Impacts of manure application timing and tillage practices on antibiotic resistant bacteria and genes in drainage water from manured fields

by

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DEDICATION

This thesis is dedicated to my dad, Dr. Daniel Guyer. Thank you for setting an example that I could not help but want to follow. From the same high school, to the same undergraduate program at Michigan State, on to graduate school in the same program (only I was at the better school), I have truly been proud to follow in your footsteps. Thank you for always being ready to remind me that "grad school can be fun" no matter the context. I will never have the words to thank you enough for being my rock, through my graduate degree and beyond.

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ABSTRACT

Agriculture is an economic cornerstone in Iowa and the surrounding states, as well as arguably the entire United States as a whole. However, there is growing concern about the use of antibiotics in the animal agriculture sector and its contribution to antibiotic resistance (Levy & Marshall, 2004). Yet it is still unclear how antibiotic resistance is affected by environmental factors at the field scale and what mechanisms can be utilized to minimize the transport. This three-year study monitors both phenotypic and genotypic antibiotic resistance markers in subsurface drainage from research plots with varying manure application times and tillage practices. Enterococcus and tylosin and tetracycline-resistant Enterococcus were monitored as well as three antibiotic resistant genes (*ermB, ermF, tetM)* to 1) quantify antibiotic resistant bacteria (ARB) and antibiotic resistant genes (ARGs) in subsurface drainage 2) evaluate the impact of field management practices, manure application timing and tillage both the antibiotic resistant bacteria (ARB) and antibiotic resistant genes (ARGs), and 3) assess relationships between phenotypic and genotypic indicators of antibiotic resistance. Results of the study show overall low levels of both ARB and ARGs leading to further research questions with the targeted improvement of new methods. Although recommendations on specific field management practices best suited to minimize ARB and ARG transport cannot be drawn from the results of this study, it was shown that manure application in the spring had the strongest potential for future research.

CHAPTER 1. INTRODUCTION

Agriculture is an economic cornerstone in Iowa and the surrounding states, as well as arguably the entire United States as a whole. However, there is growing concern between the overlap of the medical field and the agricultural sector as the use of antibiotics in animal agriculture continues to contribute to antibiotic resistance in the environment (Levy & Marshall, 2004). The World Health Organization calls antibiotic resistance "one of the biggest threats to global health, food security, and development today".

Veterinary antibiotics from animal agriculture has been traced through the environment after the manure from the animal feeding operations is used as a nitrogen amendment to promote crop growth (Hoang, Soupir, & Liu, 2013). Previous research has shown that drainage from fields amended with manure have a significantly higher level of antibiotic resistance makers when compared to drainage from fields who have not received manure application (Luby, Moorman, & Soupir, 2016). However, little research has been done to investigate what, if anything, can be done at the field scale to minimize transport of antibiotic resistant bacteria or antibiotic resistant genes through subsurface drainage and into the environment.

Many studies have monitored the impacts of agricultural systems on nutrient export, but far less is known about the emerging issue of antibiotic resistance and its transport through agricultural systems. The goal of this study is to characterize antibiotic resistance in drainage coming from plots receiving manure at different time points throughout the season, as well as different tillage practices. It is the hope that this information will provide insight as to which practices best reduce transport, so a set of best management practices may be passed on to stakeholders. By collecting and analyzing weekly subsurface drainage water grab samples from research plots with varying treatments we hope to 1) quantify in subsurface drainage enterococci and tetracycline and tylosin-resistant enterococci and genes associated with resistance (*erm*B, *erm*F, and *tet*M), 2) evaluate the impact of field management practices, manure application timing and tillage both the antibiotic resistant bacteria (ARB) and antibiotic resistant genes (ARGs), and 3) assess relationships between phenotypic and genotypic indicators of antibiotic resistance.

CHAPTER 2. LITERATURE REVIEW

2.1 Agriculture in Iowa and the Midwest

2.1.1 Overview

Iowa is located in the portion of the United States often called the corn belt, referring to the agricultural dominance in the area. Although Iowa does produce a large share of traditional rotational crops like corn and soybeans, it is also widely known for its swine production. In fact, Iowa ranks first in the nation for swine production, with 20.4 million in 2016 alone (USDA, 2016). Along with the growing number of swine, there has also been an increase in the size of the feeding operations. In 2012, over 65% were grown in operations of over 5000 swine (USDA, 2014). Livestock production facilities, regardless of size, produce huge amounts of manure annually. All of the livestock in Iowa produce about 50 million tons of manure annually (Anderson, 2014). If it is able to be obtained locally, manure is a low cost alternative to synthetic nitrogen sources for applying to crop fields, making it a highly valuable commodity. Although the production numbers may sound high, there are so many acres of crops in Iowa that need application that only 17% of Iowa's farmable acres receive manure in any given year (Anderson 2014). This shortage, along with environmental concerns, has created a push in the industry to use manure wisely and effectively.

2.1.2 Drainage Practices

Subsurface drainage tiles are used extensively throughout the Midwest agricultural sector to make otherwise unproductive soils able to support crops. This practice has increased throughout the last century in Corn Belt region. Millions of acres have been drained, with an estimated 8 million acres drained in Iowa alone, and numbers may be even higher in other states (Schilling, Keith E.; Helmers, 2010). It is estimated that 25% of cropland in the United States and Canada could not be productive without the use of subsurface drainage (Schilling, Keith E.; Helmers, 2010).

Tile drainage is used to lower the water table and drain wet soils from frequently inundated fields through a series of pipe networks installed below the fields (Schilling, Keith E.; Helmers, 2010). This is especially essential in the Midwest region with its cool humid climate. Without the drainage, many of the fields would be too wet for farm machinery and potentially damage the crops.

However, it should be noted that the benefits of tile drainage do not come without drawbacks. The installation of the pipes alters the hydrologic and ecologic organization wherever installed (Sloan, 2013). There is generally no treatment of drainage waters before being discharged, which means the installation of tiles greatly increases the connectivity between fields and the stream network (Schilling, Keith E.; Helmers, 2010). Research shows that this increased connectivity allows for the transport of nutrients in a greater capacity off the fields and into surface water (Schilling, Keith E.; Helmers, 2010). However, the transport of bacteria, unlike nutrients, has not been as widely studied.

2.1.3 Tillage Practices

Tillage has traditionally been used for weed control and pest elimination, however, recent research has shown that different tillage practices can have added benefits (Wade, Claassen, & Wallander, 2015). No till farming has particularly become of interest, as it has been shown that it is very effective in minimizing crop residue disturbance, soil evaporation, and erosion losses, while increasing carbon sequestration (Lal, Reicosky, & Hanson, 2007). No till at the top surface and maintaining the residue can reduce soil temperature, maintain soil moisture, and protect the soil from excessive wind and sunlight as well as leave the macropore channels intact (Wade et al., 2015). Using smoke tests, Hruby et al. (2016) found that higher densities of surface connected macropores were found in no till plots compared to chisel plow plots, suggesting that no till plots have a greater number of macropore connections.

Although it is thought that that no till plots can increase infiltration, and thus transport of nutrients and bacteria, there has not been differences found between no till tillage as compared to chisel plow tillage when it comes to gene concentrations (Garder, Moorman, & Soupir, 2014; Luby, 2014). However, some studies have reported increased fecal bacteria in tile drainage under no till plots when compared to the tilled counterparts (Pappas, Kanwar, Baker, Lorimor, & Mickelson, 2008; Samarajeewa et al., 2012). Interestingly, Samarajeewa et al. (2012), suggets that the timing of tillage application can influence the movement of fecal contaminates post manure application, but more research is needed in the area.

2.1.4 Manure Application Practices

The timing of manure application has been proven to have effects on nutrient transport (Sawyer & Mallarino, 2008), but its effects on bacteria transport has not been widely studied. Generally, the type of manure, weather conditions, and storage availability are the important factors that drive the application timing decision for farmers. The ultimate goal for everyone is to optimize all factors to ensure the maximum manure benefit, while also minimizing pollution potential from the manure, but that is often a tough goal to achieve (Pappas et al., 2008).

Although most only think of nutrient pollution, like nitrogen, fecal bacteria pollution is another potential harmful side effect of application. Research has found that fecal bacteria levels in drainage below manure amended fields increases significantly as quickly as 20 minutes after application (Stoddard, Coyne, & Grove, 1998). A study by Joy et al. (1998) found tracer bacteria downstream of tile drainage discharge points that could be connected back to dairy manure application. Research so far has attributed the connection between manure application and timing through drainage tiles largely to precipitation rates (Samarajeewa et al., 2012). A direct connect between seasonal application timing and bacteria transport has yet to be found.

Along with application timing, application rates can also vary. The crop fertilization requirements are the biggest driver behind this factor, largely focusing on nitrogen (Sawyer & Mallarino, 2008). The effect of application rate variance on tile water bacteria concentrations is largely variable between existing studies (Hruby, Soupir, Moorman, Shelley, & Kanwar, 2016). This could indicate that the cause of the variance could be from a source other than application rate variance. Pappas et al. (2008) who also was focusing on swine manure, found no differences between bacteria concentrations in tile waters beneath plots with varying manure rates.

2.2 Antibiotics and Antibiotic Resistance

2.2.1 Antibiotic Use in Agriculture

The use of pharmaceuticals has become integral to animal agriculture industry as we know it today. Antimicrobials have been used in livestock farming to prevent and treat infections, increase growth, and improve feed efficiency since the early 1950s (Kemper, 2008). As the demand increases for animal products, the demand for the antibiotics associated with animal production increases consequentially. It is estimated that X% (find updated figure) of all antibiotics produced in the United States in a year are used for animal agriculture.

Antimicrobials can be administered for either therapeutic purposes or subtherapeutic purposes. Antibiotics administered therapeutically are given to animals who have an illness in order to treat it. Subtherapeutic uses are those that are given at levels below the therapeutic dose in order to prevent disease outbreaks, improve animal growth, and increase feed efficiency.

Antibiotics can be classified as either medically important or non-medically important, referring to their relation to human medicine. Medically important classes of antimicrobials are those that are used in human medicine and include the two classes of antibiotics used in this study; macrolides (tylosin) and tetracycline.

2.2.2 Veterinary Feed Directive

The landscape of antibiotic use in animal agriculture was shifted in 2015 when the United States Food and Drug Administration (US FDA) implemented the veterinary feed directive (VFD) section to the Animal Drug Availability Act of 1996. Overall, the VFD regulates how some antibiotics can be used in feed and water for food-producing animals. It aims to eliminate the use of such drugs for sub-therapeutic uses and only allows judicious therapeutic uses under supervision of a licensed veterinarian (Schulz & Rademacher, 2017). Ultimately, the goal is significantly lower the quantity of antibiotics being introduced into the system. As the VFD is still a relatively new change to the animal production industry, there is very limited research published with post-VFD implementation data, meaning long term impacts in the United States are still unknown.

2.2.3 Antibiotic Pathway to the Environment

Antibiotics are naturally occurring in the environment, however, this natural process has been exploited by humans to combat disease. Though there are vectors to the environment through consumer and commercial medicine, one of the most prevalent ways for antibiotics to reach the environment is through the agricultural sector. In some cases, up to 90% of the antibiotics fed to animals may pass through the animal into their excrement (Kumar et al., 2005). This manure is then applied as a nitrogen amendment to crop land and the resistance bacteria and genes are introduced into the agricultural environment. Previous research has shown that the antibiotics, bacteria, and genes have the ability to migrate from the field surface to ground water (Kay et al., 2004). This process can be expedited by subsurface tile drainage, as its intent is to expedite the drainage process. Tile lines often drain directly into surface waters, and because they are considered nonpoint sources, the effluent is not highly regulated.

CHAPTER 3. METHODS

3.1 Study Site

This study took place at Iowa State's Northeast Research and Demonstration Farm (NERDF) near Nashua, IA from April 2016 to October 2018. The farm has 36 1-acre (4047 m^2) plots (Figure 1), each outfitted with individual subsurface drainage located 1.2 m below the surface. Additionally, border drains are outfitted along the edge of each plot to ensure no cross flow between plots. At the outlet of each plot's drain, there is an access to collect effluent, as well as a flow meter to monitor total flow out of the drainage pipe. Soils at the site are considered moderately well drained to poorly drained and classified as Kenyon silty-clay loam and Readlyn loam overtop glacial till, which are typical to the region. Slopes are low, ranging from just 1-3% (Luby et al., 2016).

Fifteen plots (Table 1) were chosen each year based on their crop rotation stage, tillage practice, and nitrogen application. Samples were obtained only from plots that received nitrogen application in the form of swine manure or Urea Ammonium Nitrate (UAN) (Table 1) within that year. As a consequence, some plots were not sampled every year, specifically when they were in a soybean phase of a corn-soybean rotation and thus did not receive nitrogen application. The fifteen plots sampled represent four different treatment combinations and one control treatment in triplicate (Table 1). Non-manure control plots received UAN and have not been had inputs of manure since 1978. Plots were only sampled in the corn rotation because nitrogen application in the form of manure is the hypothesized to be where the ARBs and ARGs are originating. manure application. Generally, manure can be applied months in advance of crop planting in the fall or in the spring shortly before planting. Our manure applications in this experiment and included application early in the fall (EFM), late in the fall (LFM), or in the spring (SM) shortly before plot monitoring and sampling began. The first treatment that varies between plots was the timing of when each received their nitrogen. No manure control plots received their UAN application in the spring. The second treatment of the experiment included two different tillage practices, chisel plow (CP) and no till (NT). Tillage practices were only compared within the early fall manure application to ensure any potential differences could be attributed to tillage and not manure application time.

Figure 1. Numbering system of plots located at the Iowa State University Northeast Research Farm (ISU NERF).

Table 1. Sampled plots and corresponding treatments for each year of study

System Number	Plot Numbers	Manure Application Time	Nitrogen Application Rate	Tillage	Crop
1	10,15,29 (16/18) 3,24,28 (17)	Control - UAN	150 lbsN/ acre	Chisel Plow	Rotational Corn
2	1,7,30 (16/18) 11,23,27 (17)	Early Fall (EFM)	200 lbsN/ acre	Chisel Plow	Rotational Corn
3.2	6,32,36 (16/17/18)	Spring (SM)	200 lbsN/ acre	Chisel Plow	Continuous Corn
4.1	5,21,26 (16/17/18)	Early Fall (EFM)	200 lbsN/ acre	No Till	Continuous Corn
6	2,16,20 (16,18) 14,25,31 (17)	Late Fall (LFM)	150 lbsN/ acre	No Till	Rotational Corn

3.2 Sample Collection

Tile drainage samples were collected from the outflow of each designated plot's effluent starting when flow began in the early Spring and concluding with the stoppage of flow in the late Fall. A total volume of 2000 mL in the form of grab samples were taken every week throughout the drainage season, whenever flow was available from the plot. Flow meter readings were recorded, regardless of apparent flow. The number of samples each year varied due to the length of the drainage season and each plot's individual flow. The samples were collected in two 1-liter plastic bottles and transported on ice back to the Water Quality Research Lab (WQRL) at Iowa State University. Samples were then immediately processed upon arrival or stored in a 4^{o}C refrigerator and processed within 24 hours.

Table 2. Quantity of samples collected each year by manure application time

	EFM	LFM	SM	Control	Overall
2016	97	60	44	35	236
2017	76	46	30	38	190
2018	113	53	55	47	268

3.3 Antibiotic Resistant Bacteria Phenotypic Analysis

All water samples were analyzed for growth of enterococci, tetracycline-resistant enterococci, and tylosin-resistant enterococci within 24 hours of collection. Membrane filtration of 300 mL of sampled water through a 0.45-micron filter, as described by APHA (1998), was performed three times for each sample. The three filters were placed on either mEnterococcus agar, mEnterococcus agar spiked with tetracycline (16 μg/mL), or mEnterococcus agar spiked with tylosin (35 μg/mL). All plates were incubated at 35°C for 24 hours to allow for bacterial growth. After incubation, each plate was enumerated and recorded in colony forming units (CFUs) per 100 mL of water filtered.

3.4 Genotypic Analysis

3.4.1 DNA Extraction

First, 250 mL of water sample was filtered through a 0.22-micron filter and placed into a bead tube (Qiagen) within 24 hours of sample collection. Bead tubes were frozen at -80°C until the full extraction process could be completed. Qiagen DNeasy PowerWater kits were used for the extraction process. This protocol isolates genomic DNA for gene identification and quantification (Luby et al., 2016).

3.4.2 Wafergen SmartChip Real-Time PCR

The detection and quantification of ARGs was performed using the Wafergen SmartChip Real-Time PCR system (Michigan State University) and select gene probes. The Wafergen Smartchip Realtime PCR system allows for high throughput qPCR assays within a small reaction volume and allows for many sample and assay combinations. We targeted three genes that have previously been shown to be associated with manure but not highly abundant in the natural environment (Choi et al., 2018). Probes targeting *erm*B and *erm*F genes were selected to represent the erythromycin family, and a probe targeting tetM was selected to represent the tetracycline family (Stedtfeld et al., 2018). A probe targeting the 16s ribosomal RNA gene was also used to evaluate total bacteria presence. Additionally, for each gene assay, a set of standards ranging from 0 to 10^8, with a total of 8 dilutions, were included with each set of samples.

CHAPTER 4. RESULTS

4.1 Manure

4.1.1 Fecal Indicator Bacteria in Manure

Manure samples were available for the second two years of data collection, and fecal indicator bacteria plating was performed to estimate total Enterococci and antibiotic resistant Enterococci. Over the two years of samples and all manure application times, concentrations varied greatly, up to an order of magnitude, for enterococci and both types of resistant enterococci. Enterococci concentrations ranged from $5x10^5$ to $6x10^6$ CFU/100mL. Tetracycline-resistant enterococci bacteria concentrations ranged from 7×10^5 to 6.0×10^6 CFU/100mL, and tylosin-resistant enterococci bacteria ranged from 6×10^5 to 5.0×10^6 CFU/100mL (Table 3).

Table 3. Concentrations for resistant and non-resistant enterococci in applied manure. Both Late Fall systems are treated as on sample. Values are averages of serially diluted manure samples.

Manure Application Time		**Enterococci**	**Tetracycline Resistant Enterococci**	**Tylosin Resistant Enterococci**
Early	2016	5.05E+06	5.99E+06	5.30E+06
	2017	3.91E+06	2.50E+06	2.79E+06
Late Fall	2016	5.58E+05	6.50E+05	5.93E+05
	2017	5.78E+06	1.86E+06	1.23E+06
Spring	2017	2.07E+06	1.95E+06	1.81E+06
	2018	4.79E+05	8.71E+05	8.86E+05

4.1.2 Resistance Genes in Manure

The two years of manure samples were also used for estimations of the abundances of the 16s rRNA and three resistance genes (*erm*B, *erm*F, *tet*M). All genes were detected in all years and applications of manure, however, in nearly all cases, detections were below the limit of quantification, so exact copy numbers were unable to be estimated.

4.1.3 Antibiotic Analysis of Manure

All manures in this study, with the exception of Spring 2016, were sent out for external antibiotic analysis. A suite of antibiotics in many different classes were tested. Fall manures from 2015 and 2016 both showed detectible levels of tylosin and was not tested for tetracyclines. Fall manure from 2017 and Spring manure from 2018 showed high levels of tetracycline but was not tested for tylosin.

4.2 Total Fecal Indicator Bacteria and Antibiotic Resistant Bacteria

4.2.1 Yearly Variation

Total enterococcus concentrations varied between each sampling year and were generally low. Drainage samples from 2016 had the highest median concentration with 7 CFU/100mL, followed by 2018 and 2017 at 6 CFU/100mL and 1 CFU/100mL, respectively (Table 4). Samples from 2017 were significantly different (Wilcoxon Ranked Sums, α = 0.05) than 2016 and 2018, however, 2016 and 2018 were not significantly different. This indicated that years may not be combined for analysis.

Tetracycline resistant Enterococcus were significantly different ($\alpha = 0.05$) in 2016 than other sampling years. Tetracycline resistant Enterococcus were detected in 63.5% of all samples, whereas only 37.3% of samples in 2018 and 16.8% of samples in 2016 had detection. Although the 2016 median concentration was <1.0 CFU/100mL, the maximum value was 72 CFU/100mL (Table 5). Similar to total enterococcus, 2018 was the next highest year with far lower detected growth of tetracycline resistant Enterococcus. The maximum concentration was nearly 3.5 times lower at 22CFU/100mL, and the median concentration was also >1CFU/100mL. 2017 manure samples had extremely low detection with a median concentration of < 1 and a maximum of only 4 CFU/100mL.

Tylosin resistant enterococci concentrations were extremely low over all three years of this study (data not shown). Median concentrations for all years were <1 CFU/100mL, and the maximum value observed over all three years was 8 CFU/100mL. The highest detection percentage followed previous trends, with 2016 being the highest (25.4%) followed by 2017 (16.8%) and 2018 (13.4%). Due to the low overall concentrations and detection, further analysis was not performed.

Table 4. Median total enterococcus concentrations by year

	Enterococcus					
	2016		**2017**		**2018**	
	Median	**St Deviation**	**Median**	**St Deviation**	**Median**	**St Deviation**
Early Fall	6	223	12	16	5	13
Late Fall	11	25	>1	9	5	16
Spring	9	19	3	16	7	13
Control	5	20	>1	7	8	15
Total	7	22	1	13	6	14

Table 5. Median tetracycline-resistant enterococcus concentrations by year

	***Enterococcus* + Tetracycline**					
	2016		**2017**		**2018**	
	Median	**St Deviation**	**Median**	**St Deviation**	**Median**	**St Deviation**
Early Fall	1	8	>1	>1	>1	2
Late Fall	2	17	>1	1	>1	>1
Spring	1	15	>1	>1	>1	1
Control	>1	5	>1	>1	>1	>1
Total	1	12	>1	>1	>1	3

Table 6. Percent detection of enterococcus concentrations by year

	Enterococcus					
	2016		**2017**		**2018**	
	Samples with Detection	**Percent Detection**	**Samples with Detection**	**Percent Detection**	**Samples with Detection**	**Percent Detection**
Early Fall	80	82.5%	57	75.0%	99	87.6%
Late Fall	56	93.3%	34	73.9%	46	86.8%
Spring	36	81.8%	24	80.0%	51	92.7%
Control	30	85.7%	23	60.5%	45	95.7%
Overall	202	85.6%	138	72.6%	241	89.9%

Table 7. Percent detection of tetracycline-resistant enterococcus concentrations by year

	***Enterococcus* + Tetracycline**					
	2016		**2017**		**2018**	
	Samples with Detection	**Percent Detection**	**Samples with Detection**	**Percent Detection**	**Samples with Detection**	**Percent Detection**
Early Fall	59	60.8%	13	17.1%	41	36.3%
Late Fall	45	75.0%	10	21.7%	21	39.6%
Spring	28	63.6%	8	26.6%	23	41.8%
Control	18	51.4%	1	2.6%	15	31.9%
Overall	150	63.5%	32	16.8%	100	37.3%

Table 8. Percent detection of tylosin-resistant enterococcus concentrations by year

	***Enterococcus* + Tylosin**					
	2016		**2017**		**2018**	
	Samples with Detection	**Percent Detection**	**Samples with Detection**	**Percent Detection**	**Samples with Detection**	**Percent Detection**
Early Fall	24	24.7%	11	14.5%	15	13.3%
Late Fall	25	41.7%	9	19.6%	7	13.2%
Spring	8	18.2%	11	36.7%	8	14.6%
Control	3	8.6%	1	2.6%	6	12.8%
Overall	60	25.4%	32	16.8%	36	13.4%

4.2.2 Comparison Between Manure Application Times

The plots sampled received manure at one of three time points; early fall, late fall, or spring. As well as a set of control plots that did not receive manure application during any time point and have not for decades. Control plots receiving no manure had the lowest percent detection of both tetracycline and tylosin ARBs throughout all three study years.

Drainage samples coming from plots receiving manure application in the late fall had the highest median concentration of tetracycline resistant Enterococcus (2 CFU/mL) and the highest percent detection (75.0%) and were the only treatment that was significantly different from the control (Wilcoxon Ranked Sums, $\alpha = 0.1$). Spring manure had the next highest percent detection at 63.6%, followed closely by Early Fall application at 60.8%. Tylosin ARBs mirrored tetracycline ARBs and also had the highest percent detection in 2016 in late fall application (41.6%).

In 2017 and 2018, samples associated with spring manure application were observed to have the highest percent detection of tetracycline-resistant enterococcus (26.7%, 41.8%) and tylosin-resistant Enterococcus (36.6%, 14.5%), although these datasets were not nearly as large as 2016.

4.3 Antibiotic Resistant Genes

Overall, detection of all resistance genes (*erm*B, *erm*F, *tet*M) was very low across all years, and thus all years were grouped together for analysis. *Erm*F had the highest percent detection across all samples at 4.7%, followed by *erm*B at 4.1% detection, and *tet*M with the least at 2.3% detection.

Plots receiving manure in the spring consistently had higher detection across all three resistance genes tested when compared to plots receiving manure at either time point in the fall or to control plots receiving no manure. *Erm*B and *erm*F both were detected in 14.7% of SM plots, and *tet*M was detected in 9.8% of SM plot samples. Drainage from plots receiving manure in the late fall had the highest percent detection across all ARGs tested, with *erm*F detected most often (7.1%), followed by *erm*B (4.5%), and *tet*M (2.5%). Both early fall plots and control plots had <2% detection for all ARGs. Overall, *tet*M had the highest median copy number with 3×10^4 copies/100mL followed by *erm*B and *erm*F both at 7×10^3 copies/100mL.

CHAPTER 5. DISCUSSION

Throughout the experiment, we observed that antibiotic resistance in drainage coming from plots receiving manure was generally low. The highest yearly median concentration of the total fecal indicator bacteria, Enterococcus, was less than one third of the US EPA recreational water quality limit of 33 CFU/100mL. Both tetracycline and tylosin resistant enterococcus median concentrations were less than 1 CFU/100mL. This indicates that the drainage coming from one plot is not inherently a risk on its own, however, comparisons to a global standard should be made with caution as they were not intended to be directly applied to this situation. Low overall concentrations in drainage do not necessarily mean that there is no resistance within the system, but indicate that perhaps other parts of the system, such as soil, might be harboring the resistance.

Total enterococci and ARB concentrations found in this study are systematically lower, yet comparable, to other studies performed at the same location in previous years. A study published by Luby et al. (2016) reported overall higher total enterococcus concentrations ranging from >1 to 110 CFU/100mL and similar low tylosin-resistant enterococci concentrations of <1 CFU/100mL. Similarly, a study also done at the same location by Garder et al. (2014) reported average enterococci concentrations of about 100 CFU/100mL or below. Neither Garder et al. nor Luby et al. considered tetracycline ARBs.

A key characteristic of our results, similar to other environmental studies, was high yearly variation. In this study, the second sampling year (2017) had significantly lower levels of total enterococcus observed compared to 2016 and 2018. This variation could be attributed to different yearly climate patterns, as both 2016 and 2018 had higher seasonal rainfall than 2017. However, there has not been a correlation between enterococci concentrations and drainage flow found in the past (Garder et al., 2014; Luby et al. 2017). It is possible that the weekly grab sampling scheme either underestimated or sometimes missed large flushes of total enterococcus and ARB concentrations due to precipitation patterns (Hoang et al., 2013), or that other environmental factors, such as precipitation, could influence yearly variation. Previously, it has been suggested that the greatest transport often occurs in the rising limb or peak of the hydrograph (Cullum, 2009), which was often missed with the sampling scheme utilized. As a result of the observed yearly variation, our ability to identify temporal patterns over this three-year study were weakened and thus we concentrated on characteristics observed across all three years rather than individual years.

Similar to ARBs, antibiotic resistant gene detection in this study were observed to be low, and lower than other comparable studies at the same site. Luby et al. (2016) was able to report detection of *erm*B and *erm*F (*tet*M not studied). *Erm*B showed up to 82% detection and *erm*F showed up to 44% detection in drainage from manured, as compared to this study which reports the highest percent detection of 14.8% in a manured system for both *erm*B and *erm*F. Garder et al. (2014) reported even higher percent detection for *erm*B and *erm*F. This study found copy numbers comparable to Garder et al. (2014), but higher than Luby et al. (2016). However, it should be noted that because this study reported far less data over the limit of quantification, the dataset is not robust enough to draw any definitive conclusions between studies.

Previous research has only compared differences between plots receiving manure and plots not receiving manure amendments. This study considers differences between the timing of the application of the manure in either early fall (EF), late fall (LF), or spring (SM). Previously, there have been no significant differences detected in tylosin-resistant enterococci in tile water between plots receiving manure and plots not receiving manure (Garder et al. (2014), Luby et al. (2017)). This study found similar results with low tylosin ARB detection. Tetracycline ARB were more often detected, however, only one manure application time in one year (2016 LFM) was found to be significantly different than the control. Low detection of ARB could indicate that the sampling scheme is missing the largest flushes of ARBs in drainage, or perhaps that no single plot is contributing a detectable amount and that efforts are better focused on larger scale studies.

Although research has not shown differences between manure application in ARBs, there has been significant differences shown in ARGs in drainage from plots receiving manure and plots not receiving manure in the fall (Luby et al., 2016). This study confirms that LFM and SM had a higher percent detection of ARGs when compared to control, however, the same cannot be said for EFM, whose percent detection was comparable to the control. It is possible that this could be attributed to the sampling scheme, as EFM sees the greatest lag time between manure application and when drainage flow sampling commences. It is important to note that in this study, the highest percent detection of all ARGs came from plots receiving SM. This could again be a function of the sampling scheme, however, further research on the SM application time, could show if this manure application time should be avoided due to ARG transport through tile waters, as other studies have only considered fall manure application.

Some research has suggested that antibiotic losses were higher from no-tillage plots compared to those tilled with chisel plow, potentially as a result of higher macroporosity in no-tillage plots (Dolliver, Gupta., 2007). However, previous research has shown that this has not been mirrored in tile drainage effluent, and no significant differences have been found between plots tilled with a chisel plow and plots with no tillage (Garder et al. (2014), Luby et al. (2017)). This study confirms these findings, however, tillage was only compared within the EFM application, which had the lowest percent detection at <1% for all three ARGs. If further research is to be conducted on tillage, this study suggests that conducting this research on plots receiving SM could provide the largest dataset, especially in the case of ARGs, and thus provide the most insight.

Finally, an objective of this study was to determine if we could analyze a connection between the phenotypic and genotypic indicators utilized in this experiment. Although this study shows low detection across both ARB and ARGs, the results within each data set do not generally agree. ARB data shows inconsistencies between study years in which manure application time provided the highest percent detection of both resistance bacteria, but ARG data shows that spring manure is consistently has the highest percent detection across all three ARGs studied. However, it should be noted that all study years had to be combined for the ARG dataset because of the low overall detection. A study done characterizing ARB and ARG on a watershed scale by Neher et al. (2019), found a similar disconnect between ARB and ARG results. It was reported that ARB and ARG results did not agree which season had the highest detection in water samples. Neher et al. (2019) suggests that enterococcus and other FIBs may be better suited for comparing contamination between locations, but ARGs are stronger indicators of antibiotic resistance.

CHAPTER 6. CONCLUSIONS

In this study, both antibiotic resistant bacteria (ARB) and antibiotic resistant genes (ARGs) were detected in tile drainage from an agricultural plot system, however, detection was low compared to previous comparable studies done in the past, especially in regard to ARGs.

FIB data was highly variable between the three years of study. Samples from 2016, the first year of study, was the only set with enough data above the limit of quantification to determine if any plot treatments were significantly different from one another. Late fall manure (LFM) application was the only treatment that was significantly different from the no manure control in tetracycline resistant ARB. However, due to the lack of detection in 2017 and 2018, these results could not be replicated, and must be further investigated. Overall, tetracycline resistant bacteria proved to be a better indicator of ARBs in drainage when compared to tylosin resistant bacteria, as it had a much higher percent detection. This shows that it is important to find out what antibiotics are primarily being used in the feeding operation from which manure will be procured to best tailor the ARB to the study site in order to maximize detection and data generation.

Finally, this study saw the largest percent detection of all three ARGs selected (*erm*B, *erm*F, and *tet*M) in drainage from plots receiving spring manure (SM). This study would suggest that SM application is the manure application time is the most relevant for ARG movement through tile drainage. In this study, due to overall low detection, it was challenging to quantify this impact. However, an opportunity to future studies would be to target research toward ARG transport in plots receiving SM. Improvements to future studies could include using larger volumes of samples across all plot treatments for processing in order to potentially increase the likelihood of detection when dealing with plot scale experiments.

6.1 Implications and Future Work

This study has confirmed other research that manure application does increase the quantity of ARBs and ARGs in the subsurface drainage leaving the field. Due to low detection of resistance bacteria and genes, it was not able to be determined definitively if the timing of the manure application plays a role in the transport of ARBs and ARGs. However, highest detection of ARGs occurred in SM application, indicating that further research could be targeted within this application time in order to see the greatest number of data points over the limit of quantification (LOQ). Tillage, for example, is one parameter that could benefit from being studied within the SM application, as in this study it was looked at within the EFM application, which did not produce enough data over the LOQ to allow for any conclusions to be drawn.

Additionally, because of the high number of data points below the LOQ, future research on the plot scale should collect larger volumes of sample to process in order to bolster the concentration. Alternatively, higher powered equipment, such as digital PCR, could be utilized to lower the LOQ.

Lastly, because environmental and yearly variation played such a large part in quantity and quality of the data, it is possible that a lab scale study would be beneficial in this scenario in order to help target later research at the larger field scale. The ability to have a closed system could help to isolate the variables and find which component of the system could be most instrumental in regards to antibiotic resistance.

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APPENDIX A. PHENOTYPIC DATA 2016

2016Sample ID	Treatment	Tillage	Total Enterococcus CFU/100mL	Tetracycline Resistant Enterococcus CFU/100mL	Tylosin Resistant Enterococcus CFU/100mL
NASH16W0P1	EFM	NT			
NASH16W0P2	LFM		1.00	0.33	0.00
NASH16W0P5	EFM	CP	0.00	0.00	0.00
NASH16W0P6	SM				
NASH16W0P7	EFM	NT			
NASH16W0P10	Control				
NASH16W0P15	Control				
NASH16W0P16	LFM		0.50	2.67	1.00
NASH16W0P20	LFM				
NASH16W0P21	EFM	CP	0.00	0.00	0.00
NASH16W0P26	EFM	CP			
NASH16W0P29	Control				
NASH16W0P30	EFM	NT			
NASH16W0P32	SM		0.00	1.33	0.00
NASH16W0P36	SM		0.00	0.00	0.00
NASH16W1P1	EFM	NT			
NASH16W1P2	LFM		0.17	0.50	0.17
NASH16W1P5	EFM	CP	0.17	0.00	0.00
NASH16W1P6	SM				
NASH16W1P7	EFM	NT			
NASH16W1P10	Control				
NASH16W1P15	Control				
NASH16W1P16	LFM				
NASH16W1P20	LFM		0.00	0.00	0.17
NASH16W1P21	EFM	CP			
NASH16W1P26	EFM	CP			
NASH16W1P29	Control				
NASH16W1P30	EFM	NT			
NASH16W1P32	SM				
NASH16W1P36	SM				
NASH16W2P1	EFM	NT			
NASH16W2P2	LFM				
NASH16W2P5	EFM	CP			

NASH16W2P6	SM				
NASH16W2P7	EFM	NT	0.00	0.00	0.00
NASH16W2P10	Control		0.67	0.00	0.00
NASH16W2P15	Control				
NASH16W2P16	LFM		1.83	2.83	1.67
NASH16W2P20	LFM				
NASH16W2P21	EFM	CP	0.00	0.00	0.00
NASH16W2P26	EFM	CP	0.00	0.00	0.00
NASH16W2P29	Control		0.33	0.00	0.00
NASH16W2P30	EFM	NT			
NASH16W2P32	SM		0.17	0.00	0.00
NASH16W2P36	SM		0.00	0.00	0.00
NASH16W3P1	EFM	NT	0.00	0.00	0.00
NASH16W3P2	LFM		0.50	0.67	0.67
NASH16W3P5	EFM	CP	0.00	0.00	0.00
NASH16W3P6	SM				
NASH16W3P7	EFM	NT			
NASH16W3P10	Control		2.83	0.00	0.00
NASH16W3P15	Control		0.00	0.00	0.00
NASH16W3P16	LFM		1.83	1.50	2.83
NASH16W3P20	LFM		0.17	0.00	0.00
NASH16W3P21	EFM	CP	9.67	0.00	0.00
NASH16W3P26	EFM	CP	0.33	0.00	0.00
NASH16W3P29	Control		0.00	0.00	0.00
NASH16W3P30	EFM	NT	0.00	0.00	0.00
NASH16W3P32	SM		1.00	0.17	0.00
NASH16W3P36	SM		0.33	0.00	0.00
NASH16W4P1	EFM	NT			
NASH16W4P2	LFM		0.17	0.00	0.00
NASH16W4P5	EFM	CP	0.00	0.00	0.00
NASH16W4P6	SM				
NASH16W4P7	EFM	NT			
NASH16W4P10	Control		0.17	0.00	0.00
NASH16W4P15	Control				
NASH16W4P16	LFM		0.50	0.33	0.67
NASH16W4P20	LFM		0.33	0.00	0.00
NASH16W4P21	EFM	CP	0.00	0.00	0.00
NASH16W4P26	EFM	CP			
NASH16W4P29	Control				
NASH16W4P30	EFM	NT	0.00	0.00	0.00
NASH16W4P32	SM				

NASH16W4P36	SM		0.00	0.00	0.00
NASH16W5P1	EFM	NT	0.00	0.00	0.00
NASH16W5P2	LFM				
NASH16W5P5	EFM	CP	0.17	0.00	0.17
NASH16W5P6	SM		0.00	0.00	0.00
NASH16W5P7	EFM	NT			
NASH16W5P10	Control				
NASH16W5P15	Control				
NASH16W5P16	LFM		1.00	1.83	1.17
NASH16W5P20	LFM		0.00	0.00	0.00
NASH16W5P21	EFM	CP			
NASH16W5P26	EFM	CP			
NASH16W5P29	Control				
NASH16W5P30	EFM	NT	0.00	0.00	0.00
NASH16W5P32	SM				
NASH16W5P36	SM				
NASH16W6P1	EFM	NT	1.17	0.00	0.00
NASH16W6P2	LFM		0.00	0.17	0.00
NASH16W6P5	EFM	CP	0.00	0.00	0.00
NASH16W6P6	SM		0.17	0.00	0.00
NASH16W6P7	EFM	NT			
NASH16W6P10	Control		0.17	0.00	0.00
NASH16W6P15	Control		0.00	0.00	0.00
NASH16W6P16	LFM		1.17	1.00	1.33
NASH16W6P20	LFM		0.00	0.00	0.00
NASH16W6P21	EFM	CP	0.00	0.00	0.00
NASH16W6P26	EFM	CP			
NASH16W6P29	Control				
NASH16W6P30	EFM	NT	0.33	0.00	0.00
NASH16W6P32	SM		0.00	0.00	0.00
NASH16W6P36	SM		0.00	0.00	0.00
NASH16W7P1	EFM	NT	0.00	5.50	0.00
NASH16W7P2	LFM		0.33	0.17	0.00
NASH16W7P5	EFM	CP	0.00	0.00	0.00
NASH16W7P6	SM		0.00	0.33	0.00
NASH16W7P7	EFM	NT	0.50	0.17	0.00
NASH16W7P10	Control		0.00	0.00	0.00
NASH16W7P15	Control		0.00	0.00	0.00
NASH16W7P16	LFM		0.33	0.50	0.00
NASH16W7P20	LFM		0.17	0.00	0.17
NASH16W7P21	EFM	CP	0.67	0.00	0.00

NASH16W7P26	EFM	CP	0.17	0.17	0.17
NASH16W7P29	Control		1.83	0.00	0.00
NASH16W7P30	EFM	NT	0.83	0.00	0.00
NASH16W7P32	SM		0.17	0.00	0.00
NASH16W7P36	SM		0.33	0.00	0.00
NASH16W8P1	EFM	NT	13.17	1.33	0.00
NASH16W8P2	LFM		26.50	2.33	0.33
NASH16W8P5	EFM	CP	22.33	0.67	0.67
NASH16W8P6	SM		30.00	5.00	1.50
NASH16W8P7	EFM	NT	17.50	4.00	2.50
NASH16W8P10	Control		11.83	3.50	0.00
NASH16W8P15	Control		7.50	0.17	0.00
NASH16W8P16	LFM		42.83	4.50	1.50
NASH16W8P20	LFM		19.67	6.83	0.33
NASH16W8P21	EFM	CP	42.33	2.50	0.33
NASH16W8P26	EFM	CP	43.67	0.83	0.17
NASH16W8P29	Control		10.67	1.17	0.00
NASH16W8P30	EFM	NT	74.17	4.00	0.17
NASH16W8P32	SM		16.00	1.50	1.50
NASH16W8P36	SM		21.50	1.83	0.67
NASH16W9P1	EFM	NT	3.83	4.00	0.00
NASH16W9P2	LFM		17.00	3.50	1.17
NASH16W9P5	EFM	CP	1.17	1.00	0.00
NASH16W9P6	SM		5.17	2.33	0.00
NASH16W9P7	EFM	NT	5.50	1.67	0.00
NASH16W9P10	Control		1.67	2.67	0.00
NASH16W9P15	Control		0.17	3.67	1.17
NASH16W9P16	LFM		38.83	5.83	1.17
NASH16W9P20	LFM		13.67	13.33	0.17
NASH16W9P21	EFM	CP	24.83	1.33	0.50
NASH16W9P26	EFM	CP	36.17	3.00	0.33
NASH16W9P29	Control		16.00	3.17	0.33
NASH16W9P30	EFM	NT	33.83	6.17	0.17
NASH16W9P32	SM		56.50	3.67	0.50
NASH16W9P36	SM		4.50	1.00	0.00
NASH16W10P1	EFM	NT	4.83	0.00	0.00
NASH16W10P2	LFM		3.00	0.50	0.00
NASH16W10P5	EFM	CP	3.17	0.50	0.00
NASH16W10P6	SM		3.33	1.00	0.00
NASH16W10P7	EFM	NT	0.17	0.17	0.00
NASH16W10P10	Control		3.33	0.00	0.00

NASH16W10P15	Control		0.17	0.00	0.00
NASH16W10P16	LFM		13.33	0.33	0.17
NASH16W10P20	LFM		2.50	0.00	0.00
NASH16W10P21	EFM	CP	1.83	0.00	0.00
NASH16W10P26	EFM	CP	2.17	0.00	0.00
NASH16W10P29	Control		1.33	0.00	0.00
NASH16W10P30	EFM	NT	3.67	8.50	1.00
NASH16W10P32	SM		3.17	0.00	0.00
NASH16W10P36	SM		1.00	0.00	0.00
NASH16W11P1	EFM	NT	2.50	0.00	0.00
NASH16W11P2	LFM		9.17	0.00	0.00
NASH16W11P5	EFM	CP	6.50	0.17	0.00
NASH16W11P6	SM		24.83	0.17	0.00
NASH16W11P7	EFM	NT			
NASH16W11P10	Control				
NASH16W11P15	Control				
NASH16W11P16	LFM		4.17	0.17	0.33
NASH16W11P20	LFM		3.00	0.00	0.17
NASH16W11P21	EFM	CP	7.33	0.83	0.00
NASH16W11P26	EFM	CP	17.50	0.00	0.00
NASH16W11P29	Control		3.00	0.17	0.00
NASH16W11P30	EFM	NT	4.67	0.17	0.00
NASH16W11P32	SM		5.17	0.17	0.00
NASH16W11P36	SM		1.33	0.00	0.00
NASH16W12P1	EFM	NT	6.67	0.50	0.00
NASH16W12P2	LFM		8.17	0.17	0.00
NASH16W12P5	EFM	CP	10.17	0.17	0.00
NASH16W12P6	SM		6.83	0.33	0.17
NASH16W12P7	EFM	NT			
NASH16W12P10	Control		4.83	9.83	0.00
NASH16W12P15	Control				
NASH16W12P16	LFM		0.83	0.00	0.00
NASH16W12P20	LFM				
NASH16W12P21	EFM	CP	2.33	0.67	0.00
NASH16W12P26	EFM	CP	3.50	0.00	0.50
NASH16W12P29	Control				
NASH16W12P30	EFM	NT	8.00	0.00	0.00
NASH16W12P32	SM				
NASH16W12P36	SM				
NASH16W13P1	EFM	NT	23.17	14.33	0.17
NASH16W13P2	LFM		13.33	10.00	0.17

NASH16W13P5	EFM	CP	11.33	15.33	2.50
NASH16W13P6	SM		12.33	12.33	0.33
NASH16W13P7	EFM	NT	33.00	10.00	0.00
NASH16W13P10	Control		7.00	4.50	0.00
NASH16W13P15	Control		6.17	2.50	0.00
NASH16W13P16	LFM		24.17	15.17	0.00
NASH16W13P20	LFM		17.83	46.67	0.00
NASH16W13P21	EFM	CP	28.67	11.33	0.00
NASH16W13P26	EFM	CP	12.33	11.00	0.00
NASH16W13P29	Control				
NASH16W13P30	EFM	NT	42.83	31.83	0.17
NASH16W13P32	SM		13.33	31.50	0.17
NASH16W13P36	SM		27.00	138.67	0.00
NASH16W14P1	EFM	NT	15.17	1.17	0.17
NASH16W14P2	LFM		24.17	1.17	0.00
NASH16W14P5	EFM	CP	14.17	0.17	0.00
NASH16W14P6	SM		34.50	3.83	0.00
NASH16W14P7	EFM	NT			
NASH16W14P10	Control		46.50	3.17	0.33
NASH16W14P15	Control		27.83	1.33	0.00
NASH16W14P16	LFM		41.17	2.83	0.33
NASH16W14P20	LFM		11.50	1.50	0.00
NASH16W14P21	EFM	CP	25.00	0.83	0.00
NASH16W14P26	EFM	CP	29.50	0.50	0.00
NASH16W14P29	Control				
NASH16W14P30	EFM	NT	131.33	2.00	0.67
NASH16W14P32	SM		80.00	3.67	2.00
NASH16W14P36	SM		24.50	1.17	0.00
NASH16W15P1	EFM	NT			
NASH16W15P2	LFM		114.67	23.17	5.33
NASH16W15P5	EFM	CP	3.33	0.67	0.00
NASH16W15P6	SM				
NASH16W15P7	EFM	NT			
NASH16W15P10	Control				
NASH16W15P15	Control				
NASH16W15P16	LFM				
NASH16W15P20	LFM		21.17	4.00	0.00
NASH16W15P21	EFM	CP			
NASH16W15P26	EFM	CP			
NASH16W15P29	Control				
NASH16W15P30	EFM	NT	16.17	3.83	0.00

NASH16W15P32	SM				
NASH16W15P36	SM				
NASH16W16P1	EFM	NT	6.00	0.00	0.17
NASH16W16P2	LFM		17.50	0.83	0.00
NASH16W16P5	EFM	CP	14.33	0.00	0.00
NASH16W16P6	SM		19.17	0.50	0.00
NASH16W16P7	EFM	NT			
NASH16W16P10	Control				
NASH16W16P15	Control				
NASH16W16P16	LFM		28.17	0.17	0.00
NASH16W16P20	LFM				
NASH16W16P21	EFM	CP			
NASH16W16P26	EFM	CP			
NASH16W16P29	Control				
NASH16W16P30	EFM	NT	24.17	0.50	0.00
NASH16W16P32	SM		5.50	1.33	0.00
NASH16W16P36	SM				
NASH16W17P1	EFM	NT			
NASH16W17P2	LFM		53.00	39.17	0.00
NASH16W17P5	EFM	CP			
NASH16W17P6	SM				
NASH16W17P7	EFM	NT			
NASH16W17P10	Control				
NASH16W17P15	Control				
NASH16W17P16	LFM		19.17	18.67	0.00
NASH16W17P20	LFM		450.00	62.00	0.00
NASH16W17P21	EFM	CP			
NASH16W17P26	EFM	CP	5.33	5.83	0.00
NASH16W17P29	Control				
NASH16W17P30	EFM	NT	52.50	36.67	0.17
NASH16W17P32	SM				
NASH16W17P36	SM				
NASH16W18P1	EFM	NT			
NASH16W18P2	LFM		46.50	16.83	0.17
NASH16W18P5	EFM	CP	14.67	5.00	0.00
NASH16W18P6	SM		30.50	2.17	0.00
NASH16W18P7	EFM	NT			
NASH16W18P10	Control				
NASH16W18P15	Control				
NASH16W18P16	LFM		17.33	5.33	0.00
NASH16W18P20	LFM				

NASH16W18P21	EFM	CP	450.00	4.83	0.17
NASH16W18P26	EFM	CP	7.33	0.17	0.00
NASH16W18P29	Control				
NASH16W18P30	EFM	NT	41.83	11.83	0.17
NASH16W18P32	SM				
NASH16W18P36	SM				
NASH16W19P1	EFM	NT			
NASH16W19P2	LFM		12.83	8.33	0.17
NASH16W19P5	EFM	CP	5.50	11.17	0.17
NASH16W19P6	SM				
NASH16W19P7	EFM	NT			
NASH16W19P10	Control				
NASH16W19P15	Control		10.50	9.67	0.00
NASH16W19P16	LFM				
NASH16W19P20	LFM				
NASH16W19P21	EFM	CP			
NASH16W19P26	EFM	CP			
NASH16W19P29	Control				
NASH16W19P30	EFM	NT	5.00	10.33	0.00
NASH16W19P32	SM				
NASH16W19P36	SM				
NASH16W20P1	EFM	NT			
NASH16W20P2	LFM		450.00	71.50	0.00
NASH16W20P5	EFM	CP			
NASH16W20P6	SM				
NASH16W20P7	EFM	NT			
NASH16W20P10	Control				
NASH16W20P15	Control				
NASH16W20P16	LFM		20.17	29.67	0.00
NASH16W20P20	LFM				
NASH16W20P21	EFM	CP			
NASH16W20P26	EFM	CP			
NASH16W20P29	Control				
NASH16W20P30	EFM	NT	8.50	16.67	0.17
NASH16W20P32	SM				
NASH16W20P36	SM				
NASH16W21P1	EFM	NT	14.33	13.50	0.00
NASH16W21P2	LFM		34.83	44.83	0.00
NASH16W21P5	EFM	CP	14.33	15.83	0.00
NASH16W21P6	SM		18.50	25.17	0.00
NASH16W21P7	EFM	NT	12.67	22.17	0.17

NASH16W21P10	Control		22.33	24.17	0.00
NASH16W21P15	Control		16.67	19.33	0.00
NASH16W21P16	LFM		9.33	18.17	0.00
NASH16W21P20	LFM		44.00	48.17	0.00
NASH16W21P21	EFM	CP	8.00	12.17	0.00
NASH16W21P26	EFM	CP	7.00	5.50	0.00
NASH16W21P29	Control		17.00	15.17	0.00
NASH16W21P30	EFM	NT	122.50	36.17	0.00
NASH16W21P32	SM		38.17	47.67	0.00
NASH16W21P36	SM		11.83	15.67	0.00
NASH16W22P1	EFM	NT	88.67	2.00	0.00
NASH16W22P2	LFM		75.00	0.00	0.00
NASH16W22P5	EFM	CP	360.00	6.67	0.00
NASH16W22P6	SM		342.00	6.00	0.00
NASH16W22P7	EFM	NT	63.00	1.00	0.00
NASH16W22P10	Control		214.00	4.00	0.00
NASH16W22P15	Control		79.00	2.00	0.00
NASH16W22P16	LFM		156.00	1.00	1.00
NASH16W22P20	LFM		195.00	6.00	0.00
NASH16W22P21	EFM	CP	228.00	3.00	0.00
NASH16W22P26	EFM	CP	140.00	1.00	0.00
NASH16W22P29	Control				
NASH16W22P30	EFM	NT			
NASH16W22P32	SM				
NASH16W22P36	SM		91.00	5.00	0.00
NASH16W23P1	EFM	NT	3.67	0.00	0.00
NASH16W23P2	LFM		12.83	0.00	0.00
NASH16W23P5	EFM	CP	10.67	0.00	0.00
NASH16W23P6	SM		11.17	0.17	0.00
NASH16W23P7	EFM	NT	4.17	0.00	0.00
NASH16W23P10	Control		15.17	0.00	0.00
NASH16W23P15	Control		3.83	0.00	0.00
NASH16W23P16	LFM		8.83	0.00	0.00
NASH16W23P20	LFM		5.50	0.00	0.00
NASH16W23P21	EFM	CP	10.33	0.00	0.00
NASH16W23P26	EFM	CP	5.50	0.00	0.00
NASH16W23P29	Control		12.83	0.00	0.00
NASH16W23P30	EFM	NT	9.17	0.17	0.00
NASH16W23P32	SM		8.17	0.00	0.00
NASH16W23P36	SM		4.83	0.00	0.00

APPENDIX B. PHENOTYPIC DATA 2017

Sample ID	Treatment	Tillage	Total Enterococcus CFU/100mL	Tetracycline Resistant Enterococcus CFU/100mL	Tylosin Resistant Enterococcus CFU/100mL
NASH17W0P3	Control				
NASH17W0P5	EFM	CP	1.17	0.00	0.00
NASH17W0P6	SM				
NASH17W0P11	EFM	NT	0.50	0.00	0.17
NASH17W0P14	LFM		0.17	0.00	0.00
NASH17W0P21	EFM	CP	1.00	0.00	0.00
NASH17W0P23	EFM	NT	1.33	0.00	0.00
NASH17W0P24	Control		0.00	0.00	0.00
NASH17W0P25	LFM				
NASH17W0P26	EFM	CP			
NASH17W0P27	EFM	NT			
NASH17W0P28	Control				
NASH17W0P31	LFM	NT			
NASH17W0P32	SM		0.33	0.00	0.00
NASH17W0P36	SM		0.33	0.00	0.00
NASH17W1P3	Control		0.67	0.00	0.00
NASH17W1P5	EFM	CP	0.33	0.00	0.00
NASH17W1P6	SM				
NASH17W1P11	EFM	NT	0.00	0.17	0.00
NASH17W1P14	LFM		0.00	0.00	0.00
NASH17W1P21	EFM	CP	0.00	0.00	0.00
NASH17W1P23	EFM	NT	0.00	0.00	0.00
NASH17W1P24	Control		0.33	0.00	0.17
NASH17W1P25	LFM		0.17	0.00	0.17
NASH17W1P26	EFM	CP	0.00	0.00	0.00
NASH17W1P27	EFM	NT	2.33	0.00	0.00
NASH17W1P28	Control		0.00	0.00	0.00
NASH17W1P31	LFM	NT	0.33	0.50	0.33
NASH17W1P32	SM		0.50	0.33	0.17
NASH17W1P36	SM		0.00	0.17	0.00
NASH17W2P3	Control		0.00	0.00	0.00
NASH17W2P5	EFM	CP	0.17	0.00	0.17
NASH17W2P6	SM		0.17	0.00	0.00

NASH17W2P11	EFM	NT	10.17	0.00	0.17
NASH17W2P14	LFM		0.00	0.17	0.00
NASH17W2P21	EFM	CP	1.67	0.00	0.00
NASH17W2P23	EFM	NT	0.00	0.00	0.00
NASH17W2P24	Control		0.00	0.00	0.00
NASH17W2P25	LFM		0.50	0.00	0.00
NASH17W2P26	EFM	CP	0.17	0.00	0.00
NASH17W2P27	EFM	NT	2.67	0.33	0.17
NASH17W2P28	Control		0.00	1.50	0.00
NASH17W2P31	LFM	NT	0.00	0.00	0.00
NASH17W2P32	SM		0.00	0.00	0.33
NASH17W2P36	SM		0.00	0.00	0.00
NASH17W3P3	Control		0.33	0.00	0.00
NASH17W3P5	EFM	CP	0.00	0.00	0.00
NASH17W3P6	SM		1.67	0.00	0.17
NASH17W3P11	EFM	NT	0.17	0.00	0.00
NASH17W3P14	LFM		0.00	0.00	0.00
NASH17W3P21	EFM	CP	1.33	0.00	0.00
NASH17W3P23	EFM	NT	0.00	0.00	0.00
NASH17W3P24	Control		0.00	0.00	0.00
NASH17W3P25	LFM		0.17	0.00	0.00
NASH17W3P26	EFM	CP	0.00	0.00	0.00
NASH17W3P27	EFM	NT	2.83	0.00	0.00
NASH17W3P28	Control		0.00	0.00	0.00
NASH17W3P31	LFM	NT	0.00	0.00	0.00
NASH17W3P32	SM		0.00	0.00	0.17
NASH17W3P36	SM		0.33	0.00	0.00
NASH17W4P3	Control		0.00	0.00	0.00
NASH17W4P5	EFM	CP	1.33	0.17	0.00
NASH17W4P6	SM		3.83	0.00	0.67
NASH17W4P11	EFM	NT	0.00	0.00	0.00
NASH17W4P14	LFM		0.00	0.00	0.00
NASH17W4P21	EFM	CP	4.17	0.00	0.00
NASH17W4P23	EFM	NT	0.00	0.00	0.00
NASH17W4P24	Control		0.17	0.00	0.00
NASH17W4P25	LFM		0.00	0.00	0.00
NASH17W4P26	EFM	CP	6.00	0.00	0.00
NASH17W4P27	EFM	NT	3.33	0.00	0.00
NASH17W4P28	Control		0.17	0.00	0.00
NASH17W4P31	LFM	NT	0.00	0.00	0.00
NASH17W4P32	SM		5.83	0.00	0.17

NASH17W4P36	SM		0.83	0.17	0.00
NASH17W5P3	Control		0.00	0.00	0.00
NASH17W5P5	EFM	CP	0.00	0.00	0.00
NASH17W5P6	SM		0.00	0.00	0.00
NASH17W5P11	EFM	NT	0.00	0.00	0.00
NASH17W5P14	LFM		0.00	0.00	0.00
NASH17W5P21	EFM	CP	3.33	0.00	0.00
NASH17W5P23	EFM	NT	0.00	0.00	0.00
NASH17W5P24	Control		0.00	0.00	0.00
NASH17W5P25	LFM		0.00	0.00	0.00
NASH17W5P26	EFM	CP	0.00	0.00	0.00
NASH17W5P27	EFM	NT			
NASH17W5P28	Control		0.00	0.00	0.00
NASH17W5P31	LFM	NT	0.00	0.00	0.00
NASH17W5P32	SM				
NASH17W5P36	SM		0.17	0.00	0.00
NASH17W6P3	Control		0.50	0.00	0.00
NASH17W6P5	EFM	CP	66.50	0.33	0.00
NASH17W6P6	SM		34.50	0.67	0.83
NASH17W6P11	EFM	NT	0.33	0.00	0.00
NASH17W6P14	LFM		0.17	0.00	0.00
NASH17W6P21	EFM	CP	27.17	0.17	0.17
NASH17W6P23	EFM	NT	0.17	0.00	0.00
NASH17W6P24	Control		0.00	0.00	0.00
NASH17W6P25	LFM		0.33	0.00	0.00
NASH17W6P26	EFM	CP	51.83	1.00	0.50
NASH17W6P27	EFM	NT	2.33	0.00	0.00
NASH17W6P28	Control		0.33	0.00	0.00
NASH17W6P31	LFM	NT	1.50	0.00	0.17
NASH17W6P32	SM		20.67	1.17	0.33
NASH17W6P36	SM		28.00	0.83	0.00
NASH17W7P3	Control		5.33	0.00	0.00
NASH17W7P5	EFM	CP	35.50	0.50	0.33
NASH17W7P6	SM		56.83	0.33	0.17
NASH17W7P11	EFM	NT	0.00	0.00	0.00
NASH17W7P14	LFM		0.33	0.00	0.00
NASH17W7P21	EFM	CP	57.17	0.50	0.67
NASH17W7P23	EFM	NT	3.33	0.00	0.00
NASH17W7P24	Control		0.83	0.00	0.00
NASH17W7P25	LFM		1.33	0.00	0.00
NASH17W7P26	EFM	CP	58.00	0.67	0.17

NASH17W7P27	EFM	NT	62.17	0.00	0.00
NASH17W7P28	Control		0.17	0.00	0.00
NASH17W7P31	LFM	NT	0.17	0.17	0.00
NASH17W7P32	SM		29.67	0.00	0.00
NASH17W7P36	SM		22.17	0.33	0.00
NASH17W8P3	Control		1.17	0.00	0.00
NASH17W8P5	EFM	CP	28.67	0.00	0.17
NASH17W8P6	SM		0.00	0.00	0.00
NASH17W8P11	EFM	NT	0.00	0.00	0.00
NASH17W8P14	LFM		0.00	0.00	0.00
NASH17W8P21	EFM	CP	32.33	0.17	0.00
NASH17W8P23	EFM	NT	0.00	0.00	0.00
NASH17W8P24	Control		0.00	0.00	0.00
NASH17W8P25	LFM		0.17	0.00	0.00
NASH17W8P26	EFM	CP	49.33	0.00	0.17
NASH17W8P27	EFM	NT			
NASH17W8P28	Control		4.67	0.00	0.00
NASH17W8P31	LFM	NT	0.50	0.33	0.17
NASH17W8P32	SM		4.17	0.00	0.00
NASH17W8P36	SM		6.33	0.00	0.00
NASH17W9P3	Control		0.67	0.00	0.00
NASH17W9P5	EFM	CP	4.50	0.00	0.00
NASH17W9P6	SM		14.67	0.00	0.00
NASH17W9P11	EFM	NT	0.00	0.00	0.00
NASH17W9P14	LFM		0.33	0.00	0.33
NASH17W9P21	EFM	CP			
NASH17W9P23	EFM	NT	0.00	0.00	0.00
NASH17W9P24	Control		0.00	0.00	0.00
NASH17W9P25	LFM		0.17	0.00	0.00
NASH17W9P26	EFM	CP			
NASH17W9P27	EFM	NT			
NASH17W9P28	Control				
NASH17W9P31	LFM	NT	2.17	2.17	3.50
NASH17W9P32	SM				
NASH17W9P36	SM				
NASH17W10P3	Control		0.00	0.00	0.00
NASH17W10P5	EFM	CP	1.17	0.00	0.00
NASH17W10P6	SM				
NASH17W10P11	EFM	NT			
NASH17W10P14	LFM		0.17	0.00	0.00
NASH17W10P21	EFM	CP			

NASH17W10P23	EFM	NT			
NASH17W10P24	Control				
NASH17W10P25	LFM				
NASH17W10P26	EFM	CP			
NASH17W10P27	EFM	NT			
NASH17W10P28	Control				
NASH17W10P31	LFM	NT	8.17	3.83	8.17
NASH17W10P32	SM				
NASH17W10P36	SM				
NASH17W11P3	Control		2.17	0.00	0.00
NASH17W11P5	EFM	CP	2.67	0.33	0.00
NASH17W11P6	SM				
NASH17W11P11	EFM	NT	0.83	0.00	0.00
NASH17W11P14	LFM		0.33	0.00	0.00
NASH17W11P21	EFM	CP			
NASH17W11P23	EFM	NT			
NASH17W11P24	Control				
NASH17W11P25	LFM				
NASH17W11P26	EFM	CP			
NASH17W11P27	EFM	NT			
NASH17W11P28	Control				
NASH17W11P31	LFM	NT	0.67	0.67	0.83
NASH17W11P32	SM				
NASH17W11P36	SM				
NASH17W12P3	Control		7.50	0.00	0.00
NASH17W12P5	EFM	CP	2.17	0.00	0.00
NASH17W12P6	SM		3.17	0.00	0.17
NASH17W12P11	EFM	NT	2.50	0.00	0.00
NASH17W12P14	LFM		1.83	0.00	0.00
NASH17W12P21	EFM	CP			
NASH17W12P23	EFM	NT	0.50	0.00	0.00
NASH17W12P24	Control		0.67	0.00	0.00
NASH17W12P25	LFM		5.50	4.00	0.00
NASH17W12P26	EFM	CP	1.17	0.00	0.00
NASH17W12P27	EFM	NT			
NASH17W12P28	Control				
NASH17W12P31	LFM	NT	2.83	0.17	0.17
NASH17W12P32	SM				
NASH17W12P36	SM				
NASH17W13P3	Control		0.67	0.00	0.00
NASH17W13P5	EFM	CP	0.17	0.00	0.00

NASH17W13P6	SM		3.67	0.00	0.17
NASH17W13P11	EFM	NT	6.50	0.33	0.00
NASH17W13P14	LFM		1.17	0.00	0.00
NASH17W13P21	EFM	CP	4.67	0.00	0.00
NASH17W13P23	EFM	NT	0.17	0.00	0.00
NASH17W13P24	Control		0.83	0.00	0.00
NASH17W13P25	LFM		3.00	0.33	0.00
NASH17W13P26	EFM	CP	0.67	0.00	0.00
NASH17W13P27	EFM	NT			
NASH17W13P28	Control				
NASH17W13P31	LFM	NT	0.67	0.00	0.00
NASH17W13P32	SM				
NASH17W13P36	SM				
NASH17W14P3	Control		10.17	0.00	0.00
NASH17W14P5	EFM	CP	2.50	0.00	0.00
NASH17W14P6	SM				
NASH17W14P11	EFM	NT	3.00	0.17	0.00
NASH17W14P14	LFM		0.33	0.00	0.00
NASH17W14P21	EFM	CP			
NASH17W14P23	EFM	NT			
NASH17W14P24	Control				
NASH17W14P25	LFM				
NASH17W14P26	EFM	CP			
NASH17W14P27	EFM	NT			
NASH17W14P28	Control				
NASH17W14P31	LFM	NT	0.67	0.00	0.00
NASH17W14P32	SM				
NASH17W14P36	SM				
NASH17W15P3	Control				
NASH17W15P5	EFM	CP	1.666667	0	0
NASH17W15P6	SM				
NASH17W15P11	EFM	NT			
NASH17W15P14	LFM				
NASH17W15P21	EFM	CP			
NASH17W15P23	EFM	NT			
NASH17W15P24	Control				
NASH17W15P25	LFM				
NASH17W15P26	EFM	CP			
NASH17W15P27	EFM	NT			
NASH17W15P28	Control				
NASH17W15P31	LFM	NT	0.5	0	0

NASH17W15P32	SM				
NASH17W15P36	SM				
NASH17W16P3	Control		23.5	0	0
NASH17W16P5	EFM	CP	82	0	0
NASH17W16P6	SM		49.33333	0	0
NASH17W16P11	EFM	NT	18.33333	0	0
NASH17W16P14	LFM		32.5	0	0
NASH17W16P21	EFM	CP	35.33333	0	0
NASH17W16P23	EFM	NT	27.66667	0	0
NASH17W16P24	Control		26.66667	0	0
NASH17W16P25	LFM		41.33333	0	0
NASH17W16P26	EFM	CP	52	0	0
NASH17W16P27	EFM	NT			
NASH17W16P28	Control		29	0	0
NASH17W16P31	LFM	NT	36.83333	0	0
NASH17W16P32	SM		13.66667	0	0
NASH17W16P36	SM		32	0	0
NASH17W17P3	Control		5.833333	0	0
NASH17W17P5	EFM	CP	16.16667	0	0
NASH17W17P6	SM				
NASH17W17P11	EFM	NT	6.5	0	0
NASH17W17P14	LFM		8.5	0	0
NASH17W17P21	EFM	CP			
NASH17W17P23	EFM	NT	7.5	0	0
NASH17W17P24	Control				
NASH17W17P25	LFM				
NASH17W17P26	EFM	CP			
NASH17W17P27	EFM	NT			
NASH17W17P28	Control				
NASH17W17P31	LFM	NT	15.33333	0	0
NASH17W17P32	SM				
NASH17W17P36	SM				

APPENDIX C. PHENOTYPIC DATA 2018

Sample ID	Treatment	Tillage	Total Enterococcus CFU/100mL	Tetracycline Resistant Enterococcus CFU/100mL	Tylosin Resistant Enterococcus CFU/100mL
NASH18W0P5	EFM	CP	0.00	0.00	0.00
NASH18W0P21	EFM	CP	0.00	0.00	0.00
NASH18W1P2	LFM		0.17	0.00	0.00
NASH18W1P5	EFM	CP	0.17	0.00	0.17
NASH18W1P6	SM		0.83	0.00	0.00
NASH18W1P7	EFM	NT	0.50	0.00	0.00
NASH18W1P10	Control		0.83	0.00	0.00
NASH18W1P15	Control		7.00	0.00	0.00
NASH18W1P16	LFM		0.50	0.00	0.00
NASH18W1P20	LFM		0.00	0.00	0.00
NASH18W1P21	EFM	CP	0.17	0.00	0.00
NASH18W1P26	EFM	CP	0.83	0.00	0.00
NASH18W1P30	EFM	NT	0.17	0.00	0.00
NASH18W1P32	SM		0.83	0.00	0.00
NASH18W1P36	SM		0.00	0.00	0.00
NASH18W2P2	LFM		0.17	0.00	0.00
NASH18W2P5	EFM	CP	0.50	0.00	0.00
NASH18W2P6	SM		0.50	0.00	0.00
NASH18W2P7	EFM	NT	1.83	0.00	0.00
NASH18W2P10	Control		1.50	0.00	0.00
NASH18W2P15	Control		11.67	0.00	0.00
NASH18W2P16	LFM		0.17	0.00	0.00
NASH18W2P21	EFM	CP	0.00	0.00	0.00
NASH18W2P26	EFM	CP	0.33	0.00	0.00
NASH18W2P30	EFM	NT	0.00	0.00	0.00
NASH18W2P32	SM		0.33	0.00	0.00
NASH18W2P36	SM		0.00	0.00	0.00
NASH18W3P1	EFM	NT	0.00	0.00	0.00
NASH18W3P2	LFM		0.83	0.00	0.17
NASH18W3P5	EFM	CP	0.00	0.00	0.00
NASH18W3P6	SM		0.17	0.00	0.00
NASH18W3P10	Control		0.00	0.00	0.00
NASH18W3P15	Control		6.00	0.00	0.00
NASH18W3P16	LFM		0.00	0.00	0.00

NASH18W3P21	EFM	CP	0.17	0.00	0.00
NASH18W3P26	EFM	CP	0.00	0.00	0.00
NASH18W3P30	EFM	NT	0.17	0.00	0.00
NASH18W3P36	SM		0.17	0.00	0.00
NASH18W4P1	EFM	NT	3.50	0.00	0.00
NASH18W4P2	LFM		4.67	0.00	0.33
NASH18W4P5	EFM	CP	2.50	0.00	0.33
NASH18W4P6	SM		6.00	0.33	1.00
NASH18W4P7	EFM	NT	1.17	0.00	0.00
NASH18W4P10	Control		1.83	0.00	0.00
NASH18W4P15	Control		1.83	0.00	0.00
NASH18W4P16	LFM		0.67	0.00	0.00
NASH18W4P20	LFM		1.17	0.00	0.00
NASH18W4P21	EFM	CP	0.50	0.00	0.17
NASH18W4P26	EFM	CP	1.17	0.00	0.00
NASH18W4P29	Control		1.50	0.17	0.00
NASH18W4P30	EFM	NT	1.33	0.00	0.17
NASH18W4P32	SM		3.50	0.33	0.67
NASH18W4P36	SM		1.50	0.17	1.00
NASH18W5P1	EFM	NT	1.00	0.00	0.00
NASH18W5P2	LFM		1.00	0.00	0.00
NASH18W4P21	EFM	CP	0.33	0.00	0.00
NASH18W4P26	EFM	CP	0.83	0.00	0.00
NASH18W4P29	Control		1.17	0.00	0.00
NASH18W4P30	EFM	NT	0.83	0.00	0.00
NASH18W4P32	SM		0.33	0.00	0.00
NASH18W4P36	SM		0.17	0.00	0.00
NASH18W5P1	EFM	NT	0.17	0.00	0.00
NASH18W5P2	LFM		0.00	0.00	0.00
NASH18W5P26	EFM	CP	0.33	0.00	0.00
NASH18W5P29	Control		0.00	0.00	0.00
NASH18W5P30	EFM	NT	0.17	0.67	0.17
NASH18W5P32	SM		0.83	0.17	0.17
NASH18W5P36	SM		0.17	0.00	0.00
NASH18W6P2	LFM		0.33	0.00	0.00
NASH18W6P5	EFM	CP	0.00	0.00	0.00
NASH18W6P6	SM		0.33	0.00	0.33
NASH18W6P10	Control		0.33	0.00	0.00
NASH18W6P15	Control		0.17	0.00	0.00
NASH18W6P16	LFM		0.00	0.00	0.00
NASH18W6P21	EFM	CP	0.33	0.00	0.00

NASH18W6P26	EFM	CP	0.00	0.00	0.00
NASH18W6P30	EFM	NT	0.00	0.00	0.00
NASH18W6P36	SM		0.00	0.00	0.00
NASH18W7P1	EFM	NT	0.33	0.00	0.00
NASH18W7P2	LFM		5.00	0.33	0.00
NASH18W7P5	EFM	CP	0.00	0.00	0.00
NASH18W7P6	SM		0.17	0.00	0.00
NASH18W7P16	LFM		0.00	0.00	0.17
NASH18W7P30	EFM	NT	0.00	0.00	0.00
NASH18W7P36	SM		0.00	0.00	0.00
NASH18W8P2	LFM		0.00	0.00	0.00
NASH18W8P5	EFM	CP	0.00	0.00	0.00
NASH18W8P16	LFM		0.00	0.00	0.17
NASH18W8P30	EFM	NT	0.00	0.00	0.00
NASH18W9P1	EFM	NT	3.50	0.00	0.00
NASH18W9P2	LFM		6.50	0.00	0.00
NASH18W9P5	EFM	CP	4.33	0.00	0.00
NASH18W9P6	SM		5.33	0.00	0.00
NASH18W9P7	EFM	NT	4.83	0.00	0.00
NASH18W9P10	Control		0.33	0.00	0.00
NASH18W9P15	Control		0.67	0.00	0.00
NASH18W9P16	LFM		6.67	0.00	0.00
NASH18W9P20	LFM		2.67	0.17	0.33
NASH18W9P21	EFM	CP	18.50	0.00	0.00
NASH18W9P26	EFM	CP	3.33	0.00	0.00
NASH18W9P29	Control		5.83	0.00	0.00
NASH18W9P30	EFM	NT	5.67	0.00	0.00
NASH18W9P32	SM		3.50	0.50	0.33
NASH18W9P36	SM		0.67	0.00	0.00
NASH18W10P1	EFM	NT	11.67	0.00	0.00
NASH18W10P2	LFM		13.83	0.33	0.00
NASH18W10P5	EFM	CP	7.17	0.00	0.00
NASH18W10P6	SM		52.00	2.17	7.83
NASH18W10P7	EFM	NT	49.50	0.33	0.00
NASH18W10P10	Control		2.00	0.00	0.00
NASH18W10P15	Control		6.83	0.00	0.00
NASH18W10P16	LFM		10.00	0.17	0.00
NASH18W10P20	LFM		28.00	0.33	0.00
NASH18W10P21	EFM	CP	9.83	0.83	0.00
NASH18W10P26	EFM	CP	27.83	2.00	0.17
NASH18W10P29	Control		41.17	1.00	0.83

NASH18W10P30	EFM	NT	9.67	0.17	0.00
NASH18W10P32	SM		6.17	0.17	0.00
NASH18W10P36	SM		1.50	0.17	0.00
NASH18W11P1	EFM	NT	24.67	0.00	0.00
NASH18W11P2	LFM		63.50	1.50	0.00
NASH18W11P5	EFM	CP	32.67	0.00	0.00
NASH18W11P6	SM		56.33	1.67	0.00
NASH18W11P7	EFM	NT	50.50	0.17	0.17
NASH18W11P10	Control		8.00	0.33	0.00
NASH18W11P15	Control		7.00	0.00	0.00
NASH18W11P16	LFM		17.17	0.00	0.00
NASH18W11P20	LFM		9.17	0.00	0.00
NASH18W11P21	EFM	CP	49.83	0.17	0.00
NASH18W11P26	EFM	CP	24.50	0.33	0.00
NASH18W11P29	Control		54.50	5.17	0.67
NASH18W11P30	EFM	NT	13.33	2.33	0.00
NASH18W11P32	SM		17.50	0.00	0.00
NASH18W11P36	SM		1.17	0.00	0.00
NASH18W12P1	EFM	NT	9.83	0.17	0.17
NASH18W12P2	LFM		30.50	0.17	0.00
NASH18W12P5	EFM	CP	9.33	0.17	0.00
NASH18W12P6	SM		42.67	0.83	0.00
NASH18W12P7	EFM	NT	23.33	0.67	0.00
NASH18W12P10	Control		6.83	0.00	0.00
NASH18W12P15	Control		11.50	0.00	0.17
NASH18W12P16	LFM		53.33	0.50	0.00
NASH18W12P20	LFM		37.33	0.17	0.00
NASH18W12P21	EFM	CP	11.00	0.83	0.00
NASH18W12P26	EFM	CP	13.83	2.00	0.00
NASH18W12P29	Control		17.50	0.67	0.00
NASH18W12P30	EFM	NT	24.67	1.17	0.00
NASH18W12P32	SM		13.67	0.00	0.00
NASH18W12P36	SM		4.67	0.17	0.00
NASH18W13P1	EFM	NT	5.50	0.00	0.00
NASH18W13P2	LFM		4.83	0.00	0.00
NASH18W13P5	EFM	CP	7.50	0.00	0.00
NASH18W13P6	SM		61.00	0.00	0.00
NASH18W13P10	Control		9.00	0.00	0.00
NASH18W13P15	Control		1.33	0.00	0.00
NASH18W13P16	LFM		13.67	0.17	0.00
NASH18W13P20	LFM		2.67	0.00	0.00

NASH18W13P21	EFM	CP	3.83	0.00	0.00
NASH18W13P26	EFM	CP	3.67	0.00	0.17
NASH18W13P29	Control		6.50	0.00	0.00
NASH18W13P30	EFM	NT	5.83	0.17	0.00
NASH18W13P32	SM		5.50	0.00	0.00
NASH18W13P36	SM		0.83	0.00	0.00
NASH18W14P5	EFM	CP	1.33	1.00	0.00
NASH18W14P6	SM		2.83	22.33	0.00
NASH18W14P30	EFM	NT	2.67	1.50	0.00
NASH18W15P5	EFM	CP	7.17	0.00	0.00
NASH18W15P30	EFM	NT	6.17	0.00	0.00
NASH18W17P2	LFM		45.17	0.17	0.00
NASH18W17P5	EFM	CP	34.17	1.50	0.00
NASH18W17P30	EFM	NT	23.33	0.00	0.00
NASH18W18P1	EFM	NT	9.83	0.00	0.00
NASH18W18P2	LFM		28.00	0.33	0.00
NASH18W18P5	EFM	CP	20.83	0.00	0.00
NASH18W18P6	SM		35.83	0.50	0.00
NASH18W18P7	EFM	NT	14.00	0.33	0.00
NASH18W18P10	Control		34.67	0.00	0.00
NASH18W18P15	Control		13.83	0.00	0.00
NASH18W18P16	LFM		31.00	0.00	0.00
NASH18W18P20	LFM		18.83	0.50	0.00
NASH18W18P21	EFM	CP	28.83	0.00	0.00
NASH18W18P26	EFM	CP	29.83	0.50	0.00
NASH18W18P29	Control		25.83	0.83	0.00
NASH18W18P30	EFM	NT	23.17	0.17	0.00
NASH18W18P32	SM		31.67	0.17	0.00
NASH18W18P36	SM		26.17	0.50	0.00
NASH18W19P2	LFM		5.00	0.17	0.17
NASH18W19P5	EFM	CP	5.17	0.00	0.00
NASH18W19P6	SM		9.33	0.00	0.00
NASH18W19P7	EFM	NT	4.83	0.00	0.00
NASH18W19P10	Control		11.17	0.00	0.00
NASH18W19P15	Control		7.83	0.00	0.00
NASH18W19P16	LFM		4.17	0.00	0.00
NASH18W19P21	EFM	CP	6.33	0.00	0.00
NASH18W19P26	EFM	CP	8.83	0.17	0.00
NASH18W19P29	Control		8.33	0.00	0.17
NASH18W19P30	EFM	NT	5.17	0.00	0.00
NASH18W19P32	SM		9.83	0.00	0.00

NASH18W19P36	SM		6.00	0.17	0.00
NASH18W20P1	EFM	NT	65	4.67	0.67
NASH18W20P2	LFM		65	5.33	0.67
NASH18W20P5	EFM	CP	65	8.00	0.00
NASH18W20P6	SM		65	4.00	0.00
NASH18W20P7	EFM	NT	65	14.00	8.00
NASH18W20P10	Control		65	3.33	0.00
NASH18W20P15	Control		65	3.33	2.00
NASH18W20P16	LFM		65	0.67	0.00
NASH18W20P20	LFM		65	7.33	0.00
NASH18W20P21	EFM	CP	65	5.33	2.67
NASH18W20P26	EFM	CP	65	2.00	2.00
NASH18W20P29	Control		65	12.00	0.00
NASH18W20P32	SM		65	0.67	2.67
NASH18W20P36	SM		65	2.00	0.00
NASH18W21P1	EFM	NT	6.83	0.00	0.00
NASH18W21P2	LFM		5.00	0.00	0.00
NASH18W21P5	EFM	CP	7.17	0.00	0.00
NASH18W21P6	SM		13.00	0.00	0.00
NASH18W21P7	EFM	NT	65	1.00	3.33
NASH18W21P10	Control		12.33	0.00	0.00
NASH18W21P15	Control		5.83	0.00	0.00
NASH18W21P16	LFM		12.00	0.00	0.00
NASH18W21P20	LFM		13.67	0.00	0.00
NASH18W21P21	EFM	CP	6.33	0.00	0.00
NASH18W21P26	EFM	CP	6.17	0.00	0.00
NASH18W21P29	Control		10.33	0.00	0.00
NASH18W21P30	EFM	NT	10.17	0.00	0.00
NASH18W21P32	SM		18.00	0.00	0.00
NASH18W21P36	SM		3.67	0.00	0.00
NASH18W22P1	EFM	NT	9.83	9.67	0.00
NASH18W22P2	LFM		10.17	1.17	0.00
NASH18W22P5	EFM	CP	10.33	1.00	0.17
NASH18W22P6	SM		6.33	2.67	0.00
NASH18W22P7	EFM	NT	7.50	5.00	0.00
NASH18W22P10	Control		5.67	0.67	0.00
NASH18W22P15	Control		29.50	0.50	0.00
NASH18W22P16	LFM		11.83	0.83	0.00
NASH18W22P20	LFM		11.33	0.50	0.00
NASH18W22P21	EFM	CP	6.67	0.83	0.00
NASH18W22P26	EFM	CP	7.00	4.17	0.00

NASH18W22P29	Control		8.17	2.17	0.00
NASH18W22P30	EFM	NT	8.83	0.17	0.00
NASH18W22P32	SM		6.17	5.50	0.00
NASH18W22P36	SM		18.67	0.17	0.00
NASH18W23P1	EFM	NT	33.17	0.83	0.00
NASH18W23P2	LFM		37.67	0.00	0.00
NASH18W23P5	EFM	CP	41.17	0.33	0.00
NASH18W23P6	SM		21.33	0.00	0.00
NASH18W23P7	EFM	NT	21.50	0.33	0.00
NASH18W23P10	Control		65	7.33	0.17
NASH18W23P15	Control		65	1.50	0.00
NASH18W23P16	LFM		48.33	0.33	0.00
NASH18W23P20	LFM		14.50	0.00	0.00
NASH18W23P21	EFM	CP	17.00	0.33	0.00
NASH18W23P26	EFM	CP	16.83	0.17	0.00
NASH18W23P29	Control		65	1.50	0.00
NASH18W23P30	EFM	NT	35.83	0.50	0.00
NASH18W23P32	SM		33.67	0.33	0.00
NASH18W23P36	SM		11.33	0.00	0.00
NASH18W24P1	EFM	NT	1.50	0.00	0.00
NASH18W24P2	LFM		0.50	0.00	0.00
NASH18W24P5	EFM	CP	1.00	0.00	0.00
NASH18W24P6	SM		0.67	0.00	0.00
NASH18W24P10	Control		7.67	0.00	0.00
NASH18W24P16	LFM		1.33	0.00	0.00
NASH18W24P21	EFM	CP	0.33	0.00	0.00
NASH18W24P26	EFM	CP	0.33	0.00	0.00
NASH18W24P30	EFM	NT	1.33	0.00	0.00
NASH18W24P36	SM		0.50	0.00	0.00

APPENDIX D. GENOTYPIC DATA

sample	Year	Week	Manure Treatment	Tillage	16s Ct	16s Copies/100mL	erm B Ct	erm B Copies/100mL	erm F Ct	erm F Copies/100mL
16W0P16	2016	0	LFM		20.75	4.49E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W0P2	2016	0	LFM		21.68	2.45E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W0P21	2016	0	EFM	CP	22.03	1.96E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W0P32	2016	0	SM		20.77	4.44E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W0P36	2016	0	SM		20.78	4.42E+05	<LOQ	<LOQ	29.30	3.70E+03
16W0P5	2016	0	EFM	CP	20.13	6.74E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W1P2	2016	1	LFM		17.69	3.27E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W1P20	2016	1	LFM		21.95	2.06E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W1P5	2016	1	EFM	CP	19.11	1.30E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W2P10	2016	2	Control		17.55	3.60E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W2P16	2016	2	LFM		17.73	3.19E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W2P21	2016	2	EFM	CP	19.60	9.48E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W2P26	2016	2	EFM	CP	20.20	6.41E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W2P32	2016	2	SM		20.37	5.74E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W2P36	2016	2	SM		21.89	2.14E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W3P1	2016	3	EFM	NT	20.26	6.19E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W3P10	2016	3	Control		18.37	2.11E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W3P15	2016	3	Control		20.01	7.27E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W3P16	2016	3	LFM		17.65	3.36E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W3P2	2016	3	LFM		17.59	3.50E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W3P20	2016	3	LFM		19.62	9.37E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W3P21	2016	3	EFM	CP	18.83	1.57E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W3P26	2016	3	EFM	CP	20.04	7.12E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W3P29	2016	3	Control		17.80	3.06E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W3P30	2016	3	EFM	NT	21.77	2.31E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W3P32	2016	3	SM		18.07	2.56E+06	27.08	9.01E+03	27.61	1.10E+04
16W3P36	2016	3	SM		18.61	1.81E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W3P5	2016	3	EFM	CP	19.73	8.72E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W4P10	2016	4	EFM	CP	19.09	1.32E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W4P16	2016	4	LFM		18.24	2.29E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W4P2	2016	4	LFM		18.09	2.54E+06	<LOQ	<LOQ	28.12	7.92E+03
16W4P20	2016	4	LFM		19.69	8.97E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W4P21	2016	4	EFM	CP	20.46	5.42E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W4P30	2016	4	EFM	NT	22.60	1.35E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W4P36	2016	4	SM		20.57	5.06E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W4P5	2016	4	Control		18.28	2.24E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W5P1	2016	5	EFM	NT	18.88	1.51E+06	<LOQ	<LOQ	<LOQ	<LOQ

16W5P16	2016	5	LFM		19.61	9.43E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W5P20	2016	5	LFM		19.01	1.39E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W5P30	2016	5	EFM	NT	19.87	7.94E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W5P5	2016	5	EFM	CP	18.97	1.43E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P1	2016	6	EFM	NT	19.12	1.30E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P10	2016	6	Control		17.50	3.72E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P16	2016	6	Control		19.59	9.56E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W6P2	2016	6	LFM		19.70	8.91E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W6P20	2016	6	LFM		19.21	1.23E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P21	2016	6	LFM		18.40	2.06E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P26	2016	6	EFM	CP	19.28	1.17E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P30	2016	6	EFM	NT	19.47	1.03E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P32	2016	6	SM		18.12	2.48E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P36	2016	6	SM		17.26	4.33E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W6P5	2016	6	EFM	CP	20.09	6.92E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W6P6	2016	6	SM		17.42	3.91E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P1	2016	7	EFM	NT	17.89	2.89E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P10	2016	7	Control		16.99	5.18E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P15	2016	7	Control		17.86	2.94E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P16	2016	7	LFM		16.58	6.76E+06	27.81	5.58E+03	<LOQ	<LOQ
16W7P2	2016	7	LFM		16.48	7.21E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P20	2016	7	LFM		18.01	2.66E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P21	2016	7	EFM	CP	18.52	1.92E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P26	2016	7	EFM	CP	18.68	1.72E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P29	2016	7	Control		18.06	2.59E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P30	2016	7	EFM	NT	18.36	2.12E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P32	2016	7	SM		18.46	2.00E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P36	2016	7	SM		17.99	2.70E+06	<LOQ	<LOQ	27.73	1.01E+04
16W7P5	2016	7	EFM	CP	18.97	1.43E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W7P6	2016	7	SM		19.98	7.41E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W7P7	2016	7	EFM	NT	17.25	4.38E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W8P1	2016	8	EFM	NT	15.86	1.08E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P10	2016	8	Control		15.72	1.18E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P15	2016	8	Control		16.62	6.58E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W8P16	2016	8	LFM		16.17	8.80E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W8P2	2016	8	LFM		15.21	1.64E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P20	2016	8	LFM		16.55	6.88E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W8P21	2016	8	EFM	CP	14.88	2.04E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P26	2016	8	EFM	CP	15.96	1.01E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P29	2016	8	Control		14.05	3.51E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P30	2016	8	EFM	NT	32.84	1.74E+02	<LOQ	<LOQ	<LOQ	<LOQ

16W8P32	2016	8	SM		16.90	5.48E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W8P36	2016	8	SM		15.75	1.16E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P5	2016	8	EFM	CP	15.11	1.75E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P6	2016	8	SM		15.58	1.30E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W8P7	2016	8	EFM	NT	16.68	6.31E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P1	2016	9	EFM	NT	16.45	7.35E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P10	2016	9	Control		16.28	8.19E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P15	2016	9	Control		17.27	4.31E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P16	2016	9	LFM		16.76	6.00E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P2	2016	9	LFM		33.73	9.74E+01	<LOQ	<LOQ	<LOQ	<LOQ
16W9P20	2016	9	LFM		18.52	1.91E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P21	2016	9	EFM	CP	16.55	6.89E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P26	2016	9	EFM	CP	17.18	4.57E+06	28.06	4.75E+03	<LOQ	<LOQ
16W9P29	2016	9	Control		17.42	3.92E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P30	2016	9	EFM	NT	32.80	1.79E+02	<LOQ	<LOQ	<LOQ	<LOQ
16W9P32	2016	9	SM		18.15	2.44E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P36	2016	9	SM		18.94	1.46E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P5	2016	9	EFM	CP	16.48	7.23E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W9P6	2016	9	SM		16.01	9.76E+06	27.99	4.97E+03	<LOQ	<LOQ
16W9P7	2016	9	EFM	NT	17.05	4.99E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P1	2016	10	EFM	NT	19.14	1.28E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P10	2016	10	Control		30.48	8.07E+02	<LOQ	<LOQ	<LOQ	<LOQ
16W10P15	2016	10	Control		18.07	2.56E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P16	2016	10	LFM		18.32	2.18E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P2	2016	10	LFM		17.12	4.76E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P20	2016	10	LFM		20.04	7.12E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W10P21	2016	10	EFM	CP	18.01	2.67E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P29	2016	10	Control		21.53	2.71E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W10P30	2016	10	EFM	NT	17.34	4.14E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P32	2016	10	SM		19.23	1.21E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P36	2016	10	SM		22.13	1.84E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W10P5	2016	10	EFM	CP	32.35	2.40E+02	<LOQ	<LOQ	<LOQ	<LOQ
16W10P6	2016	10	SM		18.85	1.55E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W10P7	2016	10	EFM	NT	25.52	2.03E+04	<LOQ	<LOQ	<LOQ	<LOQ
16W11P1	2016	11	EFM	NT	18.87	1.52E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W11P16	2016	11	LFM		17.85	2.97E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W11P2	2016	11	LFM		21.46	2.84E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W11P20	2016	11	LFM		20.14	6.68E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W11P21	2016	11	EFM	CP	18.27	2.25E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W11P26	2016	11	EFM	CP	17.59	3.50E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W11P29	2016	11	Control		19.60	9.49E+05	<LOQ	<LOQ	<LOQ	<LOQ

16W11P30	2016	11	EFM	NT	20.33	5.92E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W11P32	2016	11	SM		19.38	1.10E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W11P36	2016	11	SM		18.76	1.64E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W11P5	2016	11	EFM	CP	18.70	1.71E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W11P6	2016	11	SM		16.99	5.17E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W12P1	2016	12	EFM	NT	17.14	4.70E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W12P10	2016	12	Control		17.25	4.38E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W12P16	2016	12	LFM		18.50	1.94E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W12P2	2016	12	LFM		17.43	3.88E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W12P21	2016	12	EFM	CP	20.55	5.11E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W12P26	2016	12	EFM	CP	17.34	4.13E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W12P30	2016	12	EFM	NT	18.42	2.05E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W12P5	2016	12	EFM	CP	18.10	2.51E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W12P6	2016	12	SM		17.36	4.06E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P1	2016	13	EFM	NT	17.99	2.71E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P10	2016	13	Control		17.45	3.84E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P15	2016	13	Control		16.74	6.10E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P16	2016	13	LFM		16.30	8.09E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P20	2016	13	LFM		17.89	2.89E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P21	2016	13	EFM	CP	16.92	5.40E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P26	2016	13	EFM	CP	17.45	3.85E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P30	2016	13	EFM	NT	18.00	2.68E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P32	2016	13	SM		20.30	6.03E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W13P36	2016	13	SM		19.09	1.33E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P5	2016	13	EFM	CP	34.66	5.33E+01	<LOQ	<LOQ	<LOQ	<LOQ
16W13P6	2016	13	SM		18.67	1.73E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W13P7	2016	13	EFM	NT	17.87	2.93E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P1	2016	14	EFM	NT	17.10	4.82E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P10	2016	14	Control		15.27	1.59E+07	<LOQ	<LOQ	<LOQ	<LOQ
16W14P15	2016	14	Control		17.38	4.03E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P16	2016	14	LFM		17.41	3.94E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P2	2016	14	LFM		17.90	2.87E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P20	2016	14	LFM		18.18	2.39E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P21	2016	14	EFM	CP	16.18	8.78E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P26	2016	14	EFM	CP	16.81	5.81E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P30	2016	14	EFM	NT	17.85	2.96E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P36	2016	14	SM		34.12	7.58E+01	<LOQ	<LOQ	<LOQ	<LOQ
16W14P6-1	2016	14	EFM	CP	18.97	1.43E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W14P6-2	2016	14	SM		17.01	5.10E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W15P2	2016	15	SM		33.72	9.82E+01	<LOQ	<LOQ	<LOQ	<LOQ
16W15P20	2016	15	EFM	CP	34.54	5.77E+01	<LOQ	<LOQ	<LOQ	<LOQ

16W15P30	2016	15	LFM		32.18	2.68E+02	<LOQ	<LOQ	<LOQ	<LOQ
16W16P1	2016	16	EFM	NT	19.69	8.96E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W16P16	2016	16	SM		19.40	1.08E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W16P2	2016	16	EFM	NT	22.56	1.39E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W16P30	2016	16	LFM		21.19	3.37E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W16P32	2016	16	EFM	NT	32.98	1.59E+02	<LOQ	<LOQ	<LOQ	<LOQ
16W16P5	2016	16	LFM		23.89	5.85E+04	<LOQ	<LOQ	<LOQ	<LOQ
16W17P16	2016	17	LFM		28.70	2.56E+03	<LOQ	<LOQ	<LOQ	<LOQ
16W17P20	2016	17	LFM		30.05	1.07E+03	<LOQ	<LOQ	<LOQ	<LOQ
16W17P30	2016	17	EFM	CP	32.11	2.79E+02	<LOQ	<LOQ	<LOQ	<LOQ
16W18P2	2016	18	EFM	NT	20.62	4.89E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W18P21	2016	18	LFM		19.34	1.12E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W18P26	2016	18	EFM	CP	17.25	4.38E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W18P30	2016	18	EFM	CP	22.08	1.90E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W18P5	2016	18	LFM		24.51	3.92E+04	<LOQ	<LOQ	<LOQ	<LOQ
16W18P6	2016	18	EFM	CP	19.95	7.54E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W19P15	2016	19	EFM	CP	18.24	2.29E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W19P30	2016	19	Control		17.36	4.07E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W19P5	2016	19	LFM		17.77	3.12E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W20P16	2016	20	LFM		20.63	4.85E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W20P2	2016	20	EFM	NT	17.10	4.82E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W20P30	2016	20	LFM		18.19	2.37E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P1	2016	21	EFM	NT	18.06	2.58E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P10	2016	21	EFM	NT	18.94	1.45E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P15	2016	21	Control		18.73	1.67E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P16	2016	21	Control		18.69	1.72E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P2	2016	21	EFM	NT	18.03	2.64E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P20	2016	21	LFM		19.49	1.02E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P21	2016	21	LFM		21.18	3.39E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W21P26	2016	21	EFM	CP	20.44	5.50E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W21P29	2016	21	EFM	CP	17.50	3.73E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P30	2016	21	Control		18.60	1.82E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P32	2016	21	EFM	NT	20.34	5.86E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W21P5	2016	21	LFM		18.74	1.66E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W21P6	2016	21	EFM	CP	21.40	2.95E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W21P7	2016	21	SM		19.72	8.78E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W22P1	2016	22	SM		15.98	9.98E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P10	2016	22	EFM	NT	18.08	2.55E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P15	2016	22	Control		21.20	3.36E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W22P16	2016	22	Control		17.56	3.58E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P2	2016	22	EFM	NT	17.92	2.83E+06	<LOQ	<LOQ	<LOQ	<LOQ

16W22P20	2016	22	LFM		18.22	2.33E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P21	2016	22	LFM		17.57	3.55E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P26	2016	22	EFM	CP	19.07	1.34E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P30	2016	22	EFM	CP	19.09	1.32E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P36	2016	22	SM		18.50	1.94E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P5	2016	22	LFM		17.22	4.45E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P6	2016	22	EFM	CP	17.63	3.42E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W22P7	2016	22	SM		18.35	2.13E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P1	2016	23	EFM	NT	18.73	1.67E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P10	2016	23	Control		18.02	2.64E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P15	2016	23	Control		17.93	2.82E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P16	2016	23	LFM		19.78	8.44E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W23P2	2016	23	LFM		16.54	6.94E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P20	2016	23	LFM		20.55	5.10E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W23P21	2016	23	EFM	CP	19.51	1.01E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P26	2016	23	EFM	CP	18.79	1.61E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P29	2016	23	Control		19.01	1.40E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P30	2016	23	EFM	NT	19.81	8.28E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W23P32	2016	23	SM		20.07	7.02E+05	<LOQ	<LOQ	<LOQ	<LOQ
16W23P36	2016	23	SM		18.55	1.87E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P5	2016	23	EFM	CP	17.60	3.48E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P6	2016	23	SM		17.35	4.09E+06	<LOQ	<LOQ	<LOQ	<LOQ
16W23P7	2016	23	EFM	NT	18.91	1.49E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W0P11	2017	0	EFM	NT	18.81	1.48E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W0P14	2017	0	LFM		19.31	1.07E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W0P21	2017	0	EFM	CP	18.79	1.50E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W0P23	2017	0	EFM	NT	21.06	3.43E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W0P24	2017	0	Control		17.72	3.01E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W0P32	2017	0	SM		17.84	2.78E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W0P36	2017	0	SM		19.34	1.05E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W0P5	2017	0	EFM	CP	21.08	3.39E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W1P11	2017	1	EFM	NT	19.15	1.19E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W1P14	2017	1	LFM		21.47	2.63E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W1P21	2017	1	EFM	CP	17.87	2.73E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W1P23	2017	1	EFM	NT	20.06	6.55E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W1P24	2017	1	Control		17.82	2.82E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W1P25	2017	1	LFM		18.21	2.20E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W1P26	2017	1	EFM	CP	19.54	9.20E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W1P27	2017	1	EFM	NT	18.46	1.87E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W1P28	2017	1	Control		19.41	1.00E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W1P3	2017	1	Control		20.31	5.59E+05	<LOQ	<LOQ	<LOQ	<LOQ

17W1P31	2017	1	LFM	NT	19.93	7.14E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W1P32	2017	1	SM		17.64	3.18E+06	22.60	1.64E+05	22.14	4.07E+05
17W1P36	2017	1	SM		18.60	1.70E+06	25.79	1.87E+04	24.61	8.14E+04
17W1P5	2017	1	EFM	CP	20.36	5.39E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W2P11	2017	2	EFM	NT	18.43	1.89E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P14	2017	2	LFM		18.75	1.54E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P21	2017	2	EFM	CP	17.20	4.22E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P23	2017	2	EFM	NT	19.40	1.01E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P24	2017	2	Control		19.18	1.16E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P25	2017	2	LFM		18.27	2.11E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P26	2017	2	EFM	CP	17.99	2.53E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P3	2017	2	Control		18.62	1.67E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P31	2017	2	LFM	NT	20.62	4.57E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W2P32	2017	2	SM		16.66	6.01E+06	25.17	2.85E+04	24.94	6.56E+04
17W2P36	2017	2	SM		18.85	1.44E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P5	2017	2	EFM	CP	18.91	1.39E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W2P6	2017	2	SM		13.89	3.64E+07	25.11	2.96E+04	24.81	7.13E+04
17W3P11	2017	3	EFM	NT	18.28	2.09E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P14	2017	3	LFM		17.88	2.71E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P21	2017	3	EFM	CP	16.96	4.94E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P23	2017	3	EFM	NT	19.63	8.70E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W3P24	2017	3	Control		20.16	6.16E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W3P25	2017	3	LFM		17.82	2.83E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P26	2017	3	EFM	CP	20.23	5.87E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W3P27	2017	3	Control		17.13	4.42E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P27	2017	3	EFM	NT	17.13	4.42E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P3	2017	3	Control		19.37	1.03E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P31	2017	3	LFM	NT	18.18	2.23E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P32	2017	3	SM		18.03	2.46E+06	27.62	5.35E+03	27.10	1.60E+04
17W3P36	2017	3	SM		19.02	1.29E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P5	2017	3	EFM	CP	19.32	1.07E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W3P6	2017	3	SM		17.25	4.10E+06	27.22	7.02E+03	25.78	3.80E+04
17W4P11	2017	4	EFM	NT	19.51	9.39E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W4P14	2017	4	LFM		18.51	1.80E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W4P21	2017	4	EFM	CP	18.73	1.56E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W4P23	2017	4	EFM	NT	20.12	6.31E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W4P24	2017	4	Control		19.80	7.77E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W4P25	2017	4	LFM		19.81	7.74E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W4P26	2017	4	EFM	CP	18.97	1.34E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W4P27	2017	4	EFM	NT	15.68	1.13E+07	<LOQ	<LOQ	<LOQ	<LOQ
17W4P28	2017	4	Control		18.28	2.10E+06	<LOQ	<LOQ	<LOQ	<LOQ

17W4P3	2017	4	Control		19.28	1.09E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W4P31	2017	4	LFM	NT	19.41	1.00E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W4P32	2017	4	SM		19.86	7.49E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W4P36	2017	4	SM		20.63	4.52E+05	27.09	7.69E+03	<LOQ	<LOQ
17W4P5	2017	4	EFM	CP	21.26	3.01E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W4P6	2017	4	SM		18.39	1.94E+06	27.82	4.68E+03	<LOQ	<LOQ
17W5P11	2017	5	EFM	NT	18.22	2.17E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W5P14	2017	5	LFM		19.90	7.31E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W5P21	2017	5	EFM	CP	19.94	7.12E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W5P23	2017	5	EFM	NT	19.26	1.11E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W5P24	2017	5	Control		19.87	7.44E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W5P25	2017	5	LFM		18.10	2.35E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W5P26	2017	5	EFM	CP	17.83	2.80E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W5P28	2017	5	Control		20.67	4.42E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W5P3	2017	5	Control		18.75	1.54E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W5P31	2017	5	LFM	NT	20.04	6.67E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W5P36	2017	5	SM		19.52	9.32E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W5P5	2017	5	EFM	CP	17.52	3.44E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W5P6	2017	5	SM		18.39	1.95E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P11	2017	6	EFM	NT	16.48	6.76E+06	27.56	5.59E+03	<LOQ	<LOQ
17W6P14	2017	6	LFM		17.75	2.95E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P21	2017	6	EFM	CP	16.20	8.09E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P23	2017	6	EFM	NT	19.28	1.09E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P24	2017	6	Control		18.33	2.03E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P25	2017	6	LFM		16.92	5.07E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P26	2017	6	EFM	CP	18.75	1.54E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P27	2017	6	EFM	NT	14.10	3.17E+07	<LOQ	<LOQ	<LOQ	<LOQ
17W6P28	2017	6	Control		16.05	8.95E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P3	2017	6	Control		18.15	2.28E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P31	2017	6	LFM	NT	18.73	1.56E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P32	2017	6	SM		16.26	7.77E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P36	2017	6	SM		17.74	2.98E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P5	2017	6	EFM	CP	18.26	2.12E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W6P6	2017	6	SM		15.46	1.31E+07	27.36	6.40E+03	<LOQ	<LOQ
17W7P11	2017	7	EFM	NT	17.45	3.59E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P14	2017	7	LFM		18.99	1.32E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P21	2017	7	EFM	CP	19.71	8.26E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W7P23	2017	7	EFM	NT	16.42	7.00E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P24	2017	7	Control		18.69	1.60E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P25	2017	7	LFM		17.85	2.77E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P26	2017	7	EFM	CP	19.87	7.44E+05	<LOQ	<LOQ	<LOQ	<LOQ

17W7P27	2017	7	EFM	NT	16.04	8.96E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P28	2017	7	Control		16.44	6.91E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P3	2017	7	Control		17.13	4.42E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P31	2017	7	LFM	NT	18.93	1.37E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W7P32	2017	7	SM		20.23	5.87E+05	<LOQ	<LOQ	26.37	2.58E+04
17W7P36	2017	7	SM		20.17	6.11E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W7P5	2017	7	EFM	CP	19.89	7.36E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W7P6	2017	7	SM		20.71	4.31E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W8P11	2017	8	EFM	NT	17.02	4.75E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W8P14	2017	8	LFM		18.30	2.07E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W8P21	2017	8	EFM	CP	19.74	8.09E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W8P23	2017	8	EFM	NT	18.82	1.47E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W8P24	2017	8	Control		17.98	2.54E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W8P25	2017	8	LFM		18.67	1.62E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W8P26	2017	8	EFM	CP	19.71	8.27E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W8P28	2017	8	Control		17.35	3.83E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W8P3	2017	8	Control		18.54	1.77E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W8P31	2017	8	LFM		18.75	1.54E+06	27.25	6.90E+03	<LOQ	<LOQ
17W8P32	2017	8	SM		17.69	3.07E+06	26.40	1.23E+04	26.07	3.15E+04
17W8P36	2017	8	SM		20.15	6.19E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W8P5	2017	8	EFM	CP	16.55	6.45E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W8P6	2017	8	SM		17.09	4.53E+06	28.06	3.96E+03	<LOQ	<LOQ
17W9P11	2017	9	EFM	NT	19.02	1.30E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W9P14	2017	9	LFM		18.52	1.79E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W9P23	2017	9	EFM	NT	19.61	8.81E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W9P24	2017	9	Control		18.12	2.33E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W9P25	2017	9	LFM		19.70	8.31E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W9P3	2017	9	Control		16.54	6.48E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W9P31	2017	9	LFM		19.76	7.97E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W9P5	2017	9	EFM	CP	19.77	7.94E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W9P6	2017	9	SM		18.10	2.35E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W10P14	2017	10	LFM		18.32	2.04E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W10P3	2017	10	Control		17.29	3.98E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W10P31	2017	10	LFM	NT	17.97	2.56E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W10P5	2017	10	EFM	CP	17.14	4.38E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W11P11	2017	11	EFM	NT	16.88	5.21E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W11P14	2017	11	LFM		19.92	7.20E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W11P3	2017	11	Control		15.89	9.94E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W11P31	2017	11	LFM	NT	19.31	1.07E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W11P5	2017	11	EFM	CP	17.51	3.45E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W12P11	2017	12	EFM	NT	18.64	1.66E+06	<LOQ	<LOQ	<LOQ	<LOQ

17W12P14	2017	12	LFM		18.22	2.17E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W12P23	2017	12	EFM	NT	18.30	2.06E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W12P24	2017	12	Control		20.17	6.13E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W12P25	2017	12	LFM		17.51	3.45E+06	27.35	6.45E+03	<LOQ	<LOQ
17W12P26	2017	12	EFM	CP	16.37	7.24E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W12P3	2017	12	Control		17.85	2.77E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W12P31	2017	12	LFM	NT	19.33	1.05E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W12P5	2017	12	EFM	CP	19.42	9.97E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W12P6	2017	12	SM		18.20	2.21E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P11	2017	13	EFM	NT	17.06	4.63E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P14	2017	13	LFM		17.90	2.68E+06	28.11	3.84E+03	<LOQ	<LOQ
17W13P23	2017	13	EFM	NT	17.96	2.58E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P24	2017	13	Control		17.75	2.96E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P25	2017	13	LFM		16.18	8.20E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P26	2017	13	EFM	CP	17.34	3.87E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P3	2017	13	Control		17.04	4.69E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P31	2017	13	LFM	NT	19.17	1.17E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P5	2017	13	EFM	CP	17.76	2.93E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W13P6	2017	13	SM		17.96	2.58E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W14P11	2017	14	EFM	NT	15.95	9.54E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W14P14	2017	14	LFM		16.51	6.61E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W14P3	2017	14	Control		17.08	4.56E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W14P31	2017	14	LFM	NT	18.56	1.75E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W14P6	2017	14	EFM	CP	17.95	2.60E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W15P31	2017	15	LFM	NT	31.95	2.87E+02	<LOQ	<LOQ	<LOQ	<LOQ
17W15P5	2017	15	EFM	CP	19.59	8.94E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W16P11	2017	16	EFM	NT	14.37	2.67E+07	<LOQ	<LOQ	<LOQ	<LOQ
17W16P14	2017	16	LFM		17.19	4.26E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P21	2017	16	EFM	CP	18.75	1.55E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P23	2017	16	EFM	NT	16.66	6.00E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P24	2017	16	Control		17.75	2.95E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P25	2017	16	LFM		18.13	2.31E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P26	2017	16	EFM	CP	20.55	4.78E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W16P28	2017	16	Control		17.38	3.76E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P3	2017	16	Control		16.48	6.75E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P31	2017	16	LFM	NT	20.97	3.64E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W16P32	2017	16	SM		17.60	3.26E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P36	2017	16	SM		18.65	1.65E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P5	2017	16	EFM	CP	16.71	5.83E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W16P6	2017	16	SM		16.87	5.22E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W17P11	2017	17	EFM	NT	16.27	7.74E+06	<LOQ	<LOQ	<LOQ	<LOQ

17W17P14	2017	17	LFM		19.07	1.25E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W17P23	2017	17	EFM	NT	19.91	7.25E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W17P3	2017	17	Control		18.35	2.00E+06	<LOQ	<LOQ	<LOQ	<LOQ
17W17P31	2017	17	LFM	NT	19.78	7.89E+05	<LOQ	<LOQ	<LOQ	<LOQ
17W17P5	2017	17	EFM	CP	21.32	2.89E+05	<LOQ	<LOQ	<LOQ	<LOQ
18W0P21	2018	0	EFM	CP	16.73	8.20E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W0P5	2018	0	EFM	CP	17.06	6.66E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W1P10	2018	1	Control		14.66	3.05E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P15	2018	1	Control		15.04	2.41E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P16	2018	1	LFM		14.34	3.74E+07	27.14	6.73E+03	29.63	1.39E+03
18W1P2	2018	1	LFM		13.97	4.74E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P20	2018	1	LFM		15.54	1.75E+07	<LOQ	<LOQ	28.95	2.28E+03
18W1P21	2018	1	EFM	CP	16.22	1.14E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P26	2018	1	EFM	CP	15.51	1.79E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P30	2018	1	EFM	NT	15.87	1.42E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P32	2018	1	SM		15.27	2.08E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P36	2018	1	SM		14.37	3.68E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P5	2018	1	EFM	CP	15.49	1.81E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P6	2018	1	SM		14.27	3.92E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1P7	2018	1	EFM	NT	15.43	1.88E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W2P10	2018	2	Control		15.13	2.28E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W2P15	2018	2	Control		15.73	1.55E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W2P16	2018	2	LFM		18.04	3.58E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W2P2	2018	2	LFM		14.67	3.03E+07	27.41	5.57E+03	<LOQ	<LOQ
18W2P21	2018	2	LFM		16.16	1.18E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W2P26	2018	2	EFM	CP	16.91	7.34E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W2P29	2018	2	Control		16.41	1.01E+07	<LOQ	<LOQ	32.56	1.66E+02
18W2P30	2018	2	EFM	NT	17.00	6.92E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W2P32	2018	2	SM		16.62	8.84E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W2P36	2018	2	SM		15.53	1.76E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W2P5	2018	2	EFM	CP	15.32	2.02E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W2P6	2018	2	SM		17.12	6.43E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W2P7	2018	2	EFM	NT	14.73	2.92E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W3P1	2018	3	EFM	NT	15.42	1.88E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W3P10	2018	3	Control		15.89	1.40E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W3P15	2018	3	Control		17.15	6.32E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W3P16	2018	3	LFM		16.65	8.64E+06	<LOQ	<LOQ	30.51	7.33E+02
18W3P2	2018	3	LFM		15.80	1.48E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W3P21	2018	3	EFM	CP	18.74	2.30E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W3P26	2018	3	EFM	CP	17.69	4.47E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W3P30	2018	3	EFM	NT	18.59	2.52E+06	<LOQ	<LOQ	<LOQ	<LOQ

18W3P36	2018	3	SM		15.51	1.79E+07	<LOQ	<LOQ	26.54	1.32E+04
18W3P5	2018	3	EFM	CP	17.41	5.34E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W3P6	2018	3	SM		15.71	1.57E+07	25.08	2.79E+04	25.84	2.19E+04
18W4P1	2018	4	EFM	NT	17.96	3.78E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W4P10	2018	4	Control		15.97	1.34E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W4P15	2018	4	Control		15.83	1.46E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W4P16	2018	4	LFM		16.00	1.31E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W4P2	2018	4	LFM		15.98	1.33E+07	26.62	9.64E+03	29.55	1.47E+03
18W4P20	2018	4	LFM		18.71	2.33E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W4P21	2018	4	EFM	CP	16.26	1.11E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W4P29	2018	4	Control		16.09	1.23E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W4P30	2018	4	EFM	NT	18.88	2.10E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W4P32	2018	4	SM		16.23	1.13E+07	24.60	3.91E+04	25.73	2.38E+04
18W4P36	2018	4	SM		16.75	8.10E+06	25.50	2.09E+04	25.55	2.71E+04
18W4P5	2018	4	EFM	CP	16.27	1.10E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W4P6	2018	4	SM		15.22	2.14E+07	23.60	7.78E+04	24.42	6.17E+04
18W4P7	2018	4	EFM	NT	15.87	1.42E+07	<LOQ	<LOQ	29.25	1.83E+03
18W5P1	2018	5	EFM	NT	17.26	5.87E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W5P10	2018	5	Control		16.31	1.07E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W5P15	2018	5	Control		16.04	1.27E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W5P16	2018	5	LFM		18.02	3.63E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W5P2	2018	5	LFM		17.77	4.24E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W5P20	2018	5	LFM		16.05	1.27E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W5P21	2018	5	EFM	CP	16.08	1.24E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W5P26	2018	5	EFM	CP	18.74	2.30E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W5P29	2018	5	Control		18.44	2.78E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W5P30	2018	5	EFM	NT	17.28	5.81E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W5P32	2018	5	SM		16.93	7.22E+06	27.44	5.45E+03	27.67	5.80E+03
18W5P36	2018	5	SM		18.14	3.37E+06	<LOQ	<LOQ	28.85	2.45E+03
18W5P5	2018	5	EFM	CP	17.34	5.57E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W5P6	2018	5	SM		17.23	5.98E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W5P7	2018	5	EFM	NT	16.77	8.03E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W6P2	2018	6	LFM		17.62	4.67E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W6P5	2018	6	EFM	CP	16.44	9.88E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W6P6	2018	6	SM		16.90	7.39E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W7P1	2018	7	EFM	NT	17.06	6.69E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W7P16	2018	7	LFM		17.88	3.96E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W7P2	2018	7	LFM		16.46	9.77E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W7P30	2018	7	EFM	NT	16.94	7.19E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W7P36	2018	7	SM		17.73	4.36E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W7P5	2018	7	EFM	CP	18.24	3.16E+06	<LOQ	<LOQ	<LOQ	<LOQ

18W7P6	2018	7	SM		16.13	1.20E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W8P16	2018	8	LFM		16.60	8.92E+06	<LOQ	<LOQ	29.16	1.96E+03
18W8P2	2018	8	LFM		15.31	2.02E+07	<LOQ	<LOQ	29.28	1.80E+03
18W8P30	2018	8	EFM	NT	17.07	6.61E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W8P5	2018	8	EFM	CP	16.11	1.22E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W9P1	2018	9	EFM	NT	18.09	3.48E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W9P10	2018	9	Control		16.38	1.03E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W9P15	2018	9	Control		16.79	7.90E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W9P16	2018	9	LFM		16.77	8.03E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W9P2	2018	9	LFM		16.29	1.09E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W9P20	2018	9	LFM		17.40	5.38E+06	<LOQ	<LOQ	29.43	1.61E+03
18W9P21	2018	9	EFM	CP	16.99	6.95E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W9P26	2018	9	EFM	CP	16.50	9.51E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W9P29	2018	9	Control		16.22	1.14E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W9P30	2018	9	EFM	NT	18.91	2.06E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W9P32	2018	9	SM		<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
18W9P36	2018	9	SM		15.92	1.37E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W9P5	2018	9	EFM	CP	16.88	7.47E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W9P6	2018	9	SM		15.99	1.32E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W9P7	2018	9	EFM	NT	16.13	1.20E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W10P1	2018	10	EFM	NT	16.37	1.03E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W10P10	2018	10	Control		14.48	3.43E+07	25.63	1.91E+04	<LOQ	<LOQ
18W10P15	2018	10	Control		14.82	2.76E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W10P16	2018	10	LFM		15.51	1.78E+07	<LOQ	<LOQ	31.47	3.66E+02
18W10P2	2018	10	LFM		16.82	7.78E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W10P20	2018	10	LFM		16.88	7.50E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W10P21	2018	10	EFM	CP	16.20	1.15E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W10P26	2018	10	EFM	CP	16.44	9.86E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W10P29	2018	10	Control		15.61	1.68E+07	<LOQ	<LOQ	28.57	3.01E+03
18W10P30	2018	10	EFM	NT	18.20	3.23E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W10P32	2018	10	SM		16.11	1.22E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W10P36	2018	10	SM		16.84	7.66E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W10P5	2018	10	EFM	CP	16.41	1.01E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W10P6	2018	10	SM		15.72	1.56E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W10P7	2018	10	EFM	NT	15.49	1.81E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W11P1	2018	11	EFM	NT	16.91	7.33E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W11P10	2018	11	Control		15.55	1.74E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W11P15	2018	11	Control		15.20	2.18E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W11P16	2018	11	LFM		15.74	1.54E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W11P2	2018	11	LFM		15.54	1.75E+07	<LOQ	<LOQ	29.74	1.28E+03
18W11P20	2018	11	LFM		16.97	7.04E+06	<LOQ	<LOQ	<LOQ	<LOQ

18W11P21	2018	11	EFM	CP	17.76	4.27E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W11P26	2018	11	EFM	CP	16.37	1.03E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W11P29	2018	11	Control		17.68	4.50E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W11P30	2018	11	EFM	NT	17.36	5.52E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W11P32	2018	11	SM		16.65	8.67E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W11P36	2018	11	SM		21.96	2.98E+05	<LOQ	<LOQ	<LOQ	<LOQ
18W11P5	2018	11	EFM	CP	16.44	9.89E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W11P6	2018	11	SM		15.51	1.78E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W11P7	2018	11	EFM	NT	15.31	2.02E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W1215	2018	12	Control		15.87	1.42E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P1	2018	12	EFM	NT	16.70	8.37E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W12P10	2018	12	Control		15.64	1.64E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P16	2018	12	LFM		16.38	1.02E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P2	2018	12	LFM		15.17	2.21E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P20	2018	12	LFM		16.48	9.61E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W12P21	2018	12	EFM	CP	16.19	1.16E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P26	2018	12	EFM	CP	19.40	1.51E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W12P29	2018	12	Control		16.24	1.12E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P30	2018	12	EFM	NT	19.30	1.61E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W12P32	2018	12	SM		16.41	1.01E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P36	2018	12	SM		16.49	9.57E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W12P5	2018	12	EFM	CP	16.26	1.11E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P6	2018	12	SM		15.43	1.88E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W12P7	2018	12	EFM	NT	15.54	1.75E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W13P1	2018	13	EFM	NT	16.64	8.69E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P10	2018	13	Control		16.07	1.25E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W13P15	2018	13	Control		16.64	8.70E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P16	2018	13	LFM		16.40	1.01E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W13P2	2018	13	LFM		18.22	3.20E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P20	2018	13	LFM		17.09	6.54E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P21	2018	13	EFM		17.11	6.46E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P26	2018	13	EFM		16.48	9.61E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P29	2018	13	Control		16.91	7.34E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P30	2018	13	EFM	NT	17.78	4.23E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P32	2018	13	SM		17.13	6.37E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P36	2018	13	SM		16.34	1.05E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W13P5	2018	13	EFM	CP	17.42	5.33E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W13P6	2018	13	SM		16.48	9.63E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W14P30	2018	14	EFM	NT	16.85	7.62E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W14P5	2018	14	EFM	CP	16.65	8.64E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W14P6	2018	14	SM		16.91	7.34E+06	<LOQ	<LOQ	<LOQ	<LOQ

18W15P30	2018	15	EFM	NT	16.88	7.46E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W15P5	2018	15	EFM	CP	17.13	6.38E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W17P2	2018	17	LFM		15.88	1.41E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W17P30	2018	17	EFM	NT	15.52	1.77E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W17P5	2018	17	EFM	CP	16.16	1.18E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W18P1	2018	18	EFM	NT	15.95	1.35E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W18P10	2018	18	Control		18.53	2.63E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P15	2018	18	Control		17.12	6.43E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P16	2018	18	LFM		17.49	5.06E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P2	2018	18	LFM		14.56	3.27E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W18P20	2018	18	LFM		16.23	1.13E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W18P21	2018	18	EFM	CP	17.19	6.13E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P26	2018	18	EFM	CP	14.77	2.86E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W18P29	2018	18	Control		16.96	7.12E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P30	2018	18	EFM	NT	16.73	8.21E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P32	2018	18	SM		16.70	8.39E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P36	2018	18	SM		16.70	8.41E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P5	2018	18	EFM	CP	15.73	1.56E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W18P6	2018	18	SM		16.84	7.67E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W18P7	2018	18	EFM		16.61	8.87E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W19P10	2018	19	Control		15.94	1.36E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W19P15	2018	19	Control		15.27	2.08E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W19P16	2018	19	LFM		16.01	1.30E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W19P2	2018	19	LFM		<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
18W19P21	2018	19	EFM	CP	15.81	1.47E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W19P26	2018	19	EFM	CP	16.38	1.03E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W19P29	2018	19	Control		17.14	6.34E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W19P30	2018	19	EFM	NT	18.58	2.55E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W19P32	2018	19	SM		16.59	8.99E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W19P36	2018	19	SM		17.62	4.68E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W19P5	2018	19	EFM	CP	16.17	1.17E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W19P6	2018	19	SM		16.36	1.04E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W19P7	2018	19	EFM	NT	16.47	9.69E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W20P1	2018	20	EFM	NT	14.85	2.71E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P10	2018	20	Control		17.06	6.69E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W20P15	2018	20	Control		13.85	5.13E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P16	2018	20	LFM		16.63	8.79E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W20P2	2018	20	LFM		14.23	4.02E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P20	2018	20	LFM		16.13	1.21E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P21	2018	20	EFM	CP	14.60	3.17E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P26	2018	20	EFM	CP	16.48	9.66E+06	<LOQ	<LOQ	<LOQ	<LOQ

18W20P30	2018	20	EFM	NT	13.77	5.39E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P32	2018	20	SM		15.33	2.00E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P36	2018	20	SM		15.77	1.51E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P5	2018	20	EFM	CP	14.23	4.03E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P6	2018	20	SM		15.65	1.64E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W20P7	2018	20	EFM	NT	14.18	4.16E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W21P1	2018	21	EFM	NT	17.09	6.53E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W21P10	2018	21	Control		16.26	1.11E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W21P16	2018	21	LFM		16.50	9.49E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W21P2	2018	21	LFM		15.61	1.68E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W21P20	2018	21	LFM		15.55	1.74E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W21P21	2018	21	EFM	CP	17.08	6.59E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W21P26	2018	21	EFM	CP	17.00	6.95E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W21P29	2018	21	Control		16.20	1.15E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W21P30	2018	21	EFM	NT	16.57	9.10E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W21P32	2018	21	SM		16.71	8.35E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W21P36	2018	21	SM		16.87	7.52E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W21P5	2018	21	EFM	CP	16.87	7.50E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W21P6	2018	21	SM		15.93	1.37E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W21P7	2018	21	EFM	NT	15.80	1.48E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W21P15	2018	21	Control		15.75	1.53E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P1	2018	22	EFM	NT	16.12	1.21E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P10	2018	22	Control		15.21	2.16E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P15	2018	22	Control		18.52	2.64E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W22P16	2018	22	LFM		15.89	1.40E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P2	2018	22	LFM		15.47	1.83E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P20	2018	22	LFM		17.05	6.73E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W22P21	2018	22	EFM	CP	15.53	1.76E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P26	2018	22	EFM	CP	17.24	5.94E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W22P29	2018	22	Control		15.82	1.46E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P30	2018	22	EFM	NT	16.19	1.16E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P32	2018	22	SM		16.08	1.24E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P36	2018	22	SM		16.58	9.03E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W22P5	2018	22	EFM	CP	16.33	1.06E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P6	2018	22	SM		16.01	1.30E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W22P7	2018	22	EFM	NT	16.74	8.18E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W23P1	2018	23	EFM	NT	16.21	1.14E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W23P10	2018	23	Control		16.11	1.22E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W23P15	2018	23	Control		15.64	1.64E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W23P16	2018	23	LFM		16.64	8.74E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W23P20	2018	23	LFM		16.83	7.70E+06	<LOQ	<LOQ	<LOQ	<LOQ

18W23P21	2018	23	EFM	CP	16.29	1.09E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W23P26	2018	23	EFM	CP	16.72	8.28E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W23P30	2018	23	EFM	NT	16.08	1.24E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W23P32	2018	23	SM		16.62	8.80E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W23P36	2018	23	SM		16.82	7.78E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W23P5	2018	23	EFM	CP	16.78	7.96E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W23P6	2018	23	SM		16.85	7.64E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W23P7	2018	23	EFM	NT	16.18	1.16E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W24P1	2018	24	EFM	NT	17.21	6.08E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W24P10	2018	24	Control		16.69	8.46E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W24P16	2018	24	LFM		16.98	7.02E+06	<LOQ	<LOQ	28.37	3.47E+03
18W24P2	2018	24	LFM		16.12	1.21E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W24P21	2018	24	EFM	CP	18.11	3.43E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W24P26	2018	24	EFM	CP	16.48	9.66E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W24P30	2018	24	EFM	NT	18.89	2.09E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W24P36	2018	24	SM		15.83	1.46E+07	<LOQ	<LOQ	<LOQ	<LOQ
18W24P5	2018	24	EFM	CP	17.93	3.85E+06	<LOQ	<LOQ	<LOQ	<LOQ
18W24P6	2018	24	SM		16.69	8.42E+06	<LOQ	<LOQ	<LOQ	<LOQ