

FOOD SERVICE ESTABLISHMENT WASTEWATER
CHARACTERIZATION AND MANAGEMENT
PRACTICE EVALUATION

A Thesis

by

OCTAVIO ARMANDO GARZA

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2004

Major Subject: Biological and Agricultural Engineering

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ABSTRACT

Food Service Establishment Wastewater Characterization and
Management Practice Evaluation. (December 2004)

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Food service establishments that use onsite wastewater treatment systems are experiencing hydraulic and organic overloading of pretreatment systems and/or drain fields. Design guidelines for these systems are typically provided in State regulations and based on residential hydraulic applications. For the purposes of this research, hydraulic loading indicates the daily flow of water directed to the wastewater system. Organic loading refers to the composition of the wastewater as quantified by five-day biochemical oxygen demand (BOD₅), total fats, oils and greases (FOG), and total suspended solids (TSS).

The first part of this study included an analysis of the central tendencies of analytical data of four wastewater parameters from 28 restaurants representing a broad spectrum of restaurant types. Field sampling consisted of two sets of grab samples collected from each restaurant for six consecutive days at approximately the same time each day. These sets were collected approximately two weeks apart. The numerical data included BOD₅, FOG, and TSS. The fourth parameter evaluated was daily flow.

Data exploration and statistical analyses of the numerical data from the 28 restaurants was performed with the standard gamma probability distribution model in ExcelTM and used to determine inferences of the analytical data. The analysis shows higher hydraulic and organic values for restaurant wastewater than residential wastewater.

The second part of the study included a statistical analysis of restaurant management practices and primary cuisine types and their influence on BOD₅, FOG, TSS, and daily flow to determine if management practices and/or cuisine types may be influencing wastewater composition and flow. A self-reporting survey was utilized to collect management practice and cuisine type information.

Survey response information and analytical data were entered into an ExcelTM spreadsheet and subsequently incorporated into SASTM statistical software for statistical analysis. Analysis indicated that the number of seats in a restaurant, use of self-serve salad bars, and primary cuisine types are statistically significant indicators of wastewater characteristics.

DEDICATION

I dedicate this work to the memory of my father:

Roberto R. Garza
May 17, 1920 – July 8, 1991

You were right dad, I can do it!

ACKNOWLEDGEMENTS

First and foremost I would like to acknowledge the existence of God, for without Him nothing would be possible, and my personal Savior, Jesus Christ.

I would also like to acknowledge my committee for their continued support throughout this program. Thank you Dr. Bruce Lesikar (committee chair), for your endless patience to my unique situation and to your family for their patience in allowing you to spend so much time to help others. Also, thank you Dr. Ann Kenimer and Dr. Russell Persyn (committee members) for your patience and personal commitment to go the extra mile to help me in accomplishing this goal. Lastly, thank you Dr. Saqib Mukhtar and Dr. Sam Feagley (committee members), for taking the time away from your busy schedules to help me see this through. A big “thank you!” to the entire staff of the Biological and Agricultural Engineering Department at Texas A&M University, a unique and wonderful people dedicated to the advancement of science and engineering and the betterment of society through education.

A very special thanks to Mr. Michael Anderson and Dr. Anuradha Roy of the University of Texas, San Antonio. Simply stated, without your help in statistical analysis this research would not have been possible.

I would also like to acknowledge my beautiful wife, Lisa Garza, and my wonderful children Alexandra, Emma, and Owen, for their support and patience while I plied through this 7-year endeavor. Lisa, thanks for knowing exactly when to “encourage”,

when to “gently tug”, and when to “plant your foot squarely in the middle of my back” to complete this program. You are truly a precious godly woman unique in gifts and talents that have helped me be who I am today.

Also, thanks Mom, for your years of support and commitment to encouraging us kids to pursue an education. Not many parents can claim 8 college-educated children, 6 of whom are graduates of Texas A&M University, and 19 grandchildren, of which 4 are Aggies.

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CHAPTER I

INTRODUCTION

Published literature indicates that designers' use of industry-accepted methodologies and design values for sizing wastewater treatment systems for restaurants has resulted in systems that are inadequately designed in regard to hydraulic and organic loading (Stuth and Garrison, 1995). Angoli (2000) indicated that commercial systems serving the restaurant industry were failing and suggested that research was needed to better understand wastewater characteristics from restaurants. Another area of concern for industry professionals is the influence restaurant management practices and cuisine types have on restaurants.

Design guidelines for commercial systems are typically based on residential wastewater treatment systems applications; however, there are additional factors in restaurants such as the greater percentage of flow originating from preparation of food products including meats, fats, oils, greases, and dairy products; and the widespread and intensive use of cleaning agents such as disinfectants, cleaners, floor strippers, and soaps that create higher strength wastewater in restaurants that is more difficult to treat than in a typical household or residential home.

This thesis follows the style and format of the *Transactions of the American Society of Agricultural Engineers*.

The first component of this research focused on determining whether restaurants typically produce higher strength wastewater and larger flows than residences by statistically analyzing data obtained from 28 restaurants located in Texas and comparing the data with published data for domestic wastewater. The establishments represent a variety of restaurant types and include single and full service restaurants, buffet-type restaurants, restaurants with different cuisine types, etc.

The field sampling methodology included taking a grab sample from each of the 28 restaurants for 6 consecutive days at approximately the same time each day (noon to 3 p.m.), followed by a two-week break, and then sampling again for another 6 consecutive days, for a total of 12 samples per restaurant and 336 total observations. Laboratory analyses of the samples included five-day biochemical oxygen demand (BOD_5), total fats, oils and greases (FOG), and total suspended solids (TSS). The fourth parameter evaluated in this study was daily flow. Water meter readings were taken each day at the time samples were collected. Daily flow values were obtained by taking the difference between daily meter readings. In instances where meter readings from consecutive days were not available, the average of other days was used.

The first objective of this research was to organize and analyze the analytical data gathered from the 28 restaurants to determine statistical inferences from the measures of the central tendency and central deviation of the data. Subsequently, the results of the analysis were compared to published design values used by industry professionals for

onsite wastewater treatment systems to determine if observations made from this research differ from published information.

The second component of this research focused on statistical analysis of restaurant management practices and primary cuisine types and their influence on the four wastewater parameters. A standardized survey form was developed for this research to collect the qualitative information. Field technicians from each contracted laboratory that collected the samples requested that the survey form be completed by restaurant personnel. The surveys were completed and returned to the technicians.

The second objective of this research was to evaluate information from the self-reporting survey forms and the analytical wastewater data to determine if management practices and primary cuisine type influenced wastewater composition. Industry professionals have long alleged that certain restaurant characteristics such as the use of self-serve salad bars and cuisine type are suspect in restaurants that are experiencing wastewater treatment system problems. Other practices such as food defrosting, the absence of low-flow bathroom fixtures, use of commercial dishwashing procedures, etc. are also suspicious in creating flows that are in excess of those typical of residential applications.

CHAPTER II

METHODS FOR SAMPLE COLLECTION

Three independent laboratories under contract with the Texas Onsite Wastewater Treatment Research Council (TOWTRC) collected all samples for this research. A subgroup of TOWTRC developed the general guidelines for when, where, and how many wastewater samples were to be collected. The TOWTRC members recognized the limitations of grab sampling; therefore, a sampling scheme consisting of consecutive samples collected over a six-day time period and subsequent re-sampling was proposed.

The TOWTRC expected the laboratories to implement the data collection and each laboratory used standardized quality assurance and quality control measures developed for their particular operations and analytical equipment. The following laboratories were contracted to perform the field and analytical work; San Antonio River Authority (SARA); Lower Colorado River Authority (LCRA); City of Austin, Laboratory Services (CA). SARA, LCRA, and CA sampled 9, 9, and 10 facilities, respectively. A standardized survey form was also developed by the TOWTRC for this research. The TOWTRC and its members relied upon a literature review provided by Kommalapati (2001) and experts in the field to develop the survey. The survey was provided to the contract laboratories for implementation.

Laboratory field technicians were also tasked with presenting the survey form to restaurant personnel. For the purposes of this research, it is assumed the information on the survey forms is self-reported. In other words, the information was not obtained through an interview type setting. Limited ground truthing of the data was performed during the evaluation of the information through site visits to the establishments by research personnel.

CHAPTER III

FOOD SERVICE ESTABLISHMENT WASTEWATER CHARACTERIZATION

Synopsis

Food service establishments that use onsite wastewater treatment systems are experiencing pretreatment system and/or drain field hydraulic and/or organic overloading. This study included characterization of four wastewater parameters from 28 restaurants located in Texas during June, July, and August 2002. The establishments selected for the study represent a variety of restaurant types including single and full service, buffet-type, different cuisine types, etc. The field sampling methodology included taking a grab sample from each restaurant for 6 consecutive days at approximately the same time each day (noon to 3 p.m.), followed by a two-week break, and then sampling again for another 6 consecutive days, for a total of 12 samples per restaurant and 336 total observations. The laboratory analyses included five-day biochemical oxygen demand (BOD₅), total fats, oils and greases (FOG), and total suspended solids (TSS). The fourth parameter evaluated in this study was daily flow. Water meter readings were taken each day at the time samples were collected. Daily flow values were obtained by taking the difference between daily meter readings. In instances where meter readings from consecutive days were not available, the average of other days was used. Other data used included the number of seats (capacity) reported for each establishment by restaurant personnel.

Data exploration and statistical analyses of the data from the 28 restaurants were performed with the standard gamma probability distribution model in ExcelTM and used to determine inferences of the data. The analysis indicates greater organic and hydraulic values for restaurants than those typically used by industry designers.

Introduction

Published literature indicates that designers' use of industry-accepted methodologies and design values for sizing treatment systems for restaurants has in the past resulted in systems that are inadequately designed in regard to hydraulic and organic loading (Stuth and Garrison, 1995). A study evaluating the failure rate of two restaurants (Siegrist et al., 1984) against the mean age to failure for lesser strength residential wastewater treatment systems, 18 years (Sherman et al., 1998), raises concern in allowing existing residential based design guidelines to be used for commercial/industrial facilities. This is particularly true of treatment system designs used in food service establishments. Comparison of the above-mentioned studies shows that greater wastewater strengths can induce a faster decline of treatment system performance. Furthermore, Converse et al. (1997) states "the design practice of commercial systems has normally been substantially the same as that utilized for household systems. However, recent studies indicate that wastewater from food service establishments may be much stronger". There also exists a greater variability of wastewater quality from restaurants (Nakajima et al., 1999).

In the State of Texas, the regulations outlined in Title 30, Texas Administrative Code, Chapter 285 identify water usage rates for different types of establishments (e.g., single family dwellings, hospitals, laundries, restaurants, etc.). Texas regulations do note that water consumption rates shall be used for estimating hydraulic loading rates only, and that commercial/institutional facilities must pre-treat their wastewater to 140 mg/L BOD₅. Since water usage rates for residential facilities are listed together with commercial facilities and no guidance for various waste strengths is provided, this leaves a significant gap in information for designers. This lack of information, coupled with published literature that indicates commercial systems serving the restaurant industry are failing, suggests additional research is needed to better understand wastewater characteristics from restaurants (Angoli, 2000).

Lack of performance of onsite wastewater treatment systems serving the restaurant community could be better attributed to a lack of understanding of the hydraulic and organic demand that restaurants place on treatment systems. Not having thorough knowledge of the wastewater characteristics creates concerns in three areas; increased costs associated with system over-design; compromise of surface and groundwater quality; and public health and safety issues. A literature review indicated that published information on restaurant wastewater characteristics based on actual data is very limited. Additionally, a report by Kommalapati (2001) suggests that literature concerning design parameters and values for high strength wastewater that can be used for the design of modern treatment systems is virtually non-existent.

The objective of this paper was to organize and analyze data gathered from 28 Texas restaurants to determine if statistical inferences can be made that provide baseline information on hydraulic and organic loading rates for restaurants. This information may provide insight on why onsite wastewater treatment systems serving the restaurant industry are not functioning as intended by the designer.

Materials and Methods

Data collection consisted of taking wastewater grab samples from 28 Texas restaurants by three independent analytical laboratories. The San Antonio River Authority (SARA) sampled 9 restaurants, the Lower Colorado River Authority (LCRA) sampled 9 restaurants, and the City of Austin (CA) sampled 10 restaurants. All three laboratories performed quality control and quality assurance measures.

The sampling methodology was established considering restaurant management practices and variation in peak hours of operation. The sampling schedule was used to capture the time of day when effluent from a restaurant is typically at its largest flow and strongest concentration. In general, this occurs shortly after the noon meal to capture the influence of meal preparation and washing and rinsing of plates and silverware. Sampling occurred during June, July, and August 2002.

Each restaurant was sampled for 6 consecutive days followed by a two-week break, and then sampling again for another 6 consecutive days, for a total of 12 samples per restaurant and 336 total observations. All samples were taken downstream from the grease trap. Facility blueprints were not available for any of the establishments and

information provided by restaurant personnel with regard to commingling of grey- and black-water lines was not available. Hence, it was not possible to determine with any level of certainty whether the samples were taken before or after the commingling of the wastewater lines. In restaurant facilities, black-water refers to restroom effluent and grey-water accounts for all wastewater sources other than the restroom, e.g., dish washing, laundry, etc. For purposes of this study, the commingling issue was ignored, as the intent of this study was to determine suggestiveness of the descriptive analyses of the data.

The samples were analyzed for BOD₅, FOG, and TSS. Properly designed and sealed containers were used to transport samples to the laboratories for analyses. All samples were preserved and handled prior to analysis according to the prescribed standard procedures for the analytical methods used. Analytical methods used by each laboratory are shown in Table 3-1.

Table 3-1 - Analytical methods used by each contracted laboratory.

Entity	Method		
	BOD ₅	FOG	TSS
SARA ¹	SM 5210B	EPA 1664	SM 2540D
LCRA ²	EPA 405.1	EPA 1664	EPA 160.2
CA ³	SM 5210B	EPA 1664	SM 2540D

SM - Standard Methods for the Examination of Water and Wastewater, 20th Edition

EPA - Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes

¹ San Antonio River Authority, P.O. Box 839980, San Antonio, Texas 78283-9980

² Lower Colorado River Authority, 3700 Lake Austin Blvd., Austin, Texas

³ City of Austin, Laboratory Services Division, 14050 Summit Drive, Suite 121, Austin, Texas 78728

Problems with specific data included 19 BOD₅ values that were reported by CA as having failed Quality Assurance/Quality Control (QA/QC) procedures established by

that laboratory. These 19 values were not considered in the analysis. All values reported for FOG and TSS were used in the raw data analysis.

Daily flow values were obtained by taking the difference between daily meter readings. In instances where meter readings from consecutive days were not available, the average of other days was used. Also, in cases where the laboratory reported meter readings that were suspect (e.g., lower meter reading the second day), monthly averages were developed based on the restaurant's water use bill. Other data used includes the number of seats reported by restaurant personnel.

Results

BOD₅

In the case of BOD₅, there were 336 samples taken. Due to conditions such as no flow or bacterial interference, CA did not report 2 values and SARA did not report 11 values. As previously mentioned, 19 values from the CA report were removed due to failed QA/QC checks. The remaining 304 BOD₅ values were used in the raw data analysis. A descriptive analysis was performed on the 304 samples and a histogram is presented in Figure 3-1.

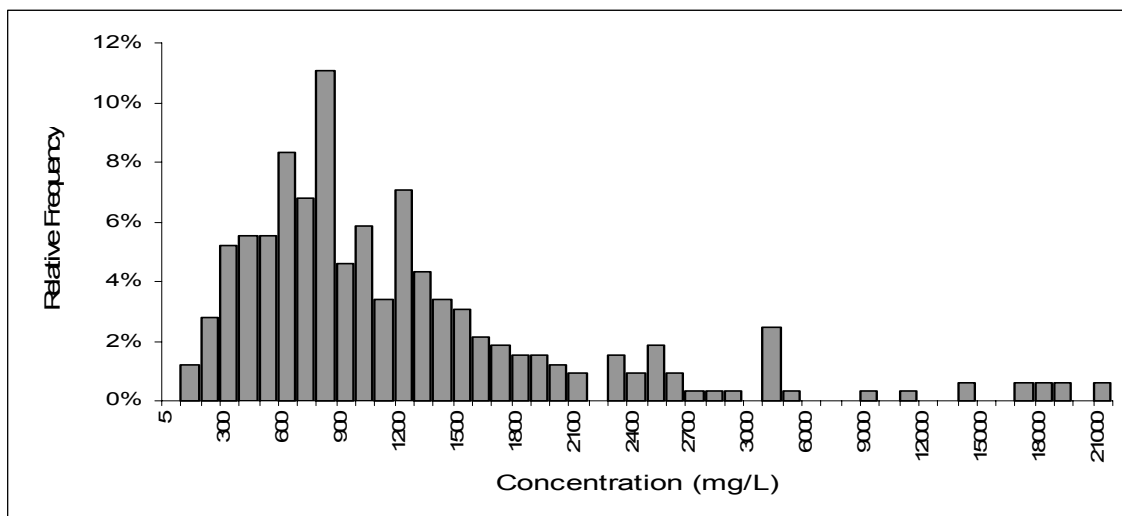


Figure 3-1 – Frequency distribution for raw BOD₅ data (n=304) collected from 28 restaurants.

A statistical analysis of the BOD₅ data was performed using the standard gamma probability distribution model in ExcelTM, a distribution model commonly used to analyze skewed data (Mendenhall et al., 1990). As can be seen in Figure 3-1, the data is skewed to the right and is bound at the lower limit by 0. Moreover, observing that the relative frequency for the higher values is substantially low, the gamma probability model was used to determine the probability of attaining the higher values. The analysis revealed that, based on 304 events, the chance of obtaining a BOD₅ value of 8,790 mg/L or higher is less than 1 in 10,000 (gamma value = 1.88E-7 at 8,790). Due to the very low probability of high concentrations, 11 values were classified as outliers and subsequently removed from the analysis, leaving a remainder of 293 events. Moreover, and as is explained further in this section, 9 BOD₅ values were not considered in the final analysis due to the removal of FOG and TSS outliers using the same aforementioned approach for a total of 284 BOD₅ events that resulted in the gamma

distribution in Figure 3-2. The “tail trimming” resulted in removing BOD₅ values that ranged from 4,100 mg/L to 20,100 mg/L.

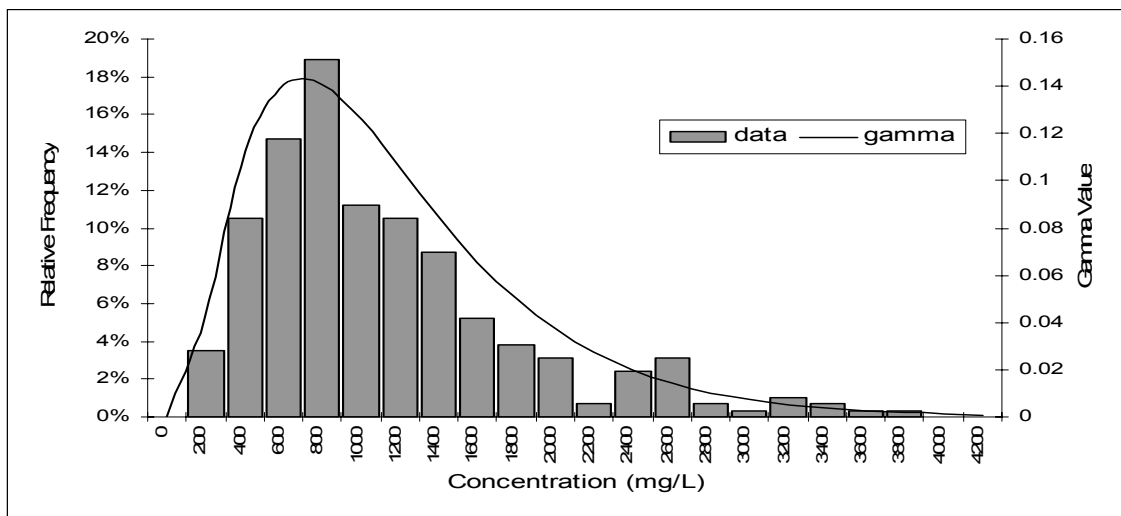


Figure 3-2 – Gamma probability distribution model for trimmed BOD₅ data (n=284) collected from 28 restaurants.

TSS

In the case of TSS, there were 336 samples taken. There were 4 values missing in the report from SARA. The remaining 332 values were used in the initial analyses and a histogram is presented in Figure 3-3.

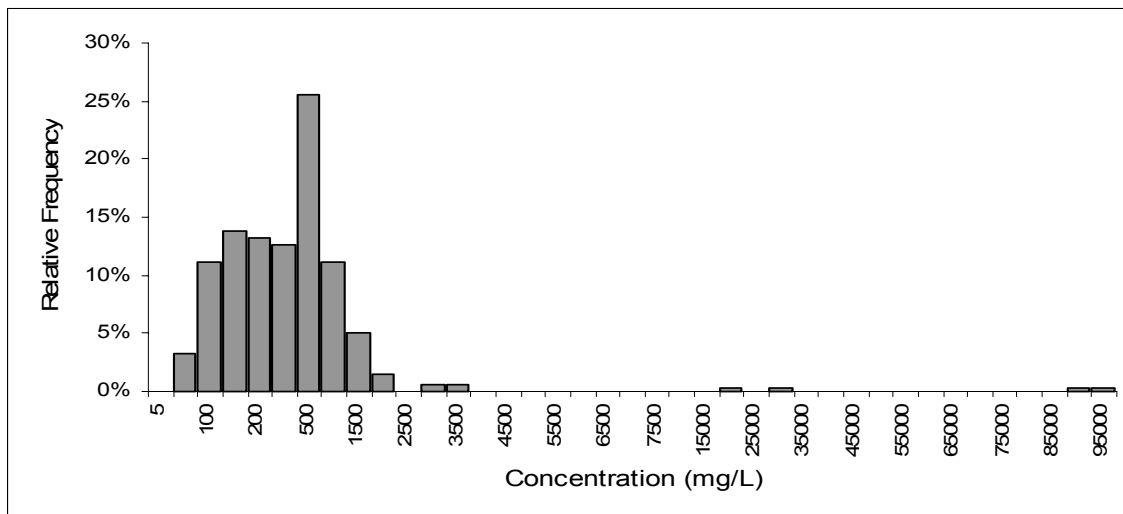


Figure 3-3 – Frequency distribution for raw TSS data (n=332) collected from 28 restaurants.

There were several samples that had extremely high TSS values. As with BOD₅, an analysis was performed using ExcelTM to determine the probability of attaining very high values. The gamma probability used to analyze the skewed data resulted in removing outliers that had less than 1 chance in 10,000 (gamma value = 5.30E-14 at 15,100) of occurring which resulted in the removal of 4 outliers that ranged in value from 15,100 mg/L to 91,800 mg/L. Sixteen TSS values were also removed in the final analysis due to the removal of BOD₅ and FOG outliers for a total of 312 TSS events. The resulting gamma distribution is shown in Figure 3-4.

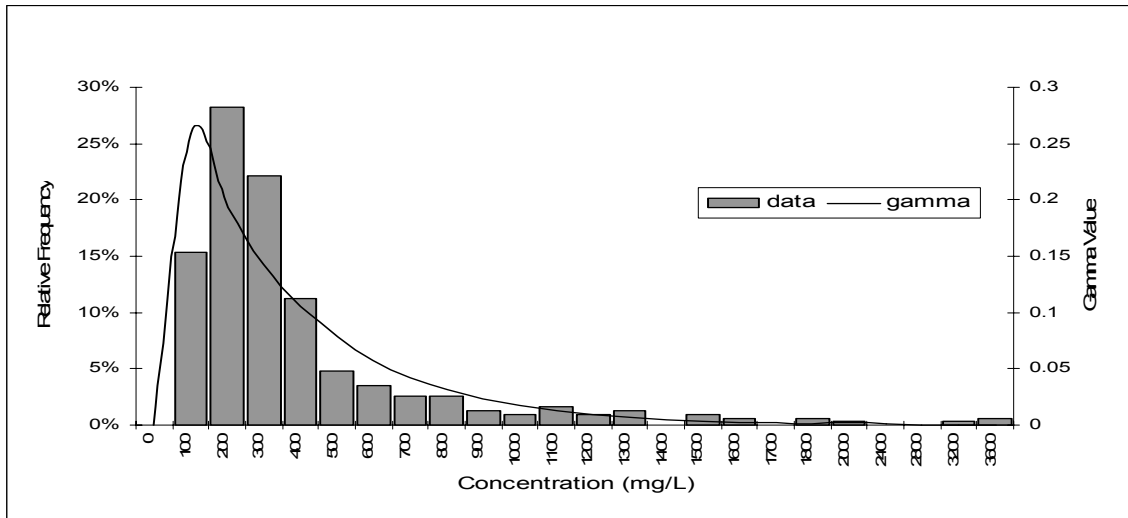


Figure 3-4 – Gamma probability distribution model for trimmed TSS data (n=312) collected from 28 restaurants.

FOG

In the case of FOG, there were 336 samples taken. There were 4 values missing from the report from SARA. Also, CA reported a non-detect for one sample. The remaining 331 values were used in the initial analyses and a histogram is presented in Figure 3-5.

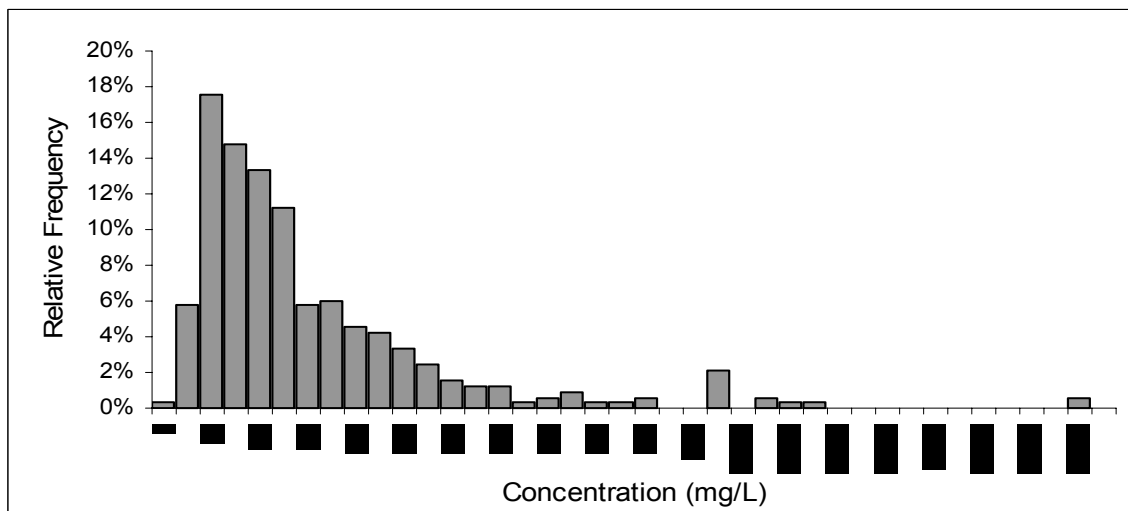


Figure 3-5 – Frequency distribution for raw FOG data (n=331) collected from 28 restaurants.

There were several samples that had extremely high FOG values. As with BOD₅ and TSS, an analysis was performed using Excel™ to determine the probability of attaining the higher values. The gamma probability used to analyze the skewed data resulted in removing outliers that had less than 1 chance in 10,000 (gamma value = 1.37E-5 at 1,129) of occurring. As a result, 13 outliers that ranged in value from 1,129 mg/L to 700,000 mg/L were removed. Seven FOG values were also removed in the final analyses due to the removal of BOD₅ and TSS outliers for a total of 311 FOG events that resulted in the gamma distribution in Figure 3-6.

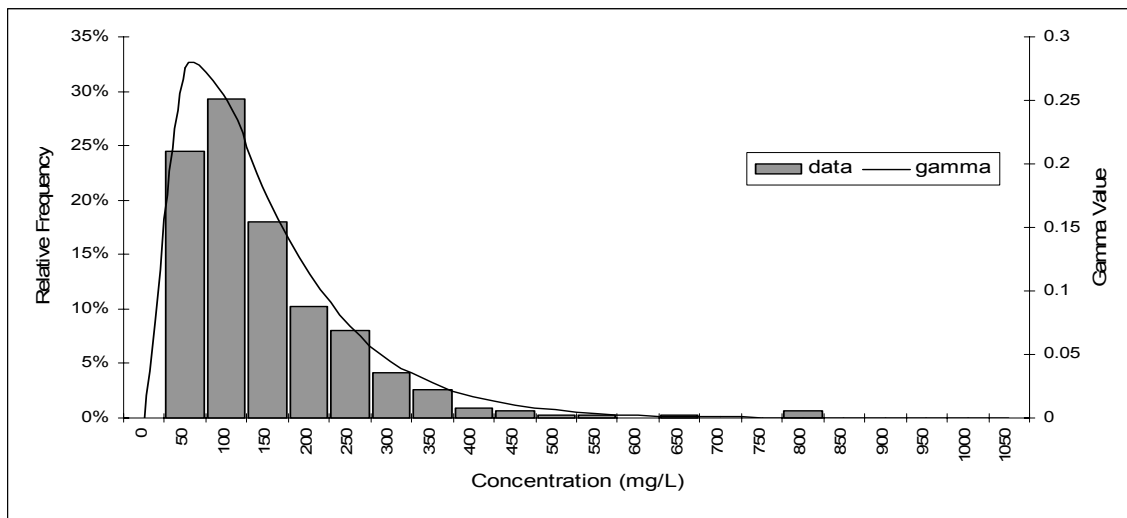


Figure 3-6 – Gamma probability distribution model for trimmed FOG data (n=311) collected from 28 restaurants.

Flow

In the case of flow, there were 336 samples taken. All values were used in the initial analysis and a histogram is presented in Figure 3-7.

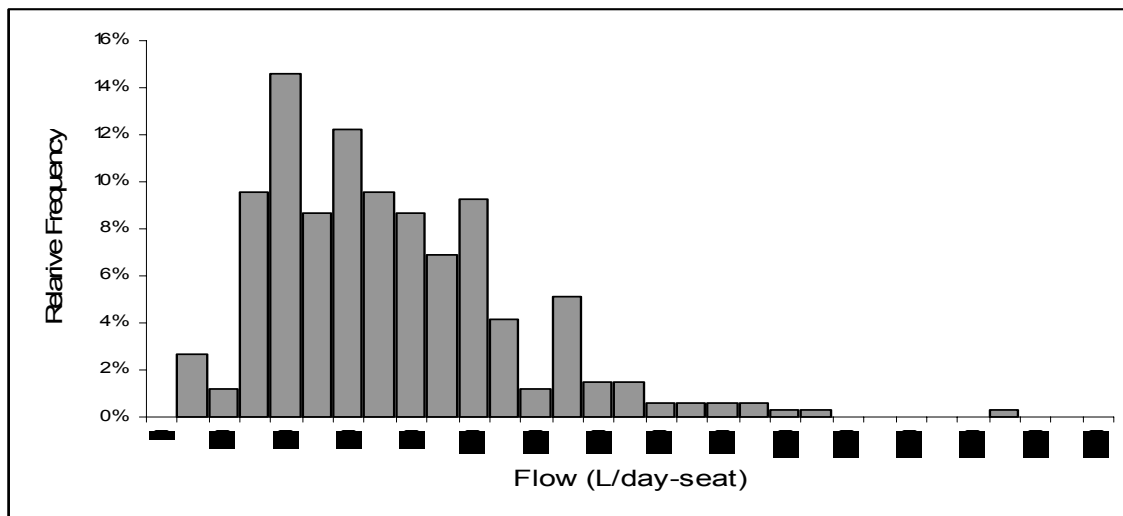


Figure 3-7 – Frequency distribution for raw flow data (n=336) collected from 28 restaurants.

The gamma probability analysis was performed using ExcelTM to determine the probability of attaining the higher values. This resulted in removing one outlier that had less than 1 chance in 10,000 (gamma value = 1.04E-5 at 97) of occurring. No values were removed in the final analysis due to the removal of outliers associated with BOD₅, TSS, or FOG. The resultant gamma distribution is presented in Figure 3-8.

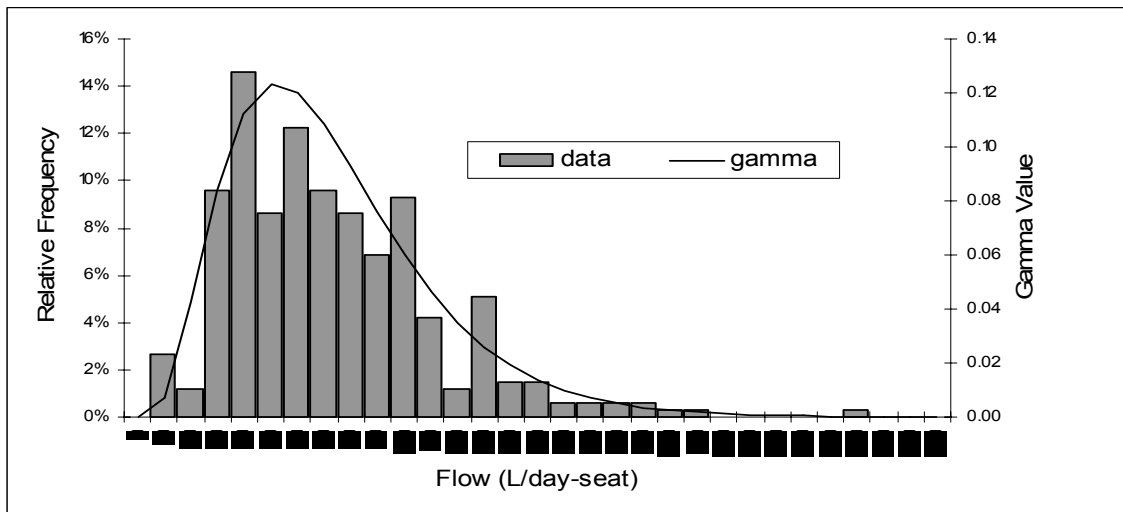


Figure 3-8 – Gamma probability distribution model for trimmed flow data (n=335) collected from 28 restaurants.

Discussion

In summary, while the chance of obtaining the outlying values for BOD₅, TSS, FOG, and daily flow may be considered remote, it is not impossible. Two similar outlying BOD₅ values were reported during two sampling events; therefore, the data is considered valid. For this study, it was assumed that there was such an improbable chance of these values occurring that they were removed in order to determine behavioral patterns in the data. Interesting observations can be made due to the stepwise removal of the data that allow inferences about descriptive measures such as the mean and standard deviation of the parameters.

Table 3-2 contains results of the values obtained from the gamma model. The first level of analysis determined the descriptive measures for the raw data, which represents data

as received from the laboratories except values removed for QA/QC reasons or other reasons associated with laboratory activities. This data set included the outliers.

The second level of analysis consisted of determining the same descriptive measures with only the outliers exceeding the “1 in 10,000 chance of occurring” criteria being removed. As can be seen in Table 3-2, there is a substantial change in mean, standard deviation, 75th, and 95th percentile values for all parameters studied when removing the outliers. At this point in the analyses, only the specific outliers were removed.

The third and final level of analysis consisted of removing the entire observation associated with any one outlier. As an example, the FOG value of 700,000 mg/L was removed as an outlier, resulting in the removal of the BOD₅ and TSS value associated with that sampling event. Consequently, a total of 20 of 336 observations were removed. One daily flow observation was removed. This last and final step in the analysis resulted in the values in the right-most column of Table 3-2. As can be observed, there does not exist a substantial change between the descriptive measures obtained by removing the outliers only and removing the entire observation associated with an outlier.

Table 3-2 - Summary of statistical results for wastewater parameters.

		Raw Data	Remove Outliers Only	Remove Entire Observation Associated with Outlier
BOD ₅ (mg/L)	Mean (Arithmetic)	1,584	1,054	1,045
	Std. Dev.	2,902	713	692
	Mean Plus One Std. Dev.	4,486	1,767	1,737
	75 th Percentile	1,806	1,411	1,400
	95 th Percentile	7,263	2,432	2,378
TSS (mg/L)	Mean (Arithmetic)	1,030	371	358
	Std. Dev.	7,113	444	430
	Mean Plus One Std. Dev.	8,143	815	788
	75 th Percentile	Not Available	509	492
	95 th Percentile	Not Available	1,264	1,223
FOG (mg/L)	Mean (Arithmetic)	4,520	123	123
	Std. Dev.	5,140	106	107
	Mean Plus One Std. Dev.	9,660	229	230
	75 th Percentile	Not Available	169	170
	95 th Percentile	Not Available	333	335
Flow (L/day-seat)	Mean (arithmetic)	68	68	Not Applicable
	Std. Dev.	42	38	Not Applicable
	Mean Plus One Std. Dev.	110	106	Not Applicable
	75 th Percentile	91	91	Not Applicable
	95 th Percentile	148	140	Not Applicable

Table 3-3 compares the means of the data observed in this study to various sources currently being used by designers in the onsite industry. As can be observed, there exists a discrepancy between the values inferred by the data in the study to those available in literature. This research suggests that currently used design practices for onsite pretreatment systems and drain field sizing used for effluent of restaurants underestimate wastewater strength. Moreover, using Texas as an example, State guidelines based on hydraulic loading typical of residential applications may result in under-designed systems that will be hydraulically and organically overloaded prematurely. The research also shows that TSS and FOG are viable constituents that should be addressed during design of high strength wastewater treatment processes.

Table 3-3 – Summary of comparisons between study and published design values.

	Texas Regulations ¹	Burks and Minnis ² (1994)		Tchobanoglous and Burton ³ (1991)			Goldstein and Moberg ⁴ (1973)	Study	
	--	Range	Typical	Weak	Med	Strong	--	Mean	Mean Plus One St. Dev.
BOD ₅ (mg/L)	N/A	100-400	250	110	220	400	450	1,045	1,737
TSS (mg/L)	N/A	100-400	220	100	220	350	N/A	358	788
FOG (mg/L)	N/A	50-150	100	50	100	150	N/A	123	230
Flow (L/day-seat)	132 ⁵ /57 ⁶	N/A	N/A	N/A	N/A	N/A	N/A	72 ^{5,7} / 57 ^{6,7}	N/A

¹ Water Usage Rate for restaurants without water saving devices

² Typical composition of untreated domestic wastewater

³ Typical composition of untreated domestic wastewater

⁴ Suggested BOD₅ concentration for restaurants

⁵ Full Service Restaurant

⁶ Single Service Restaurant (Fast-food)

⁷ Study included 8 single service restaurants and 20 full service restaurants

N/A – Not Available

The results of this study compare favorably to the results of a study by Siegrist et al. (1985) that measured effluent concentrations from 11 commercial facilities (6 restaurants, 1 motel complex, 3 country clubs, and 1 bar and grill). Siegrist observed ranges in BOD₅ from 101 to 880 mg/L, TSS from 44 to 372 mg/L, and FOG from 24 to 144 mg/L. The results of this research also compare favorably to the results of a study by Chen et al. (2000), presented in Table 3-4, which used effluent from restaurants to study the separation of pollutants from restaurant wastewater by electrocoagulation.

Table 3-4 –Characteristics (range of values) of restaurant wastewater (mg/L)¹.

Parameter	Chinese Restaurant	Western Restaurant	American Fastfood	Student Canteen	Bistro
BOD ₅	58 - 1,430	489 - 1,410	405 - 2,240	545 - 1,630	451 - 704
TSS	13.2 - 246	152 - 545	68 - 345	124 - 1,320	359 - 567
FOG	120 - 172	52.6 - 2,100	158 - 799	415 - 1,970	140 - 410

¹ After Chen et al., 2000

Careful consideration should be given to restaurant management practices, as it is not known at this time how practices such as type of cuisine, methods of serveware washing, chemicals used in cleaning, specific water use such as defrosting, use of water saving devices, use of dishwashers, garbage disposals, laundry washing machines, peak flow rates, demographics, etc. impact wastewater flow and composition. These issues are addressed in Chapter IV.

Conclusion

The data for BOD₅, TSS, FOG, and daily flow was incorporated into ExcelTM for analysis. After determining that the data was mostly normally distributed, the data was fit into the standard gamma probability distribution model in ExcelTM and the outliers determined to have a probability of less than 1 in 10,000 of occurring were identified. The entire observation associated with the particular outliers was subsequently removed and the resulting observations were then used to determine the mean, standard deviation, 75th, and 95th percentile of the remaining data.

Organization, analysis, and evaluation of the data suggest that wastewater hydraulic values and organic loading values from restaurants can be much higher and have variation in excess of the range of values reported for residential applications. The results of this research also coincide with information obtained from the literature review and cited in this work.

Designers of wastewater treatment systems serving the restaurant industry should be cautious of using published literature values that are based on residential applications due to potential under-designing of the treatment system due to higher organic and hydraulic loadings from food service establishments.

CHAPTER IV

FOOD SERVICE ESTABLISHMENT WASTEWATER CHARACTERISTICS
AS INFLUENCED BY MANAGEMENT PRACTICES AND
PRIMARY CUISINE TYPES

Synopsis

Across the nation, food service establishments using onsite wastewater treatment systems are experiencing pretreatment system and/or drain field performance problems. This study included a statistical analysis of restaurant management practices and primary cuisine types and their influence on five-day biochemical oxygen demand (BOD₅), total fats, oils and greases (FOG), total suspended solids (TSS), and daily flow to determine if management practices or cuisine type impact wastewater characteristics. Twenty-eight Texas restaurants were involved in the study and were selected to represent a variety of restaurant types. Each restaurant was asked to self-report information on management practices by completing a survey. The wastewater sampling methodology included a grab sample for 6 consecutive days and a second round of sampling over another 6 consecutive days for a total of 12 samples per restaurant and 336 total observations. Daily flow values were obtained by taking the difference between daily meter readings. In instances where meter readings from consecutive days were not available, the average of other days was used. A statistical analysis of the analytical data was performed and reported by Lesikar et al. (2004).

Survey responses and analytical data were entered into Excel™ and SAS™ statistical software for analyses. The analyses consisted of using multiple regression with backwards elimination and repeated measures using stepwise elimination to determine how management practices and cuisine type may have influenced wastewater characteristics. The analysis also consisted of determining to what extent management practices and cuisine types could be used to estimate BOD₅, FOG, TSS, and daily flow. The analysis indicated that the number of seats in a restaurant, self-serve salad bars, and primary cuisine type do play a role in wastewater characteristics.

Introduction

Onsite wastewater treatment systems serving food service establishments are experiencing hydraulic and organic overloading problems. To date, the influence of restaurant management practices and cuisine types on wastewater characteristics, such as flow and composition, have not been statistically evaluated to determine inferences. Design guidelines for these systems are typically based on residential applications; however, there are restaurant factors such as the greater percentage of flow originating from food preparation with items such as meats, fats, oils, greases, and dairy products, and the widespread and intensive use of cleaning agents such as disinfectants, cleaners, floor strippers, and soaps that create higher strength wastewater in restaurants that is more difficult to treat than in a typical residence (Lesikar et al., 2004). Another anticipated variable influencing wastewater strength between restaurants is the primary cuisine.

Industry professionals currently rely on methodologies and design values for restaurants that have historically resulted in inadequately designed systems (Stuth and Garrison, 1995) and do not consider possible influence of management practices and cuisine type. The purpose of this study is to gain an understanding of what role management practices and cuisine types play in wastewater quantities and composition. This information will assist designers in making the best decisions for designing onsite wastewater treatment systems that protect public health and safety, as well as, owner finances.

To date, there have not been any studies published that apply statistical procedures to determine relationships between restaurant management practices and primary cuisine types with wastewater characteristics. Only recently has the onsite industry begun to consider the influence of management practices and cuisine types on wastewater and how controlling and implementing management practices can assist designers in providing treatment systems that are more effective and cost efficient. Angoli (2000) states that restaurant wastewater strength is an issue for onsite wastewater treatment systems due to its direct impact on system performance. Thus, more research is needed to better understand wastewater characteristics and how management practices and cuisine types drive wastewater composition. A poor understanding of the driving forces behind the hydraulic and organic loading of onsite wastewater treatment systems can result in systems that do not perform as intended by the designer.

Adding to the difficulty of designing safe, cost efficient systems are regulations that typically rely on residential wastewater strengths and hydraulic loading rates. In the State of Texas, the regulations outlined in Title 30, Chapter 285 of the Texas

Administrative Code estimate design flow rates for different types of facilities. The regulations identify different types of establishments (e.g., single family dwellings, hospitals, laundries, restaurants, etc.) and their respective water usage rate in gallons per day. Parameters such as BOD₅, FOG, and TSS are not addressed in the regulations. The regulations do state the tables “shall be used for estimating the hydraulic loading rates only” and provide different water usage rates for single-service restaurants and full-service restaurants. This implies that differences in management practices between these two categories do exist and thus require different hydraulic loading rates.

Varying practices and differences in hydraulic loading rates may also yield different waste strengths between restaurant facilities. For example, two full-service restaurants may have different hours of operation, one may be buffet type and the other menu-based, they may have different serveware washing procedures, different floor cleaning procedures (one may be carpeted and another tiled), etc. Also, the two restaurants may serve different types of cuisines, e.g., Mexican or Asian.

It may not be possible to directly link specific management practices to certain wastewater characteristics; however, it would benefit design professionals if trends in wastewater characteristics due to differing management practices and primary cuisine types could be better defined. This would facilitate interpretation of design guidance provided in State regulations and published literature, thus designers would be able to provide a better service to the food service establishment industry.

Using certain management practices to reduce wastewater strength can also help maintain wastewater treatment system effectiveness over long periods of time. Furthermore, some management practices may be low-cost to implement or simply consist of changing behaviors, yet may result in less expensive system designs or reduced problems for existing systems. The consequence of not having thorough knowledge of how management practices influence wastewater characteristics creates concerns in three areas; increased costs associated with system over-design; compromise of surface and groundwater quality; and public health and safety.

The objective of this research was to statistically evaluate information from self-reporting survey forms and analytical wastewater data to determine if there are trends based on management practices and primary cuisine type and effluent quality and quantity.

Materials and Methods

Three contracted independent laboratories took wastewater grab samples from 28 restaurants located in Texas. The sampling methodology was established considering restaurant management practices and variation in peak hours of operation during the day. The sampling schedule was derived to capture the time of day when effluent from a restaurant is assumed to be at its highest flow and strongest concentration. In general, peak flow concentration occurs shortly after the noon meal when meal preparation has occurred and washing and rinsing processes have been initiated. All sampling occurred during June, July, and August 2002.

The field sampling included taking a grab sample from each restaurant for six consecutive days, followed by a two-week break, and a second round of sampling over another six consecutive days for a total 336 total observations.

All samples were taken downstream of the grease trap. Neither facility blueprints nor as-built drawings were available for any of the establishments and no information was provided by restaurant personnel with regard to commingling of gray- and black-water lines. Therefore, it was not possible to determine with any level of certainty whether the samples were taken before or after commingling of the wastewater lines. Black-water refers to restroom effluent and grey-water water from sources other than the restroom, e.g., dish washing, laundry, etc. For the purposes of this study, the commingling issue was ignored. Restaurant personnel were asked to complete a standardized survey form for this research presented in Figure 4-1. Also, it was assumed that the information on the forms was self-reported.

Survey	
Name of food service establishment	_____
Address	_____
Food service establishment description:	
Type of food served	_____
Salad bars/free choice salad dressing?	_____
Buffet?	_____
Specialty meals?	_____
Soft serve ice cream or yogurt machine?	_____
Self serve drinks?	_____
How is the food served (paper plates/washable plates, utensils and glasses/take-out)	_____
Types of cooking oils used (liquid or solid)	_____
Use of preservatives in foods	_____
Is there a large volume of water used in defrosting food? If so, describe	_____
Number of seats	_____
Square footage of the food service establishment	_____
Average number of meals served M___ T___ W___ Th___ F___ Sa___ Su___	_____
Hours of operation	_____
Garbage disposal used?	_____
Dishwashing procedures:	
Do they scrape the plates before washing?	_____
Do they use a commercial dishwasher or wash by hand?	_____
Temperature of water (high temp, rinse, low temp rinse, sanitizing)	_____
What kind and brand name of detergents used in dishwashing (liquid, powder, or concentrate)?	_____
Does the establishment have a public restroom?	_____
Does the establishment have low flow fixtures?	_____
Does the establishment have automatic flush fixtures?	_____
Clean water inflow:	
Ice machine condensate?	_____
Air conditioner condensate?	_____
Floor drains?	_____
After hours cleanup:	
Does the after hours cleanup result in wash down water going down a floor drain, and if so, what chemicals are included in the wash down?	_____
Does the establishment have a kitchen laundry to wash floor mats, tablecloths, and other items?	_____
Where is cleaning water disposed?	_____
Where is mop water disposed?	_____
Grease trap:	
Do they have a grease trap or interceptor?	_____
Size of the trap/interceptor?	_____
How often is it pumped?	_____
Location of the sampling point (relative to the grease trap and other business sewers)	_____

Figure 4-1. Self-reporting survey form used by restaurant personnel.

The statistical analysis consisted of using Multiple Regression with Backwards Elimination (MRBE) and Repeated Measures Analysis with Stepwise Elimination (RMASE). The dependent response variables were identified as BOD₅, FOG, TSS, and daily flow. The independent variables consisted of information from the survey.

Data were transformed to log-normal for BOD₅, FOG, and TSS due to the multiplicative effects of the untransformed data and the appearance of the data to be skewed. Also, the data was transformed to stabilize the variance of the data. The Anderson-Darling test for normality within the SASTM statistical software was used to verify the data's distribution. The Anderson-Darling test detects deviations arising from most non-normal distributions (Snedecor and Cochran, 1989). Transformation of the data allows the data to more nearly satisfy the assumptions of a normal distribution and usually makes the deterministic portion of a model a better approximation to the mean values of the transformed response (Mendenhall and Sincich, 2003). The transformed data was tested using the same test and resulted in normal distribution for most of the data. The final result was that all of the data did not result in a normal distribution; however, the data does not have to be strictly normal in order for the SASTM model to work. Further analysis of the error (residuals) of the data that did not pass the test for normality revealed that the error is very near normally distributed.

The hypotheses for this study were as follows:

$H_a: \beta_i \neq 0$ (*Research Hypothesis: at least one management practice (predictor) can be used to estimate wastewater characteristics (response variable)*)

$H_o: \beta_1 = \beta_2 = \beta_3 = \dots \beta_i \neq 0$ (*Null Hypothesis: not one management practice can be used as a predictor of wastewater characteristics*)

The first level of analysis was MRBE. A low probability value ($p < 0.05$) suggests rejection of the null hypothesis (H_o) because it indicates how unlikely it is that a management practice cannot be used as a predictor. If there is enough evidence to reject the null hypothesis for a predictor, we could conclude that there is significant evidence to support the research hypothesis (H_a).

All data were entered in the SASTM statistical software that fits all the possible models of the form,

$$(1) \quad E(\gamma) = \beta_o + \sum_{i=1}^p \beta_i \cdot x_i$$

to the data where x_i is the i th predictor variable, β is the coefficient determined by the analysis, and γ is the dependent response variable. The analysis consisted of starting with all management practices discussed in the survey form. Each predictor was methodically evaluated against the response variables and their particular influence was determined. The SASTM model systematically eliminated predictors with a probability value greater than 0.10 and repeated the analysis until the only remaining predictors had

probability values less than 0.05, which for this research was determined to be statistically significant for the first level of analysis. A critical probability value of 0.05 was used for this research since by transforming the data the distribution approximates the standard normal distribution. Since all management practices and response variables had to be considered, predictors that survived the analysis, regardless if the predictor survived only in one model (e.g. TSS) and not in another model (e.g. BOD₅), were considered in the next level of analysis.

The next level of analysis consisted of RMASE. Because there were several observations for each restaurant taken sequentially over time, repeated measures analysis was performed (Ramsey and Schafer, 2002). Repeated measures are observations measured over a period of time within the same experimental unit, a restaurant in this case, and between responses, BOD₅, FOG, TSS, and daily flow for this research. Obtaining more than one observation per restaurant can increase correlation within each restaurant as well as between response variables. The repeated measures procedure considers this correlation within and between restaurants to better identify significant predictors. In short, the theory maintains that repeated measures within and between experimental units may be correlated, and this correlation, if it exists, must be taken into account in an analysis, which is lacking in a multiple regression analysis.

Response variables were evaluated as having an influence on each other. In other words, since water was the medium that was sampled and the four response variables are water quality and quantity parameters within that same medium, it was assumed that any one response variable could have an effect on the other. With this in mind, the

analysis was approached in a manner that considered influences from one response variable to the other. A model that does not consider relationships between variables could produce misleading results since all four variables co-exist in the same medium. Also, repeated measures analysis considers the unbalanced nature of the sampling (e.g., data having unequal numbers of observations). After the repeated measures analysis was performed, a stepwise elimination was performed on the remaining predictors. This involved removing predictors that exhibited probability values greater than 0.10 and running the repeated measures analysis again until the model stabilized with values less than 0.05 for remaining predictors.

Low probability values are indicators of the strength of evidence for the predictive power of a management practice. Cuisine type was treated as a special case since it is a categorical variable and not a numerical or indicator variable and SASTM does not allow for the use of categorical variables in multiple regression. Cuisine was not considered in the first level of analysis but was considered in the more robust repeated measures analysis.

Results

MRBE yielded many predictors that are listed in Table 4-1 that could be classified as being statistically significant ($p < 0.05$). However, there is an assumption in using multiple regression that samples are random and independent. For this research it was assumed that samples were not random or independent. Another problem that arose when considering the probability values as statistically significant was that MRBE did

not consider the unbalanced nature of the sampling. Table 4-1 indicates values for all predictors, regardless if they were significant for one response variable and not for another. Again, the MRBE analysis was done as a “first cut” analysis to determine what predictors could be listed as candidates for the repeated measures analysis. As was expected, all predictors could be considered statistically significant because all predictors had a probability value less than 0.05 for at least one response variable. Predictors were expected to have low values because of anticipated high correlation of the repeated measures. This result substantiated the need for the more advanced repeated measures analysis.

Items 3 (air conditioning condensate), 6 (cleaning water disposal), 8-10 (Detergent Brand Names, Detergent Types, Dishwashing Method), 12 (Free Choice Salad Dressing), 15-17 (Grease Trap Pumping Schedule, Grease Trap Size, Ice Machine Condensate), 25 (Public Restrooms), 30-34 (Serveware Type, Specialty Meals, Use of Preservatives, Wash/Rinse Water Temperature, Plate Scraping), and 39 (Location of Sampling Point) as indicated in Table 4-1 were not considered for a variety of reasons, mostly related to unreliable data or no variability. In the case of items 10, 12, and 30 it was possible to determine the response by the answer provided in another question on the survey form. For the purposes of the research, all questions that asked for specific vendor information, such as brand of detergent used, were not considered. Specific reasons that these data were not considered are provided in Table 4-1.

All survey responses were positive for the use of public restrooms, so this question was not considered. It should be noted that 2 of the 28 restaurants were drive-up style restaurants and restroom use should be lower compared to the other 26 walk-in type facilities. For the purposes of this research, this issue was ignored. In cases where the survey responses were ambiguous or could be misinterpreted, those responses were not considered. An example would be the question “Temperature of water (high temp rinse, low temp rinse, sanitizing)?” It is not possible to tell from the survey form response “80” whether the respondent intended to mean that all temperatures were 80 or 80 was an average temperature or an estimated guess.

Table 4-1 – Response variable predictors and related probability values after multiple regression with backwards elimination analysis.

	Possible Predictor	Tested	Probability values ¹				Comments
			BOD ₅	FOG	TSS	Flow	
1	After Hours Cleanup (AHC)	Yes	<.0001	0.0003	<.0001	<.0001	--
2	AHC Chemicals Used	Yes	<.0001	<.0001	<.0001	<.0001	--
3	Air Conditioning Condensate	No	--	--	--	--	Unreliable survey responses ²
4	Automatic Flush Fixtures	Yes	<.0001	<.0001	<.0001	0.0984	--
5	Buffet Style Facility	Yes	0.0002	<.0001	<.0001	0.0660	--
6	Cleaning Water Disposal	No	--	--			Same response for all entities
7	Cuisine Type	Yes	--	--	--	--	Repeated Measures Analysis Only
7a	Full Service	--	--	--	--	--	Service type-primarily American
7b	Mexican	--	--	--	--	--	Primary food type
7c	Asian	--	--	--	--	--	Primary food type
7d	Single Service	--	--	--	--	--	Service type-primarily American
7e	Seafood	--	--	--	--	--	Primary food type
8	Detergent Brand Names	No	--	--	--	--	Confidential Information
9	Detergent Types	No	--	--	--	--	Unreliable survey responses ²
10	Dishwashing Method	No	--	--	--	--	Determined by item 27

Table 4-1 – Continued

	Possible Predictor	Tested	Probability values ¹				Comments
			BOD ₅	FOG	TSS	Flow	
11	Food Defrosting	Yes	0.1255	0.0004	0.0319	0.0419	--
12	Free Choice Salad Dressing	No	--	--	--	--	Determined by item 26
13	Full Service Alcohol Bar	Yes	<.0001	<.0001	<.0001	<.0001	Included after site visits
14	Garbage Disposal Use	Yes	<.0001	<.0001	<.0001	<.0001	--
15	Grease Trap Pumping Schedule	No	--	--	--	--	Unreliable survey responses ²
16	Grease Trap Size	No	--	--	--	--	Not a management practice
17	Ice Machine Condensate	No	--	--	--	--	Unreliable survey responses ²
18	Ice-cream /Yogurt Machines	Yes	0.0006	<.0001	0.0003	0.8376	--
19	Kitchen Laundry	Yes	<.0002	<.0001	<.0001	0.8382	--
20	Lawn Irrigation System	Yes	<.0001	0.2266	<.0001	0.0017	Included after site visits
21	Low Flow Fixtures	Yes	0.0002	<.0001	<.0001	0.8467	--
22	Mop Water Disposal	No	--	--	--	--	27 of 28 reported disposal
23	Oil Type Used (Liquid)	Yes	<.0001	<.0001	<.0001	0.0119	--
24	Oil Type Used (Solid)	Yes	0.4516	<.0001	0.0332	0.0871	--
25	Public Restrooms	No	--	--	--	--	Same response for all entities
26	Salad Bar (Self Serve)	Yes	<.0001	<.0001	<.0001	0.0025	--
27	Service Type (Full or Single)	Yes	0.8829	0.6089	0.0025	0.0024	--
29	Self Serve Fountain Drinks	Yes	0.8363	<.0001	0.0002	0.7881	--
30	Serveware Type	No	--	--	--	--	Determined by item 27
31	Specialty Meals	No	--	--	--	--	Definition not provided
32	Use of Preservatives	No	--	--	--	--	Unreliable survey responses ²
33	Wash/Rinse Water Temp	No	--	--	--	--	Unreliable survey responses ²
34	Plate Scraping	No	--	--	--	--	Same response for all entities
35	Number of Seats	Yes	0.0114	0.0020	0.0425	0.4342	--
36	Square Footage	Yes	0.0001	0.1705	<.0001	0.0005	--
37	Meals Served	Yes	0.1593	0.9396	0.0436	<.0001	--
38	Hours of operation	Yes	0.0120	0.2809	0.6400	0.1880	--
39	Location of Sampling Point	No	--	--	--	--	Not a management practice

¹Probability value after multiple regression with backward elimination analysis. Analysis assumes random independent sampling without consideration to repeated measures and unbalanced data.

² Ambiguous question in survey form.

Table 4-2 lists the predictors that were classified as significant after the repeated measures analysis.

Table 4-2 – Response variable predictors determined from repeated measures analysis.

	Possible Predictor	Probability value prior to stepwise elimination	Probability value during stepwise elimination (p<0.10)	Probability value during stepwise elimination (p<0.10)	Probability value after stepwise elimination (p<0.05)
1	After Hours Cleanup (AHC)	0.1110	--	--	--
2	AHC Chemicals Used	0.1070		--	--
3	Automatic Flush Fixtures	0.0621	0.0160	0.0409	--
4	Buffet Style Facility	0.5913	--	--	--
5	Cuisine Type	0.0368	0.0075	0.0072	0.0029
6	Food Defrosting	0.1262	0.0203	0.0648	--
7	Full Service Alcohol Bar	0.0720	--	--	--
8	Garbage Disposal Use	0.0956	0.1393 ²	--	--
9	Ice-cream /Yogurt Machines	0 ¹	--	--	--
10	Kitchen Laundry	0.0377	0.0395	0.1201 ³	--
11	Lawn Irrigation System	0.8569	--	--	--
12	Low Flow Fixtures	0.0851	0.0121	0.0490	--
13	Oil Type Used (Liquid)	0.2118	--	--	--
14	Oil Type Used (Solid)	0.1574	--	--	--
15	Salad Bar (Self Serve)	0.0400	0.0023	0.0058	0.0136
16	Service Type (Full or Single)	0.1589	--	--	--
17	Self Serve Fountain Drinks	0.1837	--	--	--
18	Number of Seats	0.1350	0.0267	0.0577	0.0029
19	Square Footage	0.1115	--	--	--
20	Meals Served	0.8656	--	--	--
21	Hours of operation	0.9208	--	--	--

¹ Values of 0 resulted from management practice having a high correlation with another management practice. This issue was eliminated through stepwise evaluation.

² Garbage Disposal was removed per criteria that would remove predictors with a p-value of 0.10 or greater until the model stabilized with p-values of 0.05 or less.

³ Kitchen Laundry was removed per criteria that would remove predictors with a p-value of 0.10 or greater until the model stabilized with p-values of 0.05 or less.

Only cuisine type, existence of a self-serve salad bar, and the number of seats resulted in a non-trivial effect.

Using the results to develop a prediction model would yield only a very limited number of possible design values for any one application. Using such a model would result in a design that is strictly based on which primary cuisine type is served and whether the

listed management practices that are statistically significant are in place. The model would exclude all other management practices addressed in the survey form.

As an example, a model used to estimate flow that does not consider how large a restaurant is could produce misleading results since the number of meals prepared and how often the restrooms are used would impact water use and disposal. Also, water consumption operations such as dishwashing, floor cleaning, laundering, etc. should be considered when developing hydraulic design values for the treatment system.

After determining that the predictor “cuisine” was statistically significant, an analysis was run on cuisine types to determine the respective direction of influence. Results are presented in Table 4-3. Seafood was randomly chosen as a baseline for comparison. A negative sign indicates that the response is lower than the baseline. For example, a predictive equation could be written as follows (Equation 2):

$$(2) \ln(\gamma) = \alpha_0 + 0.16(\text{Asian}) \pm \gamma_i$$

where α_0 is the intercept and γ is the *ith* management practice. It can be seen that after simplifying the equation the cuisine type “Asian” would increase the result by approximately 17 percent.

It can be determined that restaurants serving primarily Mexican and Asian type cuisines tend to exhibit higher BOD₅, FOG, and TSS followed by Seafood, Single-Service American, and Full-Service American. Daily flow was eliminated from the analysis due to model non-convergence resulting from insufficient data points.

Table 4-3 –Influence of cuisine type and management practices on wastewater characteristics (BOD₅, FOG, and TSS).

Possible Predictor	Final Parameter Estimate (for use in Equation 1)	Multiplier (relative increase/decrease in wastewater strength)
Cuisine Type	--	--
Primarily Mexican	0.235	1.265
Primarily Asian	0.159	1.172
Seafood ¹	0.000	1.000
Single Service-primarily American	-0.395	0.674
Full Service-primarily American	-0.446	0.640
Self-Serve Salad Bar	0.574	1.775
Number of Seats	-0.002	0.998

¹ Seafood was arbitrarily set as baseline for the Cuisine Type category.

Discussion

The resulting probability values of less than 0.05 indicate strong evidence that the listed management practices do in fact impact wastewater characteristics. Numbers of seats, self-serve salad bars, and cuisine type were the predictors determined to be statistically significant in affecting BOD₅, FOG, TSS and daily flow. Number of seats is a commonly used design parameter currently used by industry professionals in the design of onsite wastewater treatment systems. The statistical significance for this predictor validates its use as a design parameter.

Industry professionals have also alleged that self-serve salad bars are suspect in restaurants that employ their use and are experiencing wastewater treatment system problems. The results of this study prove from a statistical standpoint that self-serve salad bars do in fact impact wastewater and removal of the salad bar may be a solution to bringing a non-performing treatment and/or dispersal system to within its hydraulic and organic loading range. More importantly, special consideration should be given to self-

serve salad bars during the design phase for new systems. Salad bars create concern due many factors, some of which are the high fat content of some salad dressings, unfinished salads with dressing remaining on plates and consequently being disposed of through the wastewater lines, etc. Cuisine types also influence wastewater characteristics and should be considered when designing a treatment and dispersal system.

The data evaluation suggests that wastewater characteristics from restaurants are affected by management practices. However, due to the limited data and possible subjectivity of the self-reported information on the survey forms, there is a need for broader scale evaluations to develop a more thorough understanding of these influences.

Conclusion

A statistical analysis was performed using SASTM statistical software that consisted of using multiple regression with backwards elimination and repeated measures analysis with stepwise elimination. The dependent response variables were the analytical results of BOD₅, FOG, TSS, and daily flow and the independent variables consisted of information from the standardized survey developed for this research.

The resulting statistical analyses indicate that wastewater composition is affected by management practices and cuisine type. There is statistical validity that self-serve salad bars tend to increase the organic strength of wastewater. The results of the analysis also indicate that wastewater strength tends to be higher for restaurants serving primarily Mexican cuisine followed by Asian, Seafood, Full-Service American, and Single-Service American.

CHAPTER V

SUMMARY CONCLUSIONS

The first objective of this research was to organize and analyze analytical data from 28 restaurants to determine any statistical inferences. The data was entered into Excel™ and a standard gamma probability distribution model was developed to obtain the mean, standard deviation, 75th, and 95th percentiles for BOD₅, FOG, TSS and daily flow after removing outliers having a less than 1 in 10,000 chance of occurring and removing the entire observation associated with each outlier. The results indicate that wastewater loading for BOD₅, FOG, and TSS from restaurants can be much higher and have greater variation than typical ranges reported from residential applications.

The second objective of this research focused on statistical analysis of restaurant management practices and primary cuisine types and their influence on BOD₅, FOG, TSS and daily flow. A standardized survey form was developed to collect the information on management practices and cuisine type. The analysis consisted of using multiple regression with backwards elimination and repeated measures analysis with stepwise elimination to determine statistical significance between the dependent response variables (BOD₅, FOG, TSS, and daily flow) and the independent variables (information from the survey). The result of the analysis indicate that there is strong statistical evidence that self-serve salad bars increase the strength of wastewater. The results of the analysis also indicate that wastewater strength tends to be higher for

restaurants serving primarily Mexican cuisine followed by Asian, Seafood, Full-Service American, and Single-Service American.

CHAPTER VI

RECOMMENDATIONS

Based on the limited data there is a need for broader scale evaluations in order to develop design guidance. There is also a need for studies that investigate what impact varying restaurant management practices have on wastewater composition and flow. Specifically, more research is needed on how flow-related management practices such as automatic flush fixtures, food defrosting, etc. impact water use. Further studies in this area should also consider the extent of public restroom use. If possible, it would be preferable to determine wastewater characteristics prior to the co-mingling of wastewater lines to better understand the hydraulic and organic influence from black-water lines. This becomes more critical in applications where restaurants have a high volume of restroom users that do not necessarily eat at the restaurant, such as facilities located alongside or near major highways. Consideration should also be given to the use of lawn irrigation systems. Sampling should be conducted during the winter months due to higher water use during the summer months for lawn watering. Also, consideration should be given to a personnel training program that could be used to educate employees on how attitudes and behaviors impact wastewater quality and consequently the environment.

Lastly, if possible, all analytical work should be conducted by one laboratory in order to minimize variation between analytical methods and quality control and assurance procedures.

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APPENDIX A

The Appendix contains the information from each restaurant. There are two pages for each restaurant. The first page contains a summary of the responses included in the survey form that was completed by restaurant personnel. The second page contains the analytical data from the samples collected from each restaurant.

A-1

Restaurant	AF-1BP		
Cuisine	Asian	Detergent Brand Name	
No. of Seats	266	Detergent Brand Name	
Sq. Ft.	10604	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	Yes
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	Yes	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	Yes	Floor Drains	Yes
Buffet	Yes	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)	11	AHC Chemicals Used	Yes
Specialty Meals	Yes	Brand Names of Chemicals	Bleach
Ice Cream	No	Brand Names of Chemicals	
Yogurt	Yes	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	2500
Food Defrosting	Yes	How Often Grease Trap Pumped (months)	
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)	120		
Rinse Water Temp (Max)	150		
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	Vanguard		
Detergent Brand Name			

A-2

Restaurant	AF-1BP											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1308	1235	1235	1233	1232	1302	1320	1245	1220	1240	1215	1300
Meter Number	4277600	4283400	4290450	4296470	4304270	4328450	4433000	4440280	4446637	4454363	4461470	4486734
Flow (g/d)	6893	5800	7050	6020	7800	6893	6893	7280	6357	7726	7107	6893
Meals Served	450	450	450	450	600	450	450	450	450	450	600	450
Hours of Operation (hr/day)	10.5	10.5	10.5	10.5	11	10.5	10.5	10.5	10.5	10.5	11	10.5
DO (mg/l)			1.6	5.8	3.4	2.8	5	4	3.4	3.75	5	4.2
Temp (C)	33.6	32.8	29.9	31.7	34.3	33.6	33.9	35	34.4	33.7	33.4	34.2
pH (SU)	4.93	4.82	5.03	4.74	4.82	5.05	5.05	5.3	4.76	5.16	5.13	4.97
COD (mg/l)	2240	2710	2070	2450	2180	3388	2120	3144	2610	1844	2512	2188
BOD (mg/l)	1233	1650	1410	1200	1290	3575	1350	1757	1500	1255	1500	1333
TSS (mg/l)	434	424	406	400	298	336	370	588	680	360	414	294
FOG (mg/l)	107	92	89	120	49	311	140	233	118	95	101	111

A-3

Restaurant	AF-2GC		
Cuisine	American	Detergent Brand Name	
No. of Seats	400	Detergent Brand Name	
Sq. Ft.	10347	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	Yes	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	Yes	Floor Drains	Yes
Buffet	Yes	After Hours Cleanup (AHC)	No
Buffet Hours (p/day)	12	AHC Chemicals Used	No
Specialty Meals	No	Brand Names of Chemicals	
Ice Cream	Yes	Brand Names of Chemicals	
Yogurt	Yes	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	Yes	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	No	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	1700
Food Defrosting	No	How Often Grease Trap Pumped (months)	1.5
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	180		
Rinse Water Temp (Min)	150		
Rinse Water Temp (Max)	180		
Liquid Detergent	No		
Powder Detergent	Yes		
Detergent Concentrate			
Detergent Brand Name	Eco-Lab		
Detergent Brand Name			

A-4

Restaurant	AF-2GC											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1416	1322	1325	1314	1326	1351	1530	1450	1315	1325	1310	1340
Meter Number	5803000	5811000	5826000	5836000	5854000	5911000	6121000	6131000	6145000	6156000	6173000	6230000
Flow (g/d)	12875	8000	15000	10000	18000	12875	12875	10000	14000	11000	17000	12875
Meals Served	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Hours of Operation (hr/day)	11	11	11	11	12	11	11	11	11	11	12	11
DO (mg/l)	5.6		3	6.8	6.8	5.6	7.2	6.1	4	5.2	6	5.4
Temp (C)	36.9	31.4	36.4	39.3	36.5	41.7	40.4	39.3	39.2	35.8	32	39.3
pH (SU)	6.46	9.9	7.62	10.66	6.03	5.29	6.78	7.58	5.52	9.13	6.1	7.69
COD (mg/l)	1750	1680	1300	1380	1680	1320	1060	886	1948	1264	668	798
BOD (mg/l)	900	1385	825	760	975	778	630	575	1255	671	300	454
TSS (mg/l)	244	166	196	308	294	162	230	94	228	256	62	104
FOG (mg/l)	54	58	55	66	49	70	98	42	74	86	46	58

A-5

Restaurant	AF-3HU		
Cuisine	Asian	Detergent Brand Name	
No. of Seats	95	Detergent Brand Name	
Sq. Ft.	3553	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	No
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Soaps
Ice Cream	No	Brand Names of Chemicals	Bleach
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	500
Food Defrosting	No	How Often Grease Trap Pumped (months)	3
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	150		
Rinse Water Temp (Min)	180		
Rinse Water Temp (Max)	180		
Liquid Detergent	Yes		
Powder Detergent	No		
Detergent Concentrate			
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-6

Restaurant	AF-3HU											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1245	1218	1215	1214	1215	1243	1300	1225	1200	1200	1200	1206
Meter Number	1535560	1536990	1539010	1540490	1542330	1548450	1574705	1576214	1577903	1579160	1581264	1587231
Flow (g/d)	1666	1430	2020	1480	1840	1666	1666	1509	1689	1257	2104	1666
Meals Served	175	175	175	175	225	225	175	175	175	175	225	175
Hours of Operation (hr/day)	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
DO (mg/l)			0.7	3.8	6	5.8	3.8	4.2	6	3.2	4.8	5.4
Temp (C)	35.8	35.5	34	38.7	32.7	32	36.1	37.3	34.4	35.2	35.2	38.9
pH (SU)	6.71	4.73	4.66	5.05	4.96	5.01	4.86	4.71	4.88	4.71	4.79	5.88
COD (mg/l)	3660	6900	5270	6540	2160	1258	6044	2864	7540	2140	1940	3232
BOD (mg/l)	1850		2025	2400	1350	626	2300	1929	4100	1320	1009	3150
TSS (mg/l)	540	1268	1100	920	396	232	2840	1036	1218	288	240	614
FOG (mg/l)	205	375	1610	262	58	202	619	268	2026	168	62	316

A-7

Restaurant	AS-4JB		
Cuisine	American	Detergent Brand Name	
No. of Seats	78	Detergent Brand Name	
Sq. Ft.	2608	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	No
Service Type	Single Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Degreasers
Ice Cream	Yes	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	Yes	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	1000
Food Defrosting	No	How Often Grease Trap Pumped (months)	1.5
Paper Plates	Yes	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	No		
Glasses	No		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	140		
Rinse Water Temp (Min)	140		
Rinse Water Temp (Max)	140		
Liquid Detergent	Yes		
Powder Detergent	No		
Detergent Concentrate	No		
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-8

Restaurant	AS-4JB											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1132	1045	1047	1055	1047	1116	1130	1115	1050	1107	1050	1105
Meter Number	537500	538150	539850	539850	540800	544900	557160	558040	558830	560860	560850	564480
Flow (g/d)	1167	650	1700	1167	950	1167	874	880	790	2030	1167	1167
Meals Served	600	600	600	600	600	600	600	600	600	600	600	600
Hours of Operation (hr/day)	24	24	24	24	24	24	24	24	24	24	24	24
DO (mg/l)			2.6	5.9	5.3	6.2	7	6.8	7.2	7.2	6.5	6.6
Temp (C)	33.4	30	29	30.2	30.5	27.1	28.4	30.6	32.3	32.3	31.6	30.9
pH (SU)	5.06	4.72	4.75	4.71	4.71	5.39	4.83	6.07	4.78	4.78	5.19	4.81
COD (mg/l)	1190	1310	1500	1750	1192	594	594	1045	1578	1065	1276	1701
BOD (mg/l)	617	750	1007	1050	733	296	300	652	934	548	431	1108
TSS (mg/l)	114	138	160	194	146	82	82	182	216	132	334	180
FOG (mg/l)	26	84	112	152	104	46	46	62	129	54	105	162

A-9

Restaurant	AF-5LA		
Cuisine	American	Detergent Brand Name	
No. of Seats	340	Detergent Brand Name	
Sq. Ft.	12746	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	Yes	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Oasis Enforce
Ice Cream	No	Brand Names of Chemicals	
Yogurt	Bo	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	1700
Food Defrosting	Yes	How Often Grease Trap Pumped (months)	1.5
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent	No		
Powder Detergent	Yes		
Detergent Concentrate	No		
Detergent Brand Name	Eco-Lab		
Detergent Brand Name	Ultra		

A-10

Restaurant	AF-5LA											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1502	1403	1402	1348	1402	1428	1610	1525	1355	1355	1350	1407
Meter Number	74960400	74966130	74977350	74984830	74992900	75016000	75142469	75148672	75155342	75161272	75169426	75190820
Flow (g/d)	7432	5730	11220	7480	8070	7432	7432	6203	6670	5930	8154	7432
Meals Served	200	250	250	275	400	200	200	250	250	275	400	200
Hours of Operation (hr/day)	11	11	11	11	11	11	11	11	11	11	11	11
DO (mg/l)	4.2		5.4	10.4	3.8	3.4	3.9	4.1	5.4	6.9	6.4	3.2
Temp (C)	31.3	31	27.3	28.9	34.1	31.4	33.5	34.5	32.7	35.4	30.9	34.9
pH (SU)	6.38	5.51	6.07	6.06	5.19	5.03	5.21	5.1	5.58	4.68	6.04	5.05
COD (mg/l)	580	740	330	530	780	1630	598	674	1078	1026	440	732
BOD (mg/l)	200	55	178	135	466	381	351	416	632	414	216	445
TSS (mg/l)	136	182	60	36	164	162	218	160	134	208	46	92
FOG (mg/l)	12	55	20	17.5	45	49	44	40	41	48	4	43

A-11

Restaurant	AF-6MR		
Cuisine	Mexican	Detergent Brand Name	
No. of Seats	500	Detergent Brand Name	
Sq. Ft.	10828	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar		Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Kleen Brite
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	Yes
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	Yes	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	2500
Food Defrosting	No	How Often Grease Trap Pumped (months)	2
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	Yes		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent	No		
Powder Detergent	Yes		
Detergent Concentrate			
Detergent Brand Name	Grill Brite		
Detergent Brand Name			

A-12

Restaurant	AF-6MR											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1439	1345	1339	1328	1343	1409	1545	1505	1330	1340	1320	1348
Meter Number	58678900	58691520	58694460	58707120	58713800	58765330	58958122	58976785	58979575	59000360	59007000	59061846
Flow (g/d)	10472	12620	2940	12660	6680	10472	10472	18663	2790	20785	6640	10472
Meals Served	450		600	630	900	450	450		600	630	900	450
Hours of Operation (hr/day)	11	0	11	11	12	11	11	0	11	11	12	11
DO (mg/l)			2.4	10.2	5.8	5.4	4.2	6.2	7	6.9	5.1	5.2
Temp (C)	32.2	31.4	31.9	29.3	32.7	31.3	34.5	33	32.9	31.8	33.2	35
pH (SU)	5.11	5.33	6.89	6.62	5.92	6.05	5.2	5.45	5.27	9.54	5.99	5.71
COD (mg/l)	1610	1400	620	370	2284	998	2450	1840	1078	1154	1332	1948
BOD (mg/l)	669	800	335	132	1067	593	1462	1227	632	500	600	1118
TSS (mg/l)	177	68	604	62	312	70	310	276	134	120	104	210
FOG (mg/l)	25	19	25	16	111	36	36	39	41	22	36	38

A-13

Restaurant	AS-7MD		
Cuisine	American	Detergent Brand Name	
No. of Seats	71	Detergent Brand Name	
Sq. Ft.	3222	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Single Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Soaps
Ice Cream	Yes	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	Yes
Self Serve Soft Drinks	Yes	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	1000
Food Defrosting	No	How Often Grease Trap Pumped (months)	AR
Paper Plates	Yes	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	No		
Glasses	No		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	Yes		
Plate Scraping	Yes		
Sanitizing Water Temp	180		
Rinse Water Temp (Min)	180		
Rinse Water Temp (Max)	180		
Liquid Detergent	Yes		
Powder Detergent	No		
Detergent Concentrate	No		
Detergent Brand Name	K-Chemical		
Detergent Brand Name	DW		

A-14

Restaurant	AF-7MD											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1538	1114	1030	1037	1029	1100	1200	1130	1115	1125	1110	1126
Meter Number	3102700	3103700	3105160	3106635	3108070	3111670	3130928	3132489	3134078	3135592	3137012	3141629
Flow (g/d)	1432	1000	1460	1475	1435	1432	1432	1561	1589	1514	1420	1432
Meals Served	1810	1691	1908	1007	1770	1810	1810	1691	1908	1007	1770	1810
Hours of Operation (hr/day)	18	18	18	18	18	18	18	18	18	18	18	18
DO (mg/l)			3.1	5	6.3	6.2	7.7	7.4	5.6	4.6	5.5	6.8
Temp (C)	27.1	30.8	28.6	33	33.1	28.5	30.5	30.9	34.5	31.9	32.2	30.4
pH (SU)	4.7	6.57	5.27	4.63	4.73	5.15	5.72	6.31	4.6	5.09	5.04	5.13
COD (mg/l)	2290	1890	1210	2480	1624	1885	367	1688	1952	1648	1810	1400
BOD (mg/l)	1167	1091	706	1406	934	1050	176		1227	785	550	520
TSS (mg/l)	148	128	58	158	1107	130	118	242	144	188	70	736
FOG (mg/l)	64	70	49	49.2	31	52	16	109	49	38	36	39

A-15

Restaurant	AF-8RL		
Cuisine	Seafood	Detergent Brand Name	
No. of Seats	300	Detergent Brand Name	
Sq. Ft.	9023	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar		Ice Machine Condensate	No
Salad Bar	No	Air Conditioner Condensate	No
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Eco-Lab
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	2500
Food Defrosting	No	How Often Grease Trap Pumped (months)	1.5
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	180		
Rinse Water Temp (Min)	160		
Rinse Water Temp (Max)	160		
Liquid Detergent	No		
Powder Detergent	Yes		
Detergent Concentrate			
Detergent Brand Name	Eco-Lab		
Detergent Brand Name	Solid Brilliance		

A-16

Restaurant	AF-8RL											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1400	1312	1310	1302	1313	1332	1510	1430	1255	1310	1250	1326
Meter Number	65408184	65415785	65424230	65432930	65449360	65479285	65627458	65635069	65642384	65657842	65666310	65698182
Flow (g/d)	10004	7601	8445	8700	16430	10004	10004	7611	7315	15458	8468	10004
Meals Served	700	700	700	700	700	700	700	700	700	700	700	700
Hours of Operation (hr/day)	11	11	11	11	11	11	11	11	11	11	11	11
DO (mg/l)			1.7	2	3.8	2.2	3.6	4.2	2.8	2.4	2.5	3.4
Temp (C)	36.1	32.5	32.4	34.5	36.4	34	37.3	36.6	39.6	35	37	35.5
pH (SU)	5.61	5.6	5.47	5.27	5.19	4.88	5.1	5.15	5.06	5.06	5.2	5.06
COD (mg/l)	1470	1360	900	930	1264	688	1172	760	1192	1340	1372	834
BOD (mg/l)	750	800	574	491	794	415	717	493	800	656	720	504
TSS (mg/l)	288	250	178	146	224	118	165	114	217	218	223	160
FOG (mg/l)	70	75	35	46	45	24	44	54	40	49	28	48

A-17

Restaurant	AF-9TL		
Cuisine	American	Detergent Brand Name	
No. of Seats	283	Detergent Brand Name	
Sq. Ft.	6825	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar		Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Tide
Ice Cream	No	Brand Names of Chemicals	Pine Sol
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	2844
Food Defrosting	Yes	How Often Grease Trap Pumped (months)	1
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent	No		
Powder Detergent	Yes		
Detergent Concentrate			
Detergent Brand Name			
Detergent Brand Name			

A-18

Restaurant	AF-9TL											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1217	1158	1145	1148	1147	1220	1230	1200	1140	1145	1130	1150
Meter Number	2429750	2435700	2440100	2445900	2451950	2469000	2545880	2549375	2553240	2560890	2565570	2583920
Flow (g/d)	5236	5950	4400	5800	6050	5236	5236	3495	3865	7650	4680	5236
Meals Served	600	600	800	900	900	600	600	600	800	900	1000	600
Hours of Operation (hr/day)	11	11	11	11	12	11	11	11	11	11	12	11
DO (mg/l)		3	1.2	5.9	8.6	6.2	5	6.4	7.7	6.1	5.4	5.9
Temp (C)	35	34.4	31.5	31.9	29.5	34	37.3	30.8	32.4	32.8	35.2	33.3
pH (SU)	5.84	6.87	5.72	6.17	5.99	5.19	6.54	6.19	6.04	7.03	6.29	5.95
COD (mg/l)	1770	950	1740	1420	1024	1942	1598	1154	956	1124	1186	1190
BOD (mg/l)	875	545	1150	900	585	1160	946	767	668	679	433	733
TSS (mg/l)	264	170	310	212	154	200	219	188	140	202	202	134
FOG (mg/l)	68	73	67	68	44	110	92	62	114	38	69	19

A-19

Restaurant	AF-10TR		
Cuisine	Mexican	Detergent Brand Name	Vanguard Rinse
No. of Seats	187	Detergent Brand Name	
Sq. Ft.	5500	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	No
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	Yes	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Super Kleen
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	Yes	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	1000
Food Defrosting	No	How Often Grease Trap Pumped (months)	3
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	Yes		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	125		
Rinse Water Temp (Min)	125		
Rinse Water Temp (Max)	125		
Liquid Detergent	No		
Powder Detergent	Yes		
Detergent Concentrate			
Detergent Brand Name	Eco-Lab		
Detergent Brand Name	Power Activator		

A-20

Restaurant	AF-10TR											
Date Sampled	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/15/02	7/29/02	7/30/02	7/31/02	8/1/02	8/2/02	8/5/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	MON	TUE	WED	THU	FRI	MON
Time	1335	1256	1252	1247	1257	1315	1450	1415	1240	1300	1235	1314
Meter Number	45095660	45101020	45107090	45112990	45119040	45141250	45238630	45244590	45249900	45256350	45263182	45289520
Flow (g/d)	5992	5360	6070	5900	6050	5992	5992	5960	5310	6450	6832	5992
Meals Served	1350	1350	1650	1650	2250	1350	1350	1350	1650	1650	2250	1350
Hours of Operation (hr/day)	15	15	15	15	15	15	15	15	15	15	15	15
DO (mg/l)			3.8	6.2	6.1	7.1	6.6	6.2	7.4	5	5.6	5.8
Temp (C)	29.9	34	27.4	35.9	36.7	29.5	38.5	34.6	34.1	29.1	36.6	32.8
pH (SU)	6.57	5.91	7.91	6.66	5.02	6.54	6.1	5.5	5.11	5.22	4.99	5.74
COD (mg/l)	3020	1680	160	2070	4652	1772	4148	840	1870	1208	1562	1260
BOD (mg/l)	1414	1100	71	1140	2520	412	2280	540	1173	441	923	688
TSS (mg/l)	672	684	47	278	1152	108	800	212	348	260	290	264
FOG (mg/l)	119	329	62	99	263	20	342	30	27	258	114	240

A-21

Restaurant	LF-1BG		
Cuisine	Asian	Detergent Brand Name	
No. of Seats	90	Detergent Brand Name	
Sq. Ft.	3000	Public Restrooms	Yes
Irrigation System	No	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	No
Buffet	No	After Hours Cleanup (AHC)	No
Buffet Hours (p/day)		AHC Chemicals Used	No
Specialty Meals	No	Brand Names of Chemicals	
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	750
Food Defrosting	No	How Often Grease Trap Pumped (months)	3.5
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	140		
Rinse Water Temp (Min)	140		
Rinse Water Temp (Max)	180		
Liquid Detergent	No		
Powder Detergent	Yes		
Detergent Concentrate			
Detergent Brand Name	Sam's Club		
Detergent Brand Name			

A-22

Restaurant	LF-1BG											
Date Sampled	7/15/02	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	8/10/02
Day of the Week	MON	TUE	WED	THU	FRI	SAT	MON	TUE	WED	THU	FRI	SAT
Time	1525	1245	1335	1320	1240	1240	1206	1230	1230	1150	1230	1200
Meter Number	40190	40236	40314	40406	40490	40574	41717	41767	41825	41885	41968	42051
Flow (g/d)	718	460	780	920	840	840	718	500	580	600	830	830
Meals Served	120	120	150	150	175	150	120	120	150	150	175	150
Hours of Operation (hr/day)	10	10	10	10	10	10	10	10	10	10	10	10
DO (mg/l)	8.4		5.2	3.4	3.9	3.9	3.9	3.6	4.6	3.9	3.6	1.3
Temp (C)	23.8		28.6	30.4	29	29.1	31.3	32.3	30.3	31.3	31.8	34.2
pH (SU)	5.2		4.8	5	4.8	4.7	4.9	4.8	5.1	4.9	5	4.8
COD (mg/l)	696	1560	1870	2180	1590	1210	1490	1880	1330	2760	1990	3370
BOD (mg/l)	428	1090	910	1110	1050	720	785	1270	568	2470	985	1180
TSS (mg/l)	25	135	190	365	175	115	185	160	90	365	250	355
FOG (mg/l)	29.7	49	131	117	92.2	54.7	127	157	154	789	167	81.4

A-23

Restaurant	LF-2BP		
Cuisine	Asian	Detergent Brand Name	
No. of Seats	290	Detergent Brand Name	
Sq. Ft.	7500	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	Yes	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)	11	AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Degreaser
Ice Cream	Yes	Brand Names of Chemicals	Low Sud Powder
Yogurt	Yes	Kitchen Laundry	Yes
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	1000
Food Defrosting	Yes	How Often Grease Trap Pumped (months)	2
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent	No		
Powder Detergent	No		
Detergent Concentrate	Yes		
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-24

Restaurant	LF-2BP											
Date Sampled	6/17/02	6/18/02	6/19/02	6/20/02	6/21/02	6/22/02	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/13/02
Day of the Week	MON	TUE	WED	THU	FRI	SAT	MON	TUE	WED	THU	FRI	SAT
Time	1250	1230	1220	1230	1210	1215	1115	1120	1130	1125	1120	1120
Meter Number	10650	10656	10663	10671	10679	10688	10811	10818	10825	10832	10840	10849
Flow (g/d)	7600	6000	7000	8000	8000	9000	7600	7000	7000	7000	8000	9000
Meals Served	700	700	700	700	1000	1000	700	700	700	700	1000	1000
Hours of Operation (hr/day)	10.5	10.5	10.5	10.5	11	10.5	10.5	10.5	10.5	10.5	11	10.5
DO (mg/l)	3.6	5.1	4.1	5.7	5.6	5.8	4.9	4.9	3.9	4.9	5.1	3.6
Temp (C)	29.7	28.7	28.8	28.8	27.7	28	29.4	27.7	28.2	28.1	28.8	28.4
pH (SU)	5	5.2	5.1	5.8	5.8	6.1	5	5.2	4.7	5.6	5.3	5
COD (mg/l)	1420	1690	1690	1030	603	1130	1520	1320	2070	734	676	1850
BOD (mg/l)	968	832	998	766	566	988	764	811	1150	574	709	1320
TSS (mg/l)	510	215	250	155	80	265	550	180	195	220	255	500
FOG (mg/l)	234	156	174	221	92.6	291	137	71.8	107	103	75.4	234

A-25

Restaurant	LF-3CP		
Cuisine	American	Detergent Brand Name	
No. of Seats	210	Detergent Brand Name	
Sq. Ft.	5000	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	Yes	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)	2	AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Soap Only
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	1800
Food Defrosting	Yes	How Often Grease Trap Pumped (months)	4
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)	130		
Rinse Water Temp (Max)	160		
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	Diversey		
Detergent Brand Name	Lever		

A-26

Restaurant	LF-3CP											
Date Sampled	6/17/02	6/18/02	6/19/02	6/20/02	6/21/02	6/22/02	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/13/02
Day of the Week	MON	TUE	WED	THU	FRI	SAT	MON	TUE	WED	THU	FRI	SAT
Time	1400	1345	1340	1340	1335	1310	1330	1315	1325	1315	1310	1250
Meter Number	72402	72716	73023	73265	73587	73912	78403	78644	78880	79167	79414	79695
Flow (g/d)	2802	3140	3070	2420	3220	3250	2802	2410	2360	2870	2470	2810
Meals Served	300	300	300	300	500	400	300	300	300	300	500	400
Hours of Operation (hr/day)	11	11	11	11	11	11	11	11	11	11	11	11
DO (mg/l)	1	3.5	2.4	3.3	4.4	2.4	1.2	2.2	3.7	1.7	3.9	2.4
Temp (C)	31.5	31.2	31.6	31.2	28.4	32.9	32.8	32	28	29.4	30.2	27.4
pH (SU)	5.2	5	4.9	5.4	5.4	4.7	5.1	5.1	5.2	5.3	5.2	5.6
COD (mg/l)	1590	880	1020	1560	401	965	185	816	381	827	913	464
BOD (mg/l)	754	827	644	806	286	940	718	718	344	574	1180	584
TSS (mg/l)	240	250	260	230	60	215	20	155	95	150	425	350
FOG (mg/l)	109	45.5	27.7	82.4	32.2	51	26.2	83.6	25.5	48.3	80.1	44.1

A-27

Restaurant	LS-4FH		
Cuisine	American	Detergent Brand Name	
No. of Seats	86	Detergent Brand Name	
Sq. Ft.	2200	Public Restrooms	Yes
Irrigation System	No	Low Flow Fixtures	Yes
Service Type	Single Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	No
Salad Bar	No	Air Conditioner Condensate	No
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Tide
Ice Cream	Yes	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	Yes	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	1000
Food Defrosting	No	How Often Grease Trap Pumped (months)	6
Paper Plates		Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	No		
Glasses			
Plastic	Yes		
Garbage Disposal	No		
Commercial Dishwashing	No		
Hand Dishwashing	Yes		
Plate Scraping	Yes		
Sanitizing Water Temp	140		
Rinse Water Temp (Min)	75		
Rinse Water Temp (Max)	160		
Liquid Detergent	Yes		
Powder Detergent	Yes		
Detergent Concentrate			
Detergent Brand Name	Liquid-Sysco		
Detergent Brand Name	Powder-Tide		

A-28

Restaurant	LS-4FH											
Date Sampled	6/17/02	6/18/02	6/19/02	6/20/02	6/21/02	6/22/02	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/13/02
Day of the Week	MON	TUE	WED	THU	FRI	SAT	MON	TUE	WED	THU	FRI	SAT
Time	1120	1120	1120	1130	1120	1120	1245	1240	1255	1245	1240	1215
Meter Number	57831	57846	57857	57878	57890	57921	58164	58194	58205	58216	58244	58253
Flow (g/d)	179	150	110	210	120	310	179	300	110	110	280	90
Meals Served	400	400	400	450	550	500	400	400	400	450	550	500
Hours of Operation (hr/day)	12	12	12	12	12	12	12	12	12	12	12	12
DO (mg/l)	4.3	5.9	3.6	5.8	3.8	3	5.1	6.3	5.1	4.3	3.3	6.1
Temp (C)	29.7	27.8	29	27.7	27.7	28.6	29.2	27	27.8	28.6	29.3	25.9
pH (SU)	4.1	4.5	4.3	5	5	4.7	4.9	5.3	4.9	4.6	4.7	5.3
COD (mg/l)	1290	600	988	258	1490	961	971	441	850	1730	1110	592
BOD (mg/l)	778	1270	628	472	902	726	398	430	809	644	1510	519
TSS (mg/l)	140	65	110	25	140	165	85	55	135	120	215	95
FOG (mg/l)	144	188	116	79.5	164	207	71.7	113	189	105	161	72.7

A-29

Restaurant	LF-5LF		
Cuisine	Mexican	Detergent Brand Name	Industrial Sanitizer
No. of Seats	300	Detergent Brand Name	Rinse Additive
Sq. Ft.	5339	Public Restrooms	Yes
Irrigation System	No	Low Flow Fixtures	No
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	No
Buffet Hours (p/day)		AHC Chemicals Used	No
Specialty Meals	No	Brand Names of Chemicals	
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	
Food Defrosting	Yes	How Often Grease Trap Pumped (months)	2
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)	82		
Rinse Water Temp (Max)	132		
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	Eco-lab		
Detergent Brand Name	Keystone		

A-30

Restaurant	LF-5LF											
Date Sampled	7/15/02	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	8/10/02
Day of the Week	MON	TUE	WED	THU	FRI	SAT	MON	TUE	WED	THU	FRI	SAT
Time	1450	1215	1310	1245	1200	1215	1245	1245	1250	1220	1250	1235
Meter Number	212241	212406	212596	212780	213062	213334	217016	217320	217501	217706	218167	218487
Flow (g/d)	2564	1650	1900	1840	2820	2720	2564	3040	1810	2050	4610	3200
Meals Served	400	500	700	800	1000	800	400	500	700	800	1000	800
Hours of Operation (hr/day)	12	12	12	12	12	12	12	12	12	12	12	12
DO (mg/l)	6		7.2	5	6	5.8	6.7	6.7	7.2	7.6	5.4	7.4
Temp (C)	31.5		25	34.2	31.5	31.9	30.8	30.5	30.2	29.4	31.5	28.9
pH (SU)	5.6		6.3	6.6	5.7	5.9	6.9	7.3	7.3	9	5.7	7.1
COD (mg/l)	1070	2280	8640	3060	1630	1180	668	557	283	152	2470	951
BOD (mg/l)	2480	1190	1520	1410	857	920	1190	706	128	43.5	1190	282
TSS (mg/l)	1100	270	215	200	105	150	215	380	60	15	160	155
FOG (mg/l)	102	382	279	250	230	113	345	391	73		118	67.3

A-31

Restaurant	LF-6RS		
Cuisine	American	Detergent Brand Name	
No. of Seats	140	Detergent Brand Name	
Sq. Ft.	4906	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	No
Specialty Meals	Yes	Brand Names of Chemicals	
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	
Food Defrosting	Yes	How Often Grease Trap Pumped (months)	1
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	140		
Rinse Water Temp (Min)	140		
Rinse Water Temp (Max)	140		
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-32

Restaurant	LF-6RS											
Date Sampled	6/17/02	6/18/02	6/19/02	6/20/02	6/21/02	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/22/02	7/23/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	TUE	WED	THU	FRI	MON	TUE
Time	1320	1300	1250	1300	1240	1210	1220	1225	1215	1215	1249	1320
Meter Number	2440	2442	2444	2447	2450	2488	2491	2493	2496	2498	2515	2518
Flow (g/d)	2556	2000	2000	3000	3000	2556	3000	2000	3000	2000	2556	3000
Meals Served	70	70	80	80	120	70	70	80	80	120	70	70
Hours of Operation (hr/day)	7	7	7	7	5.5	7	7	7	7	5.5	7	7
DO (mg/l)	4	4.4	2.7	5.2	3.9	6.6	4.1	5.4	6	2.9	4.8	5.7
Temp (C)	31.1	28.1	28.7	29.1	28.5	30.7	29.2	27.6	28.2	28.5	33.6	28.9
pH (SU)	4.9	5.3	5.1	5.8	5.5	6.4	5.3	5.2	5.3	5.4	5.6	5.2
COD (mg/l)	906	569	420	392	467	1160	724	454	386	556	957	1010
BOD (mg/l)	674	320	322	188	332	165	526	422	302	550	544	643
TSS (mg/l)	260	80	45	70	65	245	145	85	130	125	85	105
FOG (mg/l)	249	28.1	73.3	13.6	58.3	72	137	78.2	111	62.9	115	141

A-33

Restaurant	LF-7SG		
Cuisine	Seafood	Detergent Brand Name	
No. of Seats	225	Detergent Brand Name	
Sq. Ft.	6065	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	No
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	Yes	Ice Machine Condensate	
Salad Bar	No	Air Conditioner Condensate	
Free Choice of Salad Dressing	No	Floor Drains	
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Degreaser
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	
Food Defrosting	Yes	How Often Grease Trap Pumped (months)	
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	Yes		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-34

Restaurant	LF-7SG											
Date Sampled	7/15/02	7/16/02	7/17/02	7/18/02	7/19/02	7/22/02	7/23/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	TUE	MON	TUE	WED	THU	FRI
Time	1400	1145	1240	1215	1130	1216	1243	1345	1330	1330	1250	1320
Meter Number	51125	51137	51152	51171	51187	51233	51246	51455	51467	51483	51498	51515
Flow (g/d)	1500	1200	1500	1900	1600	1500	1300	1500	1200	1600	1500	1700
Meals Served	160	180	180	200	240	160	180	180	200	240	200	240
Hours of Operation (hr/day)	11	11	11	11	11	11	11	11	11	11	11	11
DO (mg/l)	4.9		5.2	3.3	3.8	5.1	4.5	5.2	4.2	4.5	5.6	4
Temp (C)	29.9		28.2	32.8	31.3	28.4	29.3	31	33.1	30.6	31.4	30.6
pH (SU)	4.9		5	5.1	4.8	4.9	4.8	5.3	5	5.5	4.9	5.8
COD (mg/l)	1640	1730	1490	1570	2250	1110	1610	1160	2230	2340	1800	837
BOD (mg/l)	1540	892	1270	845	1420	584	536	737	1210	1300	1600	823
TSS (mg/l)	170	180	375	215	300	375	120	365	350	585	370	155
FOG (mg/l)	9.49	103	78.5	154	220	93.1	77.6	194	255	280	214	83.8

A-35

Restaurant	LF-8TA		
Cuisine	Mexican	Detergent Brand Name	
No. of Seats	280	Detergent Brand Name	
Sq. Ft.	5000	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	Yes	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Powder Detergent
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	200
Food Defrosting	No	How Often Grease Trap Pumped (months)	1.5
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	Yes		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	130		
Rinse Water Temp (Min)	130		
Rinse Water Temp (Max)	130		
Liquid Detergent	Yes		
Powder Detergent	No		
Detergent Concentrate			
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-36

Restaurant	LF-8TA											
Date Sampled	6/17/02	6/18/02	6/19/02	6/20/02	6/21/02	6/22/02	7/8/02	7/9/02	7/10/02	7/11/02	7/12/02	7/13/02
Day of the Week	MON	TUE	WED	THU	FRI	MON	TUE	WED	THU	FRI	MON	TUE
Time	1210	1155	1150	1200	1155	1150	1135	1145	1150	1150	1145	1145
Meter Number	293141	293156	293175	293201	293224	293243	293569	293590	293611	293635	293657	293678
Flow (g/d)	2110	1500	1900	2600	2300	1900	2110	2100	2100	2400	2200	2100
Meals Served	200	250	250	300	400	200	250	250	300	400	200	250
Hours of Operation (hr/day)	11	11	11	11	12	11	11	11	11	12	11	11
DO (mg/l)	3	4.6	6.2	5.8	2.3	4.4	3.2	3.6	4.4	2.6	3.1	2.9
Temp (C)	31.7	31.5	30.2	29.9	31.2	29.4	31.7	30.3	31	32.7	31.5	29.8
pH (SU)	5.8	6	6.2	6.7	5.6	5.6	6.2	6.1	6.3	6.3	6.3	5.8
COD (mg/l)	1910	1590	3010	255	483	779	1970	256	308	329	564	411
BOD (mg/l)	382	1380	971	709	478	854	997	286	326	1530	1170	770
TSS (mg/l)	250	815	360	405	170	220	510	85	50	280	1410	215
FOG (mg/l)	349	228	51.1	228	90.9	1430	415	35.1	90.3	78.1	753	54.3

A-37

Restaurant	LS-9WH		
Cuisine	American	Detergent Brand Name	
No. of Seats	94	Detergent Brand Name	
Sq. Ft.	3015	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Single Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	SSDC
Ice Cream	Yes	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	Yes	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	Yes	Grease Trap Size (gallons)	
Food Defrosting	No	How Often Grease Trap Pumped (months)	
Paper Plates	Yes	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	No		
Glasses	No		
Plastic	No		
Garbage Disposal			
Commercial Dishwashing			
Hand Dishwashing	Yes		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	SSDC		
Detergent Brand Name			

A-38

Restaurant	LS-9WH											
Date Sampled	7/15/02	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	8/10/02
Day of the Week	MON	TUE	WED	THU	FRI	SAT	MON	TUE	WED	THU	FRI	SAT
Time	1615	1330	1415	1430	1320	1315	1120	1135	1130	1115	1150	1120
Meter Number	370134	370225	370331	370438	370512	370629	373220	373659	373800	374711	374847	375015
Flow (g/d)	2290	910	1060	1070	740	1170	2290	4390	1410	9110	1360	1680
Meals Served	682	530	560	575	736	657	682	530	560	575	736	657
Hours of Operation (hr/day)	24	24	24	24	24	24	24	24	24	24	24	24
DO (mg/l)	4	3.3	2.2	1.1	2.2	1	1.2	0.9	1.2	1.6	1.2	1.1
Temp (C)	28.3	26.1	26	30.3	25.8	26.3	28.6	28.6	28.3	27.8	27.8	28.5
pH (SU)	7.8	6.3	6.3	4.8	4.8	6.2	4.6	5.7	5.4	5.5	6	5.9
COD (mg/l)	437	892	1250	1360	1550	833	1640	1350	1400	1420	1150	1290
BOD (mg/l)	252	566	974	626	727	694	802	745	691	946	745	600
TSS (mg/l)	55	160	75	125	110	85	125	115	90	110	135	85
FOG (mg/l)	14.3	44.4	57.5	78.6	82	49.5	88	96.3	77.8	77.9	66.3	95.5

A-39

Restaurant	SS-1CH		
Cuisine	American	Detergent Brand Name	
No. of Seats	166	Detergent Brand Name	
Sq. Ft.	4278	Public Restrooms	Yes
Irrigation System	No	Low Flow Fixtures	No
Service Type	Single Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	No
Buffet Hours (p/day)		AHC Chemicals Used	No
Specialty Meals	No	Brand Names of Chemicals	
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	1000
Food Defrosting	No	How Often Grease Trap Pumped (months)	2
Paper Plates	Yes	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	No		
Glasses	No		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	140		
Rinse Water Temp (Min)	140		
Rinse Water Temp (Max)	140		
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-40

Restaurant	SS-1CH											
Date Sampled	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	8/10/02
Day of the Week	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
Time	1734	1629	1609	1544	1523	1548	1439	1454	1457	1514	1520	1502
Meter Number	2287.61	2289.34	2291.31	2293.16	2295.26	2297.3	2325.4	2327.21	2328.68	2330.46	2332.66	2334.75
Flow (g/d)	1424	1730	1970	1850	2100	2040	1424	1810	1470	1780	2200	2090
Meals Served	430	480	490	720	620	520	420	430	480	490	720	620
Hours of Operation (hr/day)	11	11	11	11.5	11	11	11	11	11	11	11.5	11
DO (mg/l)	5.4	7.1	7.8	5.6	5.9	5.5	2.5	5.8	6.5	5.6	5.1	5.6
Temp (C)	32	29.5	28.3	36.3	35	30.5	36.1	35.1	31.6	35.2	28.5	38.6
pH (SU)	8.2	8.4	8.2	9.7	7.2	6.9	6.8	8.4	7.3	9.5	7	7.6
COD (mg/l)	195	1390	1350	772	1730	5830	111000	13700	564	22800	12500	279
BOD (mg/l)	255			18100	2330	382	784	10600	711	17000	16400	227
TSS (mg/l)	43	385	3260	140	25700	410	705	87600	280	91800	2670	205
FOG (mg/l)	16	2048	33	151	26565	700000	620000	34142	422	22774	42137	1958

A-41

Restaurant	SF-2ES		
Cuisine	Mexican	Detergent Brand Name	Klor 300
No. of Seats	120	Detergent Brand Name	U/N 1791
Sq. Ft.	3000	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Soap
Ice Cream	No	Brand Names of Chemicals	Degreasers
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	
Food Defrosting	No	How Often Grease Trap Pumped (months)	1
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)	174		
Liquid Detergent	Yes		
Powder Detergent			
Detergent Concentrate	No		
Detergent Brand Name	36A		
Detergent Brand Name	Pynsaine 310		

A-42

Restaurant	SF-2ES											
Date Sampled	6/25/02	6/26/02	6/27/02	6/28/02	6/29/02	6/30/02	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02
Day of the Week	TUE	WED	THU	FRI	SAT	SUN	TUE	WED	THU	FRI	SAT	SUN
Time	1420	1413	1433	1450	1349	1329	1622	1712	1652	1624	1605	1628
Meter Number	3730.67	3733.63	3736.63	3739.59	3742.53	3745.49	3787.73	3790.54	3792.85	3795.26	3798.35	3801.48
Flow (g/d)	1213	1213	1213	1213	1213	1213	1213	1213	1213	1213	1213	1213
Meals Served	200	250	250	500	500	300	200	250	250	500	500	300
Hours of Operation (hr/day)	15	15	15	16	16	12	15	15	15	16	16	12
DO (mg/l)	6.6	6.1	7.6	6.4	7.1	7	6.4	8.3	7.9	7.2	7	7.6
Temp (C)	29.5	33.3	26.5	29.8	27	28.9	31	25.1	28.7	30.2	29.2	29.5
pH (SU)	6.7	7.4	7.2	6.9	6.4	7.3	7.2	7.4	7.5	7.6	7.2	7.1
COD (mg/l)	7300	733	623	5170	11600	526	1700	1550	850	565	4560	683
BOD (mg/l)	1410	616	779	1220	1772	600	239	1390	1140	232	1060	394
TSS (mg/l)	580	203	270	1520	1000	320	310	1070	710	167	1460	610
FOG (mg/l)	1129	75	314	271	155	97	24	123	96	183	70	454

A-43

Restaurant	SF-3FP		
Cuisine	Mexican	Detergent Brand Name	
No. of Seats	97	Detergent Brand Name	
Sq. Ft.	2500	Public Restrooms	Yes
Irrigation System	No	Low Flow Fixtures	No
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	No
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Degreaser
Ice Cream	No	Brand Names of Chemicals	Bleach
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	No
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	500
Food Defrosting	No	How Often Grease Trap Pumped (months)	2
Paper Plates	No	Sampling Location	End of Pipe
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	120		
Rinse Water Temp (Min)	120		
Rinse Water Temp (Max)	120		
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-44

Restaurant	SF-3FP											
Date Sampled	6/25/02	6/26/02	6/27/02	6/28/02	6/29/02	6/30/02	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02
Day of the Week	TUE	WED	THU	FRI	SAT	SUN	TUE	WED	THU	FRI	SAT	SUN
Time	1300	1302	1330	1346	1252	1248	1532	1545	1541	1517	1501	1434
Meter Number	961.61	963.4	965.34	967.52	969.76	971.55	998.36	1000.17	1001.98	1003.91	1006.26	1007.8
Flow (g/d)	1938	1790	1940	2180	2240	1790	1938	1810	1810	1930	2350	1540
Meals Served	200	250	300	400	375		200	250	300	400	375	
Hours of Operation (hr/day)	9.5	9.5	9.5	10	10	0	9.5	9.5	9.5	10	10	0
DO (mg/l)	4.2	4.8	4.8	5.3	4.4	1.6	2.1	4.5	1.9	5.3	7.1	2.7
Temp (C)	44.2	46.2	45.5	43.3	44.5	26.2	30.6	50.5	32	42.7	32.9	27.6
pH (SU)	8.8	9	4.8	9.6	9.2	5.3	6.4	8.4	7	8.8	7.5	5.7
COD (mg/l)	999	1470	5280	1160	649	1190	1770	11100	2470	1180	7700	973
BOD (mg/l)	1890	673	911	600	2420	387	1640	20100	1200	332	140	600
TSS (mg/l)	770	125	830	160	90	80	818	15100	225	58	43	95
FOG (mg/l)	59	27	94	164	65	35	54	1374	114	33	70	14

A-45

Restaurant	SF-4PH		
Cuisine	FS-American	Detergent Brand Name	
No. of Seats	96	Detergent Brand Name	
Sq. Ft.	2800	Public Restrooms	Yes
Irrigation System	No	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	Yes	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	Yes	Floor Drains	Yes
Buffet	Yes	After Hours Cleanup (AHC)	No
Buffet Hours (p/day)	3	AHC Chemicals Used	No
Specialty Meals	No	Brand Names of Chemicals	
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives		Grease Trap Size (gallons)	1000
Food Defrosting	No	How Often Grease Trap Pumped (months)	3
Paper Plates	No	Sampling Location	
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent	Yes		
Powder Detergent	No		
Detergent Concentrate			
Detergent Brand Name	Autochlor		
Detergent Brand Name			

A-46

Restaurant	SF-4PH											
Date Sampled	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	8/10/02
Day of the Week	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
Time	1501	1440	1446	1427	1411	1348	1412	1421	1427	1430	1442	1433
Meter Number	15188.6	15190	15192.1	15196.2	15203	15207.8	15276.8	15281.4	15285.2	15288.7	15291	15294.3
Flow (g/d)	3670	1400	2100	4100	6800	4800	3670	4600	3800	3500	2300	3300
Meals Served	200	200	225	250	300	200	420	430	480	490	720	300
Hours of Operation (hr/day)	11	11	11	11	11	11	11	11	11	11	11	11
DO (mg/l)	2.5	4.5	6.4	4	4.1	6.4	4	4.1	5.7	3.9	2.6	4.6
Temp (C)	33.5	32.4	32.1	33.5	33.5	32.8	34.6	35.3	34.6	35.5	35.4	35.2
pH (SU)	4.4	4.4	5.8	5	4.9	4.8	5.2	5.6	4.9	4.6	4.6	5.1
COD (mg/l)	2480	2480	2810	2600	2610	2710	2670	2330	2620	2910	4320	2600
BOD (mg/l)	1750	3220	1200	1880	1420	1980	1560	1690		1930	1200	1270
TSS (mg/l)	63	408	310	270	270	330	165	155	225	300	260	1100
FOG (mg/l)	92	148	539	117	131	159	85	252	219	187	141	128

A-47

Restaurant	SF-5RO		
Cuisine	Mexican	Detergent Brand Name	
No. of Seats	350	Detergent Brand Name	
Sq. Ft.	8500	Public Restrooms	Yes
Irrigation System	No	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	Yes	Ice Machine Condensate	
Salad Bar	No	Air Conditioner Condensate	
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Degreaser
Ice Cream	No	Brand Names of Chemicals	Detergent
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	1800
Food Defrosting	No	How Often Grease Trap Pumped (months)	3
Paper Plates	No	Sampling Location	
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	Yes		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	Eeo Lab Brands		
Detergent Brand Name			

A-48

Restaurant	SF-5RO											
Date Sampled	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02	7/22/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	8/10/02
Day of the Week	WED	THU	FRI	SAT	SUN	MON	MON	TUE	WED	THU	FRI	SAT
Time	1310	1301	1218	1212	1215	1604	1250	1223	1223	1223	1248	1223
Meter Number		3814.94	3815.01	3815.12		3815.38	3815.98	3816.04	3816.21	3816.23	3816.34	3816.15
Flow (g/d)	4175	4175	4175	4175	4175	4175	3450	3450	3450	3450	3450	3450
Meals Served	2406	2668	4630	3587		802	802	2492	2406	2668	4630	3587
Hours of Operation (hr/day)	11	11	15	12	0	4	4	11	11	11	15	12
DO (mg/l)	5	7.3	8	5.7		5.9	6.2	6.5	7.3	6.2	6.3	6.7
Temp (C)	45	28	28.6	40.1		39.7	35.3	37.1	31.5	38.3	35.8	36.8
pH (SU)	9.9	8.5	8.8	9.8		9.8	8.4	9.6	8.6	9.6	9	9.4
COD (mg/l)	1060	3440	2690	11700		3760	2050	1690	498	3430	8170	4060
BOD (mg/l)		268	18800	2260		1210	1020		356	1760		1590
TSS (mg/l)	1250	1000	280	1020		420	3380	445	150	490	1270	375
FOG (mg/l)	54	94	38	202		85	133	177	135	260	181	305

A-49

Restaurant	SS-6S0		
Cuisine	American	Detergent Brand Name	
No. of Seats	60	Detergent Brand Name	
Sq. Ft.	1600	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Single Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	No
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Heavy Duty Cleaner
Ice Cream	Yes	Brand Names of Chemicals	
Yogurt	Yes	Kitchen Laundry	No
Self Serve Soft Drinks	Yes	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	1000
Food Defrosting	No	How Often Grease Trap Pumped (months)	3
Paper Plates	Yes	Sampling Location	Grease Trap
Washable Plates	Yes		
Utensils	No		
Glasses	No		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	No		
Hand Dishwashing	Yes		
Plate Scraping	Yes		
Sanitizing Water Temp	120		
Rinse Water Temp (Min)	120		
Rinse Water Temp (Max)	120		
Liquid Detergent	Yes		
Powder Detergent	No		
Detergent Concentrate			
Detergent Brand Name			
Detergent Brand Name			

A-50

Restaurant	SS-6SO											
Date Sampled	6/25/02	6/26/02	6/27/02	6/28/02	6/29/02	6/30/02	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02
Day of the Week	TUE	WED	THU	FRI	SAT	SUN	TUE	WED	THU	FRI	SAT	SUN
Time	1452	1454	1504	1515	1416	1354	1705	1742	1724	1648	1628	1650
Meter Number	3247.79	3248.02	3248.19	3248.54	3248.86	3249.06	3252.24	3252.33	3252.41	3252.62	3252.76	3252.85
Flow (g/d)	1083	1083	1083	1083	1083	1083	1083	1083	1083	1083	1083	1083
Meals Served	471	436	441	550	500	380	471	436	441	550	500	380
Hours of Operation (hr/day)	15	15	15	15	15	15	15	15	15	15	15	15
DO (mg/l)	0.1	0.2	0.3	0.4	0.4	0.7	0.4	0.8	0.7	0.6	0.9	0.8
Temp (C)	30.9	31	30.4	29.5	29.4	29.6	29.3	28.7	29.2	29.3	29.5	29.5
pH (SU)	4.3	4.3	4.4	4.4	4.2	4.2	4.4	5.5	5.2	4.1	4.3	5.4
COD (mg/l)	4410	4080	4120	4000	4490	6290	3990	2890	4170	4120	3920	3770
BOD (mg/l)	2490	3120	2800	2510	13700	3200	2470	2500	2540	13800	17600	1870
TSS (mg/l)	487	370	380	360	400	510	790	815	250	490	505	410
FOG (mg/l)	209	214	186	179	174	183	188	220	44	82	181	151

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Restaurant	SS-7TC		
Cuisine	Mexican	Detergent Brand Name	
No. of Seats	165	Detergent Brand Name	
Sq. Ft.	4668	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	Floor cleaner
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	Yes	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	Yes	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	
Food Defrosting	No	How Often Grease Trap Pumped (months)	1
Paper Plates	Yes	Sampling Location	
Washable Plates	Yes		
Utensils	No		
Glasses	No		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	No		
Hand Dishwashing	Yes		
Plate Scraping	Yes		
Sanitizing Water Temp	175		
Rinse Water Temp (Min)	175		
Rinse Water Temp (Max)	175		
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name			
Detergent Brand Name			

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Restaurant	SS-7TC											
Date Sampled	6/25/02	6/26/02	6/27/02	6/28/02	6/29/02	6/30/02	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02
Day of the Week	TUE	WED	THU	FRI	SAT	SUN	TUE	WED	THU	FRI	SAT	SUN
Time	1328	1337	1350	1418	1317	1303	1433	1521	1512	1452	1433	1410
Meter Number	3834.04	3836.53	3836.53	3838.88	3838.88	3838.88	4748.4	4750.3	4751.9	4753.7	4756.5	4759.7
Flow (g/d)	1725	1862.52	1725	1757.8	1725	1725	1725	1421.2	1196.8	1346.4	2094.4	2393.6
Meals Served	300	400	500	900	900	800	300	400	500	900	900	800
Hours of Operation (hr/day)	17	17	17	24	24	17	17	17	17	24	24	17
DO (mg/l)	0	0.2	0.2	0.8	0.4	0.6	0.3	4	0.8	1.1	0.7	0.9
Temp (C)	37	36.5	35.8	35.8	34.8	33.9	33.8	31.5	34.1	34.2	35.6	36.2
pH (SU)	4.7	4.7	4.9	4.8	4.7	4.8	4.9	4.9	6	5.1	4.9	4.9
COD (mg/l)	3560	2950	2290	2280	3140	2170	3730	1360	2820	2780	2860	2490
BOD (mg/l)	2620	2250	1960	1620	339	1400	3640	245	1200	1720	1850	1620
TSS (mg/l)	470	375	395	580	800	1770	780	1440	1580	720	510	570
FOG (mg/l)	136	135	102	76	223	91	80	119	112	75	163	201

A-53

Restaurant	SF-8TH		
Cuisine	Mexican	Detergent Brand Name	
No. of Seats	165	Detergent Brand Name	
Sq. Ft.	4668	Public Restrooms	Yes
Irrigation System	NO	Low Flow Fixtures	Yes
Service Type	Full Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	Yes	Brand Names of Chemicals	Detergents
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	No	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	
Food Defrosting	No	How Often Grease Trap Pumped (months)	
Paper Plates	No	Sampling Location	
Washable Plates	Yes		
Utensils	Yes		
Glasses	Yes		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	Yes		
Hand Dishwashing	No		
Plate Scraping	Yes		
Sanitizing Water Temp	145		
Rinse Water Temp (Min)	145		
Rinse Water Temp (Max)	145		
Liquid Detergent	Yes		
Powder Detergent	No		
Detergent Concentrate			
Detergent Brand Name			
Detergent Brand Name			

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Restaurant	SF-8TH											
Date Sampled	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	8/10/02
Day of the Week	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
Time	1244	1220	1220	1246	1239	1231	1556	1250	1250	1254	1317	1251
Meter Number	933.6	933.6	933.6		1234.08	1237.33	1282.88	1285.35	1289.32	1292.66	1296.2	1299.62
Flow (g/d)	2492.4198	2492.419833	2492.4198	2492.4198	2492.4198	2431.325	2492.4198	1847.807	2969.957	2498.654	2648.274	2558.502
Meals Served	750	800	800	800	1000	1000	750	750	800	800	800	1000
Hours of Operation (hr/day)	10	10	10	10	10	9	10	10	10	10	10	10
DO (mg/l)	6.2	2.8	4.9	3	5.2	4.9	4.7	4.3	4.5	4.2	3.7	4.9
Temp (C)	36.3	38.9	44.3	40.4	43.5	46.7	40.7	45.3	42.8	44.6	42.1	44.3
pH (SU)	7	6.2	9.2	6.7	9	8.8	7.1	8	7.4	7.1	6.9	7
COD (mg/l)	2810	1100	2330	1780	2330	2380	2690	3390	2390	2230	2060	11100
BOD (mg/l)	1340	988		396	1170	2330	1360	2050	756	295	1150	1650
TSS (mg/l)	70	1800	1900	225	350	520	385	630	665	255	1110	1300
FOG (mg/l)	153	176	247	162	239	135	192	138	215	92	286	287

A-55

Restaurant	SS-9WH		
Cuisine	American	Detergent Brand Name	
No. of Seats	60	Detergent Brand Name	
Sq. Ft.	2223	Public Restrooms	Yes
Irrigation System	Yes	Low Flow Fixtures	
Service Type	Single Service	Automatic Flush Fixtures	No
Full Service Alcohol Bar	No	Ice Machine Condensate	Yes
Salad Bar	No	Air Conditioner Condensate	Yes
Free Choice of Salad Dressing	No	Floor Drains	Yes
Buffet	No	After Hours Cleanup (AHC)	Yes
Buffet Hours (p/day)		AHC Chemicals Used	Yes
Specialty Meals	No	Brand Names of Chemicals	SSDC
Ice Cream	No	Brand Names of Chemicals	
Yogurt	No	Kitchen Laundry	No
Self Serve Soft Drinks	Yes	Cleaning Water Disposal	Yes
Cooking oil(s) - Solid	No	Mop Water Disposal	Yes
Cooking oil(s) - Liquid	Yes	Grease Trap	Yes
Preservatives	No	Grease Trap Size (gallons)	
Food Defrosting	No	How Often Grease Trap Pumped (months)	0.5
Paper Plates	Yes	Sampling Location	
Washable Plates	Yes		
Utensils	No		
Glasses	No		
Plastic	No		
Garbage Disposal	No		
Commercial Dishwashing	No		
Hand Dishwashing	Yes		
Plate Scraping	Yes		
Sanitizing Water Temp			
Rinse Water Temp (Min)			
Rinse Water Temp (Max)			
Liquid Detergent			
Powder Detergent			
Detergent Concentrate			
Detergent Brand Name	SSDC		
Detergent Brand Name			

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Restaurant	SS-9WH											
Date Sampled	7/16/02	7/17/02	7/18/02	7/19/02	7/20/02	7/21/02	8/5/02	8/6/02	8/7/02	8/8/02	8/9/02	8/10/02
Day of the Week	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
Time	1326	1609	1359	1347	1335	1510	1513	1346	1336	1548	1411	1351
Meter Number	2376.5		2378.6	2379.8	2381.1	2382.6		2436.3	2439		2445.9	2449.1
Flow (g/d)	1481	1481	1481	897.6	972.4	1122	1481	1481	2019.6	1481	1481	2393.6
Meals Served	680	700	730	787	787	750	680	680	700	730	787	787
Hours of Operation (hr/day)	24	24	24	24	24	24	24	24	24	24	24	24
DO (mg/l)	5.8		6.4	5.7	6.5	5		6.7	5.3		5.3	6.7
Temp (C)	30.8		25.1	25	27.8	31.9		27.5	26.5		24.3	30.7
pH (SU)	6.7		7.3	6.2	6.7	6.2		5.8	5.2		5.5	6.5
COD (mg/l)	2260		3680	3380	3560	5210		4480	3880		5950	5820
BOD (mg/l)	277		2020	276	2300	17900		2890	8790		3300	3500
TSS (mg/l)	110		275	260	370	290		410	190		195	270
FOG (mg/l)	107		183	140	76	13		110	66		102	101

VITA

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EDUCATION:

Bachelor of Science, Biological and Agricultural Engineering, May 1996
Texas A&M University, College Station, Texas

WORK EXPERIENCE:

City of San Antonio (November 2001-Present)

San Antonio, TX 78205

- Responsible for execution of Capital Improvement Projects.
- Design and construction contract administration.
- Coordination with the public and regulatory agencies.
- Real estate right-of-way acquisitions, environmental surface and sub-surface investigations, cultural resources surveys, and all other related items required for project completion.
- Manage A/E design teams, including contract negotiation.

San Antonio River Authority (April 2000-November 2001)

San Antonio, TX 78205

- Administration of the Regional Water Resource Development Group.
- Developed and negotiated a successful 50-year, \$12 million federal contract.
- Planned and executed a \$1 million demolition project.
- Developed agreements between governmental agencies.

Texas Department of Criminal Justice (October 1998-April 2000)

Huntsville, TX 77840

- Conducted hydraulic/hydrologic analyses of small watersheds.
- Designed erosion control systems, concrete structures, and metal structures.
- Performed technical reviews of architectural and engineering construction work.
- Interim Deputy Director of the Office for Sustainability (Energy Management).

Radian International (May 1996-October 1998)

Houston, TX 77042

- Site activity planning and coordination.
- Conducted studies of surface/ground water and soil treatment processes.
- Earthwork planning and supervision, and strategic planning.