An Assessment of Waste Vegetable Oil Supply in Brooklyn, NY and its Potential as a Biodiesel Feedstock

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Executive summary

Biodiesel (BD) refers to vegetable oil- or animal fat-derived fuels that can replace or blend with conventional diesel fuel and heating oil. BD burns cleaner than pure diesel with lower particulate and CO2 emissions and comes from natural, renewable sources that are domestically produced. Major questions facing the BD industry are associated with the source and availability of BD feedstock and the policies that can spur supply and demand. This study aims to assess the availability of one of the potential BD feedstocks, waste vegetable oil (WVO), in Brooklyn, NY. This effort is a first step in market research being conducted by Cornell University Cooperative Extension (CUCE) to assess the potential for BD production in New York City (NYC).

Primary data was collected from surveys of restaurants, food processing companies, and rendering companies. Questionnaires were implemented by phone and conducted by CUCE research assistants. Questions explored in this study include: Is WVO a viable feedstock for BD? How have policies influences BD production and industrial development? What are ideal economies of scale for BD production? Feedstock related data needs included: (a) how much oil is not being collected by the rendering industry, and (b) can the rendering industry be considered a supply source for an independent BD industry.

The survey covered 710 restaurants, 72 food-processing companies and six rendering companies. The restaurant survey produced useful results for about 116 restaurants that differed by type of cuisine, type of service, and seating capacity. These restaurants were located in all of the major zip codes of Brooklyn. The food processing company survey was unsuccessful in that only 19 useful responses were received and among these only 3 reported WVO availability. The rendering company survey provided a perspective on the competitiveness in the industry but no relevant quantitative data was obtained.

Results from the restaurant survey indicated that types of restaurant groups (such as *Chinese*) have significantly different levels of WVO. The largest restaurant group users and disposers of WVO were *Chinese, Chicken (fast food),* and *Asian (non-Chinese)* with 81, 77, and 71 gallons per month per restaurant, respectively. The average of all restaurants was about 48 gallons per month. Restaurants, further defined by seating capacity and level of service (as in, *Full*, *Limited*, or *Carry-out*), have different levels of WVO. Carry out restaurants and restaurants with seating capacity of over 100 people registered the highest WVO disposal in each category but these averages could be inaccurate because of small sample sizes. Ten restaurants, or 10% of the sample of responses, were not disposing waste with rendering companies. These restaurants averaged about 19 gallons of WVO per month. Three of these restaurants (averaging about 9 gallons/ month) said that a renderer used to collect the WVO but stopped because it was too expensive.

Borough estimates of WVO disposal volumes can be estimated using several approaches. A basic analysis, which uses average WVO over all restaurants, suggests that 1.65 million gallons of oil are disposed of each year. Another approach applies restaurant group WVO averages across the relevant groups in Brooklyn to arrive at 1.82 million gallons of WVO per year. These estimates are considerably lower than estimates derived from previous studies. These volumes are larger than a more conservative estimate that uses a smaller number of restaurants in Brooklyn. On the other hand, figuring that 10% of restaurants do not use renderers, 65,000 gallons of WVO would actually go to waste, potentially because it is too expensive to collect.

This study did not directly assess the economics of BD production. However, using data from other studies, it appears that there is not sufficient supply of WVO in Brooklyn to support a competitive commercial BD business, relying on Brooklyn WVO as an exclusive feedstock source. However, a plant located in Brooklyn, which drew feedstock supply from elsewhere in NYC metropolitan area or even as far as PA, would have sufficient supply to attain significant economies of scale, such as 10 million gallons / yr. Research that explores the optimal plant size and location in the NYC metro area could provide an important input to industrial development in this sector.

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1. Introduction

Biodiesel (BD) refers to vegetable oil- or animal fat-derived fuels that can replace or blend with conventional diesel fuel and heating oil. The original diesel engine, invented by Rudolf Diesel in the late 1800s, was actually designed to run exclusively on plant-based oils. While today's engines are designed to run on petroleum-based feedstocks, BD can be used directly in many cases without major hardware modifications. Due, however, to storage properties, long-term performance, and high cost, BD is more likely to enter the market as a fuel additive, or as a BD-diesel blend, than as a stand alone fuel.

Use of BD offers significant benefits. BD burns cleaner than diesel with lower particulate and CO2 emissions. It also has the benefit of coming from natural, renewable sources that are domestically produced, such as new and used vegetable oils and animal fats (EERE, 2005). Compared to conventional diesel, BD is safer to handle and store, and though it increases NOx emissions, it reduces overall greenhouse gas emissions. (ISU, 2005) BD has good lubricating properties even when only included as 1-2% of a diesel blend. Also, where waste oil is converted into BD, a new market for a waste product is created and less waste is sent to landfills or sewers. Growth in the BD industry would also create high- and low-skill jobs in urban and rural areas.

Major questions facing the BD industry are associated with the source and availability of BD feedstock and the policies that can spur supply and demand. Nationally, BD feedstocks across the US are derived primarily from soybeans and other oil crops. Interest has also focused on the conversion of urban sources of waste vegetable oil (WVO) into BD. Most BD feedstocks have alternative uses, thus the production of BD must be price competitive.

The purpose of this study is to better understand the WVO feedstock supply in Brooklyn, NY. This effort is the first step in a market research study undertanken by Cornell University Cooperative Extension (CUCE) to assess BD production and supporting BD industry infrastructure in New York City (NYC). Brooklyn was selected as a case study because it is home to a large number of restaurants and food processing plants that may produce WVO. In addition, Brooklyn appears to offer other locational advantages for small- to medium-scale businesses such as a large waterfront for transport, and policies that could support industrial development.

The study initially aimed to: (a) create a detailed understanding of the types, quantities, and qualities of waste oil that could be converted into BD; (b) identify neighborhood concentrations and stand-alone business sources of waste oil; (c) quantify potential changes in the supply of waste oil on either a seasonal or annual basis; and (d) identify whether supplies are projected to increase or decrease in the coming years.

These goals were modified and expanded as information was gained during the project. Primary data was collected from surveys conducted for restaurants, food processing companies, and rendering companies. This information was supplemented with reports on the BD industry. In particular, questions explored in this study include: Is WVO a viable feedstock for BD? How have policies influences BD production and industrial development? What are ideal economies of scale for BD production? Feedstock related issues included: (a) estimating how much oil that is currently not being collected by the rendering industry is potentially available as an undocumented BD source, and (b) assessing if the rendering industry could be a source of supply for an independent BD industry.

This report begins with an overview of the status, progress and growth potential of the BD industry. The next section discusses the data collection efforts, beginning with a description of the sampling and surveying methods; questionnaires are referenced and attached in the annex. An analysis of survey results follows with estimates of WVO among responses and scaled-up estimates of WVO in Brooklyn. The report concludes with a discussion of findings and implications for the supporting the BD in the NYC area.

2. Biodiesel overview

2.1. What is Biodiesel?

Biodiesel consists of mono-alkyl esters of fatty acids that are derived from the triglyceride molecules of vegetable oils or animal fats. In more simple terms, BD is produced from a chemical reaction between a vegetable oil or animal fat and an alcohol (in the presence of a catalyst). This process, called transesterification, also produces glycerol as a byproduct. BD can be produced from any fat or oil and the final quantity of BD essentially equals the amount of oil or fat used in the process. Vegetable oil, a BD feedstock, comes directly from oilseed crops, or indirectly as yellow grease, which is a rendered WVO. Animal fats, including tallow are also rendered before being directly useful as a BD feedstock.

The properties of BD are determined mostly by the amounts of each fatty acid that are present in the triglyceride molecules, especially related to the total number of carbon atoms in the fatty acid and the number of double bonds. (ISU, 2005) Fatty acid composition has implications on fuel properties such as freezing point, oxidative stability, cetane number, and NOx emissions. Monounsaturated fatty acids (containing one double carbon bond) produce BD with good performance properties. On average, yellow grease contains 50% monounsaturated Oleic acid by weight. In many cases, feedstocks require additional processing or additives to derive the right properties for BD (especially in meeting the industry ASTM quality standard).

Environmental and performance tradeoffs are apparent in feedstocks with different levels of saturation. Feedstocks with high levels of saturated fatty acids (more than one double carbon bond), such as tallow, lard, and some yellow grease, produce BD with a high risk of freezing in tanks and forming crystals that plug fuel filters. Unsaturated feedstocks reduce these effects but can generate high NOx levels compared to saturated feedstocks.

2.2. Biodiesel Products and Market

Currently, BD is typically found in the market as a blend. Products with BD blends are commonly referenced by the percent of BD in the fuel by volume; B20, for example consists of 20% BD. In this context, BD should be properly understood to be pure BD, or “B100”. B100 can be used in unmodified diesel engines and heating oil systems but not without significant technical and economic implications. Problems with B100 include material compatibility with seals, gaskets, and other fuel system components, cold weather freezing, storage stability, and NOx emissions exceeding CI engine certification levels (Tyson et al., 2004)[1]. B100’s technical problems (other than NOx emissions) can be minimized by retrofitting fuel system components (EERE, 2005).

[1] Tyson, et al (2004) is a comprehensive and independent study of the BD industry and has been extensively referenced in this paper.

BD-diesel blends up to 20% can be used in nearly all diesel equipment without modification, generate reasonable performance, and are compatible with most storage and distribution equipment. (ISU, 2005) For example, B20 reduces (but does not eliminate) problems associated with cold weather, stability, material compatibility, NOx increases, storage tank cleanliness, and costs. (Tyson et al., 2004) In addition, with respect to BD properties, B20 blends using saturated B100 can reduce NOx emissions, whereas unsaturated B100 gives B20 better flow properties. Accordingly, since many consumers would prefer unsaturated B100 blends, BD producers would need to find a market for saturated esters, or pay disposal costs. These technical issues could result in limiting the BD industry to vegetable oils and greases with low saturation levels even though saturated oils have better environmental properties (Tyson et al., 2004).

B20 market penetration will need to overcome several constraints. For example, B20 costs about $0.20/gal more than diesel fuel and this does not include fixed costs for reducing potential cold flow problems. B20 may also face marketing challenges. Currently, B20 is considered a better environmental choice. However, with the development of cleaner-burning engines that run on normal diesel, environmental advantages of BD are reduced (Tyson et al., 2004).

Low BD blend formulations, such as B2 and B5, are currently being sold commercially as a premium diesel fuel. These fuels meet standards set by the National Council of Weights and Measures, the ASTM standard for diesel fuel and satisfy all manufacturer warrantees (Tyson et al., 2004). B2 is considered a premium fuel because it serves as a lubricant, particularly for ultra low-sulfur diesel (ULSD), which has limited natural lubricity.

While B2 may seem to offer limited market penetration because of its low percentage, in aggregate, it holds promise for being integrated into all diesel fuels used today. ULSD will be available nationwide by 2006 and petroleum companies are developing low-sulfur blends for fuels other than diesel. A key advantage of B2 is that all feedstocks could be combined without regard to mixing fuels with different properties. The cold flow concerns (associated with varying types of feedstocks) are also reduced with B2. A national B2 strategy would create a market for up to 1 B gallons of B100 by 2015 (Tyson et al., 2004).

2.3. Feedstock Sources

The US produced 43.8 billion pounds of biomass oils in 2001 (Table 1). Total US biomass oil feedstock production is equivalent to 15.5 million gallons per day, or about 17% of the highway consumption of diesel fuel (Tyson et al., 2004). These feedstocks however have other uses than for BD and the potential available supply is much less. Tyson et al. (2004) assumed that feedstocks are first drawn from exports and potentially, inventories. If a product is not exported, a proxy is calculated as the difference between production and consumption. The rationale for this approach is that these supplies would be the first to be tapped if the domestic energy markets for biomass oils grows.

Table 1: Annual U.S. and NY State production of Oils / Fats and Availability for BD[1]

Oil and Fats	US Production Million lbs	US Availability Million lbs	US B100 Million gal.[3]	NY Production[4] Million lbs	NY B100 Million gal.
Soy	18,898	2,250	304	48	7
Corn	2,459	1,130	153		
Cotton	870	140	19		
Canola[2]	713	0	0	x[5]	x
Sunflower	713	465	63	x	x
Peanut	230	18	2		
Safflower	76	37	5		
Linseed	195	135	18		
Other oils	1,428				
Total Vegetable Oil	25,582	4,316	564	48	7
Edible Tallow	1,920	465	63		
Lard	1,080	85	11		
Inedible Tallow and greases	5,899	1,348	383		
Other fats and oils	399	399	54		
Poultry fat	2,215	222	30		
Fish Oils	279	28	4		
Yellow grease	2,633	406	55	180	24
Trap grease	3,808	3,808	514	20	3
Total Animal Fats and Oils	18,231	6,760	1,114	200	27
Total oil and fat	43,813	10,935	1,678	248	33

Notes

[1] Tyson et al., 2004; [2] In the case of Canola, since imports exceed production, no Canola would be available for biodiesel. [3] Approximately 7.7 lbs of biomass generates 1 gallon of BD. [4] LECG, 2004. [5] Acreage for sunflower and canola would initially compete with soybeans for acreage, thus, growth in these crops would reduce soybean production.

Table 1 indicates that the U.S. has an available potential to produce almost 1.7 billion gallons of BD representing 5.5% of on-highway diesel demand using low-level blends, or 1.1% of petroleum imports today. Estimates for NY State are derived from LEGC (2004), which collected information on soybean acreage and projected oils and greases from published studies. LEGC (2004) also indicates that the regional production of soybeans, yellow grease, and animal fats (including NJ and PA) would substantially increase NY levels.

Soybean oil dominates the vegetable oil market, comprising over 75% of the total vegetable oil volume, nationally. Soybean production has advantages for farmers because its nitrogen fixing qualities make it a good crop in a rotation schedule. It is also supported by government programs and can be sold in multiple end-use markets.

The rendering industry is the primary supply for yellow greases, tallows, animal fats and other oils. These products together comprise a little more than half of the US vegetable oil production. These products are used as inputs in a number of industries though their principle use is as a livestock feed additive. The rendering industry is highly competitive; the most competitive facet of the business involves the means of actually obtaining the product. (Peterson; Caparella, 2005). Renderers collect WVO and animal fats from restaurants, butcheries, meatpacking and food processing companies; individual relationships with such companies are considered proprietary to renderers.

Trap greases for BD may add to available feedstock supplies. What makes them particularly attractive is that they are virtually “free” and have no competing market (Wiltsee, 1998). Utilization of trap greases, however, needs further development (Peterson) because of the potential for contamination with chemicals, pesticides, sewage components, water and their high free fatty acid content. They are listed in Table 1 as potentially available.

Comparatively less is known about WVO and animal fat supplies. Wiltsee (1998) conducted a widely cited study to assess the urban supply of WVO. In 30 US cities, he examined the amount of yellow grease feedstock gathered by rendering companies from restaurants, and the amount of grease trap waste recovered or entering sewage treatment plants. On average, yellow grease amounted to about 9 pounds/year/person and trap grease was 16 pounds/year/person. The number of restaurants in metropolitan areas was around 1.4 restaurants per 1,000 people. Although differences in average WVO production exist within some cities due to cultural and dietary preferences, the variation across all metropolitan areas was not large on a per capita (and per restaurant) basis.

Wiltsee (1998) results along with others are shown in Table 2. The estimates of yellow grease production vary widely, ranging from a low of 5.78 pounds per person to a high of 11.3 pounds per person. Applying these statistics over the populations in several geographic areas around NYC (and then converting to gallons) suggests that 25 M gallons are produced in the tri-state metropolitan area and 2-4 M gallons of that would come from Brooklyn restaurants. The estimated yellow grease per restaurant generates similar numbers for NYC to Wiltsee (1998) but since Brooklyn has fewer restaurants per capita than Wiltsee estimated nationwide, the estimated yellow grease production based on the number of restaurants is less than that based on population. These figures are useful for comparing the results generated in this study.

Table 2: Estimated Potential of BD Production from Yellow Grease (Millions of Gallons) [1]

Sources	Estimated Yellow Grease lbs/Person	NYC Metro[3]	NYC[4]	Brooklyn[5]
Applewhite (1993)[2]	5.78	15.9	6.1	1.9
Render Magazine (April 2002)[2]	11.32	31.2	11.9	3.7
USDA avg production (1995-2000)[2]	9.4	25.9	9.9	3.1
Wiltsee (1998)	8.74	24.1	9.2	2.8
Wiltsee (1998) - weighted avg.	8.87	24.4	9.3	2.9
	Estimated Yellow Grease lbs/ Restaurant			
Wiltsee (1998)	6,256		10.1	1.6
Wiltsee (1998) - weighted avg.	6,268		10.1	1.6
	Restaurants/ Thousand Persons			
Wiltsee (1998) -weighted avg.	1.41			
US Census / County Business Patterns			1.53	0.78

Notes:
[1] 7.7 lbs of yellow grease / WVO = 1 gallon of biodiesel. [2] Sources are as quoted in LEGC (2005). [3] Population Estimates (in Millions): NYC Metro Area (including NY and nearby CT and NJ): 21.2; [4] U.S. Bureau of the Census 2004: Population (in Millions) in NYC: 8.1; County Business Patterns, 2001: Number of restaurants (Full-service, Limited-service eating places, only) in NYC: 12,414; [5] U.S. Bureau of the Census 2004: Population (in Millions) in Brooklyn: 2.5; County Business Patterns, 2001: Number of restaurants (Full-service, Limited-service eating places, only) in Brooklyn: 1,946

2.4. Production Costs and economies of scale

Feedstock availability is a critical consideration for BD production because the cost of the oil/fat is the single biggest determining factor in BD costs and this is largely determined by demand for non-BD uses (Table 3). Oil and fat variable costs are about 70% of the production cost of BD. Availability refers to the actual amount of feedstock that is available for BD production.

Prices for feedstock are better forecasted for agricultural sources than yellow grease and other rendered products. USDA collects acreage and productivity data in every state and has developed long-run price models that consider technology change and policies. For yellow grease, Radich (2005) found that historical prices of yellow grease and soybean oil move together and that yellow grease price is about 50% of the Soybean oil price. Currently, BD is around $1.40 per gallon and compares favorably to soybean oil but not to petroleum feedstock projections of around $0.80 / gallon (Tyson et al., 2004).

Table 3: Biodiesel Plant Costs

Cost Item	Percentage of total cost
Real Annual Cost of Capital	6.3%
Sales and Administration	8.8%
Annualized Cost of Working Capital	1.0%
Fat/Oil, lbs	69.9%
Alcohol, gallons	5.1%
Catalyst, pounds	1.6%
Plant Labor (incl. Benefits)	3.4%
Utilities, Maintenances, Insurance	4.0%

Source: Howell, 2005, Tyson et al., 2004

Howell (2005) discusses production economies of scale and notes that plant size and production must carefully consider BD demand. Larger plants have lower average costs but require sufficient demand to ensure a profit. Smaller plants (on the order of 3-10 M gallons per year) would be appropriate for levels of national annual demand of up to 100 M gallons. Even at this level, a 3 M gallon annual production capacity can be 60% more costly per unit than a 10 M gallon capacity. (Howell, 2005) These smaller plants could find competitive market share and minimize distribution costs if they were geographically spread throughout the US. A larger overall BD market of around one B gallons per year will favor large plants (15 to 50 M gallons per year) (Howell, 2005).

2.5. Policy Support for Biodiesel

Policy measures to promote BD industrial development have included production grants for soybean oil and yellow grease. For the past several years, the Commodity Credit Corporation (CCC) has made payments that reduced the variable cost of additional soybean oil and yellow grease BD to $1.10 and $0.53 per gallon, respectively, in the initial year of production. This level of CCC payment, however, was only valid for one year, after which production support was marginal (Howell, 2005). More recently, tax credits were enacted for BD blending. The credit equates to a one penny per percent of biodiesel in a fuel blend made from agricultural products like vegetable oils, and one-half penny per percent for recycled oils. This incentive is taken by petroleum distributors and passed on to consumers (EERE, 2005). These incentives make vegetable oil feedstocks more competitive with yellow grease.

The government has also shown leadership as part of the Energy Conservation Reauthorization Act of 1998 (an amendment to the Energy Policy Act) in which federal, state, and public utility fleets could meet fuel use requirements with BD. Now, U.S. Postal Service and the U.S. Departments of Defense, Energy, and Agriculture, as well as many school districts, transit authorities, national parks, public utility companies, and garbage and recycling companies use BD. (EERE, 2005)

Further efforts have sought to alleviate market concerns with BD. BD has been registered by the EPA as a legal fuel and ASTM standards have been approved to aid in regulating fuel quality (ASTM D 6751-02). In addition, a National Biodiesel Accreditation Commission (NBAC) has been established by biodiesel producers and marketers to help assure that BD meets the ASTM standard throughout production, distribution and marketing functions. (Pearl, 2002)

3. Methodology

Phone interviews were conducted from CUCE offices.[2] Two research assistants were employed by CUCE for the project. These researchers spent several weeks calling restaurants and food-processing plants, many times repeating calls to the same restaurant to locate a manager and obtain usable responses. Additional contacts were made with the Industrial & Technology Assistance Corporation/NY Waste Match, NYC Department of Environmental Protection, and NYC Sanitation to better understand issues associated with disposal and recycling of waste vegetable oil.

3.1. Data sources and Random Sampling

3.1.1 Restaurant Survey

Restaurants in Brooklyn number well over 2,000 and vary by type of service and size (see Table 4).[3] Within these categories, restaurants vary widely by type of cuisine. Anticipating that WVO production would vary with the type of restaurant a stratified random sample was developed. Population (of restaurants) stratification enabled greater control over selection of restaurants within smaller sets of restaurant types. It would also offer different approaches to scaling-up results.

Table 4: Total Number and Percentage of Restaurants in Brooklyn and NYC

NAICS Code	Type of Establishment	NYC (Total #)	Brooklyn (Total #)	Brooklyn (% of NYC)
722	**Total Food services & drinking places**	**14,738**	**2,303**	**15.6%**
7221	Full-service restaurants	6,100	830	13.6%
7222	Limited-service eating places	6,314	1,116	17.7%
7223	Special food services	938	135	14.4%
7224	Drinking places (alcoholic beverages)	1,386	222	16.0%

Source: U.S. Bureau of the Census, County Business Patterns, 2001.

A list of all Brooklyn restaurants was prepared from records contained in commercial directories. The number of restaurants on this list was over 2,800, much greater than that reported by the US Bureau of Census (Table 4). A cursory assessment of the accuracy of this list was conducted by a field visits that examined N-S and E-W transects along 2 major Avenues in Brooklyn. This process revealed that 13-18% of the listed restaurants had closed but that another 38-50% of new restaurants had opened (and were not on the initial commercial list). No effort was made to modify the commercial restaurant list because it was already much larger than the US Census Bureau (2001) data, even after factoring in an increase due to population growth. However, final results will be reconsidered if better data are made available by the NYC Health Department, which manages restaurant licenses.

[2] Initially, the project intended to collect data through in–person surveys of restaurants and food processing plants located in several representative neighborhoods in Brooklyn. This strategy was rejected after an exploratory field visit indicated that difficulties in finding managers at the time of a visit and long distances between neighborhoods would hinder data collection. In addition, neighborhood-based sampling would complicate process of scaling-up results to the borough.

[3] Table 4 was supplied by ROC-NY. Restaurant Opportunities Center of New York (ROC-NY) is dedicated to winning improved conditions for restaurant workers and raising public recognition of restaurant workers' contributions to the city.

The commercial list has built-in biases because restaurants are sometimes charged a fee to be listed and the records are not necessarily updated. The impact of these biases on the number of restaurants is unknown. The commercial directories proved useful in categorizing restaurants into over 30 groups by type of cuisine or service but in some cases, groups lacked specificity, consistency and included duplicate records and non-restaurant businesses. These records required substantial cleaning before they could be used.

Other modifications to the restaurant list involved combining and sorting out pre-defined restaurant categories. For example, categories such as Diners, Steakhouses, Grilles, and many country-specific cuisines from non-Asian countries, were merged into a group called America/European/International. In other cases, overlapping restaurant codes (such as Chicken and Fast Food) were grouped into a category that better described the type of cuisine. In this case, a restaurant cross-listed as Chicken and Fast Food would be coded as Chicken and was predominantly composed of fast food restaurants serving chicken. The final list of restaurant groups is shown in Table 5.

A more difficult problem involved assessing restaurants pre-defined as Family because they consisted of more than half of all records. These restaurants included many that could be listed in more descriptive ways as in the groups listed in Table 5. For sampling purposes, this classification was left as it was. However, an alternative classification of Family restaurants was created using the restaurant's name. This classification was used in the assessment of Brooklyn-wide statistics after data was collected.

Table 5: Total and Sampled Number of Restaurants by Sampling Category

Restaurant Groups	Total Number of Restaurants	Initial Number of Selected Restaurants	Final Number of Selected Restaurants
Asian (non-Chinese)	97	10	67
Chinese	375	38	144
American/European/Int'l	239	24	103
Latin American/Caribbean	109	12	44
Fast Food (non-chicken)	164	16	18
Chicken (Fast Food, primarily)	152	15	75
Seafood	62	7	2
Sandwich	50	7	
Family (Uncategorized)	1606	321	257
Total Restaurants	**2854**	**450**	**710**

A stratified random sample of restaurants was developed based on the above restaurant groups. In all groups except Family, about 10% of restaurants were randomly selected from the records. Since Family restaurants actually included many types, 20% of these were randomly selected. It was hoped that by increasing samples in the Family group, a better idea of the types of restaurants (by group) and volumes of WVO would be obtained. In total, 450 restaurants were originally selected and distributed among restaurants groups as shown in Table 5.

The total number of phone calls made by CUCE was 710 and the distribution of selected restaurants differed from the initial random set.[4] The list of 710 restaurants appeared to be random and comprehensive with respect to the restaurant groups (Table 5) and zip codes (Table 6). Restaurants in Zip Codes 11239 and 11241 (with 3 and 1 restaurants, respectively) were not selected, but in all other cases, the regional distribution was reasonable.

Table 6: Total number of Restaurants and Selected Restaurants by Zip Code Distribution

Zip Code	Total Num of Rest.	Total Num Selected		Zip Code	Total Num of Rest.	Total Num Selected
11201	238	51		11221	50	15
11203	83	12		11222	53	13
11204	61	11		11223	92	23
11205	58	18		11224	36	15
11206	72	33		11225	74	19
11207	82	24		11226	122	20
11208	58	21		11228	24	1
11209	130	44		11229	77	11
11210	48	14		11230	42	1
11211	149	43		11231	54	6
11212	79	19		11232	79	27
11213	57	22		11233	46	4
11214	83	33		11234	77	13
11215	126	40		11235	94	10
11216	78	14		11236	86	12
11217	76	22		11237	65	28
11218	73	15		11238	67	11
11219	45	10		11239	3	0
11220	116	35		11241	1	0
				Total	**2854**	**710**

3.1.2 Food-Processing Companies

A list of food-processing companies in Brooklyn was developed by selecting SIC codes that correspond to companies that may be using or producing oil as a byproduct. The New York Industrial Retention Network (NYIRN) assisted in identifying companies in Brooklyn that could be classified under these codes.[5] Table 7 lists the SIC codes used to identify companies and the corresponding definition. The number of companies that corresponded to these code categories is listed in the last column of Table 7. In total, 72 companies were identified by NYIRN. Because this was a relatively small list, each company was contacted for the survey.

[4] Some confusion in interview implementation resulted in approximately 267 (out of 450) selected restaurants being left off of the call list.

[5] New York Industrial Retention Network (NYIRN) is a not-for-profit organization that promotes New York City's manufacturing sector based on principles of economic and environmental justice and sustainability.

Table 7: Selected SIC Codes for Food-Processing Companies in Brooklyn

SIC Code	SIC Description	Number of Companies
2011	Meat Packing Plants	8
2013	Sausages and Other Prepared Meat Products	14
2015	Poultry Slaughtering and Processing	1
2035	Pickled Fruits and Vegetables, Sauces and Seasonings, and Salad Dressings	7
2038	Frozen Specialties, Not Elsewhere Classified	3
2076	Vegetable Oil Mills, Except Corn, Cottonseed, and Soybean	2
2077	Animal and Marine Fats and Oils	-
2091	Canned and Cured Fish and Seafoods	8
2092	Prepared Fresh or Frozen Fish and Seafoods	2
2096	Potato Chips, Corn Chips, and Similar Snacks	-
2099	Food Preparations, Not Elsewhere Classified	27

The survey was implemented primarily by phone interviews from CUCE NYC offices. Calls were made over a span of 2-3 weeks in August. The survey was also mailed to four companies by Mr. Jose Leon, Executive Director, East Williamsburg Valley Industrial Development Corporation (EWVIDCO).

3.1.3 Rendering Companies

Few rendering companies operate in the New York City area and two of them: Harry Berkowitz Industries, and Darling International, Inc. dominate the industry. The list of companies that were contacted is shown in Table 8. Each of these companies was called and surveyed. Unfortunately, not all companies were available to respond to the phone interview. The renderers could not accurately estimate how much oil and fat are processed on a weekly basis. Interviewees mentioned that they were already monitoring the development of the BD industry, and of policies encouraging investment in BD production equipment and production.

Table 8: Rendering Companies

Company	Location
American By-Products	Morristown, NJ
Baker Commodities, Inc.	Rochester, NY
Darling International, Inc.	Newark, NJ
Harry Berkowitz Industries, Inc.	Newark, NJ
J&R Rendering	West New York, NJ
M&E Soap Co., Inc.	Morris Plains, NJ

3.2. Questionnaire Designs

The designs of the restaurant and food processing company surveys were similar. Both surveys included information that could be used to further stratify the response. For example, the restaurant respondent was asked about the type of establishment (Full-service, limited-service, etc.), seating capacity, and primary type of cuisine. Food-processing companies were asked about the size of the factory floor and number of employees. The goal of the questionnaires was to learn how much oil is being used, how much is being disposed, and how much is paid for disposal. Each questionnaire was reviewed by CUCE and outside persons in each respective industry before it was finalized.

Rendering companies were approached in a different manner. These companies compete with each other for waste vegetable oil, and accordingly, their relationships with restaurants and food-processing companies are proprietary. Rendering companies were questioned more generally about the volumes of oil and fat collected and processed on a weekly basis and the sources of their supplies. These companies were also asked about their plans and interest in the BD industry.

4. Results

4.1. Survey Results

4.1.1 Restaurant Survey

Data was collected on many characteristics of the restaurant, its use and disposal of vegetable oil. Primary quantitative data includes the volumes of oil used and disposed per month as well as the price for disposal. Oil use data was helpful in verifying that responses on WVO quantities were reasonable. For example, if oil use was greater than oil waste, it was assumed that there was a problem with the response or with the data entry. In such cases, restaurants were called again in an attempt to clarify the inconsistency.

Table 9 provides a breakdown of the types of initial responses obtained by the survey. In total, 116 usable responses were obtained. One hundred of the 116 contained quantitative data on oil use and disposal and 16 mentioned that they did not use any or sufficient oil for it to be collected separately. In most cases, respondents would not identify a manager, or the manager was not present. The list also generated a large number of wrong phone numbers, suggesting that either the business closed, it changed its phone number, or the line was disconnected. No efforts were made to resolve this uncertainty. In terms of estimation, all non-responses were treated as non-calls and that they shared the same characteristics as responses.

Table 9: Summary of Response Categories for Restaurants

Total Number of Calls	Usable Responses	No Manager	Wrong phone number	Refused to respond	No English / Unable to respond
710	116	229	209	57	99

Among the 100 restaurants that disposed of oil, 90 used renderers, 7 used municipal collection, 1 used a private hauler and 2 would not say. Restaurants that used renderers shared many characteristics. About 75% of the restaurants used 55-gallon drums and one was large enough to require a 100-gallon drum. Restaurants with drums usually kept them outside in a protected area and trained staff to make sure water did not enter the drum. Restaurants without drums disposed of relatively small amounts (15 gallons / month) and used the same containers that held the cooking oil.

In total, 10 restaurants did not use renderers. More than half of these disposed of less than 10 gallons per month although several reported about 20 gallons per month and one reported 90 gallons a month. The average of all such restaurants was about 19 gallons per month. On a

Brooklyn-wide scale, assuming 10% of restaurants dispose about 19 gallons/month and do not use renderers, this would constitute an annual loss of feedstock of about 65,000 gallons. The small number of responses limits the confidence with which this estimate should be considered. One more point worth noting is that the survey revealed that 3 restaurants (averaging about 9 gallons/ month) used to use a renderer to collect the WVO but stopped because it was too expensive. This finding suggests that much of these 65,000 gallons would be expensive to collect.

Usable quantitative responses about WVO disposal were distributed among 6 restaurant groups (Table 10). No responses were obtained from the Fast Food or Seafood restaurant groups. Responses of the Family restaurant group enabled each restaurant to be appropriately classified into a relevant groups; this is why two responses were obtained from Sandwich restaurants when none were initially called. Many of the responses of the Family group ended up being self-described as part of a Latin/Caribbean group, however this does not reflect the composition of that category as a whole.

Table 10: Distribution of Responses by Sampling Category

Restaurant Groups	Number of Called Restaurants	Number of Usable Responses
Asian (non-Chinese)	67	16
Chinese	144	19
American/European/Int’l	103	21
Latin American/Caribbean	44	44
Fast Food (non-chicken)	18	
Chicken (Fast Food, primarily)	75	14
Seafood	2	
Sandwich		2
Family (Uncategorized)	257	
Total	710	116

There were interesting differences between the estimated average WVO disposal quantitities for different restaurant groups (Table 11). Chinese restaurants produced the most WVO but these averages were not statistically different from non-Chinese Asian restaurants, and Chicken (fast food, primarily) restaurants. American/European/Int’l restaurants and Latin/Caribbean restaurants used and disposed of less WVO. Sandwich shops used and disposed of almost no vegetable oil.

Table 11: Average WVO Disposal by Restaurant Group

Restaurant Groups	Number of Restaurants	Average Number of Gallons Disposed Per Month
Asian (non-Chinese)	16	70.6
Chinese	19	81.4
American/European/Int’l	21	45.9
Latin American/Caribbean	44	20.5
Chicken (Fast Food, primarily)	14	77.3
Sandwich	2	8.0
Total	116	48.1

Another way of examining the data involves assessing average WVO disposal by type of restaurant service (Table 12) and restaurant seating capacity (Table 13). Note that in these tables, the number of restaurants is less than in the previous table because of non-responses. Statistical testing to compare differences in average WVO indicate that there does not appear to be a significant difference between average WVO for restaurant service but there is a significant difference by seating capacity. For individual categories, these results suggest that Carry out restaurants and restaurants with very large seating capacity dispose of the most WVO. While these results appear confounding, the small sample sizes (5 and 3, respectively) could include biases that explain some of the difference from the overall mean. Table 14 shows the average WVO distributed by seating capacity and type of service. Note that due to non-responses, the averages for WVO do not exactly correspond.

Table 12: Average WVO Disposal by Type of Restaurant Service

Type of Service	Number of Restaurants	Average Number of Gallons Disposed Per Month
Full-service restaurants	53	46.7
Limited-service eating places	42	58.7
Carry out	5	71.6
Total	100	53.0

Table 13: Average WVO Disposal by Restaurant Seating Capacity

	Number of Restaurants	Average Number of Gallons Disposed Per Month
<10	30	57.2
10-50	49	39.8
50-100	18	66.4
>100	3	146.7
Total	100	53.0

Table 14: Average WVO Disposal by Restaurant Seating Capacity and Type of Restaurant Service

	Type of Service			
Seating Capacity	Full-service restaurants	Limited-service eating places	Carry out	Grand Total
<10	40.0	58.3	71.6	59.2
10-50	30.7	56.5		39.3
50-100	60.9	160.0		66.4
>100	146.7			146.7
Grand Total	47.6	60.1	71.6	54.1

4.1.2 Food Processing Companies

The food processing company survey was not as successful as the restaurant survey. All 73 companies were called and only 19 usable responses were obtained (Table 15). Of the usable responses, 3 reported disposing limited amounts of oil and the rest did not produce WVO. Accordingly, no accurate estimates of WVO can be obtained from this survey.

Table 15: Summary of Response Categories for Food Processing Companies

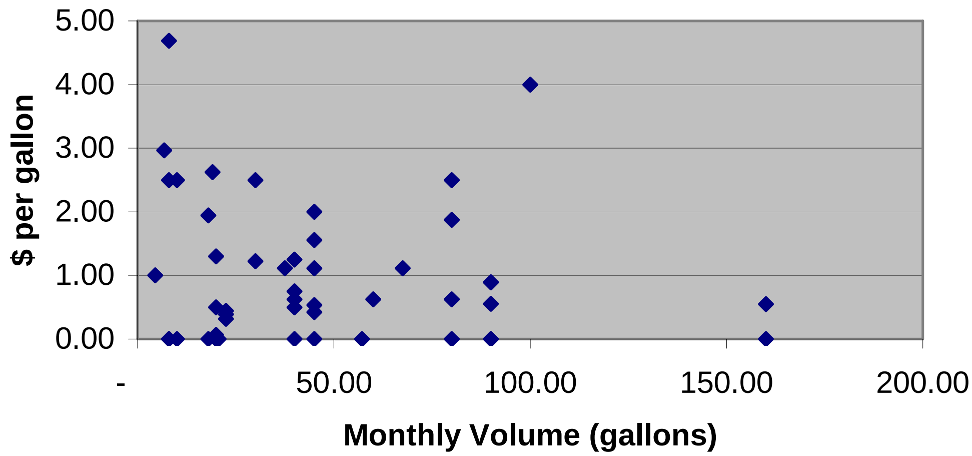
Total Number of Calls	Usable Responses	No Manager	Wrong phone number	Refused to respond	No English / Unable to respond
72	19	18	3	5	27

4.1.3 Disposal Prices

Disposal prices varied widely and depended to some extent on the frequency and volume of collection and service contract. Data on prices was more limited than the full set of usable responses: only 51 restaurants responded with price information and several of these responses were too high to be accurate. Considering reasonable responses only, on the upper end of the scale, one restaurant reported paying $90 per drum; the WVO was picked up when the drum was full and this occurred approximately once per month. On the low end, the cost of collection was zero. Normally, restaurants paid $25 - $50 per drum. If however, the restaurant was on a regular schedule for pickup, most paid approximately $25 per visit and some restaurants were visited once per week.

Pooling price data together, a price per gallon was computed for all reported prices by quantity considering all contracting arrangements. The results indicate that restaurants pay about $1 per gallon or $55 per 55-gallon drum. This cost is not unreasonable but it may be biased upwards considering the number of non-responses. The chart below plots prices paid by restaurants for WVO collection. The chart indicates a declining trend in price per gallon as total gallons increases, but in reality, rendering companies take many factors besides volume into consideration when they set WVO collection prices.

Figure 1: Cost of WVO Collection by Monthly Disposal Volume



4.2. Brooklyn Estimates of Yellow Grease from Restaurants

The estimates of yellow grease can be used with Brooklyn-level data in several ways to obtain information on the volumes of yellow grease supply in the borough. These approaches have different strengths and weaknesses.

4.2.1 Brooklyn WVO Estimate by average of all restaurants

The most basic approach considers the overall average of WVO production from restaurants and computes borough-level volumes from the total number of restaurants. This result suggests that 1.65 M gallons were disposed of and about 1.5 M gallons may be converted to yellow grease (Table 16). This estimate is more conservative because many of the uncertainties and inaccuracies in the annual restaurant WVO disposal would get averaged out. As a point of comparison, Wiltsee (1998) would have estimated a much larger amount of annual WVO per restaurant (832.8 gallons) that translated to 2.4 M gallons disposed of each year from Brooklyn restaurants.

Table 16: Brooklyn-wide Estimate of WVO from Restaurants (by Restaurant group average)

Restaurant Cuisine Groups	Number of Restaurants	Monthly Volumes per Restaurant (Gallons)	Annual Volume per Restaurant (Gallons)	Total Volume - all Restaurant Groups (Gallons)
Total Average	2854	48.1	577.20	1,647,329

4.2.2 Brooklyn WVO Estimate by Restaurant Group

A second approach uses the production of WVO by restaurant group (by cuisine) and scales up for the borough using the original restaurant list. For this approach, restaurants in the Family category were reclassified into one of the Restaurant Groups. This was necessary because responses from the original Family category were disproportionately in the Latin/Caribbean group. The reclassification is shown in Table 17. In most cases, the WVO average was applied across all restaurants in that group. For Fast Food and Seafood groups, no WVO was available so the total average was used.

Table 17: Reclassification of Family restaurants

Restaurant Groups	Original Number of Restaurants	Number of Restaurants (revised Groupings)
Asian (non-Chinese)	97	344
Chinese	375	545
American/European/Int'l	149	1079
Latin American/Caribbean	109	381
Fast Food (non-chicken)	164	171
Chicken (Fast Food, primarily)	152	152
Seafood	62	116
Sandwich	50	66
Family (Uncategorized)	1606	
Total	2854	2854

Results from this approach indicated that approximately 1.82 M gallons of WVO were disposed of by Brooklyn restaurants. Figuring that 90% may be collected by renderers, 1.6 M gallons would be converted to yellow grease and about 0.2 M gallons were wasted. This figure is larger and perhaps a better representation of the true level of WVO because of the diversity of restaurant types. This estimate however depends more on the accuracy of the estimated annual volume per restaurant type and number of restaurants in a group.

Table 18: Brooklyn-wide Estimate of WVO from Restaurants (by restaurant group)

Restaurant Cuisine Groups	Number of Restaurants	Monthly Volumes per Restaurant (Gallons)	Annual Volume per Restaurant (Gallons)	Total Volume per Restaurant Group (Gallons)
Asian	344	70.6	847.2	291,437
Chinese	545	81.4	976.8	532,356
America	1079	45.9	550.8	594,313
Latin	381	20.5	246	93,726
Fast Food	171	48.1	577.2	98,701
Chicken	152	77.3	927.6	140,995
Seafood	116	48.1	577.2	66,955
Sandwich	66	8	96	6,336
Total				1,824,820

4.2.3 Brooklyn WVO Estimate by Service Type

A third approach uses a smaller number of restaurants based on US Census Bureau data. The average annual volume of WVO per restaurant service group was applied to these restaurants by type. Note that this smaller number of restaurants was used because of uncertainties in the total number of restaurants (2,854 - from the commercial list) and how those restaurants would be classified if 2,854 was the correct number. This approach first adjusted the number of restaurants from the US Census Bureau in Table 4 by assuming that restaurants increase with population, which grew by 0.5% from 2001 to 2004. In addition, the annual volume of WVO per restaurants for Limited service and Carry Out types was computed from Table 12 as a weighted average. Using these figures, a total of 1.3 M annual gallons of WVO is estimated for Brooklyn.

Table 19: Brooklyn-wide estimate of WVO from Restaurants (by Service Group and Census Restaurants)

Restaurant Service Groups	Number of Restaurants (2004 Adjusted)	Annual Volume per Restaurant	Total Annual Volume per Service Group
Full-service restaurants	872	560.75	488,974
Limited-service + Carry out - Weighted Avg	1,172	720.66	844,613
Total	2044		1,333,587

5. Discussion

Three methodologies were employed to estimate WVO quantities in Brooklyn. The first, which used average WVO over all restaurants, suggests that 1.65 million gallons of oil are disposed of each year. The second approach applies restaurant group WVO averages across the relevant groups in Brooklyn to arrive at 1.82 million gallons of WVO per year. These estimates are considerably lower than an approach that used a smaller number of restaurants. They are higher than the estimates obtained using a more conservative figure for the number of restaurants in Brooklyn. On the other hand, assuming that 10% of restaurants do not use renderers, 65,000 gallons of WVO would actually go to waste, potentially because it is too expensive to collect. These estimates are considerably less than what would be predicted by Wiltsee (1998) (using 2,854 restaurants) and others using population-based or restaurant-based estimates (Table 2).

This study did not directly assess the economics of BD production. However, employing data from other studies, the supply of WVO in Brooklyn does not appear to be large enough to support a competitive commercial BD business on its own. However, a plant located in Brooklyn, which drew feedstock supply from elsewhere in NYC metropolitan area and PA, would have sufficient supply to attain significant economies of scale.

Two types of feedstocks, not addressed in this study, warrant further attention: animal fats and trap greases. Trap greases are still only a potential feedstock (due to technical complications), but they could become important in the future. Animal fats, on the other hand, are a large potential feedstock source, particularly in PA, but not one that would be necessarily practical for small BD producers, since these waste products must be rendered before available as a viable feedstock.

The current state of the BD industry suggests tremendous growth potential, despite its current dependency on policy support. BD feedstocks are varied (including soybean, and rendered yellow grease and animal fats) and generally available in NYC at the market price. The supply in Brooklyn does not appear sufficient to support a competitive commercial BD business on its own. However, supplementing local WVO with feedstock sources harvested elsewhere in the NYC metropolitan area or even Pennsylvania, should create sufficient supply to attain significant production economies of scale.

Currently, non-petroleum feedstocks are expensive and have alternative market outlet alternatives. Federal policies have lowered the cost of BD, yet the outlook on future policy support is uncertain. Because BD production costs largely depend on BD feedstock prices, the current situation can create a difficult investment-planning horizon. BD plants would ideally be large enough to produce at least ten million gallons per year. With increasing demand for low-level BD-diesel blends, BD production in NYC would likely be successful.

6. Research Needs

Development of a BD production plant in the New York City metropolitan area appears to have several advantages including large and varied feedstock supplies, supporting industries, well-developed infrastructure and industrial zones. What is less clear is how large a plant should be and what processing technologies would be employed. In addition, institutional, infrastructural, and policy assessments must be better understood to assess where a plant is best located in NYC or NJ.

As a brief outline, research on these issues would entail both a supply and demand side market assessment. On the supply side, production functions could be developed to determine plant sizes for different levels of output. It would be assumed that the BD produced would meet the market quality standard. Several locally-available feedstocks and associated production technologies and costs could be examined. In addition, an analysis of local industrial policy and infrastructure could identify advantages and disadvantages of several potential locations in the region. On the demand side, projected domestic and international demand for BD and BD-blends could be assessed by developing several scenarios. These scenarios could directly consider Federal and individual States efforts' to promote BD as well as increasing market acceptance. These projections, coupled with an assessment of the market supply (from other domestic and international plants), could yield critical information on projected prices. Ultimately, supply and demand projections could be integrated into a business plan framework that could define an initial plant size and a long-range investment plan that scales-up production as demand grows.

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Annex: Surveys

Restaurant Survey: Vegetable Oil Use and Disposal

Survey Information

Interviewer Name ____________________ Date ____________

Survey Number ____________________ Time ____________

Restaurant Information

Restaurant Name ____________________ Phone number ____________

Introduction

P	**Preliminary Questions**	
P1	Can I speak with the manager or owner?	Y N **If Y goto Script** **If N goto P4**
P2	(If the response to P1=N) When would be a good time to reach the owner or manager?	_______ (time) __/__/__ (day)
P3	(if unwilling to participate indicate here)	□Unwilling

Script: Hello, my name is _____. I am calling on behalf of Cornell University, which is conducting an academic study of restaurants in Brooklyn to learn about vegetable oil use and disposal. The questions will take less than 5 minutes.

Our objective is to estimate the total amount of vegetable oil that is discarded in Brooklyn. This information is important for understanding the potential for generating biodiesel in Brooklyn. Biodiesel is an emerging fuel for cars and homes that is better for the environment, human health, and reduces demand for foreign oil. A local biodiesel industry could lower disposal costs for restaurants like yours.

Your restaurant was selected at random. I want to assure you that tour responses provide a critical input to this study. All answers will remain confidential and responses will not be traceable to restaurants.

P	**Preliminary Questions cont'd**	
P4	Would you be willing to answer a few questions over the phone at this time?	Y N **If Y goto A** **If N goto P4**
P5	(If the response to P1=N) When would be a good time for me to call back?	_______ (time) __/__/__ (day)
P6	(If the response to P2=N) Would you be willing to answer questions if I mailed, e-mailed or stopped by with a survey?	Y N

A	**Restaurant and Owner Information**	
A1	Can you please tell me your name?	________________________
A2	What is your title? **[prompt for answers as indicated, check only one]**	Owner □ Manager □
A3	What type of establishment is this? **[prompt for answers as indicated, check only one]**	□ Full-service restaurants □Limited-service eating places □Carry out □Drinking establishment -Bar/Pub
A4	What is the main type of food use serve? **[prompt for answers as indicated, check only one]**	□American cuisine □Steak House / BBQ □Sandwiches □Seafood □(Primarily) Chicken (e.g. Fried) □International cuisine: Specify □Asian □Chinese □Europ.□African □Other (specify) ___________________________

B	**Vegetable Oil Use and Storage**	
B1	How much vegetable oil do you use each week?	_______ # of Boxes
B2	What type of oil do you primarily use?	□ Vegetable □ Peanut □ Sesame □ Other ______________(specify)
B3	What types of foods are fried?	□Meat □Fish □Vegetable
B4	Much oil is used for vegetables (by percentage)?	_________(%)
B5	Do have a 50 gallon drum to store the oil after cooking?	Y N **If Y goto B7** **If N goto B6**
B6	(If B5=N) What kind of container do you use?	_____________________
B7	Is the storage container placed inside or outside?	Inside □ Outside □ **If Outside goto B8** **If Inside goto C**
B8	(If B8=Outside) Is the container covered and protected from rain?	Y N
B9	Are restaurant staff trained to prevent rainwater from entering the container?	Y N

C	**Used Oil Collection and Disposal**	
C1	Does a recycling or rendering company currently collect the used oil?	Y N **If N, goto C3** **If Y, goto C9**
C2	What is the name of the company collecting the oil?	____________________
C3	Has a recycling or rendering company ever collected the used oil?	Y N **If N, goto C5** **If Y, goto C4**
C4	Can you tell me why the recycling or rendering stopped collecting your oil?	____________________ ____________________
C5	Do you currently dispose of used oil in municipal garbage collection?	Y N **If N, goto C7** **If Y, goto End of Survey**
C6	Do you dispose of used oil in privately contracted garbage collection?	Y N **If N, goto End of Survey** **If Y, goto C8**
C7	How much do you pay for garbage collection and for what quantity?	$_________ _________ (Quantity units) **Goto End of Survey**
C8	Is oil collected on a regular schedule or do you call when the container is full?	Schedule □ Full □
C8	How often is the oil collected?	____ # of times per □ Month / □ Year
C9	How much do you pay for oil disposal and for what quantity?	$_________ _________ (Quantity units) **Goto End of Survey**

D	**End Of Survey**	

D1	Would you like to receive information on findings for this study?	Y N
D2	Do you have any questions?	

Food Processor Survey: Food Grade Oil Use and Disposal

A	**Company Information**	
A1	Company Name	________________________
A2	Address	________________________
A3	Phone Number	________________________
A4	Respondent name and title	________________________ □Owner □Manager
A5	What is your primary business activity?	□Meat processing □Sauces □Fish processing □Fried foods □ Other (specify)_____________ ______________________________
A6	How many employees do you have in Brooklyn?	____________
A7	How large is your factory floor space?	____________ square feet
B	**Oil Use and Storage**	
B1	Do you buy oil for processing or produce oil as a by-product from food processing or both?	□Buy **goto B2** □Produce **goto B6** □Both **goto B2**
B2	What type of oil do you primarily buy?	□ Mixed Vegetable □ Peanut □ Partially Hydrogenated □ Other (specify)_____________ ______________________________
B3	What types of foods are fried?	□Meat □Vegetable □Fish □ Flour □ Other (specify)_____________ ______________________________
B4	How else is food grade oil used in your business?	□Preservative □Flavoring □ Other (specify)_____________ ______________________________
B5	During normal operations, is oil changed on a regular basis or as needed?	□Regular schedule □As needed
B6	What activities produce oil waste?	□Meat processing □Fish processing □ Other (specify)_____________ ______________________________
B7	Is there anything unusual in your waste oil (such as an additive) that changes its quality?	□Y □N if Y, (specify)_______________ ______________________________ ______________________________ ______________________________
B8	Do you have 50-gallon drums to store the oil after cooking?	□Y **goto B10** □N **goto B9**
B9	(If B6=N) What kind of container do you use?	________________________

B10	Is the storage container placed inside or outside?	□Inside **goto C** □Outside **goto B11**
B11	(If B8=Outside) Is the container covered and protected from rain?	□Y □N
B12	Are employees trained to prevent rainwater from entering the container?	□Y □N
B13	Do you have sufficient physical space to place containers outside considering your current rate of business growth?	□Y □N
C	**Oil Collection and Disposal**	
C1	Does a recycling or rendering company currently collect the used oil?	□Y **goto C8** □N **goto C3**
C2	What is the name of the company collecting the oil?	___________________________
C3	Has a recycling or rendering company ever collected the used oil?	□Y **goto C4** □N **goto C5**
C4	Can you tell me why the recycling or rendering stopped collecting your oil?	____________________________ ____________________________
C5	Do you currently dispose of used oil in municipal garbage collection?	□Y **goto End of Survey** □N **goto C6**
C6	Do you dispose of used oil in privately contracted garbage collection?	□Y **goto C7** □N **goto**
C7	How much do you pay for garbage collection and for what quantity?	$______________ _____________ (Quantity units) **Goto End of Survey**
C8	Is oil collected on a regular schedule or do you call when the container is full?	Schedule □ Full □
C9	How often is the oil collected?	___________ # of times per □ Month / □ Year
C10	How much do you pay for oil disposal and for what quantity?	$___________________ _________ (Quantity units) **Goto End of Survey**
D	**End Of Survey**	
D1	Do you want to receive information on study findings?	□Y □N
D2	Can someone follow up with you if we have more questions?	□Y □N

Renderer/Recycler Survey: Yellow Grease and Animal Fats

This survey is being conducted on behalf of Cornell University, which is carrying out an academic study of restaurants and food-processing companies in Brooklyn. The goal is to learn about waste vegetable oil and animal fat use and processing. We are contacting you to learn more about your business relationships with such businesses in New York metropolitan area and Brooklyn, in particular. These questions take less than 2 minutes to answer.

A	**General Company Information**	
A1	Company Name	___________________________
A2	Address	___________________________
A3	Phone Number	___________________________
A4	Your name and title	___________________________ □Owner □Manager
A5	What is your primary business activity?	□Oil and/or fat collection □Oil and/or fat processing □Oil and/or fat collection and processing
A6	Do you focus on a particular market niche within collection or processing?	(such as meat processing, fast food chain restaurants, etc. ___________________________________
A7	What are the principal industries to which you sell finished products?	□Cosmetics □Animal feed □Food □Biofuel and related lubricants □Medicine
A8	How many employees do you have in NYC area?	_____
A9	How large is your processing floor space?	_____ square feet
B	**Animal Fat and Yellow Grease Collection (if applicable)**	
B1	Do you collect yellow grease from restaurants?	□Y **Goto B2** □N **Goto B4**
B2	What is the average monthly volume or weight?	___________________________________
B3	How much do you charge for collection?	___________________________________
B4	Do you collect yellow grease from food processors?	□Y **Goto B5** □N **Goto B8**
B5	What is the average monthly volume or weight?	___________________________________
B6	How much do you charge for collection?	___________________________________
B7	What is your market share in yellow grease collection?	___________________________________
B8	Do you collect or process animal fats?	□Y **Goto B9** □N **Goto B12**
B9	What is the average monthly volume or weight?	___________________________________
B10	How much do you charge for collection?	___________________________________
B11	What is your market share in animal fat collection?	___________________________________
B12	Do you typically have long-term contracts with the businesses from which you collect?	□Y (please describe)______________ ___________________________________ □N

C	**Animal Fat and Yellow Grease Processing (if applicable)**	
C1	Do you process yellow grease from restaurants?	□Y **Goto C2** □N **Goto C4**
C2	What is the average monthly volume or weight?	________________________________
C3	Do differences in the quality from business to business affect processing?	□Y (please describe)______________ ________________________________ □N
C4	Do you process yellow grease from food processors?	□Y **Goto C5** □N **Goto C8**
C5	What is the average monthly volume or weight?	________________________________
C6	Do differences in the quality from business to business affect processing?	□Y (please describe)______________ ________________________________ □N
C7	What is your market share in yellow grease processing?	________________________________
C8	Do you process animal fats?	□Y **Goto C9** □N **Goto C12**
C9	What is the average monthly volume or weight?	
C10	Do differences in the quality from business to business affect processing?	□Y (please describe)______________ ________________________________ □N
C11	What is your market share in animal fat processing?	________________________________
C12	What are your final products from processing and how much do you sell them for?	Product Price ________________________________ ________________________________ ________________________________
D	**End Of Survey**	
D1	Do you want to receive information on study findings?	□Y □N
D2	Can I contact you at a later time if I have further questions?	□Y □N