Evaluation of Solids and Liquids from Anaerobic Digesters for Use as Bedding and Fertilizer
Final Report to
New York State Department of Environmental Conservation

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Summary

Solids and liquids from digestion of manure at 17 farms were analyzed for bacterial concentration, physical properties and/or metal concentrations. Four of these farms digested manure only and the rest accepted some type of food or food processing waste as co-digestion material. As expected, bacterial concentrations were variable and no clear trends were discovered for higher populations in solids that were digested with food and food processing waste versus those that came from manure only. In addition, no single type of waste yielded higher bacterial concentration than any other. Season played a much larger part in bacterial concentration than did co-digestion. Physical properties (% moisture and % of fine particles) of the solids were not significantly different whether digested with a co-digestion material or not. Organic matter, which may lead to increased bacterial growth in the bedding, but could be helpful for conditioning of the soil, was significantly lower in solids that were digested with manure only versus co-digestion. There were differences in the chemical properties of the solids that were co-digested versus those that were not. However, co-digestion should not affect the fertilizer value of the solids in normal farm operations as the difference favors them as fertilizer. The only one that may be of concern is increased phosphorus in runoff. Bacterial concentration in liquid digestate was similar to that of solids. Rather than co-digestion, differences in bacterial concentration were based on season, with summer having the highest bacterial load. Concentration of metals in all liquid digestate was well-below regulatory limits set for sewage sludge. Liquid digestate from co-digestion with food and food processing waste had higher concentrations of copper and zinc than liquid from digestion of manure only, but were still 5 and 10 times lower, respectively, than the New York State Department of Environmental Conservation sludge and sludge product maximum (NYSDEC 360 Rules). There was no difference in fertilizer value (N, P, K) of liquid digestate from digestion with or without co-digestion materials. The concentration of boron, a micronutrient, was significantly lower in digestate from co-digestion of all wastes studied versus manure alone and the concentration of Zn was significantly higher from co-digestion with grocery store waste than any other liquid digestate. However, neither of these would result in deficiency or toxicity. Many of the other micronutrients found in the liquid digestate, regardless of co-digestion, were above limits set by EPA for use as irrigation water. The objective of this study was to see if the addition of food and food processing wastes to agricultural digesters has an adverse or positive effect on the end products. Taking into account all of the above information, it appears that co-digestion does not change either the solid or liquid digestate and thus can be used as animal bedding and for fertilization/irrigation of farm fields.

Introduction

One avenue for disposal of acid whey and other food and food processing waste is to feed it into anaerobic digesters on dairy farms. This may generate more gas and provide tipping fees for farmers. The slurry emanating from a digester can be separated into solids and liquid. On many farms with anaerobic digesters, the solids are used for animal bedding. The cost for animal bedding on many farms can be significant and using digested solids can result in significant cost savings. The farm also needs to keep comfort and risk of injury to their animals in mind. Bedding needs to be clean and dry enough not to stick to the feet, legs and udder. In addition, some of the literature has indicated that the concentration of bacterial populations, especially those attributed to causing mastitis, may have an effect on the health of the cow and the quality of the milk. However, previous work has shown that manure solids from digesters can be used successfully as bedding without adversely affecting cow health or milk quality. The addition of food and food processing wastes may alter the characteristics of the solids. Not all of the solids will necessarily be used as bedding. Some will be spread on farm fields as a fertilizer/soil conditioner. The liquid portion of anaerobic digestion is also used as fertilizer and for irrigation.

This project compared the concentration of nutrients and pathogens, as well as the physical characteristics of digested solids as bedding, coming from digesters that accept additional wastes and those that digest manure only. In addition, there were two farms that had solids that were not digested. This project also looked at the characteristics of both solids and liquids in terms of their nutrients to determine how the soil and crops will respond. Comparison was made between digesters that accept additional waste and those that digest manure only as well as the solids that did not get digested.

Design

Sampling was done at 11 farms in New York State and at 6 farms in Vermont. Table 1 lists these farms along with what co-digestion materials they accepted, if any, as well as the type of digester and separator they use. Four farms, three in NY and one in VT, digested manure only. Three farms in VT accepted ice cream waste either alone, or with whey/milk waste or grease trap waste. One NY farm accepted fats, oils and greases, while a VT farm accepted glycerin. Four accepted whey permeate by itself, although one of those farms had manure only in the digester in the first sampling month. Two farms accepted whey permeate along with waste milk but one of those farms separated their manure prior to digestion, so the solids were undigested and not exposed to the co-digestion material. One farm accepted whey permeate along with vegetable production waste. The last farm accepted grocery store waste, but did not separate solids, so they only provided liquid samples. .

Table 1: Study Farms

ID	State	Digester	Separator	Co-Digestion	Comments	# solid samples	# liquid samples
B	NY	Plug flow	Screw press	Manure only		15	5
KSR	VT	Plug flow	Screw press	Manure only		12	4
SS	NY	Modified plug flow	Screw press	Manure only		12	4
TB	NY	Plug flow	Screw press	Manure only		15	5
GF	VT	Plug flow	Screw press	Ice cream and whey/milk waste	No ice cream in December, only whey and milk waste	12	4
PV	VT	Plug flow	Roller press	Ice cream and grease trap waste		9	3
RV	VT	Complete mix	Screw press	Ice cream waste		12	3
SH	NY	Complete mix	Screw press	Fats, oils and greases (FOG)		12	4
NB	VT	Plug flow	Screw press	Glycerin		12	4

GM	VT	Plug flow	Screw press	Whey permeate		12	4
L LS	NY	Plug flow	Screw press	Whey permeate	Undigested solids	15 15	5
R	NY	Complete mix	Screw press	Whey permeate		15	5
SV	NY	Plug flow	Screw press	Whey permeate	Manure only for first sample, then whey permeate for the next four	3 12	1 3
P	NY	Complete mix	Screw press	Whey permeate, waste milk	Manure separated BEFORE digestion. Solids are NOT digested	15	5
Z	NY	Complete mix	Screw press	Whey permeate, waste milk		9	3
LH	NY	Complete mix	Screw press	Whey, vegetable production waste		15	4
NH	NY	Complete mix		Grocery store waste	No separator – liquid samples only		5

Bacterial Concentration in the Solids

Many farmers submit bedding samples for analysis of bacterial concentration in order to determine if that may be a cause of mastitis, a costly disease for dairy farmers. Mastitis is broken down into contagious mastitis (caused by bacteria that are found in the mammary gland and spread from cow to cow largely through the milking process), and environmental mastitis (caused by bacteria that live in the environment and spread through exposure from the environment). Control of contagious mastitis is sought through milking hygiene, the use of teat dips, treatment of infected animals in lactation, culling of animals with chronic infections, and dry cow antibiotic therapy. Control of environmental mastitis is sought through stall and animal hygiene, milking procedures and improvement of host resistance.

The following bacteria are those commonly considered mastitis pathogens:

- Contagious pathogens:
    1. *Staphylococcus aureus*
    2. *Streptococcus agalactiae* and *Streptococcus dysgalactiae*, to a lesser extent also *Streptococcus uberis*.
    3. Mycoplasmas
- Environmental pathogens:
    1. *Streptococcus* species (other than the above)
    2. *Staphylococcus* species (other than above)
    3. Coliform bacteria
        - *Escherichia coli*
        - *Klebsiella* species
        - Other coliforms
    4. Gram negative bacteria

5. Gram positive bacteria
6. *Corynebacterium* species
7. *t. pyogenes*
8. *Pseudomonas* species
9. *Proteus*
10. *Prototheca*

Other organisms such as yeasts, mold and fungi may play a part.

The concentration of bacteria found in bedding materials can be reported on a wet weight ("as is"), dry weight or volume basis. Reporting on a wet weight basis is significant only for liquid samples, as for solids, it will be highly dependent on the moisture content of the material. When comparing bacterial counts within the same type of bedding material, it makes sense to do it on a dry weight basis. This is how comparison of bacterial concentration in solids was conducted between the different co-digestion regimes.

Previous research completed by Cornell Waste Management Institute (CWMI)[1] on using manure solids as bedding showed that bacterial concentrations in separated solids are highly variable. If the concentration of one type of bacteria is high in one bedding sample that does not mean that the concentration of the other bacteria measured will be high, nor does it mean that concentration of that same bacteria will be consistently high in additional samples of that same bedding. In addition, research on the effect of bacterial concentrations in bedding having an effect on animal health is variable. That is, some studies indicate there is a direct correlation, while others indicate there is not. However, bedding sample analysis for bacterial concentration is a common test that producers use to assess stall hygiene in an effort to control environmental mastitis.

The question tasked to this study was, does the addition of food and food processing waste in the digester change the bacterial composition of the separated solids in comparison to solids that were not digested with food and food processing waste (i.e. manure only). All data points for bacterial concentration in separated solids can be found in Appendix A, Table A-1. Of the environmental pathogens listed above, no *T. pyogenes*, *prototheca*, mold or yeast was found in any of the samples and only one sample (taken in October 2015 from a "manure only" farm) contained fungus. The mean, standard deviation, minimum, median and maximum bacterial concentration, measured in $\log_{10}$ colony forming units per gram of dry weight ($\log_{10}$cfu/g dm) for the rest of the bacteria in the list are shown in Table 2. The mean concentration of streptococcus species, staphylococcus species and gram negative bacteria was significantly higher in solids digested with food and food processing wastes versus those digested with manure only while concentrations of *e. coli*, corynebacter and pseudomonas were significantly higher in solids that were digested with manure only. There was no significant difference in bacterial concentrations of the remaining bacteria: *Klebsiella,* other coliforms or gram positive bacteria. Of these, the bacteria that may be the most important in terms of transmitting mastitis is *e. coli*, which was significantly lower in solids that were digested with food and food processing waste. However, since r-square values ranged between 0.02 and 0.10, the amount of variation in bacterial concentration that can be attributed to co-digestion is only between 2 and 10%, so other factors are more important than whether or not food and food processing waste is being digested with the manure.

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[1] Harrison, E., J. Bonhotal and M. Schwarz, 2008. Using Manure Solids as Bedding, Final Report. Available at http://hdl.handle.net/1813/44571

Table 2: Mean, standard deviation, minimum, median and maximum bacterial concentrations ($\log_{10}$cfu/gdm) of separated solids after digestion with food and food processing wastes (n=135) versus digestion of manure only (n=57)

Bacteria	Co-digestion	Significance r-square	Mean	Std Dev	Minimum	Median	Maximum
Streptococcus spp	Yes No	p=0.0248 r^2=0.03	9.3^a 8.8^b	0.9 2.4	1.6 1.6	9.4 9.4	10.9 10.6
Staphylococcus spp	Yes No	P=0.0041 r^2=0.04	9.0^a 8.4^b	0.8 2.2	6.5 1.6	9.1 9.1	10.7 10.1
e. coli	Yes No	P=0.0002 r^2=0.09	2.0^b 3.2^a	1.5 2.5	1.3 1.3	1.5 1.5	8.3 9.1
Klebsiella	Yes No	NS	4.7 4.5	2.0 2.9	1.4 1.4	5.3 5.5	7.8 7.5
Other coliforms	Yes No	NS	1.7 2.0	1.1 1.7	1.3 1.3	1.5 1.6	7.9 8.6
Gram negative bacteria	Yes No	P<.0001 r^2=0.10	8.4^a 7.4^b	0.9 1.9	1.5 1.4	8.4 8.0	10.4 9.2
Gram positive bacteria	Yes No	NS	6.8 6.5	3.5 3.3	1.4 1.3	8.9 8.3	10.4 9.7
Corynebacter	Yes No	P=0.0323 r^2=0.02	3.1^b 4.2^a	3.0 3.5	1.3 1.3	1.5 1.6	9.7 9.4
Pseudomonas	Yes No	P=0.0121 r^2=0.03	2.8^b 3.7^a	2.3 2.7	1.4 1.3	1.5 1.6	8.3 9.3

As shown in Table 1, farms accepting food and food processing waste accept different types and they may vary monthly on each farm. Statistical analysis of bacterial concentrations by the specific co-digestion material accepted (including manure only) showed no significant difference for streptococcus species, staphylococcus species, *klebsiella*, other coliforms, gram positive bacteria, corynebacter or pseudomonas species. There was a significant difference in the concentration of *E. coli* and gram negative bacteria (Figures 1 and 2). For each of the general categories except none (manure only) and whey, there was only one or two farms that accepted the specific food or food processing waste listed, so any difference in bacterial concentration could also be attributed to the farm or its cows, and not necessarily due to what was being accepted in their digesters. Bacterial concentration of *E. coli* in separated solids (Figure 1), was significantly higher where solids were digested with manure only (3.2 $\log_{10}$ cfu/g dm) than those that were digested with whey (1.9 $\log_{10}$ cfu/g dm) or fats, oils and grease (FOG) (2.0 $\log_{10}$ cfu/g). Solids that were digested with ice cream (2.4 $\log_{10}$ cfu/g dm) had *E. coli* concentration that was not significantly different from any of the other co-digestion material. Gram negative bacterial concentration in separated solids that were digested with FOG and with whey (both 8.4 $\log_{10}$ cfu/g dm) were significantly higher than in solids that were digested with manure only (7.4 $\log_{10}$ cfu/g dm, Figure 2). Again, there was no significant difference between those digested with ice cream and all others.

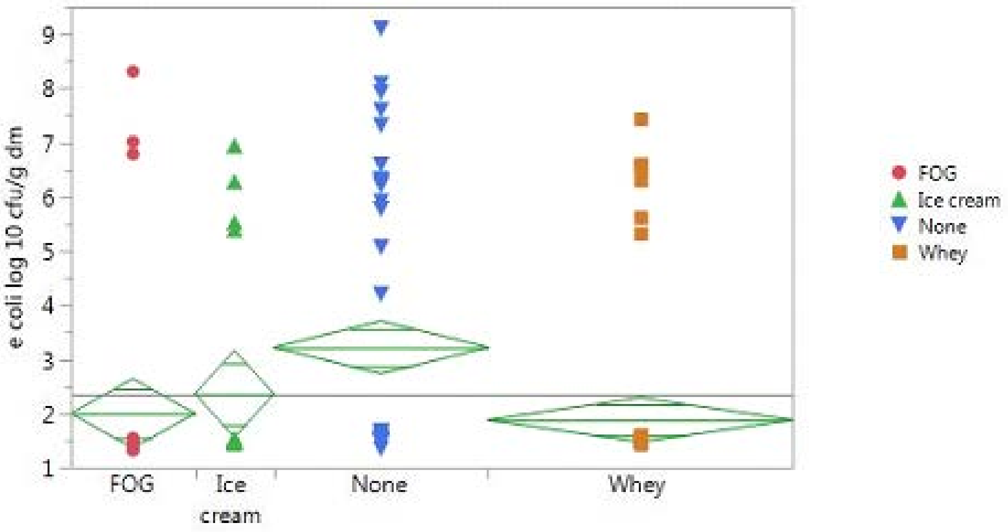

Figure 1: Mean, standard error and lower and upper 95% confidence interval for the concentration of *E. coli* in separated solids. FOG (n=27), Ice cream (n=21), none (manure only n=57), Whey (n=81).

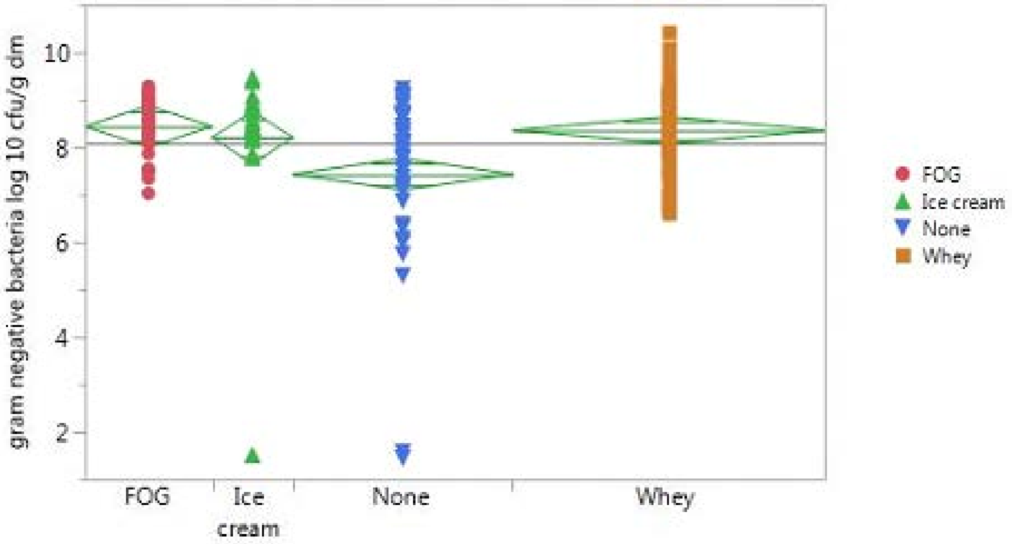

Figure 2: Mean, standard error and lower and upper 95% confidence interval for the concentration of gram negative bacteria in separated solids. FOG (n=27), Ice cream (n=21), none (manure only n=57), Whey (n=81).

Other variables that may have had an effect on the concentration of bacteria in separated solids include type of digester used, season of the year in which the samples were collected and the temperature of the solids in the digester. Analysis of these properties, along with whether or not the farm accepted co-digestion materials showed that the type of digester used (either plug flow or complete mix) had no effect on bacterial concentration, although all of the “manure only” farms had plug flow digesters, so this may not be a valid comparison. Seasonal variations were much greater, which is to be expected with bacterial concentration (Table 3). These variations also followed the same pattern as did co-digestion, suggesting that the difference in bacterial concentration between solids that have been co-digested and those that have not may be seasonal rather than from the material that is digested.

Table 3: Least square means for bacterial concentration in solids ($\log_{10}$ cfu/g dm) by season, digester type and co-digestion.

Bacteria	Significance	Season	Mean	Digester Type	Mean	Co-digest	Mean
Streptococcus spp	NS	Summer Fall Winter Spring	9.4 9.3 9.1 8.8	Complete Plug flow	9.3 9.0	Yes No	9.3 8.8
Staphylococcus spp	$p=0.0003$ $r^2=0.12$	Summer Fall Winter Spring	9.6^{a} 9.1^{ab} 8.7^{b} 8.4^{b}	Complete Plug flow	9.2 8.7	Yes No	9.2^{a} 8.7^{b}
e. coli	$P<.0001$ $r^2=0.15$	Summer Fall Winter Spring	2.1^{ab} 2.7^{ab} 2.2^{b} 3.3^{a}	Complete Plug flow	2.4 2.7	Yes No	2.0^{b} 3.1^{a}
Klebsiella	NS	Summer Fall Winter Spring	3.5 5.1 4.5 4.6	Complete Plug flow	4.4 4.5	Yes No	4.5 4.4
Other coliforms	$p<.0001$ $r^2=0.28$	Summer Fall Winter Spring	4.0^{a} 1.7^{b} 1.6^{b} 1.5^{b}	Complete Plug flow	2.2 2.2	Yes No	2.2 2.2
Gram negative bacteria	$p<.0001$ $r^2=0.15$	Summer Fall Winter Spring	7.0^{b} 7.9^{ab} 8.1^{a} 7.8^{ab}	Complete Plug flow	7.7 7.7	Yes No	8.1^{a} 7.3^{b}
Gram positive bacteria	$P<.0001$ $r^2=0.24$	Summer Fall Winter Spring	6.5^{a} 8.9^{a} 6.4^{b} 4.0^{c}	Complete Plug flow	6.9 6.0	Yes No	6.9 6.0
Corynebacter	$p=0.0021$ $r^2=0.10$	Summer Fall Winter Spring	2.6^{b} 2.6^{b} 3.6^{ab} 4.9^{a}	Complete Plug flow	3.3 3.5	Yes No	2.9^{b} 4.0^{a}
Pseudomonas	$p<.0001$ $r^2=0.53$	Summer Fall Winter Spring	2.5^{bc} 6.5^{a} 2.7^{b} 1.7^{c}	Complete Plug flow	3.2 3.5	Yes No	2.9^{b} 3.8^{a}

Physical Properties of the Solids

Some of the literature indicates that the greater the bacterial population in the bedding material, the greater the bacterial population on the teat ends. High populations are expected to cause an increase in somatic cell count (SCC) and cause greater incidence of mastitis. This is assumed because when the cow is being milked, the teat cup opens up the teat end and can allow bacteria that is on the teat end (presumably from the bedding) to enter the teat canal and cause infection, or mastitis. Therefore, cleanliness of the teats is paramount to keeping mastitis (and SCC) down. The physical properties of the bedding can have an effect on how well the teats and teat ends can be cleaned in the milking parlor. It has been suggested in the literature that with more moisture and more organic matter (OM), bacterial populations thrive. It has also been suggested that the amount of fine particles in the bedding has an effect on bacterial populations on the teat ends (the finer the material, the more likely it will stick to the teat ends, and therefore there will be a higher population of bacteria on the teat ends). This is hypothesized to, in turn, cause more mastitis. Therefore, moisture, organic matter and particle size of the material was analyzed. Particle size was analyzed as % of particles less than 2 mm and % of particles less than 0.84 mm. All data points for physical properties of the separated solids can be found in Appendix A, Table A-2. Table 4 shows the mean, standard deviation, minimum, median and maximum values of these physical properties for each of the co-digestion categories analyzed. Solids that were digested with FOG had significantly higher moisture content than all others except solids that were digested with ice cream. In addition, solids that were digested with FOG had significantly fewer fine particles (both < 2 m and < 0.84 mm) than all other solids, even when the solids that were separated with the roller press, were excluded from analysis. Organic matter in the solids was the same for all co-digestion materials, but significantly lower in solids that were digested with manure only. Again, r-square values are fairly low (0.12-0.19) meaning that less than 20% of the variation between these physical properties can be attributed to the co-digestion material. Organic matter content was significantly higher in solids that were digested with co-digestion materials and in solids that were not digested at all as compared to those that were digested with manure only. This was the only physical property where there was a difference between co-digestion and no co-digestion. Therefore, although increased OM from co-digestion could allow bacterial populations in the bedding to thrive, that same OM would be helpful in soil conditioning when spread on the fields. Co-digestion does not appear to have an adverse effect on the physical properties of solids used as bedding.

Table 4: Mean, standard deviation, minimum, median and maximum values for physical properties of separated solids after digestion with food and food processing wastes (FOG n=33, Ice cream n=21, Whey n=81) versus digestion of manure only (n=57) versus solids not digested at all (n=30)

Property	Co-digestion category	Significance r-square	Mean	Std Dev	Minimum	Median	Maximum
Moisture (%)	FOG	p<.0001	71.0^{a}	3.8	64.7	69.8	79.4
	Ice cream	$r^2=0.17$	68.3^{ab}	2.0	65.2	68.9	71.4
	None		66.1^{b}	6.6	52.9	68.3	78.1
	Whey		65.4^{b}	3.2	58.8	66.5	72.4
	Not digested		65.4^{b}	2.7	58.3	65.6	69.8
Organic Matter (% dm)	FOG	P<.0001	88.0^{a}	2.2	84.2	87.4	91.4
	Ice cream	$r^2=0.13$	87.8^{a}	3.0	81.7	86.1	91.8
	None		83.0^{b}	7.9	59.2	87.7	90.6
	Whey		87.4^{a}	2.6	82.8	87.5	92.0
	Not digested		87.7^{a}	6.0	70.5	87.9	94.0
Particles < 2 mm (%)	FOG	P<.0001	48.6^{a}	14.9	5.3	51.0	72.2
	Ice cream	$r^2=0.19$	63.3^{bc}	24.1	31.1	66.9	89.5
	None		60.8^{bc}	17.4	30.7	61.8	96.3
	Whey		65.7^{bc}	9.2	49.4	64.8	91.8
	Not digested		73.7^{c}	11.3	43.5	77.6	86.1

Particles < 0.84 mm (%)	FOG	P<.0001	17.7^{a}	8.9	0.0	19.6	36.3
	Ice cream	r^2=0.13	31.5^{b}	14.1	11.5	39.7	50.1
	None		29.3^{b}	15.6	3.9	24.8	74.4
	Whey		31.5^{b}	11.0	13.1	29.0	65.6
	Not digested		32.8^{b}	12.7	9.5	33.5	52.0

Fertilizer Value of the Solids

Fertilizer value of the solids is based on the value of its components: nitrogen, phosphorus, potassium, micronutrients and organic matter. The expected availability of nitrogen content in manure is dependent on the form of nitrogen and the application method.[2] Organic N becomes available over time to the plants so not all is available during the season it is applied. Nitrogen in the ammonia form (NH_4) if applied too early, may not be available for crop use because of its volatile nature. The nitrogen value of the manure is not the nitrogen content in the manure but the amount of nitrogen that is actually useful to the plant. Manure supplied P and K are stable and thus can be valued directly. Nitrogen based manure application can lead to excess P and K.[3] Excess P is an environmental issue while K is not. However, although K can be a luxury when consumed by plants, high K levels in forage can lead to metabolic problems post-calving; dry cows need low K forage, especially during the last four weeks of pregnancy. Organic matter has value as a soil conditioner. All data points for fertilizer value in separated solids can be found in Appendix A, Table A-3.

As discussed previously, the solids from co-digestion have significantly higher OM than those from digestion of manure alone. It would thus follow that they would also have significantly higher total, and NH_4-N as well, although organic N was not significantly different (Table 5). Phosphorus, as P_2O_5, was found in higher concentration in solids that were co-digested as compared to those digested with manure only or not digested at all, and potassium, as K_2O, was found in higher concentration in solids digested with manure only, followed by those that were co-digested and finally those that were not digested. Solids that were digested with manure only had significantly higher pH than those that were digested with food and food processing waste, and those that were not digested.

Table 5: Mean, standard deviation, minimum, median and maximum values for chemical properties of separated solids after digestion with food and food processing wastes (n=135) versus digestion of manure only (n=57) versus solids not digested at all (n=30)

Property	Co-digestion category	Significance r-square	Mean	Std Dev	Minimum	Median	Maximum
Total N (% dm)	Yes	p<.0001	2.0^{a}	0.3	1.0	2.0	2.8
	No	r^2=0.11	1.8^{b}	0.3	1.1	1.7	2.5
	Not digested		1.6^{b}	0.4	1.0	1.5	2.4
NH_4-N (% dm)	Yes	P<.0001	0.5^{a}	0.1	0.1	0.5	0.8
	No	r^2=0.24	0.4^{b}	0.1	0.1	0.4	0.7
	Not digested		0.3^{c}	0.2	0.1	0.3	0.6
Organic N (% dm)	Yes	NS	1.4	0.3	0.5	1.4	2.3
	No		1.3	0.3	0.9	1.3	1.9

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[2] Massey, R. Value of Manure as a Fertilizer, University of Missouri, Commercial Ag Program, 2007. Available at http://www.delaval.com/ImageVaultFiles/id_3942/cf_662/ValueofManureasFertilizerMassey.pdf

[3] Rasmussen, C., P. Ristow, K. Czymmek, Q. Ketterings, Value of Manure Calculator, 2010. Available at http://nmsp.cals.cornell.edu/projects/curriculum/Manure/ManureValueLecture.pdf

	Not digested		1.3	0.3	0.7	1.3	2.0
P_2O_5 (% dm)	Yes	P<.0001	1.5^a	0.6	0.1	1.4	2.7
	No	$r^2=0.25$	1.0^b	0.4	0.3	1.0	1.7
	Not digested		0.7^b	0.5	0.1	0.5	1.8
K_2O (% dm)	Yes	p<.0001	1.0^b	0.2	0.6	0.9	1.5
	No	$r^2=0.16$	1.1^a	0.3	0.6	1.1	1.9
	Not digested		0.7^c	0.1	0.5	0.7	0.9
pH	Yes	p=0.0025	8.9^b	0.5	7.7	9.1	9.4
	No	$r^2=0.05$	9.3^a	1.2	7.9	9.2	12.9
	Not digested		8.8^b	1.4	6.6	8.6	12.5

Analysis of these properties by specific co-digestion material showed that digestion with ice cream and/or whey products generated most of the differences between co-digestion versus digestion of manure only or versus undigested solids. Total N in solids digested with ice cream or whey was significantly higher (2.1 and 2.0%, respectively) than those digested with manure only (1.7%) or not digested (1.6%, Figure 3). The same was true for NH_4-N, but in addition, solids digested with FOG also had significantly higher ammonium nitrogen (Figure 4). Digestion with FOG, whey or ice cream yielded solids with 0.5% NH_4-N, versus 0.4 and 0.3% for manure only and not digested, respectively. Phosphorus, as P_2O_5, followed the same pattern (Figure 5). Solids digested with ice cream, whey and FOG had significantly higher concentrations of P_2O_5 (1.8, 1.5, 1.4%) than solids digested with manure only (1.0%) and those that were not digested (0.7%).

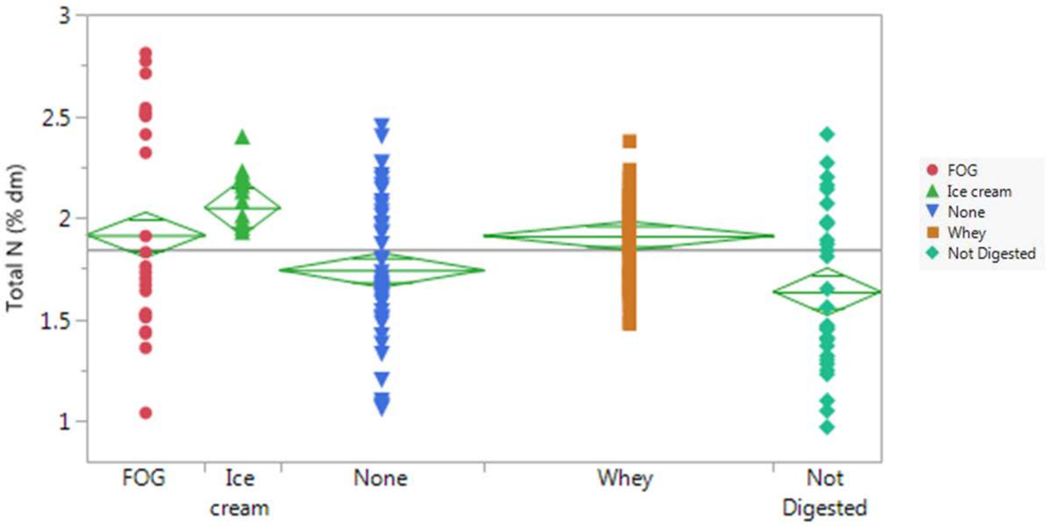

Figure 3: Mean, standard error and lower and upper 95% confidence interval for total N (% dm) in separated solids. FOG (n=33), Ice cream (n=21), none (manure only n=57), Whey (n=81), Not digested (n=30).

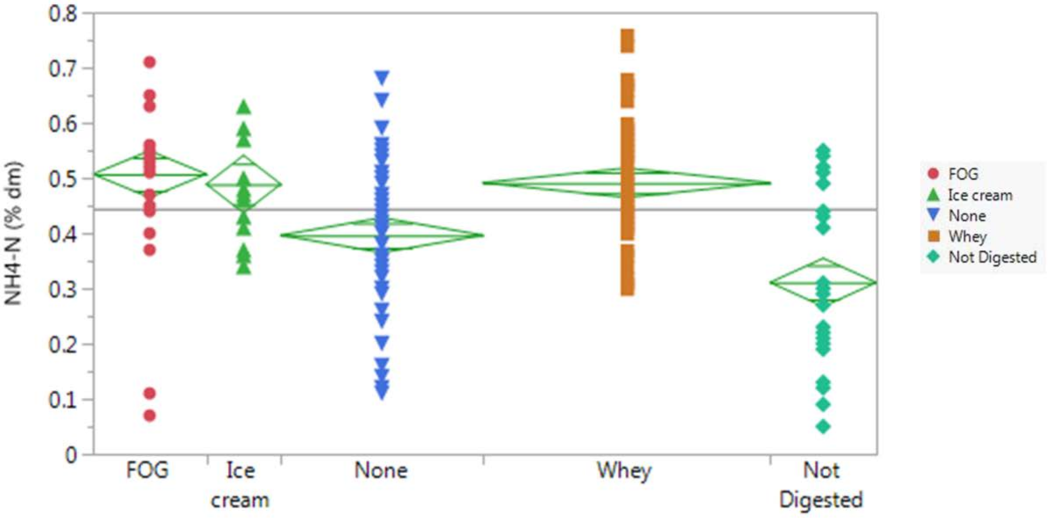

Figure 4: Mean, standard error and lower and upper 95% confidence interval for ammonium nitrogen (NH_4-N) (% dm) in separated solids. FOG (n=33), Ice cream (n=21), none (manure only n=57), Whey (n=81), Not digested (n=30).

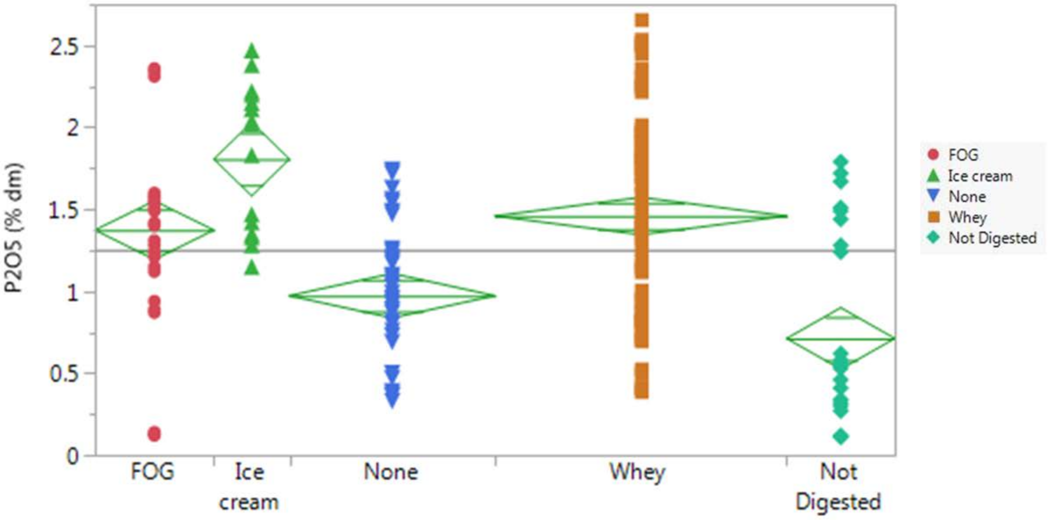

Figure 5: Mean, standard error and lower and upper 95% confidence interval for P_2O_5 (% dm) in separated solids. FOG (n=33), Ice cream (n=21), none (manure only n=57), Whey (n=81), Not digested (n=30).

Digestion with ice cream resulted in solids with significantly higher organic nitrogen versus manure alone (1.6 vs 1.3%, Figure 6) as well as significantly lower pH (8.3 vs 9.3, Figure 7). Figure 8 shows that digestion with whey and whey products resulted in significantly lower concentration of K_2O (0.9%) as compared with digestion of manure alone (1.1%). Although there were differences in the chemical properties of the solids, co-digestion should not affect the fertilizer value of the solids in normal farm operations as the difference favors them as fertilizer. The only one that may be of concern is increased phosphorus in runoff.

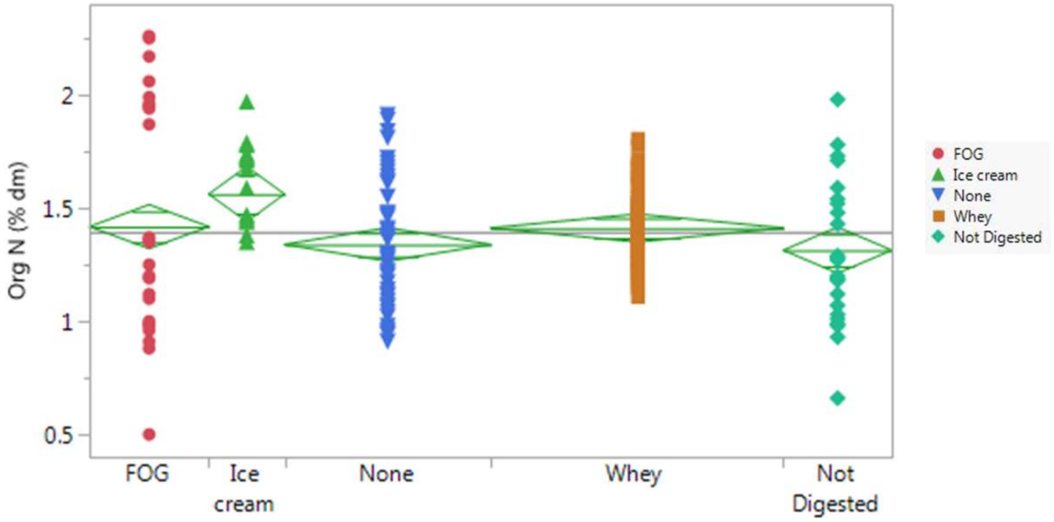

Figure 6: Mean, standard error and lower and upper 95% confidence interval for organic N (% dm) in separated solids. FOG (n=33), Ice cream (n=21), none (manure only n=57), Whey (n=81), Not digested (n=30).

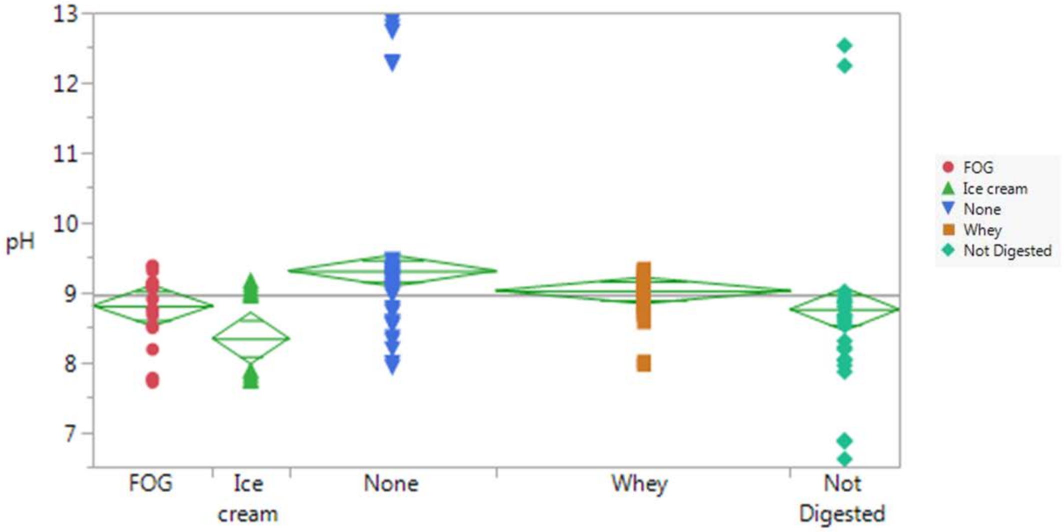

Figure 7: Mean, standard error and lower and upper 95% confidence interval for pH (% dm) in separated solids. FOG (n=33), Ice cream (n=21), none (manure only n=57), Whey (n=81), Not digested (n=30).

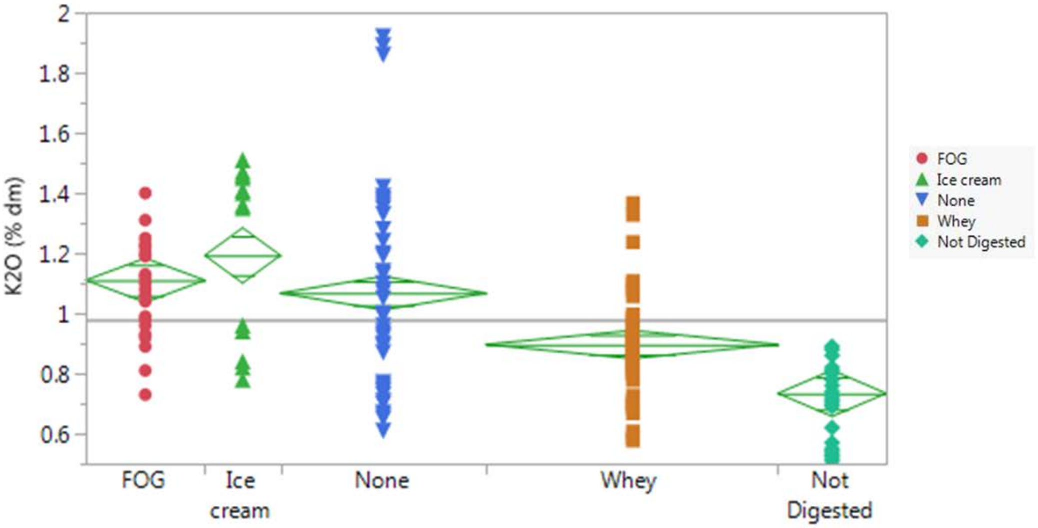

Figure 8: Mean, standard error and lower and upper 95% confidence interval for K_2O (% dm) in separated solids. FOG (n=33), Ice cream (n=21), none (manure only n=57), Whey (n=81), Not digested (n=30).

Bacterial Concentration in the Liquids

Land application of liquid manure can cause bacterial and/or chemical contamination of fields and surface waters through run-off. When human sewage wastewater is used on agricultural lands, the microbiological quality is based on total coliforms, fecal coliforms and/or *Escherichia coli* (*E. coli*). Very rarely is this studied when liquid manure is applied to fields. However, two studies were conducted on the survival of *E. coli* O157:H7 in soil and on leaf lettuce and parsley in 2004, and in soil and on carrots and onions in 2005, grown in fields treated with contaminated manure composts or irrigation water.[4] [5] Irrigation water and three types of compost were inoculated with *E. coli* at 10^5 cfu/ml and 10^7 cfu/g, respectively. Survival of *E. coli* in soil planted to lettuce from irrigation water was about 126 days, but the concentration went down very rapidly, reducing from $3.5_{\log10}$ to $0.5_{\log10}$ cfu/ml in 77 days. For parsley, it decreased to $1.5_{\log10}$ in 4 weeks, but persisted for 133 days. It survived much longer on the plant itself, remaining at $1.75_{\log10}$ 198 days after irrigation on parsley. In onions and carrots, *E. coli* survived in soil samples for 154-196 days and was detected on the plants themselves for 74 and 168 days, respectively. Both of these studies revealed that persistence of *E. coli* in soil, and on the plant itself, is dependent on the type of soil and vegetable grown. Studies such as these resulted in recommended intervals in application of manure as fertilizer and harvest of vegetables whose edible portions contact soil fertilized in this way.

Liquid digestate was analyzed for the same bacteria as solids. As with solids, the question tasked to this study was, does the addition of food and food processing waste in the digester change the bacterial composition of the liquid digestate in comparison to liquid digestate that was not digested with food and food processing waste (i.e. manure only). All data points for bacterial concentration in liquid digestate can be found in Appendix B, Table B-1. Of the environmental pathogens analyzed, no *T. pyogenes* or *prototheca* was found in any of the liquid samples. One sample from the farm that digested

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[4] Islam M., M.P. Doyle, S.C. Phatak, P. Millner, X. Juang, 2004. *Journal of Food Protection* 67(7):1365-1370.

[5] Islam M., M.P. Doyle, S.C. Phatak, P. Millner, X. Juang, 2005. *Food Microbiology* 22:63-70.

grocery store waste with their manure contained mold and two samples, one from each of two different farms that digested manure only contained fungus. The mean, standard deviation, minimum, median and maximum bacterial concentration, measured in $\log_{10}$ colony forming units per ml ($\log_{10}$cfu/ml) for the rest of the bacteria are shown in Table 6. The mean concentration of streptococcus and staphylococcus species was significantly higher in liquids that were digested with food and food processing wastes versus digested manure alone. There was no significant difference in bacterial concentrations of any of the other remaining bacteria.

Table 6: Mean, standard deviation, minimum, median and maximum bacterial concentrations ($\log_{10}$cfu/ml) of liquid digestate after digestion with food and food processing wastes (n=52) versus digestion of manure only (n=19)

Bacteria	Co-digestion	Significance	Mean	Std Dev	Minimum	Median	Maximum
Streptococcus spp	Yes No	p=0.0017 r^2=0.13	7.7^a 6.9^b	0.9 0.8	3.2 5.1	7.9 6.9	9.2 8.3
Staphylococcus spp	Yes No	p=0.0425 r^2=0.06	6.3^a 4.8^b	2.6 3.0	0.0 0.0	7.2 6.2	9.3 8.1
e. coli	Yes No	NS	3.2 2.7	2.6 2.3	0.0 0.0	4.5 3.6	6.8 5.8
Klebsiella	Yes No	NS	3.5 3.2	2.1 1.9	0.0 0.0	4.1 3.6	7.4 5.6
Other coliforms	Yes No	NS	0.3 0.6	1.1 1.4	0.0 0.0	0.0 0.0	5.6 4.6
Gram negative bacteria	Yes No	NS	6.1 5.5	1.2 1.6	0.0 0.0	6.3 6.0	8.5 7.3
Gram positive bacteria	Yes No	NS	6.0 6.5	2.9 1.7	0.0 0.0	7.0 7.0	9.2 7.8
Corynebacter	Yes No	NS	3.3 3.6	3.6 3.5	0.0 0.0	0.0 5.6	8.0 7.5
Pseudomonas	Yes No	NS	1.4 1.2	2.3 2.2	0.0 0.0	0.0 0.0	6.6 6.5

Other variables that may have had an effect on the concentration of bacteria in liquid digestate include type of separator used, season of the year in which the samples were collected and the temperature of the solids from the digester. All of the farms, except one, used a screw press separator, so this was not included in the analysis. Analysis of season and temperature of liquid digestate, along with whether or not the farm accepted any co-digestion materials showed that there was a significant negative correlation between temperature of the digestate and the concentration of cornyebacter in the liquids (Table 7). That is, the concentration of corynebacter in the liquid decreases 0.1 times for each degree F increase in liquid temperature. Seasonal variations were found in the concentration of most bacteria in liquid digestate similar to those found in digested solids. In general, liquid bacterial concentration was significantly lower in the summer, which is probably good, as that is when these liquids would most likely be used for irrigation/fertilization. As with solids, season appears to play a much larger role in liquid bacterial concentration than co-digestion material.

Table 7: Least square means for bacterial concentration in liquid digestate ($\log_{10}$ cfu/ml) by season and co-digestion.

Bacteria	Significance	Season	Mean	Co-digest	Mean
Streptococcus spp	p<.0001	Summer	6.1^b	Yes	7.5^a
	r^2=0.35	Fall	7.4^a	No	6.8^b
		Winter	7.5^a		
		Spring	7.6^a		
Staphylococcus spp	p<.0001	Summer	0.0^b	Yes	5.4^a
	r^2=0.64	Fall	6.9^a	No	4.3^b
		Winter	5.8^a		
		Spring	7.0^a		
e. coli	NS	Summer	1.5	Yes	2.9
		Fall	3.8	No	2.5
		Winter	3.5		
		Spring	1.9		
Klebsiella	p=0.0002	Summer	3.5^{ab}	Yes	3.5
	r^2=0.27	Fall	4.4^a	No	3.1
		Winter	3.8^a		
		Spring	1.5^b		
Other coliforms	p<.0001	Summer	2.5^a	Yes	0.6
	r^2=0.43	Fall	0.3^b	No	0.8
		Winter	0.0^b		
		Spring	0.0^b		
Gram negative bacteria	p=0.0009	Summer	4.4^b	Yes	5.8
	r^2=0.24	Fall	5.4^{ab}	No	5.4
		Winter	6.1^a		
		Spring	6.4^a		
Gram positive bacteria	p<.0001	Summer	6.2^a	Yes	5.9
	r^2=0.44	Fall	7.7^a	No	6.3
		Winter	7.1^a		
		Spring	3.3^b		
Corynebacter	NS	Summer	3.0	Yes	3.1
		Fall	2.0	No	3.4
		Winter	3.8		
		Spring	4.3		
Pseudomonas	p<.0001	Summer	0.0^b	Yes	1.4
	r^2=0.70	Fall	4.9^a	No	1.3
		Winter	0.6^b		
		Spring	0.0^b		

Metal Concentration in the Liquids

Richter et al., 2015[6] found that wastewater-born phytotoxic substances may be removed by soil passage, while existing soil pollutants (e.g. metals) may leach and impair percolate quality. Soil passage of treated wastewater can enhance the biodegradation of pollutants compared to the discharge into

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[6] Richter E, Hecht F, Schnellbacher N, Ternes TA, Wick A, Wode F, Coors A, 2015. Assessing the ecological long-tern impact of wastewater irrigation on soil and water based on bioassays and chemical analyses. *Water Research* 84:33-42.

streams, however, adsorptive pollutants can also be retained in the soil and accumulate. There are no specific rules for land application of liquid digestate, but land application of sewage sludges is regulated under Part 360 of NYSDEC regulations and federal (Part 503) regulations. These rules can be used as a standard for the analysis of the liquid digestate from farm digesters that co-digest with food and food processing waste versus those that digest manure only. The current EPA and DEC standards taken from the "2015 Cornell Guide for Integrated Field Crop Management"[7] are shown in Table 8. Regulatory limits have been set by EPA for nine heavy metals based on a risk assessment analysis. These include standards to be met for a sludge to qualify as "exceptional quality" (EQ). Class A EQ sludges and sludge products should be applied at agronomic rates. EPA has also set "ceiling limits" (not shown), that are significantly less stringent than the EQ limits. Federal rules allow sludges not meeting the EQ limits but within the ceiling limits to be applied, but the cumulative load of metal applied over time must be calculated and must be less than that allowed under the regulations.

Table 8: Current EPA and DEC standards for land application of sewage sludges

Contaminant	NYSDEC sludge and sludge product, monthly average (ppm)	NYSDEC sludge and sludge product max (ppm)	EPA 503 EQ limit (ppm)	NYSDEC cumulative limit (kg/ha)	EPA 503 Cumulative limit (kg/ha)
Arsenic (As)	41	75	41	None	41
Cadmium (Cd)	21	75	39	4	39
Chromium (Cr)	1,000	1,000	None	446	None
Copper (Cu)	1,500	4,300	1,500	112	1,500
Lead (Pb)	300	840	300	267	300
Mercury (Hg)	10	57	17	None	17
Molybdenum (Mo)	40	75	None	None	None
Nickel (Ni)	200	420	420	45	420
Selenium (Se)	100	100	100	None	100
Zinc (Zn)	2,500	7,500	2,800	223	2,800

All data points for the concentration of these metals in liquid digestate can be found in Appendix B, Table B-2. As can be seen in Table 9, the metals found in the liquid digestate are well below the limits set by both EPA and DEC for land application of sewage sludges. In addition, the only metal that is significantly different between liquid digestate from co-digestion versus manure alone is copper, which was found in liquid from co-digestion at a mean concentration of 17 ppm versus 6 ppm in liquid from digestion of manure alone.

Table 9: Mean, standard deviation, minimum, median and maximum metal concentration (ppm) of liquid digestate after digestion with food and food processing wastes (n=52) versus digestion of manure only (n=19)

Metal	Co-digestion	Significance	Mean	Std Dev	Minimum	Median	Maximum
Arsenic (As)	Yes	NS	0.04	0.04	0.00	0.04	0.14
	No		0.03	0.04	0.00	0.02	0.11
Cadmium (Cd)	Yes	NS	0.02	0.01	0.00	0.02	0.04

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[7] Cox, B., Thomas-Murphy, J., eds. 2015 Cornell Guide for Integrated Field Crop Management, Cornell University Cooperative Extension, Ithaca, NY

	No		0.02	0.01	0.00	0.01	0.05
Chromium (Cr)	Yes	NS	0.12	0.14	0.00	0.08	0.58
	No		0.06	0.04	0.00	0.06	0.15
Copper (Cu)	Yes	p=0.0353	17.02^b	22.09	0.10	6.53	80.08
	No	$r^2=0.06$	6.00^a	5.50	0.38	3.69	19.42
Lead (Pb)	Yes	NS	0.11	0.19	0.01	0.06	1.05
	No		0.15	0.20	0.03	0.06	0.71
Molybdenum (Mo)	Yes	NS	0.13	0.10	0.00	0.11	0.51
	No		0.15	0.11	0.02	0.16	0.52
Nickel (Ni)	Yes	NS	0.35	0.26	0.04	0.22	1.01
	No		0.37	0.33	0.06	0.28	1.24
Zinc (Zn)	Yes	NS	13.86	12.20	0.19	12.58	77.78
	No		12.03	6.10	0.87	11.81	22.06

Further analysis by type of co-digestion material shows a significant difference between levels of copper and zinc (Figures 9 and 10). Copper concentration in liquid digestate was significantly higher when manure was digested with ice cream (46.6 ppm) and FOG (26.7 ppm) than when there was no co-digestion (6.0 ppm). In addition, when manure was digested with ice cream, the concentration of copper in the liquid digestate was also significantly greater than when manure was digested with whey (11.1 ppm) or with grocery store waste (2.8 ppm). Zinc concentration in liquid digestate was significantly higher when manure was digested with grocery store waste (35.4 ppm) than any other material: FOG (13.1), none (12.0), ice cream (11.6) and whey (11.0 ppm). However, as stated previously, neither of these metals were found in concentrations that exceed the limits imposed by either EPA or NYSDEC, so should not accumulate, or will accumulate at a slow rate, in the soil when the liquid digestate is applied for irrigation.

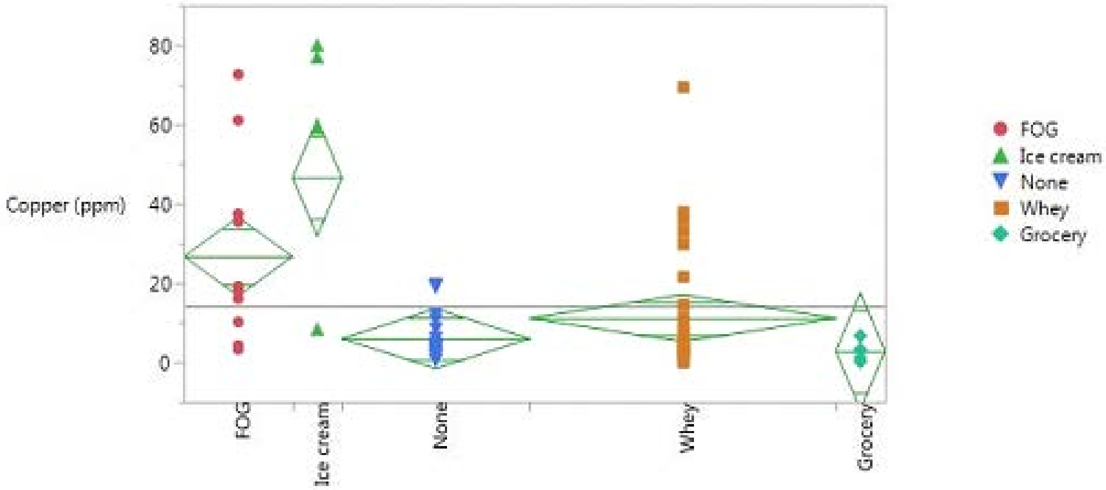

Figure 9: Mean, standard error and lower and upper 95% confidence interval for the concentration of copper in liquid digestate. FOG (n=11), Ice cream (n=5), none (manure only n=19), Whey (n=31), Grocery store waste (n=5).

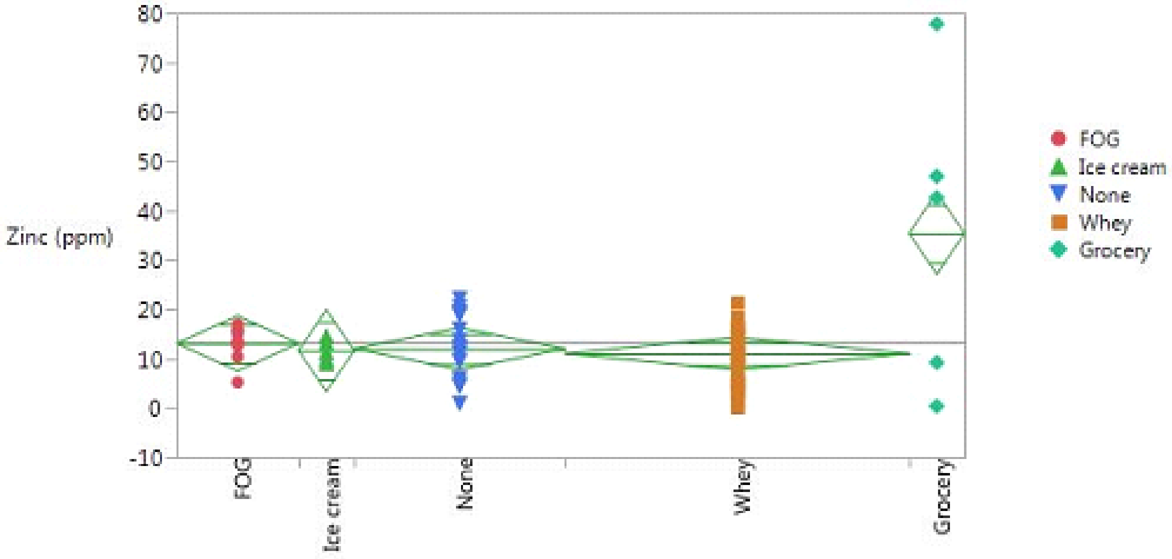

Figure 10: Mean, standard error and lower and upper 95% confidence interval for the concentration of zinc in liquid digestate. FOG (n=11), Ice cream (n=5), none (manure only n=19), Whey (n=31), Grocery store waste (n=5).

Fertilizer Value of the Liquids

The nutrients most important to a crop's needs are nitrogen (N), phosphorus (P), potassium (K), zinc (Zn), boron (B) and sulfur (S). According to the EPA, the most beneficial nutrient is N. Both the concentration and form of N need to be considered in irrigation water. While excessive amounts of N stimulate vegetative growth in most crops, it may also delay maturity and reduce crop quality and quantity. Phosphorus can build up in the soil and reduce the need for P supplementation. Excessive P levels do not appear to pose any problems to crops, but can be a problem in runoff to surface waters.

All data points for the concentration of these nutrients in liquid digestate can be found in Appendix B, Table B-3. Table 10 shows the mean, standard deviation, minimum, median and maximum concentration of the nutrients most important to a crop's needs, as well as whether or not there was a significant difference in those concentrations between liquid digestate from manure that was digested with and without food and food processing waste. The only nutrient for which there was a significant difference was boron, which was found in significantly lower concentration in liquid digestate from digestion of manure with food and food processing wastes. Boron is an essential micronutrient for crop growth and development, but is needed in very small quantities. For most crops, 1-4 mg-B/kg soil is sufficient to prevent deficiencies. As the boron level in both the liquid digestate from digestion with and without food processing waste was 1.5 and 1.9 mg/L, respectively, the difference should not result in boron deficient soil.

Table 10: Mean, standard deviation, minimum, median and maximum macronutrient concentration (mg/L) of liquid digestate after digestion with food and food processing wastes (n=52) versus digestion of manure only (n=19)

Nutrient	Co-digestion	Significance	Mean	Std Dev	Minimum	Median	Maximum
Ammonium nitrogen (NH_4-N)	Yes	NS	1355	231	615	1331	1826
	No		1414	168	1132	1368	1647

Nitrate + nitrite N ($NO_3 + NO_2$-N)	Yes No	NS	1.1 1.1	0.6 0.6	0.0 0.1	1.1 1.1	2.7 2.1
Phosphorus (P)	Yes No	NS	326.3 356.8	172.6 185.7	4.7 11.0	347.7 363.8	619.5 774.9
Potassium (K)	Yes No	NS	2046 2041	851 925	520 641	2175 2228	4695 3535
Zinc (Zn)	Yes No	NS	13.9 12.0	12.2 6.1	0.2 0.9	12.6 11.8	77.8 22.1
Boron (B)	Yes No	p=0.0034 r^2=0.12	1.49^{a} 1.93^{b}	0.45 0.73	0.56 0.82	1.47 1.69	2.5 3.4
Sulfur (S)	Yes No	NS	221.5 236.2	101.6 95.3	31.9 77.9	213.8 256.7	450.6 401.4

Further analysis by the category of food or food processing waste accepted shows a significant difference between both boron (Figure 11) and zinc (Figure 10). For boron, none of the liquid from co-digestion was different than any other (FOG – 1.5 mg/L; ice cream – 1.3 mg/L; whey – 1.5 mg/L; grocery store waste – 1.3 mg/L) but all of them had significantly lower B concentration than liquids digested with manure only (1.9 mg/L). Zinc, like boron, is needed in very small amounts for crop development and growth. Zinc deficiencies can occur when the concentration in plants is below 10-11 ppm and toxicity occurs above 70 ppm. Application of zinc when using a starter fertilizer is recommended to provide this nutrient in the year it is needed. Liquid digestate from digestion with grocery store waste had significantly higher levels of zinc (35.4 mg/L) than all other liquid digestate (FOG – 13.1 mg/L; ice cream 11.6 mg/L; none – 12.0 mg/L; whey – 11.0 mg/L). However, all zinc concentrations fell within the 10-70 mg/L range. Co-digestion with food or food processing waste does not appear to affect the nutrient fertilizer value of the liquid digestate.

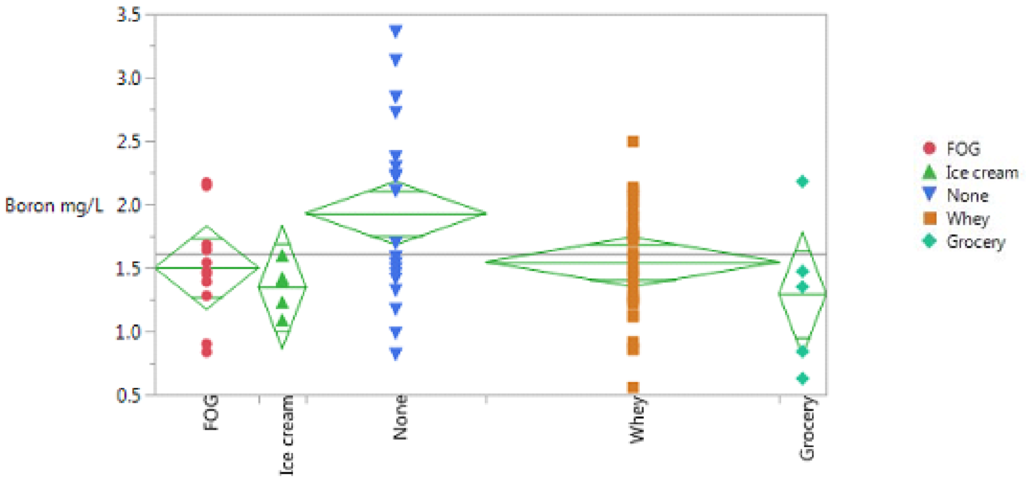

Figure 11: Mean, standard error and lower and upper 95% confidence interval for the concentration of boron in liquid digestate. FOG (n=11), Ice cream (n=5), none (manure only n=19), Whey (n=31), Grocery store waste (n=5).

The US Environmental Protection Agency (USEPA) published “Guidelines for Water Reuse”[8] which examines opportunities for substituting reclaimed water for potable water supplies, such as in agricultural irrigation (Table 11). Although these guidelines are for the use of treated human sewage wastewater, they can be used here as a guide for liquids from the digester. According to this document, the chemical constituents in reclaimed water of concern for agricultural irrigation are salinity, sodium, trace elements, excessive chlorine and nutrients. The concentration of specific ions may cause one or more trace elements to accumulate in the soil and in the plant which, with long-term build-up, may result in animal and human health hazards and/or phytotoxicity in plants. The ions of most concern for salinity are sodium, chloride and boron. In addition, excessive sodium in irrigation water (when sodium exceeds calcium by more than a 3:1 ratio) contributes to soil dispersion and structural breakdown, where the finer soil particles fill many of the smaller pore spaces, sealing the surface and greatly reducing water infiltration rates.

Table 11: Recommended limits for constituents in reclaimed water for irrigation

Constituent	Long-term Use (mg/l)	Short-term Use (mg/l)	Remarks
Aluminum (Al)	5.0	20.0	Can cause non-productiveness in acid soils, but soils at pH 5.5 to 8.0 will precipitate the ion and eliminate toxicity.
Arsenic (As)	0.10	2.0	Toxicity to plants varies widely, ranging from 12 mg/l for Sudan grass to less than 0.05 mg/l for rice.
Boron (B)	0.75	2.0	Essential to plant growth, with optimum yields for many obtained at a few-tenths mg/l in nutrient solutions. Toxic to many sensitive plants (e.g., citrus) at 1 mg/l. Usually sufficient quantities in reclaimed water to correct soil deficiencies. Most grasses are relatively tolerant at 2.0 to 10 mg/l.
Cadmium (Cd)	0.01	0.05	Toxic to beans, beets, and turnips at concentrations as low as 0.1 mg/l in nutrient solution. Conservative limits recommended.
Chromium (Cr)	0.1	1.0	Not generally recognized as an essential growth element. Conservative limits recommended due to lack of knowledge on toxicity to plants.
Cobalt (Co)	0.05	5.0	Toxic to tomato plants at 0.1 mg/l in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Copper (Cu)	0.2	5.0	Toxic to a number of plants at 0.1 to 1.0 mg/l in nutrient solution.
Iron (Fe)	5.0	20.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of essential phosphorus and molybdenum.
Lead (Pb)	5.0	10.0	Can inhibit plant cell growth at very high concentrations.
Manganese (Mn)	0.2	10.0	Toxic to a number of crops at a few-tenths to a few mg/l in acidic soils.

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[8] US Environmental Protection Agency (USEPA) (2004). Guidelines for Water Reuse. EPA/625/R-04/108. http://nepis.epa.gov/Adobe/PDF/30006MKD.pdf. Accessed August 16, 2016.

Molybdenum (Mo)	0.01	0.05	Nontoxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high levels of available molybdenum.
Nickel (Ni)	0.2	2.0	Toxic to a number of plants at 0.5 to 1.0 mg/l; reduced toxicity at neutral or alkaline pH.
Tin (Ti)			Effectively excluded by plants; specific tolerance levels unknown.
Vanadium (V)	0.1	1.0	Toxic to many plants at relatively low concentrations.
Zinc (Zn)	2.0	10.0	Toxic to many plants at widely varying concentrations; reduced toxicity at increased pH (6 or above) and in fine-textured or organic soils.

All data points for the concentration of these metals and nutrients in liquid digestate can be found in Appendix B, Table B-4. With the exception of copper (discussed above) analysis of the difference between concentrations of the micronutrients in Table 11 for liquid digestate with and without co-digestion materials showed no significant differences. However, many of the mean values of these constituents exceeded the recommended long and/or short term limits (Table 12). Only As, Pb and V did not exceed any limit. The mean concentration of Al, B, Cd, Co and Ni exceeded the long-term limits regardless of whether or not food and food processing waste was digested along with the manure. Likewise, the mean concentration of Cu, Fe, Mo and Zn exceeded the short-term limits. In addition, the mean Na:Ca ratio was above 3:1 for all liquid digestate. Chromium concentration in liquid digestate exceeded the short-term limit when co-digested but was within limits when manure alone was digested. Manganese concentration in liquid digestate exceeded the long-term limit when co-digested and the short-term limit when manure alone was digested.

Table 12: Mean, standard deviation, minimum, median and maximum micronutrient concentration (mg/L) of liquid digestate after digestion with food and food processing wastes (n=52) versus digestion of manure only (n=19).

Nutrient	Co-digestion	Limit Long/Short	Mean	Std Dev	Minimum	Median	Maximum
Aluminum (Al)	Yes	5.0/20.0	22.28	28.17	0.16	10.74	127.86
	No		20.49	16.20	0.84	16.52	62.07
Arsenic (As)	Yes	0.1/2.0	0.04	0.04	0.00	0.04	0.14
	No		0.03	0.04	0.00	0.02	0.11
Boron (B)	Yes	0.75/2.0	1.49	0.45	0.56	1.47	2.50
	No		1.93	0.73	0.82	1.69	3.35
Cadmium (Cd)	Yes	0.01/0.05	0.02	0.01	0.00	0.02	0.04
	No		0.02	0.01	0.00	0.01	0.05
Chromium (Cr)	Yes	0.1/1.0	0.12	0.14	0.00	0.08	0.58
	No		0.06	0.04	0.00	0.06	0.15
Cobalt (Co)	Yes	0.05/5.0	0.17	0.16	0.01	0.14	0.76
	No		0.17	0.12	0.04	0.14	0.57
Copper (Cu)	Yes	0.2/5.0	17.02	22.09	0.10	6.53	80.08
	No		5.97	5.50	0.38	3.69	19.42
Iron (Fe)	Yes	5.0/20.0	92.28	177.47	1.26	42.18	909.19
	No		42.37	19.30	12.01	40.10	75.77
Lead (Pb)	Yes	5.0/10.0	0.11	0.19	0.01	0.06	1.05

	No		0.15	0.20	0.03	0.06	0.71
Manganese (Mn)	Yes	0.2/10.0	10.09	5.13	0.08	11.37	20.05
	No		9.29	4.57	0.35	9.66	18.67
Molybdenum (Mo)	Yes	0.01/0.05	0.12	0.10	0.02	0.11	0.51
	No		0.15	0.11	0.00	0.16	0.52
Nickel (Ni)	Yes	0.2/2.0	0.35	0.26	0.01	0.21	1.01
	No		0.37	0.33	0.03	0.28	1.24
Vanadium (V)	Yes	0.1/1.0	0.06	0.06	0.00	0.04	0.23
	No		0.06	0.06	0.00	0.04	0.22
Zinc (Zn)	Yes	2.0/10.0	13.86	12.20	0.19	12.58	77.78
	No		12.03	6.10	0.87	11.81	22.06
Na:Ca ratio	Yes	3.0	13.00	47.63	0.08	0.74	240.03
	No		3.34	10.45	0.09	0.54	46.27

Conclusion

Solids and liquids from digestion of manure at 17 farms were analyzed for bacterial concentration, physical properties and/or metal concentrations to ascertain whether or not there is a difference in the end-products between manure digested with food and food processing waste and manure digested alone. Four farms digested manure alone and the rest accepted some type of food or food processing waste that was co-digested with manure. Bacterial concentrations in both solids and liquids were more affected by seasonal conditions and not whether the farm accepted co-digestion materials. Physical properties of the solids were not significantly different whether digested with a co-digestion material or not. Although organic matter was significantly lower in solids that were digested with manure only versus co-digestion materials this could be helpful for conditioning of the soil. There were differences in the chemical properties of the solids that were co-digested versus those that were not. However, co-digestion should not affect the fertilizer value of the solids in normal farm operations as the difference favors them as fertilizer. The only one that may be of concern is increased phosphorus in runoff. The concentration of metals in all liquid digestate was well-below regulatory limits set for sewage sludge regardless of whether or not co-digestion materials were accepted. There was no difference in fertilizer value (N, P, K) of liquid digestate from digestion with or without co-digestion materials. Where there were differences, the concentration would not result in deficiency or toxicity. The objective of this study was to see if the addition of food and food processing wastes to agricultural digesters has an adverse or positive effect on the end products. Taking into account all of the above information, it appears that co-digestion does not change either the solid or liquid digestate and thus can be used as animal bedding and for fertilization/irrigation of farm fields.

Appendix A: All data: Separated Solids

Table A-1: Bacterial concentration (log10 cfu/g dry matter) of separated solids

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Coryne-bacter	Pseudo-monas	Total coliforms	Total other bacteria	Total number bacteria
BD1 0815	10.30	10.04	1.53	7.28	8.56	8.67	1.53	1.53	1.53	8.56	8.67	10.50
BD1 1015	10.09	9.15	7.31	6.58	1.60	7.90	9.38	8.31	7.78	1.60	9.44	10.22
BD1 1215	8.51	7.70	4.19	1.65	1.65	5.75	7.49	1.65	4.19	1.65	7.50	8.61
BD1 0216	4.47	5.20	1.67	1.67	1.67	6.30	6.69	1.67	1.67	1.67	6.84	6.85
BD1 0316	1.65	1.65	1.65	1.65	1.65	5.99	6.25	1.65	1.65	1.65	6.44	6.44
BD2 0815	10.38	9.87	1.54	1.54	8.29	8.65	1.54	1.54	1.54	8.29	8.65	10.51
BD2 1015	9.88	8.61	1.59	6.79	1.59	7.51	9.21	8.31	7.15	1.59	9.27	9.99
BD2 1215	9.26	8.68	6.59	1.61	1.61	7.19	8.24	1.61	6.59	1.61	8.29	9.40
BD2 0216	1.67	1.67	1.67	1.67	1.67	5.29	6.63	1.67	1.67	1.67	6.65	6.65
BD2 0316	1.65	1.65	1.65	1.65	1.65	6.37	6.52	1.65	1.65	1.65	6.75	6.75
BD3 0815	10.47	10.08	1.53	7.28	8.36	8.87	1.53	1.53	1.53	8.36	8.87	10.63
BD3 1015	9.92	9.08	1.59	7.30	1.59	7.75	9.45	8.60	7.38	1.59	9.51	10.11
BD3 1215	8.72	8.09	5.91	1.62	1.62	6.86	8.01	1.62	5.09	1.62	8.04	8.88
BD3 0216	1.67	1.67	1.67	1.67	1.67	5.29	5.67	1.67	1.67	1.67	5.82	5.82
BD3 0316	1.65	1.65	1.65	1.65	1.65	6.07	6.25	1.65	1.65	1.65	6.47	6.47
GFD1 1115	9.34	10.13	6.29	5.19	1.54	8.20	9.52	1.54	6.13	1.54	9.54	10.28
GFD1 1215	10.03	9.76	1.52	7.20	1.52	8.66	8.99	1.52	1.52	1.52	9.16	10.25
GFD1 0216	9.54	9.67	1.53	6.42	1.53	7.78	8.78	8.78	1.53	1.53	9.10	9.97
GFD1 0316	9.75	8.20	1.52	6.01	1.52	8.87	8.86	9.24	1.52	1.52	9.51	9.95
GFD2 1115	10.44	10.67	1.54	5.15	1.54	8.95	10.38	1.54	6.78	1.54	10.40	11.00
GFD2 1215	9.82	9.70	1.52	7.37	1.52	8.65	9.40	1.52	1.52	1.52	9.47	10.16
GFD2 0216	9.59	9.90	1.52	6.21	1.52	8.59	8.78	8.31	1.52	1.52	9.08	10.11
GFD2 0316	8.93	7.54	6.95	5.86	1.52	1.52	9.30	1.52	1.52	1.52	9.30	9.46
GFD3 1115	9.74	10.15	1.54	6.21	1.54	8.42	9.98	1.54	6.61	1.54	9.99	10.47
GFD3 1215	8.78	8.99	1.51	5.24	1.51	8.09	7.99	1.51	1.51	1.51	8.34	9.25
GFD3 0216	9.20	9.76	1.53	1.53	1.53	9.40	8.90	1.53	1.53	1.53	9.52	10.03
GFD3 0316	9.75	9.38	5.53	5.93	1.52	8.83	9.08	9.01	1.52	1.52	9.46	10.04
GMD1 1115	9.82	9.48	1.50	6.17	1.50	8.12	9.92	1.50	7.27	1.50	9.93	10.26
GMD1 1215	9.86	10.29	1.53	5.59	1.53	8.46	9.72	8.29	1.53	1.53	9.76	10.51
GMD1 0216	9.35	9.17	1.49	7.78	1.49	8.95	8.78	1.49	1.49	1.49	9.17	9.72
GMD1 0316	8.53	8.76	5.62	1.55	1.55	7.50	1.55	1.55	1.55	1.55	7.50	8.97
GMD2 1115	9.51	9.32	1.51	5.28	1.51	8.27	9.51	1.51	7.18	1.51	9.53	9.94

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Corynebacter	Pseudomonas	Total coliforms	Total other bacteria	Total number bacteria
GMD2 1215	9.78	10.00	1.53	4.97	1.53	8.23	9.79	1.53	1.53	1.53	9.80	10.35
GMD2 0216	9.26	9.19	1.49	6.79	1.49	8.59	8.91	1.49	1.49	1.49	9.08	9.66
GMD2 0316	9.39	9.14	1.55	1.55	1.55	9.07	1.55	8.74	1.55	1.55	9.24	9.75
GMD3 1115	9.61	9.29	1.52	6.77	1.52	8.44	9.94	1.52	8.29	1.52	9.97	10.18
GMD3 1215	9.66	9.94	1.53	5.60	1.53	7.90	9.76	1.53	1.53	1.53	9.76	10.28
GMD3 0216	9.45	9.03	1.48	6.53	1.48	8.68	8.78	1.48	1.48	1.48	9.03	9.69
GMD3 0316	9.48	8.67	1.54	1.54	1.54	8.87	1.54	9.21	1.54	1.54	9.38	9.77
KSRD1 1115	9.26	9.06	1.47	5.58	1.47	8.30	9.26	1.47	6.76	1.47	9.31	9.70
KSRD1 1215	9.12	9.42	1.47	5.48	1.47	8.93	1.47	1.47	9.28	1.47	9.44	9.83
KSRD1 0216	9.54	9.42	1.48	1.48	1.48	8.72	9.00	8.78	7.09	1.48	9.33	9.92
KSRD1 0316	9.13	8.66	1.46	1.46	1.46	8.73	1.46	9.26	1.46	1.46	9.37	9.62
KSRD2 1115	8.96	8.74	1.48	4.31	1.48	7.92	8.90	1.48	6.79	1.48	8.95	9.37
KSRD2 1215	9.60	9.62	1.48	5.91	1.48	8.64	1.48	1.48	7.28	1.48	8.66	9.93
KSRD2 0216	9.51	9.08	1.48	1.48	1.48	8.45	8.61	1.48	6.61	1.48	8.84	9.71
KSRD2 0316	9.33	8.63	1.46	6.51	1.46	8.11	9.03	1.46	1.46	1.46	9.08	9.58
KSRD3 1115	8.54	9.06	1.45	4.98	1.45	7.73	8.28	1.45	6.43	1.45	8.40	9.24
KSRD3 1215	8.97	9.45	1.49	5.88	1.49	8.45	1.49	1.49	7.60	1.49	8.51	9.61
KSRD3 0216	8.66	9.07	1.48	5.99	1.48	7.60	8.60	1.48	6.29	1.48	8.64	9.32
KSRD3 0316	9.64	9.32	5.07	1.46	1.46	8.70	9.43	1.46	1.46	1.46	9.50	9.98
LD1 0815	9.15	9.28	6.57	5.57	7.12	7.45	9.45	1.49	1.49	7.12	9.45	9.79
LD1 1015	8.54	9.01	1.54	5.61	1.54	7.52	8.39	1.54	5.61	1.54	8.45	9.22
LD1 1215	8.90	9.64	1.45	1.45	1.45	8.41	9.38	1.45	1.45	1.45	9.42	9.89
LD1 0216	8.05	6.58	1.49	4.78	1.49	8.26	1.49	1.49	1.49	1.49	8.26	8.47
LD1 0316	9.08	8.95	1.49	1.49	1.49	9.55	1.49	1.49	1.49	1.49	9.55	9.75
LD2 0815	8.89	9.53	1.49	5.55	1.49	8.10	9.42	8.27	1.49	1.49	9.47	9.85
LD2 1015	8.25	9.47	1.52	4.78	1.52	7.38	8.90	1.52	6.08	1.52	8.91	9.60
LD2 1215	9.06	9.13	1.45	1.45	1.45	8.88	9.28	1.45	7.88	1.45	9.44	9.72
LD2 0216	8.55	7.90	1.49	1.49	1.49	8.85	8.60	1.49	1.49	1.49	9.04	9.19
LD2 0316	8.61	8.75	1.49	1.49	1.49	9.16	1.49	1.49	1.49	1.49	9.16	9.38
LD3 0815	8.79	9.27	7.45	1.49	1.49	8.01	9.45	1.49	1.49	1.49	9.46	9.73
LD3 1015	8.38	9.26	1.53	5.00	1.53	8.02	9.15	1.53	6.78	1.53	9.18	9.55
LD3 1215	9.01	9.25	1.46	1.46	1.46	8.87	9.08	1.46	1.46	1.46	9.29	9.68
LD3 0216	8.85	7.67	1.49	5.89	1.49	8.85	8.77	1.49	1.49	1.49	9.11	9.31
LD3 0316	8.31	8.82	1.49	1.49	1.49	8.17	1.49	8.30	1.49	1.49	8.54	9.09

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Corynebacter	Pseudomonas	Total coliforms	Total other bacteria	Total number bacteria
LHD1 0815	9.36	9.39	1.58	1.58	1.58	8.10	1.58	1.58	1.58	1.58	8.10	9.69
LHD1 1015	9.58	9.03	5.33	5.33	1.58	6.98	9.33	1.58	6.23	1.58	9.33	9.85
LHD1 1215	9.79	9.96	1.60	5.00	1.60	7.50	1.60	1.60	1.60	1.60	7.50	10.19
LHD1 0216	9.25	9.19	1.61	5.30	1.61	6.78	8.30	1.61	1.61	1.61	8.31	9.55
LHD1 0316	10.16	10.09	1.61	5.54	1.61	8.37	1.61	1.61	1.61	1.61	8.37	10.43
LHD2 0815	9.22	8.76	1.58	4.89	1.58	6.71	1.58	1.58	1.58	1.58	6.71	9.35
LHD2 1015	9.57	9.27	6.31	5.31	1.57	6.61	8.79	1.57	7.01	1.57	8.80	9.79
LHD2 1215	9.90	10.19	1.59	5.08	1.59	8.07	1.59	1.59	1.59	1.59	8.07	10.37
LHD2 0216	9.09	8.61	1.60	5.61	1.60	7.92	1.60	1.60	1.60	1.60	7.92	9.24
LHD2 0316	9.98	9.81	1.61	5.45	1.61	7.91	1.61	1.61	1.61	1.61	7.91	10.21
LHD3 0815	9.36	9.13	1.58	1.58	1.58	7.91	1.58	1.58	1.58	1.58	7.91	9.57
LHD3 1015	10.23	9.27	6.61	5.22	1.57	7.00	9.01	1.57	7.22	1.57	9.02	10.30
LHD3 1215	8.87	9.39	1.60	5.30	1.60	7.11	8.90	1.60	1.60	1.60	8.91	9.60
LHD3 0216	9.20	8.90	1.60	5.34	1.60	7.79	1.60	1.60	1.60	1.60	7.79	9.39
LHD3 0316	9.82	9.97	1.61	5.60	1.61	8.45	1.61	1.61	1.61	1.61	8.45	10.21
LSD1 0815	8.82	7.96	1.60	1.60	1.60	8.38	9.68	7.96	1.60	1.60	9.71	9.77
LSD1 1015	8.45	9.21	1.55	5.00	1.55	7.91	8.78	1.55	6.78	1.55	8.84	9.41
LSD1 1215	8.92	9.25	1.48	1.48	1.48	8.80	1.48	1.48	1.48	1.48	8.80	9.51
LSD1 0216	9.52	9.71	1.53	7.31	1.53	9.15	1.53	1.53	8.27	1.53	9.21	10.00
LSD1 0316	8.90	8.72	1.51	1.51	1.51	8.86	1.51	1.51	1.51	1.51	8.86	9.31
LSD2 0815	5.62	6.95	1.62	1.62	1.62	6.11	9.53	9.12	1.62	1.62	9.67	9.67
LSD2 1015	8.80	9.37	1.54	5.77	1.54	8.14	9.14	1.54	7.14	1.54	9.18	9.65
LSD2 1215	9.32	9.62	1.48	5.71	1.48	9.33	1.48	1.48	1.48	1.48	9.33	9.92
LSD2 0216	9.63	9.41	1.53	7.28	1.53	9.82	1.53	1.53	8.03	1.53	9.82	10.13
LSD2 0316	9.21	9.19	1.53	5.10	1.53	9.25	1.53	1.53	1.53	1.53	9.25	9.70
LSD3 0815	6.97	8.01	1.61	1.61	1.61	7.42	9.53	9.05	1.61	1.61	9.65	9.67
LSD3 1015	9.16	9.22	1.55	5.22	1.55	8.01	9.35	1.55	7.31	1.55	9.38	9.74
LSD3 1215	9.68	9.55	1.49	7.00	1.49	9.30	1.49	1.49	1.49	1.49	9.30	10.02
LSD3 0216	9.72	9.65	1.53	7.78	1.53	9.77	1.53	1.53	7.30	1.53	9.77	10.19
LSD3 0316	8.15	8.60	1.52	1.52	1.52	8.66	1.52	1.52	1.52	1.52	8.66	9.00
NBD1 1115	6.59	8.25	1.43	5.57	1.43	9.07	9.11	1.43	7.77	1.43	9.40	9.43
NBD1 1215	9.89	9.11	1.51	4.99	1.51	9.09	9.60	1.51	1.51	1.51	9.71	10.16
NBD1 0216	9.13	8.16	1.51	6.00	1.51	8.50	8.60	7.60	1.51	1.51	8.88	9.35
NBD1 0316	8.18	9.07	1.49	1.49	1.49	8.44	1.49	1.49	1.49	1.49	8.44	9.20

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Corynebacter	Pseudomonas	Total coliforms	Total other bacteria	Total number bacteria
NBD2 1115	9.15	7.80	1.44	5.42	1.44	8.93	9.31	1.44	7.78	1.44	9.47	9.65
NBD2 1215	9.50	8.60	1.51	1.51	6.30	8.41	9.30	1.51	1.51	6.30	9.35	9.76
NBD2 0216	9.39	8.12	1.51	5.60	1.51	8.64	8.44	7.30	6.30	1.51	8.87	9.52
NBD2 0316	9.30	9.21	1.49	1.49	1.49	7.52	1.49	1.49	1.49	1.49	7.52	9.57
NBD3 1115	8.33	7.42	1.44	1.44	1.44	8.10	9.67	1.44	6.61	1.44	9.68	9.70
NBD3 1215	9.72	8.17	1.51	1.51	1.51	8.32	9.28	1.51	1.51	1.51	9.32	9.88
NBD3 0216	9.48	8.72	1.51	5.59	1.51	8.74	9.44	1.51	1.51	1.51	9.52	9.84
NBD3 0316	8.98	8.96	1.48	1.48	1.48	7.03	1.48	7.85	1.48	1.48	7.91	9.29
PD1 0815	9.88	8.82	7.28	7.88	7.97	8.23	1.56	1.56	1.56	7.97	8.23	9.93
PD1 1015	10.24	9.49	8.35	7.61	1.54	8.65	9.52	1.54	9.09	1.54	9.69	10.41
PD1 1215	10.04	9.59	7.76	7.19	1.52	8.76	8.59	1.52	6.99	1.52	8.99	10.20
PD1 0216	10.00	9.29	1.54	6.71	1.54	8.34	1.54	8.99	1.54	1.54	9.08	10.12
PD1 0316	10.56	9.88	7.30	7.30	1.52	8.60	1.52	9.00	1.52	1.52	9.14	10.66
PD2 0815	9.66	8.65	7.57	7.74	8.05	8.47	1.56	1.56	1.56	8.05	8.47	9.74
PD2 1015	10.25	9.70	8.34	8.77	1.54	9.21	9.41	1.54	8.64	1.54	9.67	10.45
PD2 1215	9.22	9.36	7.39	7.39	1.54	8.66	8.92	1.54	1.54	1.54	9.11	9.72
PD2 0216	10.33	9.38	1.54	7.44	1.54	8.05	1.54	8.90	1.54	1.54	8.96	10.40
PD2 0316	10.56	9.51	7.78	7.45	1.52	8.54	1.52	1.52	1.52	1.52	8.54	10.60
PD3 0815	9.66	8.16	1.56	6.86	8.04	8.68	1.56	1.56	1.56	8.04	8.68	9.72
PD3 1015	8.40	9.00	1.57	5.80	1.57	1.57	8.64	8.32	1.57	1.57	8.81	9.28
PD3 1215	10.05	9.60	7.60	7.53	1.53	8.94	8.60	1.53	1.53	1.53	9.10	10.22
PD3 0216	10.18	9.70	1.54	7.45	1.54	7.99	1.54	8.30	1.54	1.54	8.48	10.31
PD3 0316	9.86	9.52	7.62	7.32	1.52	8.43	1.52	1.52	1.52	1.52	8.43	10.04
PVD1 1215	8.99	8.51	1.44	1.44	4.85	8.15	8.15	1.44	1.44	4.85	8.45	9.20
PVD1 0216	9.78	8.58	1.31	5.48	1.31	8.92	9.45	1.31	6.60	1.31	9.56	10.00
PVD1 0316	9.36	9.33	6.79	6.63	1.39	8.24	9.49	9.69	1.39	1.39	9.91	10.10
PVD2 1215	8.56	8.25	1.44	1.44	1.44	8.30	7.76	7.28	1.44	1.44	8.44	8.91
PVD2 0216	9.54	8.67	1.33	6.15	1.33	8.81	9.08	8.31	5.78	1.33	9.31	9.78
PVD2 0316	10.65	9.68	8.31	7.84	1.40	8.54	9.44	9.74	1.40	1.40	9.93	10.77
PVD3 1215	8.47	8.33	1.42	4.77	1.42	8.29	7.14	1.42	1.42	1.42	8.32	8.85
PVD3 0216	9.90	8.75	1.32	5.99	1.32	8.67	9.07	8.29	5.99	1.32	9.26	10.01
PVD3 0316	9.65	8.79	7.01	5.86	1.39	8.67	9.24	1.39	1.39	1.39	9.35	9.86
RD1 0815	9.72	10.04	1.54	1.54	7.57	8.31	9.57	1.54	1.54	7.57	9.60	10.30
RD1 1015	9.95	9.50	1.54	5.20	1.54	7.84	9.62	8.30	6.00	1.54	9.65	10.22

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Coryne-bacter	Pseudo-monas	Total coliforms	Total other bacteria	Total number bacteria
RD1 1215	9.74	9.07	1.52	1.52	1.52	10.44	9.49	1.52	7.31	1.52	10.49	10.57
RD1 0216	10.02	8.43	1.52	5.77	1.52	8.39	9.07	8.77	1.52	1.52	9.31	10.11
RD1 0316	10.27	10.39	1.57	5.94	1.57	9.22	9.69	1.57	1.57	1.57	9.82	10.69
RD2 0815	9.13	9.91	1.53	7.28	7.28	8.46	9.19	1.53	1.53	7.28	9.26	10.05
RD2 1015	9.72	9.63	1.53	5.31	1.53	8.31	9.70	1.53	6.54	1.53	9.72	10.17
RD2 1215	9.53	10.00	1.52	1.52	1.52	8.34	9.10	1.52	7.23	1.52	9.18	10.17
RD2 0216	9.85	8.23	1.52	7.31	1.52	8.51	9.15	8.31	1.52	1.52	9.29	9.96
RD2 0316	10.31	10.30	1.57	5.96	1.57	9.22	9.33	1.57	1.57	1.57	9.58	10.64
RD3 0815	9.31	10.01	1.53	1.53	7.87	8.05	9.35	1.53	1.53	7.87	9.37	10.16
RD3 1015	9.48	9.67	1.53	1.53	1.53	8.05	9.54	1.53	6.91	1.53	9.55	10.05
RD3 1215	9.50	10.04	1.52	1.52	1.52	8.54	9.20	1.52	7.77	1.52	9.30	10.21
RD3 0216	9.87	8.80	1.53	7.38	1.53	8.24	9.20	8.30	1.53	1.53	9.29	10.00
RD3 0316	1.56	10.41	1.56	6.16	1.56	9.12	9.46	1.56	1.56	1.56	9.62	10.48
RVD1 1115	9.19	9.08	1.47	5.26	1.47	8.16	9.58	1.47	1.47	1.47	9.60	9.83
RVD1 1215	8.94	9.31	1.48	1.48	1.48	8.29	1.48	1.48	1.48	1.48	8.29	9.49
RVD1 0216	9.74	9.38	1.48	1.48	1.48	8.51	1.48	1.48	1.48	1.48	8.51	9.91
RVD1 0316	8.40	7.59	5.40	1.49	1.49	7.87	8.47	1.49	1.49	1.49	8.56	8.82
RVD2 1115	9.07	9.04	1.46	4.79	1.46	8.21	10.00	1.46	6.79	1.46	10.01	10.09
RVD2 1215	9.42	9.47	1.47	1.47	1.47	8.50	1.47	1.47	1.47	1.47	8.50	9.77
RVD2 0216	9.52	9.54	1.47	1.47	1.47	8.72	1.47	1.47	1.47	1.47	8.72	9.87
RVD2 0316	10.87	10.67	1.50	6.93	1.50	9.08	9.70	9.33	1.50	1.50	9.92	11.11
RVD3 1115	9.17	9.47	1.47	5.60	1.47	8.39	9.84	1.47	1.47	1.47	9.86	10.07
RVD3 1215	8.11	8.95	1.48	1.48	1.48	8.14	8.27	8.27	1.48	1.48	8.71	9.18
RVD3 0216	8.45	9.30	1.48	1.48	1.48	9.48	1.48	1.48	1.48	1.48	9.48	9.73
RVD3 0316	8.96	8.25	1.49	6.40	1.49	8.45	8.65	1.49	1.49	1.49	8.86	9.26
SHD1 1015	9.45	8.91	1.51	4.94	1.51	9.02	8.89	1.51	6.64	1.51	9.26	9.74
SHD1 1215	9.84	10.20	1.55	6.40	1.55	9.29	1.55	1.55	1.55	1.55	9.29	10.39
SHD1 0216	9.74	8.22	1.51	5.36	1.51	8.07	8.32	8.92	1.51	1.51	9.06	9.83
SHD1 0316	9.58	8.39	1.43	4.76	1.43	8.23	1.43	8.39	1.43	1.43	8.62	9.65
SHD2 1015	9.68	9.16	1.53	4.99	1.53	9.15	9.29	1.53	7.38	1.53	9.53	9.99
SHD2 1215	10.07	9.88	1.48	1.48	1.48	9.19	8.93	1.48	1.48	1.48	9.38	10.34
SHD2 0216	9.22	7.91	1.49	5.38	1.49	7.49	7.78	8.21	1.49	1.49	8.40	9.30
SHD2 0316	9.76	8.72	1.44	5.99	1.44	7.87	1.44	8.59	1.44	1.44	8.66	9.83
SHD3 1015	9.62	9.26	1.53	5.32	1.53	8.89	9.26	1.53	6.89	1.53	9.42	9.94

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Coryne-bacter	Pseudo-monas	Total coliforms	Total other bacteria	Total number bacteria
SHD3 1215	9.95	10.01	1.46	6.22	1.46	9.07	1.46	1.46	1.46	1.46	9.07	10.31
SHD3 0216	8.99	7.58	1.50	5.00	1.50	7.35	7.91	8.35	1.50	1.50	8.51	9.13
SHD3 0316	9.14	8.00	1.43	4.60	1.43	7.55	1.43	8.78	1.43	1.43	8.80	9.33
SSD1 1015	10.18	9.25	6.20	5.78	1.59	7.08	9.30	1.59	5.78	1.59	9.30	10.28
SSD1 1215	10.12	9.61	6.29	5.99	1.61	7.59	8.29	1.61	1.61	1.61	8.37	10.24
SSD1 0216	10.12	8.35	6.26	6.48	1.58	8.06	9.31	8.91	1.58	1.58	9.47	10.22
SSD1 0316	10.29	9.52	7.31	7.01	1.59	8.02	1.59	9.21	1.59	1.59	9.24	10.39
SSD2 1015	9.97	8.92	6.32	5.49	1.61	7.36	9.16	1.61	6.62	1.61	9.17	10.07
SSD2 1215	9.68	9.47	9.10	6.32	1.63	7.92	8.80	8.92	1.63	1.63	9.19	10.02
SSD2 0216	10.06	8.99	5.77	6.57	1.58	7.79	8.90	8.30	1.58	1.58	9.02	10.13
SSD2 0316	10.18	9.26	1.58	7.48	1.58	7.90	1.58	9.38	1.58	1.58	9.40	10.29
SSD3 1015	9.89	8.78	6.30	5.08	1.60	7.20	8.58	8.90	5.30	1.60	9.08	9.98
SSD3 1215	9.58	8.84	6.28	5.98	1.61	7.36	8.76	8.28	1.61	1.61	8.90	9.72
SSD3 0216	9.67	8.10	6.25	6.55	1.58	7.16	9.16	8.25	1.58	1.58	9.21	9.81
SSD3 0316	10.18	9.94	7.59	7.44	1.58	1.58	7.89	9.07	1.58	1.58	9.10	10.40
SVD1 0815	9.31	9.20	1.50	1.50	1.50	8.45	9.50	8.27	1.50	1.50	9.56	9.86
SVD1 1015	9.47	8.47	1.52	5.37	1.52	8.44	8.47	1.52	1.52	1.52	8.76	9.58
SVD1 1215	10.07	8.93	1.51	6.84	1.51	9.80	1.51	1.51	1.51	1.51	9.80	10.28
SVD1 0216	8.15	7.23	1.53	6.38	1.53	7.60	1.53	1.53	1.53	1.53	7.60	8.30
SVD1 0316	9.07	6.87	1.53	6.99	1.53	8.68	1.53	1.53	1.53	1.53	8.68	9.23
SVD2 0815	9.08	9.40	1.51	1.51	1.51	8.10	9.19	8.29	1.51	1.51	9.27	9.75
SVD2 1015	8.77	8.25	1.53	5.20	1.53	8.25	8.14	1.53	7.70	1.53	8.57	9.06
SVD2 1215	10.00	8.77	1.52	6.02	1.52	10.10	1.52	1.52	1.52	1.52	10.10	10.37
SVD2 0216	9.09	7.73	1.54	7.09	1.54	8.93	7.62	1.54	1.54	1.54	8.95	9.34
SVD2 0316	8.78	6.60	1.53	7.07	1.53	9.10	1.53	1.53	1.53	1.53	9.10	9.27
SVD3 0815	8.65	9.61	1.50	1.50	1.50	8.31	9.61	1.50	1.50	1.50	9.63	9.94
SVD3 1015	9.26	8.75	1.54	5.21	1.54	8.21	8.56	1.54	7.30	1.54	8.73	9.47
SVD3 1215	9.00	8.60	1.52	6.38	1.52	8.99	8.77	1.52	1.52	1.52	9.20	9.47
SVD3 0216	8.36	7.54	1.54	6.43	1.54	8.49	1.54	8.31	1.54	1.54	8.71	8.89
SVD3 0316	8.20	6.99	1.52	7.00	1.52	8.37	1.52	1.52	1.52	1.52	8.37	8.62
TBD1 0815	9.00	9.31	1.44	4.97	1.44	1.44	8.74	1.44	7.55	1.44	8.77	9.56
TBD1 1015	9.15	9.26	1.49	1.49	5.78	8.23	9.63	1.49	7.60	5.78	9.65	9.88
TBD1 1215	9.08	8.97	1.49	5.64	1.49	8.71	1.49	1.49	1.49	1.49	8.71	9.42
TBD1 0216	9.97	8.10	1.34	6.63	1.34	9.23	1.34	1.34	1.34	1.34	9.23	10.04

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Coryne-bacter	Pseudo-monas	Total coliforms	Total other bacteria	Total number bacteria
TBD1 0316	10.56	9.39	8.09	6.56	1.49	9.08	1.49	8.79	1.49	1.49	9.26	10.61
TBD2 0815	8.81	9.44	1.45	5.22	1.45	1.45	8.74	1.45	7.71	1.45	8.78	9.60
TBD2 1015	9.01	9.15	1.47	5.00	4.78	8.36	9.15	1.47	6.78	4.78	9.21	9.61
TBD2 1215	8.89	9.19	1.46	5.36	1.46	8.66	8.89	1.46	1.46	1.46	9.09	9.55
TBD2 0216	10.16	8.55	1.35	6.48	1.35	9.01	1.35	8.60	1.35	1.35	9.15	10.21
TBD2 0316	10.26	9.32	7.92	6.46	1.50	9.12	1.50	9.10	1.50	1.50	9.41	10.36
TBD3 0815	8.66	9.34	1.45	1.45	1.45	1.45	8.27	1.45	7.59	1.45	8.35	9.46
TBD3 1015	8.97	9.23	1.49	5.41	1.49	8.08	9.73	1.49	6.48	1.49	9.74	9.91
TBD3 1215	9.37	9.37	1.49	1.49	1.49	8.68	8.84	1.49	1.49	1.49	9.07	9.77
TBD3 0216	9.70	8.91	1.34	6.52	1.34	9.06	1.34	8.76	1.34	1.34	9.24	9.88
TBD3 0316	9.94	8.43	7.58	6.46	1.48	8.62	1.48	8.76	1.48	1.48	9.00	10.00
ZD1 1215	9.68	9.49	1.45	4.89	1.45	7.98	1.45	1.45	1.45	1.45	7.98	9.90
ZD1 0216	9.80	8.14	1.51	5.45	1.51	9.22	9.42	1.51	1.51	1.51	9.63	10.03
ZD1 0316	9.86	8.89	1.53	5.78	1.53	8.82	1.53	1.53	1.53	1.53	8.82	9.93
ZD2 1215	9.33	9.74	1.44	5.61	1.44	8.40	9.01	7.61	1.44	1.44	9.12	9.95
ZD2 0216	9.69	8.91	1.51	5.31	1.51	9.04	9.39	1.51	1.51	1.51	9.55	9.97
ZD2 0316	9.58	9.07	1.52	6.30	1.52	8.30	1.52	1.52	1.52	1.52	8.30	9.72
ZD3 1215	10.07	9.81	1.46	5.36	1.46	8.56	9.36	1.46	1.46	1.46	9.42	10.32
ZD3 0216	10.06	7.91	1.50	5.47	1.50	9.29	9.71	1.50	1.50	1.50	9.85	10.27
ZD3 0316	10.29	9.93	1.52	5.48	1.52	8.61	1.52	1.52	1.52	1.52	8.61	10.46

Table A-2: Moisture, Organic Matter and Particle Size (%) of separated solids

ID	Moisture	Organic Matter	Particles < 2mm	Particles < 0.84 mm
BD1 0815	66.4	80.1	68.4	25.9
BD1 1015	60.5	79.7	76.1	42.0
BD1 1215	55.5	70.9	72.4	41.4
BD1 0216	52.9	60.1	95.6	74.4
BD1 0316	55.2	64.4	94.3	58.9
BD2 0815	65.7	80.0	67.0	24.5
BD2 1015	60.9	79.8	73.8	41.0
BD2 1215	59.1	78.7	67.3	35.7
BD2 0216	53.0	59.2	92.9	59.9
BD2 0316	55.6	63.6	93.9	57.7
BD3 0815	66.2	79.7	65.8	24.8
BD3 1015	61.0	80.2	74.6	40.3
BD3 1215	58.0	77.7	68.0	38.3
BD3 0216	53.1	60.3	96.3	67.2
BD3 0316	55.6	57.6	95.6	71.9
GFD1 1115	65.4	91.8	87.5	48.3
GFD1 1215	66.8	91.2	88.1	65.6
GFD1 0216	66.3	90.3	88.7	41.5
GFD1 0316	66.7	90.3	88.0	41.7
GFD2 1115	65.5	91.4	85.2	42.5
GFD2 1215	67.2	91.1	86.6	53.9
GFD2 0216	66.6	90.6	88.4	38.2
GFD2 0316	66.7	90.6	88.1	42.3
GFD3 1115	65.2	91.1	85.8	50.1
GFD3 1215	67.3	91.6	86.2	53.6
GFD3 0216	66.3	90.2	89.5	43.7
GFD3 0316	66.9	90.2	86.9	42.3
GMD1 1115	68.3	91.4	79.4	52.8
GMD1 1215	66.4	91.6	53.4	24.9
GMD1 0216	69.3	91.1	49.7	19.5
GMD1 0316	64.9	91.1	61.9	29.6
GMD2 1115	67.4	91.7	91.8	58.7
GMD2 1215	65.9	91.6	50.1	23.7
GMD2 0216	69.0	91.2	51.2	19.2
GMD2 0316	64.8	91.2	59.4	28.8

ID	Moisture	Organic Matter	Particles < 2mm	Particles < 0.84 mm
GMD3 1115	67.0	91.2	89.2	57.5
GMD3 1215	66.0	92.0	54.8	26.6
GMD3 0216	69.5	91.0	52.3	16.0
GMD3 0316	65.0	91.0	61.9	31.1
KSRD1 1115	70.6	89.6	70.1	43.7
KSRD1 1215	70.2	89.3	44.5	18.7
KSRD1 0216	69.8	89.9	60.7	36.9
KSRD1 0316	71.1	89.9	50.5	17.7
KSRD2 1115	69.8	89.7	69.7	43.4
KSRD2 1215	69.6	89.2	46.0	19.5
KSRD2 0216	69.6	90.2	49.1	14.5
KSRD2 0316	71.1	90.2	54.6	18.9
KSRD3 1115	71.6	89.6	72.1	44.1
KSRD3 1215	68.9	89.7	44.6	18.1
KSRD3 0216	70.1	90.6	48.4	18.3
KSRD3 0316	71.3	90.6	49.6	15.7
LD1 0815	69.3	90.8	70.2	30.3
LD1 1015	65.5	89.6	71.3	35.3
LD1 1215	71.6	86.8	65.4	22.2
LD1 0216	68.8	87.5	62.0	26.5
LD1 0316	69.2	86.9	64.5	25.1
LD2 0815	68.9	90.5	69.6	33.6
LD2 1015	66.9	88.1	72.7	38.6
LD2 1215	71.8	86.8	64.8	24.0
LD2 0216	68.8	87.5	60.2	22.3
LD2 0316	69.0	86.5	63.2	22.5
LD3 0815	69.3	90.4	72.6	36.0
LD3 1015	66.4	88.5	71.3	36.9
LD3 1215	71.2	86.9	70.1	40.8
LD3 0216	68.9	88.3	59.7	24.8
LD3 0316	68.8	87.6	63.5	27.1
LHD1 0815	62.3	89.3	76.1	44.6
LHD1 1015	61.6	87.9	67.9	37.7
LHD1 1215	59.8	87.6	73.5	42.7
LHD1 0216	59.7	88.3	70.0	38.4
LHD1 0316	58.8	87.6	71.1	39.3

ID	Moisture	Organic Matter	Particles < 2mm	Particles < 0.84 mm
LHD2 0815	62.0	89.0	76.2	45.6
LHD2 1015	62.7	87.7	73.8	41.8
LHD2 1215	60.9	87.2	72.7	41.5
LHD2 0216	60.0	89.2	69.5	37.0
LHD2 0316	59.4	87.5	66.8	35.5
LHD3 0815	61.8	88.8	75.7	44.6
LHD3 1015	63.0	88.0	71.5	40.2
LHD3 1215	60.5	87.2	75.9	45.1
LHD3 0216	60.6	88.2	72.1	39.8
LHD3 0316	59.5	87.9	71.7	38.9
LSD1 0815	60.1	94.0	84.9	48.8
LSD1 1015	64.6	87.6	86.1	52.0
LSD1 1215	69.8	87.3	81.2	44.7
LSD1 0216	66.5	88.4	79.7	26.6
LSD1 0316	67.9	87.7	73.7	35.5
LSD2 0815	58.3	92.5	84.8	49.1
LSD2 1015	65.0	87.8	84.5	47.8
LSD2 1215	69.7	87.2	80.6	45.9
LSD2 0216	66.0	88.1	79.8	33.4
LSD2 0316	66.1	87.9	76.2	42.8
LSD3 0815	59.0	94.0	84.4	49.2
LSD3 1015	64.6	87.9	84.9	47.9
LSD3 1215	69.3	86.8	82.2	49.3
LSD3 0216	66.4	86.9	79.1	25.7
LSD3 0316	67.1	87.1	75.2	36.9
NBD1 1115	73.0	87.0	51.3	29.7
NBD1 1215	68.0	87.3	42.4	16.8
NBD1 0216	67.6	85.4	44.8	17.0
NBD1 0316	69.4	85.4	39.9	10.1
NBD2 1115	72.4	87.1	51.0	30.0
NBD2 1215	67.8	87.7	45.8	19.9
NBD2 0216	67.4	86.3	48.9	19.7
NBD2 0316	69.4	86.3	41.4	12.2
NBD3 1115	72.4	87.6	49.5	29.2
NBD3 1215	67.7	87.8	44.5	18.7
NBD3 0216	67.5	86.0	48.3	16.7

ID	Moisture	Organic Matter	Particles < 2mm	Particles < 0.84 mm
NBD3 0316	69.8	86.0	38.8	11.4
PD1 0815	64.0	93.4	82.8	36.2
PD1 1015	65.4	76.5	67.4	23.4
PD1 1215	66.6	82.7	61.5	19.7
PD1 0216	65.3	90.6	68.3	25.6
PD1 0316	66.6	90.3	46.5	9.5
PD2 0815	64.0	93.5	80.8	34.6
PD2 1015	65.6	77.6	70.5	22.9
PD2 1215	65.3	83.4	68.6	25.5
PD2 0216	65.5	92.0	62.4	21.9
PD2 0316	66.7	89.6	43.5	9.8
PD3 0815	63.7	93.9	82.1	33.6
PD3 1015	63.2	70.5	69.4	24.5
PD3 1215	65.8	83.9	63.2	21.3
PD3 0216	65.6	91.5	68.9	26.5
PD3 0316	67.2	90.5	57.4	13.6
PVD1 1215	72.6	91.1	55.3	23.0
PVD1 0216	79.4	89.6	13.3	0.6
PVD1 016	75.4	89.6	44.3	5.3
PVD2 1215	72.5	91.4	51.9	20.1
PVD2 0216	78.5	90.0	11.6	2.1
PVD2 0316	74.9	90.0	43.2	5.1
PVD3 1215	73.8	90.7	56.0	22.0
PVD3 0216	79.3	90.0	5.3	0.0
PVD3 0316	75.2	90.0	44.5	4.1
RD1 0815	65.6	83.3	52.8	19.1
RD1 1015	65.4	83.1	58.8	25.9
RD1 1215	67.0	85.7	55.9	21.1
RD1 0216	66.8	84.0	49.4	16.8
RD1 0316	63.2	85.2	66.7	29.0
RD2 0815	65.8	84.4	58.0	21.9
RD2 1015	66.0	83.9	59.4	25.0
RD2 1215	66.6	84.4	62.6	28.2
RD2 0216	66.7	84.3	55.5	19.5
RD2 0316	62.5	84.2	67.4	31.9
RD3 0815	66.5	83.9	55.4	19.8

ID	Moisture	Organic Matter	Particles < 2mm	Particles < 0.84 mm
RD3 1015	65.9	82.8	60.4	25.5
RD3 1215	67.1	85.8	58.2	23.5
RD3 0216	66.3	84.4	61.3	20.8
RD3 0316	63.7	85.1	64.3	27.6
RVD1 1115	70.7	85.5	68.4	40.8
RVD1 1215	69.6	81.7	33.0	14.1
RVD1 0216	69.9	86.0	36.7	12.0
RVD1 0316	69.0	86.0	35.4	14.4
RVD2 1115	71.4	86.7	65.8	39.7
RVD2 1215	70.2	84.9	31.1	14.2
RVD2 0216	70.2	86.0	55.7	34.3
RVD2 0316	68.6	86.0	35.9	14.5
RVD3 1115	70.4	86.1	66.9	40.7
RVD3 1215	69.6	85.8	38.9	19.9
RVD3 0216	69.6	86.1	36.7	11.5
RVD3 0316	68.9	86.1	37.7	15.9
SHD1 1015	67.3	84.6	60.3	18.9
SHD1 1215	64.7	84.7	72.2	36.3
SHD1 0216	67.5	88.0	56.7	21.4
SHD1 0316	73.3	91.8	65.4	27.8
SHD2 1015	65.8	84.4	58.5	20.6
SHD2 1215	69.5	86.1	66.8	20.6
SHD2 0216	69.2	90.0	57.1	20.0
SHD2 0316	72.5	91.9	57.3	19.6
SHD3 1015	66.0	84.2	60.9	24.9
SHD3 1215	71.1	85.9	60.0	19.2
SHD3 0216	68.4	87.6	58.2	19.4
SHD3 0316	73.3	91.3	59.6	23.6
SSD1 1015	60.8	80.1	53.3	26.5
SSD1 1215	59.2	80.6	44.2	20.7
SSD1 0216	62.1	82.9	32.5	13.7
SSD1 0316	61.3	83.3	39.1	18.8
SSD2 1015	59.3	80.3	52.8	26.6
SSD2 1215	57.0	81.0	41.7	20.1
SSD2 0216	62.3	82.4	34.4	14.8
SSD2 0316	62.4	82.8	42.4	17.7

ID	Moisture	Organic Matter	Particles < 2mm	Particles < 0.84 mm
SSD3 1015	60.3	80.0	50.5	24.8
SSD3 1215	58.9	81.5	44.6	21.2
SSD3 0216	61.8	82.8	35.0	16.1
SSD3 0316	62.3	82.7	40.7	18.7
SVD1 0815	68.5	88.6	72.5	33.0
SVD1 1015	66.8	85.8	67.1	31.3
SVD1 1215	67.4	86.4	62.8	27.1
SVD1 0216	66.1	84.2	66.2	41.4
SVD1 0316	66.5	85.5	59.3	25.6
SVD2 0815	67.4	89.0	71.8	34.3
SVD2 1015	66.3	85.9	64.5	31.7
SVD2 1215	67.0	86.0	63.2	29.6
SVD2 0216	65.3	83.9	69.8	46.1
SVD2 0316	66.3	85.7	58.9	27.7
SVD3 0815	68.3	89.2	71.0	31.3
SVD3 1015	65.7	86.1	64.0	31.0
SVD3 1215	67.1	85.5	63.2	27.9
SVD3 0216	65.7	85.3	63.5	27.2
SVD3 0316	67.0	85.5	56.6	26.4
TBD1 0815	72.4	88.7	62.4	19.6
TBD1 1015	69.2	88.2	72.5	26.5
TBD1 1215	69.4	88.3	64.2	27.3
TBD1 0216	78.1	86.7	30.7	6.3
TBD1 0316	69.0	91.9	64.9	21.9
TBD2 0815	72.1	88.8	60.3	20.3
TBD2 1015	70.6	89.0	71.8	29.7
TBD2 1215	70.8	89.0	61.3	26.4
TBD2 0216	77.9	87.7	32.0	3.9
TBD2 0316	68.6	91.7	58.3	16.5
TBD3 0815	71.9	88.4	61.8	20.3
TBD3 1015	68.9	88.8	71.1	29.5
TBD3 1215	69.4	88.1	64.6	29.4
TBD3 0216	78.0	87.9	41.9	24.3
TBD3 0316	69.9	89.5	58.0	15.3
ZD1 1215	71.5	86.1	54.8	13.1
ZD1 0216	67.7	87.3	70.1	20.8

ID	Moisture	Organic Matter	Particles < 2mm	Particles < 0.84 mm
ZD1 0316	66.5	85.8	66.1	29.4
ZD2 1215	72.4	85.9	53.0	13.1
ZD2 0216	67.9	87.6	70.8	22.8
ZD2 0316	66.7	85.9	68.1	33.7
ZD3 1215	71.4	85.8	57.8	14.9
ZD3 0216	68.3	87.2	69.1	19.8
ZD3 0316	66.6	85.5	68.4	36.2

Table A-3: Total N, Ammonium N, Organic N, P_2O_5, K_2O (%) concentration and pH of separated solids

ID	Total N	Ammonium N	Organic N	P_2O_5	K_2O	pH
BD1 0815	1.6	0.4	1.3	1.1	0.8	9.2
BD1 1015	1.5	0.4	1.1	0.4	0.8	9.2
BD1 1215	1.4	0.3	1.0	0.9	0.6	9.1
BD1 0216	1.1	0.2	0.9	0.9	0.7	12.7
BD1 0316	1.1	0.1	0.9	0.7	0.7	12.3
BD2 0815	1.6	0.3	1.3	1.0	0.8	9.4
BD2 1015	1.5	0.4	1.0	0.3	0.7	9.2
BD2 1215	1.5	0.2	1.3	1.0	0.7	9.2
BD2 0216	1.1	0.2	0.9	0.9	0.7	12.8
BD2 0316	1.1	0.1	1.0	0.8	0.7	12.3
BD3 0815	1.6	0.3	1.3	1.0	0.8	9.3
BD3 1015	1.5	0.4	1.1	0.4	0.8	9.2
BD3 1215	1.5	0.3	1.1	1.1	0.7	9.2
BD3 0216	1.2	0.1	1.1	1.0	0.7	12.9
BD3 0316	1.1	0.1	1.0	0.8	0.7	12.3
GFD1 1115	2.1	0.4	1.7	1.2	0.8	9.1
GFD1 1215	2.0	0.4	1.6	1.3	0.9	9.3
GFD1 0216	1.9	0.5	1.5	1.4	0.9	7.9
GFD1 0316	1.9	0.5	1.5	1.4	0.9	7.9
GFD2 1115	2.2	0.4	1.8	1.3	0.8	9.0
GFD2 1215	2.0	0.4	1.7	1.2	0.9	9.2
GFD2 0216	1.9	0.5	1.5	1.5	0.9	7.9
GFD2 0316	1.9	0.5	1.5	1.5	0.9	7.9
GFD3 1115	1.9	0.3	1.6	1.3	0.8	9.0
GFD3 1215	1.9	0.4	1.6	1.4	1.0	9.1
GFD3 0216	2.0	0.5	1.5	1.4	1.0	7.9
GFD3 0316	2.0	0.5	1.5	1.4	1.0	7.9
GMD1 1115	2.2	0.4	1.8	1.7	0.9	9.2
GMD1 1215	1.9	0.5	1.5	1.3	1.0	9.3
GMD1 0216	2.1	0.4	1.7	1.1	1.1	9.3
GMD1 0316	2.1	0.4	1.7	1.1	1.1	9.3
GMD2 1115	2.1	0.4	1.7	1.8	0.9	9.1
GMD2 1215	2.1	0.4	1.6	1.5	0.9	9.3
GMD2 0216	1.9	0.4	1.5	1.2	1.1	8.0

ID	Total N	Ammonium N	Organic N	P_2O_5	K_2O	pH
GMD2 0316	1.9	0.4	1.5	1.2	1.1	8.0
GMD3 1115	2.1	0.4	1.7	1.8	0.9	9.1
GMD3 1215	1.9	0.4	1.5	1.4	0.9	9.3
GMD3 0216	2.0	0.4	1.5	1.2	1.1	8.0
GMD3 0316	2.0	0.4	1.5	1.2	1.1	8.0
KSRD1 1115	2.4	0.5	1.9	1.1	1.1	9.2
KSRD1 1215	2.1	0.5	1.6	1.2	1.2	9.3
KSRD1 0216	2.0	0.6	1.4	1.0	1.1	8.3
KSRD1 0316	2.0	0.6	1.4	1.0	1.1	8.3
KSRD2 1115	2.2	0.5	1.7	1.1	1.1	9.3
KSRD2 1215	2.2	0.5	1.7	1.2	1.2	9.3
KSRD2 0216	1.9	0.6	1.4	1.0	1.1	8.0
KSRD2 0316	1.9	0.6	1.4	1.0	1.1	8.0
KSRD3 1115	2.5	0.6	1.9	1.2	1.1	9.1
KSRD3 1215	2.1	0.5	1.6	1.3	1.2	9.3
KSRD3 0216	2.0	0.5	1.5	1.0	1.1	7.9
KSRD3 0316	2.0	0.5	1.5	1.0	1.1	7.9
LD1 0815	2.0	0.4	1.6	0.9	0.7	9.2
LD1 1015	2.0	0.4	1.5	0.5	0.7	9.1
LD1 1215	2.1	0.6	1.5	1.7	0.9	9.2
LD1 0216	2.0	0.6	1.4	1.8	1.0	9.1
LD1 0316	2.0	0.6	1.4	1.7	0.9	8.9
LD2 0815	1.9	0.3	1.6	1.0	0.7	9.1
LD2 1015	2.0	0.5	1.5	0.5	0.8	9.1
LD2 1215	2.1	0.6	1.5	1.7	0.9	9.1
LD2 0216	2.0	0.6	1.4	1.7	0.9	9.1
LD2 0316	2.1	0.6	1.5	1.7	0.9	8.9
LD3 0815	1.9	0.4	1.5	0.9	0.7	9.1
LD3 1015	2.0	0.5	1.6	0.5	0.7	9.1
LD3 1215	2.1	0.6	1.5	1.8	0.9	9.2
LD3 0216	2.1	0.6	1.5	2.0	1.1	9.1
LD3 0316	2.0	0.6	1.4	1.8	0.9	8.9
LHD1 0815	1.9	0.5	1.4	1.8	0.8	9.1
LHD1 1015	1.9	0.4	1.5	0.7	0.8	9.2
LHD1 1215	2.0	0.4	1.5	2.0	0.8	9.3
LHD1 0216	1.9	0.5	1.4	1.9	0.9	9.2

ID	Total N	Ammonium N	Organic N	P_2O_5	K_2O	pH
LHD1 0316	1.8	0.5	1.2	2.0	0.8	8.8
LHD2 0815	1.8	0.4	1.4	1.8	0.8	9.1
LHD2 1015	1.9	0.5	1.5	0.8	0.9	9.2
LHD2 1215	2.1	0.4	1.6	2.3	0.9	9.3
LHD2 0216	1.7	0.5	1.2	1.8	1.0	9.2
LHD2 0316	1.7	0.5	1.2	1.9	0.7	8.8
LHD3 0815	2.0	0.5	1.5	1.9	0.8	9.0
LHD3 1015	2.0	0.5	1.6	0.8	0.8	9.2
LHD3 1215	1.9	0.4	1.5	2.3	0.8	9.3
LHD3 0216	1.8	0.5	1.4	1.8	0.9	9.1
LHD3 0316	1.8	0.5	1.3	2.0	0.7	8.8
LSD1 0815	1.6	0.3	1.3	0.6	0.6	8.0
LSD1 1015	2.1	0.4	1.7	0.6	0.7	8.8
LSD1 1215	2.2	0.5	1.6	1.8	0.9	9.0
LSD1 0216	2.0	0.4	1.5	1.2	0.9	8.8
LSD1 0316	1.8	0.6	1.3	1.7	0.9	8.6
LSD2 0815	1.5	0.2	1.3	0.6	0.6	8.3
LSD2 1015	2.4	0.4	2.0	0.6	0.7	8.9
LSD2 1215	2.1	0.5	1.5	1.7	0.9	9.0
LSD2 0216	1.9	0.4	1.5	1.4	0.9	9.0
LSD2 0316	1.8	0.5	1.3	1.4	0.8	8.6
LSD3 0815	1.5	0.3	1.2	0.6	0.5	8.5
LSD3 1015	2.2	0.4	1.7	0.5	0.7	8.8
LSD3 1215	2.3	0.5	1.7	1.5	0.8	8.9
LSD3 0216	1.9	0.4	1.5	1.3	0.9	8.9
LSD3 0316	2.0	0.5	1.4	1.5	0.8	8.7
NBD1 1115	2.8	0.6	2.3	1.6	1.2	9.1
NBD1 1215	2.5	0.6	2.0	1.6	1.1	9.3
NBD1 0216	2.5	0.5	2.1	2.3	1.2	9.4
NBD1 0316	2.5	0.5	2.1	2.3	1.2	9.4
NBD2 1115	2.7	0.5	2.2	1.5	1.2	9.1
NBD2 1215	2.5	0.6	2.0	1.6	1.1	9.3
NBD2 0216	2.4	0.5	1.9	2.3	1.2	9.3
NBD2 0316	2.4	0.5	1.9	2.3	1.2	9.3
NBD3 1115	2.8	0.5	2.3	1.5	1.2	9.1
NBD3 1215	2.5	0.6	2.0	1.5	1.1	9.3

ID	Total N	Ammonium N	Organic N	P_2O_5	K_2O	pH
NBD3 0216	2.3	0.5	1.9	2.4	1.3	9.4
NBD3 0316	2.3	0.5	1.9	2.4	1.3	9.4
PD1 0815	1.7	0.1	1.5	0.3	0.5	6.6
PD1 1015	1.1	0.1	0.9	0.1	0.7	12.2
PD1 1215	1.3	0.2	1.0	0.5	0.7	8.7
PD1 0216	1.3	0.3	1.0	0.3	0.9	8.2
PD1 0316	1.4	0.2	1.2	0.3	0.7	8.0
PD2 0815	1.4	0.1	1.3	0.3	0.5	6.9
PD2 1015	1.1	0.1	1.0	0.1	0.7	12.2
PD2 1215	1.3	0.2	1.0	0.5	0.8	8.9
PD2 0216	1.0	0.3	0.7	0.3	0.9	8.2
PD2 0316	1.5	0.3	1.2	0.3	0.7	7.9
PD3 0815	1.9	0.1	1.8	0.3	0.5	6.9
PD3 1015	1.2	0.1	1.2	0.1	0.6	12.5
PD3 1215	1.3	0.2	1.0	0.4	0.8	8.5
PD3 0216	1.4	0.3	1.1	0.3	0.8	8.2
PD3 0316	1.3	0.2	1.1	0.3	0.7	8.0
PVD1 1215	1.8	0.5	1.3	1.2	1.1	9.1
PVD1 0216	1.6	0.7	1.0	1.3	1.3	7.8
PVD1 016	1.6	0.7	1.0	1.3	1.3	7.8
PVD2 1215	1.7	0.5	1.2	1.2	1.1	9.0
PVD2 0216	1.5	0.6	0.9	1.3	1.3	7.7
PVD2 0316	1.5	0.6	0.9	1.3	1.3	7.7
PVD3 1215	1.9	0.6	1.4	1.2	1.1	9.1
PVD3 0216	1.8	0.7	1.1	1.3	1.4	7.8
PVD3 0316	1.8	0.7	1.1	1.3	1.4	7.8
RD1 0815	1.5	0.3	1.2	0.7	0.7	9.1
RD1 1015	1.7	0.4	1.2	0.4	0.8	9.2
RD1 1215	1.7	0.5	1.2	1.3	0.9	9.4
RD1 0216	1.8	0.5	1.3	0.9	0.8	9.1
RD1 0316	1.6	0.4	1.2	0.8	0.6	8.9
RD2 0815	1.5	0.3	1.2	0.7	0.7	9.2
RD2 1015	1.7	0.4	1.3	0.4	0.8	9.2
RD2 1215	1.9	0.5	1.4	1.3	0.9	9.3
RD2 0216	1.6	0.5	1.1	1.0	0.8	9.1
RD2 0316	1.6	0.4	1.2	0.9	0.6	8.9

ID	Total N	Ammonium N	Organic N	P_2O_5	K_2O	pH
RD3 0815	1.5	0.3	1.2	0.7	0.7	9.0
RD3 1015	1.7	0.4	1.2	0.4	0.8	9.2
RD3 1215	1.7	0.5	1.2	1.4	1.0	9.3
RD3 0216	1.7	0.5	1.2	0.9	0.8	9.0
RD3 0316	1.6	0.4	1.2	0.9	0.6	8.8
RVD1 1115	2.1	0.5	1.7	2.2	1.4	9.0
RVD1 1215	2.4	0.4	2.0	1.8	1.4	9.2
RVD1 0216	2.0	0.6	1.4	2.1	1.4	7.7
RVD1 0316	2.0	0.6	1.4	2.1	1.4	7.7
RVD2 1115	2.2	0.5	1.7	2.2	1.5	9.0
RVD2 1215	2.2	0.5	1.7	2.4	1.5	9.1
RVD2 0216	2.0	0.6	1.4	2.2	1.5	7.8
RVD2 0316	2.0	0.6	1.4	2.2	1.5	7.8
RVD3 1115	2.2	0.5	1.7	2.0	1.4	9.0
RVD3 1215	2.2	0.4	1.8	2.5	1.5	9.1
RVD3 0216	2.0	0.6	1.4	2.0	1.4	7.8
RVD3 0316	2.0	0.6	1.4	2.0	1.4	7.8
SHD1 1015	1.4	0.1	1.3	0.1	0.8	8.2
SHD1 1215	1.5	0.4	1.1	1.4	0.9	9.1
SHD1 0216	1.4	0.5	0.9	1.1	1.0	9.1
SHD1 0316	1.5	0.5	1.0	0.9	0.9	8.8
SHD2 1015	1.4		1.4	0.1	0.8	8.5
SHD2 1215	1.7	0.4	1.2	1.4	1.0	9.0
SHD2 0216	1.5	0.6	1.0	1.2	1.0	9.1
SHD2 0316	1.4	0.6	0.9	0.9	0.9	8.7
SHD3 1015	1.4	0.1	1.4	0.1	0.7	8.5
SHD3 1215	1.7	0.4	1.2	1.3	0.9	8.9
SHD3 0216	1.0	0.5	0.5	1.1	1.1	9.1
SHD3 0316	1.5	0.5	1.0	0.9	1.0	8.7
SSD1 1015	1.6	0.3	1.3	0.4	0.9	9.1
SSD1 1215	1.5	0.3	1.1	0.7	0.9	9.1
SSD1 0216	1.8	0.4	1.4	0.9	1.2	9.0
SSD1 0316	1.7	0.5	1.2	0.9	0.9	8.7
SSD2 1015	1.8	0.3	1.5	0.4	0.9	9.2
SSD2 1215	1.3	0.3	1.0	0.8	0.9	9.0
SSD2 0216	1.7	0.5	1.3	0.9	1.1	9.0

ID	Total N	Ammonium N	Organic N	P_2O_5	K_2O	pH
SSD2 0316	1.6	0.4	1.2	0.9	0.9	8.6
SSD3 1015	1.4	0.4	1.1	0.3	0.9	9.0
SSD3 1215	1.5	0.3	1.1	0.8	0.9	8.8
SSD3 0216	1.7	0.5	1.2	0.9	1.1	9.0
SSD3 0316	1.5	0.4	1.1	0.9	1.0	8.7
SVD1 0815	2.3	0.5	1.8	1.5	1.1	9.0
SVD1 1015	2.0	0.6	1.5	0.8	0.9	9.1
SVD1 1215	1.9	0.6	1.2	2.5	1.0	9.1
SVD1 0216	2.1	0.7	1.4	2.3	1.0	9.0
SVD1 0316	2.0	0.7	1.3	2.5	0.9	8.7
SVD2 0815	1.7	0.4	1.3	1.5	1.0	9.2
SVD2 1015	2.0	0.6	1.4	0.8	0.9	9.1
SVD2 1215	2.1	0.6	1.4	2.2	0.9	9.1
SVD2 0216	2.0	0.7	1.3	2.5	1.0	9.1
SVD2 0316	2.1	0.8	1.3	2.5	0.9	8.7
SVD3 0815	1.7	0.5	1.2	1.5	1.0	9.1
SVD3 1015	2.4	0.6	1.8	0.9	0.9	9.1
SVD3 1215	2.1	0.5	1.6	2.4	1.0	9.2
SVD3 0216	2.2	0.7	1.5	2.7	0.9	9.0
SVD3 0316	2.0	0.7	1.2	2.5	0.8	8.6
TBD1 0815	2.1	0.4	1.6	1.6	1.4	9.2
TBD1 1015	2.1	0.5	1.7	0.5	1.4	9.2
TBD1 1215	1.9	0.3	1.6	1.7	1.4	9.4
TBD1 0216	1.9	0.7	1.3	1.2	1.9	8.5
TBD1 0316	1.6	0.2	1.4	0.7	1.2	8.4
TBD2 0815	2.3	0.4	1.8	1.6	1.4	9.1
TBD2 1015	2.2	0.5	1.7	0.5	1.4	9.3
TBD2 1215	2.0	0.3	1.7	1.7	1.4	9.5
TBD2 0216	1.9	0.6	1.3	1.2	1.9	8.5
TBD2 0316	1.6	0.3	1.3	0.7	1.3	8.2
TBD3 0815	1.9	0.5	1.5	1.5	1.3	9.0
TBD3 1015	2.1	0.4	1.6	0.5	1.4	9.3
TBD3 1215	1.8	0.4	1.4	1.7	1.4	9.5
TBD3 0216	2.0	0.6	1.4	1.2	1.9	8.7
TBD3 0316	1.7	0.3	1.4	0.8	1.4	8.3
ZD1 1215	2.0	0.6	1.4	1.8	1.2	9.0

ID	Total N	Ammonium N	Organic N	P_2O_5	K_2O	pH
ZD1 0216	1.8	0.6	1.3	1.5	1.1	9.1
ZD1 0316	1.9	0.5	1.4	1.6	0.9	8.8
ZD2 1215	2.2	0.6	1.5	1.9	1.4	9.0
ZD2 0216	1.7	0.6	1.2	1.6	1.1	9.1
ZD2 0316	1.6	0.4	1.2	1.4	0.9	8.8
ZD3 1215	2.0	0.6	1.4	2.0	1.3	9.0
ZD3 0216	1.7	0.6	1.1	1.4	1.1	9.0
ZD3 0316	1.6	0.5	1.2	1.4	0.9	8.7

Appendix B: All data: liquid digestate

Table B-1: Bacterial concentration (log10 cfu/ml) in liquid digestate by sample ID

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Corynebacter	Pseudomonas	Total coliforms	Total other bacteria	Total number bacteria
BL 0815	6.85	0.00	0.00	2.38	3.78	6.29	6.00	6.20	0.00	3.80	6.66	7.06
BL 1215	6.54	6.18	3.59	3.59	0.00	4.06	7.02	0.00	0.00	3.89	7.02	7.19
BL1015	6.44	5.59	0.00	4.07	0.00	5.67	6.94	0.00	6.55	4.07	7.10	7.20
BL 0216	7.19	0.00	5.02	5.02	0.00	6.04	6.45	7.50	0.00	5.32	7.55	7.71
BL 0316	7.50	6.31	4.80	0.00	0.00	6.59	7.50	7.10	0.00	4.80	7.68	7.91
GFL 1115	9.18	9.25	6.58	6.04	0.00	6.13	9.17	0.00	4.74	6.69	9.17	9.68
GFL 1215	7.30	7.12	4.81	4.53	0.00	5.79	7.31	0.00	0.00	4.99	7.32	7.73
GFL 0216	8.22	8.13	5.86	5.10	0.00	6.64	7.67	7.26	0.00	5.93	7.84	8.57
GFL 0316	6.99	7.29	5.47	4.99	0.00	5.84	6.69	6.52	0.00	5.59	6.95	7.59
GML 1115	8.37	8.08	5.40	4.57	0.00	6.11	8.91	0.00	4.80	5.46	8.91	9.07
GML 1215	7.17	6.66	4.28	3.88	0.00	5.24	6.96	0.00	3.58	4.42	6.97	7.45
GML 0216	7.97	7.97	5.22	4.72	0.00	6.23	7.66	0.00	4.58	5.34	7.67	8.37
GML 0316	8.15	7.42	4.63	0.00	0.00	6.76	6.93	6.93	0.00	4.63	7.36	8.28
KSRL 1115	8.34	5.39	2.16	5.55	4.55	0.00	6.16	0.00	5.46	5.59	6.23	8.35
KSRL 1215	6.94	6.43	4.73	4.43	0.00	5.73	7.13	0.00	0.00	4.91	7.15	7.41
KSRL 0216	8.23	8.05	4.30	4.64	0.00	7.26	7.75	0.00	4.00	4.80	7.88	8.55
KSRL 0316	7.15	6.55	4.21	0.00	0.00	6.18	6.99	0.00	0.00	4.21	7.05	7.46
LHL 0815	7.06	0.00	0.00	3.60	0.00	5.18	5.85	0.00	0.00	3.60	5.93	7.10
LHL 1015	8.31	7.32	5.50	3.72	0.00	5.57	7.02	0.00	5.20	5.51	7.05	8.38
LHL 1215	8.68	7.67	4.99	4.73	0.00	6.37	7.29	0.00	0.00	5.18	7.34	8.74
LHL 0316	7.11	7.83	0.00	0.00	0.00	6.90	0.00	0.00	0.00	0.48	6.90	7.95
LL 0815	7.23	0.00	4.79	4.15	5.03	0.00	6.15	5.90	0.00	5.26	6.35	7.29
LL 1015	7.06	7.36	0.00	4.13	0.00	7.20	6.80	0.00	6.26	4.13	7.38	7.76
LL 1215	7.43	6.72	0.00	0.00	0.00	6.32	7.38	0.00	0.00	0.48	7.42	7.77
LL 0216	6.62	0.00	0.00	5.84	0.00	6.99	7.42	5.72	0.00	5.84	7.56	7.62
LL 0316	8.28	8.08	4.74	0.00	0.00	6.37	0.00	7.04	0.00	4.74	7.12	8.51
NBL 1115	8.38	7.57	6.57	5.02	0.00	6.08	8.88	0.00	6.32	6.59	8.88	9.02
NBL 1215	7.10	6.26	4.27	4.45	0.00	6.13	6.92	0.00	0.00	4.67	6.99	7.38
NBL 0216	7.50	6.20	5.16	4.86	0.00	6.54	7.51	6.86	0.00	5.34	7.64	7.88
NBL 0316	7.17	5.97	0.00	4.96	0.00	6.46	6.71	0.00	0.00	4.96	6.90	7.38
NHL 0815	6.45	0.00	0.00	3.78	0.00	5.02	6.31	0.00	0.00	3.78	6.33	6.69
NHL 1015	6.97	5.71	0.00	4.56	0.00	4.82	7.25	0.00	5.19	4.56	7.26	7.45

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Corynebacter	Pseudomonas	Total coliforms	Total other bacteria	Total number bacteria
NHL 1215	7.96	5.13	4.66	3.96	0.00	4.36	7.50	0.00	0.00	4.74	7.50	8.09
NHL 0216	7.85	0.00	5.27	0.00	0.00	4.55	7.16	8.00	0.00	5.27	8.06	8.27
NHL 0316	7.94	7.29	0.00	0.00	0.00	6.43	0.00	0.00	0.00	0.48	6.43	8.04
PL 0815	7.49	0.00	4.90	5.08	5.56	5.60	7.00	0.00	0.00	5.75	7.02	7.63
PL 1015	8.92	8.27	6.85	7.37	0.00	6.97	8.37	7.37	5.67	7.49	8.43	9.12
PL 1215	8.54	8.24	5.84	6.09	0.00	6.88	0.00	7.94	0.00	6.28	7.98	8.79
PL 0216	8.93	6.56	5.82	6.07	0.00	7.12	7.70	8.00	0.00	6.26	8.21	9.01
PL 0316	8.17	8.15	0.00	3.75	0.00	6.34	0.00	6.75	0.00	3.75	6.89	8.47
PVL 1215	7.07	6.33	3.97	3.49	0.00	6.27	7.27	0.00	0.00	4.09	7.31	7.53
PVL 0216	8.50	7.00	5.10	4.52	0.00	6.40	6.62	0.00	4.62	5.20	6.83	8.52
PVL 0316	7.91	6.55	0.00	4.25	0.00	6.48	6.48	7.08	0.00	4.25	7.25	8.01
RL 0815	3.18	0.00	2.60	3.72	3.00	3.85	6.79	0.00	0.00	3.82	6.79	6.79
RL 1015	7.05	6.92	4.35	0.00	0.00	5.14	7.49	6.75	4.44	4.35	7.56	7.75
RL 1215	7.33	7.25	0.00	4.06	0.00	5.97	7.42	0.00	0.00	4.06	7.43	7.82
RL 0216	7.16	6.23	4.16	4.04	0.00	6.52	7.34	7.04	0.00	4.41	7.56	7.72
RL 0316	8.15	7.54	0.00	4.81	0.00	7.09	0.00	7.28	0.00	4.81	7.50	8.32
RVL 1115	8.67	9.01	6.57	4.95	0.00	7.13	8.84	0.00	5.67	6.58	8.85	9.34
RVL 0216	8.58	8.36	4.85	4.87	0.00	6.12	7.49	7.43	0.00	5.16	7.77	8.82
RVL 0316	7.66	7.66	4.62	0.00	0.00	6.69	6.47	7.10	0.00	4.62	7.31	8.05
SHL 1015	6.99	7.03	4.70	4.00	0.00	5.08	6.82	7.12	3.82	4.78	7.30	7.61
SHL 1215	8.00	7.83	6.50	0.00	0.00	6.66	7.30	7.30	0.00	6.50	7.65	8.33
SHL 0216	7.47	6.44	0.00	4.14	0.00	5.82	6.38	7.44	0.00	4.14	7.49	7.80
SHL 0316	8.02	7.83	0.00	0.00	0.00	7.02	0.00	7.63	0.00	0.48	7.73	8.35
SSL 1015	7.20	7.44	5.59	5.07	0.00	6.44	7.37	0.00	3.89	5.71	7.42	7.84
SSL 1215	8.00	7.47	0.00	5.30	0.00	6.88	7.57	6.39	0.00	5.30	7.67	8.25
SSL 0216	7.01	5.93	4.89	4.66	0.00	6.35	7.11	7.36	0.00	5.09	7.58	7.69
SSL 0316	6.61	7.45	5.83	0.00	0.00	6.35	0.00	0.00	0.00	5.83	6.35	7.55
SVL 1015	7.95	6.93	0.00	4.63	0.00	5.88	6.80	0.00	6.63	4.63	7.06	8.04
SVL 1215	8.68	7.31	0.00	0.00	0.00	8.48	8.43	7.83	0.00	0.48	8.81	9.06
SVL 0316	7.95	7.21	0.00	0.00	0.00	6.09	0.00	0.00	0.00	0.48	6.09	8.03
SVL 0815	6.20	0.00	0.00	3.30	0.00	5.03	6.23	5.60	0.00	3.30	6.34	6.58
TBL 0815	5.08	0.00	0.00	2.60	2.30	4.95	5.05	5.60	0.00	2.78	5.78	6.18
TBL 1015	5.90	5.72	3.72	3.42	0.00	4.42	7.20	7.02	0.00	3.90	7.42	7.44
TBL 1215	6.57	6.31	3.39	0.00	0.00	5.35	7.09	7.43	0.00	3.39	7.60	7.66

ID	Strep spp	Staph spp	*E. coli*	*Klebsiella*	Other coliforms	Gram negative	Gram positive	Corynebacter	Pseudomonas	Total coliforms	Total other bacteria	Total number bacteria
TBL 0216	6.85	0.00	0.00	3.41	0.00	5.18	6.72	7.26	3.72	3.41	7.37	7.49
TBL 0316	6.88	6.31	0.00	3.81	0.00	6.36	6.58	0.00	0.00	3.81	6.79	7.20
ZL 1215	7.55	7.65	5.12	4.25	0.00	6.14	7.69	0.00	0.00	5.18	7.70	8.11
ZL 0216	7.56	6.88	0.00	4.44	0.00	6.69	7.08	0.00	0.00	4.44	7.23	7.78
ZL 0316	7.90	8.17	0.00	0.00	0.00	6.97	0.00	7.49	0.00	0.48	7.60	8.43

Table B-2: Select metal concentration (ppm) in liquid digestate

ID	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Molybdenum	Nickel	Zinc
BL 0815	0.00	0.03	0.07	19.42	0.03	446.91	0.13	0.26	11.92
BL 1215	0.00	0.00	0.00	0.38	0.06	229.72	0.03	0.06	0.87
BL1015	0.06	0.01	0.08	10.53	0.07	609.36	0.15	0.28	22.06
BL 0216	0.00	0.00	0.01	2.45	0.03	190.37	0.03	0.06	4.86
BL 0316	0.07	0.03	0.10	8.31	0.06	573.35	0.52	0.14	19.17
GFL 1115	0.00	0.01	0.04	59.14	0.08	574.27	0.11	0.12	9.08
GFL 1215	0.02	0.01	0.04	3.24	0.07	513.19	0.10	0.20	14.41
GFL 0216	0.08	0.03	0.19	80.08	0.12	755.33	0.16	0.26	11.25
GFL 0316	0.07	0.03	0.11	77.07	0.11	704.86	0.14	0.20	9.96
GML 1115	0.00	0.00	0.04	2.15	0.04	212.17	0.05	0.04	4.99
GML 1215	0.02	0.01	0.04	4.22	0.05	564.54	0.14	0.14	11.22
GML 0216	0.06	0.02	0.09	5.81	0.06	561.13	0.32	0.22	10.94
GML 0316	0.06	0.02	0.08	5.50	0.05	569.51	0.17	0.18	11.82
KSRL 1115	0.02	0.01	0.04	3.04	0.07	446.67	0.16	0.45	9.60
KSRL 1215	0.02	0.01	0.03	3.34	0.06	526.21	0.16	0.40	10.90
KSRL 0216	0.07	0.03	0.06	4.40	0.07	563.93	0.19	0.73	11.81
KSRL 0316	0.06	0.02	0.06	3.60	0.07	571.92	0.17	1.13	11.22
LHL 0815	0.00	0.02	0.07	2.67	0.03	359.02	0.08	0.69	10.27
LHL 1015	0.03	0.01	0.04	3.57	0.03	541.82	0.14	0.77	11.65
LHL 1215	0.00	0.00	0.01	0.94	0.03	315.51	0.05	0.44	3.09
LHL 0316	0.05	0.02	0.07	3.75	0.06	535.73	0.15	0.96	12.75
LL 0815	0.00	0.01	0.09	0.71	0.03	195.57	0.02	0.08	3.75
LL 1015	0.05	0.02	0.55	3.50	0.18	536.00	0.17	0.27	12.99
LL 1215	0.00	0.00	0.04	0.10	0.03	169.13	0.03	0.07	0.19
LL 0216	0.00	0.00	0.10	4.63	0.06	213.01	0.05	0.11	5.88
LL 0316	0.04	0.02	0.14	8.77	0.07	312.67	0.09	0.15	9.40
NBL 1115	0.03	0.01	0.00	15.87	0.06	406.41	0.06	0.55	13.49
NBL 1215	0.02	0.01	0.02	16.06	0.05	525.14	0.10	0.61	15.63
NBL 0216	0.06	0.03	0.05	35.47	0.05	577.30	0.11	0.63	15.85
NBL 0316	0.06	0.02	0.05	18.09	0.06	567.25	0.11	0.63	15.13
NHL 0815	0.01	0.02	0.12	2.91	0.03	228.21	0.05	0.45	46.92
NHL 1015	0.05	0.00	0.15	6.64	0.05	475.07	0.09	0.70	77.78
NHL 1215	0.00	0.00	0.00	0.13	0.03	175.33	0.00	0.16	0.38
NHL 0216	0.00	0.00	0.02	1.10	0.03	114.52	0.01	0.15	9.20
NHL 0316	0.05	0.02	0.11	3.23	0.08	378.92	0.10	0.62	42.61

ID	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Molybdenum	Nickel	Zinc
PL 0815	0.00	0.02	0.04	11.53	0.02	267.96	0.04	0.13	8.84
PL 1015	0.11	0.01	0.09	69.56	0.01	693.37	0.12	0.20	21.44
PL 1215	0.09	0.02	0.13	21.76	0.08	834.74	0.19	0.16	14.76
PL 0216	0.01	0.00	0.02	6.42	0.03	258.28	0.02	0.07	5.41
PL 0316	0.10	0.03	0.11	38.10	0.07	584.19	0.14	0.17	12.58
PVL 1215	0.03	0.01	0.06	72.60	0.10	641.60	0.13	0.14	10.40
PVL 0216	0.08	0.03	0.08	4.24	0.08	660.87	0.14	0.33	16.93
PVL 0316	0.06	0.02	0.06	3.25	0.07	494.05	0.11	0.25	12.65
RL 0815	0.02	0.03	0.16	5.72	0.60	384.58	0.14	0.33	10.47
RL 1015	0.14	0.03	0.35	14.74	1.05	748.37	0.27	0.59	18.47
RL 1215	0.00	0.00	0.01	0.54	0.08	266.75	0.02	0.17	1.00
RL 0216	0.00	0.00	0.05	2.16	0.16	138.35	0.03	0.12	3.30
RL 0316	0.12	0.04	0.35	10.11	0.84	667.91	0.29	0.61	16.92
RVL 1115	0.01	0.01	0.04	7.43	0.06	635.48	0.17	0.17	14.36
RVL 0216	0.06	0.03	0.07	8.42	0.07	685.29	0.18	0.21	14.60
RVL 0316	0.08	0.03	0.09	8.22	0.07	602.34	0.16	0.21	13.22
SHL 1015	0.06	0.03	0.18	61.04	0.04	510.58	0.11	0.24	12.84
SHL 1215	0.06	0.02	0.12	37.40	0.10	492.50	0.13	0.11	13.30
SHL 0216	0.00	0.00	0.03	10.18	0.03	197.72	0.03	0.08	5.22
SHL 0316	0.10	0.04	0.10	19.15	0.11	518.93	0.16	0.17	12.52
SSL 1015	0.05	0.02	0.14	3.96	0.61	580.19	0.17	0.28	12.47
SSL 1215	0.00	0.01	0.05	1.30	0.29	303.70	0.07	0.16	4.28
SSL 0216	0.00	0.00	0.04	1.72	0.36	252.63	0.04	0.23	5.84
SSL 0316	0.10	0.05	0.15	4.50	0.71	722.50	0.24	0.55	15.82
SVL 0815	0.01	0.02	0.11	18.91	0.04	536.07	0.23	1.24	19.56
SVL 1015	0.05	0.02	0.58	29.94	0.19	548.46	0.34	0.82	18.48
SVL 1215	0.03	0.02	0.58	36.02	0.17	399.98	0.51	1.01	21.30
SVL 0316	0.07	0.02	0.31	33.12	0.09	432.66	0.35	0.86	16.21
TBL 0815	0.00	0.02	0.09	3.69	0.04	557.96	0.13	0.31	13.72
TBL 1015	0.11	0.01	0.08	5.89	0.03	924.07	0.22	0.30	18.75
TBL 1215	0.01	0.01	0.03	2.87	0.05	481.66	0.11	0.12	9.32
TBL 0216	0.00	0.00	0.01	3.22	0.04	216.49	0.02	0.08	5.89
TBL 0316	0.08	0.03	0.07	11.90	0.08	737.78	0.17	0.24	20.47
ZL 1215	0.00	0.01	0.03	1.49	0.04	487.25	0.06	0.45	6.40
ZL 0216	0.01	0.00	0.05	2.98	0.06	417.33	0.05	0.61	12.57
ZL 0316	0.07	0.02	0.08	3.57	0.07	600.12	0.14	0.53	15.91

Table B-3: Select nutrient concentration (ppm) of liquid digestate

ID	Ammonium Nitrogen	Nitrate + Nitrite	Phosphorus	Potassium	Zinc	Boron	Sulfur
BL 0815	1310.05	0.08	289.53	665.96	11.92	2.72	199.89
BL 1215	1247.55	0.75	10.99	2889.67	0.87	1.45	86.61
BL1015	1647.11	1.26	371.34	1651.64	22.06	2.23	246.75
BL 0216	1386.00	1.46	117.17	889.80	4.86	0.82	77.92
BL 0316	1646.00	1.75	336.99	2450.37	19.17	1.69	295.29
GFL 1115	1015.39	0.93	218.70	2353.16	9.08	1.23	157.59
GFL 1215	1157.59	0.69	383.94	1959.32	14.41	1.27	208.74
GFL 0216	1514.00	1.85	474.44	2453.02	11.25	1.60	281.34
GFL 0316	1497.10	1.59	434.38	2265.25	9.96	1.42	263.88
GML 1115	1118.11	1.24	91.02	2298.66	4.99	0.92	134.19
GML 1215	1292.81	0.86	476.32	2140.04	11.22	1.28	210.56
GML 0216	1541.60	1.65	527.90	2096.18	10.94	1.25	235.90
GML 0316	1580.10	2.43	542.13	2263.02	11.82	1.12	261.42
KSRL 1115	1153.19	1.11	363.77	2380.51	9.60	1.53	261.16
KSRL 1215	1341.93	0.93	438.80	2405.58	10.90	1.49	252.16
KSRL 0216	1579.50	2.10	460.86	2227.79	11.81	1.41	256.69
KSRL 0316	1521.30	2.07	446.37	2238.77	11.22	1.32	267.34
LHL 0815	1408.48	0.07	231.74	673.93	10.27	2.50	207.83
LHL 1015	1576.19	1.01	355.87	1751.26	11.65	1.98	241.25
LHL 1215	1489.89	1.04	82.67	2839.34	3.09	1.36	105.45
LHL 0316	1707.30	2.64	338.51	3022.24	12.75	1.72	249.77
LL 0815	1065.18	0.05	53.24	550.32	3.75	2.14	77.02
LL 1015	1263.73	1.33	502.49	1283.52	12.99	1.79	358.27
LL 1215	1218.40	0.60	6.23	1929.72	0.19	0.87	31.86
LL 0216	1247.00	1.05	174.43	966.45	5.88	0.92	101.10
LL 0316	1591.70	1.16	150.67	2357.15	9.40	1.13	137.90
NBL 1115	1158.84	1.60	237.61	2554.76	13.49	1.28	175.98
NBL 1215	1306.59	1.44	385.07	2245.85	15.63	1.68	213.15
NBL 0216	1490.70	2.21	619.08	2248.30	15.85	1.45	238.49
NBL 0316	1413.50	0.96	598.91	2409.90	15.13	1.39	236.34
NHL 0815	1460.43	0.08	208.23	596.76	46.92	2.18	178.99
NHL 1015	1210.74	0.74	441.05	1386.97	77.78	1.47	226.65
NHL 1215	1063.25	0.48	4.74	1736.91	0.38	0.84	52.46

ID	Ammonium Nitrogen	Nitrate + Nitrite	Phosphorus	Potassium	Zinc	Boron	Sulfur
NHL 0216	1144.00	0.84	89.69	602.41	9.20	0.63	50.54
NHL 0316	1380.00	2.68	264.43	1621.46	42.61	1.35	171.46
PL 0815	615.03	0.02	168.22	590.59	8.84	1.89	214.52
PL 1015	1289.36	0.58	505.19	2173.40	21.44	1.75	379.35
PL 1215	1291.00	0.43	619.50	4695.30	14.76	1.91	450.64
PL 0216	1336.00	1.11	206.17	1699.95	5.41	1.22	122.93
PL 0316	1551.70	0.96	460.35	3932.75	12.58	1.80	354.59
PVL 1215	1177.08	0.63	345.99	2061.87	10.40	1.54	220.18
PVL 0216	1456.30	1.54	519.35	2507.76	16.93	1.47	282.20
PVL 0316	1535.10	1.71	370.14	2175.71	12.65	0.90	206.27
RL 0815	1096.45	0.06	194.28	660.75	10.47	2.03	204.92
RL 1015	1533.25	1.03	453.19	1531.65	18.47	2.11	357.45
RL 1215	1159.16	0.64	8.02	2500.19	1.00	0.86	92.32
RL 0216	1153.00	0.94	72.82	519.93	3.30	0.56	57.23
RL 0316	1450.70	1.24	351.63	2082.37	16.92	1.62	265.61
RVL 1115	1236.85	1.39	272.26	2822.19	14.36	1.76	149.27
RVL 0216	1666.80	2.07	349.44	2970.24	14.60	1.40	209.23
RVL 0316	1609.60	1.98	316.79	2731.28	13.22	1.09	211.79
SHL 1015	1676.62	1.06	498.76	1850.94	12.84	2.15	300.70
SHL 1215	939.11	0.96	524.30	2263.85	13.30	2.17	437.09
SHL 0216	1299.00	1.16	193.89	1175.59	5.22	0.84	101.21
SHL 0316	1546.10	1.64	485.83	2891.93	12.52	1.64	431.65
SSL 1015	1311.49	0.92	475.05	2061.50	12.47	2.10	303.35
SSL 1215	1132.15	0.60	136.05	3208.74	4.28	1.58	142.37
SSL 0216	1299.00	1.17	196.48	1423.84	5.84	1.17	139.62
SSL 0316	1604.30	2.06	561.13	3535.38	15.82	2.37	401.41
SVL 0815	1465.23	0.08	307.42	818.49	19.56	2.84	281.46
SVL 1015	1675.62	1.12	516.74	1856.04	18.48	2.07	343.46
SVL 1215	1204.35	0.65	343.26	2593.83	21.30	2.11	320.54
SVL 0316	1826.40	1.77	417.22	2483.53	16.21	1.59	300.12
TBL 0815	1314.28	0.07	522.59	641.06	13.72	3.13	304.11
TBL 1015	1602.58	1.15	774.92	2088.29	18.75	3.35	394.61
TBL 1215	1304.70	0.77	277.29	3347.37	9.32	2.21	206.75
TBL 0216	1368.00	1.46	157.34	1023.18	5.89	0.98	82.46
TBL 0316	1636.40	1.24	535.34	2835.78	20.47	2.29	288.66

ID	Ammonium Nitrogen	Nitrate + Nitrite	Phosphorus	Potassium	Zinc	Boron	Sulfur
ZL 1215	1263.38	0.91	143.77	3202.91	6.40	1.50	161.39
ZL 0216	1326.00	1.26	339.04	1499.72	12.57	1.43	234.67
ZL 0316	1623.00	1.22	395.43	2304.90	15.91	1.48	299.61

Table B-4: Remaining metal and nutrient concentration (ppm) in liquid digestate

ID	Aluminum	Cobalt	Iron	Manganese	Tin	Vanadium	Sodium	Calcium	Sodium:Calcium
BL 0815	16.52	0.15	35.48	8.74	0.13	0.00	973.11	2964.72	0.33
BL 1215	0.84	0.10	12.01	0.35	0.10	0.00	1734.97	37.50	46.27
BL1015	29.96	0.22	64.53	11.98	0.18	0.04	377.95	4436.97	0.09
BL 0216	6.90	0.06	14.59	3.66	0.19	0.00	127.62	1045.48	0.12
BL 0316	20.73	0.22	50.41	11.60	0.34	0.06	461.27	3636.40	0.13
GFL 1115	74.46	0.09	34.70	9.77	0.49	0.02	3089.35	679.11	4.55
GFL 1215	15.74	0.14	47.36	14.53	0.47	0.04	2917.86	914.62	3.19
GFL 0216	127.86	0.09	68.20	13.67	1.11	0.07	896.52	1314.40	0.68
GFL 0316	116.13	0.07	59.84	12.16	0.90	0.09	806.95	1041.39	0.77
GML 1115	2.01	0.04	10.29	2.92	0.08	0.00	2835.06	216.38	13.10
GML 1215	7.15	0.08	27.90	9.79	0.15	0.03	2828.06	900.77	3.14
GML 0216	10.45	0.35	43.24	17.10	0.33	0.04	667.99	999.18	0.67
GML 0316	10.55	0.16	36.88	12.35	0.20	0.04	675.39	1007.63	0.67
KSRL 1115	10.22	0.12	40.10	7.90	0.28	0.03	2728.75	993.85	2.75
KSRL 1215	10.52	0.13	38.03	9.15	0.21	0.04	3143.49	1273.85	2.47
KSRL 0216	15.11	0.15	42.81	10.05	0.32	0.05	791.33	1435.53	0.55
KSRL 0316	12.93	0.15	37.05	9.66	0.27	0.06	762.58	1378.41	0.55
LHL 0815	9.74	0.23	51.00	7.94	0.10	0.00	1565.25	947.50	1.65
LHL 1015	11.26	0.27	56.10	11.54	0.00	0.03	646.72	1339.90	0.48
LHL 1215	2.04	0.14	18.57	3.09	0.02	0.01	2921.51	315.16	9.27
LHL 0316	9.59	0.33	61.63	11.19	0.14	0.05	827.92	1253.67	0.66
LL 0815	1.75	0.04	33.96	1.44	1.11	0.00	986.29	218.08	4.52
LL 1015	25.61	0.17	508.66	12.65	11.04	0.15	463.09	1977.03	0.23
LL 1215	0.16	0.02	23.10	0.46	0.34	0.01	2080.03	9.40	221.28
LL 0216	8.64	0.06	157.38	4.68	0.59	0.03	221.79	460.51	0.48
LL 0316	9.79	0.09	157.54	6.17	0.45	0.06	588.22	521.99	1.13
NBL 1115	5.83	0.17	29.83	10.92	0.12	0.01	2287.57	645.51	3.54
NBL 1215	8.05	0.21	42.00	15.23	0.10	0.03	2186.51	1295.29	1.69
NBL 0216	10.52	0.23	43.74	15.19	0.17	0.03	653.93	1395.51	0.47
NBL 0316	10.67	0.23	41.84	14.81	0.18	0.05	685.18	1462.84	0.47
NHL 0815	5.10	0.08	14.59	4.54	0.09	0.00	1686.82	614.54	2.74
NHL 1015	9.17	0.11	27.99	9.54	0.00	0.03	620.80	1140.62	0.54
NHL 1215	0.18	0.01	1.26	0.08	0.00	0.00	2153.07	8.97	240.03
NHL 0216	2.52	0.01	5.51	2.26	0.05	0.00	157.77	226.23	0.70
NHL 0316	8.42	0.11	31.29	7.75	0.21	0.05	594.12	732.26	0.81

ID	Aluminum	Cobalt	Iron	Manganese	Tin	Vanadium	Sodium	Calcium	Sodium:Calcium
PL 0815	8.51	0.13	19.95	5.90	0.08	0.00	730.63	604.57	1.21
PL 1015	30.88	0.20	58.10	13.10	0.10	0.04	341.40	4535.81	0.08
PL 1215	32.87	0.17	69.39	15.79	0.39	0.06	1025.74	4296.80	0.24
PL 0216	9.94	0.06	18.88	4.96	0.16	0.00	125.96	1306.87	0.10
PL 0316	32.62	0.19	49.60	13.02	0.42	0.06	303.31	3703.04	0.08
PVL 1215	83.49	0.08	50.41	11.96	0.64	0.05	2723.60	935.37	2.91
PVL 0216	21.77	0.20	72.11	19.34	0.79	0.06	1137.82	1359.78	0.84
PVL 0316	17.25	0.15	42.35	13.59	0.60	0.06	893.65	822.87	1.09
RL 0815	32.85	0.11	36.71	6.22	0.73	0.08	1222.85	1783.47	0.69
RL 1015	81.46	0.19	88.15	14.04	1.16	0.21	565.34	4786.03	0.12
RL 1215	0.89	0.05	8.68	0.52	0.09	0.02	2619.86	19.80	132.32
RL 0216	13.21	0.02	13.88	2.47	0.30	0.03	109.21	679.39	0.16
RL 0316	75.39	0.21	83.72	12.91	1.45	0.23	693.65	3754.26	0.18
RVL 1115	10.80	0.06	35.91	10.40	0.30	0.02	4337.78	926.05	4.68
RVL 0216	22.23	0.09	46.58	11.57	0.71	0.06	1190.22	979.18	1.22
RVL 0316	17.99	0.09	40.53	10.86	0.56	0.06	1036.39	925.51	1.12
SHL 1015	22.25	0.18	48.29	13.20	0.01	0.10	823.49	1974.24	0.42
SHL 1215	19.85	0.15	48.28	13.24	0.17	0.10	3250.21	2123.81	1.53
SHL 0216	6.71	0.07	16.68	4.96	0.15	0.03	392.21	620.55	0.63
SHL 0316	20.24	0.20	43.55	13.08	0.40	0.12	1103.68	1861.64	0.59
SSL 1015	62.07	0.23	54.83	10.93	0.80	0.20	566.56	5191.66	0.11
SSL 1215	23.81	0.13	22.89	3.80	0.55	0.11	2511.55	1449.55	1.73
SSL 0216	27.20	0.11	26.36	4.69	0.59	0.09	262.18	1548.27	0.17
SSL 0316	59.30	0.30	75.77	12.84	1.18	0.22	751.03	4762.85	0.16
SVL 0815	21.40	0.57	48.03	14.33	0.25	0.06	2703.92	1636.81	1.65
SVL 1015	30.74	0.73	563.47	20.05	10.83	0.22	732.70	2153.87	0.34
SVL 1215	19.18	0.66	713.39	16.61	5.79	0.17	2710.44	1728.21	1.57
SVL 0316	16.51	0.76	909.19	16.35	1.19	0.19	757.13	1604.32	0.47
TBL 0815	23.36	0.12	58.79	11.53	0.22	0.03	1411.35	1257.48	1.12
TBL 1015	20.68	0.16	74.85	18.67	0.00	0.04	649.15	2060.61	0.32
TBL 1215	6.80	0.11	31.70	7.77	0.07	0.02	3024.96	762.99	3.96
TBL 0216	4.73	0.04	16.70	3.87	0.07	0.00	214.13	397.38	0.54
TBL 0316	16.26	0.14	60.19	15.00	0.23	0.05	702.10	1571.86	0.45
ZL 1215	4.95	0.12	17.80	6.01	0.23	0.01	3576.10	658.57	5.43
ZL 0216	9.78	0.15	30.42	9.42	0.21	0.01	437.83	1335.26	0.33
ZL 0316	12.60	0.20	38.25	13.10	0.41	0.05	638.31	1614.47	0.40