissions from the soil, and increasing crop productivity.

Pyrolysis converts approximately 10 to 50 percent of the organic carbon biomass into a stable recalcitrant carbon. The recalcitrant carbon is "fixed" and highly stable resisting decomposition over the span of hundreds to thousands of years. Under normal circumstances, natural organic matter decay would have mineralized the carbon into CO₂. Pyrolysis changes that natural carbon-neutral process into a carbon-negative process. The potential for biochar's use to offset carbon emission was recently accepted by the international panel for climate change (IPCC) as a promising negative emissions technology. The IPCC categories the production and use of biochar under viable options for carbon dioxide removal.

Current literature is inconclusive on the impacts of biochar on soil CO₂, CH₄, and N₂O emissions. This is largely due to the large variety and complexity of soil systems. Primary factors that influence CO₂, CH₄, and N2O emissions include biochar type, crop selection, crop rotation, temperature, moisture/precipitation, cropping systems, and soil type. Several field studies and meta-analysis studies have found that biochar reduced N₂O emissions from soil (Cayuela et al., 2015; Cross et al, 2011; Fidel et al., 2018; Liu et al., 2018). Other studies have found an increase in N₂O emissions or no impact after the first year (Borchard et al., 2019; Wang et al., 2019). The N₂O emissions reductions were most apparent in paddy and sandy soils (Borchard et al., 2019; Wang et al., 2019). CH4 emissions were seen to increase when used in paddy fields (Wang et al., 2019; Zhang et al., 2010). In this study, only the fixed carbon sequestration was considered. Given the vast number of variables that can influence biochar's effect on soil GHG emissions, field testing and monitoring of biochar may be required for better estimation of GHG emission reductions. This would allow for site and application-specific impacts of biosolids based biochar.

Data provided by Bioforcetech showed that 28.6 percent of the Silicon Valley Clean Water facility's biochar was comprised of carbon. Biosolids biochar has less carbon content than woody biomass biochar and would reflect less carbon sequestration. Assuming similar conditions for the County's theoretical biochar and that 90 percent of the carbon remained fixed over its lifetime, an emissions factor was calculated to reduce 0.9337 kg of CO₂e per kg of biochar applied. **Attachment A** provides more details on estimating carbon sequestration value.

A more thorough literature review and field emissions sampling may be required to refine the assessment of biochar's impacts on GHG emissions.

Section 4: Development of Conceptual Scenarios

The technologies screened and described in the previous sections are building blocks of comprehensive biosolids treatment and use scenarios available to the County. The applicability of the short-listed technologies at each County wastewater treatment plant was dependent on the site-specific constraints, process compatibility, and County preferences. Four scenarios were developed for evaluation in this study from the short-listed technologies and each provides biosolids management for all biosolids produced by KC wastewater treatment plants. It is important to emphasize that the scenarios outlined below are just example of how a combination of appropriate technologies and strategies could be deployed. The examples below do not necessarily represent specific strategies for the named facilities, but rather high-level strategies that could be applied in a variety of combinations. The four scenarios are presented below.

- Scenario 1: Base-case Existing MAD with 100 percent Class B land application to western and eastern Washington
- Scenario 2: Enhanced Class A Existing mesophilic digestion at Brightwater with Class B biosolids hauled to an off-site Class A composting facility and local sales; Cambi at South Plant with Class A land application in western and eastern Washington (40 percent/60 percent); and TAD with batch tanks at West Point and off-site soil blending with local sales
- Scenario 3: Pyrolysis Existing mesophilic digestion at all three plants with dewatered cake hauled to offsite thermal drying and pyrolysis treatment. Biochar byproduct contracted to Bioforcetech under a public-private partnership.
- Scenario 4: Optimized Class A Existing mesophilic digestion at Brightwater with Class B biosolids hauled to an off-site Class A composting facility and local sales; TAD with batch tanks at South Plant with Class A land application in western and eastern Washington (40 percent/60 percent); and TAD with batch tanks at West Point and off-site soil blending with local sales

The development of the first three scenarios was intended to represent a comparison between the existing program, the feasibility of a 100 percent Class A biosolids program, and a pyrolysis program. Scenario 4 was later included to represent an optimized and more cost-effective Class A program than Scenario 2. All off-site facilities were assumed to be located in the South King County area based on details from the *WTD – Class A Basis of Estimate for a Composting Facility* (King County Project No. 1132733).

4.1 Flows and Loads

The sizing for each of the scenarios was based on flows and loads that were projected to a 2050 design year. Raw influent flows and loadings for each of the three plants were provided by the County as part of the Flows and Loads Study to evaluate treatment plant capacity limitations. A plant-wide solids mass balance model calibrated during that study was used to calculate digester feed solids loading rates from the 2050 raw influent flows and loadings. **Tables 8 and 9** list the 2050 annual average and 2050 max month loadings, respectively. **Table 10** contains details on the peaking factors. The peaking factors are based on a combination of loading projections provided by the County and historical data at each plant.

Table 8. 2050 Annual Average Flows and Load							
Parameters West Point South Plant Brightwater							
Digester feed TS load (lb/d)	225,860	263,760	93,910				
Digester feed TVS load (lb/d)	182,890	226,530	84,400				
Digester feed %TS	6.1	6.2	5.8				
Dewatered solids TS load (lb/d)	101,170	120,810	39,450				

Dewatered solids %TS	28.5	22.9	20.0				
Table 9. 2050 Max Month Flows and Load							
Parameters	West Point	South Plant	Brightwater				
Digester feed TS load (lb/d)	255,760	303,520	110,640				
Digester feed TVS load (lb/d)	207,660	259,700	94,300				
Digester feed %TS	6.1	6.2	5.8				
Dewatered solids TS load (lb/d)	114,240	139,470	49,400				
Dewatered solids %TS	28.5	22.9	20.0				

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Table 10. Digester Peaking Factors								
Parameters West Point South Plant Brightwat								
Digester feed max 2-week/max month load	1.18	1.20	1.10					
Digester feed max week/max month load	1.22	1.23	1.12					
Digester feed max day/max month load	1.60	1.30	1.50					

4.2 Scenario 1: Base-case

Scenario 1 was intended to represent maintaining the existing conditions of the County's biosolids management program. Each of the three plants would continue with MAD to produce a Class B biosolids product that would then be trucked to western and eastern Washington for land application. This scenario assumed all solids would be directed to land application to simplify the evaluation even though the current program produces a small amount of Class A compost (less than 1 percent of the Class B biosolids).

Figure 9 is a diagram of Scenario 1. Assumptions on existing digester capacity were taken from the analysis in the King County Treatment Plant Flows and Loadings Study.

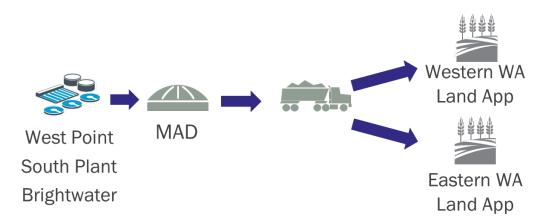


Figure 9. Scenario 1: Base-Case

4.2.1 West Point

The 2050 flows and loads projections indicate that West Point would need two additional 2.4 MG mesophilic digesters to meet future capacity requirements based on an organic loading limit of 0.17 lb VS/ft³/d. However, West Point currently faces site footprint constraints to accommodate additional digesters. Without

demolition of other existing facilities or locating in spaces allocated for future liquid stream treatment, West Point would need to convert to an intensification technology such as Class B TAD that would increase capacity without requiring additional digester buildout. For the purpose of evaluating the base case Scenario 1 in this study, two additional MAD digesters were used for costing which has a higher cost than the conversion of mesophilic digesters to TAD.

4.2.2 South Plant

The 2050 flows and loads projections indicate that South Plant would need one additional 2.75 MG mesophilic digester to meet capacity requirements based on an organic loading limit of 0.20 lb VS/ft³/d. South Plant has available space for four (4) additional digesters and would be able to site the one new digester, but South Plant's footprint availability and constraints are subject to change as other projects may take priority due to regulatory requirements or other plant needs.

4.2.3 Brightwater

The 2050 flows and loads projection indicates that Brightwater would need one additional 1.25 MG mesophilic digester to meet capacity requirements based on an organic loading limit of 0.17 lb VS/ft³/d. Brightwater currently has available space for two additional digesters and should be able to site the one new digester.

4.3 Scenario 2: Enhanced Class A

Scenario 2 was developed for comparison to other scenarios as a representative mix of Class A processes that could provide a 100 percent Class A biosolids management program for the County. West Point would be converted to a TAD-batch Class A process and would truck their dewatered cake to an off-site soil blending facility. A more detailed alternatives analysis would be needed in the future prior to selection of the final thermophilic technology, TAD or TPAD. The Class A soil blended product would then go to local sales and distribution. South Plant would be converted to a Class A THP-MAD process with land application in western and eastern Washington. Brightwater would continue with Class B MAD process and truck their dewatered cake to an off-site Class A composting facility that would be adjacent to the soil blending facility. The Class A compost products would then go to local sales and distribution. Side then go to local sales and distribution facility.



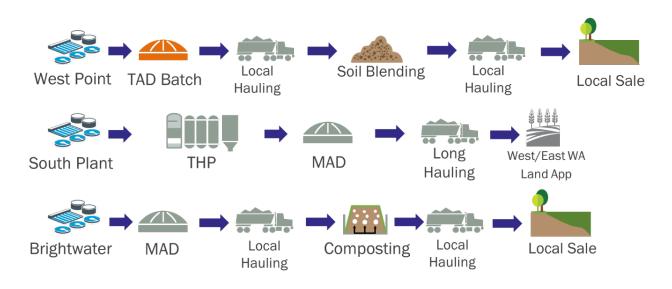


Figure 10. Scenario 2: Enhanced Class A

4.3.1 West Point

Construction of a THP-MAD system at West Point would be challenging if not impossible due to the site limitations which would potentially require the removal of two digesters to fit the ancillary equipment and THP units onsite. Additionally, to construct the new treatment system, temporary trucking of half of West Point's raw wastewater solids to South Plant would be needed for additionally processing throughout a likely three or four-year construction period. Preliminary sizing of a THP-MAD process suggests that its integration at West Point would be challenging and cost prohibited. For the purpose of this study, Therefore, TAD was selected as the Class A digestion process to be implemented at West Point.

TAD can be implemented using different types of configurations with the most common being TAD and TPAD with batch tanks. For this study, TAD with batch tanks (TAD-batch) was selected as the digestion technology.

The application of TAD can increase the organic loading rate on the digesters by more than double current limitations on MAD digesters, freeing up solids digestion capacity. This was reflected in the fact that no new TAD digesters would be required for 2050 flows and loads with an organic loading limit of 0.4 lbs VS/ft³/d. The implementation of TAD-Batch would require space for a 1.6 MG rectangular batch tank complex which represents the peak day flow. Conversion from MAD to TAD would require fixing digester covers and mixing, and heating upgrades.

4.3.2 South Plant

The available space at South Plant makes it compatible with THP-MAD. THP-MAD would require predewatering, screening, solids storage hoppers, steam boilers, and four (4) CAMBI THP process trains. No new digesters would be required for a THP-MAD process based on 2050 flows and loads and an organic load limit of 0.4 lbs VS/ft³. THP-MAD would require fixed covers, mixing, and heating upgrades.

4.3.3 Brightwater

Under all scenarios, it was assumed Brightwater would stay with MAD and require 1 new digester for 2050 loads. Note that existing Brightwater digesters have fixed covers and they were designed with space allocation for potential future conversion to TAD Dewatered cake from Brightwater would be trucked to an off-site Class A composting facility for further treatment.



4.3.4 Off-Site Composting Facility

In Scenarios 2 and 4, an off-site Class A composting facility would process the Brightwater dewatered cake. The 2050 flows and load is equal to 35,857 WT/yr, which is approximately 19 percent of the dewatered cake of King County in 2050. The composting process would use aerated static piles. The site would require space for receiving and mixing, composting, curing, screening, and compost and feedstock storage. The site would also include an administration/operation building and space for maintenance staff. The approximate site size is 23 acres and 30 acres with a buffer.

Figure 11 below shows the basic layout for an off-site composting facility.

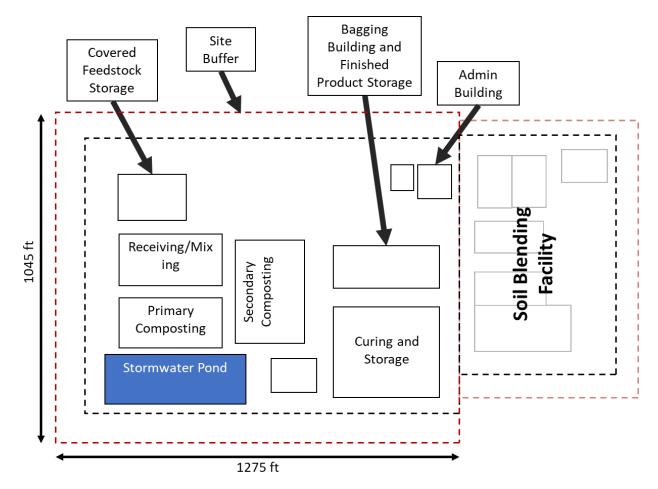


Figure 11. Example layout of an off-site Class A composting facility

4.3.5 Off-Site Soil Blending Facility

An off-site soil blending facility would process West Point's Class A dewatered cake to create a high quality blended biosolids product. The intent of this blended product is to diversify the County's program and potentially generate some revenues from bulk and bagged sale of the product. The soil-blending facility would be designed based on the City of Tacoma's blended product Tagro. This would require mixing biosolids with sand and sawdust at a ratio of 40:40:20 biosolids: sawdust: sand.

The soil blending facility would need space storage space for biosolids cake, sawdust, sand, or other material. Two horizontal auger batch mixers will be used to mix the product.



Figure 12 below shows the basic components of an off-site soil blending facility. The facility was assumed to be adjacent to the composting facility and would require additional space for the soil-blending processes. The administration and operations building, stormwater, and bagging facility was assumed to be shared with the adjacent composting facility. Additional space will be needed for mixing and storage. The approximate size of the soil blending facility would require an additional 9 acres and 11 acres with additional buffer.

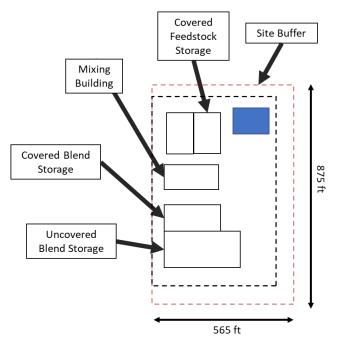


Figure 12. Example layout of an off-site soil blending facility

4.4 Scenario 3: Off-Site Pyrolysis

Scenario 3 includes the application of a pyrolysis system for all of King County's biosolids production. West Point, South Plant, and Brightwater would continue with their current Class B processes similar to Scenario 1. The dewatered cake would be transported to the pyrolysis facility to be thermally dried and pyrolyzed into biochar. The end use of biochar would be part of a public-private partnership (P3) in which Bioforcetech would transport the biochar and sell it. Approximately 10 percent of the profit would be returned to the County. **Figure 13** shows a diagram of Scenario 3.

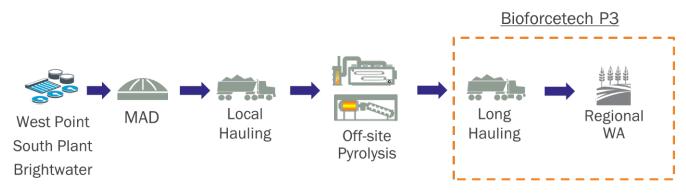


Figure 13. Scenario 3: Off-site Pyrolysis

4.4.1 West Point

Refer to **Section 3.2.1** for in-plant changes. Dewatered cake from West Point would be trucked to the off-site pyrolysis facility for further treatment.

4.4.2 South Plant

Refer to **Section 4.2.2** for in-plant changes. Dewatered cake from South Plant would be trucked to the offsite pyrolysis facility for further treatment.

4.4.3 Brightwater

Refer to **Section 4.2.3** for in-plant changes. Dewatered cake from Brightwater would be trucked to the offsite pyrolysis facility for further treatment.

4.4.4 Off-Site Pyrolysis facility

Due to site constraints at West Point, South Plant, and Brightwater, an off-site location would be required for a pyrolysis system. Bioforcetech would be used as the representative technology for pyrolysis due to it being the only technology with a U.S. installation. A belt dryer will be used upstream of the pyrolysis system rather than the Bioforcetech's Biodryer due to its low capacity which would increase cost and space requirements. This design is based on another ongoing design of a Bioforcetech facility located in Edmonds, Washington. To meet the demand 2050 flows and load projections, the site would need 12 DLT 1120 belt dryers and 24 BFT P-THREE pyrolysis units. Ancillary equipment would be needed such as odor control, storage hoppers, conveyors, and boilers. The approximate size of a facility would require 6.2 acres and 12 acres with additional buffer.

Figure 14 shows the basic footprint of the off-site pyrolysis facility.

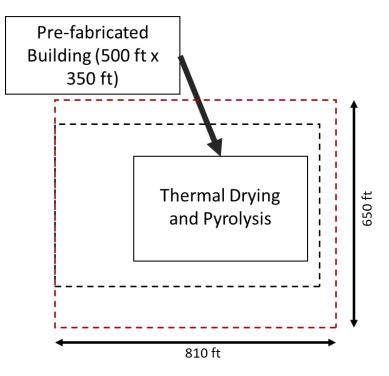


Figure 14. Example layout of an off-site pyrolysis facility



4.5 Scenario 4: Optimized Class A

Scenario 4 was added due to the high cost of the THP process and to provide an opportunity to compare a different Class A digestion approach. Scenario 4 is identical to Scenario 2 except that South Plant would also be converted to a TAD-Batch Class A digestion process instead of a THP-MAD process. **Figure 15** shows a diagram of Scenario 4.



Figure 15. Scenario 4: Optimized Class A

Refer to Section 4.3 above for details on West Point, Brightwater, soil blending, and composting.

Section 5: Solids, Energy, and Greenhouse Gas Evaluation

With the four scenarios defined, a technical evaluation of the solids, energy, and GHG emissions for each scenario was completed. BC's Solids-Water-Energy-Evaluation Tool (SWEET) was used to evaluate the mass and energy balance and the performance of the scenarios at a high level. SWEET tracks volatile solids, inert solids, and water through potential process alternatives, and considers the energy required to power and heat those processes. This allows for energy production and material recovery to be estimated based on the 2050 flows and loads. A GHG inventory was developed for each scenario-based material consumption, electricity, process fuel, transportation fuel, fugitive emissions, carbon sequestration, and fertilizer offsets.

The following sections describe the results of the evaluations using SWEET.

5.1 Mass and Energy Results

Mass and energy outputs for each scenario were developed based on annual average 2050 flows and loads and are summarized in **Table 11**. The solids treatment process performances were based on the design criteria presented in **Attachment A**, while power, chemical, and vehicle fuel consumption were based on historical data. The results of the SWEET model were used to develop the TBL and O&M costs.

Several assumptions were made to complete mass and energy balances. These are summarized in **Attachment A**. The results of the SWEET model can be seen in **Attachment B**.

Table 11. Summary of Mass and Energy Outputs from the SWEET (2050 Flows and Loads)					
Parameter	Scenario 1 Base-case	Scenario 2 Enhanced Class A	Scenario 3 Pyrolysis	Scenario 4 Optimized Class A	
Final Product, Wet (WT/d)	539	689	63	744	
Trucks Required (Trucks/d)	19	67	22	68	
Vehicle Fuel Consumption (gal/day)	1952	1360	104	1445	
Electricity Demand (MWh/d)	75	101	203	85	
Electricity Generation (MWh/d)1	-42	-45	-42	-45	
Net Power (MWh/d)	33	56	160	40	
Natural Gas Consumption (scfm)	145	260	708	210	
Digester Gas Produced (scfm)	3325	3419	3325	3502	
Methane Injected into Pipeline (scfm)	778	787	778	829	
Polymer Use (lb/day)	4611	6359	4611	4344	

¹ Electricity generated through co-gen at West Point is sold to Seattle City Light and not used internally.

5.2 Greenhouse Gas Emission Results

A GHG emissions inventory was developed for each of the scenarios based on the annual average 2050 flows and loads. GHG inventories for the scenarios were developed based on GHGs emitted during operation of the biosolids treatment facilities, and transportation and end-use of biosolids.

The emission scopes and factors were based on the guidelines published by The Climate Registry (TCR) and Intergovernmental Panel on Climate Change (IPCC) and updated with recent publications. Emissions were divided into three categories representing the system boundaries of direct and indirect emissions of GHG:

- **Scope 1 emissions** are direct emissions from sources owned by the agency (e.g., emissions from fuel combustion by the agency, fugitive emissions from the agency's facilities)
- Scope 2 emissions are indirect emissions from sources outside the agency's facility boundaries (e.g., emissions from the production of electricity consumed by the agency)
- Scope 3 emissions are all other indirect emissions such as emissions from the manufacturing of materials used by the agency (e.g., polymer used for dewatering)

Emissions were not considered for the construction of the facilities. This is largely due to the fact that lifecycle emissions have been shown to be more significant than those emitted during construction and from construction materials.

The GHG emissions from each scenario are listed in **Table 12** and shown in **Figure 16** below. The negative emissions are shown as carbon credits and come from electricity produced and sold, renewable natural gas production, carbon sequestration and fertilizer offset from land application of biosolids. More detailed information on GHG emissions can be found in **Attachment B**.

	Table 12. Summary of GHG Emissions (2050 Flows and Loads)Metric Tons of CO_2 Equivalent per Year							
Scope	Scope Parameter Scenario 1: Base-case Scenario 2: Enhanced Class A Scenario 3: Pyrolysis Scenario 4: Optimized Class							
be	Fugitive Emissions	9,444	8,489	8,536	8,642			
Sci	By Computer Fugitive Emissions 9,444 8,489 8,536 8,642 Fuel Combustion (Boilers, Machines) 4,042 9,452 19,735 8,055							

	Scope 1 Total	13,486	17,941	28,270	16,697
2	Electricity Usage	104	112	104	112
Scope 2	Electricity Exported	-100	-107	-100	-107
S	Scope 2 Total	3.6	4.4	3.6	4.4
	Polymer Consumption	6,885	9,949	6,885	6,942
Scope 3	Natural Gas Use	1,068	1,915	5,213	1,546
Scol	Hauling, Transportation, Application	8,467	4,433	924	4,803
	Scope 3 Total	16,421	16,297	13,023	13,290
	Scope 1-3 Total	29910	34242	41297	29992
	Fertilizer Offset	-9,766	-9,694	-6,029	-9,638
Credits	Carbon Sequestration	-52,919	-47,589	-19,410	-47,216
Cre	Pipeline RNG	-31,501	-31,884	-31,501	-33,585
	Credits Total	-94,186	-89,167	-56,940	-90,438
	Total (metric tons CO2e / year)	-64,276	-54,925	-15,643	-60,446
Differe	ence from S1 - Base-case (metric tons CO2e /year)	0	+9,351	+48,632	+3,830

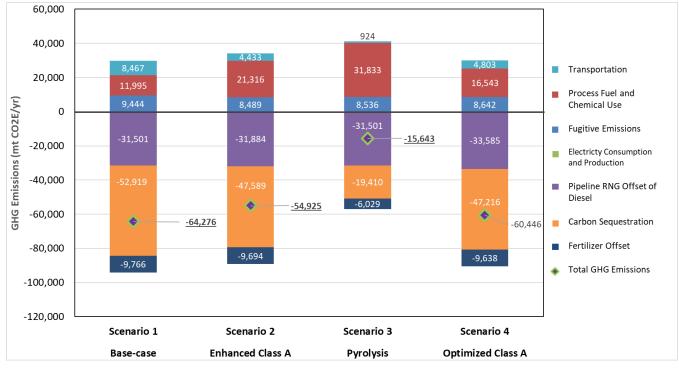


Figure 16. Summary of GHG emissions

(based on 2050 flows and loads)

The results of the GHG inventories showed that Scenario 1: Base-case had the lowest GHG emissions with Scenario 4: Optimized Class A and Scenario 2: Enhanced Class A following closely. Scenario 1: Base-case

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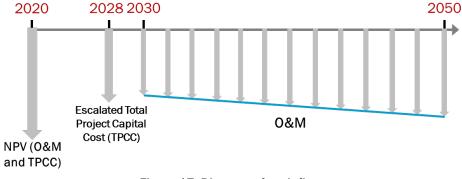
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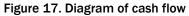
also had the lowest sum for Scope 1-3 emissions as shown in **Table 13** below. Scenario 3: Pyrolysis had more significant GHG emissions due to the lower carbon sequestration and increase in emissions from process fuel usage. An analysis of biochar's carbon sequestration potential is included in **Section 3.5.8**.

Section 6: Cost Assessment

A simplified 20-year net present value (NPV) was developed for each of the scenarios to account for both the total escalated project capital cost and the operation and maintenance (O&M) costs. The NPV are intended to be used only as comparative costs between alternatives. Salvage and replacement cost were not included. Total project capital cost (TPCC) were escalated to 2028 and discounted back to 2020. The O&M assumed operation from 2030 to 2050 and was escalated based on solids growth projections and then discounted back to 2020 for an NPV. For both capital and O&M costs, the calculations were performed using an escalation rate of 3 percent and a discount rate of 5.25 percent. Escalated TPCCs were provided in **Table 13** below and represent the true TPCC of the project. **The escalated TPCC is a better reflection of the costs that may impact budget, sewer rates, and other planning impacts**. However, future evaluations with more detailed costing will be needed to provide the classification accuracy ranges needed to understand impacts to the program. The sections below discuss these concepts in further detail.

Figure 17 below summarizes the general approach.





6.1 Total Project Capital Costs

Estimated construction costs were developed based on pre-Class 5 AACE International standards for each scenario. These costs were input into the County's cost models to develop TPCC. To reflect the present value of capital cost, project capital cost was escalated to an assumed midpoint of construction of 2028 and then discounted back to 2020. **Table 13** provides a summary of the estimated construction, project capital cost, and escalated and discounted project capital cost. More detailed information on the project capital costs can be found in **Attachment C**.

	Table 13. Summary of Capital Costs (in 2020 \$ millions)					
ScenariosFacilityEstimated ConstructionTotal Project Capital CostTotal Project Capital Cost (Escalated to midpoint 2028)Total Project Capital (Escalated and Disc						
	West Point	\$76	\$142	\$180	\$119	
S1	South Plant	\$44	\$83	\$105	\$70	
	Brightwater	\$20	\$39	\$50	\$33	

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	Total	\$139	\$264	\$335	\$222
	West Point	\$69	\$129	\$163	\$108
	Soil Blending	\$32	\$58	\$74	\$49
60	South Plant	\$292	\$520	\$659	\$438
S2	Brightwater	\$20	\$39	\$50	\$33
	Composting	\$68	\$120	\$152	\$101
	Total	\$481	\$867	\$1,098	\$729
	West Point	\$76	\$142	\$180	\$119
	South Plant	\$44	\$83	\$105	\$70
S 3	Brightwater	\$20	\$39	\$50	\$33
	Pyrolysis	\$371	\$617	\$782	\$519
	Total	\$510	\$881	\$1,117	\$741
	West Point	\$69	\$129	\$163	\$108
	Soil Blending	\$32	\$58	\$74	\$49
S 4	South Plant	\$61	\$115	\$146	\$97
	Brightwater	\$20	\$39	\$50	\$33
	Composting	\$68	\$120	\$152	\$101
	Total	\$250	\$462	\$585	\$388

6.2 Operation and Maintenance Costs

O&M costs were considered over a 20-year period and presented as a net present value. O&M costs were associated only with solids treatment including processing, handling and end-use. These costs considered labor, maintenance and parts replacement, material use, energy consumption, and end-use. Revenues from biosolids product sales, electricity and renewable natural gas were also included. Revenues from the biosolids product sales assumed a stepwise increase. Refer to **Attachment C** for more details. The O&M costs related to labor and parts replacement were built from data provided by the County. O&M costs were escalated based on the discount rate as well as a linear projection of biosolids increase from 2018 to 2050.

Table 14 and **Figure 18** provides details on the biosolids growth projections used for this analysis.**Attachment C** provides more detailed on O&M costs.

Table 14. Summary of Solids Growth									
Parameter West Point South Plant Brightwater Total									
2018 Dewatered Cake (WT/yr)	49258	64332	15948	129537					
2050 Dewatered Cake (WT/yr)	64784	96279	35998	197061					
2050 Percent of Total	32.9%	48.9%	18.3%	-					
Years	32	32	32	32					
Percent Change	31.5%	49.7%	125.7%	52.1%					
Slope	1.0%	1.6%	3.9%	1.6%					

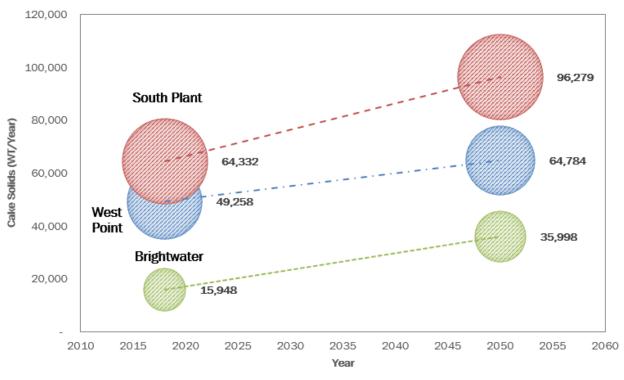


Figure 18. Diagram of solids growth projections

 Table 15 provides a summary of NPV O&M for each scenario.

Table 15. Summary of Net Present Value 0&M and Revenues (in 2020 \$ millions)					
Scenarios	Facility	0&M	Revenues	Total	
	West Point	\$171	(\$20)	\$151	
64	South Plant	\$220	(\$100)	\$120	
S1	Brightwater	\$72	(\$1)	\$71	
	Total	\$463	(\$122)	\$342	
	West Point	\$123	(\$20)	\$103	
	Soil Blending	\$97	(\$29)	\$68	
	South Plant	\$262	(\$102)	\$160	
S2	Brightwater	\$48	\$0	\$48	
	Composting	\$73	(\$34)	\$39	
	Total	\$602	(\$184)	\$418	
	West Point	\$122	(\$19)	\$104	
	South Plant	\$149	(\$98)	\$51	
S3	Brightwater	\$48	\$0	\$48	
	Pyrolysis	\$132	(\$4)	\$127	
	Total	\$451	(\$121)	\$330	
S4	West Point	\$123	(\$20)	\$103	

Total	\$534	(\$191)	\$344
Composting	\$73	\$73 (\$34)	
Brightwater	\$48	\$0	\$48
South Plant	\$194	(\$108)	\$86
Soil Blending	\$97	(\$29)	\$68

Table 16 provides a summary of annual 0&M and revenues presented in 2050 dollars, which reflects the fully operational scenarios and full maturity of the biosolids market/revenues.

Table 16. Summary of 2050 Annual O&M and Revenues (in \$ millions)						
Scenarios	Facility	0&M	Revenues	Total		
04	West Point	\$14.3	(\$1.7)	\$12.6		
	South Plant	\$19.0	(\$8.7)	\$10.3		
S1	Brightwater	\$6.8	(\$0.1)	\$6.7		
	Total	\$40.1	(\$10.4)	\$29.6		
	West Point	\$10.3	(\$1.7)	\$8.6		
	Soil Blending	\$8.1	(\$3.7)	\$4.4		
	South Plant	\$22.7	(\$8.8)	\$13.8		
S2	Brightwater	\$4.5	\$0.0	\$4.5		
	Composting	\$6.8	(\$4.3)	\$2.5		
	Total	\$52.3	(\$18.5)	\$33.8		
	West Point	\$10.2	(\$1.6)	\$8.7		
	South Plant	\$12.9	(\$8.4)	\$4.4		
S 3	Brightwater	\$4.5	\$0.0	\$4.5		
	Pyrolysis	\$11.4	(\$0.6)	\$10.9		
	Total	\$39.0	(\$10.6)	\$28.4		
	West Point	\$10.3	(\$1.7)	\$8.6		
	Soil Blending	\$8.1	(\$3.7)	\$4.4		
64	South Plant	\$18.9	(\$9.4)	\$9.6		
S4	Brightwater	\$4.5	\$0.0	\$4.5		
	Composting	\$6.8	(\$4.3)	\$2.5		
	Total	\$48.6	(\$19.0)	\$29.6		

Section 7: Triple Bottom Line

A triple bottom line (TBL) was adapted from the *KC Biosolids Program Strategic Plan 2018-2037* and modified to fit the needs of this study. Four criteria categories were developed: social, environmental, economic, and technical. A detailed description of each of the criteria and more details on the TBL and rationale for rating each criterion and scenario can be found in **Attachment D**.



Each criterion received a raw score between 0 to 5 points. The calculation of the total weighted score can be described by the formula below.

$$Total Weighted Score = \sum \left(Weighting \ x \ \frac{Raw \ Score}{Max \ Possible \ Score} \right)$$

High total weighted scores represent the best scenarios.

7.1 Social and Equity Criteria Category

The social and equity criteria category considered how each scenario could increase or decrease the quality of life of King County residents, taking into account the differing baselines for the communities around South, West Point, and Brightwater Treatment Plants. These criteria were adapted from the County's *The Determinants of Equity Report*. **Table 17** summarizes the scores of the social and equity criteria category.

Table 17. Social and Equity Criteria Category Scoring							
Criterion	Weighting factor	Scenario 1 Base-case	Scenario 2 Enhanced Class A	Scenario 3 Pyrolysis	Scenario 4 Optimized Class A		
Built and Natural Environment							
E1. Noise	2	5	2	3	2		
E2. Odors	3	4	2	2	2		
E3. Traffic	2	4	2	3	2		
E4. Economic Development/Jobs	5	3	4	3	4		
E5. Food Systems	3	3	4	2	4		
Total score (out of 15 point possible)		11	9	8	9		

7.2 Environmental Criteria Category

King County is dedicated to environmental stewardship and has adopted several initiatives to tackle climate change. As part of the *2015 Strategic Climate Action Plan*, the County has committed to meeting countywide GHG emissions reduction targets of 50 percent by 2030 and 80 percent by 2050. Additionally, the KC Wastewater Treatment Department has set a target goal of carbon-neutral operations by 2025. The environmental criteria category takes into consideration these goals and other environmental criteria. **Table 18** summarizes the scores of the environmental criteria category.

Table 18. Environmental Criteria Category Scoring								
Criterion	Weighting factor	Scenario 1 Base-case	Scenario 2 Enhanced Class A	Scenario 3 Pyrolysis	Scenario 4 Optimized Class A			
Sustainability								
C1. Greenhouse Gas Emissions	10	5	4	1	5			
C2. Energy Production/Usage	5	5	3	2	4			
C3. Fossil Fuel Usage	5	5	4	2	5			

C4. 100% Beneficial Reuse Regulatory Compliance	5	3	5	2	5
C5. Flexibility to Meet Future Regulations		2	4	5	3
Total score (out of 30 point possible)	25	24	13	27	

7.3 Economic Criteria Category

The economic criteria category considers the capital cost and lifecycle cost of the operation and maintenance of the scenarios. This category also evaluates the long-term sustainability of the biosolids management program in terms of diversification of outlets for biosolids application and risks associated with the single option program. **Table 19** summarizes the scores of the economic criteria category.

Table 19. Economic Criteria Category Scoring								
Criterion	Weighting factor	Scenario 1 Base-case	Scenario 2 Enhanced Class A	Scenario 3 Pyrolysis	Scenario 4 Optimized Class A			
E1. Net Present Value	10	4	2	2	3			
E2. Total Project Capital Cost	5	5	1	1	3			
E3. Market Diversification/Risk 10		2	5	2	5			
Total score (out of 25 point possible)		17	15	9	19			

7.4 Technical Criteria Category

Different technologies offer varying levels of operation, footprints, permitting requirements, and improvements to existing processes. This category considers the technical components of each scenario. **Table 20** summarizes the scores of the technical criteria category.

Table 20. Technical Criteria Category Scoring							
Criterion	Weighting factor	Scenario 1 Base-case	Scenario 2 Enhanced Class A	Scenario 3 Pyrolysis	Scenario 4 Optimized Class A		
T1. Process Reliability	10	5	4	2	5		
T2. Constructability/Footprint	3	3	4	3	5		
T3. Site Permitting	2	5	3	2	3		
T4. Addressing Solids Handling Capacity	5	3	5	3	5		
T5. Compatibility with Capital and Planning Projects 5		4	2	3	3		
T6. Operational Complexity 5		5	2	3	4		
Total score (out of 30 point possible)	1	26	21	16	26		

7.5 TBL Score Summary

The scores for the four criteria categories were combined for the total scores for each scenario. **Table 21** below provides a summary of those scores.



Table 21. Summary of Total TBL Scores								
Criteria Category	Category Weights	Scenario 1 Base-case	Scenario 2 Enhanced Class A	Scenario 3 Pyrolysis	Scenario 4 Optimized Class A			
Social and Equity	15	11	9	8	9			
Environmental	30	25	24	13	27			
Economic	25	17	15	9	19			
Technical	30	26	21	16	26			
Total score (out of 100 points possibl	e)	79	69	46	81			

The results of the TBL evaluation indicated that Scenario 4: Optimized Class A scored the highest with Scenario 1:Base-case close in score (less than 10 percent difference). Scenario 3: Pyrolysis scored significantly lower for the total score and scored worse in each individual criteria category compared to the other scenarios.

Section 8: Conclusions

The results of the study indicated that Scenario 4: Optimized Class A was the best scenario overall with Scenario 1: Base-case coming close in the TBL analysis. Scenario 4: Optimized Class A had similar scoring in most criteria but had slightly better ratings in the environmental, economic and technical categories. This is largely due to the reduced risk of the program through diversification and the ability to meet future capacity and regulatory concerns. Scenario 2: Enhanced Class A did not score as well due to the complexity and increase processes that were required to get to a Class A program. The cost of the program was also significantly higher compared to Scenario 4: Optimized Class A. Scenario 3: Pyrolysis scored poorly in every category compared to all three other scenarios due to the technical risks, costs, and uncertainty of the biochar market.

Scenario 1: Base-case had the lowest NPV and total project capital cost overall. It also had the best GHG footprint but Scenario 4: Optimized Class A was within 6 percent. However, Scenario 1: Base-case did not score favorably in several criteria due to risks associated with a Class B single market exposure. Scenario 1: Base-case represents the current biosolids management program used by the County which sends more than 70 percent of the biosolids produced to eastern Washington for Class B land application. This program, as reflected in the scoring of the TBL, has significant risks due to the limited diversification of end-uses for the biosolids. Expanding a Class B program into more markets faces significant regulatory, economic and market barriers. Trends in the Class B biosolids market indicate it will only become more difficult in the future. The failure of their only end-use market could result in having to landfill at high cost, currently estimated around \$3 million dollars per month, which could result in regulatory fines and would also result in significant GHG emissions until further beneficial markets could be established.

Scenario 2: Enhanced Class A did not score as well as Scenario 1: Base-case or Scenario 4: Optimized Class A due to the higher cost and complexity of the implementation of the thermal hydrolysis system at South Plant. Changing this technology to a TAD-Batch system resulted in more favorable scores due to the lower cost and greater simplicity of the solution.

Scenario 3: Pyrolysis was scored the lowest and had the second-highest lifecycle cost. The ratings for this scenario suffered from the fact that the technology is new and not fully proven, uses more energy than other options due to the need to dry the biosolids, and had high costs. Pyrolysis and gasification have the potential for applications but they may be limited to situations where other more favorable alternatives are not

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available. The risk of an undeveloped biochar market also adds to the concern of the potential failure of the biosolids management program.

In this study, the three alternative Scenarios 2, 3, and 4 represent a full conversion to a 100 percent Class A program. An incremental approach or a mixed Class A and Class B program may be more realistic due to reduced costs and the ability to grow investments to match Class A market demand.

This study was intended as a high-level analysis for categories of Class A treatment processes. Once major program directions are established, management approved project(s) would be submitted through the County Wastewater Treatment Division's capital project process where they must compete with other capital projects for prioritization and budget allocation, The capital project process would further optimize and develop the options for each individual plant and potential off-site facilities as required.

Section 9: Sensitivity Discussion

A sensitivity analysis was not a component of the scope for this work; however, this section presents a discussion on variables that could impact the results of the evaluation.

- Gas utilization strategy impacts both the revenues and GHG impacts of any biosolids management
 program. Electric utilities in this region have composite power sources that include a large and growing
 component of low-emissions based electricity generation such as hydro-electric, wind, solar, etc. South
 Plant currently has a purchasing agreement that adds a premium to their electricity rate for sourcing
 their power from renewable energy with PSE that is set to elapse by 2025. If this purchasing agreement
 cannot be renewed, the GHG impact of electricity consumption at South Plant could increase. As utilities
 increase their portfolio of renewable power generation, the net GHG benefit of cogeneration could also
 decrease.
- RINs and LCFS credits for sale of biogas at South Plant are the largest source of revenue and GHG benefit for the County. The RIN and LCFS market are variable and revenues could increase or decrease in the future. In addition, decisions on future gas use at all three plants will change the overall net revenues and benefits. However, this decision is largely independent of Class A decisions as long as the County remains invested in anaerobic digestion as their principal biosolids treatment option.
- GHG carbon sequestration due to biosolids land application ranges and varies based on various characteristics of the soil system to which the biosolids are applied. Values from King County were used and assumed to represent the biosolids applications in this study.
- Biochar carbon sequestration values were based on the assumption that the biochar carbon content was 28.6 percent and that 90 percent of this carbon remained fixed and would not convert to CO₂. No other benefits such as reduced soil emissions were considered.
- The assumption for tipping fees for woodchips and sawdust may impact the overall economic evaluation for composting and soil blending, and this market is variable. The City of Tacoma currently purchases sawdust for soil blending to prevent contamination and to maintain Class A designation. The County may also need to purchase sawdust for soil blending to also prevent contamination. A tipping fee could be used for wood waste from tree disposal and other less controlled sources since composting would allow for the time and temperature requirements for Class A.
- Land application rate and revenues from biosolids products can vary due to variables such as public perception/media, weather, agricultural tariffs, and a change of regulations. This study assumed that application rates and revenues follow typical values.
- Capital costs, the timing of capital investments, and the blend of Class A and Cass B options will impact the overall costs and TBL scores.

References

- Borchard N, Schirrmann M, Cayuela ML, Kammann C, Wrage-Mönnig N, Estavillo JM, Fuertes-Mendizábal T, Sigua G, Spokas K, Ippolito JA, Novak J. "Biochar, soil and land-use interactions that reduce nitrate leaching and N₂O emissions: a meta-analysis". Science of the Total Environment. 2019;651:2354– 2364. doi: 10.1016/j.scitotenv.2018.10.060.
- Cayuela, M. L., Jeffery, S., and van Zwieten, L.: "The molar H:Corg ratio of biochar is a key factor in mitigating N20 emissions from soil". Agr. Ecosyst. Environ., 202, 135–138, doi:10.1016/j.agee.2014.12.015, 2015.
- Fidel, Rivka & Laird, David & Parkin, Timothy. "Effect of Biochar on Soil Greenhouse Gas Emissions at the Laboratory and Field Scales". Soil Systems. 3. 8. 10.3390/soilsystems3010008. 2019.
- Groot, H., Pepke, Ed., Fernholz, K., Henderson, C., Howe, J. "Survey and Analysis of the US Biochar Industry". Dovetail Partners, Inc. WERC project MN17-DG-230. 2018
- IRENA. "Biofuels for aviation: Technology brief, International Renewable Energy Agency, Abu Dhabi". 2017.
- Kimbell, L., Kappell, A., McNamara, P. "Effect of pyrolysis on the removal of antibiotic resistance genes and class 1 integrons from municipal biosolids". Environmental Science: Water Research & Technology, 4, 1807-1818. 2018.
- Liu Q, Zhang Y, Liu B, Amonette JE, Lin Z, Liu G, Ambus P, Xie Z. "How does biochar influence soil N cycle? A meta-analysis". Plant and Soil. 2018;426(1–2):211–225. doi: 10.1007/s11104-018-3619-4.
- Ozaki, N., Nakazato, A., Nakashima, K., Kindaichi, T., & Ohashi, A. (2017). Loading and removal of PAHs, fragrance compounds, triclosan and toxicity by composting process from sewage sludge. The Science of the Total Environment, 605–606, 860–866. https://doi.org/10.1016/j.scitotenv.2017.06.165
- Paz-Ferreiro J, Nieto A, Méndez A, Askeland MPJ, Gascó G. Biochar from Biosolids Pyrolysis: A Review. Int J Environ Res Public Health. 2018;15(5):956. Published 2018 May 10. doi:10.3390/ijerph15050956
- Ross J.J., Zitomer, D.H., Miller, T.R., Weirich, C.A., McNamara, P.J. "Emerging investigators series: pyrolysis removes common microconstituents triclocarban, triclosan, and nonylphenol from biosolids". Environ. Sci.: Water Res. Technol (2) 282-289. 2016.
- Semple, K., Reid, B., & Fermor, T. R. (2001). Impact of Composting Strategies on the Treatment of Soils Contaminated with Organic Pollutants. Environmental Pollution (Barking, Essex : 1987), 112, 269– 283. https://doi.org/10.1016/S0269-7491(00)00099-3
- Techsci Research. "Global Biochar Market By Technology (Pyrolysis, Gasification & Hydrothermal Carbonization), By Application (Farming, Livestock Farming & Others), By Region, Competition, Forecast & Opportunities, 2024". 2019.
- USBI. 2018. Council of Western State Foresters Biochar Market Analysis Final Report
- Youngquist, C. P., Mitchell, S. M., & Cogger, C. G. (2016). Fate of Antibiotics and Antibiotic Resistance during Digestion and Composting: A Review. Journal of Environmental Quality, 45(2), 537–545. https://doi.org/10.2134/jeq2015.05.0256
- Yuan, Haoran & Lu, Tao & Zhao, Dandan & Huang, Hongyu & Kobayashi, Noriyuki & Chen, Yong. "Influence of temperature on product distribution and biochar properties by municipal sludge pyrolysis". Journal of Material Cycles and Waste Management. 15. 10.1007/s10163-013-0126-9. 2013.
- Wang, Y., Villamil, M.B., Davidson, P.C., and Akdeniz, N. "A quantitative understanding of the role of cocomposted biochar in plant growth using meta-analysis". Science of The Total Environment, vol. 685, pp. 741-752. 2019.

Attachment A: Solids-Water-Energy Evaluation Tool Design Basis and Assumptions



Cost Element Biogas Utilization Gas Upgrading Efficiency (1 - % Methane Loss) Methane content Biogas Utilization West Point Cogen Usage	Units	Baseline Value	Value in Model	Notes for Baseline Values	References
Biogas Utilization Gas Upgrading Efficiency (1 - % Methane Loss) Methane content Biogas Utilization West Point Cogen Usage		Dubbillite Fullet	Model		rererêncês
Gas Upgrading Efficiency (1 - % Methane Loss) Methane content Blogas Utilization West Point Cogen Usage		A			
Gas Upgrading Efficiency (1 - % Methane Loss) Methane content Blogas Utilization West Point Cogen Usage		Operation	n Assumptio	<u>ns</u>	
Methane content Blogas Utilization West Point Cogen Usage	%	90	90		
Biogas Utilization West Point Cogen Usage	%	60	60		
	%	43.5	43.5		KC Value (2017 - present)
West Point Boiler Usage	%	5.9	5.9		kC Value (2017 - present)
West Point Raw Sewage Pumps Usage	%	8.6	8.6		kC Value (2017 - present)
West Point Waste Gas Burner (Flare) Usage	%	42.0	42.0		kC Value (2017 - present)
South Plant Cogen Usage South Plant Boiler Usage	%	0.0	0.0		kC Value (2017 - present) kC Value (2017 - present)
South Plant Boner Usage	%	84.5	84.5		kC Value (2017 - present) kC Value (2017 - present)
South Plant Waste Gas Burner (Flare) Usage	%	15.5	15.5		kC Value (2017 - present)
Brightwater Boiler Usage	%	30.0	30.0		
Brightwater Waste Gas Burner (Flare) Usage	%	70.0	70.0		
West Point Plant Heat Demand (Building + Process)	MMBTU/h	8.500	8.500	Ranges from 4 to 13 MMBTU/h with peak 17.1(2014)	2016 Biogas Op Study
South Plant Heat Demand (Building + Process)	MMBTU/h	12.500	12.500	Ranges from 4 to 13 MMBTU/h with peak 17.6(2014)	2016 Biogas Op Study
Composting/Soli Blending					
Operational Parameters refer to CMPST and Sblend Sheets				Operational Parameters refer to CMPST and Sblend Sheets	Operational Parameters refer to CMPST and Sblend Sheets
Dewatering West Point Centrifuge Polymer Use	Ib active/DT	30	30		
South Plant Centrifuge Polymer Use	Ib active/DI Ib active/DT	30	30		
South Plant Centrifuge Folymer Use	Ib active/DT	15	15	Assumed Value	
South Plant Centrifuge THP Cake Solids	%	30	30	Assumed Value	
Brightwater Centrifuge Polymer Use	Ib active/DT	35	35		KC Brightwater Treatment System Technical facts and info sheet
Digestion					
West Point Mesophilic digestion VSR	%	64.01	64.01	Average History Data 01/2012-08/2017	
South Plant Mesophilic digestion VSR	%	60.03	60.03	Digester 1-4 - 56.96, Digester 1-5 - 60.03, Average History Data 07/2014-07/2017	
Brightwater Mesophilic digestion VSR	%	60.94	60.94	Average History Data 01/2013-08/2017	
THP-MAD VSR THP-MAD Gas Production	% CF gas/lb VSR-d	62 16.24	62 16.24	Assumed slight boost in VSR Assumed match of existing SP specific gas production	
THP-MAD Digester Feed	%	9	9	Assumed from SFPUC	
				Assumed slight boost in VSR. TAD VSR was similar to MAD. 68 to 74 in coupled thermo-meso (TPAD)	
TAD-Batch VSR West Point	%	68	68	pilot. Full-scale Meso 64-78	1999 pilot study
TAD-Batch VSR West Point	%	64	64	Assumed 4% increase	
TAD-Batch Gas Production	CF gas/lb VSR-d	15	15	Assumed match of existing WP specific gas production	
West Point Mesophilic Gas Production	CF gas/lb VSR-d	15	15	01/14-01/15 -> 1.5 MSCF/d	
South Plant Mesophilic Gas Production	CF gas/lb VSR-d	16.24	16.24	Average History Data 07/2014-07/2017	
Brightwater Mesophilic Gas Production	CF gas/lb VSR-d	16 555	16 555	540-570 calc from 2010-2015	BW Technical Facts document
West Point LHV South Plant LHV	Btu/scf Btu/scf	550	550	500-600	2016 Biogas Op Study 2013 SP Biogas Utilization Study
Brightwater Plant LHV	Btu/scf	550	550	Assumed Similar to WP and SP	
Pyrolysis					
Pyrolysis Temperature	°C	550	550		BFT Biochar Testing Data Sheet
Thermal Drying and Pyrolysis Mass Reduction	%	87.92	87.92		BFT Proposal
Pyrolysis VSR Reduction	%	75.91	75.91		BFT Biochar Testing Data Sheet
Biochar VS	%	33.3	33.3		BFT Biochar Testing Data Sheet
Biochar ASH Biochar N	%	64.3 2.4	64.3 2.4		BFT Biochar Testing Data Sheet BFT Biochar Testing Data Sheet
Biochar C	%	28.6	28.6		BFT Biochar Testing Data Sheet
Biochar P	70	20.0	20.0		
Thermal Hydrolysis (CAMBI)					
Steam Requirements	Ib Steam/Ib DS	1.1	1.1	SFPUC and Cambi	
		Cost A	ssumptions		
Biosolids Hauling and Disposal					
Land Application, Cost (Program Average)	\$/WT	\$67.42	\$67		King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Land Application, Cost (Western WA, Forestry)	\$/WT \$/WT	\$71.20 \$62.70	\$71	Calculated from Program Breakdown (Hauling, fuel, equipment, application, program)	King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Land Application, Cost (Eastern WA, Ag) Land Application, Cap Equipment/truck Cost/Yr	\$/WT \$/vr	\$62.70 \$400,000.00	\$63 \$400.000	Calculated from Program Breakdown (Hauling, fuel, equipment, application, program) Cost for capital expense average including truck purchase average from 2013-2018	King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Land Application, Cap Equipment/truck Cost/ Yr Land Application, Revenue (Western WA, Forestry)	\$/yr \$/WT	\$400,000.00	\$400,000		King County Communication, CurrentProgrambudgetbreakdown.xisx, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Land Application, Revenue (Western WA, Porestry)	\$/WT	\$1.73	\$1.0		King County Communication, CurrentProgrambudgetbreakdown.xisx, December 2019
Biosolids Revenue Program Start-up Structure	*/				
Revenue Year 1-2 (Commercial)	%	25	25	Compost and Soil Blend Sales	
Revenue Year 3-8 (Commercial)	%	50	50	Compost and Soil Blend Sales	
Revenue Year 9-14 (Commercial)	%	75	75	Compost and Soil Blend Sales	
Revenue Year 15-20 (Commercial)	%	100	100	Compost and Soil Blend Sales	
Revenue Year 1-2 (Consumer)	%	15	15	Compost and Soil Blend Sales	
Revenue Year 3-8 (Consumer) Revenue Year 9-14 (Consumer)	%	35 60	35 60	Compost and Soil Blend Sales Compost and Soil Blend Sales	
Revenue Year 9-14 (Consumer) Revenue Year 15-20 (Consumer)	%	90	90	Compost and Soil Blend Sales	
Chemical Costs	70		50		
Polymer Cost	\$/Ib-Active Poly	2.00	2.00		
Composting					
Hauling Fee (Bulk Material)	\$/WT	\$7.06	\$7.06		King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Hauling Fee (Fixed local)	\$/WT	\$6.65	\$6.65	Contract fee	King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019

Composting Operation Cost	\$/wt Biosolids	\$155.98	\$156	Adjusted by adding two more operators to KC Estimate. Labor, Maintenance, Program op	King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Annual Equipment Upgrades	\$/yr	\$80,000.00	\$80,000		
Compost Revenues					
Tipping Fee	\$/WT	\$20.00	\$20.00		King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Bagged Product	\$/CY	\$67.50	\$67.50		King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Bagged Product	\$/2 CF Bag	\$5.00	\$5.00		King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Bulk Retail	\$/CY	\$25.00	\$25		King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Bulk Wholesale	\$/CY	\$10.00	\$10		King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Economics					
Escalation Rate	%				
Discount Rate (WTB) (Cost of Capital)	%	5.25	5.25		King County Communication, December 2019
Discount Rate (OMB)	%	7	7		King County Communication, December 2019
WTD Real Discounted Rate	%	2.18	2.18		King County Communication, December 2019
Present Worth Comparison	years	20	20		
P:A for 20 years					
Annual Growth in Electricity Consumption	%	1	1		King County Communication, December 2019
Electricity Costs					
Electricity Costs (Average)	\$/kWh	\$0.0745	\$0.0745		
West Point	\$/kWh	\$0.0781	\$0.0781		King County Communication, December 2019
South Plant	\$/kWh	\$0.0758	\$0.0758		King County Communication, December 2019
BrightWater	\$/kWh	\$0.0697	\$0.0697		King County Communication, December 2019
Cogen Electricity Revenues	\$/SCF to Cogen	\$0.0056	\$0.0056	2018 - 223M Biogas SCF/yr ~\$1.25M sale -> 0.005593 \$/SCF to Cogen	King County Communication, KC BiogasData.xlsx, December 2019
Fuel Costs					
Diesel	\$/gal	\$3.60	\$3.60	2019 Average	EIA Data Wholesale
Propane	\$/therm	\$0.86	\$0.86	11/26/2018-11/26/2019	EIA Data Wholesale
Propane	\$/gal	\$0.78	\$0.78	11/26/2018-11/26/2019	EIA Data Wholesale
Renewable Natural Price (Sold)	\$/scf Biogas	\$0.0196	\$0.0196	SP 2017 and 2018 Average	King County Communication, KC BiogasData.xlsx, December 2019
Renewable Natural Price (Sold)	\$/scf Scrubbed	\$0.0218	\$0.0218	SP 2017 and 2018 Average	King County Communication, KC BiogasData.xlsx, December 2019
RNG RIN Market Price (Current)	\$/MMBtu	\$23.40	\$23.40	2014-2019 Median Value	
RNG CA LCFS Market Price (Current)	\$/MMBtu	\$6.21	\$6.21	2019 Average Value	
RIN Premium Allocation	%	70	70		
LCFS Premium Allocation	%	65	65		
NG Market Sale Price (Current)	\$/1000 scf	\$2.70	\$2.70		
NG Market Purchase Price (Current)	\$/1000 scf	\$6.76	\$6.76		EIA, December 2019
NG Market Purchase Price (Current)	\$/MMBtu	\$6.76	\$6.76		EIA, December 2019
Potable Water					
Potable Water Potable Water	\$/MMBtu \$/CCF	\$6.76 5.98	\$6.76 5.98	1 CCF - 748 gal	EIA, December 2019 Seattle Public Utilities Website, December 2019
Potable Water Potable Water Pyrolysis	\$/CCF	5.98	5.98	1 CCF = 748 gal	
Potable Water Potable Water Pyrolyais Hauling Fee (Fixed local)	\$/CCF \$/WT	5.98 \$6.65	5.98 \$6.65		Seattle Public Utilities Website, December 2019
Potable Water Potable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar)	\$/CCF \$/WT \$/WT	5.98 \$6.65 \$0.0	5.98 \$6.65 \$0.0	Bioforcetech's responsibility for hauling, distributing, and selling	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrobysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value	\$/CCF \$/WT \$/WT \$/WT	5.98 \$6.65 \$0.0 \$250.0	5.98 \$6.65 \$0.0 \$250.0	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrobysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value	\$/CCF \$/WT \$/WT \$/WT %	5.98 \$6.65 \$0.0 \$250.0 10	5.98 \$6.65 \$0.0 \$250.0 10	Bioforcetech's responsibility for hauling, distributing, and selling	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract)	\$/CCF \$/WT \$/WT \$/WT \$/WT %	5.98 \$6.65 \$0.0 \$250.0 10 30	5.98 \$6.65 \$0.0 \$250.0 10 30	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrobysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract)	\$/CCF \$/WT \$/WT \$/WT % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40	5.98 \$6.65 \$0.0 \$250.0 10 30 40	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-4 (P3 Contract) Revenue Year 3-4 (P3 Contract)	\$/CCF \$/WT \$/WT \$/WT % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 3-12 (P3 Contract) Revenue Year 15-20 (P3 Contract)	\$/CCF \$/WT \$/WT \$/WT % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 3-14 (P3 Contract) Revenue Year 3-15-20 (P3 Contract) Revenue Year 15-20 (P3 Contract)	\$/CCF \$/WT \$/WT \$/WT % % % % % % hrs/yr	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 3-41 (P3 Contract) Revenue Year 15-20 (P3 Contract) Revenue Year 15-20 (P3 Contract) O&M Hours Operation and Maintenance	\$/CCF \$/WT \$/WT % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2. (P3 Contract) Revenue Year 1-2. (P3 Contract) Revenue Year 0-14. (P3 Contract) Revenue Year 15-20. (P3 Contract) Revenue Year 15-20. (P3 Contract) O&M Hours Operation and Maintenance Spare parts and Components	\$/CCF \$/WT \$/WT \$/WT % % % % % % hrs/yr	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrobysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 3-14 (P3 Contract) Revenue Year 3-14 (P3 Contract) Revenue Year 3-15-20 (P3 Contract) Operation and Maintenance Spare parts and Components Soli Blending	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019
Potable Water Potable Water Pyrolysia Hauling Fee (Fixed local) Hauling Fee (Bicchar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 1-2 (P3 Contract) Revenue Year 1-2 (P3 Contract) Revenue Year 1-5 20 (P3 Contract) Revenue Year 1-5 20 (P3 Contract) O&M Hours Operation and Maintenance Spare parts and Components Soll Biending Hauling Fee (Bulk Material)	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$7.06	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 \$10 \$15.46 \$1,500,000 \$7.06	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Potable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 1-42 (P3 Contract) Revenue Year 15-20 (P3 Contract) Revenue Year 15-20 (P3 Contract) Revenue Year 15-20 (P3 Contract) Oexention and Maintenance Operation and Maintenance Spare parts and Components Soll Biording Hauling Fee (Bulk Material) Hauling Fee (Exed local)	\$/CCF \$/WT \$/WT \$/WT % % % % % % % htts/yr \$/WT \$/WT \$/WT	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,50.000 \$7.06 \$6.65	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 \$100 \$15.46 \$1,500.000 \$7.06 \$6.65	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Portobie Parologia Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 15-20 (P3 Contract) O&M Hours Operation and Maintenance Spare parts and Components Soll Blending Operation Cost	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 \$15.46 \$1.50.000 \$7.06 \$6.65 \$102.60	5.98 \$6.65 \$0.0 \$250.0 10 30 40 \$00 \$15.46 \$1,500.000 \$7.06 \$6.65 \$102.60	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Potable Water Pyrolysia Hauling Fee (Fixed local) Hauling Fee (Bicchar) Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 3-14 (P3 Contract) Ogeration and Maintenance Spare parts and Components Soll Bionding Hauling Fee (Bulk Material) Hauling Fee (Bulk Material) Hauling Fee (Fixed local) Soil Biending Operation Cost Sawdust	\$/CCF \$/WT \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$1.546 \$1.500.000 \$1.5.46 \$1.500.000 \$1.5465 \$1.02.80 \$1.29	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$1.546 \$1,500,000 \$1.546 \$1,02,60 \$1.02,60 \$1.02,60 \$1.02,60 \$1.02,60 \$1.00	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Potable Water Pytolysi Hauling Fee (Fixed local) Hauling Fee (Bischar) Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 9-14 (P3 Contract) Revenue Year 9-14 (P3 Contract) O&M Hours Operation and Maintenance Spate parts and Components Soll Blending Hauling Fee (Bulk Material) Hauling Fee (Fixed local) Soil Blending Operation Cost Sawdust Fine Sand Cost	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 \$15.46 \$1.50.000 \$7.06 \$6.65 \$102.60	5.98 \$6.65 \$0.0 \$250.0 10 30 40 \$00 \$15.46 \$1,500.000 \$7.06 \$6.65 \$102.60	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Portobia Pyrologia Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 1-2 (P3 Contract) Revenue Year 1-2 (P3 Contract) Revenue Year 1-5 20 (P3 Contract) O&M Hours Operation and Maintenance Spare parts and Components Soil Blending Operation Cost Sawdust Fine Sand Cost Soil Blend Revenues	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$14.29 \$8.23	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Porobysic Hauling Fee (Fixed local) Hauling Fee (Bicchar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 1-2 (P3 Contract) Revenue Year 1-520 (P3 Contract) Revenue Year 1-520 (P3 Contract) Revenue Year 1-520 (P3 Contract) Operation and Maintenance Spare parts and Components Soll Blending Hauling Fee (Fixed local) Soil Blending Operation Cost Sawdust Fine Sand Cost Soil Blending Fee	\$/CCF \$/WT \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 \$00 \$1.546 \$1.500.000 \$1.500.000 \$1.500.000 \$2.500 \$2.500	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 \$15.46 \$1.500.000 \$1.546 \$6.65 \$1.02.60 \$1.429 \$8.23 \$25.00	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Potable Water Pytolpia Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 12 (P3 Contract) Revenue Year 38 (P3 Contract) Revenue Year 914 (P3 Contract) O&M Hours Operation and Maintenance Spare parts and Components Soll Blending Hauling Fee (Fixed local) Soil Blending Operation Cost Sawdust Fine Sand Cost Soil Blend Revenues Tipping Fee Bagged Product	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1.50,000 \$1.5.46 \$1.50,000 \$1.5.46 \$4.29 \$1.4.29 \$1.4.29 \$1.4.29 \$1.4.29 \$1.4.29 \$1.4.29 \$1.4.29 \$1.4.29 \$1.4.29 \$1.5.000 \$1.5.000 \$1.5.000 \$1.5.000 \$1.5.000 \$1.5.000 \$1.5.0000 \$1.5.0000 \$1.5.0000 \$1.5.0000 \$1.5.0000 \$1.5.0000 \$1.5.0000 \$1.5.0000 \$1.5.0000 \$1.5.00000 \$1.5.00000 \$1.5.00000 \$1.5.000000 \$1.5.00000000000000000000000000000000000	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500.000 \$7.06 \$6.65 \$102.60 \$14.29 \$25.00 \$25.00 \$54.00	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Portable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value KC Share of Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 1-2 (P3 Contract) Revenue Year 1-2 (P3 Contract) Revenue Year 1-5/20 (P3 Contract) Revenue Year 1-5/20 (P3 Contract) Operation and Maintenance Spare parts and Components Soll Blending Hauling Fee (Fixed local) Soil Blending Operation Cost Sawdust Fine Sand Cost Soil Blend Revenues Tipping Fee Bagged Product	\$/CCF \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23 \$25.00 \$25.00 \$4	5.98 5.98 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$1.5.46 \$1,500,000 \$1.5.46 \$1,500,000 \$1.5.46 \$1.5.06 \$1.5.26 \$1.29 \$5.23 \$2.23 \$2.25.00 \$4.29 \$5.40 \$2.5.00 \$2.5.00 \$4.29 \$2.5.00 \$4.29 \$2.5.00 \$4.20 \$4.20 \$2.5.00 \$4.00 \$4.00 \$4.00 \$4.00 \$4.00 \$4.00 \$4.00 \$4.00 \$4.00 \$4.00 \$4.00 \$4.00	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Portable Water Pyrolysia Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P8 Contract) Revenue Year 15-20 (P3 Contract) Operation and Maintenance Operation and Maintenance Soll Blending Hauling Fee (Bulk Material) Hauling Fee (Fixed local) Soil Blending Fine Sand Cost Soil Blend Revenues Tipping Fee Bagged Product Bagged Product Bagged Product	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$280.0 10 30 40 80 100 \$10.40 \$15.46 \$1.50.000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23 \$25.00 \$54.00 \$54.00 \$25.00	5.98 5.98 5.0.0 \$250.0 10 30 40 80 100 \$10.4 80 100 \$10.4 \$0 \$15.46 \$1.500.000 \$1.54.66 \$1.02.60 \$1.4.29 \$2.5.00 \$5.4.00 \$4.00 \$2.50.0	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xisx, December 2019
Potable Water Portable Water Pyrolysis Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value Revenue Year 1.2 (P3 Contract) Revenue Year 3.8 (P3 Contract) Revenue Year 9.14 (P3 Contract) Revenue Year 9.14 (P3 Contract) Odd Mours Operation and Maintenance Spare parts and Components Soil Blending Hauling Fee (Buck Material) Hauling Fee (Fixed local) Soil Blending Operation Cost Sawdust Fine Sand Cost Soil Blending Product Bagged Product Bagged Product Bagged Product Bulk Wholesale	\$/CCF \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT \$/WT	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23 \$25.00 \$25.00 \$4	5.98 5.98 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$1.5.46 \$1,500,000 \$1.5.46 \$1,500,000 \$1.5.46 \$1.5.06 \$1.5.26 \$1.29 \$5.23 \$2.23 \$2.25.00 \$4.29 \$5.40 \$2.5.00 \$5.40 \$2.5.00 \$2.5.00 \$4.29 \$5.40 \$2.5.00 \$4.29 \$5.40 \$2.5.00 \$4.29 \$5.40 \$5.40 \$2.500 \$5.400 \$4.29 \$5.400 \$5.400 \$5.400 \$5.400 \$5.400 \$5.400 \$5.400 \$5.400 \$5.400 \$5.400 \$5.400	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019
Potable Water Potable Water Pytolysi Hauling Fee (Fixed local) Hauling Fee (Bischar) Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P3 Contract) Revenue Year 9-14 (P3 Contract) Odd Mours Operation and Maintenance Spare parts and Components Soll Blending Hauling Fee (Fixed local) Soil Blending Fine Sand Cost Soil Blend Revenues Tipping Fee Bagged Product Bagged Product Bagged Product Bagged Product	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$280.0 10 30 40 80 100 \$00 \$15.46 \$1.5.46 \$1.50.000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23 \$25.00 \$54.00 \$54.00 \$25.00 \$54.00 \$25.00 \$20.00	5.98 5.98 5.0.0 \$250.0 10 30 40 80 100 \$15.46 \$1.500.000 \$15.46 \$1.00.000 \$1.54.65 \$1.02.60 \$1.4.29 \$2.5.00 \$54.00 \$4.00 \$2.5000 \$2.5000 \$2.5000 \$2.5000 \$2.50000 \$2.5000 \$2.5000 \$2.5000 \$2.50000 \$2.50000 \$2.50	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xisx, December 2019
Potable Water Portable Water Pyrolysis Hauling Fee (Elschar) Biochar Value KC Share of Biochar Value Revenue Year 12 (P3 Contract) Revenue Year 38 (P3 Contract) Revenue Year 914 (P3 Contract) Revenue Year 914 (P3 Contract) O&M Hours Operation and Maintenance Spare parts and Components Soll BlendIng Hauling Fee (Ekulk Material) Hauling Fee (Ekulk Material) Hauling Fee (Fked local) Soil BlendIng Operation Cost Sawdust Fine Sand Cost Soil Blend Revenues Tipping Fee Bagged Product Bagged Product Bagged Product Bulk Retail Bulk Wholesale Trestment Plants West Point	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1.50.000 \$15.46 \$1.50.000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23 \$2.5.00 \$4.4.00 \$4.00 \$2.5.00 \$4.000 \$20.000 \$10.000 \$2.5.000 \$2.5.000 \$2.5.000 \$2.5.000 \$2.5.0000 \$2.5.0000 \$2.5.0000 \$2.5.0000 \$2.5.00000 \$2.5.00000 \$2.5.00000 \$2.5.00000000000000000000000000000000000	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500.000 \$15.46 \$1,500.000 \$14.29 \$8.23 \$25.00 \$54.00 \$4.00 \$25.00 \$4.00 \$25.00 \$25.00 \$4.00 \$25.00 \$4.00 \$25.00 \$4.00 \$25.00 \$5.00 \$4.00 \$25.00 \$5.0	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019 King County Communicatio
Potable Water Portable Water Pyrolysia Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 1-520 (P3 Contract) Operation and Maintenance Operation and Maintenance Spare parts and Components Soll Blending Hauling Fee (Fixed local) Soil Blend Revenues Fine Sand Cost Soil Blend Revenues Tipping Fee Bagged Product Bagged Product Bagged Product Bulk Wholesale Treatment Plants West Point Operation and Maintenance	\$/CCF \$/WT \$/CY \$/CY \$/CY \$/CY \$/CY \$/CY \$/CY	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23 \$25.00 \$54.00 \$54.00 \$25.00 \$4.00 \$25.00 \$14.29 \$8.23 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$14.29 \$25.00 \$10 \$10 \$10 \$10 \$10 \$10 \$10 \$	5.98 \$6.65 \$0.0 \$250.0 10 \$250.0 10 \$00 \$100 \$00 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$1.54.00 \$1.429 \$8.23 \$25.00 \$14.29 \$8.23 \$25.00 \$14.29 \$1.28	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting Assume high quality sawdust needed that is free of seeds and disease	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xisx, December 2019
Potable Water Portable Water Pyrolysia Hauling Fee (Fixed local) Hauling Fee (Bitchar) Biochar Value Revenue Year 1-2 (P3 Contract) Revenue Year 3-8 (P8 Contract) Revenue Year 15-20 (P3 Contract) Operation and Maintenance Operation and Maintenance Soll Blending Hauling Fee (Bulk Material) Hauling Fee (Fixed local) Soil Blending Hauling Fee (Fixed local) Soil Blending Hauling Fee (Fixed local) Soil Blending Operation Cost Sawdust Fine Sand Cost Soil Blend Revenues Tipping Fee Bagged Product Bagged Product Buik Retail Buik Rotail Buik Retail Buik Rotail Buik Retail Additional Operation and Maintenance Additional Operation and Maintenance	\$/CCF \$/WT \$/WT \$/WT % % % % % % % % % % % % %	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1.50.000 \$15.46 \$1.50.000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23 \$2.5.00 \$4.4.00 \$4.00 \$2.5.00 \$4.000 \$20.000 \$10.000 \$2.5.000 \$2.5.000 \$2.5.000 \$2.5.000 \$2.5.0000 \$2.5.0000 \$2.5.0000 \$2.5.0000 \$2.5.00000 \$2.5.00000 \$2.5.00000 \$2.5.00000000000000000000000000000000000	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500.000 \$15.46 \$1,500.000 \$14.29 \$8.23 \$25.00 \$54.00 \$4.00 \$25.00 \$4.00 \$25.00 \$25.00 \$4.00 \$25.00 \$4.00 \$25.00 \$4.00 \$25.00 \$5.00 \$4.00 \$25.00 \$5.0	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019 King County Communicatio
Potable Water Potable Water Pytolpia Hauling Fee (Fixed local) Hauling Fee (Biochar) Biochar Value Revenue Year 12 (PS Contract) Revenue Year 32 (PS Contract) Revenue Year 15-20 (PS Contract) Revenue Year 15-20 (PS Contract) Odd Hours Operation and Maintenance Spare parts and Components Soll Blending Operation Cost Sawdust Fine Sand Cost Soil Blending Operation Cost Bagged Product Bagged Product	\$/CCF \$/WT \$/ZC \$/ZC \$/ZC \$/ZC \$/WT \$/ZC \$/ZC \$/WT \$/WT \$/WT \$/WT \$/ZC \$/ZC \$/WT	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$7.06 \$6.65 \$102.60 \$14.29 \$8.23 \$25.00 \$4.40 \$4.00 \$4.00 \$4.00 \$25.00 \$4.00 \$25.00 \$4.00 \$4.00 \$4.00 \$4.00 \$5.40 \$4.00 \$5.40 \$4.00 \$5.40 \$4.00 \$5.40 \$4.00 \$5.40 \$4.23 \$6.65 \$4.00 \$5.40 \$4.00 \$5.40 \$4.23 \$6.65 \$4.00 \$5.40 \$4.00 \$5.40 \$4.00 \$5.40 \$4.00 \$5.40 \$4.29 \$6.25 \$6.25 \$4.00 \$5.40 \$4.00 \$5.40 \$4.00 \$5.40 \$4.00 \$5.40 \$5.40 \$4.00 \$5.40 \$	5.98 \$6.65 \$0.0 \$250.0 10 30 40 80 100 500 \$15.46 \$1,500,000 \$15.46 \$1,500,000 \$1,5.46 \$1,200,000 \$1,5.40 \$1,500,000 \$1,5,40 \$1,500,000 \$1,500,000 \$1,500,000 \$1,500,000 \$1,500,000 \$1,200,000 \$1,200,000 \$1,200,000 \$1,4.29 \$2,200 \$5,400 \$1,0000 \$1,0000 \$1,0000 \$1,0000 \$1,0000 \$1,0000 \$1,0000 \$1	Bioforcetech's responsibility for hauling, distributing, and selling Bioforcetech's approximate sale value Bioforcetech share of profit to KC 5750,000 for 120,000 WT/yr. Scaled to 200,000 WT/yr Contract fee Contract fee Contract fee Labor, Maintenance, Program op. Reduced based on shared cost with Composting Assume high quality sawdust needed that is free of seeds and disease	Seattle Public Utilities Website, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 Bioforcetech Communication, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xlsx, December 2019 King County Communication, CurrentProgrambudgetbreakdown.xl
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Emissions element	Units	Baseline Value	Value in	Notes for Baseline Values	References
	01110	Dusonno Tunuo	Model		
nit Conversions	kWh	0.0002928	0.0002928		
1 MMBtu =	kWh	293	293		
1 kg =	lb	2.205	2.205		
1 scf NG=	MMBtu	0.001	0.001	нни	
1 scf Scrubbed Biogas	MMBtu	0.00099	0.00099		
1 gal Gasoline	MMBtu	0.114	0.114		
1 gal Diesel	MMBtu	0.137381	0.137381		
1 GGE	MMBtu	0.125	0.125		
1 gal =	L	3.785	3.785		
1 tonne (MT) =	kg	1000	1000		
1 scf CH4=	lb	0.042	0.042		Biogas Volume Calculator v2, BEAM, EPA GHG Tool v5
1 scf Natural Gas (Compressed)=	lb	0.0458	0.0458		
obal Warming Potential	kg CO2e/kg CO2e	1	1		IPCC (2014). Climate Change 2014 Synthesis Report Fifth Assessment Report
4	kg CO2e/kg CO2e kg CO2e/kg CH4	28	28		IPCC (2014). Climate Change 2014 Synthesis Report Fifth Assessment Report IPCC (2014). Climate Change 2014 Synthesis Report Fifth Assessment Report
0	kg CO2e/kg N20	265	265		IPCC (2014). Climate Change 2014 Synthesis Report Fifth Assessment Report
octricity	10020/10120	200	200		
ghtwater Electricity	kg CO2e/MWh	8.9	8.9	SnoPUD (80% Hydro, <10% Nuclear, 7% Wind)	King County Communication, Sep 2019
uth Plant Electricity	kg CO2e/MWh	0	0	PSE, KC purchasing 100% renewable	King County Communication, Sep 2019.
est Point Electricity	kg CO2e/MWh	6.5	6.5		King County Communication, Sep 2019
ating					
al	kg CO2e/MMBtu	121	121	Includes production emmissions	Biomass Energy Centre (UK)
al	kg CO2e/MMBtu	104	104		2015 Climate Registry Table 12
1	kg CO2e/MMBtu	92	92	Includes production emmissions	Biomass Energy Centre (UK)
No.2	kg CO2e/MMBtu	74	74		2015 Climate Registry Table 12
t Gas	kg CO2e/MMBtu	67	67	Includes production emmissions	Biomass Energy Centre (UK)
t Gas	kg CO2e/MMBtu	53	53		2015 Climate Registry Table 12
ogas	kg CO2e/MMBtu	0	0	Excludes CO2 because biogas is biogenic	2015 Climate Registry Table 12.9.1
emicals	1.1.000. //	9.00	9.00		BEAM default
lymer	kg CO2e/kg polymer	0.90		Emission for use of ploymer	
ne thanol	kg CO2e/kg lime	3.71	0.90	Emission for use of lime (stabilization)	BEAM default NY Hunts Pt GHG SWEET model
ansportation Fuels	kg CO2e/gal methanol	3.71	3.71	Credit for methonal displaced	NT HUNIS PL GHG SWEET MODEL
ansportation rueis asoline	kg CO2e/L	2.83	2.83	Includes production emmissions	Elsayed et al., 2003
asoline	kg CO2e/L	2.80	2.80	Includes production emmissions	Biomass Energy Centre (UK)
soline	kg CO2e/L	2.32	2.32		2015 Climate Registry Table 13
esel	kg CO2e/L	3.14	3.14	Includes production emmissions	Biomass Energy Centre (UK)
esel	kg CO2e/L	2.70	2.70		2015 Climate Registry Table 13
ansportation					
el for biosolids land application	kg CO2e/WT solids applied	4.55	4.55		BEAM default
iel for Composting Machinery	Gallon/Day	274.00	274.00	Front End Loader (3.5 gal/hr -> 8 hrs) [4], Vertical/Horiz Aug Mixers (7 gph ->6 hrs) [2], Trommel Screen	
ier for composting machinery	Galion/ Day	214.00	274.00	(1 gal/hr->6 hrs)[1], Grinder (12 gal/hr -> 6 hrs) [1]	
el for Soil Blending Machinery	Gallon/Day	234.00	234.00	Front End Loader (3.5 gal/hr -> 8 hrs) [3], FEL (3.5 gal/hr -> 4 hrs) [1], Vertical/Horiz Aug Mixers (7 gph -	
				>6 hrs) [2], Trommel Screen (1 gal/hr->4 hrs)[1], Grinder (12 gal/hr -> 4 hrs) [1]	
C Fuel for Forestry Application	Gallon/WT	0.44	0.44	11,000 gallons of Diesel per 25,000 WT (2018)	King County Communication, Nov 2019
C Fuel for Biosolids Land Application	Gallon/WT	0.32	0.32	33,000 gallons of Diesel per 103,000 WT (2018)	King County Communication, Nov 2019
ssenger Vehicle Mileage	Miles/gallon gasoline	25.00	25.00		https://www.fueleconomy.gov/
cal Distribution Truck (full)	Miles/gallon diesel	6.00	6.00		
cal Distribution Truck (empty)	Miles/gallon diesel	10.00	10.00		
Biosolids Truck Hauling Mileage (full)	Miles/gallon diesel	4.18	4.18	Cation at a d	King County Communication, Nov 2019
Biosolids Truck Hauling Mileage (empty) Truck Capacity	Miles/gallon diesel WT/truck	8.00	8.00 31.00	Estimated	King County Communication, Nov 2019
cal Distribution Truck Capacity	CY/truck	18.00	18.00	15 CY for topsoil and 22 CY for mulch. Assume in between for compost	ning county communication, nov 2013
cal Compost/Soil Blend Capacity	CY/truck	3.00	3.00		
ansportation (Miles)	,	2.00	5.00		
IP Transportation to Off-site processing, Roundtrip	Miles	30	30	Distance to off-site composting, soil-blending, or pyrolysis	
edstock (Sand), Roundtrip	Miles	75	75	Average distance to several local bulk aggregate companies	
edstock (Woodchips, Sawdust), Roundtrip	Miles	160	160	Distance From Renton to Hampton Lumber Mills (selected for size via google)	
estern Washington (Foresty/or local agriculture), Roundtrip	Miles	70	70		King County Communication, Nov 2019
stern Washington (Agriculture), Roundtrip	Miles	420	420		King County Communication, Nov 2019
cal Application (Compost or local retail), Roundtrip	Miles	25	25		King County Communication, Nov 2019
gional Application (Biochar), Roundtrip	Miles	200	200		
d-use					
enario 1			1		
Bulk Land Application	%		-		
Western Washington Split	%	10	10		
Eastern Washington Split	%	90	90		
enario 2	117 (0		+		
Bulk Land Application (South Plant)	WT/Day	10			King County Construction New 2010
Western Washington Split (100% Forestry)	%	40	40		King County Communication, Nov 2019
Eastern Washington Split (100% Agriculture)	%	60	60		King County Communication, Nov 2019
oil Blending (West Point)	WT/Day	00	20		King County Communication, New 2010
Bagged Donated	%	20 10	20 10		King County Communication, Nov 2019
Donated Bulk Wholesaler	70	10 40	10		King County Communication, Nov 2019
Bulk Wholesaler Bulk Retail	%	40	40		King County Communication, Nov 2019
Composting (Brightwater)	% WT/Day	JU	30		ning overry ourinnumcation, nov 2013

Donated	%	10	10		King County Communication, Nov 2019
Bulk Wholesaler	%	40	40		
Bulk Retail	%	30	30		King County Communication, Nov 2019
Scenario 3					
Biochar Retail	%	100	100		
Fertilizer Offset (BEAM)					
Nitrogen Amount Added	%	4.00%	4.00%	%N by dry weight	
Nitrogen Offset	kg CO2e/kg N applied	-4	-4	Credit for N applied; Can assume 4% N by dry weight	BEAM default
Phosphorus Amount Added	%	1.50%	1.50%	%P by dry weight	
Phosphorus Offset	kg CO2e/kg P applied	-2	-2	Credit for P applied; Can assume 1.5% P by dry weight	BEAM default
Fertilizer Offset (King County)					
Nitrogen and Phosphorus Offset (Agriculture)	kg CO2e/ kg dry biosolds	-0.29	-0.29	Agriculture 1.54 (0.29 fertilizer offset, 1.25 accumulation of carbon in the soil)	King County Communication, December 2019
Nitrogen and Phosphorus Offset (Forestry)	kg CO2e/ kg dry biosolds	0	0	Forestry 1.0 (1.0 accumulation of carbon in the soil)	King County Communication, December 2019
Nitrogen and Phosphorus Offset (Compost)	kg CO2e/ kg dry biosolds	-0.29	-0.29	Compost 0.64 (0.29 fertilizer offset, 0.41 accumulation of carbon in the soil)	King County Communication, December 2019
Sequestration (BEAM)					
Land Application	kg CO2e/ kg dry biosolds	-0.25	-0.25		BEAM default
Mine Reclamation	kg CO2e/kg dry biosolds	-1.3	-1.3		BEAM Data Table for BC copper mine
Compost	kg CO2e/ kg dry biosolds	-0.25	-0.25		BEAM default
Soil Blend	kg CO2e/ kg dry biosolds	-0.25	-0.25		BEAM default
Sequestration (King County)		0.20	0.20		
Land Application (Agriculture)	kg CO2e/ kg dry biosolds	-1.25	-1.25	Agriculture 1.54 (0.29 fertilizer offset, 1.25 accumulation of carbon in the soil)	King County Communication, December 2019
Land Application (Agriculture)	kg CO2e/kg dry biosolds	-1.25	-1.25	Forestry 1.0 (1.0 accumulation of carbon in the soil)	King County Communication, December 2019
Compost	kg CO2e/ kg dry biosolds	-0.41	-0.41	Compost 0.64 (0.29 fertilizer offset, 0.41 accumulation of carbon in the soil)	King County Communication, December 2019
Soil Blend	kg CO2e/ kg dry biosolds	-0.41	-0.41	Assumed same as compost impacts	
Fugitive Emissions	Ng CO2C/ Ng ury biosoius	-0.41	-0.41	Assumed sume as compose impacts	
Digester (fixed cover)	of CH4 production	0.0001	0.0001	Through pressure relief valve only; 10% gas loss for 10 hrs/yr	sik estimate
Digester (floating cover)	of CH4 production	0.017	0.017	Based on 80-ft dia digester and 4-in annulus w/o water bath for skirt	sjk estimate
Sludge Dewatering (high s.g.)	g CH4/L of sludge	0.000022	0.000022	Assume 5% gas in sludge flow from well-mixed digester; no odor treatment	sjk estimate
Sludge Dewatering (low s.g.)	g CH4/L sludge	0.086	0.086	Assume 20% gas in sludge flow from poorly-mixed digester; no odor treatment	sik estimate
Sludge Dewatering with biofilter	g CH4/ L sludge	0.030	0.030	Assume 20% gas in studge now norm poor pointed digester, no duor treatment	sjk estimate: Nikiema et al., 2005
Sludge Dewatering with biolitier	g CH4/L sludge	0.013	0.013	Without RTO emission control; from residual and soluble gas	sik estimate
Sludge Drying	g CH4/L sludge	0.0001	0.0001	With RTO emission control at 1% slip (Andritz drier)	sik est; E. Jacobson on RTO
Cogen (recip engine; low eff)	of CH4 to engine	0.02088	0.02088	with RTO emission control at 1% silp (Andriz drier)	Willis et al. 2013
Cogen (recip engine; high eff)	of CH4 to engine	0.02088	0.02088		Willis et al. 2013 Willis et al. 2013
Cogen Turbine/Microturbine	of CH4 to engine	0.000438	0.000438		Willis et al. 2013 Willis et al. 2013
Boiler (very efficient)	of CH4 to turbine	0.000012	0.00012	Also see "Heating (boiler)" above for alternative CH4 and N20 emissions	Willis et al. 2013 Willis et al. 2013
Gas upgrading with thermal ox	of CH4 to scrubber	0.001	0.00005	PA and membrane scrubbers 10% slip and 1% slip from thermal oxidizer	Eron Jacobson
	of CH4 to scrubber	0.001	0.001	Water solvent w/o RTO 1.5% slip	Eron Jacobson
Gas upgrading Fuel cell	of CH4 to scrubber	0.015	0.0105	Requires gas upgrade prior to fuel cell	Willis et al. 2013
Flare (candle stick)	of CH4 to flare	0.0105	0.0105	Requires gas upgrade prior to ruel cell	Willis et al. 2013 Willis et al. 2013
		0.004	0.004	PC areas 4% twicely achieve 0.4%	
Flare (modern enclosed) Flare (efficient)	of CH4 to flare of CH4 to flare	0.004	0.004	BC specs 1%; typically achieve 0.4%	sjk estimate BEAM Data Tables
Flare (enclosed; low NOx)	of CH4 to flare	0.003	0.0003		Willis et al. 2013
Land Application (High), CH4		0.00003	0.00003	From residual and soluble gas after dewatering; same as drying	sik estimate
Land Application (High), CH4 Land Application (High), N20	g CH4/L sludge	0.01	0.01	From residual and soluble gas after dewatering; same as drying	sjk estimate
Land Application (High), N20 Land Application (Low), CH4	kg N20/ kg N g CH4/L sludge	0.50%	0.005	From residual and soluble gas after dewatering; same as drying From residual and soluble gas after dewatering; same as drying	sjk estimate
Land Application (Low), CH4 Land Application (Low), N20		0.002	0.01	From residual and soluble gas after dewatering; same as drying	sjk estimate
Land Application (Low), N20 Landfill (poor capture), CH4 Capture	kg N20/ kg N	0.002	0.002	Assume 40% additional VSR (sjk estimate from Sacramento FSLs)	BEAM Data Tables
Landfill (poor capture), CH4 Capture Landfill (poor capture), CH4 Oxidation	+	0.2	0.2	Assume 40% additional VSR (sjk estimate from Sacramento FSLs) Assume 40% additional VSR (sjk estimate from Sacramento FSLs)	BEAM Data Tables
Landfill (good capture), CH4 Oxidation	+	0.1	0.1	Assume 40% additional VSR (sjk estimate from Sacramento FSLs) Assume 40% additional VSR (sjk estimate from Sacramento FSLs)	BEAM Data Tables
	1	0.75			
Landfill (good capture), CH4 Oxidation	1		0.4	Assume 40% additional VSR (sjk estimate from Sacramento FSLs)	BEAM Data Tables BEAM Data Tables
Sludge Lagoon, CH4 Capture Sludge Lagoon, CH4 Oxidation	1	0	0	Assume 40% additional VSR (sjk estimate from Sacramento FSLs) Assume 40% additional VSR (sjk estimate from Sacramento FSLs)	BEAM Data Tables BEAM Data Tables
	ling Old (ling O down i			Assume 40 % auunonai VSR (SjK esumate from Sacramento FSLS)	
Compost (uncovered)	kg CH4/kg C dry wt	0.01	0.01		BEAM Data Tables
Compost (uncovered)	kg N20/kg N dry wt			Assume 40% remained in increasing modia biofilter (20% for extensis modia)	BEAM Data Tables
Compost (covered with biofilter)	kg CH4/kg C dry wt	0.006	0.006	Assume 40% removal in inorganic media biofilter (20% for organic media)	sjk estimate; Nikiema et al., 2005
Compost (with C:N above 30)		0.04	0.01		
Soil Blend, CH4	kg CH4/kg dry wt	0.01	0.01	Assume same as uncovered compost	sjk estimate
Soil Blend, N2O	kg NO2 initial N	0.013	0.013	Assume same as uncovered compost	sjk estimate
Incineration, CH4	kg CH4/ kg dry solids	0.0000485	0.0000485	Assumes 20% TS cake	BEAM Data Tables
Incineration, N20	kg N20/kg dry wt	0.00049	0.00049	Assumes 20% TS cake	BEAM Data Tables

Final TS, W NG NG LHVI Electricity R Power Generar No. of Trucks Required (tr Digester Gas Produced Methane Produced Scrubbed Gas	S1 Output Summary Scenario 1 - [Baseline] 100% Class B application with MAD at all three plants No. Req. (r/h) 8706 No. NG (HY MMBtu/h) 11 Electricity Req. (k/h) 3138 Power Generation (k/h) 1760 Net Prover (k/h) -1378 Digester Gas Produced (scrim)** 3325 Metane Produced (scrim)** 1995 Scrubed Gas (scrim)** 700 Polymer Use (bl/day) 4611														
	West Point														
I	Feedstock	Stabilization		Gas Utilization		Dewatering	End Use								
Dry Mass Flow TS VSR Calorific Value	225560 PPD 6.1% 81% 64% 10,000 Btu/lb VS Feedstock Type PS + WAS	Digester (Meso) VSR 64.0%	CHP Engine 909 NG LHV Therm Eff. 36% Nat gas usage, cfh 0 Biogas Fuel use 44%	Boller 909 NG LHV Therm Eff. 85% Nat gas usage, cfh 0 Biogas Fuel use 10%		Centrifuge 92% Capture 29% TS	100% Land Application 100295 PPD 28.5% 61% End Use Land Application								
×.	Energy Consumption 0 hp 90% Efficiency	Sludge Intet Temp 60 Operation Temp 98 F 553 Bhuf 15 ctills VS 5.09 MMBBuhr Energy Consumption 40 hptunit 10% Efficiency Shell Heat Loss 15% Duty No. 5	Engine Electrical Eff. 34% Heat Recovery 6.36 MMBuuhr 289 hplunit 90% Efficiency Duty No. 1	Heat Recovery 2.0.2 MMBluhr Energy Consumption 40 hplunit 90% Efficiency Duty No. 2 Duty No.	hp/unit Efficiency 2	Energy Consumption 225 hplunit 30% Efficiency Duty No. 4 Poymer Use 30 Ibs/DT	Energy Consumption 0 topunit 90% Efficiency								
Wet Mass Flow Dry Mass Flow VS Water TS VS Wet flow Calorific Value Electrical Demand Unit Heat Bal. Total Heat Bal. Cum Junt Process Fuel Bal. Cum Junt Process Fuel Bal. Cum Unit Process Fuel Bal. Cum Unit Process Fuel Bal. Cum Unit Process Fuel Bal. Generated Steam Power Generation No of Trucks Required Vehicle Fuel Consumption Digester Gas Produced Methane Production Methane Utilized Scrubbed Gas Unit Polymer Use	154,276 Ibihr 9,411 Ibihr 112.9 DTPD 7,620 Ibihr 144,865 Ibihr 4,878 Ibihr 4,878 Ibihr 10,000 Btulib VS 0.0 MBBuihr 0 Scfm 0 scfm	149.398 Ib/hr 443.33 Ib/hr 54.4 DTPD 2/143 Ib/hr 13.63% Ib/hr 61% Ib/hr 28.6 gpm 10.000 Bull/b VS 58.5 MMBhu/hr 58.5 MMBhu/hr 58.5 MMBhu/hr 0.00 Scfm 0.00 Scfm 0.00 Scfm 0.00 Scfm 0.20 Scfm 0.30 Scfm 0 galdsty 752 Scfm 0 scfm 0 Scfm 0 Scfm 0 Scfm 0 Scfm 0 Scfm	149,398 Ibhr 4,533 Ibhr 54.4 DPD 2,743 Ibhr 144,865 Ibhr 3.03% 61% 61% Ibhr 2,86.5 gpm 10,000 Builb VS 238.7 KW 6.36 MMBluhr 0.00 MMBluhr 0.00 MMBluhr 0.00 MMBluhr 0.00 Buhb VS 23.4 MMBluhr 0.6 Buhb 17.6 MMBluhr 0.8 scfm 0.9 scfm 0.9 scfm 0.8 scfm 1368 scfm 0.8 scfm	49,398 Ibhr 4,533 Ibhr 54.4 DPD 2,743 Ibhr 144,865 Ibhr 3.05% 61% 0 Ibhr 0 Ibhr 0 Bhr 0.0 MMBuhr 0.00 MWBuhr 0.00 Bhr 0.00 MWBuhr 0.00 G.00 0 galday 0 scim 0 scim 0 scim 0 scim 0	Ib/hr Ib/hr DTPD Ib/hr Ib/hr Bh/r Btu/lb VS KW MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr Ib/hr Bh/hr Btu/lb S MBtu/hr Ib/hr Ib/hr Ib/hr Ib/hr Ib/hr	14,663 Ib/Ir 4,179 Ib/Ir 4,179 Ib/Ir 50.1 DTPD 2,528 Ib/Ir 10,084 Ib/Ir 2,85% 61% 0 Ib/Ir 746.0 KW 0.00 MMBru/Irr 0.00 Scfm 0.50 MV 0.50 Scfm 0.51 BU/day	14,653 Ibihr 4,179 Ibihr 50.1 DPD 2,528 Ibihr 10,484 Ibihr 28,50% Ibihr 61% Ibihr 0 Ibihr 28.3 gpm 0.0 Bulb VS 0.0 MBEuhr 0.00 MMBEuhr 0.00 MMBEuhr 0.00 MMBEuhr 0.00 MMBEuhr 0.00 MMBEuhr 0.00 Scim 0.00 Scim 0.00 Scim 0.00 MBEuhr 0.00 MBEuhr 0.00 Scim 0.00 Scim								

South Plant

Feedstock	Stabilization		Gas Uti	Dewatering	End Use		
		•				·	100% Land
263760 PPD 6.2% 85.8% 60.0% 10,000 Btw/lb VS	Digester (Meso)	CHP Engine 909 NG LHV	Boiler 909 NG LHV	Biogas Upgrading	Flare	Centrifuge 95% Capture 23% TS	121334 PPD 22.9% 71%
Feedstock Type PS + WAS	VSR 60.0%	Nat gas usage, cfh 0	Therm Eff. 85% Nat gas usage, cfh 8,706 Biogas Fuel use 0%	Nat gas usage, cfh O Biogas Fuel use 85%			End Use Land Application
Energy Consumption 0 hp/unit 90% Efficiency	Studge Inlet Temp 65 F Operation Temp 98 F 550 Blu/cf 16.24 cfflb VS 5.85 MMBtuhr Energy Consumption 40 hptunit 100% Efficiency Shell Heat Loss 15% Duty No. 4	145 hp/unit 90% Efficiency	Heat Recovery 6.73 MMBtu/hr Energy Consumption 40 hp/unit 90% Efficiency Duty No. 2	Energy Consumption 738 hplunit 100% Efficiency Duty No. 1	Energy Consumption 0 hp/unit 90% Efficiency Duty No. 2	Energy Consumption 223 hplunit 90% Efficiency Duty No. 4	Energy Consumption 0 hplunit 90% Efficiency
_ +		(2-1 -0		Ŵ ŗ ∎₽		Polymer Use 35 ibs/DT	
177,258 Ib/hr 10,990 Ib/hr 13,13 DTPD 9,439 Ib/hr 16,205 Ib/hr 6,205 Ib/hr 5,666 Ib/hr 354.2 gpm 10,000 Bt/l/h 0.0 kW 0 MMBtul/hr 0 MMBtul/hr 0 MMBtul/hr 0 MMBtul/hr 0 MMBtul/hr 0 MMBtul/hr 0 gal/day 0.00 rcxts/day 0 gal/day 0 scfm 0 scfm 0 scfm 0 scfm	171,592 lbhr 5,324 lbhr 6,3,9 0TPD 3,773 lbhr 166,268 lbhr 3,10% 71% 0 lbhr 3,40% gpm 10,000 Btulb VS 119,4 kW 6.73 MMBtuhr 6.74 MMBtuhr 0.00 MMBtuhr 50.61 MMBtuhr 50.61 MMBtuhr 0 lbhr 153.4 scfm 920 scfm 0 scfm 0 scfm 0.00 scfm 0.01 scfm	171,592 Buhr 5,324 Buhr 6,39 DTPD 3,773 Buhr 166,288 Buhr 3,10% 71% 0 Buhr 342.9 gpm 10,000 Builts VS 0.0 MMBuhr -6.73 MMBuhr 0.00 Scht 0.00 Truckatday 0 scht 0 scht	171,592 Ibhr 5,324 Ibhr 63.9 DTPD 3,773 Ibhr 166,268 Ibhr 3,0% 71% 0 Ibhr 342.9 gpm 10,000 Bulb VS 66.3 kW 6.73 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.01 Ibhr 0.02 MMBtuhr 0.03 Galday 0 Ibhr 0.00 MMBtuhr 0.00 Scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 Iblday	171,592 Ibhr 5,24 Ibhr 63,3 OTPD 3,773 Ibhr 166,268 Ibhr 3,10% 71% 0 Ibhr 342,9 gpm 10,000 Btull VS 550,4 kW 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 7.91 MMBtuhr 0.00 MMBtuhr 0.00 mMBtuhr 0.00 mMBtuhr 0.00 mMBtuhr 0.00 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 Ibday	171,592 Ib/hr 5,324 Ib/hr 6,33 DTPD 3,773 Ib/hr 166,268 Ib/hr 3,10% T1% 0 Ib/hr 342,9 gpm 10,000 Btu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 Bh/hr 0.00 Scfm 0 Ib/hr 0.30 Scfm 0 scfm 0 Scfm 0 Ib/hr	22,077 Ibhr 5,356 Ibhr 60,7 DTPD 3,583 Ibhr 17,021 Ibhr 71,021 Ibhr 71,021 Ibhr 0 Ibhr 10,000 Builb VS 746.0 KW 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0 Ibhr 0.00 trucksday 0 scm 0 scm 0 scm 0 scm 0 scm	22,077 Ibhr 5,056 Ibhr 60,7 DTPD 3,883 Ibhr 17,021 Ibhr 22,90% 71% 0 Ibhr 0.0 Bully V 0.0 Bully V 0.0 MMStuhr 0.00 Bully V 0.00 MMStuhr 0.00 Bully V 0.00 MMStuhr 0 Ibhr 0.00 MMStuhr 0 Bully V 9.00 truckiday 0 scfm 0 scfm 0 Iblday

Brightwater_													
Feedstock	Stabilization	Gas Utilization	Dewatering	End Use									
				100% Land Application									
93910 PPD 5.8% 90% 61% 10,000 Btu/lb VS	Digester (Meso) VSR 60.9%	Boiler 909 NG LHV	Centrifuge 93% Capture 20% TS	39295 PPD 20.0% 78%									
Feedstock Type PS + WAS		Therm Eff. 85% Nat gas usage, cfh encyses rus 70%		End Use Land Application									
Energy Consumption 0 hptunit 90% Efficiency	Sludge Inlet Temp 65 F Operation Temp 98 F 550 Bhu/cf 16 cfll VS 2.23 MMBtu/hr Energy Consumption 40 hptunit 100% Efficiency Shell Heat Loss 15% Duty No. 3	Heat Recovery 11.22 MMBtu/hr Energy Consumption 40 hplunit 90% Efficiency Duty No. 1 Duty No. 1	Energy Consumption 200 hplunit 90% Efficiency Duty No. 2 Polymer Use 35 Ibs/DT	Energy Consumption 0 hplunit 90% Efficiency									
67,464 lb/hr	65.321 lb/hr	65.321 lb/hr	8,186 ibhr	3,186 Ib/hr									
3,913 lb/hr 47.0 DTPD 3,517 lb/hr 63,551 lb/hr 5.80% 90%	1,770 lb/hr 21.2 DTPD 1,374 lb/hr 63,551 lb/hr 2,71% 78%	1,770 Iblhr 1,770 Iblhr 21.2 DTPD 21.2 DTPD 1,374 Iblhr 1,374 Iblhr 63,551 Iblhr 63,551 Iblhr 78% 78% 78%	1,637 lb/hr 19.6 DTPD 1,271 lb/hr 6,549 lb/hr 20.00% 78%	1,637 Ib/hr 19.6 DTPD 1,271 Ib/hr 6,549 Ib/hr 20.00% 78%									
2,143 Iblhr 134.8 gpm 10,000 Btullb VS 0 kW 0 MMBtuhr 0 MMBtuhr 0 MMBtuhr 0 MMBtuhr 0 MMBtuhr	0 lb/hr 130.5 gpm 10,000 Btullb VS 88.5 kW -2.56 MMBtul/hr 0.00 MMBtul/hr 0.00 MMBtul/hr 18.86 MMBtul/hr	0 IbIhr 0 IbIhr 130.5 gpm 130.55 gpm 10,000 Btulib VS 10,000 Btulib VS 33.2 kW 0.0 kW 11.22 MMBtulhr 0.00 MMBtulhr 8.66 MMBtulhr 0.66 MMBtulhr 0.00 MMBtulhr 0.00 MMBtulhr -13.20 MMBtulhr -5.66 MMBtulhr -5.66 MMBtulhr -0.00 MMBtulhr	0 Ibhr 16.4 gpm 10,000 Btulls VS 33.1.6 KW 0.00 MMBbuhr 0.00 MMBbuhr 0.00 MMBbuhr 0.00 MMBbuhr 0.00 MMBbuhr	0 Ib/hr 16.4 gpm 0.0 Btu/lb VS 0.0 k/W 0.00 MMBtu/hr 8.66 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr									
0 lb/hr 0 MW 0.00 trucks/day 0 gal/day 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 lb/day	0 Ibhr 0.00 MW 0.00 trucks/day 0 gal/day 571 scfm 343 scfm 0 scfm 0 scfm 0 scfm 0 lb/day	0 IbIhr 0 Ib/hr 0.00 MW 0.00 MW 0 gal/day 0 gal/day 0 scfm 0 scfm 0 scfm 0 scfm -240 scfm 0 scfm 0 lb/day 0 lb/day	0 Ibl/hr 0.00 MW 0.00 trucks/day 0 gal/day 0 scfm 0 scfm 0 scfm 0 scfm 743 Ibl/day	0 lb/hr 0.00 MW 4.00 trucks/day 0 gal/day 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 lb/day									

<u>Brightwater</u>

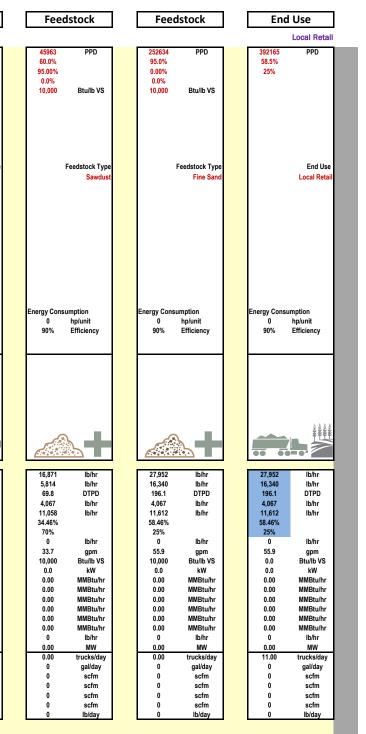
Scenario 2 - TAD with Batch Tanks at West Point to Soil Blending, Cambi at South Plant to direct Land App, and Brightwater with MAD and Off-site Composting.

S2 Output Summary	
Final TS, Wet (WT/D)	0
NG Req. (cfh)	15611
NG (LHV MMBtu/h)	14
Net heat (MMBtu/h)	9
Electricity Req. (kWh)	4222
Power Generation (kWh)	1886
Net Power (kWh)	-2336
No. of Trucks Required (trucks/day)	34
Digester Gas Produced (scfm)**	3419
Methane Produced (scfm)**	2052
Scrubbed Gas (scfm)**	708
Polymer Use (Ib/day)	6359

West Point

Off-site Soil Blending

	Feedstock	Stabilization	Energy Recovery		Gas Utilization	Dewatering	End Use	Feedstock
							100% Off-Site Soil Blending	
Dry Mass Flow TS VS Calorific Value	225860 PPD 6.1% 81% 68% 10,000 Btu/lb VS	Digester (Thermo) VSR 68.0%	HEX	CHP Engine 909 NG LHV	Boiler 909 NG LHV	Centrifuge 92% Capture 29% TS	93568 PPD 28.5% 58%	93568 PPD 28.5% 57.66% 10,000 Btu/lb VS
%	Feedstock Type PS + WAS		Inlet Temperature 131 F Outlet Temperature 100 F	Therm Eff. 36% Nat gas usage, cfh 0 Biogas Fuel use 44%	Therm Eff. 85% Nat gas usage, cfh 0 Biogas Fuel use 10%		End Use Off-Site Soil Blending	Feedstock Type Dewatered Cake
	Energy Consumption 0 hp 90% Efficiency	Sludge Inlet Temp 65 F Operation Temp 131 F 560 Btu/cf 15 cf/lb VS 10.18 MMBtu/hr Energy Consumption 40 hp 90% Efficiency Shell Heat Loss 15%	HEX Efficiency 70 % 3.24 MMBtu/hr Energy Consumption 150 hp 90% Efficiency	Engine Electrical Eff. 34% Heat Recovery 6.82 MMBtu/hr Energy Consumption 145 hp/unit 90% Efficiency	Heat Recovery 2.16 MMBtu/hr Energy Consumption 40 hp/unit 90% Efficiency 90% Efficiency		Energy Consumption 0 hp/unit 90% Efficiency	Energy Consumption 0 hp/unit 90% Efficiency
	*	Duty No. 5	Duty No. 1	Duty No. 2	Duty No. 2 Duty No.	2 Duty No. 4 Polymer Use 30 Ibs/DT		_ +
Wet Mass Flow Dry Mass Flow VS Water TS VS Wet flow Calorific Value Electrical Demand Unit Heat Bal. Total Heat Bal. Unit Aux. Fuel Bal. Cum Unit Process Fuel Bal. Generated Steam Power Generation No of Trucks Required Vehicle Fuel Consumption Digester Gas Produced Methane Utilized Scrubbed Gas Unit Polymer Use	144,865 lb/hr 6.10% 81% 5,182 lb/hr 308.3 gpm 10,000 Btu/hr 0 MMBtu/hr 0 MMBtu/hr 0 MMBtu/hr 0 MMBtu/hr 0 MMBtu/hr 0 MMBtu/hr 0 MMBtu/hr 0 MMBtu/hr 0 MMBtu/hr 0 MMBtu/hr	149,094 Ib/hr 4,229 Ib/hr 50.7 DTPD 2,439 Ib/hr 144,855 Ib/hr 144,855 Ib/hr 2,84% 58% 0 Ib/hr 297.9 gpm 10,000 Btu/lb VS 165.8 kW -11.71 MMBtu/hr 0.00 MMBtu/hr 43.53 MMBtu/hr 0.00 Mb/tu/hr 43.53 MMBtu/hr 0.00 mWb/tu/hr 0.00 trucks/day 0 gal/day 1295 scfm 777 scfm 0 scfm 0 scfm 0 scfm	149,094 Ib/hr 4,229 Ib/hr 50.7 DTPD 2,439 Ib/hr 144,865 Ib/hr 2,84% 58% 0 Ib/hr 29.7.9 gpm 10,000 Btu/lb VS 124.3 kW 3.24 MMBtu/hr 0.00 MBtu/hr 0.00 MBtu/hr 0.00 MWW 0.00 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm	149,094 lb/hr 4,229 lb/hr 50.7 DTPD 2,439 lb/hr 144,865 lb/hr 144,865 lb/hr 2,84% 5% 0 lb/hr 297.9 gpm 10,000 Btu/lb VS 239.7 kW 6.82 MMBtu/hr -1.66 MMBtu/hr 0.00 MMBtu/hr -18.93 MMBtu/hr -18.93 MMBtu/hr 0 lb/hr 1.8.9 MW 0.00 trucks/day 0 scfm -338 scfm 0 scfm 0 scfm 0 lb/day	4,229 ib/hr 4,229 ib/hr 50.7 DTPD 50.7 DT 2,439 ib/hr 2,439 ib 144,865 ib/hr 2,439 ib 144,865 ib/hr 2,434 144,865 ib 2,84% 58% 2,84% 58% 0 ib/hr 0 ib 2,97.9 gpm 297.9 gp 10,000 Btu/h 0.00 MME 66.3 kW 0.00 MME 0.00 MME 0.51 MMBtu/hr 0.51 MME 0.00 MME 0.00 MMEtu/hr 0.00 MME 0.00 MME 0.00 MWW 0.00 MME 0.00 MME 0.00 mWW 0.00 MME 0.00 MME 0 galday 0 galday 0 galday 0 galday 0 galday 0 scfm 0 scfm -394 s	Inr 13,680 Ib/hr /hr 3,899 Ib/hr PD 46.8 DTPD /hr 2,248 Ib/hr /hr 9,761 Ib/hr 2,248 Ib/hr 2,80% 58% 58% /hr 0 Ib/hr pm 27.3 gpm Ib VS 10,000 Btu/lb VS W 746.0 kW Stu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 Stu/hr 0.00 MW Stu/hr 0.00 MW Stu/hr 0.00 MBtu/hr 0.00 trucks/day 0 stu/hr 0.00 scfm 0 scfm <	13,680 Ib/hr 3,899 Ib/hr 46.8 DTPD 2,248 Ib/hr 9,781 Ib/hr 28,55% 58% 0 Ib/hr 27.3 gpm 0.0 Btu/hv 0.0 Btu/hv 0.0 MBtu/hr 0.00 MMBtu/hr 0.00 MW 6.00 trucks/day 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm	13,680 Ib/hr 3,899 Ib/hr 46.8 DTPD 2,248 Ib/hr 9,781 Ib/hr 28.50% 58% 0 Ib/hr 27.3 gpm 10,000 Btu/hb VS 0.0 kW 0 MMBtu/hr 0 Ib/hf 0 Scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm



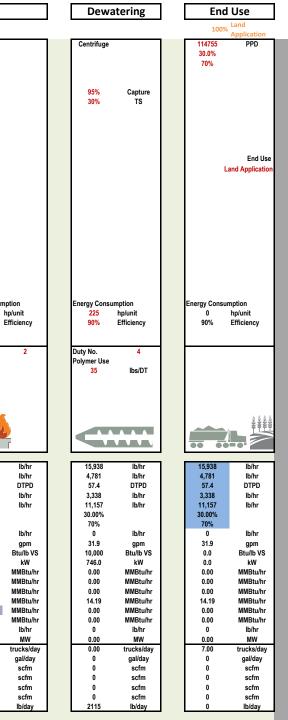
Gas Utilization

	reeu	SLUCK						Stabilization							Gast	/unze	ation	
												-						
Γ	263760 6.2% 85.88% 62.0%	PPD	Pre-dewatering			Dilution water		Thermal Hydrolysis	Dilution water		Digester (Meso)]	CHP Engine 909 NG LHV	, ,	Boiler 909 NG LHV		Biogas Upgrading	Flare
	10,000 F	Btu/lb VS Feedstock Type PS + WAS	98% 17%	Capture TS		lb/day 0			lb/day 1305479		VSR 62.0%		Therm Eff. 38% Nat gas usage, cff O Biogas Fuel use 0%		Therm Eff. 85% Nat gas usage, cfh 15,611 Biogas Fuel use 0%		Nat gas usage, cfh 0 Biogas Fuel use 85%	
En		nption hp/unit Efficiency	Energy Consur 150 90% Duty No. Polymer Use	hp Efficiency 4	-	Energy Consumption 0 hp 90% Efficiency	-	Sludge Inlet Temp 65 F Operation Temp 302 F 11.49 MMBtu/hr Energy Consumption 100 hp 100% Efficiency Shell Heat Loss 5% Duty No. 3	Energy Consumption 0 hp 90% Efficiency		Sludge Inlet Temp 65 F Operation Temp 98 F 550 Btu/cf 16.24 cf/lb VS 0.00 MMBtu/hr Energy Consumption 40 hp 100% Efficiency Shell Heat Loss 15% Duty No. 4		Engine Electrical Eff 30% Heat Recovery 0.00 MMBtu/hr Energy Consumption 145 hp/unit 90% Efficiency Duty No. 0		Heat Recovery 12.06 MMBtu/hr Energy Consumption 40 hp/unit 90% Efficiency Duty No. 2		Energy Consumption 747 hp/unit 100% Efficiency Duty No. 1	Energy Consumptio 0 hp/u 90% Effic Duty No.
	177 258	lh/br		lbs/DT		65 274 bibr			119.660 lb/br		113.024 bibr		(2) L-9					113.934
	177,258 10,990 131,9 9,439 166,26% 86% 5,852 354,2 10,000 0,0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Ib/hr Ib/hr DTPD Ib/hr Ib/hr gpm Btu/lb VS kW MBtu/hr MBtu/hr MBtu/hr MBtu/hr MBtu/hr MBtu/hr MBtu/hr Ib/hr MBtu/hr Ib/hr MBtu/hr Ib/hr wW trucks/day gal/day scfm scfm scfm scfm	65,274 10,770 129,2 9,250 54,504 16,50% 86% 5,735 130.4 10,000 497.3 0,00 0,000000	Ib/hr Ib/hr DTPD Ib/hr Ib/hr gpm Btu/lb VS kW MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr MMBtu/hr Ib/hr MMBtu/hr Ib/hr W W trucks/day gal/day scfm scfm scfm lb/day	-	65,274 lb/hr 10,770 lb/hr 129.2 DTPD 9,250 lb/hr 16,50% 86% 5,735 lb/hr 130.4 gpm 10,000 Btu/lb VS 0.0 kW 0.00 MMBtu/hr 0.00 Scfm 0 scfm 0 scfm 0 scfm 0 lb/day		65.274 Ib/hr 10,770 Ib/hr 129.2 DTPD 9,250 Ib/hr 14,504 Ib/hr 16.50% 86% 5,735 Ib/hr 130.4 gpm 10,000 Btu/lb VS 223.8 kW -12.07 MMBtu/hr 0.00 MWW 0.00 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 lb/day	119,669 Ib/hr 10,770 Ib/hr 129.2 DTPD 9,250 Ib/hr 108,899 Ib/hr 9,0% 86% 5,735 Ib/hr 239.1 gpm 10,000 Btu/lb VS 0.0 kW 0.00 MMBtu/hr -12.07 MMBtu/hr 0.00 MStu/hr 0.00 MStu/hr 0.00 MStu/hr 0.00 MStu/hr 0.00 MStu/hr 0.00 Scfm 0 scfm 0 scfm 0 Ib/day	-	113,934 Ib/hr 5,035 Ib/hr 60.4 DTPD 3,515 Ib/hr 108,899 Ib/hr 4,42% 70% 0 Ib/hr 10,000 Btu/lb VS 119.4 kW 0.00 MMBtu/hr 0.00 MVW 0.00 WW 0.00 trucks/day 0 gal/day 1552 scfm 931 scfm 0 scfm 0 Ib/day		113,934 Ib/hr 5,035 Ib/hr 60.4 DTPD 3,515 Ib/hr 108,899 Ib/hr 4,42% 70% 0 Ib/hr 10,000 Btu/lb VS 0.0 kW 0.00 MMBtu/hr -12.06 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MStu/hr 0.00 MStu/hr 0.00 Scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 lb/day		113,934 lb/hr 5,035 lb/hr 60.4 DTPD 3,515 lb/hr 108,899 lb/hr 4.42% 70% 0 lb/hr 227.7 gpm 10,000 Btu/lb VS 66.3 kW 12.06 MMBtu/hr 0.00 MMBtu/hr 14.19 MMBtu/hr 0.00 MMBtu/hr 0.00 MWBtu/hr 0.00 MWW 0.00 trucks/day 0 gal/day 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 lb/day		113,934 Ib/hr 5,035 Ib/hr 60.4 DTPD 3,515 Ib/hr 108,699 Ib/hr 4.42% 70% 0 Ib/hr 227.7 gpm 10,000 Btu/lb VS 557.1 kW 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0 Ib/hr 0.00 MWW 0.00 trucks/day 0 gal/day 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm	113,934 5,035 60.4 I 3,515 108,899 4.42% 70% 0 227.7 10,000 Bt 0.0 0.00 MM 0.00 MM 0.00 MM 0.00 MM 14,19 MM 14,19 MM 14,19 MM 0.00 MM

Stabilization

South Plant

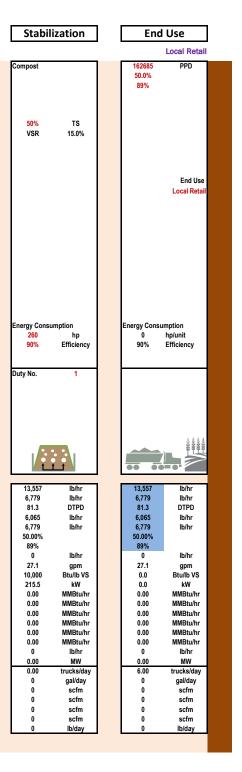
Feedstock



Brightwater				Off-site Composti	ing
Feedstock	Stabilization	Gas Utilization	Dewatering End	Use Feedstock	Feedstock Feedstock
			100%	Land Application	
93910 PPD 5.8% 90% 61% 10,000 Btu/lb VS	Digester (Meso) VSR 60.9%	Boiler 909 NG LHV Therm Eff. 85%	Centrifuge 39295 20.0% 78% 93% Capture 20% TS	PPD 39295 PPD 20.0% 77.61% 15.0% 10,000 Btu/lb VS	132465 PPD 16611 PPD 55.0% 55.0% 89.68% 15.0% 15.0% 15.0% 10,000 Btu/lb VS 10,000 Btu/lb VS
Feedstock Type PS + WAS		Nat gas usage, cfh O Biogas Fuel use 70%	La	End Use Feedstock Type and Application Dewatered Cake	Feedstock Type Feedstock Type Virgin Woodchips Screened Overs
Energy Consumption 0 hp/unit 90% Efficiency	Sludge Inlet Temp 65 F Operation Temp 98 F 550 Btu/cf 16 cf/lb VS 2.23 MMBtu/hr Energy Consumption 40 hp/unit 100% Efficiency Shell Heat Loss 15% Duty No. 3	Heat Recovery 11.22 MMBtu/hr Energy Consumption 40 hp/unit 90% Efficiency Duty No. 1 Duty No. 1		Imption Energy Consumption hp/unit 0 hp/unit Efficiency 90% Efficiency	Energy Consumption 0 hp/unit 0 hp/unit 90% Efficiency 90% Efficiency
 +					
67,464 Ib/hr 3,913 Ib/hr 47.0 DTPD 3,517 Ib/hr 63,551 Ib/hr 5.80% 90% 2,143 Ib/hr 134.8 gpm 10,000 Btu/hb VS 0 MMBtu/hr 0 MWBtu/hr 0 mWW 0.00 trucks/day 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm	65,321 Ib/hr 1,770 Ib/hr 21.2 DTPD 1,374 Ib/hr 63,551 Ib/hr 2,71% 78% 0 Ib/hr 130.5 gpm 10,000 Btu/lb VS 89,5 kW -2.56 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 18.86 MMBtu/hr 18.86 MMBtu/hr 0 Ib/hr 0.00 MW 0.00 trucks/day 0 gal/day 571 scfm 343 scfm 0 scfm 0 scfm 0 scfm	65,321 Ibhr 1,770 Ibhr 1,374 Ibhr 63,551 Ibhr 63,551 Ibhr 10,000 Btu/Ib VS 10,000 Btu/Ib VS 10,000 Btu/Ib VS 33.2 kW 0.0 MBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MWBtuhr 0.00 MWBtuhr	8,186 Ib/hr 8,186 1,637 Ib/hr 1,637 19.6 DTPD 19.6 1,271 Ib/hr 1,271 6,549 Ib/hr 6,549 20.00% 78% 78% 0 Ib/hr 0 16.4 gpm 16.4 10,000 Btu/lb VS 0.0 331.6 kW 0.0 0.00 MMBtu/hr 0.00 0.00 MWBtu/hr 0.00 0.00 MWBtu/hr 0.00 0.00 MWBtu/hr 0.00 0 Ib/hr 0 0 gal/day 0 0 scfm 0 0 scfm 0 0 scfm 0 0 scfm 0	Ib/hr 8,186 Ib/hr Ib/hr 1,637 Ib/hr DTPD 19.6 DTPD Ib/hr 1,271 Ib/hr Ib/hr 1,271 Ib/hr 1b/hr 1,271 Ib/hr 1b/hr 1,271 Ib/hr 1b/hr 191 Ib/hr gpm 16.4 gpm Btulb VS 10,000 Btulb VS kW 0.0 kW MBtu/hr 0 MMBtu/hr MBtu/hr 0 MMBtu/hr MBtu/hr 0 MBtu/hr MW 0 MW 0 Jb/hr 0 MW 0 MW ft 0 scfm scfm 0 scfm scfm 0 scfm	18,222 lb/hr 7,157 lb/hr 85.9 DTPD 9,514 lb/hr 11,065 lb/hr 39,28% 40,29% 91% 91% 977 lb/hr 10,000 Btu/hr 0.00 MMBtu/hr 0.00 MW 0.00 MW 0.00 MW 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0

Brightwater

Off-site Composting



S3 Output Summary	
Final TS, Wet (WT/D)	0
NG Req. (cfh)	42506
NG (LHV MMBtu/h)	39
Net heat (MMBtu/h)	11
Electricity Reg. (kWh)	8441
Power Generation (kWh)	1760
Net Power (kWh)	-6681
No. of Trucks Required (trucks/day)	22
Digester Gas Produced (scfm)**	3325
Methane Produced (scfm)**	1995
Scrubbed Gas (scfm)**	700
Polymer Use (lb/day)	4611

Scenario 3 - MAD at all three plants with off-site Thermal Drying and Pyrolysis

West Point

	Feed	lstock	Stabili	zation				Gas Ut	ilization				Dewa	atering	1 1	En	d Use
														ž	- 1		Off-site Processing
Dry Mass Flow TS VS VSR Calorific Value	225860 6.1% 81% 64% 10,000	PPD Btu/lb VS	Digester (Mes	D)	CHP Engine	909 NG LHV		Boiler	909 NG LHV		Flare		Centrifuge	Capture		100295 28.5% 61%	PPD
	F	eedstock Type PS + WAS	VSR	64.0%	Therm Eff. Nat Biogas Fuel use			Therm Eff. Nat Biogas Fuel use	85% gas usage, cfh 10%				29%	TS		0	End Use ff-site Processing
%			65 98 555 15 5.09	dge Inlet Temp F Iperation Temp F Btu/cf cf/lb VS MMBtu/hr	34% 6.36	Heat Recovery MMBtu/hr		2.02	Heat Recovery MBBtu/hr								
	Energy Cons 0 90%	umption hp Efficiency	Energy Consu 40 100% Shell Heat Los 15% Duty No.	hp/unit Efficiency	Energy Const 289 90% Duty No.	umption hp/unit Efficiency 1		Energy Consu 40 90% Duty No.	imption hp/unit Efficiency 2			mption hp/unit Efficiency 2		hp/unit Efficiency 4	-		Imption ip/unit Efficiency
		+			Ø	-0						r r		••••			
Wet Mass Flow	154,276 9.411	lb/hr lb/hr	149,398 4,533	lb/hr lb/hr	149,398 4.533	lb/hr lb/hr	1	149,398 4.533	lb/hr lb/hr	ľ	149,398 4.533	lb/hr lb/hr	14,663 4,179	lb/hr lb/hr	1 1	14,663 4,179	lb/hr lb/hr
Dry Mass Flow	112.9	DTPD	54.4	DTPD	54.4	DTPD		54.4	DTPD		54.4	DTPD	50.1	DTPD		50.1	DTPD
VS Water	7,620 144,865	lb/hr lb/hr	2,743 144,865	lb/hr lb/hr	2,743 144,865	lb/hr lb/hr		2,743 144,865	lb/hr lb/hr		2,743 144,865	lb/hr lb/hr	2,528 10,484	lb/hr lb/hr		2,528 10,484	lb/hr lb/hr
TS	6.10%	10/11	3.03%	10/11	3.03%	10/11		3.03%	10/11		3.03%	10/11	28.50%	10/11		28.50%	10/11
VS VSR	81% 4,878	lb/hr	61% 0	lb/hr	61% 0	lb/hr		61% 0	lb/hr		61% 0	lb/hr	61% 0	lb/hr		61% 0	lb/hr
Wet flow	308.3	gpm	298.6	gpm	298.6	gpm		298.6	gpm		298.6	gpm	29.3	gpm		29.3	gpm
Calorific Value Electrical Demand	10,000 0.0	Btu/lb VS kW	10,000 149.2	Btu/lb VS kW	10,000 239.7	Btu/lb VS kW		10,000 66.3	Btu/Ib VS kW		10,000 0.0	Btu/lb VS kW	10,000 746.0	Btu/lb VS kW		0.0	Btu/lb VS kW
Unit Heat Bal.	0	MMBtu/hr	-5.85	MMBtu/hr	6.36	MMBtu/hr		2.02	MMBtu/hr		0.00	MMBtu/hr	0.00	MMBtu/hr		0.00	MMBtu/hr
Total Heat Bal. Unit Aux. Fuel Bal.	0	MMBtu/hr MMBtu/hr	-5.85 0.00	MMBtu/hr MMBtu/hr	0.50	MMBtu/hr MMBtu/hr		2.52	MMBtu/hr MMBtu/hr		2.52	MMBtu/hr MMBtu/hr	2.52 0.00	MMBtu/hr MMBtu/hr		2.52	MMBtu/hr MMBtu/hr
Cum. Aux. Fuel Bal.	0	MMBtu/hr	0.00	MMBtu/hr	0.00	MMBtu/hr		0.00	MMBtu/hr		0.00	MMBtu/hr	0.00	MMBtu/hr		0.00	MMBtu/hr
Unit Process Fuel Bal. Cum Unit Process Fuel Bal.	0	MMBtu/hr MMBtu/hr	40.61 40.61	MMBtu/hr MMBtu/hr	-17.66 22.94	MMBtu/hr MMBtu/hr		-2.38 20.57	MMBtu/hr MMBtu/hr		-20.57	MMBtu/hr MMBtu/hr	0.00	MMBtu/hr MMBtu/hr		0.00	MMBtu/hr MMBtu/hr
Generated Steam	0	lb/hr	0	lb/hr	0	lb/hr		0	lb/hr		0	lb/hr	0	lb/hr		0	lb/hr
Power Generation No of Trucks Required	0.00	MW trucks/day	0.00	MW trucks/day	1.76	MW trucks/day		0.00	MW trucks/day		0.00	MW trucks/day	0.00	MW trucks/day	-	0.00 6.00	MW trucks/day
Vehicle Fuel Consumption	0	gal/day	0	gal/day	0	gal/day		0	gal/day		0	gal/day	0	gal/day		0	gal/day
Digester Gas Produced Methane Production	0	scfm scfm	1219 732	scfm scfm	0	scfm scfm		0	scfm scfm		0	scfm scfm	0	scfm scfm		0	scfm
Methane Utilized	0	scfm	0	scfm	-318	scfm		-43	scfm		-371	scfm	0	scfm		0	scfm
Scrubbed Gas Unit Polymer Use	0	scfm Ib/dav	0	scfm Ib/dav	0	scfm lb/dav		0	scfm lb/dav		0	scfm lb/dav	0 1632	scfm lb/day		0	scfm Ib/dav
		,		,						•							

South Plant

Feedstock	Stabilization		Gas Utiliz	Dewatering	End Use		
							100% Offsite Processing
263760 PPD 6.2% 85.88% 60.0% 10,000 Btu/lb VS	Digester (Meso)	CHP Engine 909 NG LHV	Boiler 909 909 NG LHV	Biogas Upgrading	Flare	Centrifuge 95% Capture	121334 PPD 22.9% 71%
Feedstock Type PS + WAS	VSR 60.0%	Nat gas usage, cfh 0	Nerm Eff. 85% Nat gas usage, cfh 8,706 Biogas Fuel us 0%	Nat gas usage, cfh 0 Biogas Fuel use 85%		23% TS	End Use Offsite Processing
	Sludge Inlet Temp 65 F Operation Temp 98 F 550 Bluucf 16,24 cftlb VS 5.85 MMBtuhr	Engine Electrical Eff. 30% Heat Recovery 0.00 MMBtuhr	Heat Recovery 6.73 MMBturhr				
Energy Consumption 0 hplunit 90% Efficiency	Energy Consumption 40 hplunit 100% Efficiency Shell Heat Loss 15% Duty No. 4	145 hp/unit 90% Efficiency	40 hp/unit 90% Efficiency	738 hp/unit 100% Efficiency	Energy Consumption 0 hp/unit 90% Efficiency Duty No. 2	Energy Consumption 225 hp/unit 90% Efficiency Duty No. 4 Polymer Use 35 lbs/DT	Energy Consumption 0 hp/unit 90% Efficiency
 +				Ŵ r∃ ŀ			
177,233 Ibihr 10,980 Ibihr 131.9 DTPD 9,439 Ibihr 166,268 Ibihr 5666 Ibihr 5646 Ibihr 354.2 gpm 10,000 Btulib VS 0.0 KW 0 MMBtulinr 0 MMBtulinr 0 MMBtulinr 0 Ibihr 0 galday 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm	171,592 Ibhr 5,232 Ibhr 63.9 DTPD 3,773 Ibhr 166,268 Ibhr 3,10%, Ibhr 71% Ibhr 0 Ibhr 3,29 gpm 10,000 Bulb VS 119.4 kW 4.7.3 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 MMBtuhr 0.00 IbhW 0.00 IbhW 0.00 IbhW 0.00 IbhW 0.00 scfm 920 scfm 920 scfm 0 scfm 0 scfm	171,592 Ibhr 5,324 Ibhr 63.9 DTPD 3,173 Ibhr 166,268 Ibhr 3,10% 71% 0 Ibhr 3,00% Buhr 3,00% MMBuhr 0,00 MMBuhr 0,00 MMBuhr 0,00 Buhr 0,00 Scim 0,00 Scim <	171,592 lb/hr 5,324 bb/hr 5,324 bb/hr 5,324 bb/hr 5,3273 lb/hr 166,288 lb/hr 3,10% 71% 0 lb/hr 42.9 gpm 10,000 Bt/lb/VS 66.3 kW 6.73 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MWBtu/hr 0.00 ft rucks/day 0 gal/day 0 gal/day 0 sc/m 0 sc/m 0 sc/m 0 bc/day	171,592 Iblr 5,324 Iblr 5,334 Iblr 5,373 Iblr 166,288 Iblr 3,10% 71% 0 Iblr 3,00% 71% 0 Iblr 3,00% Bullb VS 556.4 KW 0.00 MtBulhr 0.00 MtBulhr 7.91 MtBulhr 0.00 mks/sday 0 galday 0 scfm 0.30 scfm 0.778 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 776 scfm 700 scfm	171,992 Bohr 5,324 Bohr 5,324 D1PD 3,773 Bohr 166,689 Bohr 3,173 Bohr 166,689 Bohr 3,10% T1% 0 Bohr 342.9 ggm1 0,000 Btulb VS 0.0 MBBuhr 0.00 Scfm 0.354 MBBuhr 0.00 Scfm 0.354 Scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm 0 scfm	22.077 Ib/hr 5.056 Ib/hr 60.7 Di/hr 3.583 Ib/hr 17.021 Ib/hr 7.021 Ib/hr 7.021 Ib/hr 7.021 Ib/hr 7.021 Ib/hr 7.021 Ib/hr 7.020 Btu/lb VS 745.0 KW 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 MMBtu/hr 0.00 scfm 0.00 scfm	22.077 Ibhr 5.055 Ibhr 5.055 Ibhr 17.021 Ibhr 17.021 Ibhr 17.021 Ibhr 17.021 Ibhr 0 Ibhr 0.0 Bullb VS 0.0 Bullb VS 0.0 MMBtuhr 0.00 Scim 0.00 Scim 0.00 Scim 0.00 Scim 0 scim 0 scim 0 scim 0 scim 0 scim

Feed	lstock	l [Stabi	lization	ľ		Gas l	Jtiliz	ation		1	Dewa	tering	1	End	Use
													-	1	100%	Off-Site Processing
93910 5.8% 90% 61% 10,000	PPD Btu/lb VS	1	Digester (Mes	50)		Boiler	909 NG LHV		Flare			Centrifuge 93%	Capture		39295 20.0% 78%	PPD
	-eedstock Type PS + WAS		VSR	60.9%		Therm Eff. Nat Diogas ruei	85% gas usage, cfh) 70%					20%	TS		Off-	End Use Site Processing
Energy Consi 0 90%	umption hp/unit Efficiency		65 98 550 16 2.23 Energy Cons 40 100% Shell Heat Lo	hp/unit Efficiency		11.23 Energy Consi 40 90%	Heat Recovery 2 MMBtu/hr umption hp/unit Efficiency		Energy Cons 0 90%	umption hp/unit Efficiency		Energy Consi 200 90%	umption hp/unit Efficiency		Energy Consı 0 90%	umption hp/unit Efficiency
	+	ī	15% Duty No.	3		Duty No.			Duty No.	1		Duty No. Polymer Use 35	2 Ibs/DT			
67,464	lb/hr	Γ	65,321	lb/hr	ľ	65,321	lb/hr	ľ	65,321	lb/hr	1	8,186	lb/hr	1	8,186	lb/hr
3,913 47.0	lb/hr DTPD		1,770 21.2	lb/hr DTPD		1,770 21.2	lb/hr DTPD		1,770 21.2	lb/hr DTPD		1,637 19.6	lb/hr DTPD		1,637 19.6	lb/hr DTPD
3,517 63,551 5.80% 90%	lb/hr lb/hr		1,374 63,551 2.71% 78%	lb/hr lb/hr		1,374 63,551 2.71% 78%	lb/hr lb/hr		1,374 63,551 2.71% 78%	lb/hr lb/hr		1,271 6,549 20.00% 78%	lb/hr lb/hr		1,271 6,549 20.00% 78%	lb/hr lb/hr
2,143	lb/hr		0	lb/hr		0	lb/hr		0	lb/hr		0	lb/hr		0	lb/hr
134.8 10,000	gpm Btu/lb VS		130.5 10,000	gpm Btu/lb VS		130.5 10,000	gpm Btu/lb VS		130.5 10,000	gpm Btu/lb VS		16.4 10,000	gpm Btu/lb VS		16.4 0.0	gpm Btu/lb VS
0	kW		89.5	kW		33.2	kW		0.0	kW		331.6	kW		0.0	kW
0	MMBtu/hr MMBtu/hr		-2.56 -2.56	MMBtu/hr MMBtu/hr		11.22 8.66	MMBtu/hr MMBtu/hr		0.00 8.66	MMBtu/hr MMBtu/hr		0.00 8.66	MMBtu/hr MMBtu/hr		0.00 8.66	MMBtu/hr MMBtu/hr
0	MMBtu/nr MMBtu/hr		-2.56	MMBtu/hr MMBtu/hr		8.66	MMBtu/hr MMBtu/hr		8.66	MMBtu/hr MMBtu/hr		8.66	MMBtu/hr MMBtu/hr		8.66	MMBtu/nr MMBtu/hr
0	MMBtu/hr		0.00	MMBtu/hr		0.00	MMBtu/hr		0.00	MMBtu/hr		0.00	MMBtu/hr		0.00	MMBtu/hr
0	MMBtu/hr MMBtu/hr		18.86 18.86	MMBtu/hr MMBtu/hr		-13.20 5.66	MMBtu/hr MMBtu/hr		-5.66	MMBtu/hr MMBtu/hr		0.00	MMBtu/hr MMBtu/hr		0.00	MMBtu/hr MMBtu/hr
0	lb/hr		0	lb/hr		0	lb/hr		0.00	lb/hr		0	lb/hr		0	lb/hr
	MW	_	0.00	MW		0.00	MW		0.00	MW		0.00	MW		0.00	MW
0	trucks/day		0.00	trucks/day gal/day		0.00	trucks/day gal/day		0.00	trucks/day gal/day		0.00	trucks/day gal/day		4.00 0	trucks/day gal/day
0.00									ő	gunday						
	gal/day scfm		571	scfm		0	scfm			scfm		0	scfm		0	scfm
0.00 0 0	gal/day scfm scfm		571 343	scfm scfm		0	scfm		0	scfm		0	scfm		0	scfm
0.00	gal/day scfm		571	scfm												

Brightwater

Feedstock	Drying a	nd Pyrolysis	Gas Utilization	End Use
				100% Contracted
260925 PPD	Thermal Dryer	Pyrolysis	Boiler	125590 PPD
24.6% 67.9%	909 NG LHV		909 NG LHV	100.0%
2%	NG LIV		NG LHV	070
10,000 Btu/lb VS				
	90.0% TS			
		Therm Eff. 50%	Therm Eff. 85%	
Foundationals Trans				E-411-
Feedstock Type PS + WAS	Nat gas usage, cfh		Nat gas usage, cfh 33,799	End Us Contracted
10.100	Diogas ruei 0%		Biogas Fuel use 0%	Contracted
	100			
	Inlet / Out Temp.			
	60 F	Heat Recovery	Heat Recovery	
		21.29 MMBtu/hr	26.12 MMBtu/hr	
	300 F	Enthalpy 5.84 MMBtu/hr		
	1,400 Btu/lb	5.64 MMBtu/fr		
	45.15 MMBtu/hr			
nergy Consumption	Energy Consumption	Energy Consumption	Energy Consumption	Energy Consumption
0 hp/unit	339 hp/unit	94 hp/unit	40 hp/unit	0 hp/unit
90% Efficiency	90% Efficiency	90% Efficiency	90% Efficiency	90% Efficiency
	Heat Loss 5%			
	Duty No. 12	Duty No. 24	Duty No. 2	
		Temp (*C) 550		
	_			
				1000
				00 00-0 ¹
44,166 lb/hr 10,872 lb/hr	11,916 lb/hr 10,724 lb/hr	5,233 lb/hr 5,233 lb/hr	5,233 lb/hr 5,233 lb/hr	5,233 lb/hr 5,233 lb/hr
10,872 ID/II 130.5 DTPD	10,724 ID/NF 128.7 DTPD	62.8 DTPD	62.8 DTPD	62.8 DTPD
7,382 lb/hr	7,234 lb/hr	1,743 lb/hr	1,743 lb/hr	0 lb/hr
33,294 lb/hr	1,192 lb/hr	0 lb/hr	0 lb/hr	0 lb/hr
24.62% 68%	90.00% 67%	100.00% 33.3%	100.00% 33%	100.00% 0%
68% 148 lb/hr	67% 0 lb/hr	33.3% 0 lb/hr	33% 0 lb/hr	0% 0 lb/hr
88.3 gpm	23.8 gpm	10.5 gpm	10.5 gpm	10.5 gpm
10,000 Btu/lb VS	10,000 Btu/lb VS	10,000 Btu/lb VS	10,000 Btu/lb VS	0.0 Btu/lb VS
0 kW	3366.9 kW	1870.0 kW	66.3 kW	0.0 kW
0 MMBtu/hr	-47.41 MMBtu/hr	21.29 MMBtu/hr	26.12 MMBtu/hr	0.00 MMBtu/hr
0 MMBtu/hr 0 MMBtu/hr	-47.41 MMBtu/hr 0.00 MMBtu/hr	-26.12 MMBtu/hr 0.00 MMBtu/hr	0.00 MMBtu/hr 30.72 MMBtu/hr	0.00 MMBtu/hr 0.00 MMBtu/hr
0 MMBtu/hr	0.00 MMBtu/hr	0.00 MMBtu/hr	30.72 MMBtu/hr	30.72 MMBtu/hr
0 MMBtu/hr	0.00 MMBtu/hr	0.00 MMBtu/hr	0.00 MMBtu/hr	0.00 MMBtu/hr
0 MMBtu/hr	0.00 MMBtu/hr	0.00 MMBtu/hr	0.00 MMBtu/hr	0.00 MMBtu/hr
0 lb/hr 0 MW	0 lb/hr 0.00 MW	0 lb/hr 0.00 MW	0 lb/hr 0.00 MW	0 lb/hr 0.00 MW
0 MW 0.00 trucks/day	0.00 MW 0.00 trucks/day	0.00 MW 0.00 trucks/day	0.00 MW 0.00 trucks/day	0.00 MW 3.00 trucks/day
0 gal/day	0 gal/day	0 gal/day	0 gal/day	0 gal/day
0 scfm	0 scfm	0 scfm	0 scfm	0 scfm
0 scfm	0 scfm	0 scfm	0 scfm	0 scfm
0 scfm	0 scfm	0 scfm	0 scfm	0 scfm
0 scfm 0 lb/day	0 scfm 0 lb/day	0 scfm 0 lb/day	0 scfm 0 lb/day	0 scfm 0 lb/day
				 Ibiday

Off-site Pyrolysis

34. Dutput Summary Fini TS, Wet (W7/D) 0 No Rec. (cf) 1.2804 MG (LWY MMB(z)/h) 1.1 Electricity Rec. (wh) 388 Power Generation (WH) 1.886 No. of Trucks Required (trucks/deg) 1.8 Digestre Generation (trucks/deg) 1.8 Digestre Generation (trucks/deg) 1.8 Digestre Generation (trucks/deg) 1.7 Methemore Poolution (screen)** 3.74 Pointer Use (trucks/deg) 1.8 Digestre (dec)** 2.74 Pointer Use (trucks/deg) 1.4	Scenario 4 - TAD-Batch at West Poin	to Soll Blending, TAD-Batch at South Plant to direct i	and App, and Brightwater with	1 MAD and Off-site Composting		
West Point					Off-site Soil Blending	
Feedstock	Stabilization Energy Reco	very Gas Utilization		Dewatering End Use	Feedstock Feedstock	Feedstock End Use
Dry Mass Few 22586 PPD TS 6.1% VS 61% Calorific Value 10,000 Bluilb VS	Digester (Thermo) NEX	CHP Engine 900 NG LIVV Boiler 900 NG LIVV Therm Eff. 36% Therm Eff. 85%	Flure C	1000 United for United for 2556 PPO 2555 SPS SPS 82% Capture 2 SPS	33356 PPD 45953 PPD 28.5% 57.6% 95.0% 10.0% 10,050 Brulle VS 10.000 Brulle VS	25384 PPD 362165 PPD 95,0% 58,0% 58,0% 25% 0,0% 25% 25% 10,000
Feedstock Type PS + WAS	Het Temperature 131 Oddet Temperature 100 Studge Intel Temp HEXI			End Use Off-Site Soll Blending	Feedstock Type Developed Cale Savebart	Feedstock Type End Use Fire Sand Local Retail
Energy Cossumption 0 hp 90%, Efficiency	Operation Temp 3.24 MA 11 F 50 Bluid' 15 oth VS 10.1 MMEtuhr Energy Consumption 40 hp 100 40% Efficiency 90% EN 5% Efficiency 90% Efficiency 15% Duty No. 5 Duty No.	N Hea Recovery Categories Constraints of the Recovery Categories C	0 bpUnit 90% Efficiency Duty No. 2 Dut	nergy Cossumption 23 hplank 90% Efficiency atly No. 4 30 lba/OT	Energy Cosumption 0 plant 90% Efficiency 90% Efficiency	Energy Consumption 9 bybinit 90% Efficiency 9 Binicipation 9 Binicipation
Wet Mass Fox 15,276 Mr Dy Mass Fox 12,3 bhr Dy Mass Fox 12,3 bhr Vet 12,455 bhr Vet 12,456 bhr Vet 12,458 bhr Vet 12,83 bgr Vet flow 38,3 bgr Calorific Value 10,000 Bully Vet Unit Heat Bal 0 MBBuhr Generated Steam 0 bhr Power Generation 0 galdy Unit Arout Stequizet 0.60 scfm Methane Utilizet 0 scfm Methane Utilizet 0 scfm Methane Utilizet 0 scfm <	140,094 Ibhr 460,094 4,229 Ibhr 4,229 90,7 OTPD 50,7 C19 2,439 Ibhr 2,439 Ibhr 2,439 144,845 Ibhr 2,439 Ibhr 2,439 2,65 2,95 S9 S9 S9 0 Ibhr 0,97 T1 S9 16,000 Bubb V5 0 S9 S9 16,000 Bubb V5 10000 Bub S1 S9 S9	Arr hr 142,094 Bhr bhr 142,094 Bhr bhr 142,29 Dhr 2,243 Bhr 142,29 Dhr 2,233 Bhr 142,29 Dhr 2,233 Bhr 144,855 Bhr 2,243 Bhr 144,855 Bhr 2,245 Bhr 144,855 Bhr 2,245 Bhr 159 Bhr 2,233 Bhr 169 2,210,9 gmr 2,245 Bhr 169 2,210,9 gmr 2,263 Bhr 169 2,210,9 gmr 2,263 Bhr 180 6,22 MMBuhr 0,16 MBuhr 190 G MBuhr 0,00 MBuhr 100 MBuhr 0,00 MBuhr 0,00 MBuhr 120 6,29 MBuhr 0,00 MBuhr 0,00 MBuhr 120 0,00 MBuhr 0,00 MBuhr 0,00 MBuhr	4,223 bihr 9,7 DTPD 2,439 bihr 14,6455 bihr 2,45% 5 0 bihr 2,75 gpn 10,000 Builb V 0,0 MMBuihr 0,00 MMBuihr 0,00 MMBuihr	13.60 bh 4.61 DTP0 2.411 bhr 4.61 DTP0 2.411 bhr 2.575 Bhr 0 bhr 2.575 Bhr 0.0 Bubr 10.00 Bubr 2.575 Bhr 0.0 Bubr 10.00 Bubr 10.00 Bubr 10.00 MBSuhr 0.0 Bubr	13,60 bir 3,89 bir 3,90 bir 3,90 bir 3,60 bir 3,90 bir 3,90 bir 3,90 bir 3,00 bir 3,00 bir 3,00 bir 0,00 bir <td>Arrow Control Barr Control Mater Control Control Control <thcontrol< th=""> <thcontro< th=""> <thcon< td=""></thcon<></thcontro<></thcontrol<></td>	Arrow Control Barr Control Mater Control Control Control <thcontrol< th=""> <thcontro< th=""> <thcon< td=""></thcon<></thcontro<></thcontrol<>

King County, Washington



Brown AND Caldwell

Feedstock	Stabilization	Energy Recovery		Gas Uti	lization	Dewatering	End Use
263760 PPD	Director (Therma)	HEX	CHP Engine	Boiler	Biogas Upgrading Flare	e Centrifuge	100% Application
263760 PPD 6.2% 85.85% 64.0% 10,000 Btuilb VS	Digester (Thermo) VSR 64.0%	nex	909 NG LHV	909 NG LHV	Biogas Upgrading Flare	e Centruige 95% Capture 23% TS	112794 PPD 22.9% 69%
Feedstock Type PS + WAS		Iniet Temperature 131 F Outlet Temperature 100 F	Them Eff. 38% Nat gas usage, cfh 0 Biogas Fuel use 0%	Therm Eff. 85% Nat gas usage, cfh 12,604 Biogas Fuel use 0%	Nat gas usage, cfh 0 Bioges Fuel use 85%		End Use Land Application
Energy Consumption 0 hplunit 90% Efficiency	Studge Intel Temp 65 F 09 Feation Temp 131 Deartion Temp 150 Fluid 1524 citls V5 117.70 MIBlushr Energy Consumption 90% Efficiency Shell Heat Loss	HEX Efficiency 70 % 3.72 MMBtuhr Energy Consumption 150 hp 90% Efficiency	Engine Electrical Eff. 30% Heat Recovery 0.00 MMBtuhr Energy Consumption 145 hp/unit 90% Efficiency	Hest Recovery 9.74 MMBtuhr Energy Consumption 40 hptmt 90% Efficiency	787 hp/unit	rgy Consumption Energy Consumption 9 hplinit 223 hplinit 90% Efficiency 90% Efficiency	Energy Consumption 0 hplunit 90% Efficiency
+	15% Duty No. 4	Duty No. 1	Duty No. 0	Duty No. 2	Duty No. 1 Duty	y No. 2 Duty No. 4 Polymer Use 35 BaDT	
177.246 Dub 10.390 Dbhr 13.13 DTPD 9.439 Ibhr 16.265 Bohr 6.205 Bohr 5.21 Bohr 6.241 Bohr 6.245 Bohr 6.205 Bohr 0.00 Bullu VG 0 MMBsuhr 0 MMBsuhr 0 MMBsuhr 0 Bohr 0 Bohr 0 Bohr 0 MBsuhr 0 Bohr 0 Bohr	171.213 Buhr 4.540 Bihr 59.4 DTPD 3.38 Buhr 166.285 Buhr 2.8% Buhr 0 Buhr 10.2.2 Buhr 110.00 Buhr 121.6 MW 13.45 MMBbuhr 0.00 MMBbuhr 5.44 MMBbuhr 5.44 MMBbuhr 0.00 MMB 0.00 MMBbuhr 0.4 Buhr 0.9 Buhr 0.9 Buhr 0.9 Buhr 0.8 Buhr 0.9 Buhr 0.8 Buhr 0.8 Buhr 0.9 Buhr 0.8 Buhr 0.8 Buhr 0.8 Buhr 0.8 Buhr 0.8 Buhr 0.8 Schn 0.8 Schn 0	171:31 Buh 49.63 bbr 95.4 DTPD 3.38 bhr 165.285 bhr 2.89% b 9.2 bhr 172.2 bhr 172.2 bhr 172.3 bhr 172.4 MBEuhr 0.00 mBeuhr<	171.217 Bahr 45.60 Bahr 45.60 Bahr 53.86 Bahr 156,528 Bahr 2.85% Bahr 9.1 Bahr 10.00 Baba 10.00 Baba 0.1 Baba 0.0 MMBuhr 0.00 MMBuhr 0.00 MMBuhr 0.00 MMBuhr 0.00 MWBuhr 0.00 MW 0.00 acfm 0.00 MW 0.00 scfm 0.00 scfm 0.00 scfm 0.00 scfm 0.00 scfm 0.00 scfm	17.217 Buhr 47.62 Buhr 59.4 DTPD 3.398 Buhr 166.268 Buhr 2.89% Buhr 0.2 Buhr 0.2.2 Buhr 0.3.398 Buhr 0.2.3 Buhr 0.4.4 MMBLuhr 0.0.5 MMBLuhr 11.46 MMBLuhr 0.0.0 MMBLuhr 0.0.0 MMBLuhr 0.0.0 Buhr 0.0.0 Buhr 0.0.0 MMBLuhr 11.46 MMBLuhr 0.0.0 Buhr 0.0.0	4.549 bbhr 58.4 DTPD 3.38 bbhr 16.5,28 bbhr 12.29% bbhr 3.42.2 gps 16.00 Bbhr 10.00 Bbbr 55.00 Bbbr 0.00 MMBbbhr 11.46 MMBbbhr 11.46 MMBbbhr 11.46 bbhr 0.00 truckstday 0.00 truckstday 0.00 truckstday 0.00 truckstday 0.00 truckstday 0.00 truckstday 0.00 truckstday 0.00 truckstday 0.00 truckstday 0.00 truckstday	171211 Buhr 20,523 Buhr 58.4 DTPD 55.4 DTPD 58.4 DTPD 55.4 DTPD 58.6 Ibhr 32.27 Ibhr 56.28 Ibhr 32.527 Ibhr 69% 0.9 Buhr 15.823 69% 0.9 Buhr 15.823 10,00 Buhr 0.0 Buhr 10,00 Buhr 0.0 Buhr 0.0 MMStuhr 0.0 Buhr 0.0 MMStuhr 0.0 MMStuhr 0.0 MMStuhr 0.00 MMStuhr 0.0 Buhr 0.00 MMStuhr 0.0 MMStuhr 0.00 MMStuhr 0.0 Buhr 0.00 MMStuhr 0.0 MMStuhr 0.00 MMStuhr 0.0 Buhr 0.00 MMStuhr 0.00 MMStuhr 0.00 MMStuhr 0.00 MMStuhr 0.00	26331 Bhr 564 DTPD 3227 Bhr 15,823 Bhr 22,95% Bhr 0 Bhr 0.0 Bhr 0.3 Buhr 0.3 Buhr 0.0 Bhr 0.0 MMBuhr 0.00 MMBuhr 0.00 MMBuhr 0.00 MMBuhr 0.00 Bhr 0.0 MMBuhr 0.0 Bhr 0.0 MMBuhr 0.0 Bhr 0 gaidsty 0 ecfm 0 br 0 br 0 br 0 br 0 br 0 br

King County, Washington

South Plant

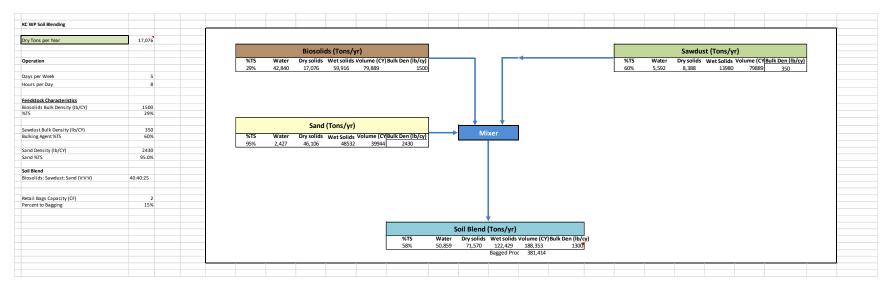
King County Class A Biosolids Technology Evaluation

Brightwater		<u>c</u>	Off-site Composting	
Feedstock Stabilization	Gas Utilization	Dewatering End Use	Feedstock Feedstock Stabilization	End Use
93910 PPD 1.5% 9% 9% 10,000 Btulls VS VSR 60.9%	Boller 500 NG LINY Them Eff. 85%	Centrifuge 39295 PPD 20.0%	38285 PPD 132485 PPD 16611 PPD 30 ph 55 ph 55 ph 55 ph 55 ph 55 ph 15 ph 15 ph 15 ph 15 ph 15 ph 15 ph 15 ph 15 ph 10,000 Btufle VS 10,000 Btufle VS 10,000 Btufle VS 10,000 Btufle VS 10,000 Btufle VS 10,000 Btufle VS 10,000 Btufle VS	16285 PPD 50.0% 89%
Feedatoch Type 95 + WAS 50 Gauge Iniet Temp 65 F 0 Operation Temp 98 F 59 Baudri	Nat gas usage, ch 0 Bioges Fuel use 70% Heast Recovery 11.22 MMBturbr	End Use Land Application	Feedstock Type Dewatered Cake Virgin Woodchips Screened Overs	End Use Local Retail
Energy Consumption 9 hplinit 90% Efficiency 195 here y Consumption 196 hplinit 197 hplinit 198 hplinit 198 here 198 hplinit 199 here 199	Energy Consumption 4 hptinit 5% Efficiency Duty No. 1 Energy Consumption 0 hptinit 0% Efficiency Duty No. 1	Energy Consumption 200 hpiont 95% Efficiency 35 hs/0T	Energy Consumption by heining by Efficiency Energy Consumption by heining by Efficiency Energy Consumption by Efficiency Daty No. 1	Energy Consumption 0 hplunit 95% Efficiency
67,44 bhr 3,913 bhr 47,6 DTPO 3,517 bhr 53,511 bhr 53,511 bhr 53,511 bhr 53,511 bhr 2,343 bhr 1,374 bhr 1,348 gam 10,000 Buill VS 0 MBlishr 0 schn 0 schn 0 bhr 13,5 mBlishr 0 schn	45,221 bhr 1,770 bhr 1,770 bhr 1,72 bhr 1,734 bhr 1,374 bhr 1,305 gan 10,000 Buikby 3,32 WW 0,00 MBichr 0,00 WMichr 0,00 MBichr 0,00 MBichr 0,00 WMichr 0,00 WMichr 0,00 wMichr 0,00 trukskigr	8,166 bhr 1,57 bhr 15.6 DTP0 1,271 bhr 2,00% 22 70% bhr 2,00% 20 70% bhr 16.6 DTP0 12.71 bhr 2,00% 20 70% bhr 10.000 Bubry 55 33.15 kW 0.0 MMEtuhr 0.0 scfm	5,186 Ibhr 11,522 Bhr 7,469 Bhr 11,557 Bhr 1,155 DTPD 8,58 DTPD 8,58 DTPD 8,54 Bhr 6,779 Bhr 1,271 Bhr 1,555 DTPD 8,54 Bhr 6,739 Bhr 1,271 Bhr 1,055 Bhr 7,135 Bhr 6,635 Bhr 2,505,h 32,275,h 40,279,5 50,079,8 5	13,557 Ibitr 13,357 Ibitr 81.3 DTPO 6,055 Ibitr 6,779 Ibitr 6,779 Ibitr 7,71 Botr 9 Pubr 0.0 Bothr 0.0 Bothr 0.0 Bothr 0.0 MMBuitr 0.00 MMBuitr 0.00 MMBuitr 0.00 MMBuitr 0.00 Bothr 0.00 MMBuitr 0.00 Bothr 0.00 MMBuitr 0.00 Bothr 0.00 Bothr 0.00 Bothr 0.00 Bothr 0.00 Bothr 0 acfm 0 acfm 0 Bothr 0 Bothr

King County Class A Biosolids Technology Evaluation

KC Brightwater Biosolids Production			_	-			-	-			-		-	-	-		-		-	-	
- onginemater biosonas rioduction																					
Dry Tons per Year	7.171																				
%TS	20%							•													
				Bios	olids (Ton	is/yr)															
Operation		Bulk Den	(Ib/ %TS	Water	VS	Dry solids	Wet solids	Volume (CY)			Grir	ider	4						- ()		
		1	300 20%	28,685	5,566	7,171	35,857	55,164									Bulking A	gent (Ton			
Days per Week	5							1						%TS	Water	VS	Dry solids	ws	Solver WS	Volume (CY)	Bulk Den (lb/cy)
Hours per Day	8								+	+				55%	19,779	22966	24,175	43954	4395		450
																-					
Feedstock Characteristics									Mixe												
Biosolids Bulk Density (Ib/CY)	1300										-										
Biosolids VS	78%		%TS	Water	VS	Dry solids	Wet solids	Volume (CY)			Bulk Density	lb/cy)									
Bulking Agent Bulk Density (Ib/CY)	350		40.03%	51,496	31,251	34,378	85,874	143,123			1200										
Bulking Agent %TS	55%					90.9%		,	1												
Bulking Agent %VS	95%		-			55.57	VSR	1.				Water			1	-					
Screened Overs %TS	60%						2.031	-	Phase		\rightarrow	10.591			-		-				
Screened Overs %VS	89.7%						-,	1				,		-			-			-	
Screened Overs Bulk Density (Ib/CY)	800		%TS	Water	vs	Dry solids	Wet solids	Volume (CY)			Bulk Density	lb/cv)									
			44%	40,906	29,219	32,346	73,252	146504			1000										
Aerated Static Pile Parameters								1	+												
Bulk to Biosolids Ratio (V:V)	3.9						VSR		Phase	2		Water									
Bulk to Biosolids Ratio (M:M)	1.2						1,354		Pilase	2		3,530									
Assumed total solids loss thru phases 1 and 2	8%																				
Curing loss thru phase 3	5%		%TS	Water	VS	Dry solids		Volume (CY)			Bulk Density										
Compost Mixture %TS	40%		45%	37,376	27,865	30,992	68,368	151928			900										
Screen %TS Requirement	55%							-	*												
Screenings Recycled	10%		_				VSR 677		Phase	3	\rightarrow	Water									
Final Compost %TS	50%						6//	1				7,060									
		Composted	_	%TS	Water		Dry solids	Wet solids	Volume (CY)		Bulk Density	Hr (_						-	
Final Compost Parameters		Material Storag	e	50%	30,315	VS 27,188	30,315		134734		900										
Carbon of Biosolids	25.3%			30%	Reduction	87.0%					300			-	-						
Nitrogen of Biosolids	3.0%			-	neduction	87.07	00.27	70.0%	' ↓						-	-	-		-		
Carbon of Woodchips	45.0%			-			-	-		_									1	-	
Nitrogen of Woodchips	0.8%								Scree	n	\rightarrow			Ov	vers (Tons	/yr)				-	
Carbon of Yardwaste	44.5%										1	%TS	Water	VS	Dry solids	Wet solids	Volume (CY)	Bulk Den (lb/	(cv)		
Nitrogen of Yardwaste	2.0%			Finished	Compost	(Ions/yr)						50%	3.032	2719	3.032	6.063	22047		1	-	
Carbon of Recycle	25%	%TS	Water	VS	Dry solids	Wet solids	Volume (CY)	Bulk Density	(lb/cy)												
Nitrogen of Recycle	1.00%	50%		24,469		54,567	145512														
				VS (%)				1													
Carbon:Nitrogen	31.5			89.7%																	
Retail Bags Capacity (CF)	2																				
Percent to Bagging	15%																				
				_																	
			_	_										_						-	
															-	-					
															-	-					

Equipment Sizing							
Equipment	Manufacturer	Capacity (CF/batch)	Real Capacity (CY/batch)	Batches per Hour	Throughput (CY/Day)	Required Volume Mixed (CY/Day)	Number of Equipment (N+1)
Vertical Mixer	ECS/Lucknow 2295	1100	28.5	4	798.5	550	2
Equipment	Manufacturer	Capacity (CF/hr)	Real Capacity (CY/hr)	Batches per Hour	Throughput (CY/Day)	Required Throughput (CY/Day)	Number of Equipment
Screen	MultiStar L3 Type	8825	261	N/A	1830	518	1
Equipment	Manufacturer	Capacity (CF/bag)	Real Capacity (CF/bag)	Bags per Hour	Throughput (Bags/Day)	Required Throughput (Bags/Day)	Number of Equipment
Bagging Equipment	RotoChopper Go-Bagger 250	2	2	250	1750	1133	1



Equipment Sizing								
Equipment	Manufacturer	Capacity (CF/batch)	Real Capacity (CY/batch	Batches per Hour	Throughput (CY/Day)	Required Volume Mixed (CY/Day)	Number of Equipment (N+1)	
Horizontal Mixer	RotoMix 1220-20	1220	31.6	4	885.6	768	2	2
Equipment	Manufacturer	Capacity (CF/hr)	Real Capacity (CY/hr)	Batches per Hour	Throughput (CY/Day)	Required Throughput (CY/Day)	Number of Equipment	
Screen	MultiStar L3 Type	8825	261	N/A	1830	724	1	Compost Screener can be used as redundant unit
Equipment	Manufacturer	Capacity (CF/bag)	Real Capacity (CF/bag)	Bags per Hour	Throughput (Bags/Day	Required Throughput (Bags/Day)	Number of Equipment	
Bagging Equipment	RotoChopper Go-Bagger 250	2	2	250	1750	1467	1	1

Biochar Carbon Sequestration

$$22,920 \frac{DT}{yr}Biochar \times 28.6\% Carbon = 6,555 \frac{tons}{yr} carbon$$

$$6,555 \frac{tons}{yr} carbon \times 90\% Fixed = 5,900 \frac{tons}{yr} fixed carbon$$

$$5,900 \frac{tons}{yr} fixed carbon \times 907 \frac{kg}{ton} = 5,352,006 \frac{kg}{yr} fixed carbon$$

$$5,352,006 \frac{kg}{yr} fixed carbon \times \frac{44 CO_2}{12 C} = 19,624,023 \frac{kg CO_2 e}{yr}$$

$$\frac{19,624,023 \frac{kg CO_2 e}{yr}}{21,017,640 \frac{kg}{yr} biochar} = 0.9337 \frac{kg CO_2 e}{kg biochar}$$

$$\frac{1}{21,017,640} \frac{kg \ biochar}{yr} = 0.7337 \ kg \ biochar}{kg \ biochar}$$

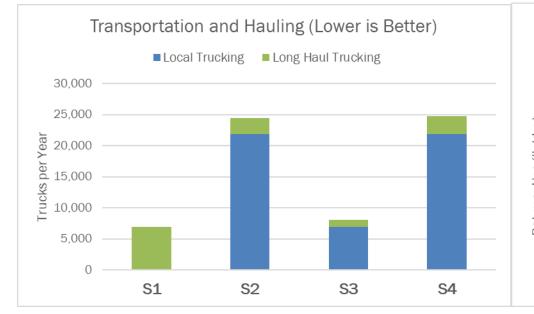
Attachment B: Solids-Water-Energy Evaluation Tool Results

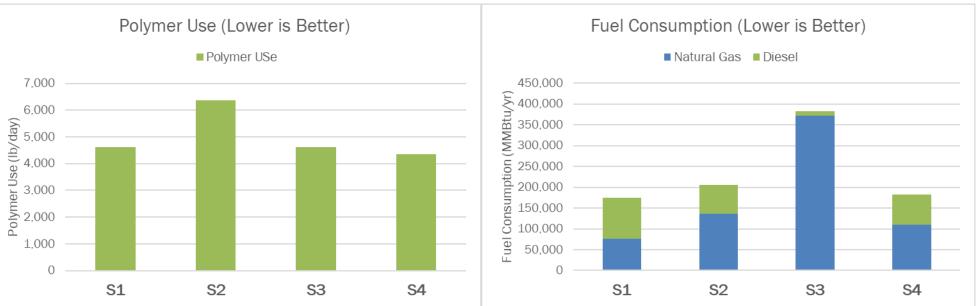


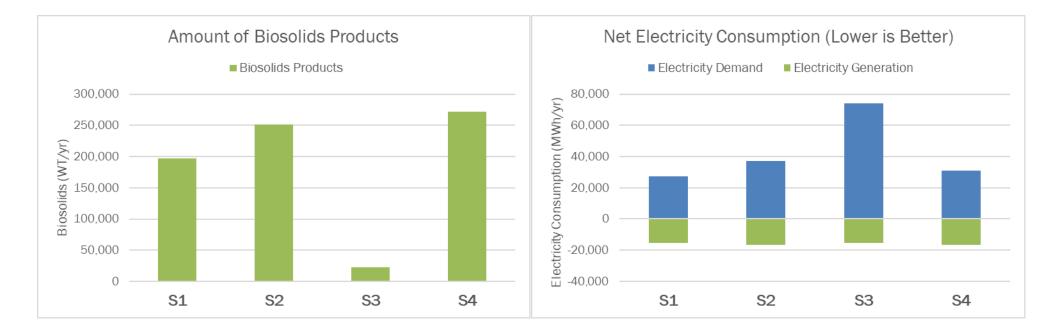
Scenario	Facility	Stabilization	Dewatering	Post Dewatering	Biosolids Classification	End-Use
	West Point	MAD				Land Application
Scenario 1	South Plant	MAD	Centrituge - Class B -		Land Application West/East WA	
	Brightwater	MAD				West/East WA
	West Point	TAD-Batch		Composting		Local Retail
Scenario 2	South Plant	THP-MAD	Centrifuge	-	Class A	Land Application West/East WA
	Brightwater	MAD		Soil Blending		Local Retail
	West Point	MAD			Unknown (Dotontial	
Scenario 3	South Plant	MAD	Centrifuge	Pyrolysis	Unknown (Potential	Regional Retail
	Brightwater	MAD			Class A)	
				-		
	West Point	TAD-Batch		Composting		Local Retail
Scenario 4	South Plant	TAD-Batch	Centrifuge	-	Class A	Land Application West/East WA
	Brightwater	MAD		Soil Blending		Local Retail

Parameter	<u>S1</u>	<u>S2</u>	<u>S3</u>	<u>S4</u>
Final Product, Wet (WT/d)	539	689	63	744
Trucks Required (Trucks/d)	19	67	22	68
Vehicle Fuel Consumption (gal/day)	1952	1360	104	1445
Electricity Demand (MWh/d)	75	101	203	85
Electricity Generation (MWh/d)	-42	-45	-42	-45
Net Power (MWh/d)*	33	56	160	40
Natural Gas Consumption (scfm)	145	260	708	210
Digester Gas Produced (scfm)	3325	3419	3325	3502
Methane Injected into Pipeline (scfm)	778	787	778	829
Polymer Use (lb/day)	4611	6359	4611	4344

Fuel Consumption			S1	S2	S3	_	S4
Natural Gas (SCF/yr)			76,267,424	136,752,625	372,349,6	51	110,410,948
Natural Gas (MMBtu/y	vr)		76,267	136,753	372,350		110,411
Diesel (gal/yr)			712,453	496,321	77,773		527,438
Diesel (MMBtu/yr)			97,877	68,185	10,685		72,460
Total MMBtu/yr			174,145	204,938	383,034		182,871
Hauling and Trucking	S1		S2	S3	S4		
Local Trucking		0	21,85	5	6,935	21,855	
Long Haul Trucking		6,935	2,55	5	1,095	2,920	







Performan	ce Summary			1	2	3	
Solids Flows a			Notes	100% Class B application with MAD at all three plants	TAD-Batch , Cambi, and Off- site Soilblending or Composting	Off-site Pyrolysis	TAD-Batch and Off-site Soil blending or Composting
Element			_	\$1	<u>\$2</u>	\$3	S4
West Point Treat	-						
Solids	Loading and Flows						
	PS + WAS	Average Digester Feed Load, dry lbs TS/hr		9,410.8	9,410.8	9,410.8	9,410.8
	PS + WAS	Average Digester Feed Load, %TS		6.1%	6.1%	6.1%	6%
	PS + WAS	Average Digester Feed Load, %VS		81.0%	81.0%	81.0%	81%
Chabill							
Stabili		Turne				MAD	
	Digester	Type		MAD	TAD-BATCH	MAD	TAD-BATCH
	Digester	Biogas Production, mmbtu/hr		40.6	43.5	40.6	44
	Digester	Biogas Production, SCFM		1,219.5	1,295.5	1,219.5	1295
	Digester	Methane Production, SCFM		731.7	777.3	731.7	777
0.0-11					<u> </u>		
Gas Ut	tilization	Pierce Itilization mmhtu/hr		-17.7	-18.9	-17.7	-18.9
	Cogen	Biogas Utilization, mmbtu/hr					
	Cogen	Methane Utilization, SCFM		-318.3	-338.1	-318.3	-338.1
	Boiler	Biogas Utilization, mmbtu/hr		-2.4	-2.5	-2.4	-2.5
	Boiler	Methane Utilization, SCFM		-42.8	-45.5	-42.8	-45.5
	Boiler	NG Utilization, mmbtu/hr		0.0	0.0	0.0	0.0
	Boiler	NG Utilization, SCFM		0.0	0.0	0.0	0.0
	Gas Upgrading	Biogas Utilization, mmbtu/hr		0.0	0.0	0.0	0.0
	Gas Upgrading	Methane Utilization, SCFM		0.0	0.0	0.0	0.0
	Flare	Biogas Utilization, mmbtu/hr		-20.6	-22.0	-20.6	-22.0
	Flare	Methane Utilization, SCFM		-370.6	-393.7	-370.6	-393.7
Inerma	al Supply	The weed Frances Direction were by the			2.0	0.0	2.0
	Heat Exchanger	Thermal Energy Production, mmbtu/hr Thermal Energy Production, mmbtu/hr		0.0	3.2 6.8	0.0 6.4	3.2 6.8
	Cogen				6.8		2.2
	Boiler (biogas)	Thermal Energy Production, mmbtu/hr		2.0	0.0	2.0	0.0
	Boiler (NG)	Thermal Energy Production, mmbtu/hr		0.0		0.0	
	Subtotal	Thermal Energy Production, mmbtu/yr		73,395.0	107,014.1	73,395.0	107014.1
These	al Daman d						
inerma	al Demand	Thormal Energy Domand methods		-5.9	-11.7	FO	-11.7
	Digester	Thermal Energy Demand, mmbtu/hr Thermal Energy Demand, mmbtu/hr		-5.9	-11.7	-5.9 0.0	-11.7
	Thermal Hydrolysis						
	Pyrolysis	Thermal Energy Demand, mmbtu/hr		0.0	0.0	0.0	0.0
	Subtotal	Thermal Energy Demand, mmbtu/yr		-51,287.8	-102,575.6	-51,287.8	-102575.6
Total T	hermeel Delemen						
Iotal I	Thermal Balance Solids Treatment	Theymal Energy Total remetty for		22,107.2	4,438.5	22,107.2	4,438.5
	Solius treatment	Thermal Energy Total, mmbtu/yr		22,107.2	4,438.9	22,107.2	4,438.0
Flaght	city Consumption				<u> </u>		
Electric	Digestion	Electricity Load, kW		-149.2	-165.8	-149.2	-165.8
	-	Electricity Load, kW		-149.2	-165.8 -124.3	-149.2	-165.8 -124.3
	Heat Exchanger CHP	Parasitic Loads. kW			-124.3 -239.7		_
	-	,		-239.7		-239.7	-239.7
	Boiler	Parasitic loads, kW		-66.3	-66.3	-66.3	-66.3
	Gas Upgrading	Parasitic loads, kW		0.0	1.0	0.0	1.0
	Flare	Parasitic loads, kW		0.0	0.0	0.0	0.0

	Dewatering	Electricity Load, kW	-746.0	-746.0	-746.0	-746.0
	Subtotal	Electricity Load, MWh/yr	-10,522.8	-11,748.5	-10,522.8	-11,748.5
					·	,
Electri	city Production					
	CHP	Electricity Production, kW	1,759.7	1,886.3	1,759.7	1,886.3
	CHP	Electricity Production, MWh/yr	15,415.3	16,523.7	15,415.3	16,523.7
Total E	Electricity Balance					
	Solids Treatment	Electricity Total, MWh/yr	-10,522.8	-11,748.5	-10,522.8	-11,748.5
	Solids Treatment	Electricity Export, kWh/yr	15,415.3	16,523.7	15,415.3	16,523.7
	Solids Treatment	Electricity Import, kWh/yr	10,522.8	11,748.5	10,522.8	11,748.5
Chemi	cal Usage					
	Dewatering	Polymer Use, Ib per year	595,636.8	555,684.0	595,636.8	555,684.0
Hauleo	d Solids					
	Hauling	Average Hauled, wet tons/yr	64,224.3	59,916.4	64,224.3	59,916.4
	Hauling	Dry Solids, %	28.5%	28.5%	28.5%	
	Hauling	Trucks per Day	6.0	6.0	6.0	
	Hauling	Trucks per Year	2,190.0	2,190.0	2,190.0	2,190.0
			-			
	t Dianat					
reatment						
Solids	Loading and Flows	Average Distantes Fred Lond day the TC (by	40.000.0	10,000,0	10,000,0	10.000.0
_	PS + WAS	Average Digester Feed Load, dry lbs TS/hr	10,990.0	10,990.0	10,990.0	10,990.0
_	PS + WAS PS + WAS	Average Digester Feed Load, %TS	6.2% 85.9%	6.2% 85.9%	6.2% 85.9%	6.2% 85.9%
	P5 + WA5	Average Digester Feed Load, %VS	85.9%	85.9%	85.9%	85.9%
Stabili	Tation					
Stabili	Digester	Туре	MAD	THP-MAD	MAD	TAD-Batch
	Digester	Biogas Production, mmbtu/hr	50.6	51.2	50.6	54.94
	Digester	Biogas Production, SCFM	1,533.6	1,552.3	1,533.6	1,635.04
	Digester	Methane Production, SCFM	920.2	931.4	920.2	981.03
	2.80010.		01011			001.00
Gas Ut	tilization					
	Cogen	Biogas Utilization, mmbtu/hr	0.0	0.0	0.0	0.0
	Cogen	Methane Utilization, SCFM	0.0	0.0	0.0	0.0
	Boiler	Biogas Utilization, mmbtu/hr	0.0	0.0	0.0	0.0
	Boiler	Methane Utilization, SCFM	0.0	0.0	0.0	0.0
	Boiler	NG Utilization, mmbtu/hr	-7.9	-14.2	-7.9	-11.5
	Boiler	NG Utilization, SCFM	-145.1	-260.2	-145.1	-210.1
	Gas Upgrading	Biogas Utilization, mmbtu/hr	-42.8	-43.3	-42.8	-46.4
	Gas Upgrading	Methane Utilization, SCFM	-777.5	-787.0	-777.5	-829.0
	Flare	Biogas Utilization, mmbtu/hr	-7.8	-7.9	-7.8	-8.5
	Flare	Methane Utilization, SCFM	-142.6	-144.4	-142.6	-152.1
Therm	al Supply					
	Cogen	Thermal Energy Production, mmbtu/hr	0.0	0.0	0.0	0
	Boiler (Biogas)	Thermal Energy Production, mmbtu/hr	0.0	0.0	0.0	0.0
	Boiler (NG)	Thermal Energy Production, mmbtu/hr	6.7	12.1	6.7	9.7
	Subtotal	Thermal Energy Production, mmbtu/yr	58,928.0	105,661.9	58,928.0	85,309.0
	1					1

	Digester	Thermal Energy Demand, mmbtu/hr	-6.7	0.0	-6.7	-13.5
		Thermal Energy Demand, mmbtu/hr	0.0	-12.1	0.0	0.0
	Subtotal	Thermal Energy Demand, mmbtu/yr	-58,928.0	-105,662.0	-58,928.0	-117,856.1
Total Th	ermal Balance					
	Solids Treatment	Thermal Energy Total, mmbtu/yr	0.0	0.0	0.0	-32,547.0
Electricit	ty Consumption					
	Digestion	Electricity Load, kW	-119.4	-119.4	-119.4	-133
	THP	Electricity Load, kW	0.0	-223.8	0.0	0
	СНР	Electricity Load, kW	0.0	0.0	0.0	0
	Boiler	Electricity Load, kW	-66.3	-66.3	-66.3	-66
	Gas Upgrading	Electricity Load, kW	-550.4	-557.1	-550.4	-587
	Flare	Electricity Load, kW	0.0	0.0	0.0	0
	Predewatering	Electricity Load, kW	0.0	-497.3	0.0	0
	Dewatering	Electricity Load, kW	-746.0	-746.0	-746.0	-746
	Subtotal	Electricity Load, MWh/yr	-12,983.2	-19,358.9	-12,983.2	-13,418.2
Electrici	ty Production					
	CHP	Electricity Production, kW	0.0	0.0	0.0	0
	СНР	Electricity Production, MWh/yr	0.0	0.0	0.0	0.0
Total Ele	ectricity Balance					
	Solids Treatment	Electricity Total, MWh/yr	-12,983.2	-19,358.9	-12,983.2	-13,418.2
	Solids Treatment	Electricity Export, kWh/yr	0.0	0.0	0.0	1.0
	Solids Treatment	Electricity Import, kWh/yr	12,983.2	19,358.9	12,983.2	13,418.2
Process	Water Usage					
	THP	Dilution Water, MG/yr	0.0	57.1	0.0	0
Chemica						
				700.040.0		
	Predewatering	Polymer Use, Ib per year	0.0	722,043.0	0.0	0
		Polymer Use, Ib per year Polymer Use, Ib per year	0.0 816,156.7	722,043.0 771,898.5	0.0 816,156.7	0 758,712
Hauled S	Predewatering Dewatering			,		
	Predewatering Dewatering			,		
	Predewatering Dewatering Solids	Polymer Use, Ib per year	816,156.7	771,898.5	816,156.7	758,712
	Predewatering Dewatering Solids Hauling	Polymer Use, Ib per year Average Hauled, wet tons/yr	816,156.7 96,696.5	771,898.5 69,809.0	816,156.7 96,696.5	758,712
	Predewatering Dewatering Sollds Hauling Hauling	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, %	816,156.7 96,696.5 22.9%	771,898.5 69,809.0 30.0%	816,156.7 96,696.5 22.9%	758,712 89,891 22.9%
	Predewatering Dewatering Sollds Hauling Hauling Hauling	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day	816,156.7 96,696.5 22.9% 9.0	771,898.5 69,809.0 30.0% 7.0	816,156.7 96,696.5 22.9% 9.0	758,712 89,891 22.9% 8
Hauled S	Predewatering Dewatering Sollds Hauling Hauling Hauling Hauling	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day	816,156.7 96,696.5 22.9% 9.0	771,898.5 69,809.0 30.0% 7.0	816,156.7 96,696.5 22.9% 9.0	758,712 89,891 22.9% 8
Hauled S	Predewatering Dewatering Sollds Hauling Hauling Hauling Hauling ment Plant	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day	816,156.7 96,696.5 22.9% 9.0	771,898.5 69,809.0 30.0% 7.0	816,156.7 96,696.5 22.9% 9.0	758,712 89,891 22.9% 8
Hauled S	Predewatering Dewatering Sollds Hauling Hauling Hauling Hauling	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day	816,156.7 96,696.5 22.9% 9.0	771,898.5 69,809.0 30.0% 7.0	816,156.7 96,696.5 22.9% 9.0	758,712 89,891 22.9% 8
Hauled S	Predewatering Dewatering Sollds Hauling Hauling Hauling Hauling ment Plant oading and Flows	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day Trucks per Year	816,156.7 96,696.5 22.9% 9.0 3,285.0	771,898.5 69,809.0 30.0% 7.0 2,555.0	816,156.7 96,696.5 22.9% 9.0 3,285.0	758,712 89,891 22.9% 8 2,920.0
Hauled S	Predewatering Dewatering Solids Hauling Hauling Hauling Hauling ment Plant oading and Flows PS + WAS	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day Trucks per Year Average Digester Feed Load, dry lbs TS/hr	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9	771,898.5 69,809.0 30.0% 7.0 2,555.0 3,912.9	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9	758,712 89,891 22.9% 8 2,920.0 3,912.9
Hauled S	Predewatering Dewatering Solids Hauling Hauling Hauling Hauling Hauling Bauling Patheric Soliton PS + WAS PS + WAS PS + WAS	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day Trucks per Year Average Digester Feed Load, dry Ibs TS/hr Average Digester Feed Load, %TS	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8%	771,898.5 69,809.0 30.0% 7.0 2,555.0 3,912.9 5.8%	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8%	758,712 89,891 22.9% 8 2,920.0 3,912.9 5.8%
Hauled S	Predewatering Dewatering Solids Hauling Hauling Hauling Hauling Hauling Pauling Ps + WAS PS + WAS PS + WAS PS + WAS	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day Trucks per Year Average Digester Feed Load, dry Ibs TS/hr Average Digester Feed Load, %TS Average Digester Feed Load, %VS	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8% 89.9%	771,898.5 69,809.0 30.0% 7.0 2,555.0 3,912.9 5.8% 89.9%	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8% 89.9%	758,712 89,891 22.9% 8 2,920.0 3,912.9 5.8% 89.9%
Hauled S	Predewatering Dewatering Solids Hauling Hauling Hauling Hauling Hauling Paulon PS + WAS PS + WAS PS + WAS PS + WAS PS + WAS	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day Trucks per Year Average Digester Feed Load, dry Ibs TS/hr Average Digester Feed Load, %TS Average Digester Feed Load, %VS Type	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8% 89.9% MAD	771,898.5 69,809.0 30.0% 7.0 2,555.0 3,912.9 5.8% 89.9% MAD	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8% 89.9% MAD	758,712 89,891 22.9% 8 2,920.0 3,912.9 5.8% 89.9% MAD
Hauled S	Predewatering Dewatering Solids Hauling Hauling Hauling Hauling Hauling Paulon Paulon PS + WAS PS + WAS PS + WAS PS + WAS PS + WAS Digester Digester	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day Trucks per Year Average Digester Feed Load, dry Ibs TS/hr Average Digester Feed Load, %TS Average Digester Feed Load, %VS Type Biogas Production, mmbtu/hr	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8% 89.9% MAD 18.9	771,898.5 69,809.0 30.0% 7.0 2,555.0 3,912.9 5.8% 89.9% MAD 18.9	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8% 89.9% MAD 18.9	758,712 89,891 22.9% 8 2,920.0 3,912.9 5.8% 89.9% MAD 18.9
Hauled S	Predewatering Dewatering Solids Hauling Hauling Hauling Hauling Hauling Paulon PS + WAS PS + WAS PS + WAS PS + WAS PS + WAS	Polymer Use, Ib per year Average Hauled, wet tons/yr Dry Solids, % Trucks per Day Trucks per Year Average Digester Feed Load, dry Ibs TS/hr Average Digester Feed Load, %TS Average Digester Feed Load, %VS Type	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8% 89.9% MAD	771,898.5 69,809.0 30.0% 7.0 2,555.0 3,912.9 5.8% 89.9% MAD	816,156.7 96,696.5 22.9% 9.0 3,285.0 3,912.9 5.8% 89.9% MAD	758,712 89,891 22.9% 8 2,920.0 3,912.9 5.8% 89.9% MAD

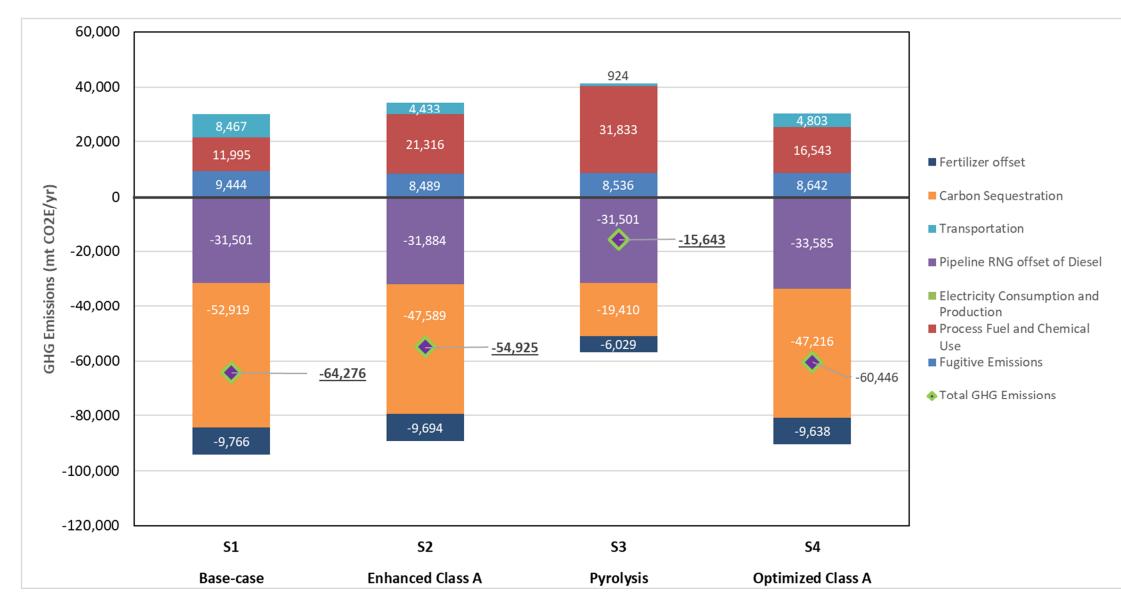
Gas Utiliza	ation					
	Cogen	Biogas Utilization, mmbtu/hr	0.0	0.0	0.0	0.0
	Cogen	Methane Utilization, SCFM	0.0	0.0	0.0	0.0
	Boiler	Biogas Utilization, mmbtu/hr	-13.2	-13.2	-13.2	-13.2
	Boiler	Methane Utilization, SCFM	-240.0	-240.0	-240.0	-240.0
	Gas Upgrading	Biogas Utilization, mmbtu/hr	0.0	0.0	0.0	0.0
	Gas Upgrading	Methane Utilization, SCFM	0.0	0.0	0.0	0.0
	Flare	Biogas Utilization, mmbtu/hr	-5.7	-5.7	-5.7	-5.7
	Flare	Methane Utilization, SCFM	-102.9	-102.9	-102.9	-102.9
Thermal S						
	Cogen	Thermal Energy Production, mmbtu/hr	0.0	0.0	0.0	0.0
	Boiler	Thermal Energy Production, mmbtu/hr	11.2	11.2	11.2	11.2
	Subtotal	Thermal Energy Production, mmbtu/yr	98,296.4	98,296.4	98,296.4	98,296.4
Thermal D						
	Digester	Thermal Energy Demand, mmbtu/hr	-2.6	-2.6	-2.6	-2.6
	Thermal Hydrolysis	Thermal Energy Demand, mmbtu/hr	0.0	0.0	0.0	0.0
	Pyrolysis	Thermal Energy Demand, mmbtu/hr	0.0	0.0	0.0	0.0
	Subtotal	Thermal Energy Demand, mmbtu/yr	-22,427.9	-22,427.9	-22,427.9	-22,427.9
Total Than	rmal Balance	 				
	Solids Treatment	Thermal Energy Total, mmbtu/yr	75,868.5	75.868.5	75.868.5	75,868.5
	Solius Treatment		15,808.5	15,608.5	13,808.5	15,808.5
Electricity	Consumption	· · · · · · · · · · · · · · · · · · ·				
	Digestion	Electricity Load, kW	-89.5	-89.5	-89.5	-89.5
	CHP	Electricity Load, kW	0.0	0.0	0.0	0.0
	Boiler	Electricity Load, kW	-33.2	-33.2	-33.2	-33.2
	Gas Upgrading	Electricity Load, kW	0.0	0.0	0.0	0.0
	Flare	Electricity Load, kW	0.0	0.0	0.0	0.0
	Dewatering	Electricity Load, kW	-331.6	-331.6	-331.6	-331.6
	Subtotal	Electricity Load, MWh/yr	-3,979.1	-3,979.1	-3,979.1	-3,979.1
	Production					
	СНР	Electricity Production, kW	0.0	0.0	0.0	0.0
	СНР	Electricity Production, MWh/yr	0.0	0.0	0.0	0.0
T . 4 ·	4-1-14- D-1-					
	tricity Balance	Flashisin Tatal MM//s (0.070.1	0.070.1	2.070.1	0.070 /
	Solids Treatment	Electricity Total, MWh/yr	-3,979.1	-3,979.1	-3,979.1	-3,979.1
	Solids Treatment	Electricity Export, kWh/yr	0.0 3.979.1	0.0 3,979.1	0.0 3,979.1	0.0 3.979.1
	Solids Treatment	Electricity Import, kWh/yr	3,979.1	3,979.1	3,979.1	3,979.1
Chemical	lisage			+		
	Predewatering	Polymer Use, Ib per year	0.0	0.0	0.0	0.0
	Dewatering	Polymer Use, lb per year	271,319.5	271,319.5	271,319.5	271,319.5
					,010.0	212,020.0
Hauled So	lauled Solids					
	Hauling	Average Hauled, wet tons/yr	35,856.8	35,856.8	35,856.8	35,856.8
	Hauling	Dry Solids, %	20.0%	20.0%	20.0%	20%
	Hauling	Trucks per Day	4.0	4.0	4.0	4.0
	Hauling	Trucks per Year	1,460.0	1,460.0	1,460.0	1,460.0
	пашінд					

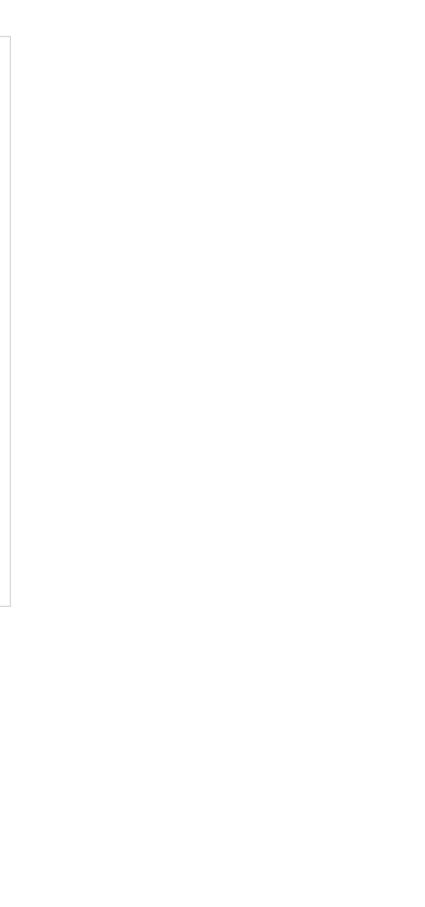
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Solids Loading and Flows			
Dewatered Cake	Average Load, dry lbs TS/hr	1,637	1.637
Dewatered Cake	Average Load, %TS	20.0%	20%
Dewatered Cake	Average, %VS	77.6%	78%
Woodchips	Average Load, dry lbs TS/hr	5,519	5,519
Woodchips	Average Load, %TS	55.0%	55%
Woodchips	Average, %VS	95.0%	95%
Screened Overs	Average Load, dry lbs TS/hr	 692	692
		 55.0%	55%
Screened Overs	Average Load, %TS		
Screened Overs	Average, %VS	89.7%	90%
Feed Mixture	Average Load, dry lbs TS/hr	7849	7,849
Feed Mixture	Average Load, %TS	40.3%	40%
Feed Mixture	Average, %VS	90.9%	91%
Electricity Consumption			
Electricity Consumption Composting	Electricity Load, kW	-216	-216
Composing		-210	-210
Fuel Consumption			
Composting	Fuel Consumption (Diesel), gal/day	274	274
Hauling and Transportation			
Composting	Finished Compost, wet tons/yr	59,380	59,380
Composting	Dry Solids, %	50%	50%
Composting	Finished Compost, CY/yr	145,512	145,512
Commercial	Compost, wet tons/yr	41,566	41,566
Residential	Compost, wet tons/yr	5,938	5,938
Donated	Compost, wet tons/yr	11.876	11,876
te Soll Blending (West Point Sol	lds)		
Solids Loading and Flows			
Dewatered Cake	Average Load, dry lbs TS/hr	3,899	3,899
Dewatered Cake	Average Load, %TS	28.5%	29%
Dewatered Cake	Average, %VS	57.7%	58%
Sawdust	Average Load, dry lbs TS/hr	1,915	1,915
Sawdust	Average Load, %TS	60.0%	60%
Sawdust	Average, %VS	95.0%	95%
Fine Sand	Average Load, dry lbs TS/hr	10,526	10.526
Fine Sand	Average Load, %TS	95.0%	95%
Fine Sand	Average, %VS	0.0%	0%
			070
Electricity Consumption			
Soil Blending	Electricity Load, kW	0	0
Fuel Consumption			
Soil Blending	Fuel Consumption (Diesel), gal/day	234	234
Hauling and Transportation			
Soil Blending	Blended product, wet tons/yr	122,429	122,429
Soil Blending	Dry Solids, %	58%	58%
Soil Blending	Blended product, CY/yr	188,353	188,353

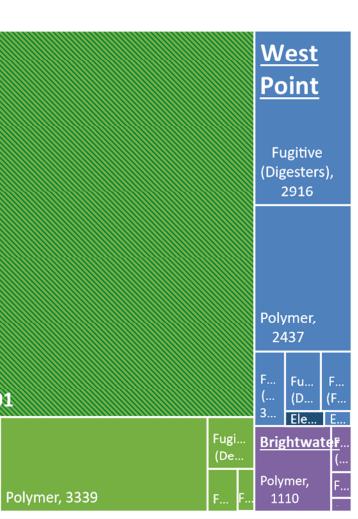
	a	Disusted and duct such taxes (a)	05 700		05 700
	Commercial	Blended product, wet tons/yr	85,700		85,700
	Residential	Blended product, wet tons/yr	24,486		24,486
	Donated	Blended product, wet tons/yr	12,243		12,243
	I				
Site Thermal D	rying and Pyrolysis				
Solids Lo	ading and Flows				
	Dewatered Cake	Average Load, dry lbs TS/hr		10,872	
	Dewatered Cake	Average Load, WT/yr		193,448	
	Dewatered Cake	Average Load, %TS		24.6%	
	Dewatered Cake	Average, %VS		67.90%	
Electricit	y Consumption				
	Boiler	Electricity Load, kW		66	
	Thermal Drying	Electricity Load, kW		3,367	
	Pyrolysis	Electricity Load, kW		1,870	
	Subtotal	Electricity Load, MWh/yr		46,456.3	
Thermal					
	Boiler	NG Utilization, mmbtu/hr		30.72	
	Boiler	NG Utilization, SCFM		563	
	Boiler	Thermal Energy Production, mmbtu/hr		26.12	
	Thermal Drying	Thermal Energy Production, mmbtu/hr		0	
	Pyrolysis	Thermal Energy Production, mmbtu/hr		21	
	Subtotal	Thermal Energy Production, mmbtu/yr		415,294	
	<u> </u>				
Inermai	Demand			47	
	Thermal Drying	Thermal Energy Demand, mmbtu/hr		-47	
	Pyrolysis	Thermal Energy Demand, mmbtu/hr		0	
	Subtotal	Thermal Energy Demand, mmbtu/yr		-415,295	
Total The	ermal Balance				
	Solids Treatment	Thermal Energy Total, mmbtu/yr		-0.2	
Hauling	and Transportation				
	Hauling	Average Hauled, wet tons/yr		22,920.1	
	Hauling	Dry Solids, %		100.0%	
	Hauling	Solids Reduction		51.9%	
	Hauling	Trucks per Day		3.0	
	Hauling	Trucks per Year		1,095.0	

GHG Emission Category	Emission Type	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Fugitive Emissions [SC1FST]	9,444	8,489	8,536	8,642
be 1	Fuel Combustion (Boilers, Machines) [SC1NGST, SC1MST]	4,042	9,452	19,735	8,055
Scope 1	Subtotal	13,486	17,941	28,270	16,697
	Subtotal (Check)	13,486	17,941	28,270	16,697
	Electricity Usage [SC2E]	104	112	104	112
Scope 2	Electricity Exported [SC2EC]	-100	-107	-100	-107
Scop	Subtotal	4	4	4	4
0,	Subtotal (Check)	4	4	4	4
	Polymer Consumption [SC3PST]	6,885	9,949	6,885	6,942
	Fertilizer Offset [SC3FCST]	-9,766	-9,694	-6,029	-9,638
	Carbon Sequestration [SC3CCST]	-52,919	-47,589	-19,410	-47,216
)e 3	Natural Gas Use (Production) [SC3NGST]	1,068	1,915	5,213	1,546
Scope 3	Pipeline RNG [SC3BGST]	-31,501	-31,884	-31,501	-33,585
0,	Hauling, Transportation, Application [SC3TST]	8,467	4,433	924	4,803
	Subtotal	-77,765	-72,871	-43,917	-77,148
	Subtotal (Check)	-77,765	-72,871	-43,917	-77,148
	<u>Total</u>	-64,276	-54,925	-15,643	-60,446

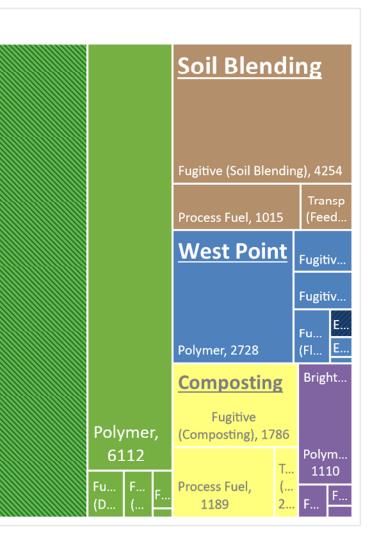


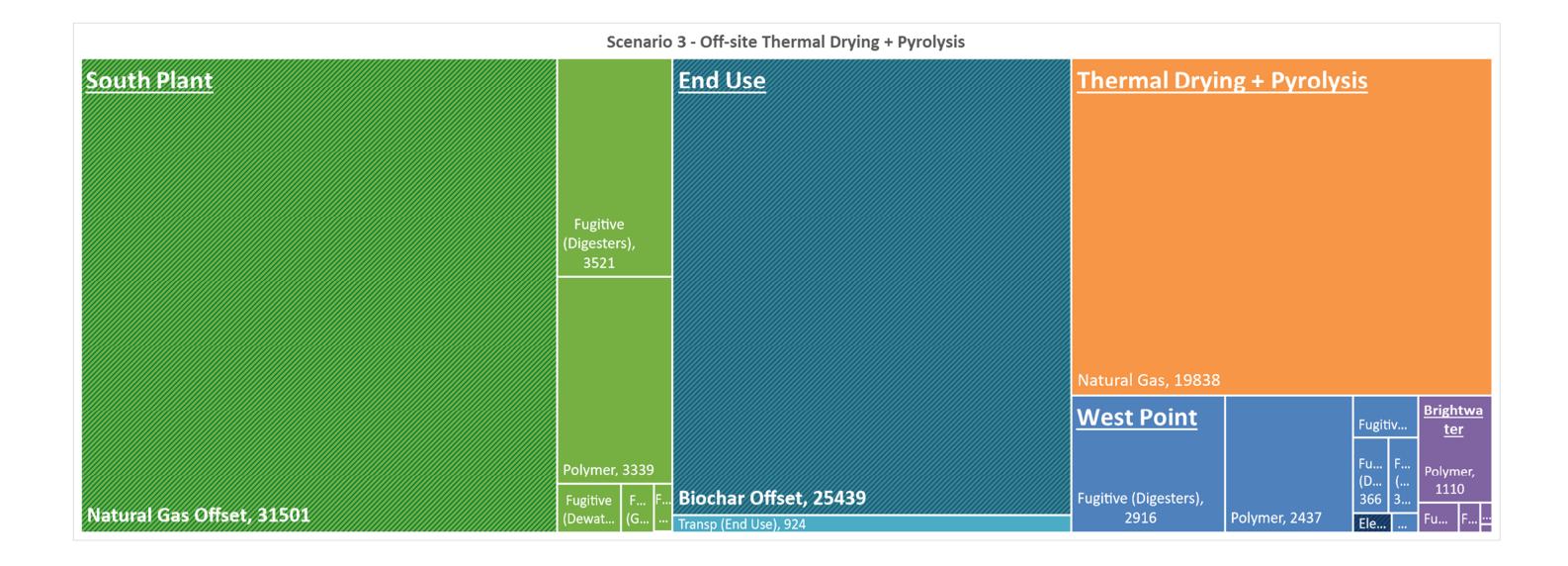


	Scenario 1 - Baseline (100% Class B - M	AD)
End Use	Transp (End Use), 7690	South Plant
Land App Offsets (Ag), 58365	Land App Offsets (Forestry), 4320 Land App (Ag), 1498	Natural Gas Offset, 31501

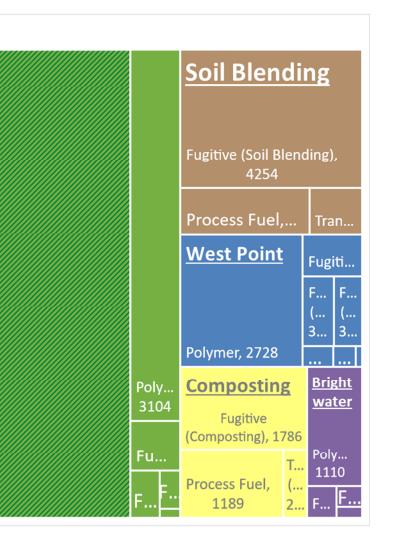


	So	cenario 2 - Enhanced Cla	ss A (TAD, THP, So	oil Blending, and Composting)
<u>End Use</u>		Compost Offset, 125		South Plant
Soil Blend Offset, 19201	Land App Offsets (Ag), 17555	Land App Offsets (Forestry), 7600	Transp (End Use), 4220 Land Land	Natural Gas Offset, 31884





		Scenario 4 - Optimized Class A (TAD, Soil Blending, and Composting)				
<u>End Use</u>		Compost Offset, 129		South Plant		
Soil Blend Offset, 19201	Land App Offsets (Ag), 17255	Land App Offsets (Forestry), 7470	Transp (End Use), 4502 Land Land	Natural Gas Offset, 33585		



HG Emissions Inventory				1	2	3	4
G Emissions Inventory nent			Notes	Base-case	Enhanced Class A	Pyrolysis	Optimized Class A
				S1	\$2	\$3	S4
est Point Treatmen	t plant						
Electrical E	missions						
Liectricar L	Solids Treatment	Electricity Production, MWh/yr		15.415	16.524	15.415	16.524
	Solids Treatment	Electricity Sold, MWh/yr		15,415	16,524	15,415	16.524
SC2EC	Solids Treatment	Emissions Offset, kg C02e/yr		-100,199	-107,404	-100,199	-107,404
	Solids Treatment	Electricity Consumption, MWh/yr		-10,523	-11,748	-10,523	-11,748
	Solids Treatment	Electricity Purchased, MWh/yr		10,523	11,748	10,523	11,748
SC2E	Solids Treatment	Emission, kg CO2e/yr		68,398	76,365	68.398	76,365
SC2EST		Subtotal, kg CO2e/yr		-31,801	-31,039	-31,801	-31,039
				· · · ·			
Natural Gas	Emissions						
	Solids Treatment	Thermal Production, MMBtu/yr		73,395	107,014	73,395	107,014
	Solids Treatment	Thermal Consumption, MMBtu/yr		-51,288	-102,576	-51,288	-102,576
	Solids Treatment	Thermal Balance, MMBtu/yr		22,107	4,438	22,107	4,438
	Solids Treatment	External Natural Gas, scf/yr		0	0	0	
SC1NG	Combustion	Emission, kg CO2e/yr		0	0	0	
SC1NGST		Subtotal, kg CO2e/yr		0	0	0	
SC3NG	Extraction/Production	Emission, kg CO2e/yr		0	0	0	
SC3NGST		Subtotal, kg CO2e/yr		0	0	0	
Chemical E	missions						
	Dewatering	Polymer Use, Ib per yr		595,637	555,684	595,637	555,684
SC3P	Dewatering	Polymer Manufacturing, kg CO2e/yr		2,436,696	2,727,903	2,436,696	2,727,903
SC3PST		Subtotal, kg CO2e/yr		2,436,696	2,727,903	2,436,696	2,727,903
Process Fu	gitive Emissions						
SC1F	Digestion	Digester Floating Cover (WP = 5, SP = 4, BW = 0), kg CO2e/yr		2,912,229	0	2,912,229	0
SC1F	Digestion	Digester Fixed Covers (WP = 0 SP = 1, BW = 3), kg CO2e/yr		3426	21838	3426	21.838
SC1F	Dewatering	Fugitive Emissions, kg CO2e/yr		365,873	365,128	365,873	365.128
SC1F	Cogen	Fugitive Emissions, kg CO2e/yr		391.671	416.085	391.671	416.085
SC1F	Boiler	Fugitive Emissions, kg CO2e/yr		601	639	601	639
SC1F	Flaring	Fugitive Emissions, kg CO2e/yr		312,362	331,833	312,362	331,833
SC1FST		Subtotal, kg C02e/yr		3,986,162	1,135,523	3,986,162	1,135,523
Hereitard	d Tropoportation						<u> </u>
Hauling and	d Transportation	Average Hauled wat tons /vr		64,224	E0.040	64.224	59,916
	Hauling	Average Hauled, wet tons/yr		28.5%	59,916 28.5%	64,224 28.5%	59,916
	Hauling Hauling	Dry Solids, % Trucks per year		28.5%	28.5%	28.5%	2.190
	Hauling	Off-site Processing, Total Miles		2,190	65,700	65,700	65,700
	Hauling	Fuel Usage Round Trip, gal/yr		0	11,965	11.965	11.965
SC3T	•	Emissions, kg CO2e/yr		0	142,204	142,204	142,204
3631	Hauling Hauling	Emissions, kg CO2e/ yr Eastern Washington, Total Miles		827,820	142,204	142,204	142,204
	Hauling	Fuel Usage Round Trip, gal/yr		150,760			
SC3T	Hauling	Emissions, kg CO2e/yr		1,791,771			
3031	Hauling	Western Washington, Total Miles		15,330	To Off-site Soil Blending	To Off-site Pyrolysis	To Off-site Soil Blendin
	•	Fuel Usage Round Trip, gal/yr		53.572			
SC3T	Hauling Hauling	Emissions, kg CO2e/yr		636,704			
SC3TST	пашінд	Subtotal, kg CO2e/yr		2,428,474	142,204	142,204	142,204
363131		Subtotal, kg COZe/ yr		2,420,414	142,204	142,204	142,204

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Land Applicat	lion					
	Agriculture	KC Fuel for Agriculture (Eastern) Application, gal/yr	18,519			
SC3T	Agriculture	Emissions, kg CO2e/yr	220,097			
	Forestry	KC Fuel for Forestry (Western) Application, gal/yr	2,826			
SC3T	Forestry	Emissions, kg CO2e/yr	33,585			
SC3TST	-	Subtotal, kg CO2e/yr	253,682			
SC1F	Agriculture	N2O and CH4 Emissions, kg CO2e/yr	316,760	-		
SC1F	Forestry	N20 and CH4 Emissions, kg CO2e/yr	35.196	-		
SC1FST		Subtotal, kg CO2e/yr	351,955	To Off-site Soil Blending	To Off-site Pyrolysis	To Off-site Soil Blo
Carbon Offset	~					
		Nitra can and Dhaanhama Fartillian Offact Jac 000a (m	4 222 040	-		
SC3FC SC3FC	Agriculture	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr	-4,333,916	_		
	Forestry	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr	-	_		
SC3FCST		Subtotal, kg CO2e/yr	-4,333,916	_		
SC3CC	Agriculture	Land App Carbon Sequestration, kg CO2e/yr	-18,680,671			
	Forestry	Land App Carbon Sequestration, kg CO2e/yr	-1,660,504	_		
SC3CCST		Subtotal, kg CO2e/yr	-20,341,175			
WP GHG Plan	t Total					
	Scope 1	CO2 Emissions, mt CO2e/yr	4,338	1,136	3,986	1,136
	Scope 2	CO2 Emissions, mt CO2e/yr	-32	-31	-32	-31
	Scope 3	CO2 Emissions, mt CO2e/yr	-19,556	2,870	2,579	2,870
	Plant Total	CO2 Emissions, mt CO2e/yr	-15,250	3,975	6,533	3,975
	Plant Total Check	CO2 Emissions, mt CO2c/yr	-15.250	3,975	6.533	3.975
	Fidilit Total Check		-13,200	3,915	0,000	3,515
atment plant	-					
	sions					
Electrical Emi		Electricity Production MWh/yr	0	0	0	0
	Solids Treatment	Electricity Production, MWh/yr	0	0	0	0
Electrical Emi	Solids Treatment Solids Treatment	Electricity Sold, MWh/yr	0	0	0	0
	Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr	0	0	0	0
Electrical Emi	Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr	0 0 -12,983	0 0 -19,359	0 0 -12,983	0 0 -13418
Electrical Emi	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr	0 0 -12,983 12,983	0 0 -19,359 19,359	0 0 -12,983 12,983	0 0 -13418 13418
Electrical Emi SC2E SC2E	Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0	0 0 -19,359 19,359 0	0 0 -12,983 12,983 0	0 0 -13418 13418 0
Electrical Emi	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr	0 0 -12,983 12,983	0 0 -19,359 19,359	0 0 -12,983 12,983	0 0 -13418 13418
Electrical Emi SC2E SC2E	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0	0 0 -19,359 19,359 0	0 0 -12,983 12,983 0	0 0 -13418 13418 0
SC2E SC2E SC2E SC2E SC2EST	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0	0 0 -19,359 19,359 0	0 0 -12,983 12,983 0	0 0 -13418 13418 0
SC2E SC2E SC2E SC2E SC2EST	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment missions	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr	0 0 -12,983 12,983 0 0	0 0 -19,359 19,359 0 0	0 0 -12,983 12,983 0 0	0 0 -13418 13418 0 0
SC2E SC2E SC2E SC2E SC2EST	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment <u>missions</u> Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr	0 0 -12,983 12,983 0 0 0 58,928	0 0 -19,359 19,359 0 0 0 105,662	0 0 -12,983 12,983 0 0 0 58,928	0 0 -13418 13418 0 0 0 85,309 -117,856
Electrical Emi SC2E SC2E SC2EST Natural Gas E	Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424	0 0 -19,359 19,359 0 0 0 105,662 -105,662 136,752,625	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424	0 0 -13418 13418 0 0 0 85,309 -117,856 110,410,948
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment <u>missions</u> Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173	0 0 -19,359 19,359 0 0 0 105,662 -105,662 -105,662 136,752,625 7,247,889	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173	0 0 -13418 13418 0 0 0 85,309 -117,856 110,410,944 5,851,780
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NGST	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment missions Solids Treatment Solids Treatment Solids Treatment Combustion	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173	0 0 -19,359 19,359 0 0 0 	0 0 -12,983 12,983 0 0 0 58,928 -58,928 76,267,424 4,042,173 4,042,173	0 0 -13418 13418 0 0 0 85,309 -117,856 110,410,948 5,851,780 5,851,780
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NG SC1NGST SC3NG	Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744	0 0 -19,359 19,359 0 0 0 	0 0 -12,983 12,983 0 0 0 58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744	0 0 -13418 13418 0 0 0 85,309 -117,856 110,410,944 5,851,780
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NGST	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Combustion Extraction/Production	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744	0 0 -19,359 19,359 0 0 0 105,662 -105,662 136,752,625 7,247,889 7,247,889 1,914,537 1,914,537	0 0 -12,983 12,983 0 0 58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744	0 0 -13418 13418 0 0 85,309 -117,856 110,410,944 5,851,780 5,851,780 1,545,753
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NG SC1NGST SC3NG	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Combustion Extraction/Production	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 4,042,173 1,067,744 1,067,744	0 0 -19,359 19,359 0 0 0 105,662 -105,662 136,752,625 7,247,889 7,247,889 7,247,889 1,914,537 1,914,537 372,282,694	0 0 -12,983 12,983 0 0 0 58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 367,809,910	0 0 -13418 13418 0 0 85,309 -117,856 110,410,944 5,851,780 5,851,780 5,851,780 1,545,753 1,545,753
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NG SC1NGST SC3NG	Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Gallon of Gasoline Equiv, gal/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744	0 0 -19,359 19,359 0 0 0 105,662 -105,662 136,752,625 7,247,889 7,247,889 7,247,889 1,914,537 1,914,537 372,282,694 2,948,479	0 0 -12,983 12,983 0 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744	0 0 -13418 13418 0 0 85,309 -117,856 110,410,944 5,851,780 5,851,780 5,851,780 1,545,753 1,545,753 392,134,504 3,105,705
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NGST SC3NG SC3NGST	Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Gallon of Gasoline Equiv, gal/yr RNG as Diesel Equiv, gal/yr	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744 2,913,054 2,913,054 2,650,525	0 0 -19,359 19,359 0 0 0 105,662 105,662 136,752,625 7,247,889 7,247,889 7,247,889 1,914,537 1,914,537 372,282,694 2,948,479 2,682,757	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 367,809,910 2,913,054 2,650,525	0 0 -13418 13418 0 0 85,309 -117,856 110,410,944 5,851,780 5,851,780 1,545,753 392,134,504 3,105,705 2,825,814
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NGST SC3NG SC3NGST SC3NGST SC3NGST	Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Gallon of Gasoline Equiv, gal/yr RNG as Diesel Equiv, gal/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744 2,913,054 2,913,054 2,650,525 -31,501,228	0 0 -19,359 19,359 0 0 105,662 -105,662 136,752,625 7,247,889 7,247,889 1,914,537 1,914,537 372,282,694 2,948,479 2,682,757 -31,884,301	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 3,67,809,910 2,913,054 2,650,525 -31,501,228	0 0 -13418 13418 0 0 0 85,309 -117,856 110,410,944 5,851,780 5,851,780 1,545,753 1,545,753 392,134,500 3,105,705 2,825,814 -33,584,517
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NGST SC3NG SC3NGST	Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Gallon of Gasoline Equiv, gal/yr RNG as Diesel Equiv, gal/yr	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744 2,913,054 2,913,054 2,650,525	0 0 -19,359 19,359 0 0 0 105,662 105,662 136,752,625 7,247,889 7,247,889 7,247,889 1,914,537 1,914,537 372,282,694 2,948,479 2,682,757	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 367,809,910 2,913,054 2,650,525	0 0 -13418 13418 0 0 0 85,309 -117,856 110,410,94 5,851,780 5,851,780 1,545,753 1,545,753 392,134,50 3,105,705 2,825,814 -33,584,517
Electrical Emi SC2E SC2E SC2EST Natural Gas E SC1NG SC1NGST SC3NG SC3NGST SC3NGST SC3NGST	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Combustion Extraction/Production Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Gallon of Gasoline Equiv, gal/yr RNG as Diesel Equiv, gal/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744 2,913,054 2,913,054 2,650,525 -31,501,228	0 0 -19,359 19,359 0 0 105,662 -105,662 136,752,625 7,247,889 7,247,889 1,914,537 1,914,537 372,282,694 2,948,479 2,682,757 -31,884,301	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 3,67,809,910 2,913,054 2,650,525 -31,501,228	0 0 -13418 13418 0 0 0 85,309 -117,856 110,410,944 5,851,780 5,851,780 1,545,753 1,545,753 1,545,753 392,134,500 3,105,705 2,825,814 -33,584,517
Electrical Emi SC2E SC2E SC2EST SC2EST SC2EST SC2EST SC2NG SC1NG SC1NG SC1NG SC1NG SC3NG SC3NG SC3NG SC3NG SC3BG SC3BG SC3BG SC3BGST	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Combustion Extraction/Production Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr Thermal Consumption, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Gallon of Gasoline Equiv, gal/yr RNG as Diesel Equiv, gal/yr Emission, kg CO2e/yr	0 0 -12,983 12,983 0 0 0 58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744 2,913,054 2,913,054 2,650,525 -31,501,228	0 0 -19,359 19,359 0 0 105,662 -105,662 136,752,625 7,247,889 7,247,889 1,914,537 1,914,537 372,282,694 2,948,479 2,682,757 -31,884,301	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 3,67,809,910 2,913,054 2,650,525 -31,501,228	0 0 -13418 13418 0 0 0 85,309 -117,856 110,410,948 5,851,780 5,851,780 1,545,753 1,545,753 1,545,753 392,134,504 3,105,705 2,825,814 -33,584,517
Electrical Emi SC2E SC2E SC2EST SC2EST SC2EST SC2EST SC2NG SC1NG SC1NG SC1NG SC1NG SC3NG SC3NG SC3NG SC3NG SC3BG SC3BG SC3BG SC3BGST	Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Combustion Extraction/Production Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment Solids Treatment	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr External Natural Gas, scf/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Renewable Natural Gas Export, scf/yr Gallon of Gasoline Equiv, gal/yr RNG as Diesel Equiv, gal/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744 367,809,910 2,913,054 2,650,525 -31,501,228 -31,501,228	0 0 -19,359 19,359 0 0 105,662 -105,662 136,752,625 7,247,889 7,247,889 1,914,537 1,914,537 1,914,537 372,282,694 2,948,479 2,682,757 -31,884,301 -31,884,301	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 1,067,744 367,809,910 2,913,054 2,650,525 -31,501,228 -31,501,228	0 0 -13418 13418 0 0 85,309 -117,856 110,410,948 5,851,780 5,851,780 5,851,780 1,545,753 392,134,504 3,105,705 2,825,814 -33,584,517
Electrical Emi SC2E SC2E SC2EST SC2EST SC2EST SC2EST SC2EST SC2EST SC1NG SC1NGST SC3NGST SC3NGST SC3BG SC3BGST Chemical Emi	Solids Treatment Pre-Dewatering	Electricity Sold, MWh/yr Emissions Offset, kg CO2e/yr Electricity Consumption, MWh/yr Electricity Purchased, MWh/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Thermal Production, MMBtu/yr External Natural Gas, scf/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Emission, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Renewable Natural Gas Export, scf/yr Gallon of Gasoline Equiv, gal/yr RNG as Diesel Equiv, gal/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Subtotal, kg CO2e/yr Brinssion, kg CO2e/yr Subtotal, kg CO2e/yr	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 4,042,173 4,042,173 4,042,173 2,657,744 1,067,744 367,809,910 2,913,054 2,650,525 -31,501,228 -31,501,228	0 0 -19,359 19,359 0 0 105,662 -105,662 136,752,625 7,247,889 7,247,889 7,247,889 1,914,537 1,914,537 372,282,694 2,948,479 2,682,757 -31,884,301 -31,884,301 -31,884,301 -722,043	0 0 -12,983 12,983 0 0 58,928 -58,928 -58,928 76,267,424 4,042,173 4,042,173 1,067,744 1,067,744 367,809,910 2,913,054 2,650,525 -31,501,228 -31,501,228 0	0 0 -13418 13418 0 0 85,309 -117,856 110,410,948 5,851,780 1,545,753 392,134,504 3,105,705 2,825,814 -33,584,517 -33,584,517 0

SC3PST		Subtotal, kg CO2e/yr	3,338,823	6,111,579	3,338,823	3,103,823
			-,,-	-, , -		-,,
Process Fugiti	ve Emissions					
SC1F	Digestion	Digester Floating Cover (KP = 5, SP = 4, BW = 0), kg CO2e/yr	3,515,991	0	3,515,991	0
SC1F	Digestion	Digester Fixed Covers (KP = 0, SP = 1, BW = 3), kg CO2e/yr	5,171	26,167	5,171	27,563
SC1F	Dewatering	Fugitive Emissions, kg CO2e/yr	420,225	279,021	420,225	419,307
SC1F	Cogen	Fugitive Emissions, kg CO2e/yr	0	0	0	0
SC1F	Boiler	Fugitive Emissions, kg CO2e/yr	2,038	3,655	2,038	2,951
SC1F	Gas Upgrading	Fugitive Emissions, kg CO2e/yr	218,457	221,113	218,457	232,904
SC1F	Flaring	Fugitive Emissions, kg CO2e/yr	120,216	121,678	120,216	128,166
SC1FST		Subtotal, kg CO2e/yr	4,282,097	651,635	4,282,097	810,891
Hauling and T		Average Hauled wat tone ///	96,696	69,809	96,696	89,891
	Hauling	Average Hauled, wet tons/yr	22.9%	30.0%	22.9%	23%
	Hauling	Dry Solids, %	3,285	2,555	3,285	23%
	Hauling	Trucks per year		,	,	
	Hauling	Off-site Processing, Total Miles	0	0	98,550 17,948	0
SC3T	Hauling	Fuel Usage Round Trip, gal/yr	0	0	213,306	0
3631	Hauling Hauling	Emissions, kg CO2e/yr Eastern Washington, Total Miles	1,241,730	643,860	213,300	735,840
	Hauling	Fuel Usage Round Trip, gal/yr	226,140	117,258	-	135,840
SC3T	Hauling	Emissions, kg CO2e/yr	2,687,656	1,393,600	-	1,592,685
3031	Hauling	Western Washington, Total Miles	2,087,050	71.540	To Off-site Pyrolysis	81,760
	Hauling	Fuel Usage Round Trip, gal/yr	80,359	48,799		55,770
SC3T	Hauling	Emissions, kg CO2e/yr	955,055	579,967		662,820
SC3TST	naunng	Subtotal, kg CO2e/yr	3,642,712	1,973,567	213,306	2,255,505
505151		Subtotal, ng USZC/ yi	5,042,112	1,010,001	213,300	2,200,000
Land Applicat	ion					
	Agriculture	KC Fuel for Agriculture (Eastern) Application, gal/yr	27,882	13,420		17,280
SC3T	Agriculture	Emissions, kg CO2e/yr	331,379	159,491	-	205,370
	Forestry	KC Fuel for Forestry (Western) Application, gal/yr	4,255	12,286	-	15,821
SC3T	Forestry	Emissions, kg CO2e/yr	50,566	146,023	-	188,028
SC3TST		Subtotal, kg CO2e/yr	381,945	305,513	-	393,398
SC1F	Agriculture	N2O and CH4 Emissions, kg CO2e/yr	383,206	161,078	-	158,326
SC1F	Forestry	N2O and CH4 Emissions, kg CO2e/yr	42,578	241,617		237,489
SC1FST		Subtotal, kg CO2e/yr	425,784	402,695	To Official Developing	395,816
					To Off-site Pyrolysis	
Carbon Offset	<u>s</u>				7	
SC3FC	Agriculture	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr	-5,243,033	-3,305,811		-3,249,338
SC3FC	Forestry	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr	0	0		0
SC3FCST		Subtotal, kg CO2e/yr	-5,243,033	-3,305,811		-3,249,338
SC3CC	Agriculture	Land App Carbon Sequestration, kg CO2e/yr	-22,599,279	-14,249,184		-14,005,769
SC3CC	Forestry	Land App Carbon Sequestration, kg CO2e/yr	-2,008,825	-7,599,565		-7,469,743
SC3CCST		Subtotal, kg CO2e/yr	-24,608,104	-21,848,749		-21,475,512
	Tatal				╡────┤	
SP GHG Plant		COO Emissions ant COOs/us	9.750	0 202	0.204	7 050
	Scope 1	CO2 Emissions, mt CO2e/yr	8,750	8,302 0	8,324	7,058
	Scope 2 Scope 3	CO2 Emissions, mt CO2e/yr CO2 Emissions, mt CO2e/yr	-52,921	-46,734		-51,011
					-26,881	,
	Plant Total	CO2 Emissions, mt CO2e/yr	<u>-44,171</u>	<u>-38,431</u>	<u>-18,557</u>	<u>-43,952</u>
	Plant Total Check	CO2 Emissions, mt CO2e/yr	-44,171	-38,431	-18,557	-43,952
-				1	+ +	
water Treatment	Plant					
Electrical Emi	ssions				1	

	Solids Treatment	Electricity Production, MWh/yr	0	0	0	0
	Solids Treatment	Electricity Sold, MWh/yr	0	0	0	0
SC2E	Solids Treatment	Emissions Offset, kg CO2e/yr	0	0	0	0
	Solids Treatment	Electricity Consumption, MWh/yr	-3,979	-3,979	-3,979	-3,979
	Solids Treatment	Electricity Purchased, MWh/yr	3,979	3,979	3,979	3,979
SC2E	Solids Treatment	Emission, kg C02e/yr	35,414	35,414	35,414	35,414
SC2EST		Subtotal, kg CO2e/yr	35,414	35,414	35,414	35,414
				- /	- /	- /
Natural Gas	s Emissions					
	Solids Treatment	Thermal Production, MMBtu/yr	98,296	98,296	98,296	98,296
	Solids Treatment	Thermal Consumption, MMBtu/yr	-22,428	-22,428	-22,428	-22,428
	Solids Treatment	Thermal Balance, MMBtu/yr	75,868	75,868	75,868	75,868
	Solids Treatment	External Natural Gas, scf/yr	0	0	0	0
SC1NG	Combustion	Emission, kg CO2e/yr	0	0	0	0
SC1NGST		Subtotal, kg CO2e/yr	0	0	0	0
SC3NG	Extraction/Production	Emission, kg CO2e/yr	0	0	0	0
SC3NGST	,	Subtotal, kg CO2e/yr	0	0	0	0
Chemical E	missions					
	Pre-Dewatering	Polymer Use, Ib per yr	0	0	0	0
SC3P	Pre-Dewatering	Polymer Manufacturing, kg CO2e/yr	0	0	0	0
	Dewatering	Polymer Use, Ib per yr	271,320	271,320	271,320	271,320
SC3P	Dewatering	Polymer Manufacturing, kg CO2e/yr	1,109,944	1,109,944	1,109,944	1,109,94
SC3PST		Subtotal, kg CO2e/yr	1,109,944	1,109,944	1,109,944	1,109,94
	gitive Emissions					
SC1F	Digestion	Digester Floating Cover (KP = 5, SP = 4, BW = 0), kg CO2e/yr	0	0	0	0
SC1F	Digestion	Digester Fixed Covers (KP = 0, SP = 1, BW = 3), kg CO2e/yr	9,634	9,634	9,634	9,634
SC1F	Dewatering	Fugitive Emissions, kg CO2e/yr	159,970	159,970	159,970	159,970
SC1F	Cogen	Fugitive Emissions, kg CO2e/yr	0	0	0	0
SC1F	Boiler	Fugitive Emissions, kg CO2e/yr	3,372	3,372	3,372	3,372
SC1F	Gas Upgrading	Fugitive Emissions, kg CO2e/yr	0	0	0	0
SC1F	Flaring	Fugitive Emissions, kg CO2e/yr	86,703	86,703	86,703	86,703
SC1FST		Subtotal, kg CO2e/yr	259,679	259,679	259,679	259,679
Hauling and	d Transportation					
	Hauling	Average Hauled, wet tons/yr	35,857	35,857	35,857	35,857
	Hauling	Dry Solids, %	20.0%	20.0%	20.0%	20.0%
	Hauling	Trucks per year	1,460	1,460	1,460	1,460
	Hauling	Off-site Processing, Total Miles	0	43,800	43,800	43,800
	Hauling	Fuel Usage Round Trip, gal/yr	0	7,977	7,977	7,977
SC3T	Hauling	Emissions, kg CO2e/yr	0	94,803	94,803	94,803
	Hauling	Eastern Washington, Total Miles	551,880			
	Hauling	Fuel Usage Round Trip, gal/yr	100,507			
SC3T	Hauling	Emissions, kg CO2e/yr	1,194,514	To Off-site Composting	To Off-site Pyrolysis	To Off-site Com
	Hauling	Western Washington, Total Miles	10,220	i en ene composting		
	Hauling	Fuel Usage Round Trip, gal/yr	35,715			
SC3T	Hauling	Emissions, kg CO2e/yr	424,469			
SC3TST		Subtotal, kg CO2e/yr	1,618,983	94,803	94,803	94803
Land Applic						
	Agriculture	KC Fuel for Agriculture (Eastern) Application, gal/yr	10,339			
SC3T	Agriculture	Emissions, kg CO2e/yr	122,881			
	Forestry	KC Fuel for Forestry (Western) Application, gal/yr	1,578			
SC3T	Forestry	Emissions, kg CO2e/yr	18,751			
SC3TST		Subtotal, kg CO2e/yr	141.632			

SC1F	Agriculture	N20 and CH4 Emissions, kg C02e/yr	124,104			
SC1F	Forestry	N2O and CH4 Emissions, kg CO2e/yr	13,789			
SC1FST		Subtotal, kg CO2e/yr	137,894	To Off-site Composting	To Off site Durchusis	To Off site Osmanostin
				To Off-site Composting	To Off-site Pyrolysis	To Off-site Compostin
Carbon Offsets						
SC3FC	Agriculture	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr	-188,667			
SC3FC	Forestry	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr	0			
SC3FCST	,	Subtotal, kg CO2e/yr	-188,667	_		
SC3CC	Agriculture	Land App Carbon Sequestration, kg CO2e/yr	-7,318,972	_		
SC3CC	Forestry	Land App Carbon Sequestration, kg CO2e/yr	-650,575			
SC3CCST		Subtotal, kg CO2e/yr	-7,969,547			
			.,			
SP GHG Plant	lotal					
	Scope 1	CO2 Emissions, mt CO2e/yr	398	260	260	260
	Scope 2	CO2 Emissions, mt CO2e/yr	35	35	35	35
	Scope 3	CO2 Emissions, mt CO2e/yr	-5,288	1,205	1,205	1,205
	Plant Total		-4,855	1,500	1,500	1,500
_		CO2 Emissions, mt CO2e/yr				
	Plant Total Check	CO2 Emissions, mt CO2e/yr	-4,855	1,500	1,500	1,500
Site Composting						
Houling and Tr	anonartation					
Hauling and Tr		Foodstook (Soudust) wat tone (vir		24,175		24,175
	Hauling	Feedstock (Sawdust), wet tons/yr		,		,
	Hauling	Large Trucks per year		779.8		780
	Hauling	Feedstock to Off-site Processing, Total Miles		124,773		124,773
	Hauling	Fuel (Diesel) Usage Round Trip, gal/yr		22,723		22,723
SC3T	Hauling	Emissions, kg CO2e/yr		270,065		270,065
	Hauling	Commercial/Donation Usage, wet tons/yr		47,504		47,504
	Hauling	Medium Trucks per year		7,038		7,038
	Hauling	Off-site Processing to Customer, Total Miles		175,941		175,941
	Hauling	Fuel (Diesel) Usage Round Trip, gal/yr		20,900		20,900
SC3T	Hauling	Emissions, kg CO2e/yr		248,400		248,400
	Transportation	Residential Usage, wet tons/yr		11,876		11,876
	Transportation	Vehicles per year		42,754		42,754
	Transportation	Fuel (Gasoline) Usage Round Trip, gal/yr		42,754		42,754
SC3T	Transportation	Emissions, kg CO2e/yr		453.104		453.104
SC3TST	Transportation	Subtotal, kg C02e/yr		971,568		971,568
000101				512,000		012,000
Fuel Emissions						
	Composting	Machinery Fuel Consumption (Diesel), gal/day		274		274
SC1M	Composting	Emissions, kg CO2e/yr		1,188,609		1,188,609
SC1MST	Composing	Subtotal, kg CO2e/yr		1,188,609		1,188,609
001001		Subtotal, ng 6626/ yi		1,100,000		1,100,005
Electrical Emis	sions					
	Composting	Electricity Consumption, MWh/yr		-1,888		-1.888
	Composting	Electricity Purchased, MWh/yr		1.888		1.888
SC2E	Composting	Emission, kg CO2e/yr		0		0
SC2EST	Somposung	Subtotal, kg CO2e/yr		0		0
302231	<u> </u>	Subtotal, ng 6026/ yi		0		0
Process Fugitiv	e Emissions	+				
riocess rugitin	Composting	Biosolids, dry lb/hr		1,637.3		1.637
SC1F		N20 Emissions, kg C02e/yr		691,058.6		691,059
	Composting					,
SC1F	Composting	CH4 Emissions, kg CO2e/yr		1,095,262.7		1,095,263
SC1FST	1	Subtotal, kg CO2e/yr		1,786,321.3		1,786,321

Carbon Offse				
SC3FC	Land Application	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr	-1,886,283.6	-1,886,284
SC3FCST		Subtotal, kg CO2e/yr	-1,886,283.6	-1,886,284
SC3CC	Land Application	Land App Carbon Sequestration, kg CO2e/yr	-11,040,853	-11,040,853
SC3CCST		Subtotal, kg CO2e/yr	-11,040,853	-11,040,853
	Scope 1	CO2 Emissions, mt CO2e/yr	2,975	2,975
	Scope 2	CO2 Emissions, mt CO2e/yr	0	0
	Scope 3	CO2 Emissions, mt CO2e/yr	-11,956	-11,956
	Plant Total	CO2 Emissions, mt CO2e/yr	<u>-8,981</u>	<u>-8,981</u>
	Plant Total Check	CO2 Emissions, mt CO2e/yr	-8,981	-8,981
Soll Blending				
	_			
Hauling and	Transportation	Eadstock (Soudust) wat tons /ur	13,980	12.090
_	Hauling	Feedstock (Sawdust), wet tons/yr	,	13,980
	Hauling	Large Trucks per year	451.0	451
_	Hauling	Feedstock to Off-site Processing, Total Miles	72,157	72,157
C.007	Hauling	Fuel (Diesel) Usage Round Trip, gal/yr	13,141	13,141
SC3T	Hauling	Emissions, kg CO2e/yr	156,181	156,181
-	Hauling	Feedstock (Fine Sand), wet tons/yr	48,532	48,532
	Hauling	Large Trucks per year	1,565.6	1,566
	Hauling	Feedstock to Off-site Processing, Total Miles	117,417	117,417
	Hauling	Fuel (Diesel) Usage Round Trip, gal/yr	21,384	21,384
SC3T	Hauling	Emissions, kg CO2e/yr	254,142	254,142
	Hauling	Commercial/Donation Usage, wet tons/yr	97,943	97,943
	Hauling	Medium Trucks per year	8,371	8,371
	Hauling	Off-site Processing to Customer, Total Miles	209,281	209,281
	Hauling	Fuel (Diesel) Usage Round Trip, gal/yr	21,048	21,048
SC3T	Hauling	Emissions, kg CO2e/yr	250,152	250,152
	Transportation	Residential Usage, wet tons/yr	24,486	24,486
	Transportation	Vehicles per year	50,855	50,855
	Transportation	Fuel (Gasoline) Usage Round Trip, gal/yr	50,855	50,855
SC3T	Transportation	Emissions, kg CO2e/yr	538,963	538,963
SC3TST		Subtotal, kg CO2e/yr	 945,296	945,296
Fuel Emissio	ons			
	Soil Blending	Machinery Fuel Consumption (Diesel), gal/day	234	234
SC1M	Soil Blending	Emissions, kg CO2e/yr	1,015,089	1,015,089
SC1MST		Subtotal, kg CO2e/yr	1,015,089	1,015,089
Electrical En	nissions		 	
	Soil Blending	Electricity Consumption, MWh/yr	0	0
	Soil Blending	Electricity Purchased, MWh/yr	0	0
SC2E	Soil Blending	Emission, kg CO2e/yr	0	0
SC2EST		Subtotal, kg CO2e/yr	0	0
Process Fug	itive Emissions		0.000.7	
	Soil Blending	Biosolids, dry lb/hr	3,898.7	3,899
SC1F	Soil Blending	N20 Emissions, kg C02e/yr	1,645,521.9	1,645,522
SC1F	Soil Blending	CH4 Emissions, kg CO2e/yr	2,607,996.9	2,607,997
SC1FST		Subtotal, kg CO2e/yr	4,253,518.8	4,253,519
Carbon Offse	ets			
SC3FC	Land Application	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr	-4,501,899.4	-4,501,899

01/23/2020

SC3FCST		Subtotal, kg CO2e/yr	-4,501,899.4		-4,501,899
SC3CC	Land Application	Land App Carbon Sequestration, kg CO2e/yr	-14,699,522		-14,699,522
SC3CCST		Subtotal, kg CO2e/yr	-14,699,522		-14,699,522
			5.000		
	Scope 1	CO2 Emissions, mt CO2e/yr	5,269		5,269
-	Scope 2	CO2 Emissions, mt CO2e/yr	0		0
	Scope 3	CO2 Emissions, mt CO2e/yr	 -18,256		-18,256
	Plant Total	CO2 Emissions, mt CO2e/yr CO2 Emissions, mt CO2e/yr	<u>-12,988</u> -12,988		<u>-12,988</u> -12,988
	Plant Total Check	CO2 Emissions, mt CO2e/ yr	-12,900		-12,988
1					
Thermal Drying	and Pyrolysis				
Hauling and 1	Transportation_				
	Hauling	Biochar, wet tons/yr		22,920.1	
	Hauling	Large Trucks per year		1,095.0	
	Hauling	Biochar to Customers, Total Miles		219.000.0	
	Hauling	Fuel (Diesel) Usage Round Trip, gal/yr		39.883.7	
SC3T	Hauling	Emissions, kg CO2e/yr		474,013.5	
SC3TST		Subtotal, kg CO2e/yr		474,013.5	
				,	
Electrical Em					
	Solids Treatment	Electricity Production, MWh/yr		0.0	
	Solids Treatment	Electricity Sold, MWh/yr		0.0	
SC2E	Solids Treatment	Emissions Offset, kg CO2e/yr		0.0	
	Solids Treatment	Electricity Consumption, MWh/yr		46,456.3	
	Solids Treatment	Electricity Purchased, MWh/yr		46,456.3	
SC2E	Solids Treatment	Emission, kg CO2e/yr		0.0	
SC2EST		Subtotal, kg CO2e/yr		0.0	
Natural Gas E	Emissions				
	Solids Treatment	Thermal Production, MMBtu/yr		415,294	
	Solids Treatment	Thermal Consumption, MMBtu/yr		-415,295	
	Solids Treatment	Thermal Balance, MMBtu/yr		0	
	Solids Treatment	External Natural Gas, scf/yr		296,082,227	
SC1NG	Combustion	Emission, kg CO2e/yr		15,692,358	
SC1NGST		Subtotal, kg C02e/yr		15,692,358	
SC3NG	Extraction/Production	Emission, kg CO2e/yr		4,145,151	
SC3NGST		Subtotal, kg CO2e/yr		4,145,151	
Process Fugit	tive Emissions				
SC1F	Boiler	Fugitive Emissions, kg CO2e/yr		7,913.5	
SC1FST	Bolici	Subtotal, kg CO2e/yr		7,913.5	
	·				
Carbon Offse		Nitragen and Disconfermine Familities off at the OOO - for		0.000.070.0	
SC3FC	Land Application	Nitrogen and Phosphorus Fertillizer Offset, kg CO2e/yr		-6,028,670.2 -6,028,670.2	
SC3FCST SC3CC	Land Application	Subtotal, kg CO2e/yr		, ,	
SC3CC	Land Application	Land App Carbon Sequestration, kg CO2e/yr Subtotal, kg CO2e/yr		-19,410,031 -19,410,031	
3030031		Subiolal, ng 6025/ yi		-13,710,031	
	Scope 1	CO2 Emissions, mt CO2e/yr		15,700	
	Scope 2	CO2 Emissions, mt CO2e/yr		0	
	Scope 3	CO2 Emissions, mt CO2e/yr		-20,820	
	Plant Total	CO2 Emissions, mt CO2e/yr		<u>-5,119</u>	
	Plant Total Check	CO2 Emissions, mt CO2e/yr		-5,119	

Attachment C: Cost Estimating



		End of Year	NPV LCCA	Project Capital Cost	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030 0	2031 1	2032 2	2033 3
		Solids Flows and Loads	ž		49258	49743	50228	50713	51199	51684	52169	52654	53139	53624	54110	54595	154859	156969	159079	161189
	West Point Treatment plant Capital Cost	MAD Additional Digesters		NPV Capital Cost																
	Operation and Maintenance			NPV Capital Cost \$141,914,692 Escalated and Discounted																
	Solids Treatment	Operation and Maintenance, \$/yr		\$119,384,603	\$7,781,156	\$7,857,802	\$7,934,447	\$8,011,093	\$8,087,738	\$8,164,384	\$8,241,030	\$8,317,675	\$8,394,321	\$8,470,966	\$8,547,612	\$8,624,257	\$8,700,903	\$8,777,549	\$8,854,194	\$8,930,840
	Land Application Land App	Land App East/West WA Cost, \$/yr			\$3,103,283	\$3,133,851	\$3,164,418	\$3,194,986	\$3,225,554	\$3,256,122	\$3,286,690	\$3,317,258	\$3,347,825	\$3,378,393	\$3,408,961	\$3,439,529	\$3,470,097	\$3,500,664	\$3,531,232	\$3,561,800
	CHP	Electricity Sales, \$/yr			-\$1,185.667	-\$1.197.346	-\$1,209.025	-\$1,220,704	-\$1.232.383	-\$1,244.062	-\$1.255.741	-\$1.267.420	-\$1,279.099	-\$1.290.778	-\$1.302.457	-\$1.314.136	-\$1.325.815	-\$1.337.494	-\$1.349.173	-\$1.360.851
	Land App	Land App East/West WA Revenue, \$/yr			-\$113,193	-\$114,308	-\$115,423	-\$116,538	-\$117,653	-\$118,768	-\$119,883	-\$120,998	-\$122,113	-\$123,228	-\$124,343	-\$125,458	-\$126,573	-\$127,687	-\$128,802	-\$129,917
	South Treatment Plant Capital Cost			<u>NPV Capital Cost</u> \$83,127,778																
	Operation and Maintenance			\$83,127,778 Escalated and Discounted																t
	Solids Treatment	Operation and Maintenance, \$/yr		\$69,930,581	\$8,585,519	\$8,718,754	\$8,851,989	\$8,985,223	\$9,118,458	\$9,251,693	\$9,384,928	\$9,518,163	\$9,651,398	\$9,784,633	\$9,917,868	\$10,051,102	\$10,184,337	\$10,317,572	\$10,450,807	\$10,584,042
S1	Land App	Land App East/West WA Cost, \$/yr			4,106,032	4,169,752	4,233,471	4,297,191	4,360,911	4,424,630	4,488,350	4,552,070	4,615,789	4,679,509	4,743,229	4,806,949	4,870,668	4,934,388	4,998,108	5,061,827
	Biogas	Renewable Natural Gas Sales, \$/yr			-\$5,632,026	-\$5,719,427	-\$5,806,828	-\$5,894,228	-\$5,981,629	-\$6,069,030	-\$6,156,431	-\$6,243,832	-\$6,331,233	-\$6,418,634	-\$6,506,035	-\$6,593,436	-\$6,680,837	-\$6,768,238	-\$6,855,639	-\$6,943,039
	Land App Brightwater Treatment Plant	Land App East/West WA Revenue, \$/yr			-\$149,768	-\$152,093	-\$154,417	-\$156,741	-\$159,065	-\$161,389	-\$163,714	-\$166,038	-\$168,362	-\$170,686	-\$173,010	-\$175,334	-\$177,659	-\$179,983	-\$182,307	-\$184,631
	Capital Cost			<u>NPV Capital Cost</u> \$39,098,386																
	Operation and Maintenance	Operation and Maintenance. \$/yr		Escalated and Discounted	\$1,980,025	40.055.000	*****	10.010.110	to 004 000	+0.000.000	40.440.800	10 50 / 505	±0.000.000	to 000 100		40.005.555		10 001 000	to one 101	
	Solids Treatment			\$32,891,206		\$2,057,820	\$2,135,616	\$2,213,412	\$2,291,208	\$2,369,003	\$2,446,799	\$2,524,595	\$2,602,390	\$2,680,186	\$2,757,982	\$2,835,777	\$2,913,573	\$2,991,369	\$3,069,164	\$3,146,960
	Land App Revenues	Land App East/West WA Cost, \$/yr			\$1,009,486	\$1,049,149	\$1,088,812	\$1,128,475	\$1,168,138	\$1,207,801	\$1,247,464	\$1,287,127	\$1,326,790	\$1,366,453	\$1,406,116	\$1,445,778	\$1,485,441	\$1,525,104	\$1,564,767	\$1,604,430
	Land App	Land App East/West WA Revenue, \$/yr			-\$36,821	-\$38,268	-\$39,715	-\$41,161	-\$42,608	-\$44,055	-\$45,502	-\$46,948	-\$48,395	-\$49,842	-\$51,288	-\$52,735	-\$54,182	-\$55,629	-\$57,075	-\$58,522
		<u>Subtotal</u> Total	\$563.764.215	\$222,206,389														\$23,577,616	\$23,895,277	\$24,212,938
		10(3)	3003,/04,213																	
	West Point Treatment plant Capital Cost	TAD-Batch		NPV Capital Cost																
	Operation and Maintenance			NPV Capital Cost \$128,586,966 Escalated and Discounted																
	Solids Treatment	Operation and Maintenance, \$/yr		\$108,172,760	\$7,820,822	\$7,897,858	\$7,974,895	\$8,051,931	\$8,128,967	\$8,206,004	\$8,283,040	\$8,360,076	\$8,437,113	\$8,514,149	\$8,591,185	\$8,668,221	\$8,745,258	\$8,822,294	\$8,899,330	\$8,976,367
	Land Application Land App	Land App East/West WA Cost, \$/yr															\$0	\$0	\$0	\$0
	Revenues	Electricity Sales, \$/yr			-\$1,259,574	-\$1,271,981	-\$1,284,388	-\$1,296,795	-\$1,309,202	-\$1,321,609	-\$1,334,016	-\$1,346,423	-\$1,358,830	-\$1,371,237	-\$1,383,644	-\$1,396,051	-\$1,408,458	-\$1,420,865	-\$1,433,272	-\$1,445,679
	Land App South Treatment Plant	Land App East/West WA Revenue, \$/yr				. , ,		. , , .					. ,,				\$0	\$0	\$0	\$0
	Capital Cost	THP-MAD		NPV Capital Cost																
	Operation and Maintenance			\$520,446,443 Escalated and Discounted																
	Solids Treatment	Operation and Maintenance, \$/yr		\$437,821,421	\$12,049,067	\$12,236,052	\$12,423,036	\$12,610,020	\$12,797,004	\$12,983,988	\$13,170,972	\$13,357,956	\$13,544,941	\$13,731,925	\$13,918,909	\$14,105,893	\$14,292,877	\$14,479,861	\$14,666,846	\$14,853,830
	Land App Revenues	Land App East/West WA Cost, \$/yr			\$3,083,253	\$3,131,100	\$3,178,948	\$3,226,796	\$3,274,643	\$3,322,491	\$3,370,339	\$3,418,186	\$3,466,034	\$3,513,881	\$3,561,729	\$3,609,577	\$3,657,424	\$3,705,272	\$3,753,120	\$3,800,967
	Biogas	Renewable Natural Gas Sales, \$/yr Land App East/West WA Revenue, \$/yr			-\$5,700,514	-\$5,788,978	-\$5,877,442	-\$5,965,906	-\$6,054,370	-\$6,142,833	-\$6,231,297	-\$6,319,761	-\$6,408,225	-\$6,496,688	-\$6,585,152	-\$6,673,616	-\$6,762,080	-\$6,850,543	-\$6,939,007	-\$7,027,471
	Land App Brightwater Treatment Plant	- · · · · · · · · · · · · · · · · · · ·			-\$190,406	-\$193,361	-\$196,316	-\$199,270	-\$202,225	-\$205,180	-\$208,135	-\$211,090	-\$214,045	-\$216,999	-\$219,954	-\$222,909	-\$225,864	-\$228,819	-\$231,774	-\$234,728
	Capital Cost	MAD		<u>NPV Capital Cost</u> \$39,098,386																t
	Operation and Maintenance Solids Treatment	Operation and Maintenance, \$/yr		Escalated and Discounted \$32,891,206	\$1,980.025	\$2.057.820	\$2,135.616	\$2,213,412	\$2,291,208	\$2,369,003	\$2,446,799	\$2,524,595	\$2.602.390	\$2.680.186	\$2,757,982	\$2,835,777	\$2,913,573	\$2,991,369	\$3.069.164	\$3,146,960
	Land Application	Land App East/West WA Cost, \$/yr		402,001,200	\$1,500,025	\$2,001,020	\$2,130,010	ψ 2,210,12	\$2,231,200	\$2,303,003	\$2,440,135	\$2,024,000	<i>\\</i> 2,002,330	\$2,000,100	\$2,101,302	\$2,000,111	¥2,515,615			
S2	Land App Revenues																	\$0	\$0	\$0
52	Land App Off-Site Composting (Brightwater Solids)	Land App East/West WA Revenue, \$/yr																\$0	\$0	\$0
	Capital Cost	Composting		<u>NPV Capital Cost</u> \$119,906,031																
	Hauling and Transportation	an Hauling 9 Fuel Coat ¢ (<u>Escalated and Discounted</u> \$100.869.993														\$441.251	\$452.726	\$464.202
	Operation and Maintenance	bs Hauling & Fuel Cost, \$/yr		\$100,869,993														. ,	. , .	
	Composting Revenues	Operation and Maintenance, \$/yr																\$4,133,571	\$4,241,072	\$4,348,573
	Woodchips	Tipping Fee, \$/yr																-\$588,359 -\$279,995	-\$603,661 -\$287,277	-\$618,962 -\$589,117
	Composting Composting	Revenue Year (Commercial), \$/yr Revenue Year (Consumer), \$/yr																-\$279,995 -\$197,214	-\$287,277 -\$202,343	-\$589,117 -\$484,101
	Off-Site Soli Blending (West Point Solids) Capital Cost	Soil Blending		NPV Capital Cost																
	Hauling and Transport			\$58,462,405 Escalated and Discounted																
	Biosolids & Feedstock	ks Hauling & Fuel Cost, \$/yr		\$49,181,032														\$846,764	\$854,158	\$861,552
	Feedstock Purchase Fine Sand	Material Purchase, \$/yr																\$513,903	\$518,391	\$522,878
	Operation and Maintenance Soil Blending	Operation and Maintenance, \$/yr																\$5,570,677	\$5,619,320	\$5,667,963
	Revenues Soil Blend	Revenue Year (Commercial), \$/yr																		
	Soil Blend	Revenue Year (Commercial), \$/yr Revenue Year (Consumer), \$/yr																-\$403,875 -\$261,711	-\$407,402 -\$263,996	-\$821,857 -\$621,324
		Subtotal		\$728,936,411	а.	·			·		·	·						\$31,273,581	\$31,705,396	\$30,800,052
		<u>Total</u>	\$1,146,904,715	<u> </u>																

No.04 94.06/110 94.027/120 95.27/20 95.27/20 95.27/20 95.000020 95.27/20 95.000020 95.27/20 95.000020 95.27/20 95.000020 95.27/20 95.00002	
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\$164.033 \$163.765 \$1.723.419 \$1.763.082 \$1.802.745 \$1.822.071 \$1.921.734 \$1.921.734 \$1.921.734 \$1.921.734 \$1.921.734 \$2.001.060 \$2.040.723 \$2.020.485 \$2.129.712 \$2.219.715 \$2.239.038 \$2.278.701 \$39.373.491 \$59.969 \$65.445 \$62.862 \$54.309 \$65.766 \$67.202 \$568.649 \$70.995 \$71.542 \$72.999 \$74.366 \$77.533 \$77.76 \$580.223 \$81.669 \$83.116 \$24.84.259 \$25.165.902 \$25.83.581 \$25.801.242 \$26.736.224 \$27.707.105 \$27.395.966 \$27.707.077 \$28.024.868 \$28.347.58 \$28.97.750 \$29.995.511 \$29.93.73 \$1.92.92.93.77 \$24.848.259 \$25.165.902 \$25.813.501 \$26.745.623 \$26.765.627 \$27.707.168 \$27.707.07 \$28.024.868 \$28.347.58 \$28.97.750 \$28.92.95.511 \$29.925.511 \$29.925.511 \$29.925.913 \$29.925.913 \$29.925.913 \$29.925.913 \$29.925.913 \$29.925.913 \$29.925.913 \$28.913.416.29 \$28.917.61	\$47,601,147.62 \$0.00
459.999 \$61.415 462.862 564.309 \$65.766 \$67.202 \$68.649 \$70.096 \$71.542 \$72.999 \$77.426 \$77.329 \$78.776 \$80.223 \$81.669 \$83.116 \$24.530.599 \$25.65.920 \$25.483.581 \$25.81.242 \$26.118.903 \$26.76.224 \$27.07.805 \$27.07.207 \$28.024.868 \$28.342.528 \$28.60.189 \$29.97.500 \$29.95.511 \$29.91.3172 \$24.530.599 \$24.448.259 \$25.403.581 \$25.801.242 \$26.118.903 \$26.76.224 \$27.07.805 \$28.024.868 \$28.342.528 \$28.60.189 \$29.97.500 \$29.95.51 \$29.95.51 \$29.61.317 \$29.053.403 \$9.130.439 \$9.27.476 \$9.28.27.66 \$9.76.730 \$9.823.766 \$9.97.839 \$10.054.875 \$10.319.11 \$10.285.984 \$9.928.806 \$9.053.403 \$9.130.439 \$9.27.476 \$9.28.27.66 \$9.90.802 \$9.977.839 \$10.013.911 \$10.285.984 \$9.928.806 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0	\$24,268,730.46 \$0.00
NAME NAME <th< td=""><td>-\$885,207.19</td></th<>	-\$885,207.19
Image: black	\$70,984,670.89
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	\$103,227,876
\$15,040,814 \$15,227,798 \$15,414,782 \$15,601,766 \$15,788,750 \$15,975,735 \$16,162,719 \$16,349,703 \$16,536,687 \$16,723,671 \$16,910,655 \$17,097,640 \$17,284,624 \$17,471,608 \$17,658,592 \$17,845,576 \$18,032,560 \$339,417,094 \$17,345,656 \$17,097,640 \$17,284,624 \$17,471,608 \$17,658,592 \$17,845,576 \$18,032,560 \$139,417,094 \$17,318,458,576 \$18,032,560 \$139,417,094 \$17,318,458,576 \$18,032,560 \$10,094 \$17,284,624 \$17,471,608 \$17,658,592 \$17,845,576 \$18,032,560 \$139,417,094 \$17,318,458,576 \$18,032,560 \$139,417,094 \$17,618 \$10,094 \$17,618 \$10,094 \$17,618 \$10,094 \$10,0	\$208,840,863.17 \$0.00
S0 10 10 10 10 10 10 10 10 10 10 10 10 10	\$53,440,580.93 \$0.00
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Image: Constraint of the state of	\$160,176,868
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\$3,224,756 \$3,380,357 \$3,458,143 \$3,535,938 \$3,613,734 \$3,691,530 \$3,769,325 \$3,847,121 \$3,924,917 \$4,080,508 \$4,158,304 \$4,236,099 \$4,313,895 \$4,391,691 \$4,469,486 \$77,522,124 .	\$47,601,147.62 \$0.00
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Image: Constraint of the second se	
\$475,677 \$487,153 \$498,628 \$510,104 \$521,579 \$533,055 \$544,530 \$566,006 \$567,481 \$578,956 \$590,432 \$601,907 \$613,383 \$624,858 \$636,334 \$647,809 \$659,285 \$11,005,356	\$7,021,548.40
4,456,073 \$4,671,074 \$4,778,575 \$4,886,076 \$5,101,077 \$5,208,578 \$5,316,078 \$5,531,079 \$5,638,580 \$5,746,081 \$5,961,082 \$6,068,582 \$6,176,083 \$103,096,544	\$0.00 \$65,776,827.67
Image: Constraint of the state of	\$0.00 -\$9,362,466.00
\$603,681 \$618,244 \$632,808 \$647,371 \$661,935 \$1,036,593 \$1,058,438 \$1,080,283 \$1,122,128 \$1,527,759 \$1,556,886 \$1,615,140 \$1,644,267 \$1,673,394 \$20,340,047 \$496,068 \$508,035 \$520,003 \$531,970 \$543,938 \$993,011 \$1,014,527 \$1,035,042 \$1,055,558 \$1,614,110 \$1,675,657 \$1,706,430 \$1,737,203 \$1,675,557	(12,465,138) (11,910,043)
Image: Constraint of the state of	\$39,060,729
Image: Second	
\$868,946 \$876,340 \$883,734 \$891,128 \$898,522 \$905,916 \$913,310 \$920,704 \$935,492 \$942,886 \$950,279 \$957,673 \$965,067 \$972,461 \$979,855 \$987,249 \$18,340,134 \$0 <td< td=""><td>\$11,809,836.66 \$0.00</td></td<>	\$11,809,836.66 \$0.00
\$527,365 \$531,853 \$536,340 \$540,828 \$545,315 \$549,802 \$556,270 \$563,265 \$577,527 \$577,270 \$581,214 \$585,702 \$591,676 \$599,164 \$111,30,671 \$500 \$500 \$500,800 \$540,828 \$540,828 \$540,820 \$558,777 \$563,265 \$577,527 \$581,214 \$585,702 \$590,189 \$599,164 \$111,30,671 \$500,180 \$500,189 \$500	\$7,167,417.67 \$0.00
\$5,716,607 \$5,765,250 \$5,813,893 \$5,862,536 \$5,911,179 \$5,959,822 \$6,008,466 \$6,057,109 \$6,105,752 \$6,154,395 \$6,203,038 \$6,251,681 \$6,300,325 \$6,348,968 \$6,397,611 \$6,446,254 \$6,494,897 \$120,655,743	\$77,694,340.45
\$828,910 \$835,964 \$843,017 \$\$850,070 \$\$857,123 \$\$1,296,265 \$\$1,317,425 \$\$1,328,005 \$\$1,339,165 \$\$1,812,933 \$\$1,827,099 \$\$1,841,206 \$\$1,869,419 \$\$1,883,525 \$\$2,874,060	\$0.00 (15,361,659)
-\$626,656 -\$631,988 -\$633,321 -\$642,653 -\$647,985 -\$1,119,973 -\$1,129,114 -\$1,138,255 -\$1,147,396 -\$1,165,678 -\$1,765,229 -\$1,775,940 -\$1,789,652 -\$1,803,364 -\$1,817,075 -\$1,803,781 -\$21,999,634 \$31,211,173 \$31,622,294 \$32,033,415 \$32,855,658 \$31,632,711 \$32,020,666 \$32,408,622 \$33,184,534 \$33,157,489 \$31,999,811 \$32,262,130 \$32,086,768 \$33,449,087 \$33,844,9087 \$103,282,853	(13,408,253)
	\$67,901,683

-\$18,654, -\$1,780,; \$150,809,! \$148,808, \$71,167,! -\$97,617, -\$2,595,; \$119,763,!	859.91 566.82 792.69 \$0.00 934.94 \$0.00 274.00
\$47,601, \$24,268, -\$885, \$70,984,6	147.62 \$0.00 730.46 \$0.00 207.19 570.89
\$123,044, -\$19,816,; \$103,2 ;	\$0.00
\$208,840,; \$53,440,; -\$98,804,; -\$3,300,; \$160,1 ;	\$0.00 357.29 218.63
\$47,601, \$47,6 0	147.62 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00
\$7,021, \$65,776, -\$9,362, (12,46 (11,91 \$39,0 0	\$0.00 827.67 \$0.00 466.00 (5,138) 0,043)
\$11,809, \$7,167, \$77,694, (15,36 (13,40	\$0.00 340.45 \$0.00 (1,659)

West	Point Treatment plant Capital Cost			NPV Capital Cost																	
				\$141,914,692																	
	Operation and Maintenance Solids Treatment	Operation and Maintenance, \$/yr		Escalated and Discounted \$119,384,603		\$7,781,156	\$7,857,802	\$7,934,447	\$8,011,093	\$8,087,738	\$8,164,384	\$8,241,030	\$8,317,675	\$8,394,321	\$8,470,966	\$8,547,612	\$8,624,257	\$8,700,903	\$8,777,549	\$8,854,194	\$8,930,840
	Land Application Land App	Land App East/West WA Cost, \$/yr																\$0	\$0	\$0	\$0
	Revenues									±1,000,000			±1.007.100								
	CHP Land App	Electricity Sales, \$/yr Land App East/West WA Revenue, \$/yr				-\$1,185,667	-\$1,197,346	-\$1,209,025	-\$1,220,704	-\$1,232,383	-\$1,244,062	-\$1,255,741	-\$1,267,420	-\$1,279,099	-\$1,290,778	-\$1,302,457	-\$1,314,136	-\$1,325,815 \$0	-\$1,337,494 \$0	-\$1,349,173 \$0	-\$1,360,851 \$0
Sout	h Treatment Plant Capital Cost			NPV Capital Cost																	
				\$83,127,778																	
	Operation and Maintenance Solids Treatment	Operation and Maintenance, \$/yr		Escalated and Discounted \$69,930,581		\$8,585,519	\$8,718,754	\$8,851,989	\$8,985,223	\$9,118,458	\$9,251,693	\$9,384,928	\$9,518,163	\$9,651,398	\$9,784,633	\$9,917,868	\$10,051,102	\$10,184,337	\$10,317,572	\$10,450,807	\$10,584,042
	Land Application	Land App East/West WA Cost, \$/yr																\$0	\$0	\$0	\$0
	Revenues																				
	Biogas Land App	Renewable Natural Gas Sales, \$/yr Land App East/West WA Revenue, \$/yr				-\$5,632,026	-\$5,719,427	-\$5,806,828	-\$5,894,228	-\$5,981,629	-\$6,069,030	-\$6,156,431	-\$6,243,832	-\$6,331,233	-\$6,418,634	-\$6,506,035	-\$6,593,436	-\$6,680,837 \$0	-\$6,768,238 \$0	-\$6,855,639 \$0	-\$6,943,039 \$0
S3 Brigh	itwater Treatment Plant																	4 0	**	* 0	<u> </u>
	Capital Cost			NPV Capital Cost \$39,098,386																	+
	Operation and Maintenance Solids Treatment	Operation and Maintenance, \$/yr		Escalated and Discounted \$32,891,206		\$1,980,025	\$2,057,820	\$2,135,616	\$2,213,412	\$2,291,208	\$2,369,003	\$2,446,799	\$2,524,595	\$2,602,390	\$2,680,186	\$2,757,982	\$2,835,777	\$2,913,573	\$2,991,369	\$3,069,164	\$3,146,960
	Land Application			\$32,891,200		\$1,580,025	\$2,037,820	\$2,133,010	\$2,213,412	\$2,291,208	\$2,309,003	\$2,440,735	\$2,024,090	\$2,002,390	\$2,080,180	\$2,131,382	\$2,833,111				
	Land App Revenues	Land App East/West WA Cost, \$/yr																\$0	\$0	\$0	\$0
	Land App Ite Thermal Drying and Pyrolysis	Land App East/West WA Revenue, \$/yr																\$0	\$0	\$0	\$0
	Capital Cost			NPV Capital Cost																	
	Hauling and Transportation			\$617,273,184 Escalated and Discounted																	<u> </u>
	Biosolids	Hauling & Fuel Cost, \$/yr		\$519,276,145															\$1,133,355	\$1,148,590	\$1,163,826
	Operation and Maintenance Drying + Pyrolysis	Operation and Maintenance, \$/yr																	\$7,976,332	\$8,083,557	\$8,190,782
	Revenues Biochar	Revenue Year (Contract P3), \$/yr																	-\$136,927	-\$138,768	-\$187,478
	Diochai	Subtotal		\$741,482,534															\$22,953,517	\$23,262,734	\$23,525,080
		Total	\$1,071,510,251	. , . , .																	
					-T - T		Γ	T	т	T	T	T	1	T	Γ	[]			T		
wes	Point Treatment plant Capital Cost	TAD-Batch		NPV Capital Cost																	
	Operation and Maintenance			\$128,586,966 Escalated and Discounted																	
	Solids Treatment	Operation and Maintenance, \$/yr		\$108,172,760		\$7,820,822	\$7,897,858	\$7,974,895	\$8,051,931	\$8,128,967	\$8,206,004	\$8,283,040	\$8,360,076	\$8,437,113	\$8,514,149	\$8,591,185	\$8,668,221	\$8,745,258	\$8,822,294	\$8,899,330	\$8,976,367
	Land Application Land App	Land App East/West WA Cost, \$/yr																			
	Revenues																				
	CHP Land App	Electricity Sales, \$/yr Land App East/West WA Revenue, \$/yr				-\$1,259,574	-\$1,271,981	-\$1,284,388	-\$1,296,795	-\$1,309,202	-\$1,321,609	-\$1,334,016	-\$1,346,423	-\$1,358,830	-\$1,371,237	-\$1,383,644	-\$1,396,051	-\$1,408,458	-\$1,420,865	-\$1,433,272	-\$1,445,679
Sout	h Treatment Plant	TAD-Batch																			
	Capital Cost	TAD-Batch		<u>NPV Capital Cost</u> \$115,485,340																	
	Operation and Maintenance Solids Treatment	Operation and Maintenance, \$/yr		Escalated and Discounted \$97,151,122															\$10,437,136	\$10,571,914	\$10,706,693
	Land Application			****																	
	Land App Revenues	Land App East/West WA Cost, \$/yr																	\$4,771,147	\$4,832,759	\$4,894,371
	Biogas Land App	Renewable Natural Gas Sales, \$/yr Land App East/West WA Revenue, \$/yr																	-\$7,215,846 -\$294,642	-\$7,309,027 -\$298,447	-\$7,402,208 -\$302,251
Brigh	itwater Treatment Plant																		-\$294,042	-\$298,447	-\$302,251
	Capital Cost	MAD		<u>NPV Capital Cost</u> \$39,098,386																	<u>├</u>
	Operation and Maintenance			Escalated and Discounted		A. 000	±0.05	10 10		+0 05 ·	to of	to 1		to or	*****	40 ===	+0.00	** ***	10.01	to oo- · - ·	
	Solids Treatment	Operation and Maintenance, \$/yr		\$32,891,206		\$1,980,025	\$2,057,820	\$2,135,616	\$2,213,412	\$2,291,208	\$2,369,003	\$2,446,799	\$2,524,595	\$2,602,390	\$2,680,186	\$2,757,982	\$2,835,777	\$2,913,573	\$2,991,369	\$3,069,164	\$3,146,960
C1	Land App	Land App East/West WA Cost, \$/yr																			
S4	Land App	Land App East/West WA Revenue, \$/yr																			
Off-S	Ite Composting (Brightwater Solids) Capital Cost	Composting		NPV Capital Cost																	
				\$119,906,031																	
	Hauling and Transportation Biosolids & Woodchips	Hauling & Fuel Cost, \$/yr		Escalated and Discounted \$100,869,993						-									\$441,251	\$452,726	\$464,202
	Operation and Maintenance	Operation and Maintenance, \$/yr																	\$4,133,571	\$4,241,072	\$4,348,573
	Composting Revenues																				
	Woodchips Composting	Tipping Fee, \$/yr Revenue Year (Commercial), \$/yr																	-\$588,359 -\$279,995	-\$603,661 -\$287,277	-\$618,962 -\$589,117
	Composting	Revenue Year (Consumer), \$/yr																	-\$197,214	-\$202,343	-\$484,101
off-s	Ite Soli Blending (West Point Solids) Capital Cost	Soil Blending		NPV Capital Cost																	+
				\$58,462,405																	
		Hauling & Fuel Cost, \$/yr		Escalated and Discounted \$49,181,032															\$846,764	\$854,158	\$861,552
	Feedstock Purchase Fine Sand	Material Purchase, \$/yr			+														\$513,903	\$518,391	\$522,878
	Operation and Maintenance																				
	Soil Blending Revenues	Operation and Maintenance, \$/yr																	\$5,570,677	\$5,619,320	\$5,667,963
	Soil Blend Soil Blend	Revenue Year (Commercial), \$/yr Revenue Year (Consumer), \$/yr			-														-\$403,875	-\$407,402	-\$821,857
	Son Dienu	Subtotal		\$388,266,112			1	1	1	1	1	1	1	1	1	1			-\$261,711 \$27,865,605	-\$263,996 \$28,253,411	-\$621,324 \$27,304,059
1 1		Total	\$757,081,691	\$000,200,112															\$21,000,000	\$20,200,711	÷21,001,000
			******	I																	

King County Class A Biosolids Technology Evaluation	

																	-	
																	-	
\$9,007,485	\$9,084,131	\$9,160,777	\$9,237,422	\$9,314,068	\$9,390,713	\$9,467,359	\$9,544,004	\$9,620,650	\$9,697,296	\$9,773,941	\$9,850,587	\$9,927,232	\$10,003,878	\$10,080,524	\$10,157,169	\$10,233,815	\$198,814,537	\$122,420,640.57
\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0 \$0	\$0.00 \$0.00
-\$1,372,530	-\$1,384,209	-\$1,395,888	-\$1,407,567	-\$1,419,246	-\$1,430,925	-\$1,442,604	-\$1,454,283	-\$1,465,962	-\$1,477,641	-\$1,489,320	-\$1,500,999	-\$1,512,678	-\$1,524,357	-\$1,536,036	-\$1,547,715	-\$1,559,394	\$0 -\$30,294,694	\$0.00 -\$18,654,047.74
\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0 \$168,519,843	\$0.00 \$103,766,593
																	\$100,515,045	\$105,700,555
																	-	
\$10,717,277	\$10,850,512	\$10,983,747	\$11,116,981	\$11,250,216	\$11,383,451	\$11,516,686	\$11,649,921	\$11,783,156	\$11,916,391	\$12,049,626	\$12,182,860	\$12,316,095	\$12,449,330	\$12,582,565	\$12,715,800	\$12,849,035	\$241,850,408 \$0	\$148,808,792.69 \$0.00
\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0 \$0	\$0.00 \$0.00
-\$7,030,440 \$0	-\$7,117,841 \$0	-\$7,205,242 \$0	-\$7,292,643 \$0	-\$7,380,044 \$0	-\$7,467,445 \$0	-\$7,554,846 \$0	-\$7,642,247 \$0	-\$7,729,648 \$0	-\$7,817,049 \$0	-\$7,904,450 \$0	-\$7,991,851 \$0	-\$8,079,251 \$0	-\$8,166,652 \$0	-\$8,254,053 \$0	-\$8,341,454 \$0	-\$8,428,855 \$0	-\$158,651,764 \$0	-\$97,617,274.00 \$0.00
																	\$83,198,643	\$51,191,519
\$3,224,756	\$3,302,551	\$3,380,347	\$3,458,143	\$3,535,938	\$3,613,734	\$3,691,530	\$3,769,325	\$3,847,121	\$3,924,917	\$4,002,712	\$4,080,508	\$4,158,304	\$4,236,099	\$4,313,895	\$4,391,691	\$4,469,486	\$77,522,124	\$47,601,147.62
\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0 \$0	\$0.00 \$0.00
\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0 \$0	\$0.00 \$0.00
																	\$77,522,124	\$47,601,148
\$1,179,061	\$1,194,297	\$1,209,533	\$1,224,768	\$1,240,004	\$1,255,239	\$1,270,475	\$1,285,711	\$1,300,946	\$1,316,182	\$1,331,417	\$1,346,653	\$1,361,888	\$1,377,124	\$1,392,360	\$1,407,595	\$1,422,831	\$25,561,855	\$16,414,497.08
\$8,298,007	\$8,405,232	\$8,512,457	\$8,619,682	\$8,726,907	\$8,834,132	\$8,941,358	\$9,048,583	\$9,155,808	\$9,263,033	\$9,370,258	\$9,477,483	\$9,584,708	\$9,691,933	\$9,799,158	\$9,906,383	\$10,013,608	\$0 \$179,899,401	\$0.00 \$115,522,063.86
-\$189,933	-\$192,387	-\$194,841	-\$197,295	-\$199,750	-\$404,408	-\$409,316	-\$414,225	-\$419,133	-\$424,042	-\$428,950	-\$542,324	-\$548,459	-\$554,595	-\$560,731	-\$566,866	-\$573,002	\$0 -\$7,283,432	\$0.00 (4,468,103)
\$23,833,683	\$24,142,285	\$24,450,888	\$24,759,491	\$25,068,093	\$25,174,492	\$25,480,640	\$25,786,789	\$26,092,937	\$26,399,085	\$26,705,234	\$26,902,917	\$27,207,839	\$27,512,760	\$27,817,681	\$28,122,602	\$28,427,524	\$198,177,824	\$127,468,458
\$9,053,403	\$9,130,439	\$9,207,476	\$9,284,512	\$9,361,548	\$9,438,584	\$9,515,621	\$9,592,657	\$9,669,693	\$9,746,730	\$9,823,766	\$9,900,802	\$9,977,839	\$10,054,875	\$10,131,911	\$10,208,947	\$10,285,984	\$199,828,036	\$123,044,705.59
																	\$0 \$0	\$0.00 \$0.00
-\$1,458,086	-\$1,470,493	£1.482.000	-\$1,495,307	-\$1,507,714	-\$1,520,121	-\$1,532,528	-\$1,544,935	¢4 557 242	-\$1,569,749	-\$1,582,156	-\$1,594,563	-\$1,606,970	-\$1,619,377	-\$1,631,784	¢1 644 101	\$1,656,509	\$0	\$0.00
-\$1,458,086	-\$1,470,493	-\$1,482,900	-\$1,495,307	-\$1,507,714	-\$1,520,121	-\$1,532,528	-\$1,544,935	-\$1,557,342	-\$1,569,749	-\$1,582,156	-\$1,594,565	-\$1,606,970	-\$1,019,377	-\$1,031,784	-\$1,644,191	-\$1,656,598	-\$32,183,084 \$0	-\$19,816,829.34 \$0.00
																	\$167,644,952	\$103,227,876
\$10,841,472	\$10,976,251	\$11,111,030	\$11,245,809	\$11,380,587	\$11,515,366	\$11,650,145	\$11,784,924	\$11,919,703	\$12,054,482	\$12,189,260	\$12,324,039	\$12,458,818	\$12,593,597	\$12,728,376	\$12,863,155	\$12,997,934	\$234,350,690	\$150,533,236.19
\$4,955,982	\$5,017,594	\$5,079,206	\$5,140,817	\$5,202,429	\$5,264,041	\$5,325,652	\$5,387,264	\$5,448,876	\$5,510,488	\$5,572,099	\$5,633,711	\$5,695,323	\$5,756,934	\$5,818,546	\$5,880,158	\$5,941,769	\$107,129,166	\$68,813,537.58
-\$7,495,389	-\$7,588,570	-\$7,681,751	-\$7,774,932	-\$7,868,113	-\$7,961,294	-\$8,054,475	-\$8,147,656	-\$8,240,837	-\$8,334,018	-\$8,427,199	-\$8,520,380	-\$8,613,561	-\$8,706,742	-\$8,799,924	-\$8,893,105	-\$8,986,286	-\$162,021,312	-\$104,073,055.74
-\$306,056	-\$309,861	-\$313,666	-\$317,471	-\$321,276	-\$325,080	-\$328,885	-\$332,690	-\$336,495	-\$340,300	-\$344,105	-\$347,909	-\$351,714	-\$355,519	-\$359,324	-\$363,129	-\$366,933	-\$6,615,753 \$172,842,791	-\$4,249,574.29 \$111,024,144
\$3,224,756	\$3,302,551	\$3,380,347	\$3,458,143	\$3,535,938	\$3,613,734	\$3,691,530	\$3,769,325	\$3,847,121	\$3,924,917	\$4,002,712	\$4,080,508	\$4,158,304	\$4,236,099	\$4,313,895	\$4,391,691	\$4,469,486	\$77,522,124	\$47,601,147.62
\$5,22 4 ,100	\$5,502,001	\$3,300,341	\$5,450,145	\$3,000,000	\$5,015,154	\$5,051,050	\$5,105,525	\$0,047,121	\$5,52 4 ,511	\$ 1 ,002,112	\$4,000,000	\$4,100,004	ψ 1 ,230,033	\$ 1 ,515,655	φ 1 ,551,651	\$4,405,400	\$0	\$0.00
																	\$0 \$0	\$0.00 \$0.00
																	\$0 \$77,522,124	\$0.00 \$47,601,148
																	-	
\$475,677	\$487,153	\$498.628	\$510,104	\$521,579	\$533,055	\$544,530	\$556,006	\$567,481	\$578,956	\$590,432	\$601,907	\$613,383	\$624,858	\$636,334	\$647,809	\$659,285	\$11,005,356	\$7,021,548.40
																	\$0	\$0.00
\$4,456,073	\$4,563,574	\$4,671,074	\$4,778,575	\$4,886,076	\$4,993,576	\$5,101,077	\$5,208,578	\$5,316,078	\$5,423,579	\$5,531,079	\$5,638,580	\$5,746,081	\$5,853,581	\$5,961,082	\$6,068,582	\$6,176,083	\$103,096,544 \$0	\$65,776,827.67 \$0.00
-\$634,263 -\$603,681	-\$649,565 -\$618,244	-\$664,866 -\$632,808	-\$680,167 -\$647,371	-\$695,469 -\$661,935	-\$710,770 -\$1,014,747	-\$726,071 -\$1,036,593	-\$741,372 -\$1,058,438	-\$756,674 -\$1,080,283	-\$771,975 -\$1,102,128	-\$787,276 -\$1,123,974	-\$802,578 -\$1,527,759	-\$817,879 -\$1,556,886	-\$833,180 -\$1,586,013	-\$848,482 -\$1,615,140	-\$863,783 -\$1,644,267	-\$879,084 -\$1,673,394	-\$14,674,437 -\$20,340,047	-\$9,362,466.00 -\$12,465,137.79
-\$496,068	-\$508,035	-\$520,003	-\$531,970	-\$543,938	-\$952,980	-\$973,496	-\$994,011	-\$1,014,527	-\$1,035,042	-\$1,055,558	-\$1,614,110	-\$1,644,883	-\$1,675,657	-\$1,706,430	-\$1,737,203	-\$1,767,977	-\$19,655,546 \$59,431,870	-\$11,910,043.36 \$39,060,729
																	+	<i>\$55,666,723</i>
	405	+00	400	400	4005	4047-717	4005	400	4007	44.1	448	A48	440	4487	400	405		
\$868,946	\$876,340	\$883,734	\$891,128	\$898,522	\$905,916	\$913,310	\$920,704	\$928,098	\$935,492	\$942,886	\$950,279	\$957,673	\$965,067	\$972,461	\$979,855	\$987,249	\$18,340,134	\$11,809,836.66
\$527,365	\$531,853	\$536,340	\$540,828	\$545,315	\$549,802	\$554,290	\$558,777	\$563,265	\$567,752	\$572,239	\$576,727	\$581,214	\$585,702	\$590,189	\$594,676	\$599,164	\$11,130,671	\$7,167,417.67
\$5,716,607	\$5,765,250	\$5,813,893	\$5,862,536	\$5,911,179	\$5,959,822	\$6,008,466	\$6,057,109	\$6,105,752	\$6,154,395	\$6,203,038	\$6,251,681	\$6,300,325	\$6,348,968	\$6,397,611	\$6,446,254	\$6,494,897	\$120,655,743	\$77,694,340.45
-\$828,910	-\$835,964	-\$843,017	-\$850,070	-\$857,123	-\$1,296,265	-\$1,306,845	-\$1,317,425	-\$1,328,005	-\$1,338,585	-\$1,349,165	-\$1,812,993	-\$1,827,099	-\$1,841,206	-\$1,855,312	-\$1,869,419	-\$1,883,525	-\$24,874,060	(15,361,659)
-\$626,656 \$27,671,172	-\$631,988 \$28,038,284	-\$637,321 \$28,405,397	-\$642,653 \$28,772,509	-\$647,985 \$29,139,622	-\$1,119,973 \$27,872,667	-\$1,129,114 \$28,216,614	-\$1,138,255 \$28,560,561	-\$1,147,396 \$28,904,508	-\$1,156,537 \$29,248,455	-\$1,165,678 \$29,592,402	-\$1,762,229 \$27,975,716	-\$1,775,940 \$28,294,026	-\$1,789,652 \$28,612,337	-\$1,803,364 \$28,930,647	-\$1,817,075 \$29,248,958	-\$1,830,787 \$29,567,268	-\$21,969,634 \$103,282,853	(13,408,253) \$67,901,683
		0,.00,001	0,2,000									0,20 ,020		0,000,041		0,00.,200	÷105,202,055	201,005

\$148,808,792.69 \$0.00 \$0.00 \$0.00 -\$97,617,274.00 \$0.00 \$51,191,519	
\$47,601,147.62 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$47,601,148	
\$16,414,497.08 \$0.00 \$115,522,063.86 \$0.00 (4,468,103) \$127,468,458	
\$123,044,705.59 \$0.00 \$0.00 \$0.00 -\$19,816,829.34	
\$0.00 \$103,227,876	
\$150,533,236.19 \$68,813,537.58	
-\$104,073,055.74 -\$4,249,574.29	
\$111,024,144	
\$47,601,147.62 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$47,601,148	
\$7,021,548.40 \$0.00	
\$65,776,827.67 \$0.00	
-\$9,362,466.00	
-\$12,465,137.79 -\$11,910,043.36	
\$39,060,729	
\$11,809,836.66	
\$7,167,417.67	
\$77,694,340.45	
(15,361,659) (13,408,253)	
\$67,901,683	

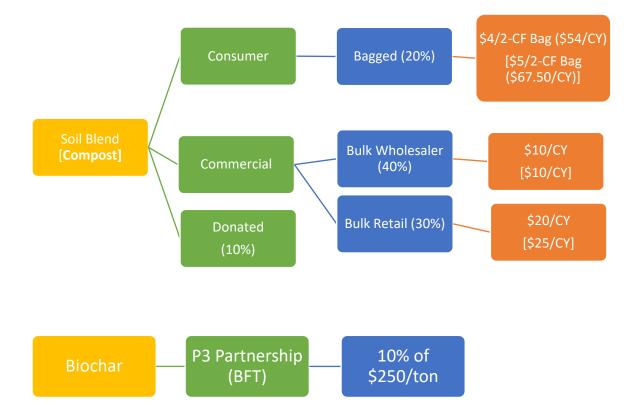
Perfor	rmance	e Summary			1	2	3	4
	osts Bas	ed on 2050 Flows	and Loads	Notes	100% Class B application with MAD at all three plants	TAD-Batch , Cambi, and Off- site Soil Blending or Composting	Off-site Pyrolysis	TAD-Batch and Off-site Soil Blending or Composting
Element					\$1	\$2	S 3	S4
West Poil	nt Treatm	ent plant						
	0							
	Operatio	n and Maintenance	Operation and Maintenance & (m		¢0.000.700	\$7.669.298	¢0.000.700	* 7.000.000
		Solids Treatment TAD-Batch	Operation and Maintenance, \$/yr Operation and Maintenance, \$/yr		\$8,220,708 \$0	\$7,669,298 \$365.490	\$8,220,708 \$0	\$7,669,298 \$365,490
	-	TAD-Batch	Operation and Maintenance, \$/ yr		\$0	\$365,490	\$0	\$365,490
	Process I	Fuel Consumption						
		Solids Treatment	Natural Gas Consumption, \$/yr		\$0	\$0	\$0	\$0
	Fleetrieit	. Concurrention						
	Liectricity	y Consumption Solids Treatment	Electricity Consumption, \$/yr		\$821,834	\$917,555	\$821,834	\$917,555
	-	Solids Treatment	Electricity Consumption, \$/ yr		\$821,834	\$917,555	\$821,834	\$917,555
	Electricity	y Sales	1					
		СНР	Electricity Sales Revenue, \$/yr		\$1,559,394	\$1,656,598	\$1,559,394	\$1,656,598
	Ohamalaa							
	Chemica	Dewatering	Polymer Use, \$/yr		\$1,191,274	\$1,111,368	\$1,191,274	\$1.111.368
		-			\$1,191,274	\$222,274	<u>۵۲,191,274</u> \$0	\$222,274
		Dewatering (TAD)	Polymer Use, \$/yr			\$222,274	\$ 0	\$222,274
	Land Application							
		Agriculture	Land App Eastern WA Cost, \$/yr		\$3,624,176			
		Forestry	Land App Western WA Cost, \$/yr		\$457,277	To Off-site Soil Blending	To Off-site Pyrolysis	To Off-site Soil Blending
		Agriculture	Land App Eastern WA Revenue, \$/yr		\$99,997	To on-site Soil Diending	To on-site Lytolysis	To on-site Son Dienting
		Forestry	Land App Western WA, Revenue, \$/yr		\$48,875			
South Tre	eatment P	lant						
	Operatio	n and Maintenance						
		Solids Treatment	Operation and Maintenance, \$/yr		\$9,717,031	\$9,717,031	\$9,717,031	\$9,717,031
		THP-MAD	Operation and Maintenance, \$/yr		\$0	\$2,479,298	\$0	
	Breesee	Fuel Consumption						
	FIUCESSI	Solids Treatment	Natural Gas Consumption, \$/yr		\$515,568	\$924,448	\$515,568	\$746,378
							. ,	,
	Potable \	Water Usage						
		THP	Potable Water, \$/yr		\$0	\$456,495	\$0	0.0
	Bioge II	pgrading Sales						
	Diogas U	Biogas	Renewable Natural gas Value, \$/yr		\$994,558	\$1,006,652	\$994,558	\$1,060,332
		Biogas	Renwable Natural Gas RINs, \$/yr		\$5,964,479	\$6,037,011	\$5,964,479	\$6,358,932
		Biogas	Renwable Natural Gas CA LCFS, \$/yr		\$1,469,818	\$1,487,692	\$1,469,818	\$1,567,022
	Electricity	y Consumption Solids Treatment	Electricity Consumption, \$/yr		\$984,123	\$1,467,406	\$984,123	\$1,017,100
		Solius rreatment			əəo4,123	ΦΙ ,407,400	₽ 904,⊥23	φ1,017,100
	Chemica	Usage			1			
		Predewatering	Polymer Use, \$/yr		\$0	\$1,444,086	\$0	\$0

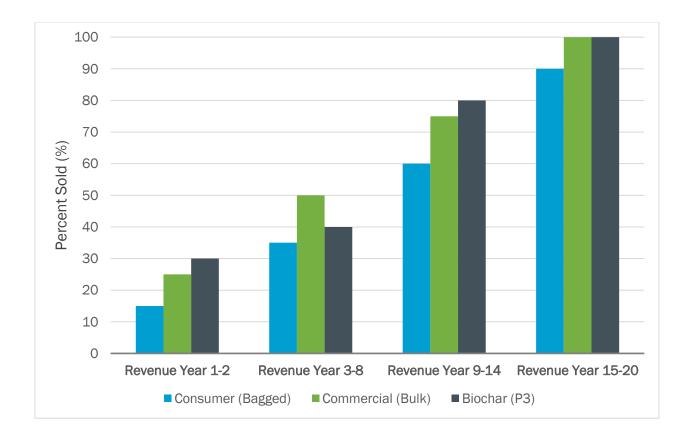
1/21/2020

	Dewatering	Polymer Use, \$/yr	\$1,632,313	\$1,543,797	\$1,632,313	\$1,517,425	
Land Ap	oplication						
	Agriculture	Land App Eastern WA Cost, \$/yr	\$5,456,583	\$2,626,216		\$3,381,685	
	Forestry	Land App Western WA Cost, \$/yr	\$688,479	\$1,988,161	To Off-site Pyrolysis	\$2,560,085	
	Agriculture	Land App Eastern WA Revenue, \$/yr	\$150,556	\$72,462	To on-site Fyrolysis	\$93,306	
	Forestry	Land App Western WA, Revenue, \$/yr	\$73,586	\$212,499		\$273,627	
water Treatr	ment Plant						
Operatio	on and Maintenance						
Operauc	Solids Treatment	Operation and Maintenance, \$/yr	\$3,649,507	\$3.649.507	\$3.649.507	\$3,649,507	
	Solius Treatment	operation and maintenance, \$/ yr	\$3,849,507	\$3,649,507	\$3,649,507	\$3,649,507	
Process	Fuel Consumption						
	Solids Treatment	Natural Gas Consumption, \$/yr	\$0	\$0	\$0	\$0	
Electrici	ity Consumption						
	Solids Treatment	Electricity Consumption, \$/yr	\$277,341	\$277,341	\$277,341	\$277,341	
					. ,	. ,	
Chemica	al Usage						
	Dewatering	Polymer Use, \$/yr	\$542,639	\$542,639	\$542,639	\$542,639	
Land Ap	oplication						
	Agriculture	Land App Eastern WA Cost, \$/yr	\$2,023,400				
	Forestry	Land App Western WA Cost, \$/yr	\$255,301	To Off-site Composting	To Off-site Pyrolysis	To Off-site Compostin	
	Agriculture	Land App Eastern WA Revenue, \$/yr	\$55,829	To on-site composting	To on-site Pyrolysis	To on-site composition	
	Forestry	Land App Western WA, Revenue, \$/yr	\$27,287				
	ng (Brightwater Solids						
Hauling	and Transportation						
	Biosolids	Hauling Cost, \$/yr		\$238,448		\$238,448	
	Biosolids	Fuel Cost (Diesel), \$/yr		\$28,716		\$28,716	
	Woodchips	Hauling Cost, \$/yr		\$310,317		\$310,317	
	Woodchips	Fuel Cost (Diesel), \$/yr		\$81,804		\$81,804	
Operatio	on and Maintenance						
				1		\$5,592,946	
	Composting	Operation and Maintenance, \$/yr		\$5,592,946		. , ,	
	Composting	Equipment Upgrades, \$/yr		\$5,592,946		\$80,000	
	Composting					\$80,000	
Electricit	Composting Ity Consumption	Equipment Upgrades, \$/yr		\$80,000			
Electricit	Composting					\$80,000	
	Composting Ity Consumption Composting	Equipment Upgrades, \$/yr		\$80,000			
	Composting Ity Consumption Composting Fuel Consumption	Equipment Upgrades, \$/yr		\$80,000		\$143,101	
	Composting Ity Consumption Composting	Equipment Upgrades, \$/yr		\$80,000			
Process	Composting Ity Consumption Composting Fuel Consumption Composting	Equipment Upgrades, \$/yr		\$80,000		\$143,101	
	Composting Ity Consumption Composting Fuel Consumption Composting Es	Equipment Upgrades, \$/yr		\$80,000 \$143,101 \$360,036		\$143,101	
Process	Composting Ity Consumption Composting Fuel Consumption Composting es Woodchips	Equipment Upgrades, \$/yr		\$80,000 \$143,101 \$360,036 \$879,084		\$143,101 \$360,036 \$879,084	
Process	Composting Ity Consumption Composting Fuel Consumption Composting es Woodchips Compost	Equipment Upgrades, \$/yr		\$80,000 \$143,101 \$360,036 \$879,084 \$418,348		\$143,101 \$360,036 \$879,084 \$418,348	
Process	Composting Ity Consumption Composting Fuel Consumption Composting es Woodchips Compost Compost Compost	Equipment Upgrades, \$/yr Electricity Costs, \$/yr Electricity Costs, \$/yr Fuel Consumption (Diesel), \$/yr Tipping Fee, \$/yr Revenue Year 1-2 (Commercial) Revenue Year 3-8 (Commercial)		\$80,000 \$143,101 \$360,036 \$879,084 \$418,348 \$836,697		\$143,101 \$360,036 \$879,084 \$418,348 \$836,697	
Process	Composting Ity Consumption Composting Fuel Consumption Composting es Woodchips Compost Compost Compost Compost Compost Compost	Equipment Upgrades, \$/yr Electricity Costs, \$/yr Fuel Consumption (Diesel), \$/yr Tipping Fee, \$/yr Revenue Year 1-2 (Commercial) Revenue Year 3-8 (Commercial) Revenue Year 9-14 (Commercial)		\$80,000 \$143,101 \$360,036 \$879,084 \$418,348 \$836,697 \$1,255,045		\$143,101 \$360,036 \$879,084 \$418,348 \$836,697 \$1,255,045	
Process	Composting Ity Consumption Composting Fuel Consumption Composting es Woodchips Compost Compost Compost	Equipment Upgrades, \$/yr Electricity Costs, \$/yr Electricity Costs, \$/yr Fuel Consumption (Diesel), \$/yr Tipping Fee, \$/yr Revenue Year 1-2 (Commercial) Revenue Year 3-8 (Commercial)	Image: Constraint of the sector of the se	\$80,000 \$143,101 \$360,036 \$879,084 \$418,348 \$836,697		\$143,101 \$360,036 \$879,084 \$418,348 \$836,697	

	Compost	Boyonuo Voor 0 14 (Concumor)		\$1,178,651		\$1,178,651
	Compost	Revenue Year 9-14 (Consumer)				
	Compost	Revenue Year 15-20 (Consumer)		\$1,767,977		\$1,767,977
	ng (West Point Solids	\$)				
Hauling	and Transport					
	Biosolids	Hauling Cost, \$/yr		\$398,444		\$398,444
	Biosolids	Fuel Cost (Diesel), \$/yr		\$43,074		\$43,074
	Woodchips	Hauling Cost, \$/yr		\$98,702		\$98,702
	Woodchips	Fuel Cost (Diesel), \$/yr		\$47,308		\$47,308
	Fine Sand	Hauling Cost, \$/yr		\$322,740		\$322,740
	Fine Sand	Fuel Cost (Diesel), \$/yr		\$76,981		\$76,981
Feedstoo	k Purchase					
	Fine Sand	Feedstock Purchase, \$/yr		\$399,443		\$399,443
	Saw Dust	Feedstock Purchase, \$/yr		\$199,721		\$199,721
Operatio	n and Maintenance					
Operatio	Soil Blending	Operation and Maintenance, \$/yr		\$6,147,421		\$6,147,421
	Soil Blending	Equipment Upgrades, \$/yr		\$40,000		\$40,000
	-			• •		
Electricit	y Consumption					
	Soil Blending	Electricity Costs, MWh/yr		\$0		\$0
Process	Fuel Consumption					
	Soil Blending	Fuel Consumption (Diesel), \$/yr		\$307,476		\$307,476
Devenue						
Revenue		Boyonyo Voor 1.2 (Commercial)		\$470,881		\$470,881
	Soil Blend	Revenue Year 1-2 (Commercial)				
	Soil Blend	Revenue Year 3-8 (Commercial)		\$941,763		\$941,763
	Soil Blend	Revenue Year 9-14 (Commercial)		\$1,412,644		\$1,412,644
	Soil Blend	Revenue Year 15-20 (Commercial)		\$1,883,525		\$1,883,525
	Soil Blend	Revenue Year 1-2 (Consumer)		\$305,131		\$305,131
	Soil Blend	Revenue Year 3-8 (Consumer)		\$711,973		\$711,973
	Soil Blend	Revenue Year 9-14 (Consumer)		\$1,220,524		\$1,220,524
	Soil Blend	Revenue Year 15-20 (Consumer)		\$1,830,787		\$1,830,787
f-Site Thermal D	rying and Pyrolysis					
Hauling	and Transport					
	Biosolids	Hauling Cost, \$/yr			\$1,286,429	
	Biosolids	Fuel Cost (Diesel), \$/yr			\$136,402	
Orrenatio						
Operatio	n and Maintenance	Operation and Maintenance, # ////			\$2,990,705	
	Drying + Pyrolysis	Operation and Maintenance, \$/yr				
	Drying + Pyrolysis	Spare parts and replacement, \$/yr			\$1,500,000	
Electricit	y Consumption					
	Drying + Pyrolysis	Electricity Costs, \$/yr			\$3,521,388	
Brooses	Fuel Consumption					
FIUCESS	Drying + Pyrolysis	Natural Gas Consumption, \$/yr			\$2,001,516	
	Crying - Fylolysis				ψ2,001,010	
Revenue	s					
	Biochar	Revenue Year 1-2 (Contract P3)			\$171,901	
	Biochar	Revenue Year 3-8 (Contract P3)			\$229,201	

	Biochar	Revenue Year 9-14 (Contract P3)		\$458,402	
	Biochar	Revenue Year 15-20 (Contract P3)		\$573,002	





Base Year	Estimate Year
2020	2020

Project Name: KC Class A Biosolids Tech Evaluation			-		
			Date:		1/2/2020
Location: West Point			Estimator:	Steve	Krugel and Trung Le
Description: MAD upgrades			Version:		Revision 01
DIRECT: SUBTOTAL CONST	RUCTION COST	'S			
Item No. Item Description	Quantity	Units	Unit Cost		Item Cost
1 MAD Digester - West Point (2 Additional 2.4 MG Digesters)	4.80	\$/MG	8000000		38,400,000
4				\$	
	C	onstruc	tion Cost Markup	\$	11,712,000
	Su	btotal (Construction Costs	\$	50,112,000
Allowand	ce for Indeterm	ninates	(Design Allowance)	\$	12,528,000
			Street Use Permit	\$	
ESTIMATED F	\$	62,640,000			
DIRECT: SUBTOTAL ADDITIONAL			-		
	\$				
	\$	6,264,00			
	\$				
	Subtotal Prim		struction Amount struction Sales Tax	\$	68,904,00
	\$	6,959,30			
Owner Furnished Equipment Outside Agency Construction					
			on to Construction	Ş	75,863,30
DIRECT: SUBTOTAL OTHER C				-	
	KC/W		ct Implementation		407.00
			Misc. Capital Costs		137,80
		.T CON	STRUCTION COSTS	\$	76,001,00
INDIRECT: NON-CONSTRU		d Cana	ruction Consulting	ć	22,442,52
			Consulting Services		22,442,52
	Permitting & Other Agency Support				689,04
	i erinteni	5 4 011	Right-of-Way	\$ \$	089,04
		Misc	Service & Materials	\$	551,23
			Non-WTD Support	· · · · ·	585,68
			WTD Staff Labor		7,923,94
	Subtoto	al Non-	Construction Costs	\$	32,192,41
		Р	roject Contingency	\$	32,458,05
			Initiatives	\$	1,263,10
		NI CON	STRUCTION COSTS	\$	65,913,58
τοτΑ	LINDIRECT NO	N-CON:	STRUCTION COSTS	Y	00)010)000

Base Year	Estimate Year
2020	2020

	Estimate - AACEI Cla	ss 5				Base Year	Estimate Yea
Project Name:	KC Class A Biosolids Tech Evaluation		D	ate:	1/2/2020	2020	2020
ocation:	West Point			stimator:	Steve Krugel and Trung Le		-
Description:	MAD upgrades			ersion:	Revision 01		
	CONSTRUCTION COS	TS					
Item No.	Item Description	Quantity	Units	Unit Cost	Item Cost		
1	MAD Digester - West Point (2 Additional 2.4 MG Digesters)	4.80	\$/MG \$	\$ 8,000,000.00	\$ 38,400,000		
2	2						
	Iter	n Subtotal Con	struction	Costs (Year 2020)	\$ 38,400,000		
	DIRECT: CONSTRUCTION COST	MARK-UPS					
	Gene	eral Conditions	10%	1.1	\$ 3,840,000		
		Demobilization		1.1	\$ 3,840,000		
	Overhead	& Profit (OHP)	8%	1.08	\$ 3,072,000		
		Insurance		1.015			
		Bonding		1.01			
Escalation Multiplier from ENR-CCI 0% 1.0000							
	Iter	n Subtotal Con	struction	Costs (Year 2020)	\$ 50,112,000		
	Di	rect: Subtot	al Cons	truction Costs	\$ 50,112,000		

Base Year	Estimate Year
2020	2020

	Estimate - AACEI	Class 5					
Project Name:	KC Class A Biosolids Tech Evaluation			Date:		1/2/2020	
Location:	South Plant			Estimator:	Steve	e Krugel and Trung Le	
Description:	MAD upgrades			Version:		Revision 01	
	DIRECT: SUBTOTAL CONSTR	UCTION COST	s				
Item No.	Item Description	Quantity	Units	Unit Cost		Item Cost	
1	MAD Digester - South Plant (1 Additional 2.75 MG Digesters)	2.75	\$/MG	8000000	\$	22,000,00	
2	2				\$		
		Ca	onstruc	tion Cost Markup	\$	6,710,00	
		Su	btotal (Construction Costs	\$	28,710,00	
	Allowanc	e for Indeterm	inates	(Design Allowance)	\$	7,177,50	
				Street Use Permit	\$		
	ESTIMATED PROBABLE COST OF CONSTRUCTION BID \$						
	DIRECT: SUBTOTAL ADDITIONAL C	ONSTRUCTION		S			
Mitigation Construction Contracts S Construction Change Order Allowance S Material Pricing Uncertainty Allowance S							
						3,588,75	
		Subtotal Prim	ary Cor	struction Amount	\$	39,476,25	
Construction Sales Tax						3,987,10	
Owner Furnished Equipment					\$		
				gency Construction			
	Si	ıbtotal KC Con	tributi	on to Construction	\$	43,463,35	
	DIRECT: SUBTOTAL OTHER C/	APITAL CHARG	ES				
		KC/W	TD Dire	ct Implementation			
				Misc. Capital Costs	\$	78,95	
		TOTAL DIREC	T CON	STRUCTION COSTS	\$	43,542,00	
	INDIRECT: NON-CONSTRU						
				ruction Consulting		13,941,05	
				Consulting Services			
		Permitting	g & Oth	er Agency Support	\$	394,76	
				Right-of-Way	\$		
				Service & Materials	\$	315,81	
				Non-WTD Support	\$	335,54	
				WTD Staff Labor		4,851,33	
		Subtota	-	Construction Costs	\$	19,838,51	
			Р	roject Contingency	\$	19,014,24	
				Initiatives	\$	732,72	
	TOTAL			STRUCTION COSTS	\$	39,585,47	
		тс	DTAL	PROJECT COST	\$	83,127,778	

Base Year	Estimate Year
2020	2020

	Estimate - AACEI C	lass 5				Base Year	Estimate Yea
Project Name:	KC Class A Biosolids Tech Evaluation		D	Date: 1/2/2020		2020	2020
ocation:	South Plant			stimator:	Steve Krugel and Trung Le		
Description:	n: MAD upgrades			/ersion: Revision 01			
	CONSTRUCTION CO	DSTS					
Item No.	m No. Item Description		Units	Unit Cost	Item Cost		
1	1 MAD Digester - South Plant (1 Additional 2.75 MG Digesters)	2.75	\$/MG \$	\$ 8,000,000.00	\$ 22,000,000		
2	2				\$ -		
	h	tem Subtotal Con	nstruction	Costs (Year 2020)	\$ 22,000,000		
	DIRECT: CONSTRUCTION CO	ST MARK-UPS					
		eneral Conditions		1.1	\$ 2,200,000		
	Mobilizatio	n/Demobilization	10%	1.1	\$ 2,200,000		
	Overhei	ad & Profit (OHP)	8%	1.08	\$ 1,760,000		
		Insurance		1.015			
		Bonding		1.01			
	Escalation Multip			1.0000			
	h	tem Subtotal Con	struction	Costs (Year 2020)	\$ 28,710,000		
		Direct: Subtot	tal Cons	truction Costs	\$ 28,710,000		

Base Year	Estimate Year
2020	2020

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				Class 5	Estimate - AACE		
1/2/2020		Date:			Biosolids Tech Evaluation	oject Name:	
ve Krugel and Trung Le	Steve	Estimator:			er	cation:	
Revision 01		Version:			ogrades	escription:	
		1	5	UCTION COST	DIRECT: SUBTOTAL CONST		
Item Cost		Unit Cost	Units	Quantity	Item Description	Item No.	
10,000,00	\$	8000000	\$/MG	1.25	ster - Brightwater (1 Additional 1.25MG Digesters)	1	
	\$					2	
3,050,00	\$	tion Cost Markup	nstruct	Co			
13,050,00	\$	Construction Costs	ototal (Su			
3,262,50	\$	(Design Allowance)	inates (e for Indeterm	Allowar		
	\$	Street Use Permit					
16,312,50	\$	ESTIMATED PROBABLE COST OF CONSTRUCTION BID					
		S	COSTS	ONSTRUCTION	DIRECT: SUBTOTAL ADDITIONAL		
	\$	struction Contracts	on Cons	Mitigati			
1,631,25	\$	Construction Change Order Allowance					
	\$						
17,943,75	\$						
1,812,31	\$	Construction Sales Tax					
	\$	Owner Furnished Equipment					
	\$	Outside Agency Construction					
19,756,06	\$	Subtotal KC Contribution to Construction					
			ES	APITAL CHARG	DIRECT: SUBTOTAL OTHER		
	\$	ct Implementation	TD Dire	KC/W			
35,88		Misc. Capital Costs					
19,792,00	\$	STRUCTION COSTS	T CONS	TOTAL DIREC			
				CTION COSTS	INDIRECT: NON-CONSTR		
7,109,83		truction Consulting					
		Consulting Services					
179,43		er Agency Support	g & Oth	Permittin			
		Right-of-Way					
143,55	\$	Service & Materials					
152,52	\$	Non-WTD Support					
2,437,16		WTD Staff Labor					
10,022,50	\$			Subtoto			
8,944,33		roject Contingency	Pi				
339,58	\$	Initiatives					
19,306,43	\$	STRUCTION COSTS	N-CONS	INDIRECT NO	τοτλ		
39,098,386	\$	PROJECT COST	TAL F	тс			

Base Year	Estimate Year
2020	2020

	Estimate - AACEI Cla	Base Year	Estimate Yea				
Project Name:	KC Class A Biosolids Tech Evaluation	Date: 1/2/2020				2020	2020
ocation:	Brightwater			Estimator:	Steve Krugel and Trung Le		
Description:	MAD Upgrades	Version:		Revision 01			
	CONSTRUCTION COSTS						
Item No.	Item Description	Quantity	Units	Unit Cost	Item Cost		
	1 MAD Digester - Brightwater (1 Additional 1.25MG Digesters)	1.3	\$/MG	\$ 8,000,000.0	5 \$ 10,000,000		
	2	\$ -					
	Item Subtotal Construction Costs (Year 2020) \$ 10,000,000						
	DIRECT: CONSTRUCTION COST MARK-UPS						
	· · · · · · · · · · · · · · · · · · ·	eral Conditions		1			
		Demobilization		1			
	Overhead	d & Profit (OHP)	8%		8 \$ 800,000		
		Insurance			5 \$ 150,000		
		Bonding		1.0			
		Itiplier from ENR-CCI 0% 1.0000 \$					
				n Costs (Year 202			
	D	irect: Subtot	al Con	struction Cost	s \$ 13,050,000		

Base Year	Estimate Year
2020	2020

				El Class 5	Estimate - AAG				
1/2/2020		Date:			KC Class A Biosolids Tech Evaluation	Project Name:			
e Krugel and Trung Le	Steve	Estimator:			West Point	Location:			
Revision 01		Version:			TAD System at West Point	Description:			
			OSTS	TRUCTION CO	DIRECT: SUBTOTAL CON	•			
Item Cost		Unit Cost	Units	Quantity	Item Description	Item No.			
16,900,000		16900000	LS		MAD to TAD Digester Upgrades	1			
19,200,000		19200000	LS	1	TAD Batch Tanks	2			
-	\$					3			
11,010,500	\$	tion Cost Markup	onstruct	C					
47,110,500	\$	Construction Costs	btotal C	Sı					
9,422,100	\$	Design Allowance)	inates (e for Indetern	Allowan				
-		Street Use Permit	Street Use Perm						
56,532,600	\$	INSTRUCTION BID	ESTIMATED PROBABLE COST OF CONSTRUCTION BIL						
		STS	ION COS	L CONSTRUCT	DIRECT: SUBTOTAL ADDITION				
-	\$	truction Contracts	on Cons	Mitigati					
5,653,260	\$	e Order Allowance	n Change	Constructio					
-	\$	Material Pricing Uncertainty Allowance							
62,185,860	\$	Subtotal Primary Construction Amount							
6,280,772	\$	Construction Sales Tax							
	\$	Owner Furnished Equipment							
-		Outside Agency Constructio							
68,466,632	\$	on to Construction	ntributio	ubtotal KC Co	٤				
					DIRECT: SUBTOTAL OTHE				
-		ct Implementation		KC/W					
124,372		Misc. Capital Costs	1						
68,591,000	\$	STRUCTION COSTS	CT CONS	TOTAL DIRE					
			TS	RUCTION COS	INDIRECT: NON-CONS				
20,557,872	\$	ruction Consulting	d Const	Design ar					
-		Consulting Services							
621,859		er Agency Support	g & Oth	Permittin					
-		Right-of-Way							
497,487	т	ervice & Materials	Misc. S						
528,580		Non-WTD Support							
7,237,417		WTD Staff Labor							
29,443,215				Subtot					
29,410,265		roject Contingency	Pr						
1,142,483		Initiatives							
59,995,963		TRUCTION COSTS	N-CONS	INDIRECT NO	ΤΟΤΑ				
128,586,966	\$	PROJECT COST	DTAL P	Т					

Base Year	Estimate Year
2020	2020

			El Class 5	Estimate - AAG			
1/2/2020	e:	D		KC Class A Biosolids Tech Evaluation	Project Name:		
e Krugel and Trung Le	mator:	E		South Plant	Location:		
Revision 01	sion:	v		TAD System at South Plant	Description:		
		OSTS	TRUCTION CO	DIRECT: SUBTOTAL CON	-		
Item Cost	Unit Cost	Units	Quantity	Item Description	Item No.		
13,920,000	13920000 \$	LS		MAD to TAD Digester Upgrades	1		
18,360,000	18360000 \$	LS	1	TAD Batch Tanks	2		
	\$				3		
9,845,400	Cost Markup \$	onstructio	С				
42,125,400	truction Costs \$	btotal Co	Su				
8,425,080	gn Allowance) \$	inates (D	e for Indeterm	Allowan			
	eet Use Permit \$						
50,550,480	RUCTION BID \$	T OF CON	ROBABLE COS	ESTIMATED			
		ION COST	L CONSTRUCT	DIRECT: SUBTOTAL ADDITION			
	tion Contracts \$	on Constr	Mitigati				
5,055,048		Construction Change Order Allowance					
		Material Pricing Uncertainty Allowance					
55,605,528		Subtotal Primary Construction Amount					
5,616,158	ction Sales Tax \$	Construction Sales Tax					
		Owner Furnished Equipment					
-	y Construction \$						
61,221,686	Construction \$	ntribution	ıbtotal KC Col	2			
				DIRECT: SUBTOTAL OTHE			
	plementation \$		KC/W				
111,211	. Capital Costs \$	M					
61,333,000	CTION COSTS \$	T CONST	TOTAL DIRE				
		-		INDIRECT: NON-CONS			
18,683,252	ion Consulting \$		Design ar				
-	ulting Services \$						
556,055	gency Support \$	g & Other	Permittin				
	Right-of-Way \$						
444,844	ce & Materials \$						
472,647	-WTD Support \$						
6,557,411	TD Staff Labor \$						
26,714,209	truction Costs \$		Subtot				
26,414,132	ct Contingency \$	Pro					
1,024,101	Initiatives \$						
54,152,443	CTION COSTS \$			ΤΟΤΑ			
115,485,340	JECT COST \$	DTAL PF	т				

Base Year	Estimate Year
2020	2020

	Estimate - AACEI Clas	ss 5						Base Year	Estima
Project Name:	KC Class A Biosolids Tech Evaluation			Da	te:	1/2/2020	ľ	2020	20
Location:	South Plant			Est	timator:	Steve Krugel and Trung Le	-		-
Description:	TAD System at South Plant			Ve	rsion:	Revision 01			
	CONSTRUCTION COS	TS							
Item No.	Item Description	Quantity	Units		Unit Cost	Item Cost			
	MAD to TAD Digester Upgrades	1.0	LS	\$	13,920,000	\$ 13,920,000			
	P Floating Cover to Fixed Cover Upgrade	4.0	EA	\$	1,000,000				
	B Heat Exchanger Upgrades	4.0	EA	\$	300,000				
	Boiler upsize	2.0	EA	\$	1,000,000	\$ 2,000,000			
1	Digester Cleaning, Repairs, and General Upgrades, and New Mixing (4.0	EA	\$	1,680,000	\$ 6,720,000			
	TAD Batch Tanks	1.0	LS	\$	18,360,000	\$ 18,360,000			
	7 Batch tanks	1.5	\$/MG	\$	12,000,000	\$ 18,360,000			
:	3					\$-			
	Ite	m Subtotal Co	nstructi	on C	Costs (Year 2020)	\$ 32,280,000			
	DIRECT: CONSTRUCTION COST	MARK-UPS							
	Gene	ral Conditions	10%		1.1	\$ 3,228,000			
	Mobilization/D	emobilization	10%		1.1	\$ 3,228,000			
	Overhead 8	& Profit (OHP)	8%		1.08	\$ 2,582,400			
		Insurance	1.5%		1.015	\$ 484,200			
		Bonding	1.0%		1.01	\$ 322,800			
	Escalation Multiplier	from ENR-CCI	0%		1.0000	\$ -			
	Ite	m Subtotal Co	nstructi	on C	Costs (Year 2020)	\$ 42,125,400			
	Di	rect: Subto	tal Co	nst	ruction Costs	\$ 42,125,000			

Base Year	Estimate Year
2019	2020

	Estim	ate - AACEI Class 5				
Project Name:	KC Class A Biosolids Tech Evaluation			Date:		1/2/2020
Location:	South Treatment Plant			Estimator:	Steve K	rugel and Trung Le
Description:	THP-MAD System at South Plant			Version:		Revision 01
	DIRECT: SUBTO	DTAL CONSTRUCTION CO	OSTS	•		
Item No.	Item Description	Quantity	Units	Unit Cost		Item Cost
1	THP-MAD Digester Upgrades	1	LS	10720000	\$	10,720,000
2	Solids Screening and Pre-dewatering	1	-	84000000		84,000,000
	Thermal Hydrolysis (CAMBI)	1	-	53200000		53,200,000
	Steam Boilers	1		7910000	\$	7,910,000
	Cooling Towers	1	LS	4690000	\$	4,690,000
6					\$	-
				tion Cost Markup	\$	48,958,600
				Construction Costs	\$	209,478,600
		Allowance for Indeterm	ninates (Design Allowance)	\$ \$	31,421,790
						-
	-	IMATED PROBABLE COS			\$	240,900,390
	DIRECT: SUBTOTAL A	DDITIONAL CONSTRUCT			-	
		9		struction Contracts	\$ \$	
	Construction Change Order Allowance Material Pricing Uncertainty Allowance					
	\$ \$	-				
Subtotal Primary Construction Amount						264,990,429
				struction Sales Tax	\$	26,764,033
				rnished Equipment	\$	
			-	gency Construction	\$	
				on to Construction	\$	291,754,462
	DIRECT: SUBTO	TAL OTHER CAPITAL CHA				
		KC/W		ct Implementation		520.004
		7074/ 0/05		Misc. Capital Costs	\$ \$	529,981
				STRUCTION COSTS	\$	292,284,000
	INDIRECT: NO	DN-CONSTRUCTION COS		rustion Consultin-	ć	71 072 420
		Design ar		truction Consulting		71,072,436
		Dormittin		er Agency Support	\$ \$	2,649,904
		Permittin	g a utn	Right-of-Way	\$ \$	2,049,904
			Misc S	Service & Materials	ş Ś	2,119,923
				Non-WTD Support	\$	2,252,419
				WTD Staff Labor	\$	26,324,583
		Subtoti	al Non-(Construction Costs	\$	104,419,266
				roject Contingency	\$	119,011,113
				Initiatives	\$	4,731,621
		TOTAL INDIRECT NO	N-CONS		\$	228,162,000
				PROJECT COST	\$	520,446,443
		10		105201 0051	7	320,770,443

Base Year	Estimate Year
2019	2020

	Estimate - AACEI Class 5						
Project Name:	KC Class A Biosolids Tech Evaluation			Date:	1/2	/2020	
Location:	South Treatment Plant			Estimator:	Steve Krugel and Trung Le		
Description:	THP-MAD System at South Plant			Version:	Revision 01		
	CONSTRUCTION COSTS						
Item No.	Item Description	Quantity	Units	Unit Cost	Iter	n Cost	
1	THP-MAD Digester Upgrades	1	LS	\$ 10,720,000.00	\$	10,720,000	
2	Floating Cover to Fixed Cover Upgrade	4	EA	\$ 1,000,000.00	\$	4,000,000	
3	Digester Cleaning, Repairs, and General Upgrades, and New Mixing (Draft Tube)	4	EA	\$ 1,680,000.00	0.00 \$ 6,720,00		
4	Solids Screening and Pre-dewatering	1	LS	\$ 84,000,000.00	\$	84,000,000	
5	Thermal Hydrolysis (CAMBI)	1	LS	\$ 53,200,000.00	\$	53,200,000	
6	Steam Boilers	1	LS	\$ 7,910,000.00	\$	7,910,000	
7	Cooling Towers	1	LS	\$ 4,690,000.00	\$	4,690,000	
	Item Subtotal Construction Costs (Year 2020)						
	DIRECT: CONSTRUCTION COST MARK-	UPS					
	Gene	General Conditions 10%		1.1	\$	16,052,000	
	Mobilization/Demobilization 10%		10%	1.1	\$	16,052,000	
	Overhead & Profit (OHP) 8%		1.08	\$	12,841,600		
	Insurance 1.5% 1.015		\$	2,407,800			
	Bonding 1.0% 1.01		\$	1,605,200			
Escalation Multiplier from ENR-CCI 0% 1.0000				\$	-		
Item Subtotal Construction Costs (Year 2020)						209,478,600	
Direct: Subtotal Construction Costs						209,479,000	

					I Class 5	Estimate - AAC						
12/30/2019	:	Dat			KC Class A Biosolids Tech Evaluation	Project Name:						
Trung Le		nator:	Esti			King County - South End, Site To be Determined	Location:					
Revision 01		ion:	Ver			ASP Composting Facility	Description:					
	DIRECT: SUBTOTAL CONSTRUCTION COSTS											
Item Cost		Unit Cost	_	Units	Quantity	Item Description	Item No.					
6,905,580	\$	157	\$		44,018	Primary Composting						
8,747,068	\$	125	\$		69,728	Secondary Composting						
5,081,233	\$	75	\$		67,750	Process/Maintenance Buildings						
1,125,000	\$	150	\$	SF	7,500	Office/Administration Building						
						Admin Parking, Roads, Truck Access, Maintenance Yard,						
1,425,222	\$	8	\$		178,153	Curing and Storage, Screening						
674,963	25 \$		\$		26,999	Dry Wood Storage						
2,228,184	\$	20	\$		111,409	Ponds and Collection System						
1,955,000	\$	1,955,000	\$	LS	1	Equipment Purchases (ECS)						
1,225,000	\$	1,225,000	\$ \$	LS	1	Install Equipment Purchases (ECS)						
933,093	\$	1	Ş	51	629,055	Site Preparation / Demolition						
262 10	\$	5	\$	CV	58,246	Site Mass Grading (whole site using avg. of 2.5' of cut to fill)	11					
262,100	\$ \$	250,000	\$ \$	LS	,	Water / Sewer / Electrical Services to Site						
133,99	\$ \$	250,000	\$ \$		4,496	Site Perimeter - Chain Link Fencing						
1,428,194	\$ \$		\$		170,023	Site Perimeter - New Landscape						
9,893,320	\$	Cost Markup			,	Site Fermieter - New Landscape	14					
42,330,46	ې \$	ruction Costs										
11,288,865	, \$				for Indeterm	Allowance						
11,200,003	et Use Permit		inates (for mueterm	Allowalice							
53,619,32				OPARIECOS	ESTIMATED PR							
55,015,52.	\$	COCTION BID										
	\$	tion Contracts	DIRECT: SUBTOTAL ADDITIONAL CONSTRUCTION COSTS Mitigation Construction Contract									
5,644,432	\$	Construction Change Order Allowance										
5,044,45	\$	Material Pricing Uncertainty Allowance										
59,263,75		Subtotal Primary Construction Amount										
5,985,639		tion Sales Tax				·						
			Owner Furnished Equipment									
		Outside Agency Construction										
68,074,39	Subtotal KC Contribution to Construction											
,,	\$					DIRECT: SUBTOTAL OTHER						
	\$	plementation	ct Im									
124,178	\$	Misc. Capital Costs			-							
68,199,00	\$	CTION COSTS	TRU	T CONS	TOTAL DIREC							
				TS	RUCTION COS	INDIRECT: NON-CONST						
14,228,182	\$	on Consulting	truct	d Const	Design an							
	Other Consulting Services											
310,444	\$ \$	gency Support										
	\$	Right-of-Way										
1,117,598	\$	Misc. Service & Materials										
527,754	\$	WTD Support	Non-WTD Suppor									
6,941,389	\$	TD Staff Labor	WTD Staff Labor									
23,125,36	\$	ruction Costs	Subtotal Non-Construction Costs									
27,482,780	\$	t Contingency	Project Contingenc									
1,099,310	\$	Initiatives										
51,707,452	\$	TOTAL INDIRECT NON-CONSTRUCTION COSTS										
119,906,031	\$	IECT COST	RO	TAL P	то							

Base YearEstimate Year20202020

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	Estimate - AACEI Class	5					
Project Name:	KC Class A Biosolids Tech Evaluation Date:						12/30/2019
Location:	King County - South End, Site To be Determined			Esti	mator:		Trung Le
Description:	ASP Composting Facility Version:						Revision 01
	CONSTRUCTION COSTS	S					
Item No.	Item Description	Quantity	Units		Unit Cost		Item Cost
1	Primary Composting	44,018	SF	\$	156.88	\$	6,905,580
2	Primary Compost Process Area	1	LS	\$	-	\$	-
3	Secondary Composting	69,728	SF	\$	125.45	\$	8,747,068
4	Secondary ASP Area	1	LS	\$	-	\$	-
5	Process/Maintenance Buildings	67,750	SF	\$	75.00	\$	5,081,231
6	Pre-process & Tip Building	44,821	SF	\$	75.00	\$	3,361,594
7	Maintenance Building	5,000	SF	\$	75.00	\$	375,000
8	Bagging Building	17,929	SF	\$	75.00	\$	1,344,638
9	Office/Administration Building	7,500	SF	\$	150.00	\$	1,125,000
	Admin Parking, Roads, Truck Access, Maintenance Yard, Curing and			\$	8.00		
10	Storage, Screening	178,153	SF			\$	1,425,221
11	Admin Parking	2,500	-	\$	8.00	\$	20,000
12	Roads	59,112	SF	\$	8.00	\$	472,896
13	Truck Access	26,893	SF	\$	8.00	\$	215,142
14	Maintenance Yard	8,964	SF	\$	8.00	\$	71,714
15	Screening Area	13,446	SF	\$	8.00	\$	107,571
16	Curing and Storage Area	67,237	SF	\$	8.00	\$	537,898
17	Dry Wood Storage	26,999	SF	\$	25.00	\$	674,963
18	Ponds and Collection System	111,409	SF	\$	20.00	\$	2,228,184
19	Contact Water Pond and Collection System	36,409		\$	15.00	\$	546,138
20	Storm water Pond	75,000	SF	\$	5.00	\$	375,000
21	Equipment Purchases (ECS)	1	LS	\$	1,955,000.00	\$	1,955,000
22	Wood Grinder (mid-large Horizontal)	1	EA	\$	500,000.00	\$	500,000
23	Mixer System (ECS/LuckNow 2295)	2	EA	\$	260,000.00	\$	520,000
24	Screen (MultiStar L3 Type)	1	EA	\$	550,000.00	\$	550,000
25	Bagging Equipment (RotoChopper Go-Bagger 250)	2	EA	\$	60,000.00	\$	120,000
26	Radial Stacking Conveyors	3	EA	\$	195,000.00	\$	585,000
27	Install Equipment Purchases (ECS)	1	LS	\$	1,225,000.00	\$	1,225,000
28	Install Mixer System (ECS/LuckNow 2295)	2	EA	\$	520,000.00	\$	1,040,000
29	Install Bagging Equipment (RotoChopper Go-Bagger 250)	1	EA	\$	120,000.00	\$	120,000
30	Install Radial Stacking Conveyors	3	EA	\$	195,000.00	\$	585,000
31	Site Preparation / Demolition	629,055	SF	\$	1.48	\$	933,091
32	Demo Existing Building (1/4 of site size)	1,315,759	CF	\$	0.50	\$	657,879
33	Demo Existing Hard Surfaces (1/2 of site size)	314,528	SF	\$	0.75	\$	235,896
34	Demo Existing Landscape/Trees (1/4 of site size)	157,264	SF	\$	0.25	\$	39,316
	Site Mass Grading (whole site using avg. of 2.5' of cut to fill)	58,246	СҮ	\$	4.50	\$	262,106
	Water / Sewer / Electrical Services to Site		LS	\$	250,000.00	\$	312,500
	Site Perimeter - Chain Link Fencing	4,496		\$	29.80	\$	133,995
38	Site Perimeter - New Landscape	170,023	SF	\$	8.40	\$	1,428,194
			ruction	Cost	ts (Year 2020)	\$	32,437,134
	DIRECT: CONSTRUCTION COST N	ARK-UPS					
	Gene	ral Conditions			1.1	\$	3,243,713.38
	Mobilization/D	emobilization	10%		1.1	\$	3,243,713.38
	Overhead	& Profit (OHP)	8%		1.08	\$	2,594,970.71
		Insurance	1.5%		1.015	\$	486,557.01
		Bonding	1.0%		1.01	\$	324,371.34
	Escalation Multiplier		0%		1.0000	\$	-
	Item S	ubtotal Const	ruction	Cost	ts (Year 2020)	\$	42,330,460
	Dire	ct: Subtotal	Cons	tru	ction Costs	Ś	42,330,000

	Estimate - AACEI Cla	ss 5				
Project Name:	KC Class A Biosolids Tech Evaluation	12/30/2019				
Location:	King County - South End, Site To be Determined			Estimator:	Trung Le	
Description:	ASP Composting Facility			Version:		Revision 01
	CONSTRUCTION COS	TS				
Item No.	Item Description	Quantity	Units	Unit Cost		Item Cost
1	Equipment Purchases (ECS)	1	LS	\$ 2,825,040	\$	2,825,040
2	Large Front End Loader (Cat 980, Type)	4	EA	\$ 550,000	\$	2,200,000
3	Small Front End Loader (Cat 950, Type)	1	EA	\$ 300,000	\$	300,000
4	Compost Turner (X67 Type)	0	EA	\$ 600,000	\$	-
5	Forklift	1	EA	\$ 50,000	\$	50,000
6	Repair Shop Tools	1	LS	\$ 200,000	\$	200,000
7	Sport Utility Vehicle	1	EA	\$ 36,960	\$	36,960
8	Pickup Truck	1	EA	\$ 38,080	\$	38,080
S						
		Item Subt	otal Constr	uction Costs (Year)	\$	2,825,040
	DIRECT: CONSTRUCTION COST	MARK-UPS	5			
	General	Conditions	10%	1.1		included
	Mobilization/Demobilization 10% 1.1 inclu					
	Overhead & Profit (OHP) 10% 1.1 inclu					
	Insurance 1.5% 1.015 inc					
	Bonding 1.0% 1.01 incl					
	Escalation Multiplier fro	om ENR-CCI	0%	1.0000	\$	-
		Item Subt	otal Constru	uction Costs (Year)	\$	2,825,040
	Di	rect: Sub	total Con	struction Costs	\$	2,825,000

	Estimate - AAC	El Class 5					
Project Name:	KC Class A Biosolids Tech Evaluation Date:			12/30/2019			
Location:	King County - South End, Site To be Determined			Estimator:		Trung Le	
Description:					Revision 01		
	DIRECT: SUBTOTAL CONSTRUCTION COSTS						
Item No.	Item Description	Quantity	Units	Unit Cost		Item Cost	
	1 Process Building (Prefab Building)	22,400		157		3,516,800	
	2 Feedstock Storage (Tensile Membrane)	24,600	-	20	\$	492,000	
	3 Finished Product Storage (Tensile Membrane)	15,000		20		300,000	
	4 Misc Buildings	15,000		75	\$	1,125,000	
	5 Office/Administration Building	5,000	SF	75	\$	375,000	
	Admin Parking, Roads, Truck Access, Maintenance Yard,						
	6 Screening, Finished Product Storage (Uncovered)	150,000		8	\$	1,200,000	
	7 Ponds and Collection System	60,000		22	\$	1,300,000	
	B Equipment Purchases		LS	2,200,000		2,200,000	
	Install Equipment Purchases		LS	1,510,000		1,510,000	
	Site Preparation / Demolition	438,000		2	\$	1,012,875	
	1 Site Mass Grading (whole site using avg. of 2.5' of cut to fill)	40,556		5	\$	182,500	
	2 Water / Sewer / Electrical Services to Site		LS	250,000		250,000	
	3 Site Perimeter - Chain Link Fencing	4,000		30		119,200	
14	4 Site Perimeter - New Landscape	95,000		8	\$	798,000	
				tion Cost Markup	\$	4,386,319	
				Construction Costs	\$	18,767,694	
Allowance for Indeterminates (Design Allowance)					\$	5,360,674	
				Street Use Permit	\$		
				ONSTRUCTION BID	\$	24,128,368	
	DIRECT: SUBTOTAL ADDITIONA						
				struction Contracts	\$	-	
				ge Order Allowance	\$	2,680,337	
			-	certainty Allowance	\$	-	
		Subtotal Pr	,	nstruction Amount	\$	26,808,705	
				nstruction Sales Tax	\$	2,707,679	
				irnished Equipment	\$	2,675,000	
				gency Construction	\$ \$	-	
				ion to Construction	Ş	32,191,384	
	DIRECT: SUBTOTAL OTHE			at local an eater the	L é		
		KC,	VVID DIre	ect Implementation	_	-	
		TOTAL DU		Misc. Capital Costs	\$ \$	58,967	
				STRUCTION COSTS	Ş	32,250,000	
	INDIRECT: NON-CONS			truction Computer	ć	7 740 007	
		Design		truction Consulting Consulting Services	_	7,718,967	
		Dormit		her Agency Support	\$ \$	-	
		reillill	ung & Uli	Right-of-Way	\$ \$	147,419	
			Micc	Service & Materials	\$ \$	530,707	
			IVIISC.	Non-WTD Support	\$ \$	250,611	
				WTD Staff Labor	ې \$	3,602,776	
		Subt	otal Non-	Construction Costs	ې \$	12,250,480	
		5001		Project Contingency	, \$	13,431,302	
			г	Initiatives	\$	530,272	
	τοτ			STRUCTION COSTS	\$	26,212,053	
	101	- member i			\$ \$		
			TOTAL	PROJECT COST	Ş	58,462,405	

	Estimate - AACEI Class	5					
Project Name:	KC Class A Biosolids Tech Evaluation			Date		12/30/2019	
Location:	King County - South End, Site To be Determined				nator:	Trung Le	
Description:	Soil Blending Facility (Adjacent to Composting) Version:					Revision 01	
•	CONSTRUCTION COSTS	5					
Item No.	Item Description	Quantity	Units	ι	Jnit Cost	Item Cost	
1	Process Building (Prefab Building)	22,400	SF	\$	157	\$ 3,516,80	
2	Primary Mixing Area	20,000	SF	\$	157	\$ 3,140,00	
3	Feedstock Day Storage	2,400	SF	\$	157	\$ 376,80	
4	Feedstock Storage (Tensile Membrane)	24,600	SF	\$	20	\$ 492,00	
5	Feedstock Storage (Sawdust)	15,000	SF	\$	20	\$ 300,00	
6	Feedstock Storage (Biosolids and Fine Sand)	9,600	SF	\$	20	\$ 192,00	
7	Finished Product Storage (Tensile Membrane)	15,000	SF	\$	20	\$ 300,00	
8		15,000	-	\$	75	\$ 1,125,00	
9		5,000	-	\$	75	\$ 375,00	
10		10,000		\$	75	\$ 750,00	
11	Office/Administration Building	5,000	SF	\$	75	\$ 375,00	
	Admin Parking, Roads, Truck Access, Maintenance Yard, Screening,						
12		150,000		\$	8	\$ 1,200,00	
13	Admin Parking	2,500	-	\$	8	\$ 20,00	
14		50,000		\$	8	\$ 400,00	
15	Truck Access	25,000		\$	8	\$ 200,00	
16		5,000		\$	8	\$ 40,00	
17	Screening Area	7,500		\$	8	\$ 60,00	
18		60,000	-	\$	8	\$ 480,00	
19		60,000		\$	22	\$ 1,300,00	
20		20,000		\$	25	\$ 500,00	
21	Stormwater Pond	40,000	-	\$	20	\$ 800,00	
22		1		\$ \$	2,200,000	. , ,	
23	Wood Grinder (mid-large Horizontal)	2		\$ \$	500,000 350,000	\$ 500,00 \$ 700,00	
24	Mixer System (Horizontal Rotomix 1220-20, Stationary) Screen (MultiStar L3 Type)	1	EA	\$ \$	550,000	\$ 700,00	
25		1		ې \$	60,000	\$ 530,00	
20	Radial Stacking Conveyors	2		\$	195.000	\$ 390,00	
28		1		Ś	1,510,000	\$ 1,510,00	
20	Install Mixer System (Rotomix 1220-20, Stationary)	2		\$	500,000	\$ 1,000,00	
30			EA	\$	120,000	\$ 120,00	
31	Install Radial Stacking Conveyors	2		\$	195,000	\$ 390,00	
32		438,000		\$	2.31	\$ 1,012,87	
33	Demo Existing Building (1/4 of site size)	1,642,500		\$	0.50	\$ 821,25	
34		219,000	SF	\$	0.75	\$ 164,25	
35	Demo Existing Landscape/Trees (1/4 of site size)	109,500	SF	\$	0.25	\$ 27,37	
36	Site Mass Grading (whole site using avg. of 2.5' of cut to fill)	40,556	СҮ	\$	4.5	\$ 182,50	
37	Water / Sewer / Electrical Services to Site	1	LS	\$	250,000	\$ 250,00	
38	Site Perimeter - Chain Link Fencing	4,000	LF	\$	30	\$ 119,20	
39	Site Perimeter - New Landscape	95,000	SF	\$	8	\$ 798,00	
	Item S	Subtotal Const	ruction	Costs	(Year 2020)	\$ 14,381,37	
	DIRECT: CONSTRUCTION COST N	ARK-UPS					
	Gene	ral Conditions	10%		1.1	\$ 1,438,137.5	
	Mobilization/D	emobilization	10%		1.1	\$ 1,438,137.5	
	Overhead	& Profit (OHP)	8%		1.08	\$ 1,150,510.0	
		Insurance	1.5%		1.015	\$ 215,720.6	
		Bonding	1.0%		1.01	\$ 143,813.7	
	Escalation Multiplier	from ENR-CCI	0%		1.0000	\$ -	
		Subtotal Const	ruction	Costs	(Year 2020)	\$ 18,767,69	

	Estimate - AACEI Cla	iss 5				
Project Name:	KC Class A Biosolids Tech Evaluation Date:					12/30/2019
Location:	King County - South End, Site To be Determined			Estimator:		Trung Le
Description:	Soil Blending Facility (Adjacent to Composting)		Version:		Revision 01
-	CONSTRUCTION CO	STS				
Item No.	Item Description	Quantity	Units	Unit Cost		Item Cost
1	Equipment Purchases (ECS)	1	LS	\$ 2,675,040	\$	2,675,040
2	Large Front End Loader (Cat 980, Type)	3	EA	\$ 550,000	\$	1,650,000
3	Small Front End Loader (Cat 950, Type)	1	EA	\$ 300,000	\$	300,000
4	Compost Turner (X67 Type)	0	EA	\$ 600,000	\$	-
5	Forklift	1	EA	\$ 50,000	\$	50,000
6	Repair Shop Tools	1	LS	\$ 200,000	\$	200,000
7	Sport Utility Vehicle	1	EA	\$ 36,960	\$	36,960
8	Pickup Truck	1	EA	\$ 38,080	\$	38,080
S	Articulating Hauler Truck	1	EA	\$ 400,000	\$	400,000
10						
		Item Subt	otal Constr	uction Costs (Year)	\$	2,675,040
	DIRECT: CONSTRUCTION COS	T MARK-UPS	5			
	Genera	l Conditions	10%	1.1		included
	Mobilization/Demobilization 10% 1.1					included
	Overhead & Profit (OHP) 10% 1.1					included
	Insurance 1.5% 1.015					included
	Bonding 1.0% 1.01					included
	Escalation Multiplier fr		0%			-
		Item Subt	otal Constr	uction Costs (Year)	\$	2,675,040
	D	irect: Sub	total Con	struction Costs	\$	2,675,000

Base Year	Estimate Year
2020	2020

	Estimate - AACI	El Class 5				
Project Name:	KC Class A Biosolids Tech Evaluation			Dat	e:	12/30/2019
Location:	King County - South End, Site To be Determined			Esti	mator:	Trung Le
Description:	Thermal Drying Pyrolysis Off-site Facility Version:				sion:	Revision 01
	DIRECT: SUBTOTAL CONS	TRUCTION CO	STS			
Item No.	Item Description	Quantity	Units		Unit Cost	Item Cost
1	Office/Administration Building	5000	SF	\$	150	\$ 750,000
2	Admin Parking, Roads, Truck Access	50000	SF	\$	8	\$ 400,000
3	Process/Maintenance Building	175000	SF	\$	218	\$ 38,155,000
4	Equipment Purchases	1	LS	\$	94,828,600	\$ 94,828,600
5	Install Equipment Purchases	1	LS	\$	51,783,950	\$ 51,783,950
6	Site Preparation / Demolition	270000	SF	\$	2	\$ 624,375
7	Water / Sewer / Natural Gas / Electrical Services to Site	1	LS	\$	1,000,000	\$ 1,000,000
8	Site Perimeter - Chain Link Fencing	2000	LF	\$	30	\$ 60,000
9	Site Perimeter - New Landscape	2000	SF	\$	10	\$ 20,000
	•	Ca	onstruct	tion	Cost Markup	\$ 57,102,687
		Su	btotal (Cons	truction Costs	\$ 244,724,612
	Allowance	e for Indeterm	inates (Des	gn Allowance)	\$ 61,181,153
				Stre	eet Use Permit	
	ESTIMATED P	ROBABLE COST	T OF CO	NST	RUCTION BID	\$ 305,905,765
	DIRECT: SUBTOTAL ADDITIONAL	L CONSTRUCTI	ON CO	STS		
Mitigation Construction Contracts						\$ -
Construction Change Order Allowance					\$ 30,590,577	
Material Pricing Uncertainty Allowance						\$ -
		Subtotal Prim	ary Con	stru	ction Amount	\$ 336,496,342
			Con	stru	ction Sales Tax	\$ 33,986,131
Owner Furnished Equipment					ed Equipment	\$
		Out	side Ag	genc	y Construction	\$
	Su	ıbtotal KC Con	tributio	on to	Construction	\$ 370,482,472
	DIRECT: SUBTOTAL OTHER	CAPITAL CHA	RGES			
		KC/W	TD Dire	ct In	plementation	\$ -
				Miso	. Capital Costs	\$ 672,993
		TOTAL DIREC	T CONS	STRL	ICTION COSTS	\$ 371,155,000
	INDIRECT: NON-CONST	RUCTION COS	ΓS			
		Design an	d Const	ruct	ion Consulting	\$ 57,089,958
			Other (Cons	ulting Services	\$ -
Permitting & Other Agency Suppor						\$ 1,682,482
Right-of-Wa					\$	
Misc. Service & Materials					\$ 6,056,934	
Non-WTD Support				-WTD Support	2,860,219	
					TD Staff Labor	31,528,089
		Subtota	I Non-C	Cons	truction Costs	\$ 99,217,682
	Project Contingenc		\$ 141,111,944			
					Initiatives	5,788,093
	TOTAL	INDIRECT NO	N-CONS	TRL	ICTION COSTS	\$ 246,117,719
			DTAL F			\$ 617,273,184

	Estimate - AACEI Class 5						
Project Name:	KC Class A Biosolids Tech Evaluation			Date	e:	12/30/2019	
Location:	King County - South End, Site To be Determined Estimator:					stimator: Trung Le	
Description:	Thermal Drying Pyrolysis Off-site Facility			Vers	sion:		Revision 01
	CONSTRUCTION COSTS						
Item No.	Item Description	Quantity	Units		Unit Cost		Item Cost
1	Office/Administration Building	5,000	SF	\$	150	\$	750,000
2	Admin Parking, Roads, Truck Access	50,000	SF	\$	8	\$	400,000
3	Admin Parking	2,500	SF	\$	8	\$	20,000
4	Roads (Asphalt)	25,000	SF	\$	12	\$	300,000
5	Truck Access	10,000	SF	\$	8	\$	80,000
6	Process/Maintenance Building	175,000		\$	218.03	\$	38,155,000
7	Pre-Fabricated Building - Process, Maintenance, Electrical, Mechanical	175,000	SF	\$	175	\$	30,625,000
8	Concrete Slab	161,200	SF	\$	25	\$	4,030,000
9	Additional Electrical	175,000	SF	\$	20	\$	3,500,000
10	Equipment Purchases	1	LS	\$	94,828,600	\$	94,828,600
11	DLT 1120 Belt Dryers	12	EA	\$	2,723,217	\$	32,678,600
12	BFT P-THREE Pyrolysis Unit	24	EA	\$	2,075,000	\$	49,800,000
13	Conveyence System, Sludge Pumps, etc	1	EA	\$	750,000	\$	750,000
14	Hot Water Boilers		EA	\$	500,000	\$	1,000,000
15	Storage Hoppers	-	EA	\$	500,000	\$	2,500,000
16	Odor Control		LS	\$	7,500,000	\$	7,500,000
17	Storage Containers		EA	\$	300,000	\$	600,000
18	Install Equipment Purchases	1	LS	\$	51,783,950	\$	51,783,950
19	Install DLT 1120 Belt Dryer		EA	\$	2,042,413	\$	24,508,950
20	Install BFT P-THREE Pyrolysis Unit		EA	\$	1,037,500	\$	24,900,000
21	Install Hot Water Boiler	2	EA	\$	250,000	\$	500,000
22	Install Conveyance System and Hoppers	5	EA	\$	375,000	\$	1,875,000
23	Site Preparation / Demolition	270,000	SF	\$	2.31	\$	624,375
24	Demo Existing Building	1,012,500	CF	\$	0.50	\$	506,250
25	Demo Existing Hard Surfaces	135,000	SF	\$	0.75	\$	101,250
26	Demo Existing Landscape/Trees	67,500	SF	\$	0.25	\$	16,875
	Water / Sewer / Natural Gas / Electrical Services to Site	1	LS	\$	1,000,000	\$	1,000,000
	Site Perimeter - Chain Link Fencing	2,000	LF	\$	30.00	\$	60,000
29	Site Perimeter - New Landscape	2,000	SF	\$	10.00	\$	20,000
	Item :	Subtotal Const	ruction	Cost	rs (Year 2020)	\$	187,221,925
	DIRECT: CONSTRUCTION COST MA	RK-UPS					
	Gene	eral Conditions	10%		1.1	\$	18,722,192.50
	Mobilization/I	Demobilization	10%		1.1	\$	18,722,192.50
	Overhead	& Profit (OHP)	8%		1.08	\$	14,977,754.00
		Insurance	1.5%		1.015	\$	2,808,328.88
		Bonding	1.0%		1.01	\$	1,872,219.25
	Escalation Multiplier	from ENR-CCI	0%		1.0000	\$	-
	Item	Subtotal Const	ruction	Cost	s (Year 2020)	\$	244,324,612
	Dire	ct: Subtota	Cons	truc	ction Costs	\$	244,325,000



Project Planning and Delivery Section

BASIS OF ESTIMATE

Project Name	King County Class A Biosolids Technology Evaluation
Project Number	151084
Date Prepared	01/24/2020
Requested by	Catherine Gowan, King County WTD
Prepared by	Trung Le, Brown and Caldwell
Estimate Classification	Class 5 AACE International
Estimate Purpose	Formulation Project
Estimate ID (Version)	01
Project Manager	Catherine Gowan
Project Control Engineer	
Cc or Distribution List	John Conway, Ashley Mihle

Note that the accuracy of the associated cost estimate is dependent upon the various underlying assumptions, inclusions, and exclusions described herein. Actual project costs may differ and can be significantly affected by factors such as changes in the external environment, the manner in which the project is executed and controlled, and other factors that may impact the estimate basis or otherwise affect the project. Estimate accuracy ranges are only assessments based upon the cost estimating methods and data employed in preparing the estimate and are not a guarantee of actual project costs.

Project Name	Project Title		
Project Number:	151084.452	Date:	01/24/2020

1.0 Purpose

The purpose of this project was to conduct a Class A biosolids technology evaluation for King County (County). This project was developed to assist the County in preparing their response to King County Council Proviso 2019-0148.P3 Version 2. The proviso calls for the identification of Class A alternatives to the current Class B biosolids application in forest and farm environments. The County is interested in diversifying the biosolids products to increase resiliency. The evaluation built upon the Solids Processing Technology Evaluation (Task 450) that was performed as part of the King County Treatment Plant Flows and Loads Study. The previous evaluation identified and screened solids treatment technologies for each of the County's three regional treatment plants. Other earlier studies conducted for the County on Class A biosolids treatment alternatives were also used as background materials for the study.

The TM documents the following subtasks:

- Class A technology screening
- Overview descriptions of the short-listed technologies, including a more detailed description of the gasification/pyrolysis technology
- Development of biosolids treatment and disposal/reuse scenarios
- Conceptual modeling of each scenario to evaluate solids production, energy usage, and greenhouse gas (GHG) emissions.
- Development of conceptual capital and operating and maintenance (O&M) cost estimates
- Evaluation of the scenarios based on triple bottom line (TBL) criteria.

Class 5 probable cost of construction estimates for the different scenarios were developed and used for the economic analysis and TBL evaluation. The expected accuracy range was +100%/-50% as typical with Class 5 estimates.

2.0 **Project Scope Definition**

The construction estimates were based on the four scenarios below. These scenarios were developed from the short-listed technologies, and each scenario provides biosolids management for all biosolids produced by King County wastewater treatment plants. They are as follows:

- Scenario 1: Base-case Existing MAD with 100 percent Class B land application to western and eastern Washington
- Scenario 2: Enhanced Class A Existing mesophilic digestion at Brightwater with Class B biosolids hauled to an off-site Class A composting facility and local sales; Cambi at South Plant with Class A land application in western and eastern Washington (40 percent/60 percent); and TAD with batch tanks at West Point and off-site soil blending with local sales
- Scenario 3: Pyrolysis Existing mesophilic digestion at all three plants with dewatered cake hauled to off-site thermal drying and pyrolysis treatment. Biochar byproduct contracted to Bioforcetech under a public-private partnership.
- Scenario 4: Optimized Class A Existing mesophilic digestion at Brightwater with Class B biosolids hauled to an off-site Class A composting facility and local sales; TAD with batch tanks at

Project Name	Project Title		
Project Number:	151084.452	Date:	01/24/2020

South Plant with Class A land application in western and eastern Washington (40 percent/60 percent); and TAD with batch tanks at West Point and off-site soil blending with local sales

The sizing for each of the scenarios was based on flows and loads that were projected to a 2050 design year. Raw influent flows and loadings for each of the three plants were provided by the County as part of flows and loads study to evaluate treatment plant capacity limitations. A plant-wide solids mass balance model calibrated during that study was used to calculate digester feed solids loading rates from the 2050 raw influent flows and loadings. **Table 1** presents a summary of the construction.

Scenarios	Facility	Construction
	West Point	2 New Meso Digester
S1	South Plant	1 New Meso Digester
	Brightwater	1 New Meso Digester
	West Point	TAD Conversion (heating upgrades, mixing, cleaning)
	Soil Blending	New Off-Site Facility (buildings, site prep, machinery, utilities, etc)
S2	South Plant	THP-MAD System (pre-dewatering, screens, steam boilers, etc)
	Brightwater	1 New Meso Digester
	Composting	New Off-Site Facility (buildings, site prep, machinery, utilities, etc)
	West Point	2 New Meso Digester
	South Plant	1 New Meso Digester
S 3	Brightwater	1 New Meso Digester
	Pyrolysis	New Off-Site Facility (buildings, site prep, thermal dryers, pyrolysis equipment, odor, utilities, etc)
	West Point	TAD Conversion (heating upgrades, mixing, cleaning)
	Soil Blending	New Off-site Facility (buildings, site prep, machinery, utilities, etc)
S4	South Plant	TAD Conversion (heating upgrades, mixing, cleaning)
	Brightwater	1 New Meso Digester
	Composting	New Off-site Facility (buildings, site prep, machinery, utilities, etc)

Table 1 – Summary of Scenario Construction

Scenario 1

New mesophilic digesters will be required at each of the wastewater treatment plants as reflected in **Table 1**. The cost for these digesters were unit prices sourced from an average of other projects in the region. This estimate was inclusive and assumed similar sizing to existing digesters, materials, digestion mixing, floating/fixed covers, and other ancillary components.

Project Name	Project Title		
Project Number:	151084.452	Date:	01/24/2020

West Point's conversion to a TAD system would require no additional digesters. However, the existing floating covers and mixing system would need to be upgraded. An additional two boilers would be installed to supply the heat required to maintain thermophilic digestion. A heat pump would be used to cool and recover the heat to preheating of the sludge. The cost estimates included minor repairs and cleaning of the digesters.

South Plant would utilize Cambi's thermal hydrolysis process. This system requires additional ancillary equipment that includes pre-dewatering, screening, blend tanks, and steam boilers. These systems along with the THP process would be housed in a new multi-floor building.

The soil blending facility was sized based on Tacoma's Tagro blended product that is comprised of 40:40:20 biosolids to sawdust to sand. The soil blending would occur in a prefabricated semi-closed building. Feedstocks and a portion of the blended product would be stored under a membrane canopy building. Other facilities include a bagging building. Maintenance and admin buildings would be shared with the adjacent composting facility. Major equipment includes batch auger mixers, trommel screen, front end loaders, hauling trucks, conveyors, a grinder, and bagging equipment.

Brightwater would require the additional construction of a fixed cover mesophilic digester.

The composting facility was modeled based on the aerated static pile system (Option 2) in the Compost Facility Basis of Estimation document (under King County Project 1132733). This system uses a perforated aeration pipe network floor for the active compost phase. The composting and curing process occurs under a roof. Feedstocks are also covered. Additional facilities include maintenance and admin buildings, and a bagging facility. Major equipment includes batch auger mixers, trommel screen, front end loaders, hauling trucks, conveyors, a grinder, and bagging equipment.

Scenario 3

Scenario 3 requires the same construction requirements as Scenario 1 but with the addition of an offsite thermal drying and pyrolysis facility. Major equipment includes thermal dryers, pyrolysis units, and odor control. The facility will be housed in an enclosed prefabricated metal facility. Construction costs were inclusive of utilities and other ancillary components.

Scenario 4

This scenario has the same construction requirements as Scenario 2 except for South Plant which would use TAD instead of THP-MAD. This would significantly reduce the construction requirement and only require the conversion of the MAD system to TAD. This includes replacing existing floating covers with fixed covers and upgrading the mixing system. An additional two boilers would be installed to supply the heat required to maintain thermophilic digestion. A heat pump would be used to cool and recover the heat to preheating of the sludge. The cost estimates included minor repairs and cleaning of the digesters.

3.0 Design Basis

The design basis of the scenarios was developed from KC Class A Biosolids Technology Evaluation Technical Memorandum. Additional information can be found in this technical memorandum.

Project Name	Project Title		
Project Number:	151084.452	Date:	01/24/2020

4.0 Planning Basis

This project is a high-level alternative analysis of feasible Class A biosolids management programs. A more thorough alternatives analysis would need to be completed at a later date to develop further scope parameters, cost and etc.

5.0 Cost Basis

The cost estimate has been prepared in accordance with AACE International as a Class 5 estimation for projects with a maturity level of 0% to 2%. The cost estimate was intended for concept screening and uses costing methodologies such as capacity factored, parametric models, judgment, or analogy. The expected high side accuracy range is +30% to +100% and the low side accuracy is -20% to -50%. For this study, it is expected that the range of accuracy is within -50% to +100% of the estimate. Table 2 represents the total project capital cost for each of the scenarios and is inclusive of all KC WTD allowances.

Table 2 – Total Project Capital Cost

Parameters and Scenarios	Low Range (AACE: -20% to - 50%)	Total Project Capital Cost	High Range (AACE: +30% to +100%)
Accuracy Range	-50%	-	+100%
Scenario 1: Base-case	\$132,000,000	\$264,000,000	\$528,00,000
Scenario 2: Enhanced Class A	\$433,000,000	\$867,000,000	\$1,734,000,000
Scenario 3: Pyrolysis	\$441,000,000	\$881,000,000	\$1,762,000,000
Scenario 4: Optimized Class A	\$231,000,000	\$462,000,000	\$924,00,000

Methods and sources used to determine construction costs are listed below:

- All construction, direct and indirect costs were estimated utilizing local unit price analysis. The unit price analyses were derived from other local projects or national projects which were adapted using ENR-CCI factors
- All costs are estimated in 2020 dollars unless stated.
- Vendor quotes were provided for thermal drying and pyrolysis equipment in scenario 3
- Costs for THP were derived from 100% design documents and estimations.

6.0 Allowances

The Allowance for Indeterminates (AFI) was applied to the construction cost and varied depending on the sourcing of the cost estimation. The AFI is an allowance that accounts for the cost of known but undefined requirements necessary for a complete and workable project. **Table 3** provides a summary of the AFI selected for each of the cost estimates.

Project Name	Project Title				
Project Number:	151084.452	Date:	01/24/2020		

Table 3 – Summary of Data Sourcing and Allowances for Indeterminates

Scenarios	Facility	Modification	Data Source	AFI	
	West Point	2 New Meso Digester			
S1	South Plant	1 New Meso Digester	Compiled Project Data (Various Years)	25%	
	Brightwater	1 New Meso Digester	routoy		
	West Point	TAD Conversion (heating upgrades, mixing, cleaning)	100% Design (2018)	20%	
	Soil Blending	New Off-site Facility (buildings, site prep, machinery, utilities, etc)	Engineer's Estimate/ Project Data	25%	
S2	South Plant	THP-MAD System (predewatering, screens, steam boilers, etC)	100% Design (2019 West Coast)	15%	
	Brightwater	1 New Meso Digester	Compiled Project Data (Various Years)	25%	
	Composting	New Off-site Facility (buildings, site prep, machinery, utilities, etc)	Scaled from King County Project (1132733) BOE Compost Facility, Engineer's Estimate/ Project Data	25%	
	West Point	2 New Meso Digester			
	South Plant	1 New Meso Digester	Compiled Project Data (Various Years)	25%	
S 3	Brightwater	1 New Meso Digester			
	Pyrolysis	New Off-site Facility (buildings, site prep, machinery, utilities, etc)	Vendor Quotes	25%	
	West Point	TAD Conversion (heating upgrades, mixing, cleaning)	100% Design (2018)	20%	
	Soil Blending	New Off-site Facility (buildings, site prep, machinery, utilities, etc)	Engineer's Estimate/ Project Data	25%	
S4	South Plant	TAD Conversion (heating upgrades, mixing, cleaning)	100% Design (2018)	20%	
	Brightwater	1 New Meso Digester	Compiled Project Data (Various Years)	25%	
	Composting	New Off-site Facility (buildings, site prep, machinery, utilities, etc)	Scaled from King County Project (1132733) BOE Compost Facility, Engineer's Estimate/ Project Data	25%	

7.0 Assumptions

General assumptions are documented below if not already explicitly stated elsewhere in the estimate basis. Some assumptions were carried over from the BOE 20% Composting Facility estimate previously completed under Project 1132733.

Project Name	Project Title		
Project Number:	151084.452	Date:	01/24/2020

- Off-site facilities (blending, composting, and pyrolysis) are assumed to be located within King County but separate from any existing King County WTD facilities. Impacts to project cost may occur based on the selection of locations.
- Assumptions related to potential South King County site preparation will require:
 - Existing Building Demolition assumed building covers ¼ of the site and is 15' tall.
 - One half of the existing site is covered by asphalt/concrete requiring removal of same.
 - o It is assumed that 1/4 of the site will be covered by vegetation/trees that will require removal.
 - Earthwork the estimate assumes that the site will require rough grading. An assumption
 of a need to cut and fill the site to obtain required grades would be an average of 2.5 feet
 in depth across the whole site.
- The WTD Prism cost model default values were used to included costs for permitting, easements, and WTD costs.
- It is assumed that the project generally aligns with WTD's Treatment PRISM cost model.
- It is assumed that all work will be performed utilizing safe work methods at all times.
- It is assumed that work will be sequenced to minimize process, service, and community interruptions.
- Any additional work discovered during project excavation would need to be either a supplemental approval or be approved as an additional project.
- It is assumed that any community impact costs are minimal. Any substantial impacts and their subsequent costs are beyond the scope of this project.
- It is assumed that this project will be engineered to meet any normal area seismic requirements.
- It is assumed that the current site selection is only conceptual, at this time and will be further analyzed under Alternative Analysis.
- Contractor project mark-ups have been included as add-ons to the construction estimates and were left as default values.
- This estimate does not include any allowances for ESJ. It is assumed that ESJ opportunities will be explored at project initiation and that any associated costs will be budgeted for at that time.

8.0 Exclusions

All potential items of cost which might be associated with the project but for which no costs have been included are listed below:

- No land acquisition/purchase costs were included.
- No hazardous waste removal costs such as asbestos, lead paint, or contaminated soils were included.

Project Name	Project Title				
Project Number:	151084.452	Date:	01/24/2020		

- Site specific concerns or difficulties unique to a specific site.
- Geotechnical requirements or special foundations.
- Additional work/costs related with neighborhood and homeowners association requirements.
- No estimated costs are included for any potential delays due to interferences.
- No estimated costs were included for sequencing of offline digesters.
- No costs are included for any additional scope beyond that as detailed in the current scope of work.
- No additional estimating allowances for WTD indirect costs have been included in the Total Project Cost estimate since a Routine degree of complexity rating was applied for Construction Management, Permitting & Licenses, Operations Support, Project Management, and Project Controls.
- No allowances for tariffs have been included.

9.0 Exceptions

Not Applicable.

10.0 Risks (Threats and Opportunities)

The magnitude of this evaluation has risks in costing. Siting of off-site facilities can potentially result in unknow costs for preparation, remediation, and permitting requirements.

Pyrolysis represents a new technology that has financial risks due to the uncertainty of operation and market acceptance.

11.0 Contingency

A contingency is a cost element intended to cover uncertainties and unforeseeable elements of cost within the defined project scope. Contingency covers inadequacies in project scope definition, estimating methods, and estimating data.

Contingency specifically excludes changes in project scope, and unforeseen major events such as earthquakes, prolonged labor strikes, etc.

A 30% Project Contingency was added to the base estimate of Total Project Costs (direct and indirect) in accordance with the King County WTD project delivery process. The total project cost at a 50% confidence level is typically used for funding and baselining of a project at this stage of engineering and project development.

12.0 Management Reserve

Management reserves are an owner's contingency and have not been applied per the default County Prism model.

Project Name	Project Title		
Project Number:	151084.452	Date:	01/24/2020

13.0 Reconciliation

Not Applicable.

14.0 Benchmarking

Not Applicable.

16.0 Attachments

Not Applicable.

Attachment D: Triple Bottom Line



TBL Evaluation

King County Class A Biosolids Technology Evaluation Brown and Caldwell 1/28/2020

Scenario 1 - Base Case Scenario 2 - Enhanced Class A Scenario 3 - Pyrolysis Scenario 4 - Optimized Class A

	Class A	Biosolids	Technolo	gy Evaluati	on			
ID	Evaluation Criteria	Weighting Factor	Possible Score	Scenario 1- Base Case	Scenario 2 - Enhanced Class A	Scenario 3 - Pyrolysis	Scenario 4 - Optimized Class A	Notes
	Social and Equity Category							
	Built & Natural Environment							
S1	Noise	2	5	5	2	3	2	S2, S3, S4 have more local noise generation due to the operation of offsite facilities. Off-site facilities assumed to be located in South Plant region (based on previous comp more severe.
S2	Odor	3	5	4	2	2	2	Compost, Soil Blending, Pyrolysis will generate some additional odor. More odor generated from soil-blending and composting. Pyrolysis has odors but a smaller footprint. Of a high ESJ opportunity and high SVI score, impacts to these communities would be more severe.
S 3	Traffic	2	5	4	2	3	2	S1 is mostly long haul trucking. S2 has more local trucking and less long haul. Limited long haul trucking in S3 but more local traffic. Off-site facilities assumed to be located score, impacts to these communities would be more severe.
S 4	Economic Development/Jobs	5	5	3	4	3	4	For Economic Development and Jobs: S2 and S4 would require the greatest amount of additional staff to operate and maintain facilities. S3 would require additional staff to Additionally, retail sales of compost and soil blended products would help to support the local economy via nurseries, landscapers, garden stores, and donations. Working C potentially hazardous environments
S 5	Food Systems	3	5	3	4	2	4	Although S1 contributes the most to agriculture, it is located in Eastern Washington and used for mostly wheat, grains, and hops. S2 and S4 products will be largely sold loca intended for more niche applications such as cannabis production and less on agriculture. Blending into a product may make it more economic for agriculture use.
	Subtotal	15		10.8	9.2	7.8	9.2	
	Environmental Category							
	Sustainability							
C1	Greenhouse Gas Emissions	10	5	5	4	1	5	S1 and S4 have the lowest GHG emissions and are less than 10% from each other. S2 is close to S1 and S4. S3 has significantly higher GHG emissions than any of the other
C2	Energy Production/Usage	5	5	5	3	2	4	Energy Production is the same across the scenarios due to no changes in the gas utilization strategy. Electricity was consumed in the order from high to low S2, S3, S4, S1
С3	Fossil Fuel Use	5	5	5	4	2	5	Fossil fuel usage was greatest in S3 with double the fossil fuel usage as S1 and S4. S2 is approximately 20% higher than S1. S1 and S4 are less than 5% of a difference. Re
C4	100% Beneficial Reuse Regulatory Compliance/Risk	5	5	3	5	2	5	S3 has the highest risk in not meeting 100% beneficial reuse due to the market uncertainty and putting 100% of product into one processing market/customer. There is no likely send to landfill. S3 also has a bit of uncertainty with WA DOE evaluating biosolids biochar on a case-by-case basis for beneficial reuse. S1 has the second lowest score reuse goals.
C5	Flexibility to Meet Future Regulations	5	5	2	4	5	3	Current research suggests that biological treatment such as MAD only degrade some contaminants of emerging concern (CEC). TAD has improvements over MAD for degrac Pyrolysis has been shown to significantly decrease a wide range of different types of CEC. Compost and soil blending can also decrease concentrations through dilution with
	Subtotal	30		25	24	13	27	
	Economic Category							
E1	Lifecycle Cost	10	5	4	2	2	3	S1 was given 4 because it still represents a high cost. S2 and S3 are almost double the cost and given a 2. S4 was given a 3 as it was 50% more of the cost. Refer to Section
E2	Total Project Capital Cost	5	5	5	1	1	3	S1 has lowest capital cost. S4 is two times the capital cost of S1. S2 and S3 is 4 times the capital cost of S1. Refer to Section 5 of the report or Appendix C
E3	Market Diversification/Risk	10	5	2	5	2	5	S2 and S4 have the most product and market diversity compared to S1 and S3. Less risk that comes with single market exposure. S3 has a potentially large market diversit risk due to unproven demand for product and single entity handling the biosolids. S1 has the least amount of market diversity but already large available market for product
	Subtotal	25		17	15	9	19	
	Technical Category							
T1	Process Reliability	10	5	5	4	2	5	S3 has the lowest process reliability given that only one pyrolysis system is in operation in the United States and few in the rest of the world. One THP-MAD facility in the Unit
Т2	Constructability/Footprint	3	5	3	4	3	5	Constructability/footprint assessed at the treatment plant only. S4 has the least plant footprint requirement and most constructible design. S4 Less footprint than S2. S1 an additional digesters for S1 and S4.
тз	Site Permitting	2	5	5	3	2	3	Off-site permitting challenging for S2, S3, and S4. S3 air permitting challenging to acquire.
Т4	Addressing Solids Handling Capacity	5	5	3	5	3	5	S1 and S3 do not address capacity increases at WP. S2 and S4 provides significant digestion capacity increase at WP and SP
Т5	Compatibility with Capital and Planning Projects	5	5	4	2	3	3	S1 has the lowest capital requirements and does not impact future nutrient programs. S2 has increased high capital and ammonia recycle. S3 has increased high capital re
Т6	Operational Complexity	5	5	5	2	3	4	Additional processes would result in greater complexity. THP-MAD in S2 and thermal drying and pyrolysis in S3 are the most complex systems. S4 has soil blending and com
	Subtotal	30		25.8	20.6	15.6	26.2]
	<u>Total</u>	100		<u>78.6</u>	<u>68.8</u>	<u>45.4</u>	<u>81.4</u>	

mposting study) which has a high ESJ opportunity and high SVI score, impacts to these communities would be . Off-site facilities assumed to be located in South Plant region (based on previous composting study) which has ated in South Plant region (based on previous composting study) which has a high ESJ opportunity and high SVI

ff to operate offsite facility but less than S2 and S4. S1 would require the least amount of additional staff. g Conditions would be the worst for S2 and S4 due to outdoor facility and odors. S3 would deal with odors and

locally for use in gardens and lawns which would likely see increase in local agriculture production. Biochar is

ther scenarios Refer to Figure 4-1 in the report or Appendix B

. Refer to Appendix B

no redundancy or flexibility through this P3. If the facility fails or BFT can't sell their product, biosolids would ore due to limited market diversity and single product. S2 and S4 are more resilient in meeting 100% beneficial

pradation of some addition CECE. Composting and THP have been shown to decrease a larger group of CEC while with clean feedstocks .

ction 5 of the report or Appendix C

ersity due to uses in non traditional biosolids applications such as industrial and commercial uses but greater uct

Jnited States but there are more than 30+ facilities in the world with THP-MAD from Cambi

and S3 requires additional digesters which would consume more plant footprint. Constructability issues for

I requirements. S4 has increased ammonia recycle (S4) but lower capital than (S2, S3)

omposting process and TAD which increases system complexity compared to S1

Social and Equity Category

The social and equity criteria category factors how each scenario can increase or decrease the quality of life of King County residents, taking into account the differing baselines for the communities around South, West Point, and Brightwater Treatment Plants.

The Center for Disease Control has developed a Social Vulnerability Index (SVI) as an indicator of how resilience communities are to external stresses on human health caused by natural or humancaused disaster, or disease pandemic. The rating is from 0 to 1, with 1 being completely vulnerable and unable to handle external stresses and 0 being very resilient. SVI can be directly correlated to the community's socioeconomic, racial, and language diversity statuses. Less affluent and more diverse communities are often closer to a value of 1. Equity opportunities exist in communities with high diversity and low socioeconomic status. SVI is a tool that King County has used to identify those opportunities for improvement. The table below summarizes the SVI values for the communities around King County's treatment plants.

	West Point	South Plant	Brightwater
Community by Plant (Overall SVI)	0.04	0.69-0.92	0.18
Service Area Average	0.33	-	0.33
County Average SVI		0.36	

Based on this information, the communities surrounding South Plant have more vulnerabilities to external stresses due to greater diversity and low socioeconomic environment. This would indicate that the impacts of projects to the community would be more severe. Therefore for this study, impacts to the community in the South Plant area was scored lower than impacts in other areas.

Built & Natural Environment (Ordinance Definition: Healthy built and natural environments for all people that include mixes of land use that support: jobs, housing, amenities and services; trees and forest canopy; clean air, water, soil and sediment)

Noise (2) – increases in noise is a generally a result of the use of heavy machinery as well as the addition of processes outside the current boundaries of the treatment plants

Traffic (2) – Greater volumes of biosolids will require additional trucking and hauling. These additional vehicles can impact local and regional traffic

Odor/Air Quality (3) – Odor, dust, fumes, and smoke can create a nuisance to surrounding community

Economic Development/Jobs (5) The addition of treatment processes will require an increase in staff to operate and maintain the new facilities, which will create local jobs for the community. Additionally, consideration was given scenarios that were able to increase economic opportunities for farmers, nursery owners, contractors, or other businesses, which in turn could stimulate the local economy, and return benefits to the community through increased capital.

Working conditions for King County public works staff can be impacted based on indoor and outdoor facilities, system complexity, and hazardous and nuisance working conditions.

Food Systems (3)

 Includes information about increased or decreased opportunities for local (<100 miles) food production

Environmental Category

Sustainability

Greenhouse Gas Emissions (10) - King County has developed a Strategic Climate Action Plan with a goal to achieve carbon-neutral operations by 2025. Management of a biosolids program with a focus on energy recovery, low energy solutions, increase in carbon sinks, and the reduction in sources of greenhouse gas (GHG) emissions will aid King County in reaching these goals. A GHG inventory was used to track emissions from the scenarios and include fugitive emissions, carbon sequestration, fertilizer offsets, energy use, and material consumption.

Net Energy Use/Production (5) - The generation and use of renewable energy is one of the major goals of King County's Energy Plan. With a target to reduce normalized energy consumption by at least 10 percent by 2025 and energy neutrality in operations and purchasing by the same deadline, renewable energy production and the reduction in external power consumption is vital to meeting those targets.

Fossil Fuel Use (5) - The non-renewable and limited supply of fossil fuels in the world make its use unsustainable. To conserve energy for future generations, fossil fuel usage will be considered for each scenario. Increased fossil fuel usage will generate a lower rating for the scenario.

100% Beneficial Reuse Regulatory Compliance and Risk (5)

This criterion was intended to evaluate the risks of failing to meet 100% Beneficial reuse regulatory compliance from an environmental standpoint. This criterion is based on the assumption that Class B biosolids would have limited options other than landfill. Landfilling of biosolids has a significant environmental impact as result of GHG emissions several times larger than other sources of GHG emissions.

Flexibility to Meet Future Regulations (5)

Increasing concern over emerging contaminants has become a hot topic for biosolids management programs. As research and studies continue develop the understanding of the health and environmental risk of these compounds, future regulations may be a possible outcome. This criterion considers whether the selected scenarios have any potential to reduce these compounds. General research has suggested that biological processes are less capable of removal of CEC when compared to thermal and chemical based processes.

Economic Category

Lifecycle Cost (10)

Net present worth (NPW) lifecycle costs for capital cost and operations and maintenance (O&M) for each scenario was considered. This cost reflects a 20-year useful service life of each scenario and reflect the potential impacts of O&M to a project. Estimated O&M costs included annual salaries for King County staff to operate and maintain the proposed facilities, general equipment maintenance, energy and material costs, and other related costs.

Capital Cost (5)

Capital costs are the costs associated with the procurement of equipment and construction for each scenario. These costs reflect the upfront cost of the project. Capital cost and O&M can have different impacts on utilities based on available funds and funding sources.

Market Diversification and Risk (10)

Market diversification is indicative of a more sustainable biosolids management program as there is flexibility to shift to different markets when circumstances can reduce demand in others. Exposure to only a single market can put a program at risk. This situation has been seen around the country as a result of legal action, climate change, or negative media. When demand changes unexpectedly for a single market program, the only viable option tends to be landfilling which has financial implications. For this criterion, favorable ratings are given to scenarios that can generate a diversified biosolids program. This criterion considers the financial risk of low market diversification. Class A biosolids generally have more alternative avenues for end-users compared to Class B biosolids and will receive higher scores.

Technical Category

Process Reliability (10)

Process reliability refers to the resiliency of a technology or process. Proven and mature technologies have long track records, wide adoption, and comprehensive experience. These generally reflect a decrease in risk in the adaption and long-term use of a technology or process.

Constructability/Footprint (3)

The limitation of space and high cost of land can make it challenging to implement projects of large scale. This criterion is intended to take into consideration the challenges of construction and the required amount of footprint of each scenario.

Site Permitting (2)

Site permitting can be challenging due to a variety of different regulations including, stormwater, air, and site restrictions. This criterion is intended to consider the challenge of permitting on-site and off-site locations.

Solids Handling Capacity Impact (5)

King County has seen a drastic increase in population over the last two decades and is projected to continue to grow. As population grows, available capacity will decrease resulting in required improvements in solids handling capacity. Intensification processes can increase capacity without significant construction requirements. Scenarios will be rated based on their abilities to increase capacity.

Compatibility with Capital and Planning Projects (5)

This criterion is intended to evaluate the compatibility of the scenarios with future capital and planning projects. This can include impacting future processes/projects such as nitrogen removal.

Operational Complexity (5)

The addition of processes and technologies can increase the complexity of the plant making it more challenging to operate.