Wasteshed Analysis TM

CAAP – Methane Recovery Feasibility Study

Completed by HDR Engineering, Inc. on behalf of the City of Iowa City, to support the Climate Action and Adaptation Plan (CAAP) and the associated Action Items 3.7 and 3.8.

Iowa City, Iowa

February 27, 2020

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Technical Memorandum

Date:	Thursday, February 27, 2020
Project:	City of Iowa City – Climate Action and Adaptation Plan Methane Feasibility Study
To:	Joe Welter, IA City; Tim Wilkey, IA City; Jennifer Jordan, IA City
From:	Morgan Mays, HDR; Eric Evans, HDR; Eric Sonsthagen, HDR
Subject:	Wasteshed Analysis TM

This memorandum presents the next step in the methane feasibility study as part of the City of Iowa City's (City's) Climate Action and Adaptation Plan (CAAP) Methane Feasibility Study. As shown in Figure 1, the overall methane feasibility study is a holistic evaluation intended to capture the interconnected facilities. This TM focuses on the inputs side of the overall feasibility study including municipal solids waste (MSW), compostables, municipal wastewater solids (residues), and industrial (manufacturing) wastes. The objective of this TM is to identify and quantify waste sources that makeup the inputs. As a result, it focuses on wasteshed organics that can be utilized at the wastewater treatment plant (WWTP) and the landfill.

The wasteshed evaluation evaluates solids currently digested at the WWTP and organics disposed in the current landfill. The wasteshed also evaluates external organic wastes, not currently received by these two facilities that could be directed to the facilities to enhance biogas production potential. Source separated organics, or hauled wastes, may be brought in from industries and commercial facilities, or diverted from composting. The outside wastes may increase biogas production at the WWTP, in the landfill, or at both facilities.

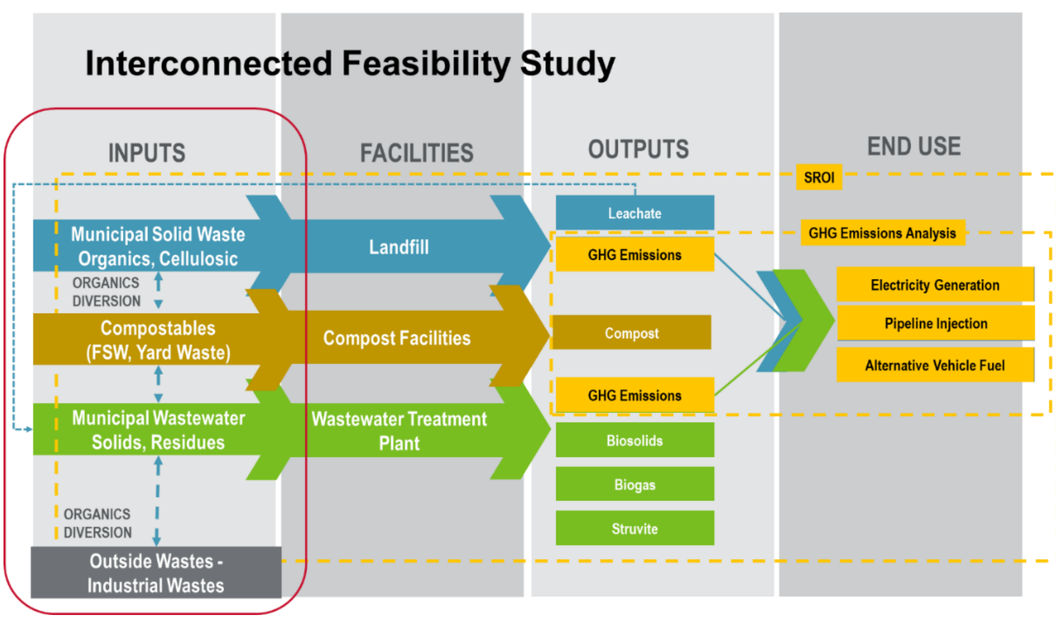

Figure 1. Interconnected Methane Feasibility Study, Wasteshed or Inputs Analysis

Wasteshed Analysis

This wasteshed analysis evaluates waste generation potential at the WWTP and landfill from outside sources (such as composting). Wastes generated can be utilized in either the digestion system at the WWTP or directed to the landfill to generate biogas. The economic and greenhouse gas (GHG) impacts of waste diversion to the WWTP or landfill differ. This analysis focuses on 1) identifying waste streams that makeup the wasteshed, and 2) conducting a preliminary evaluation of the implications of directing waste streams to either the WWTP or the landfill.

An overall summary of the wasteshed is presented in Table 1. The WWTP wasteshed consists of WWTP solids (currently treated at WWTP), consumer product waste (generated by Proctor and Gamble), and leachate waste (generated by the landfill. Landfill wastes include yard waste, food service waste, paper waste, and other wastes. The compost facility receives yard waste and food service waste primarily. A range of outside waste sources including fats, oils and grease (FOG) waste, biodiesel waste, and food manufacturing waste.

As part of the future steps in this evaluation, data from Table 1 will be revisited to determine if the wastes are directed to the best final destination based on minimizing GHG generation. For example, should compost and outside waste streams be considered for the WWTP or the landfill. Further, should current WWTP or landfill wastes be redirected; e.g. landfilled instead of digested at the WWTP or vice versa.

Table 1. Summary of Wasteshed for the WWTP, the Landfill, and wastes currently directed to composting

Waste Stream or Source	WWTP[1] (ton/yr)	Landfill[2] (ton/yr)	Composting (ton/yr)	Outside Wastes[3] (ton/yr)
WWTP Solids (Residues)	2,535-2,580	300	N/A	2,500-3,000
Yard Waste[4]	N/A	2,492	8,263	0
Food Service Waste	0	32,534	728	300-400
FOG Waste	0	N/A	N/A	2,000-2,500
Biodiesel Waste	0	N/A	N/A	24,000-26,000
Ethanol Waste	0	N/A	N/A	
Food (and Beverage) Waste	0	N/A	N/A	3,000-3,500
Paper Mfr / Paper Waste[5]	0	9,576	N/A	0
Consumer Product Waste[6]	850-900	N/A	N/A	0
Leachate Waste[6]	15-20	N/A	N/A	0
Other Landfilled Wastes	---	86,282	---	---
TOTAL	3,400-3,500	131,184	8,991	31,800-35,400

[1]Ranges are estimated based on the projected total wastes in the wasteshed and a range of capture efficiencies that would be typical for this waste source. WWTP Solids are currently process at the WWTP, but all other waste streams represent new waste potential for the WWTP.

[2] Landfill disposal rates assume the most recent five year average total disposal tonnage and mean composition determined in the 2017 Iowa Statewide Waste Characterization Study for the Iowa City Landfill Sort Data; as presented in Section, "Landfill and Compost Wastes" of this TM.

[3] Outside wastes - not currently received by the WWTP, the landfill, or the compost facility (possibly from outside of Iowa City).
[4] Includes leaves.
[5] Paper waste quantity reflects only the compostable fraction of paper waste.
[6] Received on liquid treatment side; i.e. not directly fed to digestion process. Mass represents the solids potential from the organic content of the liquid stream. This is a current part of the WWTP solids mass.

Iowa City WWTP Solids

Solids residuals are generated by both primary and secondary treatment process at the WWTP currently. These solids are captured or generated onsite due to the influent pollutant load. Table 2 shows that the average raw solids generated (primary plus secondary solids, based on the digester feed rate, is 19,500 lb/d. Future solids production rates are expected to increase as Iowa City grows as shown in Table 2. If Iowa City expands differently (more rapidly or slowly) than in recent history, adjustments to this projection should be made. A more detailed analysis of solids generation at the WWTP is included in the existing facilities evaluation TM.

Table 2. Raw Solids Generation (lb/d)

	2017-2019 Raw Solids to Digesters	2030 Raw Solids to Digesters	2040 Raw Solids to Digesters
Average	19,500	21,200	22,900
50th Perc.	19,000	20,700	22,300
91.7th Perc.	24,800	26,300	28,400
99.7th Perc.	36,800	49,600	53,600

The yield factor is assumed to represent the typical yield for the WWTP. This solids generation rate corresponds to an average overall (primary and secondary) solids yield of 0.9 lb-TSS/lb-$cBOD_5$. As flows and loads increase, it is assumed this yield factor is representative of future potential solids capture and generation by the system. It may be possible to increase the yield, if desired, to capture more solids and increase biogas production. Increased yield may be achieved by enhancing primary clarifier capture using chemical coagulants.

Table 3. Overall Plant Yield

	Plant Solids Yield (lb-TSS/lb-$cBOD_5$)
Average	0.90
Stand. Dev.	0.24
50th Perc.	0.88

Landfill and Compost Wastes

The Iowa City Sanitary Landfill has disposed of approximately 131,180 tons of waste annually on average from 2015 through 2019 based on the historical waste disposal rates. Over this same time period the population of Iowa City has grown an average of 1.2 percent per year and the per capita waste disposal has averaged approximately 1.8 tons per person per year. The amount of material landfilled in 2019 decreased by approximately 9 percent from 2018 and was approximately 2.7 percent lower than the recent 5-year average disposal rate. In discussions with the City landfill staff, the recent trend of reduced waste disposed of at the landfill is expected to continue in the near term future.

Table 4. Historical Landfill Quantities

FY Year	Total Disposal (tons)	Yard Waste @ 1.9% (tons)	Food Waste @ 24.8% (tons)	Paper Waste @ 7.3% (tons)
2015	123,692	2,350	30,676	9,030
2016	126,875	2,411	31,465	9,262
2017	137,107	2,605	34,003	10,009
2018	140,657	2,672	34,883	10,268
2019	127,587	2,424	31,642	9,314
5-year Average	**131,184**	**2,492**	**32,534**	**9,576**

During 2015 through 2019, the amount of material processed by composting has averaged approximately 8,990 tons per year. The amount of material processed by the composting facility has been relatively steady over this timeframe as it is operating near capacity based on its existing footprint constraints. Future quantities of material composted are expected to be near the recent historical average as no changes to the composting operation method or area are known at this time.

Table 5. Historical Compost Quantities

FY Year	Total Disposal (tons)	Leaves (tons)	Yard Waste (tons)	Food Waste (tons)
2015	7,454	197	6,817	440
2016	8,850	1,588	6,713	549
2017	10,018	1,068	8,197	753
2018	8,109	488	6,590	1,032
2019	10,524	1,075	8,583	866
5-year Average	**8,991**	**883**	**7,380**	**728**

Outside Wastes

Additional outside organic waste streams not currently directed to the WWTP, the landfill, or the compost facilities, such as from industries and commercial facilities, could be captured and used to increase biogas (methane) production rates. This section describes several potential sources of external or hauled wastes to be considered as part of the wasteshed analysis including food service wastes; fats, oils, and grease (FOG); biodiesel waste; ethanol waste; and food manufacturing waste[1]. Potential waste sources have been evaluated based on the Iowa biogas assessment model (IBAM).

Food Service Wastes

Food service wastes include organic, solids wastes from restaurants and schools. These wastes may be directed to either the WWTP or the landfill; however, enhanced receiving facilities are needed to utilize and process the material at the WWTP. Incorporation into WWTP anaerobic digesters would be further limited by the capacity available within the digestion process.

For Iowa City, the highest potential for food service waste would be from the University of Iowa including the hospitals. Currently, the University of Iowa has invested heavily into a composting program and currently composts over 800,000 lb/yr (400 ton/yr) of food service wastes. The biogas potential of food service waste at the WWTP is typically between 9 and 14 ft^3/lb-volatile solid removed (VSR).

Fats, Oils, and Grease (FOG) Waste

Fats, oils and grease (FOG) are the waste captured in grease traps from restaurants and industrial pretreatment processes (e.g. dissolved air flotation [DAF] separation). Food service establishments (FSE) are typically the largest FOG contributors, but some industries (e.g. renderers) generate FOG as well. It is estimated that sewer discharges of grease from food preparation are on the order of 50 to 100 lb/person/year with an additional 15 lb/person/year of waste grease generated from other sources.

Direct addition of FOG into the anaerobic digestion process results in increased biogas production at the WWTP. Similar to food service wastes, enhanced receiving facilities are recommended for use at the WWTP. Depending on the source, a single FSE generates between 800 and 17,000 lb/year of FOG. FOG quality varies, but in general, FOG digestion results in biogas production yields at the WWTP between 18 and 25 ft^3/lb-VSR. Biogas production by FOG addition is connected to a FOG program by the city and maybe be considered as part of an overall program. This waste stream is generally not applicable for landfilling due to the high moisture content.

Agricultural Residues

Agricultural or ag residues are not being considered as a waste or feedstock for generating biogas by Iowa City at this time. While there is substantial carbon available from agricultural residues, the WWTP digestion system is not configured to support digestion of ag residues, which could compromise the treatment process. This waste stream could be landfilled and decompose to generate landfill gas, however, existing gate fees for disposal may not support acceptance on a large scale. Separate consideration could be given to a future program and partnership with the power plant to collect, dry, and utilize these ag residues as a fuel source.

[1] Feeding of hauled waste into an anaerobic digestion system is best achieved with a dedicated receiving system designed with rock removal, screenings removal, heating, and storage for controlled addition of digestible materials.

Animal Feed Operations

Wastes from animal feed operations are not being considered as a waste or feedstock for generating biogas by Iowa City at this time. As with ag residues, the WWTP digestion system is not configured to support digestion of wastes from animal feed operations, which could compromise the treatment process. This waste stream is generally not applicable for landfilling due to the high moisture content.

Biodiesel Facilities

Biodiesel facilities convert agricultural products (soy, algae, etc.) and residues into diesel fuel. Waste from biodiesel facilities include waste glycerin (containing a high $cBOD_5$ content) and wastewater (containing high concentrations of highly biodegradable methanol). Both of these streams offer a high biogas potential due to the high organic carbon content. Biodiesel wastes generate between 5 and 10 ft^3/lb-VSR. Despite the potential biogas from biodiesel wastes, biodiesel production within a 25 mile radius of Iowa City is limited. Iowa biogas assessment model shows a biodiesel plant near Washington (Iowa Renewable Energy) and another plant near Crawfordsville (W2 Fuel). The Washington plant generates approximately 100,000 to 110,000 lb/d of waste potential, and the biogas plant near Crawfordsville generates between 34,000 and 35,000 lb/d of waste. These waste streams are typically liquid in nature but highly concentrated and could be hauled to the WWTP. This waste stream is generally not applicable for landfilling due to the high moisture content.

Municipal WWTP Solids

In addition to digesting solids generated at Iowa City's WWTP, solids from other nearby WWTPs could be hauled into either the Iowa City WWTP or landfill and converted to biogas. Regional treatment of WWTP solids is often evaluated as an option to gain cost efficiency. Nearby facilities that generate WWTP solids include Coralville, West Liberty, Muscatine, and Cedar Rapids. The total estimate WWTP solids is between 13,000 and 16,000 lb/d (2,500 and 3,000 ton/yr) excluding Cedar Rapids[2]. In general, solids from wastewater plants generate between 12 and 18 ft^3/lb-VSR in a WWTP anaerobic digestion process. Hauling of solids from outside WWTPs results in GHG emission and costs due to transport depending on hauling distance and the water content of the solids. Additional drying of solids may be required prior to landfilling to reduce the moisture content prior to disposal within the landfill.

Ethanol Facilities

Ethanol or bio-ethanol facilities convert agricultural products (wheat, corn, etc.) and residues (cellulosic) into ethanol for use as fuel. Ethanol production results in a wastewater stream with a high organic content (as much as 100 mg-chemical oxygen demand [COD]/L) that can yield biogas on the order of 18 ft^3/lb-VSR. Despite the potential biogas from ethanol wastes, ethanol production within a 25 mile radius of Iowa City is limited. Iowa biogas assessment model shows an ethanol plant in Cedar Rapids (ADM) and Blairstown (Fiberight LLC). The waste potential of the Cedar Rapids Plant provided by the model and may be limited since the Cedar Rapids

[2] Cedar Rapids owns and operates a large WWTP with its own solids treatment process managing 100 dry ton per day (DTPD) of solids residues.

facility is a dry corn milling plant (high utilization efficiency). The waste potential of the Blairstown Plant is 73,000-74,000 lb/d, but the plant is indicated to be idle currently.

Food (and Beverage) Manufacturing Facilities

Food (and beverage) manufacturing facilities vary from grain processing and cereal production to corn syrup and soda bottling. Most of these manufacturing facilities produce waste streams with a high organic content, but due to the wide range of facilities, the characteristics of the waste stream vary considerably as well. Some waste streams are high in suspended solids while others are very soluble. Some have a neutral pH while others are acid or alkaline. Waste streams from food facilities act as good substrates for biogas generation generally, but it is important to verify the impacts when fed to a WWTP digestion system; particularly when the suspended solids content is high or pH is extreme; careful blending of food wastes with onsite solids and other wastes can be used to maintain healthy digestion. Conversely, incorporation of food wastes into a landfill maybe appropriate when the food wastes are high in solids but less practical when highly soluble. The estimated waste production from food manufacturers within 25-30 miles of Iowa City is about 18,400-19,190 lb/d total (as listed below). Practical capture and conversion of the organics is estimated to be less than 50% of the total, however.

Food Manufacturers List

- Hubbard Feeds Inc. (Iowa City, IA) – 130-140 lb/d
- Heyens Ice Cream (Iowa City, IA) – 30-40 lb/d
- Brick Arch Winery (Iowa City, IA) – 5-10 lb/d
- Backpocket Brewing (Coralville, IA) – 90-100 lb/d
- Taste The World Inc. (Coralville, IA) – 20-30 lb/d
- Cole’s Quality Foods, Inc. (North Liberty, IA) – 180-200 lb/d
- West Liberty Foods (Processed Meats, West Liberty, IA) – 4,500-4,600 lb/d
- West Liberty Locker & Processing (West Liberty, IA) – 20 – 30 lb/d
- Tortilleria El Norte (West Liberty, IA) – 5-10 lb/d
- Kalona Feed (Kalona, IA) – 10 – 20 lb/d
- Dekalb Feed (Kalona, IA) – 90-100 lb/d
- Farmer’s All Natural Creamery (Wellman, IA) – 290-300 lb/d
- ADM Corn Processing (Cedar Rapids, IA) – 1,300-1,400 lb/d
- Canadian Harvest (Cedar Rapids, IA) – 130 -140 lb/d
- Cargill (Cedar Rapids, IA) – 1,000-1,100 lb/d
- Diamond V (Cedar Rapids, IA) – 330-340 lb/d
- General Mills (Cedar Rapids, IA) – 3,100-3,200 lb/d
- Halal Food Processors (Cedar Rapids, IA) – 60-70 lb/d
- Ingredion (Cedar Rapids, IA) – 1,000 – 1,100 lb/d
- Kraft Heinz (Cedar Rapids, IA) – 900 – 910 lb/d
- Midamar (Cedar Rapids, IA) – 90-100 lb/d
- Quaker Oats (Cedar Rapids, IA) – 4,000-4,100 lb/d
- Specialty Blending (Cedar Rapids, IA) – 290-300 lb/d
- Third Base Sports & Brewery (Cedar Rapids, IA) – 130-140 lb/d

- TreeHouse Private Brands (Cedar Rapids, IA) – 670-680 lb/d
- Roehrkasse Meat Co (Williamsburg, IA) – 20 – 30 lb/d

Paper Manufacturing Facilities

Paper manufacturing waste streams tend to be high in soluble organic wastes with a medium to high biogas potential. In addition, paper production generates a consistent wastewater volume and load typically, which results in process stability. Challenges with paper waste result from the chemicals used in the process, which range from bleach to sulfuric acid. These chemicals can inhibit the process or generate a high sulfide content. International Paper (Cedar Rapids) is the closest paper manufacturer, but due to the high wastewater volume, it may not be practical as a hauled in waste.

Consumer Products

Iowa City is home to one of Proctor and Gamble's production plants. Proctor and Gamble is a consumer products manufacturer. Their Iowa City plant produces body care products (shampoo, soap, toothbrush) historically. Proctor and Gamble's waste stream is a high volume waste stream discharged to the WWTP's liquid treatment process currently. Based on the waste characteristics, Proctor and Gamble's waste stream would be challenging to divert to the anaerobic digesters directly. Additionally, Proctor and Gamble's discharge contains siloxanes, which become a component of the biogas when digested and require more intensive biogas treatment.