Ontario

Ministry of Environment and Energy
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August 28, 1996

To: Restaurant Sector Bio-augmentation Working Group
See attached distribution list

From: Henry Kronis
Oil and Grease Committee

Re: Bio-augmentation in the Restaurant Sector - Review of Second Draft

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Attached is a copy of the second draft describing the result of the restaurant sector bio-augmentation program. Please review the document and provide me with your comments by September 20, 1996. If no comments are received by this date I will assume that you concur with the content of this report.

When reviewing the report please remember that the prime objectives of this study were to assess the impact of bio-augmentation on grease trap performance and sewer maintenance.

Any questions, then please call me at (416)314-3906. Your assistance on this activity is appreciated.

Henry Kronis

For Oil and Grease Committee

(SECOND DRAFT)

DRAFT

BIO-AUGMENTATION IN THE RESTAURANT SECTOR

BY

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PROGRAM DEVELOPMENT BRANCH

POLLUTION PREVENTION OFFICE

MINISTRY OF ENVIRONMENT AND ENERGY

JULY 1996

EXECUTIVE SUMMARY

Bio-augmentation is a process which uses bacteria to promote the breakdown of fat, oil and grease in wastewater. This study assessed bio-augmentation for application in the restaurant sector which has been identified by municipalities as a major source of fat, oil and grease discharges to sewer systems. Discharges containing fat, oil and grease in excess of municipal sewer use by-law limits can have adverse effects on sewer systems in the form of flow restrictions, blockages, and ongoing sewer maintenance activities.

Bacteria evaluated was provided by three manufacturers of biochemicals for a 16 week study program. The study was conducted within Metropolitan Toronto during the summer of 1995 with voluntary participation by ten restaurants, located in the vicinity of sewers requiring frequent maintenance activities.

Specific study objectives included an assessment of bio-augmentation on grease trap performance such as the effect on pump-out frequency, odour, potential of attaining compliance with sewer use discharge limits, and the resulting impact on municipal sewers.

Study results indicate that bio-augmentation has the potential of reducing fat,oil and grease in discharges from the restaurant sector by up to 50 % and also bring facilities into compliance with sewer use discharge limits.

Bio-augmentation did not facilitate compliance with the BOD discharge limits, however, some BOD reductions were attained.

Bio-augmentation eliminated odour problems, originating in grease traps, from facilities which had historical odour problems.

Bio-augmentation has the potential of performing sewer maintenance activities by removing and preventing fat, oil and grease accumulations in sewer systems. Sewer maintenance, however, based on other studies, appears to be more effective if biochemicals are directly added to sewers instead of through restaurant grease traps.

Grease trap pump-out frequency is not expected to be significantly reduced by bio-augmentation unless facilities also adopt enhanced housekeeping practices which minimize the discharge of solid food waste. To this end, implementing and following the proposed Best Management Practices Plan, developed for this sector, is recommended.

No adverse effects, as a result of bio-augmentation, were identified within restaurant grease traps, lateral sewers and main sewers. The study has demonstrated, that under the right conditions, bio-augmentation has the potential of enhancing fat, oil and grease management in the restaurant sector, and reduce sewer maintenance activities for municipalities. The full potential

of bio-augmentation, however, is not realized with the prevailing small sized grease traps in Ontario restaurants.

Cost of bio-augmentation would be in the order of $100.0 to $150.0 per month per facility for biochemicals, and a one time initial cost of about $200.0 for a feed pump with timer.

Biochemical products for bio-augmentation are available from several sources and no specific brand or formulation is recommended or endorsed by this Ministry or municipalities which participated with this study.

This report was prepared in support of the proposed Restaurant Sector Best Management Practices Plan and should be of interest to municipalities, the restaurant sector, and food processing facilities who are interested to implement bio-augmentation as a mechanism to resolve maintenance or sewer use compliance problems.

ACKNOWLEDGEMENTS

The author acknowledges the continuous support received during the bio-augmentation study from

Vic Lim, John McDonald and Jack Chan of the Metropolitan Toronto Works Department, Water Pollution Control and laboratory Sections, for assistance with the selection of facilities, effluent monitoring and analytical services.

Gary Stinson and Thanh Le of the Cities of Scarborough and Etobicoke Works Departments respectively, for providing remote in-sewer monitoring services

Leanne Knuckles of the City of Brantford for ongoing support and suggestions toward this program

Rachelle Wood of the Ontario Restaurant Association for negotiating voluntary participation by selected facilities with this study

Ray Leach of Waste Alternatives Inc. for ongoing technical support and liaison with participating facilities and biochemical manufacturers

manufacturers of biochemicals, notably Doug Dent of Sybron Chemicals Inc., John Christiansen of InterBio; and Daniel Couillard of Innu-Science Inc. for providing biochemicals and ongoing technical support.

management of the following restaurants for voluntary participation and cooperation by making facilities available for case studies:

McDonald's Restaurants of Canada Limited

Red Lobster Canada

Kentucky Fried Chicken

Swiss Chalet Restaurants

Sam Woo Holdings Corporation

Tre Rose Bakery Limited

New Pacific and International Chinese Restaurants

Taco Bell of Canada

Pizza Hut of Canada

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BIO-AUGMENTATION IN THE RESTAURANT SECTOR

A STUDY TO ASSESS BIO-AUGMENTATION IN THE RESTAURANT SECTOR

1.0 INTRODUCTION

1.1 Background Information

As a component for the development of a Restaurant Sector Best Management Practices Plan (BMP) which is intended to minimize the uncontrolled discharge of fats, oil and grease (FOG) to municipal sewers, the Ministry of Environment and Energy, jointly with Metro Toronto, area municipalities, the Ontario Restaurant Association (ORA), including support from their membership, and manufacturers of biochemicals, have undertaken a study to assess bio-augmentation in the Restaurant Sector.

Historically, wastewater from food preparation facilities is discharged to municipal sewer systems with minimal pre-treatment and consequently, under current treatment practices or available equipment, municipal sewer use discharge limits are not always attainable.

The prevailing method of intercepting and removing FOG from these wastewaters is through the use of grease traps. Grease traps are intended to provide some retention time to cool the warm liquified grease for separation in the form of a surface scum or oil layer. Unfortunately, most grease traps are undersized and provide only minimal FOG separation prior to discharge to sewers. Additionally, emulsified oil, unless the emulsion breaks, will normally not separate in grease traps. To make things worse many facilities do not adequately maintain or service grease traps. Further, grease trap efficiency, relating to the separation of FOG, is often further reduced by excessive discharges of solid food waste which accumulate in the grease trap and consequently even less retention time is available for FOG separation.

FOG which is not removed in grease traps will cool down in sewers, both private and municipal, and in this way grease will gradually build-up within sewers, leading to flow restrictions or complete blockages.

To enhance grease trap performance and to minimize the formation of flow restrictions or blockages in sewers, a process called bio-augmentation is being promoted by manufactures and distributors of bacteria, also referred to as biochemicals, which, according to these suppliers, are intended to utilize FOG in wastewater as a source of food. By dosing these bacteria to wastewater, ahead of or

directly to grease traps, it has been claimed that the quantity of FOG which has to be removed from grease traps through routine pump-outs could be reduced. Additionally, it is also claimed that as the bacteria multiply and move downstream from the grease trap, they perform a maintenance function which minimizes the gradual build-up of FOG within sewers.

1.2 Objective of Bio-augmentation Study

The study is intended to assess the claims made by manufacturers and suppliers of bacteria as they relate to potential reductions of FOG in discharges to sewers and the additional benefit of maintaining a clean sewer system.

Bio-augmentation assessment will include the following aspects:

- effect of relative reduction or prevention of FOG accumulations in sewer systems
- identify adverse effects, if any, on sewer systems
- effect on grease trap performance
- attainment of compliance with municipal sewer use by-laws
- a review of results attained by independent distributors of bacteria and a discussion of their experiences with bio-augmentation
- recommendations on bio-augmentation

1.3 Presentations and Participation by Suppliers

Identified suppliers of bacteria, at that time, June 1994, were invited to make presentations to the oil and grease committee. Specifically, the committee was interested in the following aspects as they relate to applications in the restaurant sector:

- introduction to bio-augmentation
- description and properties of the material
- intended uses and benefits
- process description of FOG bio-degradation
- site requirements for bio-augmentation, grease trap, retention time, kitchen practices, housekeeping/cleaning practices
- end products formed, odour

- economics, dosage, effect on pump-outs
- effect on private and municipal sewer systems, benefits
- documented case studies in support of claims made
- local facilities practicing bio-augmentation, and assessment of these installations

1.4 Municipalities and Restaurant Sector

Consequently to the above presentations, three manufacturers of bacteria agreed to participate with a bio-augmentation study. The manufacturers agreed to make bacteria available, at no charge to the committee, for a 16 week study, using 10 suitable facilities, to assess the claims made in their presentations.

The bio-augmentation study was conducted within Metro Toronto with active participation by MOEE, Metro Toronto, the ORA and selected ORA members.

Bacteria for the study, including installation of bacteria feeding equipment, was provided by the respective local bacteria distributors for the manufacturers.

With the assistance of the ORA and Metro, ten facilities were identified as acceptable for participation with the study program. To be acceptable, the facility had to have an accessible grease trap, and sampling/monitoring access via a manhole serving the lateral private/municipal sewer sections. Details on facility selection are presented in the section on study methodology.

2.0 STUDY METHODOLOGY

2.1 Required Information

The study was designed to allow for the assessment of potential benefits, as claimed by suppliers of bacteria, attainable through bio-augmentation, and to use this information as a component in support of the Restaurant Sector BMP plan. Specifically, the committee was interested in the following aspects:

- oil and grease reductions attainable within prevailing grease traps typically found in Ontario.
- effect on grease trap pump-out frequency
- effect on sewer maintenance activities
- effect on FOG concentrations in facility wastewaters
- effect on grease trap odour
- effect by type of restaurant or operation practices
- conclusions which would allow as to make recommendations for bio-augmentation, such as:
  - attainable discharge levels or compliance with sewer use by-laws
  - grease trap sizing, design and location
  - selection and use of cleaning/disinfectant materials
  - frequency of grease trap pump-out
  - food waste or solids control to grease traps
  - facility requirements for effective bio-augmentation, pre bio-augmentation activities
  - bio-augmentation to maintain clean sewer systems

2.2 Selection of Facilities for Participation

To qualify for participation in this study the following on-site conditions were essential:

- installed and operating grease trap, all kitchen discharges to grease trap (dishwasher discharge may by-

pass grease trap, depending on local by-laws)

- accessibility of grease trap for routine visual observations of grease trap content appearance
- accessibility to collect samples from grease trap influent and effluent, at the minimum from the facility discharge through a manhole located at the facility-municipal property line
- accessibility with a video camera, through a manhole, to assess lateral and main sewers for condition of sewers, such as grease deposits
- location of facility. Preference was given to sites or clusters of sites, located within close proximity of each other. This allowed assessment of the combined impact from a number of facility discharges on the respective main sewers.
- lateral and main sewers serving the selected facilities had historical problems such as blockages, flow restrictions, or require routine clean-outs.
- facility was prepared to participate on a voluntary basis

Ten facilities were selected on the basis of the above criteria. This was the maximum number of sites we could accommodate under the current fiscal constraints.

The sites included: - Seven fast food type outlets,

- Two Chinese family type restaurants
- One deli-bakery type restaurant

All bacteria suppliers were informed of and taken to the selected sites for their comments or recommendations.

Facility management was informed of the proposed activities during the study period. We agreed that we would not interrupt kitchen activities and not conduct routine inspection visits during peak periods. Additionally, facilities were not expected to change their routine kitchen activities as a means to enhance the study results. Consequently, the bio-augmentation study was conducted under prevailing restaurant-kitchen operations.

Participating facilities were also assured that all study results would remain confidential, and would not be used for compliance enforcement purposes. To this end this report identifies

participating facilities by code letters, A to L. Facilities, however, have the option to request identification of their respective facility.

2.3 Agreement with Bacteria Suppliers

Bacteria manufacturers, through their local distributors, agreed to make bacteria available, for a four month study period, to the participating facilities. The local distributors provided commercial preparations of bacteria, in liquid media, in five gallon pails, and feeding pumps with timers. Initial installation and dosage setting was done by the local distributors. Bacteria replacement was done on a three week cycle. Committee staff was present during the initial start up and all subsequent site visits by the local suppliers.

2.4 Assessment Activities

A committee member conducted weekly site visits to each participating facility to visually assess the condition, appearance of grease traps, assure that bacteria was actually delivered to grease trap, and arrange for supplies of bacteria and/or services as needed.

Metro Toronto Works staff conducted all on-site facility wastewater discharge monitoring and subsequent analytical testing.

Sewer system inspections, using remote video cameras, were arranged or done by respective municipal staff.

Grease trap pump-out frequency was either left as was currently in place, or was changed as suggested by the bacteria supplier. Based on visual observation during the study period additional changes would be made as needed.

2.5 Sampling and Analytical Methodology

Field sampling activities were divided into two sections, namely:

- background sampling, three weeks preceding to bio-augmentation, six samples per site
- bio-augmentation period, 16 weeks, 10 samples per site

All samples were of the composite type collected during the operating period of the facilities, typically from about noon to midnight. Depending on local site conditions, composite sample collection was either done manually on an hourly basis,or by auto-sampler at a 15 minute frequency. It was recognized that accepted

sampling procedures for FOG could not always be followed. The committee acknowledged that under the prevailing sampling conditions, at most of the sites, a compromise on the preferred sampling methodology had to be made in order to get a sample at all.

All sampling was done at the facilities manholes. The exception was one site which had a large 1000 gal. grease trap, where both grease trap influent and effluent were sampled.

Sampling frequency during the bio-augmentation phase consisted of a weekly composite sample per site during the first 4 weeks, and then every second week during the remaining 12 weeks of the study.

The two main sewers, identified for assessment, were monitored by remote video camera prior to and at completion of the bio-augmentation study. Main sewers were not sampled.

Throughout the study period all sites were inspected on a weekly frequency for grease trap appearance such as quantity of scum, oil, odour, solids accumulation, potential wash-outs, back-ups, pH, or any other unpredicted conditions.

Analytical parameters for all collected samples included:

- solvent extractables (FOG)
- BOD
- SS

All analytical work was done by the Metro Toronto Laboratory according to Standard Methods.

Analytical methods development for solvent extractables was included as a component of the study program. This included assessment of solvents for FOG extraction using methylene-dichloride and hexane, followed by gravimetric and FTIR quantitative determination of FOG. The FTIR method allows analysis for the animal/vegetable component of the total extracted material.

3.0 Description of Participating Facilities - Summary

3.1 Summary - Details in Appendix A

Facilities participating with the Bio-augmentation study included fast food outlets, family type and Chinese restaurants. Seating capacity varied from nil for take out only to up to 200. Operating hours varied for the type of facility, typically from about 6:30am to 11:00pm. Chinese facilities generally operated from about 11:00 am to well after midnight.

Kitchen facilities, such as equipment and operating practices also varied from site to site. All facilities had one or more large type compartment sinks and deep fryers. Only family type restaurants, including Chinese restaurants, had dishwashers. Most fast food outlets use disposable plates and cutlery. Pots, pans etc. are normally washed in sinks. Exhaust system filters are frequently cleaned by passing them through a dishwasher, or manually in a sink.

All facilities disposed of their spent deep fryer grease to a container, located outside, and provided by a rendering facility which collects the spent grease at selected intervals.

All participating facilities had grease traps of varying design and size. Most grease traps were located somewhere within the kitchen, under a sink or just below floor level. Grease trap sizes were primarily in the order of 25 to 50 gallons. A few facilities, however, had 100 and 1000 gallon traps. Grease trap maintenance, such as routine pump-out could be on a weekly basis if done by in-house staff, or anywhere from three weeks to two months if done by a licensed waste hauler. Further, some sites have their grease traps pumped-out only as needed or whenever an odour problem develops.

Private lateral sewer sections, at some of the facilities, are power flushed on a routine basis by a contractor once or twice per year. Others have their lateral sewer cleaned as the need arises, normally indicated by slow drainage from the grease trap or worse the sewer backs up through the grease trap. With the exception of routine clean-outs or pump-outs, no other routine grease trap monitoring program was in place. It appears that most facilities, the exception being when servicing is done by in-house staff, leave all activities relating to grease trap servicing to a waste hauler.

A number of the facilities had some problems relating to slow drainage or wastewater backing-up into the kitchen through the grease trap. At one site sewer clogging produced frequent overflows from an outside manhole. Facilities which are aware of historical sewer related problems have a preventative maintenance program by having their sewers cleaned once or twice per year. Even with a

preventative program the occasional sewer back-up may occur. Some facilities have an ongoing odour problem originating from their grease trap. The source of odour problems appear to be related to the type of restaurant (type of food served) and the use of disinfectants or deodorizers.

4.0 Presentation and Discussion of Results

4.1 Visual Observations During Facility Site Visits

The following discussions represent summaries of visual observations which were made during the weekly site inspections at participating facilities, identified as A to L.

Facility A

Bacteria feeding commenced May 12,1995, to drain leading to grease trap at a rate of 800 ml per dose. Pump timer was set to deliver a daily single dose of bacteria at 1:00 am. Facility staff was asked to stop cleaning the grease trap until further notice. Eventually, based on on-site observations of odour and solids and oil-grease build-up in the trap, a four week cleaning cycle was established. On May 31 bacteria dose was reduced to 700 ml.

No objectionable odours were observed throughout the study period. However, following four weeks with no trap cleaning, food waste (solids) and oil/grease had formed a thick soupy (oily) appearing mixture, with a trace of odour.No significant surface grease layer (scum) was observed at any time. Clean-out was indicated at this time and performed. Following each four week clean-out the initially watery-soupy appearance of the grease trap content changed, within a week, to an ever increasing oily content of a solid-water-oil mixture. Grease trap pH was normally close to 7.0. Trap temperature was in the order of 30 deg. C. Frequent dumps of wastewater containing soap suds were indicated. No sewer discharge problems were indicated during the study period. Lateral sewers were inspected by video.

The relatively small sized grease trap allowing for frequent mixing of trap content, elevated grease trap temperatures which prevents solidification of liquid oil/grease, and short retention times, are probable factors for the above observations.

Facility B

Bacteria feeding commenced May 12, 1995, to drain line just ahead of grease trap. Feed pump timer was set for 1:00 am to deliver a single daily dose of 800 ml. Management at this facility did not allow grease trap inspection during business hours as they apparently had historical bad odour problems. (trap was located in an area open to the deli eating and sales facilities). It was agreed

that the trap would be inspected after business hours at a later date. On May 31 dosage was reduced to 700 ml.

No objectionable odours were observed throughout the study period. The grease trap was not cleaned until the end of the study period mainly for the reason given by management that there was no odour from the trap. When the trap was finally opened the upper half was filled with grease and food waste and oily liquid below. pH of the oily liquid was 6.0. Amazingly, upon opening the trap lid no objectionable odours were given off.

Trap appearance at this stage suggested that the bulk of wastewater passed directly through the grease trap without the opportunity for any oil-water separation. Apart from the elimination of grease trap odour no other apparent enhancements due to bio-augmentation were indicated. No sewer discharge problems were indicated during the study period.

No facility effluent sampling was done here since the facility was included into the study at the last minute, and no additional resources for analytical work were available. The lateral sewer was inspected by video.

Facility C: Feeding of bacteria commenced May 12, 1995, to drain line just ahead of grease trap. Pump timer was set to provide a single, daily 800 ml slug dose at 1:00 am. Weekly inspections throughout the study period indicated a 1/2 to 2.0 inch surface scum layer. From its appearance it was judged to be mainly cheese waste. Liquid below the scum layer was at all times clear water. pH of grease trap content was in the range of 6.0 to 7.0. No objectionable odour was noticed during the weekly inspection when the lid to the grease trap was opened. Facility staff, however, mentioned that during pump-out, close to end of study period, when the settled food waste solids were stirred up, a bad odour was temporarily emitted.

Facility staff reported no grease trap or sewer problems during the study period. The lateral sewer was inspected by video.

Facility D: Bacteria feeding commenced May 12, 1995, to drain line just ahead of grease trap. Feed pump was set

to provide a single daily slug dose of 800 ml, at 1:00 am. Throughout the study period, during weekly grease trap inspections, no objectionable odours were observed. The grease trap itself contained up to 1.0 inch of scum, mainly food waste and grease, covering all or part of the trap surface. Clear water was observed at all times below the scum. A quick test to indicate grease trap flushout was done by dumping a sink full of water to the trap. This stirred-up the trap and essentially flushed all the scum from the trap. A number of these flushes per day would achieve the appearance of a relatively clean trap, attainable with or without the use of bacteria. Potentially, this could be an explanation for no oil layer, only water, in the grease trap. The grease trap had not been pumped-out for the duration of the study, and since management had recently changed (a problem common to most manager operated facilities) no records of grease trap pump-out were available. pH of the trap content was at all times around 7.0. Trap temperature was in the range of 20 to 45 deg. C.

Facility staff reported no grease trap or sewer problems throughout the study period. The lateral sewer was inspected by video.

Facility E: Feeding of bacteria commenced May 12,1995, to drain line upstream of grease trap. The pump and timer were set to deliver a single, daily slug dose of 800 ml, at 1:00 am. Grease trap pump-out was maintained at the three week cycle. At start-up, during the initial inspection of the grease trap, a rather objectionable strong odour was given off from the grease trap. On the following inspection no odour was noticed. Further, throughout the study period, even just before a scheduled pump-out, no further odour problems were noticed. Depending on elapsed time from pump-out, the surface scum layer, consisting of a mixture of grease and food waste, varied from 1/2 to 4.0 inches. Similarly, the oil layer below the scum also varied. On occasion it appeared as if the whole trap was filled with an oily-watery mixture. pH of grease trap content varied within a range of 5.0 to 7.0. The grease trap also received dishwasher wastewater which included grease from the washing of exhaust emission baffles.

Historically, the facility has had sewer backups through the grease trap. One such backup occurred

about half-way through the study. Management was unable to provide reasons for this back-up. Under such conditions it is the policy to call a contractor to service the grease trap and lateral sewer. The lateral sewer was inspected by video.

Facility staff working in the vicinity of the trap acknowledged that the typically bad odours from the trap have disappeared soon following the addition of bacteria.

Facility F: Feeding of bacteria commenced May 12, 1995 to the drain line upstream of the grease trap. Pump timer was set to deliver 800 ml, daily, as a single slug dose, at 1:00 am. Trap pump-out was maintained at a three week cycle. At start of bacteria feeding the whole basement was contaminated with a bad odour problem. Odour was particularly bad when the grease trap was opened. Within a few weeks from dosing bacteria the bad odour gradually disappeared. Weekly inspections indicated one to three inches of scum, essentially grease, with an oily liquid layer below the scum. Actual discharge from the trap appeared to be watery. pH of grease trap content was in the range of 4.5 to 6.5. Trap temperature was usually at about 35 deg. C.

Facility staff reported no grease trap or sewer problems throughout the study period. They acknowledged, however, the disappearance of the objectionable odours. The lateral sewer was inspected by video.

Facility G: Feeding of bacteria commenced May 17,1995 to the drain line ahead of the grease trap. Pump-timer was set to dose 750 ml as a single slug dose, daily, at 1:00 am. At the recommendation of the bacteria supplier, facility staff maintained the weekly trap clean-out frequency. Staff indicated, that an on-going odour problem, also observed during the initial set-up, and particularly noticeable during clean-out, was eliminated within two weeks of bacteria addition. Throughout the study period a surface scum layer of up to one inch, usually only covering a portion of the trap surface, was observed. The liquid below the scum had, most of the time, a watery soupy appearance. At times it was also considerably oily. Grease trap pH was in the range of 6.0 to 7.0.

No grease trap or sewer problems were indicated

during the study period. The lateral sewers were inspected by video.

Facility H: Pre-inspection of this facility indicated that the grease trap was almost completely filled with a mixture of grease, oil and food waste. The surface section of this material was in fact drying and cracking. At our request the trap was completely pumped out just prior to commencing the addition of bacteria.

Feeding of bacteria commenced May 17, 1995 at a dose of 750 ml directly to the influent compartment of the grease trap. The pump timer was set to dose bacteria as a single, daily slug at about 1:00 am. Within one week from pump-out grease-food waste was again building up significantly, gradually increasing to fill about half of the trap. Below the scum layer was, at all times, a heavy layer of oil. Even with the heavy accumulation of grease, food waste and oil no objectionable odours were noticed at any time prior to or during the bio-augmentation phase. Although, grease trap pump-out was maintained at the monthly frequency, the rapid build-up of grease, oil and food waste did not allow to observe significant changes in the visual appearance of the grease trap contents during the weekly site visits.

On July 20/95, dosing of extra strength bacteria commenced. By August 15, oily patches appeared on the surface, visible as an oily soup mixed with food waste. The reason for this, increased bacterial activity or pump-outs, has not been established. pH of the grease trap content was in the range of 5.5 to 7.0.

Facility staff reported no grease trap or sewer problems during the study period. The lateral sewer was inspected by video.

Facility K: This facility has three grease traps serving the: potato preparation and deep fryer area, dishwasher area, and exhaust system of the barbecue ovens respectively.

Bacteria feeding the grease traps serving the dishwasher and barbecue ovens commenced May 17,1995 and to the potato preparation/ deep fryer area June 8, 1995. The latter required a battery powered system.

Potato/deep fryer area grease trap received a daily single 500 ml dose at about 1:00 am upstream of the grease trap. Trap pump-out was maintained at the prevailing three week frequency. No bad odours were noticed prior to or during the study period. During the weekly grease trap inspections we observed a rapid accumulation of very fine solid material which appeared to be primarily potato waste, essentially starch, associated with considerable foaming. Between pump-outs the surface scum would build up to about six inches. Liquid below the scum was at all times relatively clear water. pH of this water was normally in the range of 5.0 to 6.5. Potato preparation required a continuous flow of cold tap water and consequently trap temperature during site visits was normally in the range of 15 to 20 deg. C. Bacteria addition to this trap appeared to have no observable effect.

The trap serving the dishwasher area received a single, daily 750 ml dose at about 1:00 am, upstream of the grease trap. Trap pump-out was maintained at the three week interval. No bad odours were noticed before or during bio-augmentation. Surface scum accumulation, consisting of food waste and grease, was minimal, varying from no scum to up to 1.0 inch depending on what was happening at the facility. We felt that dishwasher discharge was flushing the trap content. Trap liquid was most of the time a watery soup, but was occasionally oily as well. pH of trap content, which also received considerable fresh water from food preparation areas, was normally 7.0. However, following a dishwasher dump could go up to 11.5.

The trap serving the barbecue ovens and associated duct system also received a single daily 750 ml dose at about 1:00 am just ahead of the grease trap. This trap contained some grease, but was normally quite clean containing essentially only clear water. No significant scum accumulation was noticed. For this reason pump-out from this trap was only done twice per year. pH of trap content was within a range of 6.5 to 8.0.

Toward the end of the study period facility staff noticed that discharge rate from the dishwasher area grease trap was considerably reduced from the normal rate, observed by an increased level in the trap, indicating a flow restriction in the lateral sewer section. Normally the lateral sewer sections,

which receive the combined discharge from the three grease traps, are flushed out twice per year. We delayed flushing at the start of this study with the intent that bio-augmentation would remove accumulated grease from the sewers and maintain them in a clean state. Consequently, the sewers were flushed upon completion of the study, but after sewer videoing.

Facility L: Feeding of bacteria commenced May 11, 1995 to the inlet section of the grease trap. Pump timer was set to deliver initially 1000 ml as a daily slug dose, around 1:00 am. On May 30, bacteria dosage was reduced to 500 ml. The trap had been pumped out a few weeks prior to commencing bio-augmentation. Normal pump-out frequency is every three to four months. No bad odours were observed throughout the study period. Surface scum at the start of the study was about two inches. This level varied throughout the study reaching a high of about 6 inches and at times was down to one inch including visible oily patches. During bio-augmentation the surface sludge or scum had a more uniform consistancy, was fluffy and light coloured in appearance. Below the scum we always noticed a deep layer of oil. Another observation was the discharge of large quantities of food waste. Food waste settled to the bottom of the grease trap and gradually filled the trap. By August 22 the trap was completely filled with waste food (solid waste) and was consequently pumped out. Coinciding with this event was also a sewer blockage causing an overflow from an outside manhole close to the grease trap. The municipality had ongoing complaints over a number of years of sewer blockages and associated overflows from this manhole. Observations during the study period indicated that the manhole was always more or less flooded with the level varying according to the rate of facility discharge. Following a mechanical cleanout of this sewer, the level in the manhole remained fairly constant. Initially, we had hoped that bio-augmentation would remove any grease accumulations within this lateral sewer and maintain it in a clean condition. Due to the constant flooded state of this lateral sewer, videoing of this sewer was not possible. pH of grease trap content was in the order of 6.5 to 7.0. Following the August 22 pump-out, the surface grease layer varied in the range from one to three inches, including open patches showing the oil

layer below, and remained at this level until the completion of the study, by mid September. By October 18 the grease level had increased to about six inches. (All grease levels observed in the discharge section of the trap). Further, for the first week, following pump-out liquid below the grease layer was essentially water. Gradually, an increasing layer of oil accumulated below the solid grease layer. Ongoing observations of the manhole contents suggests that large quantities of grease continuously escape from the grease trap. This observation, however is not confirmed through direct observations of grease trap discharge.

This grease trap is managed by the property owners, not the restaurants.

Summary

Inspecting and observing appearances of grease traps, although relatively crude, can serve as a tool to assess grease trap performance. Primarily, this includes relative estimates of the seperated quantity or depth of the grease/food waste layer with time, and appearance of grease trap discharge. Effectiveness of bio-augmentation would be indicated by a possible reduction in surface scum accumulation. For example, in this study, visual observations at facilities E, F, G, H and L indicated a reduction, although not consistently, of the seperated FOG surface layer by up to 50%. Generally, however, measurements of the surface FOG layer, and particularly the underlying liquid oil layer, are, if not impossible, difficult to monitor at most sites. Additionally, the rate of settled food waste and seperated grease waste accumulation provides an indication on the effectiveness of facility housekeeping practices.

4.2 Visual Inspection of Lateral and Main Sewers

4.2.1 Lateral Sewers - Private and Municipal Sections

Lateral sewers transmit wastewater from the users, in this case food preparation facilities, to the local municipal main sewer. Lateral sewers normally consist of a private and a municipal section, including a manhole which is, in most cases, located at the property line. Size of lateral sewers, serving facilities participating with the study program, had a six inch diameter. Exceptions to the above are older, downtown locations, which may have no access manhole.

Visual inspections of lateral sewers was done from the respective inspection manholes. Inspection involved manually advancing a video camera within the laterals, first from the manhole toward the facility and secondly from the manhole toward the main sewer. At each site the camera was advanced as far as possible, directly to under the site or to the main sewer. On occasion, due to heavy build-up of a combination of grease and food waste, it was not possible to advance the camera all the way. For this reason, and for the background inspections only, some of the sewers were initially flushed. Even with flushing, some of the laterals still had heavy grease and food waste accumulations.

All video inspection activities were done by municipal staff or by their contractor. A committee member was present during all video inspections. Sewer conditions were directly observed on a monitor as the camera was advanced up or down the laterals and were also recorded on video tape. Unfortunately, video tape reproductions did not turn out as clear as the observed picture during on-site monitoring.

4.2.2 Background Inspection:

All facilities contained more or less accumulated grease and or food waste. In most cases grease accumulations increased notably in the vicinity of the main sewer. Additionally, most sites had moderate to heavy patchy grease accumulations which might be observed anywhere within the laterals.

During the initial background inspection, some laterals were so badly clogged with grease and food waste that the camera could not be advanced any further. For this reason these laterals were flushed during the background inspection. Having some laterals flushed and others not allowed for the assessment of bio-augmentation on sewers which were initially cleaned in comparison to those which were left for bio-augmentation to do all the cleaning, not merely maintaining an initially relatively clean sewer in a clean state. Figures 1A, 2A and 3A illustrate the relative FOG accumulations and locations as observed during the background inspections.

4.2.3 Bio-augmentation Phase Inspection:
Lateral Sewers

Following a four months period of bio-augmentation, with dosing of bacteria to sewers via the participating facilities grease traps, as detailed earlier in this report, the sewers were again visually inspected by remote camera.

In general, bio-augmentation indicated some positive effects on the lateral sewers. Primarily, this was assessed by comparing residual FOG-food waste deposits with what had been observed during the

background inspections. The reader should be aware that this type of visual assessment involves considerable best available judgement techniques. Accordingly, observed relative FOG accumulations are described as very heavy, heavy, moderate, light, not bad, or patchy. This is illustrated by Figures 1A-1B, 2A-2B, and 3A-3B which describe the relative FOG accumulations prior to and following the four months bioaugmentation program.

In general, there was some indication of reduction and/or removal of original grease build up, as based on relatively cleaner laterals at some of the study sites. However, some laterals still had relatively heavy grease deposits in the vicinity of the main sewer while other sites showed heavier grease deposits close to the facility with a relatively clean municipal lateral even in the vicinity of the main sewer. The reason for this behaviour has not been determined but could possibly be explained in terms of the type of fats/oils used, wastewater temperature and short term emulsion of FOG.

Facilities known to have had sewer clogging or back-ups prior to this study had at least one sewer/grease trap problem during or at completion of the study. It is only fair to mention that maintenance/service practices at some of these facilities may play a key factor for causing problems regardless of whether or not bio-augmentation had been practiced. In summary, however, the observed results due to bio-augmentation were not as dramatic as had initially been visualized or expected on the basis of manufacturers claims for these bacterial products. Possible reasons for less effective bio-augmentation could be due to the type of cleaning material used by the facility, particularly chlorinated disinfectants such as Javex which potentially could kill the bulk of the added bacteria and/or prevent multiplication of bacteria.

Although, the manufacturers had warned us not to expect too much relating to grease reductions within the relatively small prevailing grease traps, 30 to 50 gallons (typically 1000 to 1500 gallons in the U.S.), we observed that bio-augmentation eliminated bad odours from grease traps, at sites where odours were a problem.

4.2.4 Main Sewers

Visual inspections of main sewers were similarly done at two locations to assess the impact of indirect bio-augmentation, as a result of bacteria carry-over from restaurant facilities, on main sewers.

4.2.5 Main Sewer Background Inspection:

A trolley mounted camera was used to inspect main sewers. The intent was to inspect sections of main sewers to which

participating facilities discharged. Inspection commenced from an upstream manhole. During the main sewer inspection, serving facilities A to F, the trolley, as it was advanced downstream or upsream from the starting manhole, became stuck in grease and other solid waste which had accumulated below water level. Following a number of unsuccessful attempts to push the trolley further ahead municipal staff called for a flusher truck to clean the section of sewer scheduled for inspection. Following sewer flushing a 430 foot section was inspected until a physical obstruction damaged the camera and stopped further background inspection.

Inspection of the above main sewer section, following flushing, revealed a relatively clean sewer section with patchy segments of heavier grease deposits. It was also evident that grease accumulations were primarily within the wetted, flow cross-section, of the sewer. This accumulation gradually forms a bench type build-up which is observable from the surface. Clearly, in this fashion, the effective cross-section of the sewer pipe is gradually decreased. This sewer section has a history of flow restrictions which in the past had resulted in wastewater backing up into adjacent residential dwellings. At that time, about two years ago, this section of main sewer was cleaned using the bucket method.

The downstream main sewer sections serving facilities G and H had heavy grease deposits. Municipal records indicated that this sewer had been flushed only a few months prior to this study. This appears to indicate that grease accumulation in sewers can occur within a short time period. Upstream sections were relatively clean.

4.2.6 Bio-augmentation, Impact on Main Sewers.

Inspection of main sewer sections, serving facilities A to F, following the bio-augmentation phase, was difficult and only possible for short distances, both upstream and downstream, from consecutive manholes extending over the locations of the participating facilities. This included the sections flushed prior to background inspection. Attempts to advance the trolley within the sewer failed within about 20 to 50 feet from the respective manholes due to below water level grease and solids accumulations. Inspection, however, indicated that the pipe surfaces above the prevailing waterline were relatively clean with only some patchy grease deposits. It appeared, that the sewer sections which were flushed for background inspection and observed following bioaugmentation (short sections only) were estimated, at least above water level, to appear as clean as had been observed during background inspection.

The sewer section immediately downstream of the initially flushed sewer was, however, heavily clogged with grease accumulations. These accumulations had built up completely around the inside

perimeter of the sewer pipe, significantly reducing the effective pipe cross-section. This accumulation did not allow camera advancement beyond a few feet. Although, this section of main sewer received the combined discharge from five facilities on bio-augmentation no observable benefits on sewer maintenance, such as removal of accumulated grease, without prior sewer cleaning, was indicated.

Inspection of the main sewer sections, serving facilitates G and H, indicated a substantially cleaner sewer than had been observed during background inspection. The sewer still had some patchy grease deposits but in general we could say that bacterial activity contributed to the maintenance of cleaner sewer conditions. This is particularly significant in light of the grease build-up which had occurred between the period of flushing and background inspection of these sewer sections.

4.2.7 Impact of Bio-augmentation on Sewers - Summary

In summary, bio-augmentation indicated some positive results relating to FOG management in grease traps, lateral and main sewers. However, for a number of possible reasons, the attained results were not as dramatic as might have been expected on the basis of claims made by suppliers of these bacteria. Specific reasons as to why bioaugmentation appears to perform better at some sites than others has not been established but could relate to the type of facility or housekeeping practices. The sewer inspection results for both, lateral and main sewers, indicating relative levels of grease deposits before and following bio-augmentation, are summarized by Figures 1A-1B, 2A-2B and 3A-3B.

The study, however, indicated that bio-augmentation has no adverse effects on current FOG management in the restaurant sector or municipal maintenance in sewer systems. The worst that could possibly happen is that for some reason or another bio-augmentation will not work.

Other studies have shown that direct bio-augmentation of main sewers in the vicinity of identified problem areas, rather than going through restaurant grease traps and associated lateral sewers, appears to be more effective on sewer maintenance. The studies have also shown that an initial sewer cleanout by flushing or other means enhances sewer maintenance by bioaugmentation.

For example, the City of Toronto has effectively used bio-augmentation for a number of years to maintain clean sewers in previously identified problem areas, particularly in downtown areas having a heavy concentration of restaurants. Besides maintaining clean sewers the additional benefit is the reduction of street

closings due to sewer maintenance activities.

4.3 Analytical Test Results

Analytical test results for facilities which participated with the bio-augmentation study program are presented in Tables 1 to 8. The specific parameters, sampled and tested for each facility effluent include SS, BOD and solvent extractables (FOG). FOG analysis was done by four different methods. Extraction included the use of methylene dichloride and hexane. Subsequently each extract was analysed for FOG by the gravimetric and FTIR methods. The latter was in support for a methods development and methods selection for FOG analysis. As can be seen from the data the four methods do not consistently agree. Currently, methylene dichloride (MECL2) extraction is the accepted method. A key factor which may produce questionable information for FOG analysis, even if analytical methods are acceptable, is the difficulty of obtaining representative samples from facility discharges including separation of the collected samples into aliquots for the different types of analytical methods. It should be noted, however, that for each solvent used the same extract was used for the gravimetric and FTIR analytical methods. Waste characteristics of these discharges can vary significantly reflecting the changes in ongoing kitchen activities, and also by the type of facility. Facilities C and D were, as a result of the on-site sewer layout, sampled jointly as one unit. Facility B, which was included into the study program at a later stage was not sampled for effluent analysis.

A review of the data in Tables 1 to 8, each displaying background and bio-augmentation data, indicates that four of the nine sampled facilities had about a 50% reduction of FOG materials in their effluent during bio-augmentation. Average FOG concentrations for the background and bio-augmentation study periods, and percent FOG reduction, are summarized in Table 9. The above assumes that facility kitchen activities remained relatively constant during the study period. In fact,however, when comparing the grease trap influent for the background and bio-augmentation periods, as shown in Table 9, it becomes apparent that discharge characteristics can change significantly. This is a factor which potentially could bias the bio-augmentation results attained from this study.

Substantial BOD reductions are indicated for three of the nine sites which include those sites identified for good FOG reductions. Again, the difficulty of obtaining representative samples could be one reason for the wide variability in BOD reductions for the respective sites. Suspended solids reductions appear to follow in line with those sites which had effective BOD reductions.

Several potential reasons for poor BOD and FOG reductions through bio-augmentation became apparent during the weekly inspection site

visits. These include:

- FOG does not separate into surface layers, but remains as a soupy mixture consisting of water, oil and food waste. Under these conditions effluent quality may further deteriorate by a reduction of trap clean-out frequency (facility A)

- emulsification of FOG due to detergents containing emulsifiers prevents FOG separation and consequently passes through the grease trap. The on-going development of enhanced grease cutting detergents is likely detrimental to grease trap performance.

- grease traps are often small and shallow with inadequate flow baffling. During a sink dump the trap contents can be flushed out. This can result in a relatively clean trap at all times without any pump-outs. (facilities C, D and K)

- poor grease trap maintenance. This reduces retention time for FOG separation by the accumulation of a FOG-food waste mixture layer at the surface, followed by an oil layer directly below the solid layer, and settled food waste at the bottom of the trap. At some of the sites build-up of food waste from the bottom up appeared to have more of an adverse impact on grease trap operation than the actual separated FOG at the surface. (facilities E, F, H and L)

- use of disinfectants, such as Javex or equivalent products, but necessary under health regulation to maintain a bacteria free environment in food preparation facilities, have the potential of killing bacteria being added to grease traps for bio-remediation. Under these conditions multiplication of bacteria for bio-augmentation, both in the grease trap and downstream sewer systems would be minimal.

- difficulty of sample collection representing facility discharge. Potential for wide variations in discharge quality as demonstrated by occasional excessively high or low concentrations for BOD and FOG. Program did not identify extent of this variability.

Analytical test results, in light of the difficulty of collecting representative wastewater samples from these facilities, need to be assessed cautiously. In fact the relatively low levels of the test results for SS, BOD and FOG do not support the in-sewer visual

observations which indicate heavy grease build-ups in the lateral and main sewers serving the facilities studied. Additionally, these sewers require routine preventative maintenance to avoid potential blockages. Based on these observations the value of conducting future sampling for assessment purposes needs to be re-assessed. Remote sewer inspections, using a camera, may possibly provide more useful information on the discharge characteristics of a facility and the resulting impact on sewer systems.

5. Conclusions

The intent of this study was to assess the impact of bio-augmentation on grease trap performance, and the potential additional benefits attainable toward sewer maintenance.

1. Of the nine facilities assessed (sampled)

   - five facilities were in compliance with the discharge limits of 150 mg/l FOG without bio-augmentation
   - all nine facilities complied with the 150 mg/l discharge limits during the bio-augmentation period
   - two facilities were in compliance with the discharge limits of 300 mg/l for BOD without bio-augmentation.
   - bio-augmentation did not facilitate compliance with the BOD discharge limits. However, some BOD reductions were attained

2. Bio-augmentation eliminated odours, originating in grease traps, from those facilities which had historical odour problems.

3. Bio-augmentation has the potential of reducing FOG levels in facility discharges by up to 50%. This is attainable regardless of whether or not the facility is initially in compliance, but appears to be facility dependent.

4. Bio-augmentation attained BOD reductions of up to 50% in some facility discharges. These reductions, however, were not sufficient to facilitate compliance by the affected facilities.

5. The study indicates that effective bio-augmentation is facility specific, potentially relating to the type of disinfectants/cleaners used, and size and maintenance of grease traps. Not all facilities may be acceptable for bio-remediation without making appropriate operating changes.

6. Bio-augmentation has the potential of performing sewer maintenance activities by removing and preventing FOG accumulations in private and municipal sewers. This is accomplished by bacteria which move downstream, use FOG as a food source, and multiply, following injection into grease traps. Again, effective sewer maintenance, although attained at some sites, appears to relate to the type of facility.

7. The effect of bio-augmentation on grease trap maintenance, such as pump-out frequency, may not be realized by facilities

which discharge large quantities of food waste through kitchen drains leading to grease traps. These wastes build-up as settled solid material, from the bottom of traps, gradually reducing grease trap efficiency. Under such conditions, and to maintain grease trap efficiency, grease traps are filled with food waste necessitating a pump-out before the need arises due to FOG accumulations. Similarly, extending the frequency of grease trap pump-out or clean-out will adversely affect grease trap performance and FOG levels in facility discharges to municipal sewers.

8. In light of the study results attained for FOG discharges and their relationship to the actual sewer conditions such as FOG accumulations, particularly in areas having a high density of restaurants, municipalities and/or MOEE may have to re-assess the relevance of the current 150 mg/l discharge limit. It appears that facilities complying with the 150 mg/l FOG discharge limit have the potential of generating substantial grease deposits, both in the lateral and main sewers. Time factors, over which excessive grease deposits will form, under high or low levels of FOG discharge was beyond the scope of this study, but should be established.

9. Main sewer maintenance, on the basis of information obtained from municipalities practicing bio-augmentation, appears to be more effective when bacteria is directly added to sewers within problem areas, rather than going through restaurant grease traps.

10. No adverse effects, as a result of bio-augmentation, were identified within restaurant grease traps, lateral sewers and main sewers. The study has demonstrated, that under the right conditions, bio-augmentation has the potential of enhancing FOG management. The worst that could happen is that bio-augmentation could be ineffective under the prevailing conditions it is being used.

11. FOG concentrations, as obtained for this study, appear to be relatively low and may tend to give the impression that this sector has no major sewer use compliance problems. However, this fact is not substantiated by the observed in-sewer conditions which indicate relatively high levels of grease accumulations. Again, this could be a reflection of the difficulty of attaining truly representative facility effluent samples.

12. Analytical test results for the four different test methods used, particularly in light of the problem of collecting representative samples from these waste streams, appear to agree reasonable well.

13. The FTIR analytical test method was developed to identify the animal/vegetable component in the sample extract, regardless of solvent used. To this end FTIR results should not exceed results obtained by the gravimetric method. Our data indicates that this is not always true. Interference from other unknown materials, also extracted by the solvents, is one explanation.

14. Cost of bio-augmentation, on the basis of biochemicals used during this study, about 20 to 25 litres per month per facility, would be in the order of $100.0 to $150.0 per month. An initial cost for a feed pump with timer at about $200.0 would also be incurred per facility per grease trap.

6. Recommendations

Based on the results and observations from this study, literature reviews, and discussions with bacteria distributors who have done independent assessments with bio-augmentation within the restaurant sector, we have the following recommendations under which bio-augmentation may have a chance for success:

- Facility must have dedicated, trained staff

- Distributor or facility staff must be aware that bio-augmentation involves more than providing a pail of bacteria and delivery pump with timer. This assumption, which is widely promoted in bio-augmentation advertising, will in most cases not produce acceptable results.

- Distributors of bacteria should have a demonstration kit. The kit should demonstrate the break-down of grease, for example a sample of grease trap content including surface grease layer to which bacteria is dosed at a controlled rate for a selected time period. We feel that such a demonstration would be essential to convince facility management to accept bio-augmentation, at least on a trial basis. This kit could also be used to demonstrate the effect on commonly used cleaners/disinfectants in kitchen areas. Reports from other studies indicate a minimum two day retention to break down FOG into water and carbon dioxide.

- Suppliers of bacteria must have a demonstrated methodology under which bio-augmentation will normally be successful. Restaurant facilities considering bio-augmentation must be made aware of the requirements under which bio-augmentation would have a chance to succeed. Requirements, including employee training, would include the following aspects:

  - grease trap size, retention time
  - kitchen practices, food waste, solids, to grease trap
  - quantity of fat, grease, oil to grease trap
  - pump-out frequency
  - type of bacteria used
  - cleaning/disinfectant materials
  - assessment of bacterial activity in event of negative results, and appropriate response
  - facility must comply with guidelines, provided by bacteria supplier, to obtain effective bio-augmentation
  - awareness of handling and health aspects in a food preparation environment. Emergency procedures in the event of a spill, contamination of food, or skin contact.

- municipalities already practicing bio-augmentation in their sewer systems should be encouraged to generate documentation,

such as by visual inspections using remote cameras prior to and following bio-augmentation, or the effect on sewer maintenance activities.

TABLE 1

BIO-AUGMENTATION STUDY

FACILITY: A

DATE	SAMPLING PERIOD	FACILITY EFFLUENT SS	BOD	FOG MECL2 EXTRACTION GRAV	FOG MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	pH
BACKGROUND								
04-12-95	11:40A-11:00P	282.0	390.0	54.0	43.0			
04-19-95	11:00A-11:00P	1455.0	590.0	93.0	73.0	83.0	68.0	5.8
04-24-95	11:00A-11:00P	116.0	200.0	61.0	61.0	55.0	59.0	
04-26-95	11:00A-11:00P	78.0	410.0	17.0	17.0	12.0	8.0	
05-03-95	11:15A-12:00M	98.0	590.0	4.0				
05-09-95	11:30A-02:00A	132.0	450.0	33.0	36.0	36.0	36.0	
AVERAGE		360.2	438.3	43.7	46.0	46.5	42.8	
BIO-AUGMENTATION								
05-17-95	11:30A-02:00A	274.0	740.0	8.0	18.0	69.0	59.0	
05-24-95	12:00N-02:00A	136.0	520.0	80.0	71.0			
05-31-95	11:30A-02:00A	594.0	830.0					
06-07-95	11:30A-02:00A	276.0	540.0	29.0	31.0	76.0	69.0	
06-14-95	11:30A-02:00A	610.0	710.0					
06-17-96	11:30A-02:00A			172.0	133.0	87.0	67.0	
06-28-95	02:00P-06:00A	184.0	430.0					6.5
07-05-95	11:30A-02:00A	190.0	500.0	79.0	69.0	70.0		5.1
07-26-95	11:30A-02:00A	202.0	910.0	74.0	66.0	64.0	58.0	
08-16-95	11:00A-02:00A	320.0	604.0	134.0	122.0	134.0	119.0	
08-30-95	11:00A-02:00A	140.0	1350.0	66.0	51.0	58.0	50.0	5.5
AVERAGE		292.6	713.4	80.3	70.1	79.7	72.6	

TABLE 2

BIO–AUGMENTATION STUDY

FACILITIES: C AND D (COMBINED EFFLUENT)

DATE	SAMPLING PERIOD	FACILITY EFFLUENT SS	BOD	MECL2 EXTRACTION GRAV	MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	pH
BACKGROUND								
04–12–95	11:25A–11:25A	134.0	340.0	80.0	77.0			5.6
04–19–95	11:00A–11:00A	132.0	360.0	81.0	85.0	83.0	92.0	6.8
04–24–95	11:00A–04:00A	50.0	140.0	27.0	30.0	52.0	61.0	
04–26–95	11:00A–03:00A	84.0	210.0			25.0	18.0	
05–03–95	11:30A–02:OOA	95.0	240.0	41.0	51.0	51.0	60.0	
05–09–95	11:30A–02:00A	92.0	190.0	28.0		45.0	50.0	
AVERAGE		97.8	246.7	51.4	60.8	51.2	56.2	
BIO–AUGMENTATION								
05–17–95	11:30A–02:00A	128.0	390.0	74.0	75.0	62.0	55.0	
05–24–95	12:00N–02:00A	126.0	350.0	48.0				
05–31–95	11:30A–02:00A	92.0	180.0					
06–07–95	11:30A–02:00A	104.0	240.0	26.0	29.0	36.0	38.0	
06–14–95	11:30A–02:00A	180.0	390.0	71.0	48.0	63.0		
06–29–95	02:00P–06:00A	160.0	400.0					
07–05–95	11:30A–02:00A	86.0	230.0	49.0	45.0	29.0		
08–16–95	11:00A–02:00A	188.0	290.0	66.0	69.0	43.0	47.0	
08–30–95	11:00A–02:00A	204.0	560.0	74.0	74.0	79.0	80.0	
AVERAGE		140.9	336.7	58.3	56.7	52.0	55.0	

TABLE 3

BIO–AUGMENTATION STUDY

FACILITY: E

DATE	SAMPLING PERIOD	FACILITY EFFLUENT SS	BOD	FOG MECL2 EXTRACTION GRAV	FOG MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	pH
BACKGROUND								
04–12–95	11:25A–11:25A	108.0	160.0	39.0	29.0			6.4
04–19–95	11:00A–11:00A	74.0	220.0	48.0	53.0	46.0	50.0	6.8
04–24–95	11:30A–02:00A	162.0	90.0	54.0		45.0	54.0	
04–26–95	11:30A–02:00A	150.0	410.0	125.0	118.0	115.0	109.0	
05–03–95	12:30P–02:00A	63.0	190.0	51.0	62.0	45.0	59.0	
05–09–95	11:00A–02:00A	180.0	440.0	88.0	105.0	128.0	134.0	
AVERAGE		122.8	251.7	67.5	73.4	75.8	81.2	
BIO–AUGMENTATION								
05–17–95	12:00N–02:00A	204.0	230.0	71.0	88.0	72.0	90.0	
05–24–95	12:00N–02:00A	104.0	150.0	40.0	40.0			
05–31–95	11:30A–02:00A	136.0	360.0					
06–07–95	11:30A–02:00A	78.0	180.0	23.0	32.0	31.0	34.0	
06–14–95	11:30A–02:00A	64.0	110.0	5.0	4.0	18.0		
06–28–95	02:00P–06:00A	145.0	310.0					
07–05–95	11:30A–02:00A	46.0	90.0	19.0	22.0	16.0		
07–26–95	11:30A–02:00A	120.0	220.0	61.0	61.0	68.0	84.0	
08–16–95	11:00A–02:00A	216.0	170.0	42.0	56.0			
08–30–95	11:00A–02:00P	114.0	360.0	54.0	66.0	61.0	68.0	6.5
AVERAGE		122.7	218.0	39.4	46.1	44.3	69.0	

TABLE 4

BIO-AUGMENTATION STUDY

FACILITY: F

DATE	SAMPLING PERIOD	FACILITY EFFLUENT SS	BOD	FOG MECL2 EXTRACTION GRAV	FOG MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	pH
BACKGROUND								
04-03-95	12:00N-02:00A	780.0	1280.0					5.6
04-12-95	11:25A-11:25A	2090.0	2550.0	243.0	209.0			6.3
04-19-95	11:00A-11:00A	3040.0	2880.0	237.0	219.0	205.0	221.0	
04-24-95	11:00A-01:00A	964.0	930.0	159.0	143.0	129.0	129.0	
05-03-95	12:00N-02:00A			230.0	113.0	191.0	192.0	
05-09-95	11:30A-02:00A	3250.0	2750.0	151.0	177.0	215.0	202.0	
AVERAGE		2024.8	2078.0	204.0	172.2	185.0	186.0	
BIO-AUGMENTATION								
05-17-95	11:30A-02:00A	128.0	2130.0	269.0	243.0	365.0	435.0	
05-24-95	12:00N-02:00A	980.0	950.0	165.0	182.0			
05-31-95	11:30A-02:00A	1100.0	1870.0					
06-07-95	11:30A-02:00A	1245.0	1060.0	96.0	97.0	144.0		
06-14-95	11:30A-02:00A	605.0	530.0	124.0	107.0	99.0		
06-28-95	02:00P-06:00A	980.0	1080.0					
07-05-95	11:30A-02:00A	575.0	500.0	50.0	43.0	31.0		
07-26-95	11:30A-02:00A	648.0	1350.0	122.0	123.0	159.0	146.0	6.0
08-16-95	11:00A-02:00A	118.0	250.0	56.0	55.0	62.0	59.0	
08-30-95	11:00A-02:00A	284.0	660.0	150.0	154.0	137.0	123.0	6.3
AVERAGE		666.3	1038.0	129.0	125.5	142.4	190.8	

TABLE 5

BIO-AUGMENTATION STUDY

FACILITY: G

DATE	SAMPLING PERIOD	FACILITY EFFLUENT SS	BOD	FOG MECL2 EXTRACTION GRAV	FOG MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	pH
BACKGROUND								
04-06-95	11:00A-12:00M	140.0	2780.0	156.0	173.0	105.0	109.0	
04-11-96	11:00A-12:00M			184.0	189.0	207.0	214.0	
04-18-95	11:00A-12:00M	134.0	480.0	145.0	144.0	118.0	125.0	
04-27-95	11:00A-11:00P	82.0	170.0	90.0	90.0	64.0	66.0	
05-02-95	11:00A-11:00P	775.0	310.0	126.0		116.0	119.0	
05-11-95	11:00A-11:00P	324.0	440.0	66.0	75.0	63.0	57.0	
AVERAGE		291.0	836.0	127.8	134.2	112.2	115.0	
BIO-AUGMENTATION								
05-15-95	11:00A-11:00P	275.0	530.0	120.0	127.0	106.0	101.0	
05-25-95	11:00A-11:00P	208.0	330.0	121.0	71.0	55.0	55.0	
06-01-95	11:00A-11:00P	156.0	430.0	37.0	37.0	72.0	60.0	
06-05-95	11:00A-12:00M	86.0	100.0	24.0	25.0	24.0		
06-22-95	11:00A-11:00P	450.0	900.0	143.0	134.0	133.0	126.0	
07-04-95	11:00A-11:00P	226.0	260.0	65.0	69.0	44.0		
07-20-95	11:00A-11:00P	138.0	200.0	35.0	40.0	39.0	38.0	
08-03-95	11:00A-11:00P	102.0	170.0	23.0	16.0	29.0	26.0	
08-16-95	11:00A-12:00M		410.0	10.0	14.0			
08-30-95	10:00A-01:30A	144.0	420.0	26.0				
AVERAGE		198.3	375.0	60.4	59.2	62.8	67.7	

TABLE 6

BIO-AUGMENTATION STUDY

FACILITY: H

DATE	SAMPLING PERIOD	FACILITY EFFLUENT SS	BOD	MECL2 EXTRACTION GRAV	MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	pH
BACKGROUND								
04-06-95	11:00A-01:00A	644.0	2340.0	580.0	564.0	540.0	583.0	
04-11-95	11:00A-01:00A	268.0	590.0	188.0	219.0	227.0	272.0	
04-18-95	11:00A-01:00A	690.0	2200.0	841.0	829.0	452.0	528.0	
04-27-95	11:00A-01:00A	458.0	1000.0	574.0	555.0	630.0	721.0	
05-02-95	11:00A-01:00A	240.0	440.0	186.0		217.0	250.0	
05-11-95	11:00A-01:00A	320.0	790.0	83.0	99.0	79.0	89.0	
AVERAGE		436.7	1226.7	408.7	453.2	357.5	407.2	
BIO-AUGMENTATION								
05-15-95	11:00A-01:00A	290.0	500.0	110.0	141.0	84.0	96.0	
05-25-95	11:00A-01:00A	246.0	1240.0	75.0	79.0	72.0	80.0	
06-01-95	11:00A-01:00A	486.0	1320.0	324.0	396.0	235.0	250.0	
06-05-95	11:00A-01:00A	308.0	600.0	145.0	151.0	152.0		
06-22-95	11:00A-01:00A	355.0	940.0	183.0	108.0	113.0	136.0	
07-04-95	11:00A-01:00A	254.0	740.0	174.0	192.0	125.0	170.0	
07-20-95	11:00A-01:00A	288.0	70.0	140.0	167.0	111.0	130.0	
08-03-95	11:00A-01:00A	346.0	1010.0	245.0	276.0	236.0	259.0	
08-16-95	11:00A-01:00A	204.0	450.0	85.0	116.0	124.0	135.0	
08-30-95	10:00A-01:00A	312.0	1000.0	97.0				
AVERAGE		308.9	787.0	157.8	180.7	139.1	157.0	

TABLE 7

BIO–AUGMENTATION STUDY

FACILITY: K

DATE	SAMPLING PERIOD	FACILITY EFFLUENT SS	BOD	FOG MECL2 EXTRACTION GRAV	FOG MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	pH
BACKGROUND								
04–12–95	11:25A–11:25A	544.0	520.0	124.0	117.0			6.4
04–19–95	11:00A–11:00A	290.0	480.0	26.0	33.0	31.0	33.0	6.7
04–24–95	11:00A–04:00A	98.0	180.0	66.0	58.0	42.0	49.0	
04–26–95	11:00A–02:00A	216.0	490.0	102.0		121.0	92.0	
05–03–95	12:00N–02:00A	182.0	360.0	119.0	119.0	77.0	86.0	
05–09–95	11:30A–02:00A	264.0	310.0	40.0	46.0	45.0	46.0	
AVERAGE		265.7	390.0	79.5	74.6	63.2	61.2	
BIO–AUGMENTATION								
05–17–95	11:30A–02:00A	198.0	270.0	40.0	42.0	44.0	43.0	
05–24–95	12:00N–02:00A	118.0	240.0	33.0	49.0			
05–31–95	11:30A–02:00A	292.0	560.0					
06–08–95	11:30A–02:00A	340.0	350.0	23.0	31.0	50.0		
06–14–95	11:30A–02:00A	885.0	1020.0	151.0	99.0			
06–28–95	02:00P–06:00A	365.0	410.0					
07–05–95	11:30A–02:00A	465.0	480.0	152.0	136.0	154.0		
07–26–95	11:30A–02:00A	786.0	850.0	49.0	37.0	42.0	47.0	6.1
08–16–95	11:00A–02:00A	556.0	410.0	67.0	66.0	59.0	61.0	
08–30–95	11:00A–02:00A	132.0	370.0	50.0	54.0	65.0	76.0	5.9
AVERAGE		413.7	496.0	70.6	64.3	69.0	56.8	

TABLE 8

BIO-AUGMENTATION STUDY

FACILITY: L

DATE	SAMPLING PERIOD	GREASE TRAP INFLUENT SS	BOD	FOG MECL2 EXTRACTION GRAV	FOG MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	GREASE TRAP EFFLUENT pH	SS	BOD	FOG MECL2 EXTRACTION GRAV	FOG MECL2 EXTRACTION FTIR	FOG HEXANE EXTRACTION GRAV	FOG HEXANE EXTRACTION FTIR	pH
BACKGROUND															
04-10-95	03:30P-12:00M	175.0	220.0					7.0	190.0	270.0	151.0	182.0	171.0		7.0
04-11-95	04:30P-12:00M	255.0	170.0	78.0	90.0	96.0	111.0	7.0	218.0	330.0	210.0	234.0	202.0	206.0	7.0
04-13-95	12:00N-05:00P	92.0	230.0	320.0	317.0	237.0	246.0	7.0	100.0	220.0	64.0	97.0	76.0	62.0	7.0
04-18-95	11:30A-06:30P	2030.0	610.0	700.0	546.0	409.0	369.0	7.0	100.0	280.0	57.0	66.0	56.0	65.0	7.0
04-19-95	12:30P-12:00M														
04-26-95	03:30-12:00M	110.0	230.0	58.0	71.0	52.0	57.0		92.0	300.0	360.0	370.0	304.0	339.0	
04-27-95	02:30P-11:30P	1084.0	1390.0	69.0	73.0	77.0	73.0			480.0	172.0		83.0	104.0	
04-30-95													67.0	71.0	7.0
05-01-95	04:00P-11:30P	66.0	170.0	50.0		45.0	59.0	7.0	124.0	330.0	90.0				
AVERAGE		544.9	431.4	212.5	219.4	153.0	152.5		137.3	315.7	160.6	169.6	137.3	145.2	
BIO-AUGMENTATION															
05-23-95	12:00N-12:00M	332.0	5700.0	194.0	187.0	176.0		7.0	172.0	890.0	115.0	123.0	75.0	71.0	7.0
05-30-95	01:30P-11:30P	146.0	280.0	95.0	105.0	64.0	62.0	7.0	144.0	250.0	89.0	79.0	44.0	37.0	7.0
06-05-93	13:30P-11:00P	218.0	640.0	40.0	49.0	156.0	166.0		122.0	400.0	56.0	64.0	66.0	69.0	
06-13-95	12:00N-11:00P	192.0	290.0	120.0	152.0	105.0	114.0		186.0	520.0	84.0	104.0	53.0	66.0	
06-22-95	11:30-12:00M			161.0	181.0	82.0	85.0				64.0	83.0	66.0		
07-06-95	11:00A-07:00P	215.0	340.0	82.0	84.0	81.0	80.0		340.0	360.0	133.0	145.0			7.4
07-20-95	03:45P-08:00P	236.0	400.0	100.0	106.0	94.0		7.3	154.0	250.0	63.0	71.0	82.0		4.5
08-03-95	01:00P-11:00P	3020.0	6710.0					6.5	172.0	380.0			77.0	82.0	7.0
08-16-95	02:00P-11:30P	160.0	350.0	315.0	189.0	606.0	513.0	7.0	174.0	410.0	105.0	137.0	104.0	115.0	6.2
08-29-95	11:30A-11:00P	158.0	320.0	121.0	127.0			6.2	112.0	310.0	69.0	71.0			6.0
09-12-95	12:00N-11:30P	80.0	220.0	69.0	85.0	81.0	88.0	6.3	140.0	290.0	82.0	97.0	82.0	93.0	
AVERAGE		476.9	1625.0	129.7	126.5	160.8	161.1	6.8	171.8	410.0	86.2	97.4	73.8	76.1	

TABLE 9

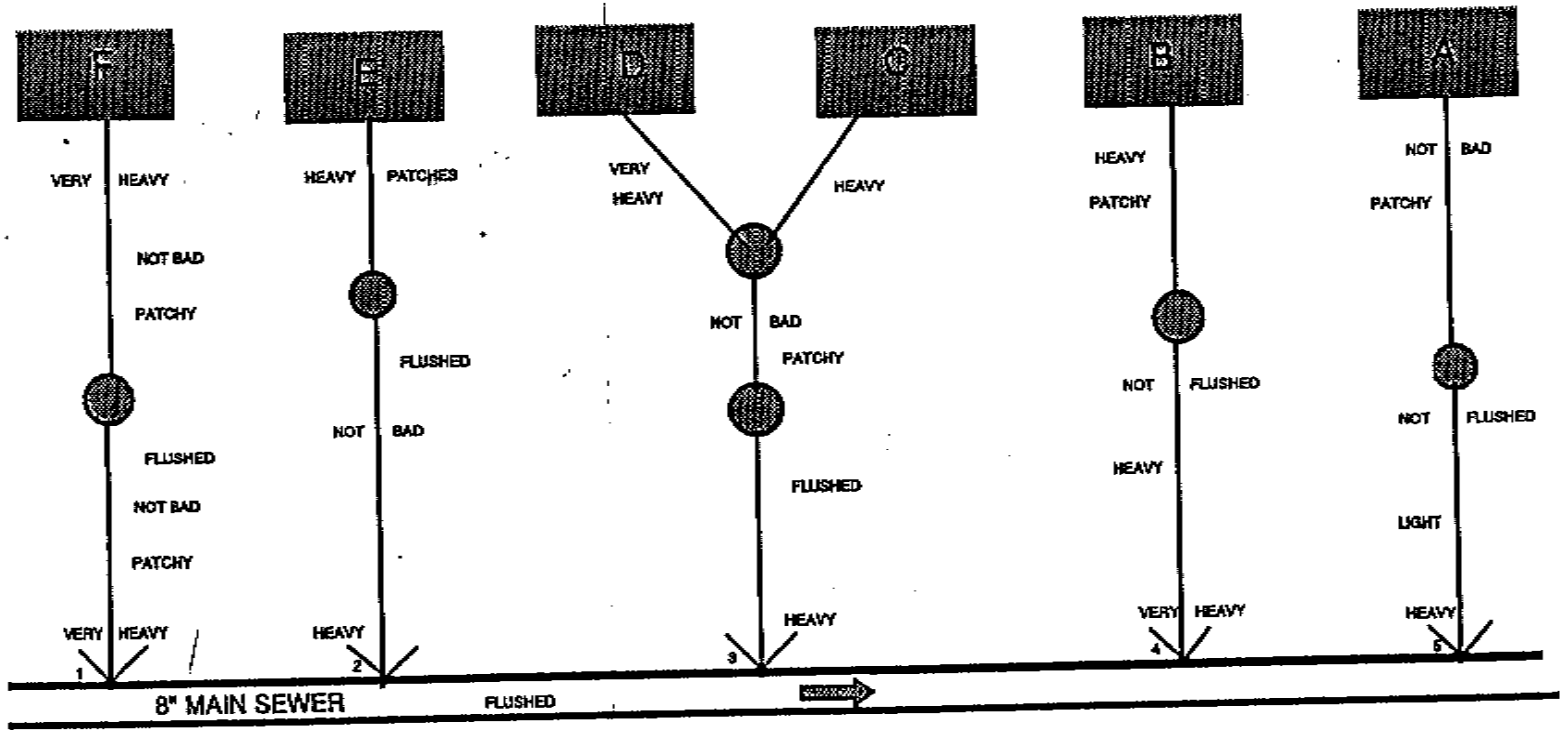
FACILITY EFFLUENT QUALITY DATA – SUMMARY

FACILITY	FACILITY EFFLUENT BACKGROUND						FACILITY EFFLUENT BIO–AUGMENTATION						%RED	% RED.	FOG REDUCTION – %			
	SS	BOD	FOG				SS	BOD	FOG									
			MECL2 EXTRACTION		HEXANE EXTRACTION				MECL2 EXTRACTION		HEXANE EXTRACTION				MECL2 EXTRACTION		HEXANE EXTRACTION	
			GRAV	FTIR	GRAV	FTIR			GRAV	FTIR	GRAV	FTIR	SS	BOD	GRAV	FTIR	GRAV	FTIR
A	360.2	436.3	43.7	46.0	46.5	42.6	292.6	713.4	80.3	70.1	79.7	72.6	18.8	-62.6	-83.8	-52.4	-71.4	-69.6
C&D	97.6	246.7	51.4	60.6	51.2	56.2	140.9	336.7	58.5	56.7	52.0	55.0	-44.1	-36.5	-13.4	6.7	-1.6	2.1
E	122.6	251.7	87.5	73.4	75.6	61.8	122.7	218.0	39.1	46.1	44.3	69.0	0.1	13.4	42.1	37.2	41.6	15.6
F	2024.8	2076.0	204.0	172.0	185.0	166.0	666.3	1038.0	120.8	125.5	142.4	190.0	67.1	50.0	36.4	27.0	23.0	-2.2
G	291.0	836.0	127.8	134.2	112.2	115.0	198.3	375.0	60.4	59.2	62.8	67.7	31.9	55.1	52.7	55.9	44.0	41.1
H	436.7	1226.7	408.7	453.2	357.5	407.2	306.9	787.0	157.8	160.7	139.1	157.0	29.3	35.8	61.4	60.1	61.1	61.4
K	265.7	390.0	79.5	74.9	63.2	61.2	413.7	496.0	70.8	64.3	69.0	66.8	-55.7	-27.2	11.2	13.8	-9.2	7.2
L	137.3	315.7	160.8	169.8	137.3	146.2	171.8	410.0	86.2	97.4	73.6	78.1	-25.1	-29.9	46.3	48.7	46.2	47.9

Negative percent reductions indicate an increase of respective parameters during bioaugmentation phase

FIGURE 1A
VISUAL OBSERVATIONS

BACKGROUND - APRIL 1995 FACILITIES A TO F



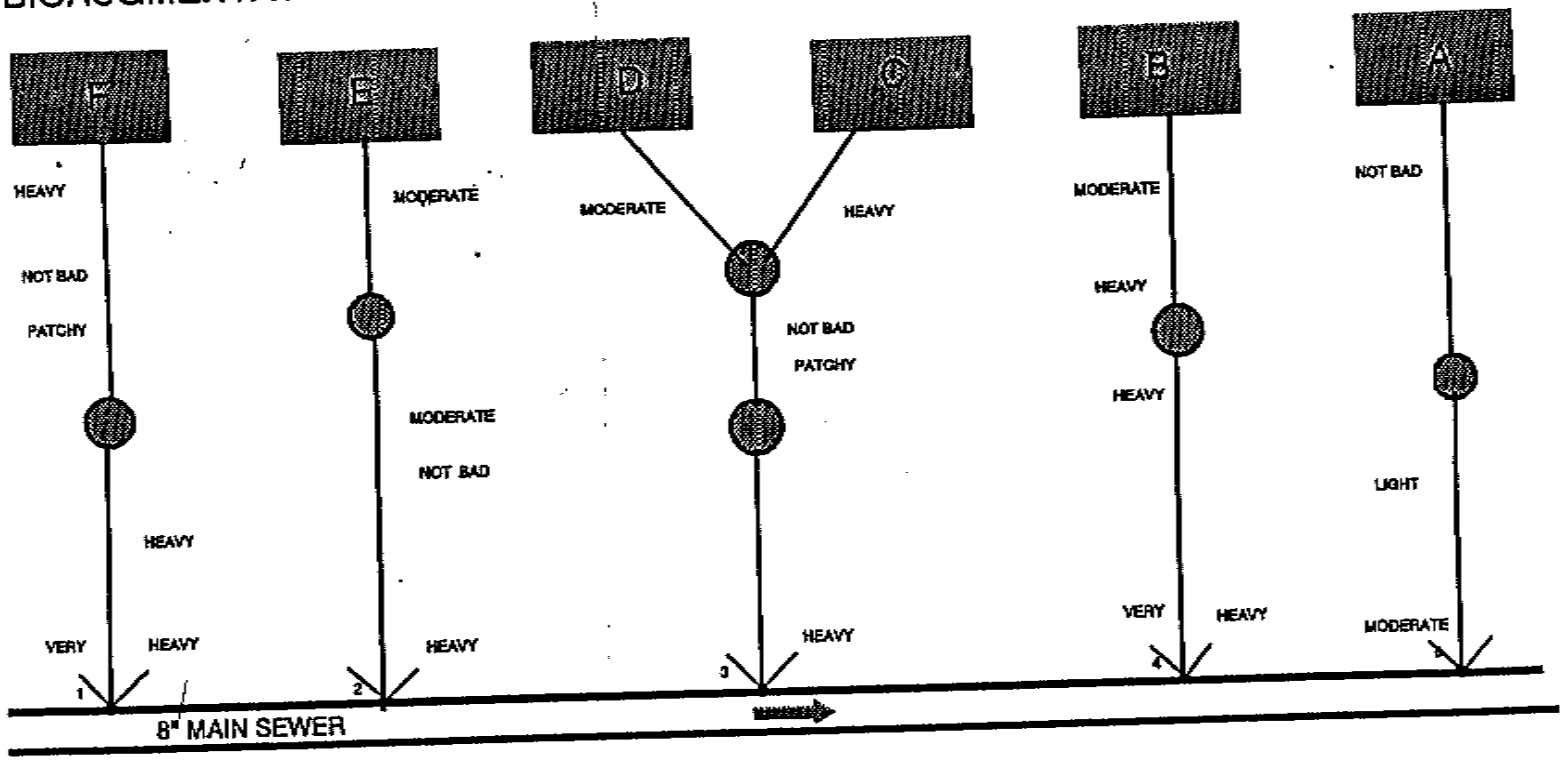
REMARKS ON FIGURE INDICATE RELATIVE LOCATION AND QUANTITY OF GREASE BUILD-UP

MAIN SEWER SECTIONS 2 - 4 SOME HEAVY PATCHES, BUT MAINLY NOT BAD

INITIAL FLUSHING WAS REQUIRED TO ALLOW CAMERA TO ADVANCE IN SEWER

FIGURE 1B
VISUAL OBSERVATIONS

BIOAUGMENTATION - SEPT. 1995 FACILITIES A TO F



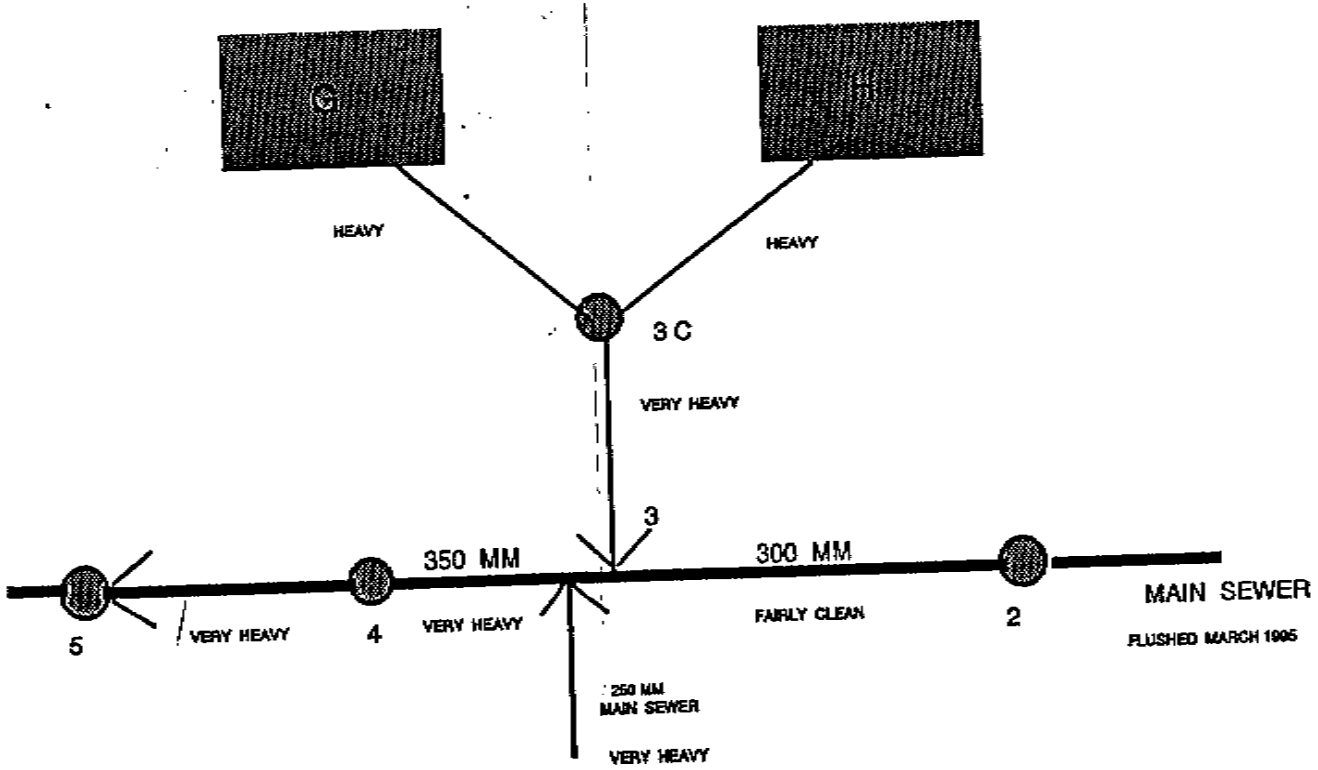
REMARKS ON FIGURE INDICATE RELATIVE LOCATION AND QUANTITY OF GREASE BUILD-UP

MAIN SEWER SECTIONS 1 TO 4 SOME PATCHY SECTIONS BUT NOT BAD, DEBRIS AND GREASE BUILD-UP BELOW WATER LEVEL,, CAMERA JAMS WITHIN SHORT DISTANCES FROM MANHOLES

VERY HEAVY GREASE BUILD-UP BEYOND 4, ALL AROUND PIPE, THIS SECTION NOT FLUSHED AT START OF STUDY

FIGURE 2A
VISUAL OBSERVATIONS

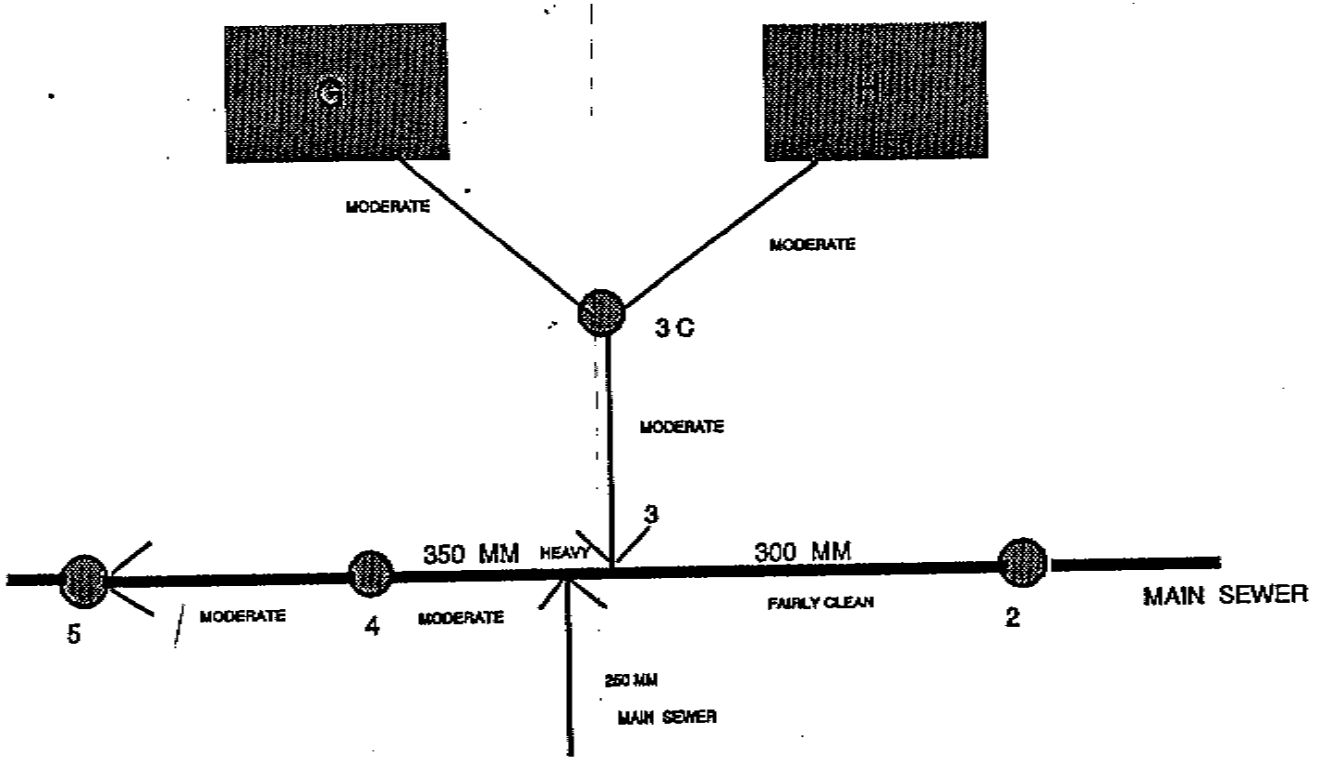
BACKGROUND - MAY 1995 FACILITIES G AND H



REMARKS ON FIGURE INDICATE RELATIVE LOCATION AND QUANTITY OF GREASE BUILD-UP

FIGURE 2B
VISUAL OBSERVATIONS

BIOAUGMENTATION - SEPT. 1995 FACILITIES G AND H



REMARKS ON FIGURE INDICATE RELATIVE LOCATION AND QUANTITY OF GREASE BUILD-UP

FIGURE 3A

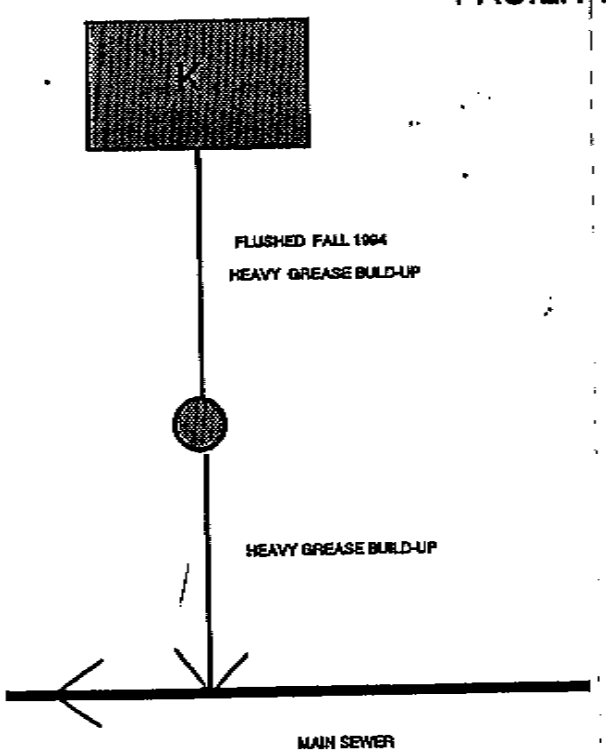
FIGURE 3B

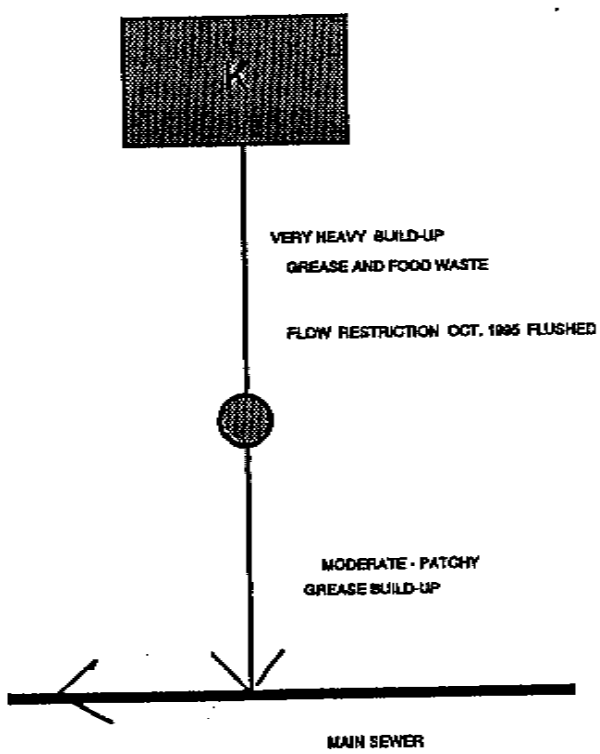
VISUAL OBSERVATIONS

BACKGROUND APRIL 1995

BIOAUGMENTATION SEPT. 1995

FACILITY K

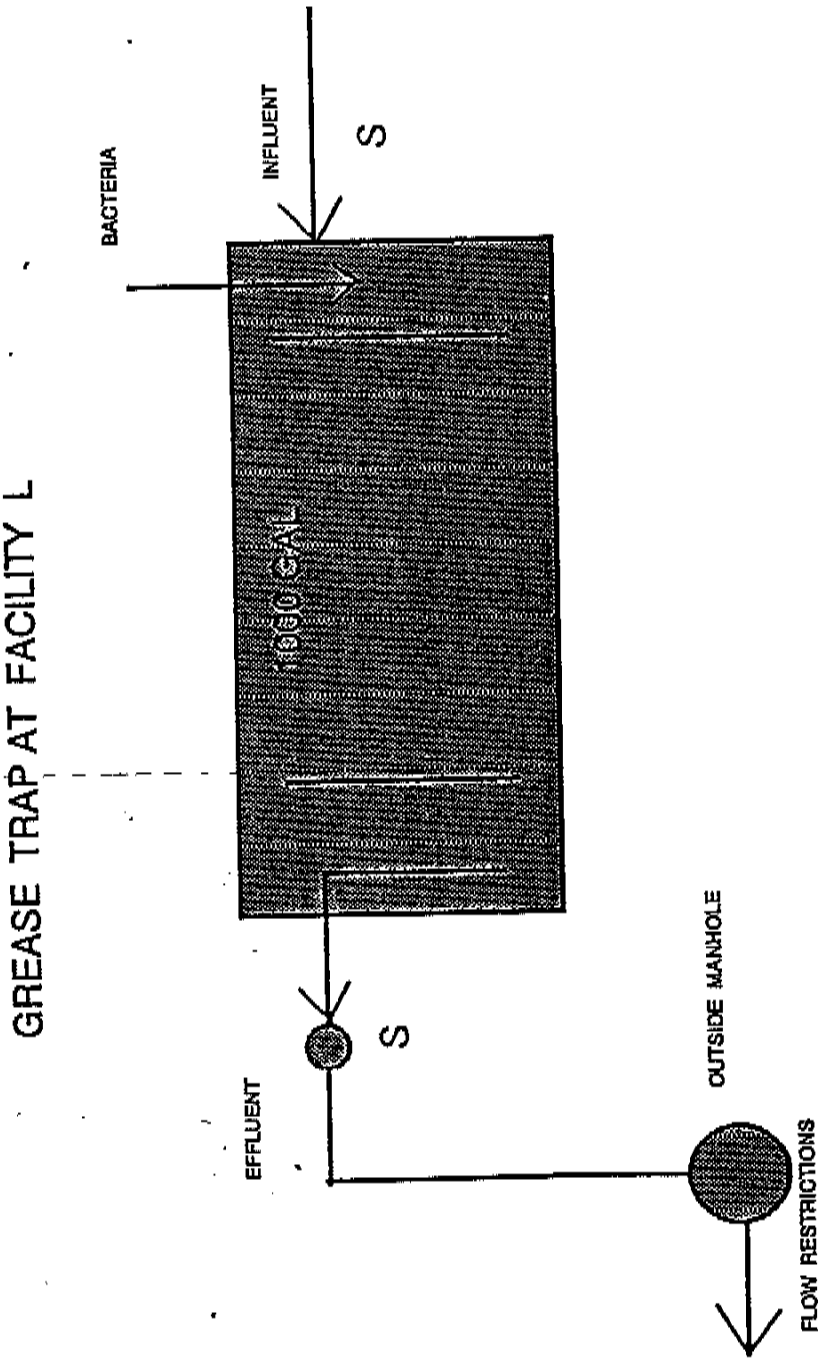




REMARKS ON FIGURE INDICATE RELATIVE LOCATION AND QUANTITY OF GREASE BUILD-UP

FIGURE 4

GREASE TRAP AT FACILITY L



Appendix A

Facility Description (Facility Background Information)

Information and study results on participating facilities are confidential. For reporting purposes of study results participating facilities are identified by letters, A to L.

Facility A: Fast food outlet including take-out and table service. Operating from 6:30am to 11:00pm. Facility has a 20 gal grease trap located under multi compartment sink. Facility uses disposable plates and cutlery, and has no dishwasher. Spent deep fryer oil is collected separately for pick-up by a rendering company. Grease trap is cleaned weekly by facility staff. Facility discharge was monitored from a manhole located at the facility -municipal property line. Facility staff was not aware of any grease trap or sewer back-up problems. No routine sewer cleaning is in place. Facility is owner operated.

For the study period the bacteria supplier suggested a reduced frequency for grease trap clean-out. Eventual clean-out frequency to be established on basis of visual observations.

Facility B: This facility represents a combination of bakery, deli including table service. Facility operates from 8:00 am to 11:00pm. A 20 gal. grease trap is in the deli area floor, below a sink. Input to the grease trap is from a sink and a dishwasher. Trap is cleaned on demand by facility staff, usually three times per year, or whenever an odour problem develops. Facility has 30 employees and a seating capacity for 60. Facility staff were not aware of any known grease trap or sewer back-up problems. No routine sewer cleaning is in place.

Facility did not want to make any changes to the prevailing grease trap servicing procedures. Due to potential odour problems grease trap could not be inspected during business hours. No samples were taken from this facility but lateral sewer was monitored by video.

Facility C: Fast food outlet including both take-out and table service. Operating hours are 10:00am to 11:00pm. Facility has a 20 gal. grease trap located in floor under multi compartment sink. Two sinks discharge

to grease trap. Grease trap is pumped out every two months by a licensed waste hauler. This pump-out frequency was maintained for the study period. Spent deep fryer oil is collected for rendering. Facility has 35 employees and a seating capacity of 46. Facility uses disposable plates and cutlery and has no dishwasher. Monitoring of facility discharge was from an outside manhole. Facility staff were not aware of any known grease trap or sewer back-up problems. No routine sewer cleaning is in place.

Facility D: Fast food service including both take-out and table service. Operating hours are from 11:30am to 1:30am. Facility has a 25 gal. grease trap located in floor under kitchen sink. Grease trap is cleaned monthly by a licensed waste hauler. More frequently if odour problems develop. No changes were made to the pump-out schedule. Only kitchen sinks discharge to grease traps. Facility has no dishwasher. Spent deep fryer oil is collected for pick-up by a rendering company. Facility discharge was monitored from an outside manhole. Facility staff were not aware of any grease trap or sewer back-up problems. No routine sewer cleaning is in place. Due to the local sewer layout this facility discharge was sampled jointly, as one combined sample, with facility C.

Facility E: This is a full service facility. Operating hours are 11:30am to 10:00pm. Facility has a 25 gal grease trap in kitchen floor. Two multi compartment sinks and a dishwasher discharge to the grease trap. Grease trap is pumped out every three weeks by a licensed waste hauler. Spent deep fryer oil is collected for pick-up by a rendering company. Facility discharge was monitored from an outside manhole. Facility staff were aware of the occasional sewer back-up to the kitchen floor, and odour problems, from the grease trap. Facility lateral sewer is cleaned once per year, or as needed.

Facility F: This is a fast food outlet providing take-out service only. Operating hours are 11:00am to midnight. Facility has a 100 gal. grease trap in basement, above floor level. Trap is pumped out every three weeks by a licensed waste hauler. Spent deep fryer oil is collected for pick-up by a rendering company. Facility discharge was monitored from an outside manhole. Lateral facility sewer had not been cleaned for the past three years. Facility staff was not aware of any problems from sewer or

grease trap. Facility has an odour problem.

Facility G: Fast food outlet providing both take-out and table service. Operating hours are 6:30am to midnight. Facility has a 25 gal. grease trap located above floor, under a multi-compartment sink. This is the only fixture connected to the grease trap. The grease trap is cleaned weekly by facility staff. Spent deep fryer oil is collected by a rendering company. The facility has 75 employees and a seating capacity of 120. Facility discharge monitoring was done from an external manhole. Facility is owner operated. Facility staff are not aware of any problems relating to grease trap operation or sewer back-ups.

Facility H: This is a full service facility. Operating hours are 11:00 am to 2:00am. Facility has a 50 gal. grease trap located under the floor of a storage area. A number of sinks are connected to the grease trap. Pump-out is done monthly by a licensed waste hauler. Spent deep fryer oil is collected for pick-up by a rendering company. The lateral facility sewer is flushed annually. Dishwasher discharge by-passes the grease trap. Facility discharge was monitored from an external manhole.

Facility K: This is a fast food outlet providing both take-out and table service. Operating hours are 11:00am to 10:30pm. Facility has three grease traps. A 100 gal. trap serves the potato preparation and deep fryer area, a 25 gal. trap serves the dishwasher, and a 50 gal. trap serves the exhaust duct filter wash system for the barbecue ovens. The 100 and 25 gal. traps are pumped out every three weeks, and the 50 gal. trap about two or three times per year. Pump-outs are done by a licensed waste hauler. Spent deep fryer oil is collected for pick-up by a rendering company. The lateral facility sewer is power flushed every six months. Facility is not aware of any problems relating to grease trap or sewer operation provided the preventative maintenance activities are performed. Facility discharge monitoring was done from an external manhole.

Facility L: Two full service facilities, with historical sewer blockage problems, discharge their wastewaters to a common grease trap. The grease trap has a 1000 gal. capacity. grease storage is designed for a one foot depth, or about 400 gal. Pump-out by a licensed waste hauler has been every four months, but has

recently (following this study) been reduced to every two months. Spent deep fryer oil is collected separately by a rendering company. The lateral facility sewer is power flushed as needed, whenever a problem occurs. Sampling at this facility was done from the influent and effluent pipes of the grease trap.

Apendix B

General Comments on Grease Traps

Prevailing grease trap sizes in Ontario restaurants are in the 25 to 50 gallon range. Within this size range grease traps are not efficient for effective fat, oil and grease separation with or without bio-augmentation. Typically, these small traps provide insufficient retention or cooling time for fat, oil and grease separation from the bulk of the waste water. Depending on the type of fat, oil or grease and prevailing temperature, separation normally results in the formation of solid grease or liquid oil layers, or both. Observations during this study indicate that in most cases where separation occurs, a layer of semi-solid (soft grease) is formed at the surface of the trap content and a liquid oil layer directly below the solid layer. Additionally, more or less food waste, depending on the type of operation, will blend and remain with these layers. Solid grease layers were found, depending on grease trap size, type of facility, and frequency of pump-out, in the range of one to six inches. Typically, this layer would build-up with time between pump-outs. Liquid oil was normally present below the solid phase.

Solid food wastes also tend to seperate from the waste water by settling to the bottom of the trap. With time, somtimes within a few days or weeks, a trap can reach a condition when it becomes less and less effective to seperate both grease and solids from the waste water. Eventually, when no further seperation takes place, and both grease or oil and solids pass directly through the trap, a trap pump-out is indicated. Preferably, a trap pump-out should be done prior to pass-through conditions.

Other observations indicated that in the absence of adequate baffling or flow restrictions, particularly within small traps, can lead to trap flush-outs whenever a sink, full of water, is dumped. This condition will flush previously separated material to sewer. It was also noted that facilities operating under these conditions rarely have to pump-out their grease trap.

Bio-augmentation study results indicated some FOG reductions in grease trap discharges, and reduced levels of grease accumulation within grease traps. The full potential of bio-augmentation, however, and as indicated by suppliers of biochemicals, is not realized with these small traps.

Site inspections also indicated that visual observations or sampling of grease trap discharge are not always a good indicator of FOG or solids discharges to sewers. Direct sewer inspection by remote camera may, in some cases, produce more meaningful information on grease trap efficiency for the seperation of FOG.

Effective bio-augmentation within grease traps has been demonstrated in U.S. facilities where grease traps in the order of 1000 gallons are often required.

BIOAUG2.RES