

COMMERCIAL FOOD WASTE DISPOSAL STUDY

New York City
Department of Environmental Protection

WITH SUPPORT FROM

New York City Department of Sanitation
New York City Economic Development Corporation
Business Integrity Commission

Steven W. Lawitts, Acting Commissioner

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Table of Contents

Executive Summary Summary-1

1: Introduction 1-1
- 1.1 About this Study 1-1
- 1.2 Putrescible Commercial Waste in New York City 1-2
- 1.3 Potential Implications of Food Waste Disposers 1-3
- 1.4 Study Approach 1-4
- 1.5 How This Report is Organized 1-4

2: Commercial Food Waste Disposal in New York City Today and Plans for the Future 2-1
- 2.1 Introduction 2-1
- 2.2 Who Generates Commercial Food Waste Today 2-1
- 2.3 How Commercial Food Waste Is Disposed Today 2-2
- 2.4 Disposal Costs of Commercial Food Waste 2-4
- 2.5 Effects on Communities from Current Land-Based Commercial Food Waste Disposal 2-4
- 2.6 Planned Changes in Future Land-Based Private Waste Disposal 2-6

3: About Commercial Food Waste Disposers 3-1
- 3.1 Introduction 3-1
- 3.2 What Are Commercial Food Waste Disposers? 3-1
- 3.3 Plumbing and Utility Considerations for Food Waste Disposers 3-2
- 3.4 Who Uses Commercial Food Waste Disposers and Where? 3-4

4: Food Waste Generation and Characterization in New York City 4-1
- 4.1 Introduction 4-1
- 4.2 Food Service Establishments in New York City 4-1
- 4.3 Commercial Food Waste Characterization 4-3

5: Potential Benefits of Commercial Food Waste Disposers 5-1
- 5.1 Introduction 5-1
- 5.2 Solid Waste and Truck Trip Reductions 5-2
- 5.3 Cost Savings and Convenience to FSES 5-5
- 5.4 Beneficial By-Products Generated Through the Wastewater Treatment Process 5-8

6: Potential Impacts of Commercial Food Waste Disposers on Water Supply and Conservation Efforts 6-1
- 6.1 Introduction 6-1
- 6.2 Overview of New York City's Water Supply Network 6-1
- 6.3 Current NYCDEP Programs for the Water Supply 6-2
- 6.4 Impacts From Commercial FWD Use on Water Supply and Conservation 6-3

7: Potential Impacts of Commercial Food Waste Disposers on the Sewer Network and Combined Sewer Overflows 7-1
7.1 Introduction 7-1
7.2 Overview of New York City's Sewer System 7-2
7.3 Sewer Backups 7-3
7.4 Fats, Oil, and Grease 7-4
7.5 Combined Sewer Overflow 7-5
7.6 Current NYCDEP and PlaNYC Initiatives for Addressing Stormwater and CSOs 7-6
7.7 Impacts from Commercial FWD Use on CSOs and on Sewers 7-9

8: Potential Impacts of Commercial Food Waste Disposers at the Water Pollution Control Plants 8.1
8.1 Introduction 8-1
8.2 The Wastewater Treatment Process 8-3
8.3 Increases in Flows and Loads from Commercial FWD Use 8-5
8.4 Impacts on Biological Nutrient Removal (BNR) from Commercial FWD Use 8-6
8.5 Impacts on Newtown Creek WPCP from Commercial FWD Use 8-12
8.6 Impacts on Solids Handling and Sludge Management from Commercial FWD Use 8-14
8.7 Impacts on Secondary Treatment from Commercial FWD Use at the Remaining WPCP Plants 8-18
8.8 Impacts of Fats, Oils, and Grease (FOG) from Commercial FWD Use 8-20
8.9 Permitting Challenges and Additional Environmental Impacts 8-21
8.10 Summary of Cumulative Costs 8-23

9: Commercial Food Waste Disposal in New York City's Neighborhoods: Four Case Studies 9-1
9.1 Introduction 9-1
9.2 Manhattan Community Board 3 9-2
9.3 Brooklyn Community Board 1 9-4
9.4 Bronx Community Boards 1 and 2 9-6
9.5 Staten Island Community Board 1 9-9

References References-1

Appendix A: Commercial Food Waste Study

Appendix B: Wastewater Treatment Process in New York City

Appendix C: Potential Impacts of Commercial Food Waste Disposers at Various Penetration Rates and Analysis Years

List of Tables

4-1 FSE Universe....4-2
4-2 Projected Generation Estimate (in Tons/Day)....4-4
5-1 Average Disposal Costs.... 5-6
5-2 Costs-Benefit for the FSE.... 5-7
8-1 Summary of WPCP Costs With Implementation of Commerical FWDs....8-2
8-2 Incremental Increase in Flows and Loads With FWD in 2030 (50 Percent Penetration)..8-5
8-3 Effluent Nitrogen Load (lb/d) to the East River (Varying Market Penetrations)....8-9
8-4 Effluent Nitrogen Load (lb/day) to Jamaica Bay (Varying Market Penetrations)....8-9
8-5 Performance Benefit from Denitrification Filters at BNR Plants....8-10
8-6 Estimated Capital Cost of Denitrification Filters....8-11
8-7 Estimated Operation and Maintenance Costs (in 2008 Dollars)....8-11
8-8 Incremental Equipment Requirement for 2030 (50 Percent Penetration)....8-16
8-9 Estimated Project Capital Costs (50 Percent Penetration, 2030)....8-17
8-10 Estimated Incremental Annual Operation and Maintenance Costs (50 Percent Penetration, 2030)....8-18
8-11 Incremental Equipment Requirement for Secondary Treatment at the Remaining WPCPs in 2030 (50 Percent Penetration)....8-20
8-12 Increases in Scum Quantities Due to FOG in FWD At 50 Percent Penetration....8-21
8-13 Projected Energy Demand at WPCPs in 2030....8-22
8-14 Newtown Creek Consent Judgment and SPDES Penalties....8-23
8-15 Nitrogen Consent Judgment and SPDES Penalties....8-23
8-16 Summary of WPCP Costs With Implementation of Commerical FWDs....8-24

List of Figures

S-1 Commercial Food Waste Management Process
S-2 Summary of Impacts on Wastewater Conveyance and Treatment
S-3 Citywide Sewer Backup Complaints
S-4 Summary of Potential Impacts of Commercial Food Waste Disposers at the Water Pollution Control Plants (2030, 50% penetration)
S-5 Summary of Capital Investment and Operational Costs with Food Waste Digestors (2030, 50 percent penetration)
S-6 Summary of Potential Effects in the Representative Study Areas
2-1 Commercial Food Waste Management Process
2-2 Putrescible Waste Transfer Stations and Truck Routes in New York City
2-3 Truck Routes Leaving New York City
2-4 Brooklyn/Queens Border with a Concentration of Waste Transfer Stations
2-5 Bronx Community Boards with High Concentration of Waste Transfer Stations
3-1 How Commercial Food Waste Disposers Work
3-2 Typical Grease Recovery Trap Layout
3-3 Commercial Food Waste Disposers in Select U.S. Cities
4-1 The Universe of Food Service Establishments
5-1 Food Waste Diverted at 50 Percent Penetration
5-2 Changes in the Amount of Daily Truck Trips as a Result of FWDs
6-1 New York City Water Supply System
7-1 City Wide Sewer Backup Complaints
7-2 City Wide Notices of Violations
7-3 Combined Sewer Overflow Locations
8-1 New York City WPCP Drainage Areas and WPCPs
8-2 Typical Sewage Treatment Plant Process
8-3 Flow and Load Increases from Commercial Food Waste Disposers (2030, 50% penetration)
8-4 Effect on East River Nitrogen Limits
8-5 Effect on Jamaica Bay Nitrogen Limits
8-6 Incremental Equipment Requirements for Newtown Creek WPCP (2030, 50% penetration)
8-7 Increase in Sludge Production from Food Waste Disposers (2030, 50 percent penetration)
8-8 Investments Needed to Address Impacts from Food Waste Digestors (2030, 50% penetration)
8-9 Summary of Capital Investment and Operational Costs with Food Waste Digestors (2030, 50 percent penetration)
9-1 Study Area Locations
9-2 Summary of Potential Effects in the Representative Study Areas
9-3 Manhattan Community District 3
9-4 Manhattan Community District 3—Land Use, FSE Concentrations, Sewer Backups, and Notices of Violations

9-5 Brooklyn Community District 1
9-6 Brooklyn Community District 1 - Land Use, FSE Concentrations, Sewer Backups, and Notices of Violations
9-7 Bronx Community Districts 1 and 2
9-8 Bronx Community Districts 1 and 2 - Land Use, FSE Concentrations, Sewer Backups, and Notices of Violations
9-9 Staten Island Community District 1
9-10 Staten Island Community District 1 - Land Use, FSE Concentrations, Sewer Backups, and Notices of Violations

1. OVERVIEW

The New York City Department of Environmental Protection (NYCDEP) has undertaken this study of the costs and benefits of allowing the use of commercial food waste disposers (FWDs) in New York City. The study was conducted pursuant to requirements in the City's approved Comprehensive Solid Waste Management Plan for the period of 2006 through 2025 (SWMP), which tasks NYCDEP, with support from the Department of Sanitation (DSNY) and the New York City Economic Development Corporation (EDC), to study the economic, engineering, and environmental impacts that FWDs could have on NYCDEP infrastructure and operations and on the current land-based commercial waste management system.

STUDY CONTEXT

The current land-based waste management system, with its reliance on trucks and waste transfer stations, takes a toll on a number of communities within New York City. Air, noise, and odor impacts associated with waste disposal are the primary issues of concern. While planned marine transfer stations will reduce many of these impacts, particularly for the residential waste stream, significant amounts of commercial waste will continue to be managed by current practices.

This study finds that because food waste represents a small percentage of commercial waste—approximately 4 percent (and a much smaller percentage of total waste generated in the City)—and only certain types of food service establishments (FSEs) would purchase the FWDs, only a very small percentage of the volume handled by commercial waste transfer stations and trucks would be diverted. The associated impacts of air and noise emissions and vermin would be only slightly reduced with the use of commercial FWDs.

If FWDs are permitted, a potentially large percentage of food waste could be removed from the commercial waste management stream and diverted via sink discharges through the sewer system to the City's 14 water pollution control plants (WPCPs), which treat the flow before it is eventually released into various waterbodies surrounding New York City.

The amount of waste that could be diverted through the use of FWDs would have costly implications on the City's highly constrained wastewater conveyance and treatment system. New York City has invested billions of dollars in its wastewater infrastructure over the past decades to clean up the City's waterways and provide public access to them. Ocean dumping, once an acceptable means for sewage disposal, was banned in the 1980s, and a sludge disposal system was developed to divert this waste from waterways.

The City is continuing to make significant large infrastructure investments in treatment plants and measures to reduce combined sewer overflows (CSOs) to meet very stringent water quality standards. Currently, the City has spent approximately $4 billion to upgrade the Newtown Creek WPCP to meet secondary treatment requirements, $1.4 billion on Biological Nutrient Removal (BNR), and $2 billion on CSOs and wet weather abatement infrastructure. Source control and reducing loadings to the City's capacity-constrained wastewater system is a goal of the City's recently released Sustainable Stormwater Management Plan and the City's water conservation program. Even with these programs and investments in place, meeting stringent water quality standards with the City's aging infrastructure and budget constraints will continue to be a challenge. Based on the finding of this study, it is projected that allowing commercial FWDs would threaten to reverse major water quality improvements.

In conclusion, the study projects that with commercial FWDs, there would be very small reductions in commercial waste volumes and trucks at the cost of multi-billion dollars of investment that would be needed in wastewater infrastructure. Allowing commercial FWDs could jeopardize water quality standards and state mandates and runs counter to a number of PlaNYC sustainability initiatives.

As documented in case studies provided at the end of this summary and in Chapter 9 of the report, even if FWDs were to be implemented in a limited area of the City, few benefits would be expected, with a high risk to the wastewater system. A limited area implementation would demonstrate few, if any, truck trip and solid waste volume reductions. Further, due to the current and future constraints and stringent regulatory requirements placed on the City's wastewater infrastructure, even small contributions could present considerable risks of violating standards and mandates at many of the City's WPCPs. Moreover, it would be difficult to trace the cause and effect to FWDs in such a large system. By the time the adverse effects may make themselves known, it could be too late to make the infrastructure investments needed to address the problems, especially given the long lead times—often 10 years or more—necessary to design, permit and construct the infrastructure. Lastly, while there are a few WPCPs that are not as heavily constrained, they are typically located in areas with far fewer FSEs, hence fewer benefits from FWD implementation, and would not be representative of implementation at most of the other City plants.

STUDY FINDINGS

The major findings of the study, as detailed below, are:

BENEFITS

- **Food Waste Reductions.** At 50 percent penetration rate of commercial FWDs, it is estimated that 500 tons per day (tpd) of waste could be diverted from the commercial waste stream, representing 4 percent of the total commercial waste stream and 10 percent of the commercial putrescible waste stream.
- **Truck Reductions.** Nine trucks per day would be reduced citywide due to the implementation of FWDs at 50 percent penetration. The number of trucks reduced that service commercial waste transfer stations would be partially offset by the need for additional trucks to transport sludge from the WPCPs.

  There would be some additional trucks reduced from curbside collection; however, trucks serving FSEs are not expected to be appreciably reduced due to the nature of the existing collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce truck trips.
- **Cost Savings to FSEs.** For larger institutions, such as colleges and universities and medical establishments, there could be a relatively short payback period given the large amounts of food waste they generate. Based on the costs of installing and operating a FWD compared to

savings in disposal costs, many retail food establishments, restaurants, and hotels would not likely see a cost-benefit to installing FWDs. However, larger restaurants that generate higher volumes of food waste could see a benefit. This is consistent with information provided by FWD manufacturers that purchasers of these units are typically larger institutions, rather than restaurants.

ADVERSE ENVIRONMENTAL CONSEQUENCES

- **Water Consumption.** FWDs require significant amounts of potable water to run the system. Use of FWDs would introduce an additional demand of 11 million gallons a day (mgd) for 50 percent penetration of commercial FWDs. Use of drinking water to operate commercial FWDs in New York City is expected to counter the significant investment of more than $400 million that the City has made to reduce water demand by over 300 mgd since 1990; the City's future water conservation program targeted to reduce at least 60 mgd under PlaNYC; and the efforts being made to develop additional water supply sources to allow for the repair of the Rondout-West Branch segment of the Delaware Aqueduct and other water supply infrastructure. The replacement cost for the 11 mgd of additional water use by FWDs would be an estimated $165 million to $220 million.
- **Sewer Clogging**. The City's aging sewer system is overtaxed and capacity-constrained in many areas of the City resulting in sewer backups and flooding during heavy storms. Sewers are designed to efficiently carry human waste and stormwater- not FOG, which has a different consistency and flowrate – away from residences and businesses. While it is illegal to discharge fats, oil, and grease (FOG) into the sewer system, FOG is still a cause of sewer backups. Due to the high fat content of food waste, use of FWDs would discharge substantial amounts of FOG to the sewer system, which could lead to more sewer backups and maintenance needs. The use of grease interceptors, which would likely be required to accompany FWDs, would remove a portion of the FOG from the waste stream entering the system. Since the actual reduction of FOG from grease interceptors is unknown; the additional FOG presented is based on the results of the food waste characterization described in Chapter 4 and Appendix A.
- **Combined Sewer Overflows (CSOs).** The additional sanitary flow from commercial FWDs is estimated to be 11 mgd citywide and 9.7 mgd in combined sewer areas; this additional flow, would offset gains in CSO abatement and in stormwater management source control initiatives and run counter to numerous City initiatives currently underway to improve water quality and support public recreation at over 90 percent of New York City tributaries. To offset the contribution of an additional 11 mgd of flows, $66 to $440 million would need to be invested in stormwater best management practices or CSO retention facilities.
- **WPCP Impacts.** Use of commercial FWDs would result in significantly greater treatment demands at the City's WPCPs. In particular, use of FWDs could jeopardize billions of dollars of investments made by the City in BNR and at the Newtown Creek WPCP to upgrade the plant to meet secondary treatment requirements under the Clean Water Act.
- **Nitrogen Loadings.** To remain in compliance with New York State Department of Environmental Conservation (NYSDEC) nitrogen limits in the East River, at penetration rates over 25 percent, an alternate BNR process would need to be constructed at either Wards Island or Bowery Bay WPCPs. This alternate process, such as biological denitrification filters, would be more effective and significantly more costly than the current treatment process. In Jamaica Bay, it is expected that denitrification filters would be required at the 26th Ward WPCP. Capital

costs would be $650 million for Wards Island, $390 million for Bowery Bay, and $240 million for 26th Ward WPCPs. Note that upgrades at one of either Wards Island or Bowery Bay would be needed; the Wards Island upgrade would be more likely.

- **Newtown Creek Upgrades.** Newtown Creek has limited excess organic loading capacity and the additional loadings from FWDs could jeopardize permit limits and secondary treatment requirements. Should this loading capacity be exceeded, primary tanks would be required at an enormous cost to the City. Severe space limitations at the plant would potentially dictate that the primary tanks be decked over the existing plant process and would add considerably to these costs. Capital costs for primary tanks are estimated to be $1.7 billion.
- **Solids Handling and Sludge Production.** Other WPCP impacts include increased sludge production and solids handling needs. To accommodate this added demand, additional equipment (e.g., thickeners, centrifuges, and sludge storage tanks) would be required. The additional sludge would require additional processing and transport. The additional trucks required for sludge disposal would substantially offset reductions in commercial waste hauling trucks. Capital costs for solids handling facilities are estimated to be $172 million. Significant annual costs for sludge disposal and other operations and maintenance costs would total $23 million.
- **Fats, Oils, and Grease (FOG).** FOG contained in the food waste would increase the FOG loadings at the plants and affect both primary and secondary treatment. At the Newtown Creek WPCP, FOG loadings would increase tenfold.
- **Investments Needed at the WPCPs.** Use of commercial FWDs at a 50 percent penetration rate would result in the need for very costly investments of $1.0 billion at the treatment plants. Should primary tanks be required at Newtown Creek WPCP, an additional investment of $1.7 billion would be required, for a total of $2.7 billion. Annual operation and maintenance (O&M) costs would be between $34 and 35 million a year.

CUMULATIVE COSTS

Use of commercial FWDs at a 50 percent penetration rate would result in the need for very costly investments of $1.4 billion to $1.7 billion. Should primary tanks be required at Newtown Creek WPCP, an additional investment of $1.7 billion would be required, for a total of $3.1 billion to $3.4 billion. Annual O&M costs would be between $34 and 35 million a year. None of these costs are funded; in the current economic climate, and with NYCDEP already struggling to meet its regulatory mandates and repair needs under an increasingly constrained budget, it can ill-afford these investments. These costs would be borne by New York City’s water and sewer ratepayers at an increase up to 3–6 percent per year.

The costs presented are likely to be underestimated due to numerous unknowns at this time. All costs are based on conceptual level designs. When more detailed design is done, costs often increase significantly due to new needs that are identified related to limited space, electricity constraints, and myriad other miscellaneous costs that become apparent on more detailed evaluation. In addition, land acquisition and/or landfilling costs were not included in the estimates. Lastly, the costs do not include severe penalties that would be incurred by the City for violations of Consent Orders, Consent Judgments, and permit limits.

Due to the long lead times for design and construction of wastewater and water supply facilities, the investments would need to be made before the full impact of FWDs is known.

CONCLUSION

The study finds that, with commercial FWDs, there would be a reduction of approximately 4 percent of the commercial waste stream and nine trucks per day citywide. These savings would come at a cost of multi-billion dollars of investment that would be needed in water and wastewater infrastructure. The benefits provided to approximately 5,500 FSEs would be borne by ratepayers through significant rate increases. Allowing commercial FWDs could jeopardize water quality standards and state mandates and runs counter to PlaNYC sustainability initiatives.

HOW MUCH FOOD WASTE CAN BE DIVERTED FROM THE SOLID WASTE STREAM THROUGH THE USE OF COMMERCIAL FWDS?

Throughout New York City, approximately 13,000 tons of commercial waste—including 7,000 tons of non-putrescible and 5,000 tons of putrescible waste (that is, trash that contains food waste)—is generated each day, with much of this waste ending up in landfills. It is estimated that food waste accounts for 1,640 tpd of this putrescible waste,[1] which is generated by the tens of thousands of commercial FSEs, such as restaurants, hotels, supermarkets, medical facilities, colleges, bakeries, delis, and other places that serve food. See **Figure S-1** for an overview of the commercial food waste management process.

Based on a detailed review of available data for FSEs in New York City and phone interviews of randomly selected FSEs, only 11,000 of the more than 17,000 FSEs would consider installing a FWD. There are many FSEs that either generate small quantities of food waste (e.g., delis), have food waste that is not appropriate for use with a FWD (e.g., bakeries), or do not have operations conducive to use of FWDs (e.g., fast food restaurants). Of the 11,000 FSEs that may consider installing a FWD if they were permitted, many would not be inclined to do so given the relatively high initial investment, large water consumption charges, and long payback periods entailed when compared to the costs of disposing the waste through the land-based system (see cost analysis under "Benefits" below). Other FSEs would elect not to install FWDs because they would not see large advantages given that they would continue to require waste pickup for their remaining waste and due to potential clogging and other negative effects associated with FWDs. Even without a financial benefit, many FSEs may choose to install FWDs for their convenience and due to space limitations in many restaurants and other FSEs.

The study assumes that 50 percent of the 11,000 FSEs, or about 5,500, would install FWDs (although analyses were also conducted of 25 percent, 75 percent, and 100 percent penetration rates). At this penetration rate, it is estimated that 500 tpd of waste could be diverted from the commercial waste stream if commercial FWDs were allowed. This represents 4 percent of the total commercial waste stream and 10 percent of the commercial putrescible waste stream.

2. THE BENEFITS OF FOOD WASTE DISPOSAL WITH FWDS

Several benefits could accrue to FSEs and New York City if commercial FWDs are allowed, including a modest reduction in truck traffic and financial benefits to certain FSEs. These benefits are summarized below.

[1] *Source*: Table 1.4-2, DSNY Commercial Waste Management Study (2004).

1 Food waste is generated by restaurants and other users

Of the approximate 5,000 tons per day (tpd) of New York City's commercial putrescible waste that is either recycled or disposed, about 1,640 tpd is commercial food waste.

2 It is collected by private haulers

All commercial entities must make arrangements with private waste haulers to have their waste picked up, which can cost up to $10.42 per 100 pounds, according to BIC's maximum allowable rate cap.

3 Haulers truck the waste to transfer stations or directly out of the City

Most putrescible commercial waste ends up at one of the City's transfer stations, concentrated along the Brooklyn-Queens border and in the Bronx. Some waste is taken directly out of state by truck for disposal.

4 At the transfer stations, waste is sorted and loaded onto larger vehicles to be shipped out of the City

The transfer stations are busy operations and the source of neighborhood traffic, noise, air, and other related impacts. Only two transfer stations ship out commercial waste by rail.

5 Food waste eventually ends up in landfills or burned in incinerators

Commercial food waste typically ends up in facilities west and south of the city.

FIGURE S-1 Commercial Food Waste Management Process

12.29.08

SOLID WASTE AND TRUCK TRIP REDUCTIONS

If 500 tpd were diverted to FWDs (at 50 percent penetration), it is expected that there would be a reduction of a nominal number of truck trips per day citywide. These trucks collect waste from FSEs (including trucks that deliver to transfer stations and export directly outside the City) and export waste from the transfer stations. These reductions would be offset by increases in trucks for sludge disposal after processing at the WPCPs (for further information see "Impacts of Food Waste Disposal with FWDs," below). Estimates are that there would be a(n):

- Reduction of 24 trucks per day leaving the waste transfer stations for export. The implementation of FWD would see the largest reduction in truck trips from the reduction in waste trucked out of New York City from private transfer stations. These trucks represent approximately 4 percent of the total commercial waste trucks and 10 percent of the putrescible waste trucks.
- Increase of 15 trucks per day leaving the WPCPs for processing and export. These trucks would be carrying the additional sludge—296 tons per day—produced from FWD use.

Based on these estimates, nine trucks per day would be reduced citywide due to the implementation of FWDs at 50 percent penetration. There would be some additional trucks reduced from curbside collection; however, trucks serving FSEs are not expected to be appreciably reduced due to the nature of the existing collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce truck trips.

This reduction in trucks represents a very small fraction of the number of trucks servicing the commercial waste sector. The largest reductions would be expected to occur in communities with the largest concentrations of solid waste transfer stations, such as Brooklyn Community Board (CB) 1 and Bronx CBs 1 and 2.

Some ancillary benefits would accrue from the reduction in truck trips. There would be air quality benefits from the reduced regional truck trips and lower emissions of air, noise, and odor along truck routes in the local communities with transfer stations. However, because of the small changes that would result, the benefit may not be noticeable.

COST SAVINGS AND CONVENIENCE TO FSES

Certain FSEs would have more of a financial incentive than others to install FSEs. As shown in **Table S-1**, for larger institutions such as colleges and universities, there could be a relatively short payback period given the large amounts of food waste they generate. For colleges and universities, medical establishments, and "average" other FSEs, the payback period would be 0.4, 2.1, and 0.6 years, respectively. Based on the costs of installing and operating a FWD compared to savings in disposal costs, many retail food establishments, restaurants, and hotels would not likely see a cost-benefit to installing FWDs. However, larger restaurants that generate higher volumes of food waste could see a benefit. This is consistent with information provided by FWD manufacturers that purchasers of these units are typically the larger institutions, rather than restaurants.

Table S-1
Costs-Benefit for the FSE

FSE Category	Potential Reduction in Annual Disposal Costs for Average FSE[1]	Initial Cost for FWD(s)	Initial Cost for Grease Interceptor	Additional Annual Water and Sewer Costs[2]	Potential Annual Savings[3]	Payback Period (years)
Colleges and universities	$53,246	$11,876	$4,000	$8,952	$42,415	0.4
Medical establishments	$19,777	$11,876	$4,000	$8,952	$10,831	2.1
Retail food establishments	$5,325	$6,569	$4,000	$5,728	$(1,615)	NA
Restaurants and hotels	$4,564	$6,569	$4,000	$5,728	$(2,376)	NA
Other FSEs	$25,862	$6,569	$4,000	$5,728	$18,923	0.6

Notes:

1 The annual disposal fee assumes $10.42/100 lbs of solid waste per based on BIC's maximum allowable rate increase of December 26, 2008. The potential reduction in annual disposal costs due to reduction of food waste disposal is assumed to be 100 percent of the cost of current disposal of all the FSE's waste.

2 Annual water usage - 6 hours for a 2- or 3-hp FWD and 3 hours per 1-hp FWD

3 Includes costs for annual water usage and the cost for a FWD installation, assumed as $6,500, annualized over 5 years for a 2-hp unit with water saving device and $11,900 for a 1-hp and 3-hp unit with water saving device. It is assumed that units would be replaced every five years. Assumptions on water usage for the study are described in section 6.3 of this report.

NA – There would be no cost savings.

In general, although the cost of a food waste disposer including installation may be relatively modest for many businesses, about $4,500 for a 0.75-hp unit to $8,000 for a 7.5-hp unit[1], there are a number of other significant expenses that would be incurred. The installation would require a grease interceptor rather than the much less expensive grease trap that is typically installed. Although water would be used intermittently throughout the day, water consumption and water charges would be considerable, even with the installation of a water conservation device. Further, the FWD would typically need to be replaced every 5 years and larger institutions would require more than one to serve their operations.

Note that if the costly investments for water and wastewater infrastructure due to FWD use were to be paid by the FWD users as a water and sewer rate surcharge, most, if not all, of the financial incentive for installing a FWD would be eliminated (see "Impacts on Costs and Ratepayers," below).

In addition to cost savings for some FSEs, FWDs would make waste disposal quicker and easier. Despite this convenience, FWDs do clog on occasion, resulting in the need for additional maintenance. With the diversion of food waste from curbside pickup, there could be less curbside odor, vermin, and mess. Even without a financial benefit, many FSEs may choose to install FWDs for their convenience and due to space limitations in many restaurants and other FSEs. In fact, FWDs are installed in residences throughout the United States, with little to no financial benefit.

BENEFITS ASSOCIATED WITH THE WASTEWATER TREATMENT PROCESS

Food waste processed at the plant could provide beneficial by-products. The additional biosolids generated at the City's WPCPs could be applied to land directly to improve vegetation or processed further (heated to destroy all pathogens and dried out into pellets) to be sold as compost or fertilizer. This is a more beneficial end-use than landfilling solid waste. The

[1] Costs from Salvajor 2008 cost lists, including water-saving controls.

introduction of FWDs would also yield additional digester gas production at WPCPs, some of which would be reused in the boilers of WPCPs to provide heat for the treatment process in the wintertime. However, during summer months, these plants typically have more gas than they can use beneficially, so the excess gas is burned off. NYCDEP is exploring ways to capture and reuse more of this energy.

3. THE IMPACTS OF FOOD WASTE DISPOSAL WITH FWDS

Use of commercial FWDs would affect many aspects of the City's water supply, sewer network, and water treatment systems, as described below. Impacts of additional pollutant loadings at the City's facilities and consequential investments that would need to be made in the infrastructure to comply with standards are discussed below.

To support the analysis of impacts on the City's water supply and wastewater networks, the study began with a food waste characterization evaluation to analyze the amount and composition of food waste generated by potential commercial FWD users. The physical and chemical composition of food waste, including solids, grease, and nitrogen, was analyzed as well.

The sections below and **Figure S-2** provide an overview of the impacts that FWDs could have on the City's Water Conservation Program, sewer network, and WPCPs. All analyses assume a 50 percent penetration rate (impacts associated with 25, 75, and 100 percent penetration rates are provided in Appendix D).

IMPACTS ON WATER SUPPLY AND CONSERVATION EFFORTS

FWDs require significant amounts of potable water to run the system. Water must run while the device grinds food and after grinding to flush the device. During normal operation, the FWD would be turned on and off to grind food during typical activities that generate food waste, such as prep and dishwashing. This study estimates that use of FWDs would introduce an additional demand of 11 mgd for 50 percent penetration of commercial FWDs.

Although New York City is fortunate in being located in a water-rich region, conserving water is of paramount importance. The region is faced with droughts on an intermittent basis. These drought periods are expected to be further exacerbated by climate change due to reduced snowmelt that feeds the reservoir and increased demand that comes with rising temperatures. At the same time, there is an ongoing need to reduce flows going to the City's wastewater treatment plants to remain below permit limits and enable treatment of greater quantities of wet weather flow.

Water conservation is even more critical given the need for NYCDEP to take critical, aging water supply infrastructure offline for repair. NYCDEP's Dependability Program addresses the need to provide redundancy in the City's water supply conveyance to allow for necessary repair and maintenance of key supply system infrastructure. First and foremost of the program's priorities is the repair of the Rondout-West Branch Tunnel, a critical component of the Delaware Reservoir system. The City is exploring the development of additional water supply sources or the construction of a parallel tunnel that would need to be put in place before the repair work can begin. During any such period, it would be necessary for the City to implement measures to encourage conservation and decrease demand. An enhanced water conservation program is a cornerstone of the Dependability Program.

Use of drin king water to operate commercial FWDs in New York City is expected to counter:

1 Approximately 5,500 FSEs citywide would install FWDs with 50% penetration.

FWDs would use approximately 11 mgd of potable water, impacting decades of water conservation programs, and would divert approximately 500 tons of food waste per day through the sewer infrastructure.

2 Additional 11 mgd would flow through sewer network with increased fats, oils, and grease (FOG).

The additional flow would increase grease blockages in sewers and sewer backups caused by grease increasing maintenance needs. To protect the waterways from increased combined sewer overflows (CSOs) and offset the additional 11 mgd in the system, the City would need to invest in additional best management practices (BMPs) at approximately $20 per gallon or through hard infrastructure, such as CSO retention tanks and tunnels, at $6 to $40 per gallon.

3 Increased wastewater flow and pollutant load would trigger additional treatment and equipment needs with high capital and O&M costs at the City's WPCPs.

The City's wastewater pollution control plants (WPCPs) would require additional equipment citywide to maintain secondary treatment, meet nitrogen effluent limits, and process the additional sludge at a cost of $1.3 to $3.0 billion while an additional $33.6 to $34.6 million a year would be required for operation and maintenance (O&M) costs.

Biological Nutrient Reduction (BNR):
Due to the high nitrogen content of food waste, allowing FWDs would impact nitrogen loadings at the WPCPs and jeopardize the City's BNR program. To remain in compliance with existing and expected NYSDEC nitrogen limits in the East River and Jamaica Bay, dentrification filters would be needed at either Wards Island or Bowery Bay WPCPs at a cost of approximately $650 million or $390 million, respectively and at 26th Wards at a cost of $240 million.

Newtown Creek WPCP:
Newtown Creek has limited excess organic loading capacity and the additional loadings from FWDs could jeopardize permit limits and secondary treatment requirements. Primary tanks could be required at a cost of $1.7 billion.

4 Additional daily truck trips would be required to and from the City's WPCPs.

The increase in 500 tons of food waste would result in 296 wet tons per day of sludge. Processing this additional sludge would require more marine vessels and 15 additional truck trips. Since trucks would be reduced from the City's transfer stations by diverting food waste, the citywide impact would be a reduction of 9 trucks per day.

FIGURE S-2 Summary of Impacts on Wastewater Conveyance and Treatment

- The significant investment of more than $400 million that the City has made to reduce water demand by over 300 mgd since 1990;
- The future water conservation program targeted to reduce at least 60 mgd under PlaNYC; and
- The efforts being made to develop additional water supply sources to allow for the repair of the Rondout-West Branch segment of the Delaware Aqueduct and other water supply infrastructure.

The replacement cost for the 11 mgd of additional water use by FWDs would be an estimated $15 to $20 per gallon or $165 million to $220 million on top of the programs the City is currently implementing.

IMPACTS ON THE SEWER NETWORK

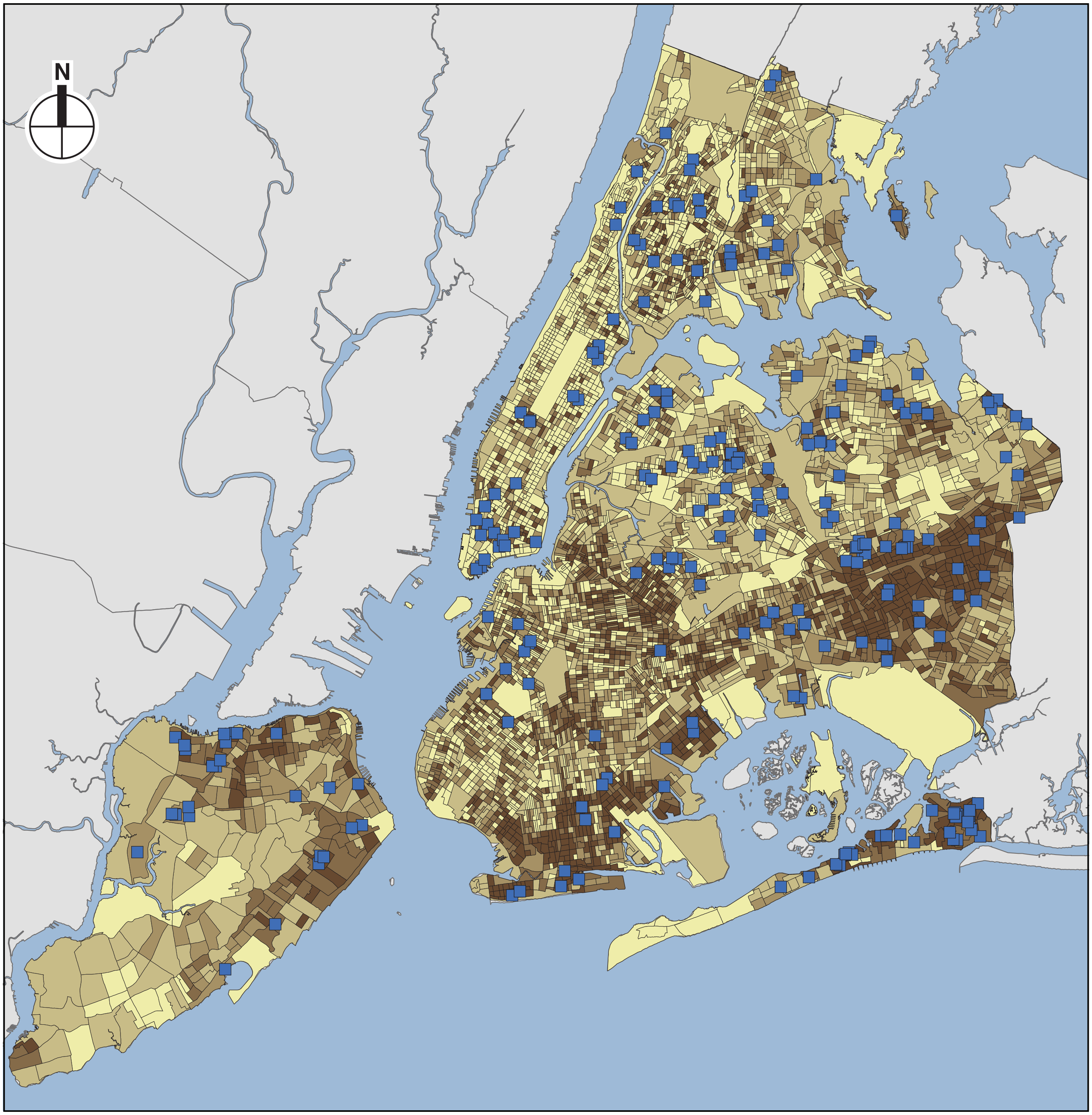
The City's aging sewer system is overtaxed and capacity-constrained in many areas resulting in sewer backups and flooding during heavy storms (see **Figure S-3**). The illegal discharge of FOG into the sewer system by restaurants, other commercial and institutional food service establishments, and residences is a common cause of sewer backups. Not only does FOG in the sewer system constrain sewer lines and cause backups, it also increases odor. FOG also impacts the treatment process at WPCPs, as described below. In response, NYCDEP cleans problem sewers burdened by FOG, enforces against illegal grease dischargers, and has an education program to address FOG discharges from restaurants and other FSEs. Due to the high fat content of food waste, use of FWDs would discharge substantial amounts of FOG to the sewer system, which could lead to more sewer backups and maintenance needs.

NYCDEP is investing approximately $2 billion in programs to build CSO retention facilities and on other CSO abatement measures. The Mayor's Office of Long Term Planning and Sustainability has recently issued the City's Sustainable Stormwater Plan, which calls for concerted efforts to increase on-site stormwater control and reduce CSOs. Allowing the additional sanitary flow from commercial FWDs, estimated to be 11 mgd, would reduce the wet weather capacity of sewers, and could potentially trigger additional CSOs. Grease slicks and floatable discharges to waterbodies could increase. The discharges would also offset gains in CSO abatement and in stormwater management source control initiatives and would run counter to numerous City initiatives currently underway to improve water quality and increase public access to over 90 percent of New York City tributaries.

The cost of installing stormwater best management practices (BMPs) to offset the 11 mgd of additional discharges from FWDs would be an estimated $15 to $20 per gallon, or $165 to $220 million on top of the programs the City is currently implementing. Hard infrastructure, such as CSO retention tanks and tunnels, cost between $6 and $40 per gallon captured; to offset the additional 11 mgd from FWDs would cost between $66 and $440 million.

IMPACTS AT THE WATER POLLUTION CONTROL PLANTS

Use of commercial FWDs would result in significantly greater treatment demands at the City's WPCPs. In particular, use of FWDs could jeopardize huge investments made by the City in BNR and at the Newtown Creek WPCP to upgrade the plant to meet secondary treatment requirements under the Clean Water Act. Following are the principal impacts that would occur at the WPCPs based on a 50 percent penetration rate as projected to the year 2030 (see **Figure S-4** for a summary of these impacts). This section is followed by a discussion of cost implications of investments needed to address these impacts.



Source: Reported sewer backup data 1/2003 - 12/2007, NYCDEP

Sewer Back Up Complaints per Acre

MOST

LEAST

Degreasing Location

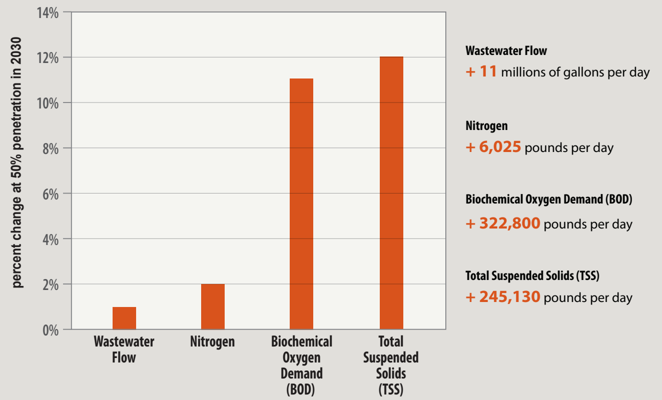
US Census Block Group

Borough	Number of Degreasing Locations
Manhattan	28
Bronx	32
Brooklyn	27
Queens	143
Staten Island	27

0 2 5 MILES

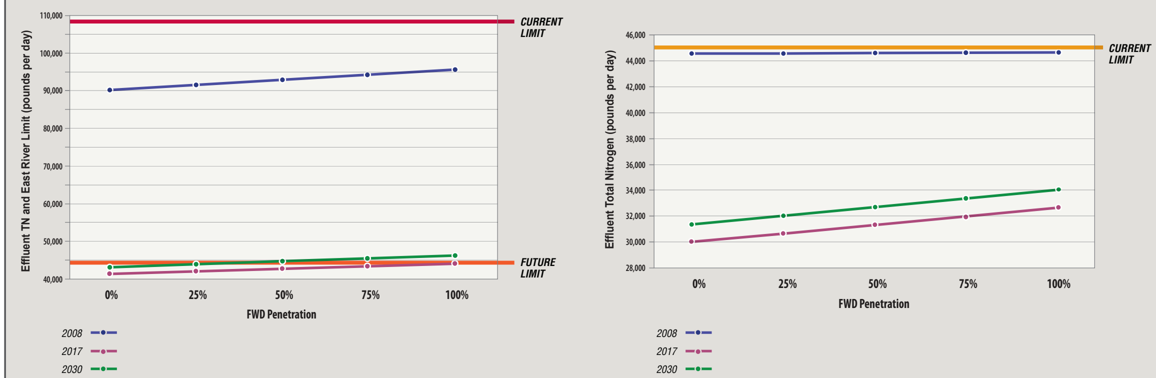
SCALE

FIGURE S-3 Citywide Sewer Backup Complaints



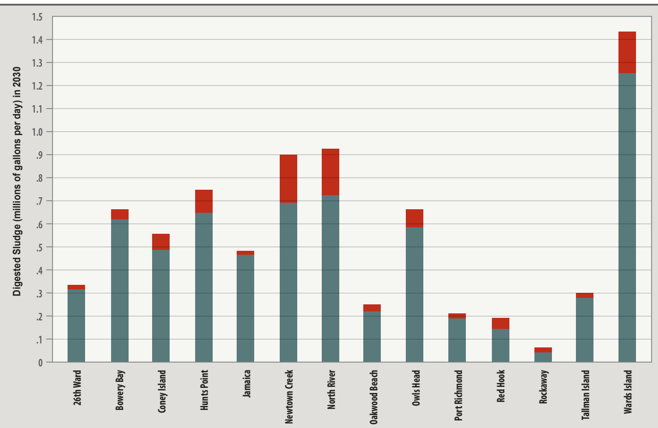
1. Flows and loads would increase

The use of commercial food waste disposers would increase the amount of wastewater headed to the City's WPCPs. There would also be higher levels of pollutants in the wastewater requiring treatment. The additional suspended solids would not break down readily at the WPCPs thus having significant cost implications for sludge disposal and risking the ability to remove nitrogen at several WPCPs.



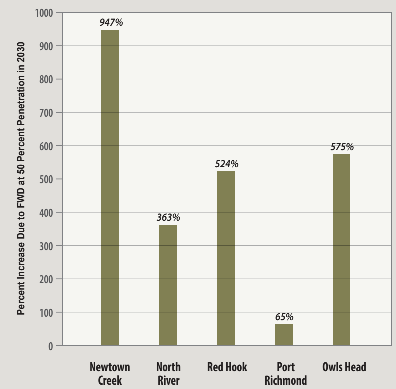
2. Nitrogen releases into waterbodies may exceed regulatory limits

Without additional capital investments, levels of nitrogen entering the East River and Jamaica Bay would either exceed or reach state and federal existing or potential limits intended to protect aquatic life.



3. Sludge production would rise

Adding food waste to wastewater would increase treatment demands at the WPCPs and would result in more sludge production.



4. Greasy deposits (or scum) could surge

Even with grease interceptors with FWDs, fats, oil, and grease (FOG) from food waste could present enormous challenges in the sewers and at WPCPs.

Thickeners: ■ ■	+2
Digesters*:	
Centrifuges**: ■ ■ ■ ■ ■	+5
Aeration Blowers: ■ ■ ■ ■ ■ ■ ■	+7
Primary Sludge Pumps: ■	+1

* While no new digesters are assumed, additional heat exchangers and associated boiler capacities will need to be increased to accommodate additional sludge from food waste.

** The centrifuges proposed for Bowery Bay, Red Hook, and Tallman Island are replacements with larger capacity units.

5. New equipment at the plants would be needed

Some 19 pieces of equipment, as well as greater capacity for heat exchangers and storage tanks, would be needed at the WPCPs to handle the demands of food waste at 50% penetration rate.

FIGURE S-4 Summary of Potential Impacts of Commercial Food Waste Disposers at the Water Pollution Control Plants (2030, 50% penetration)

12.30.08

IMPACTS ON THE BIOLOGICAL NUTRIENT REMOVAL (BNR) PROGRAM

Due to the high nitrogen content of food waste, allowing FWDs would impact nitrogen loadings at the WPCPs and jeopardize the City's BNR program. Excessive nitrogen discharges contribute to hypoxia, a condition in which water does not have enough oxygen to support fish and other aquatic life. Nitrogen discharges contribute to hypoxia by encouraging the growth of planktonic algae, which consumes oxygen during the decaying process. Both the Long Island Sound and Jamaica Bay suffer from low dissolved oxygen and episodic hypoxia. Through various studies and Consent Orders with the State[1], nitrogen discharge limits have been or are currently being established for WPCPs in the East River and Jamaica Bay. For the East River, the final mandated nitrogen limit is 44,325 pounds per day (lbs/d) starting January 2017.[2] This number reflects the combined effluent nitrogen limits of six WPCPs—the Upper East River plants (Tallman Island, Bowery Bay, Hunts Point, and Wards Island) and the Lower East River plants (Newtown Creek and Red Hook).[3] Jamaica Bay is subject to an effluent nitrogen limit of 45,300 lbs/d starting January 1, 2009. This number reflects the combined effluent nitrogen limits of the four WPCPs that discharge effluent to Jamaica Bay: Rockaway, Jamaica, 26th Ward, and Coney Island. However, discussions with the NYSDEC are ongoing and will likely result in more stringent nitrogen limits.

Implementation of BNR will enable NYCDEP to substantially reduce the amount of nitrogen discharged from WPCP effluents. BNR is accomplished by modifying the secondary treatment process to grow specialized organisms that can convert ammonia to nitrogen gas and remove it from the wastewater. This requires a larger solids inventory in the aeration basins, achieved by running at a higher solids concentration in the basins or by increasing the aeration volume, and compartmentalization of the aeration tanks into zones that are aerated (aerobic) and zones that are not aerated (anoxic). In addition, special processes have been added to remove the ammonia from the liquids recycled from sludge processing. At present, NYCDEP is spending over $1.4 billion to comply with these stringent limits with upgrades such as aeration system upgrades, froth control systems, alkalinity addition systems, and return activated sludge upgrades at the East River and 26th Ward WPCPs.

The most significant impact of FWDs on the process performance at BNR plants would be decreased nitrification due to lower solids retention time (SRT). To remain in compliance with NYSDEC nitrogen limits in the East River, at penetration rates over 25 percent, either Wards Island or Bowery Bay WPCP would need to construct an alternate BNR process that would be more effective than the current treatment process, such as biological denitrification filters. Biological denitrification filters at Wards Island or Bowery Bay WPCP would cost

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[1] The current nitrogen limit if 108,375 lbs/d. By January 2017, the nitrogen limit will be 44,325 lbs/d and The April 2002 Nitrogen Consent Order required that the City design and implement BNR upgrades in accordance with United States Environmental Protection Agency-approved TMDL requirements and based on recommendations of the Long Island Sound Study. The 2006 Nitrogen Consent Judgment modified the 2002 Nitrogen Consent Order and includes nitrogen upgrade activities, construction schedules and limits that collectively represent a reasonable and appropriate program to meet the long-term nitrogen reduction goals of the original Nitrogen Consent Order and the Long Island Sound TMDL.

[2] As set forth in the 2006 Nitrogen Consent Judgment, effluent nitrogen limits will become increasingly stricter as construction of BNR improvements are completed.

[3] The specific formula is Upper East River WPCPs Nitrogen Discharge + (Lower East River WPCPs Nitrogen Discharge/4) = Combined Nitrogen Discharge.

approximately $650 million or $310 million, respectively. Nitrogen limits for Jamaica Bay are expected to be required in the near future and, with FWDs, denitrification filters at 26th Ward (at a cost of $240 million) would likely be required. Capital improvements at these plants would be extremely difficult due to lack of available land. At Bowery Bay WPCP, the implementation of dentrification filters would require filling in and construction within the bay to the northeast or demolishing the existing aeration tanks and installing denitrification. The costs for filling in the bay are estimated at $81 million, but the required approvals would be difficult to obtain; the costs for replacing the existing aeration facility and replacing with denitrification would be significantly higher as secondary treatment would need to be maintained during construction. Due to the anticipated challenges in obtaining approvals and the significant costs for alterative construction options at Bowery Bay WPCP, denitrfication filters are assumed at Wards Island WPCP for this analysis.

IMPACTS ON NEWTOWN CREEK WPCP

The City has invested almost $4 billion to bring Newtown Creek WPCP up to federally mandated secondary treatment requirements and to implement other improvements. The upgrade, taking over a decade of construction, will be completed in 2013. The Newtown Creek WPCP serves lower Manhattan and areas of Brooklyn and Queens that contain high concentrations of FSEs. With substantial penetration of FWDs in the Newtown Creek service area, organic loadings to the plant would increase, jeopardizing secondary treatment. Loadings of total suspended solids (TSS) would increase by 19 percent and biochemical oxygen demand (BOD) by 25 percent. The most significant impact would be the lower solids retention time from the addition of food waste. The Newtown Creek WPCP is extremely land constrained and as a result will not be constructing primary tanks; thus, its secondary treatment process operates with a low SRT of 2.2 days on average and 1.8 days under maximum month conditions (conventional secondary process requires a 4–6 day SRT). It is projected that the food waste loading associated with a 50 percent FWD penetration rate would drop the SRT to less than 1.6 days and would likely jeopardize attaining secondary treatment standards.

At the Newtown Creek WPCP, which does not have primary tanks, much of the food waste solids would be incorporated directly into the aeration tank portion of secondary treatment. This would result in an increase in the amount of waste-activated sludge to be pumped from secondary treatment and would also increase demand for blowers. In addition, scum associated with FWDs would collect and become entrapped in the baffled aeration tank, where it could result in foam levels that could adversely affect the secondary treatment process and carry over into the anaerobic digesters.

Newtown Creek WPCP has limited excess organic loading capacity and the additional loadings from FWDs could jeopardize permit limits and secondary treatment requirements. Should this loading capacity be exceeded, primary tanks would be required at an enormous cost to the City. Severe space limitations at the plant would potentially dictate that the primary tanks be decked over existing plant process and would add considerably to these costs.

At the Newtown Creek WPCP, the increase in scum volume due to commercial FWD use would be many times what the plant currently experiences and handles. Fats, oils, and grease inputs could increase ten-fold. In addition to labor and operational concerns, additional costs would be associated with carting and disposing of the scum removed from the plants.

IMPACTS ON SOLIDS HANDLING AND SLUDGE MANAGEMENT

The increase in flows and loads from using commercial FWDs would result in increased sludge production and solids handling. To accommodate this added demand, additional equipment (i.e., thickeners, centrifuges, and sludge storage tanks) would be required. The additional sludge could require additional processing and transport. Additional trucks would be needed to cart the 296 tpd of dewatered sludge for additional processing so that it can be beneficially reused. These trucks would substantially offset reductions in commercial waste hauling trucks from FWD use.

IMPACTS ON SECONDARY TREATMENT AT THE REMAINING WPCPS

Evaluations of the potential impacts from commercial FWDS on secondary treatment at the North River, Red Hook, Owls Head, and Port Richmond WPCPs were analyzed. The analysis concluded that allowing the use of commercial FWDs in New York City would result in the need for significant additional capital investments in the form of new and increased capacity for aeration blowers and sludge pumping from secondary treatment tanks.

IMPACTS OF FATS, OIL, AND GREASE

FOG contained in the food waste would increase the FOG loadings at the plants and affect both primary and secondary treatment. The additional FOG would increase the amount of scum that would accumulate and need to be removed from the surface of the primary sedimentation tank. At Newtown Creek alone, FOG loadings could increase tenfold.

IMPACTS ON COSTS (CAPITAL AND OPERATION AND MAINTENANCE) AND RATEPAYERS

As shown in **Table S-2** and **Figure S-5**, use of commercial FWDs at a 50 percent penetration rate would result in the need for very costly investments of $1.3 billion to $1.7 billion. Should primary tanks be required at Newtown Creek WPCP, an additional investment of $1.7 billion would be required, for a total of $3.0 billion to $3.4 billion. Annual O&M costs would be $34.3 million to $35.3 million a year. Additional investments and maintenance would be needed for the sewer system; cost estimates were not made for these programs due to the severity of cost implications absent these programs.

Table S-2
Summary of WPCP Costs with Implementation of Commerical FWDs

FWD Tactic	Capital Costs	Annual O&M Costs
Newtown Creek (without and with Primary Tanks)	$2.6 Million-$1.7 Billion	$1.2 Million - 2.2 Million
Wards Island Denitrification Filters	$650 Million	$3.8 Million
26th Ward Denitrification Filters	$240 Million	$2.1 Million
Solids Handling Upgrades	$128 Million	$23.3 Million
Secondary Treatment Upgrades	$5.2 Million	$3.2 Million
Additional Water Supply/Conservation	$193 Million	
Stormwater Management/CSO Abatement	$66-$440 Million	
Total	**$1.3B-$3.4B**	**$33.6 M- $34.6 M**
Note: * All costs are in 2008 dollars		

These costs represent NYCDEP's entire capital program for one year. In the current economic climate, and with NYCDEP already struggling to meet its regulatory mandates and repair needs under an increasingly constrained budget, it can ill-afford these investments.

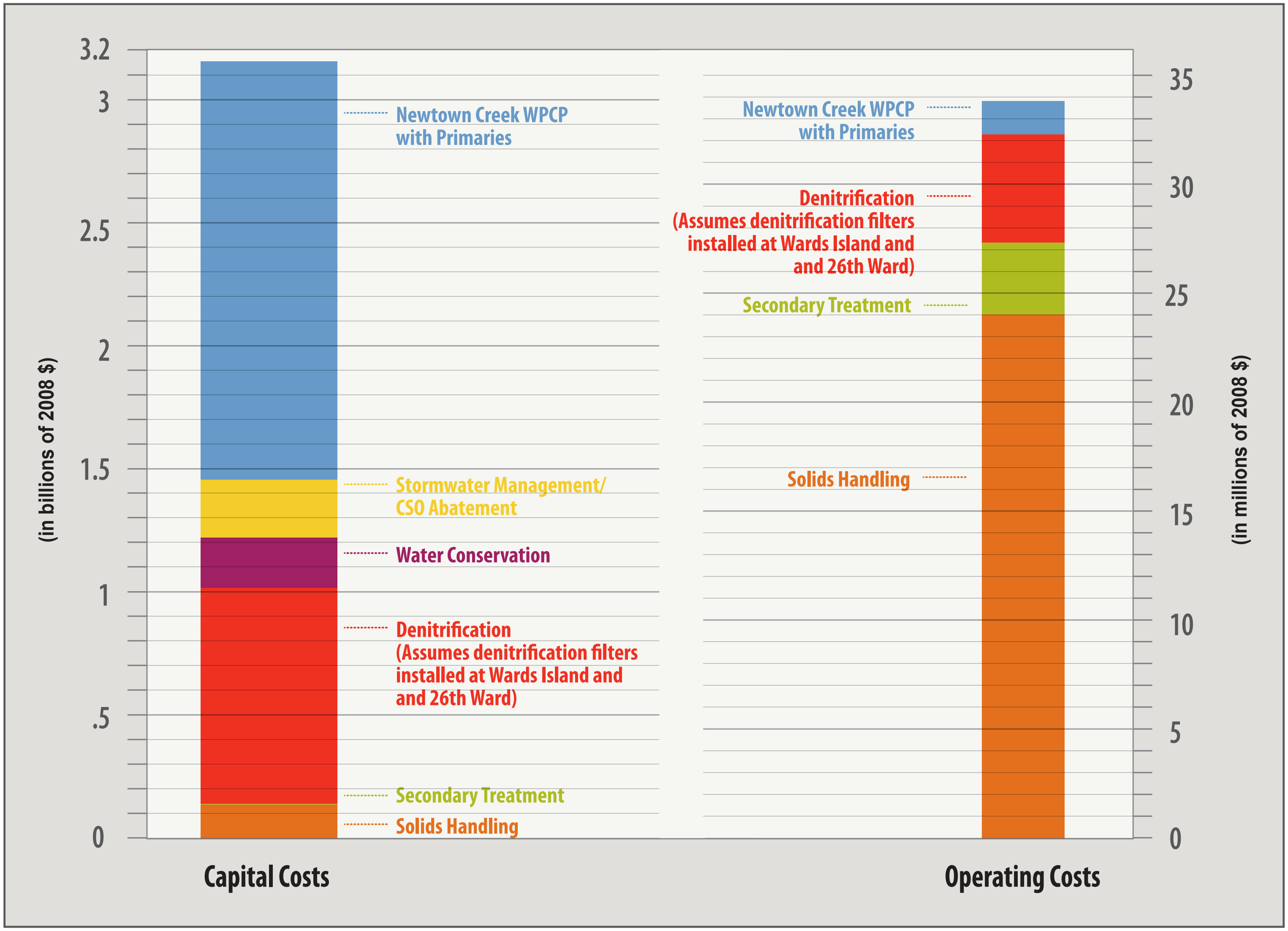

FIGURE S-5 Summary of Capital Investment and Operational Costs with Food Waste Digestors (2030, 50 percent penetration)

The costs presented are likely to be underestimated due to numerous unknowns at this time. All costs are based on conceptual level designs. When more detailed design is done, costs often increase significantly due to new needs that are identified related to limited space, electricity constraints, and myriad other miscellaneous costs that become apparent upon more detailed evaluation. In addition, land acquisition and/or landfilling costs were not included in the estimates. Lastly, the costs do not include severe penalties that would be incurred by the City for violations of Consent Orders, Consent Judgments, and permit limits.

These costs would be borne by New York City's sewer ratepayers at an increase up to 3-6 percent per year. Considerable public opposition to NYCDEP's rate increases already exists. Burdening the rate payers with an increased charge to offset the costs of private enterprise requires consideration.

Alternatively, these investments could be paid for by FSEs through a user surcharge. With approximately 5,500 FSEs that may install these devices (at 50 percent penetration), this would amount to up to an additional $25,000 to $45,000 per FSE per year, which would make installation of FWDs prohibitive for most FSEs and offset most, if not all, financial incentives they could provide.

4. CASE STUDIES: A SNAPSHOT OF IMPACTS AT THE LOCAL LEVEL

In addition to potential overall citywide benefits and impacts that could result from using FWDs, there would be specific benefits and impacts in local communities. These include both potential benefits (e.g., FSEs that could benefit from FWD implementation, less truck traffic from solid waste disposal, and less air, noise, and odor pollution along truck routes) and potential adverse impacts (e.g., additional sewer backups or additional discharges into local waterbodies) in these communities.

Four study areas were analyzed for the study: Brooklyn Community Board 1, Bronx Community Boards 1 and 2, and Manhattan Community Board 3, and Staten Island Community Board 1. The study areas were selected because they are food waste generating and/or receiving areas:

- A food waste generating area is an area that contains a high concentration of FSEs. These communities could benefit from FWDs through potential reductions in trucks that pick up waste. On the other hand, these communities would face increased discharges into the sewer system.
- Receiving areas are communities with commercial putrescible transfer stations that could benefit from FWDs through a reduction in truck traffic to and from these transfer stations and a potential reduction in waste volumes being processed at these transfer stations. A relatively small number of neighborhoods contain operating transfer stations.

Community Board 3 in Manhattan was selected due to the high concentration of restaurants and retail food establishments in the area. It is considered to be a food waste generating area. The area discharges to the Newtown Creek WPCP.

Community Board 1 in Brooklyn is both a generating and receiving area due to its concentration of FSEs in residential and commercial neighborhoods and the concentration of transfer stations in manufacturing areas. The Newtown Creek WPCP is located in this community board.

Community Boards 1 and 2 in the Bronx are mainly a receiving area, with its transfer stations located in Hunts Point and Port Morris south of Bruckner Boulevard; however, there are also a few waste generating communities north of Bruckner Boulevard. The Hunts Point WPCP is located in Community Board 2.

Community Board 1 in Staten Island is a generating area. Although it does not have commercial transfer stations, the Port Richmond WPCP is located in this community board.

Figure S-6 summarizes the possible benefits and impacts that would result in each of these four neighborhoods.

As documented in the case studies, even if FWDs were to be implemented in a limited area of the city, there would be few benefits expected, with a high risk to the wastewater system. A limited area implementation would demonstrate few, if any, truck trip and solid waste volume reductions. Further, due to the current and future constraints and stringent regulatory requirements placed on the City's wastewater infrastructure, even small contributions could present considerable risks of violating standards and mandates at many of the City's WPCPs. Moreover, it would be difficult to trace the cause and effect to FWDs in such a large system. By the time the adverse effects may make themselves known, it could be too late to make the infrastructure investments needed to address the problems, especially given the long lead times often between 10-20 years necessary to design, permit and construct the infrastructure. Lastly, while there are a few WPCPs that are not as heavily constrained, they are typically located in areas with far fewer FSEs, hence fewer benefits from FWD implementation, and would not be representative of implementation at most of the other City plants.

The specific reasons for why a limited area implementation would not provide adequate information on environmental benefits and impacts are elaborated below and include:

- Environmental benefits from a FWD implementation pilot would be negligible. Since many private haulers pick up from a given neighborhood or a given street, local truck trips would not appreciably decrease. Solid waste reductions from a limited area could be spread out among many transfer stations as private haulers are able to choose the most advantageous transfer station for each truck. Any truck trips reduced would at least be partially offset by additional sludge disposal trucks. Thus, truck trips would not appreciably be reduced.
- Many of the city's WPCPs are highly constrained and implementation in the areas served by these plants could trigger the need for expensive infrastructure investments. In areas with less constrained systems, a limited area implementation would not be indicative of impacts in most other areas of the city. WPCPs with fewer constraints tend to have fewer FSEs.
- Furthermore, the effects of implementation in a limited area would be difficult to detect. Facility upgrades often need to be planned at least 10 years in advance to allow time to design and construct the facility while remaining in compliance with current and future regulations.
- As described in this study, treatment facilities and sewers were designed to carry sanitary flow and stormwater away from properties, and were not designed to handle grease. Implementation of FWDs in a concentrated area could have localized impacts on the sewer system and could exacerbate sewer back ups and CSOs.

Case Study 1—Manhattan Community Board 3 is a food waste generating community due to the high concentration of restaurants and retail food establishments. With the use of FWDs, Manhattan CB 3 could see the diversion of 30 tpd from curbside pickup to the sewer system.

Bronx Community Board 1 and 2

- Potential FSEs that could use FWDs = 213
- Estimated Food waste generation from likely FSEs
  50% penetration = 11 tpd
- Truck trip reduction from transfer station
  50% penetration = 12
- Sewer Backups and Notices of Violations would be exacerbated

Manhattan Community Board 3

- Potential FSEs that could use FWDs = 642
- Estimated Food waste generation from the FSEs
  50% penetration = 30 tpd
- Sewer Backups and Notices of Violations would be exacerbated

Brooklyn Community Board 1

- Potential FSEs that could use FWDs = 312
- Estimated Food waste generation from likely FSEs
  50% penetration = 13 tpd
- Truck trip reduction from transfer station
  50% penetration = 6
- Sewer Backups and Notices of Violations would be exacerbated

Staten Island Community Board 1

- Potential FSEs that could use FWDs = 212
- Estimated Food waste generation from likely FSEs
  50% penetration = 10 tpd
- Sewer Backups and Notices of Violations would be exacerbated

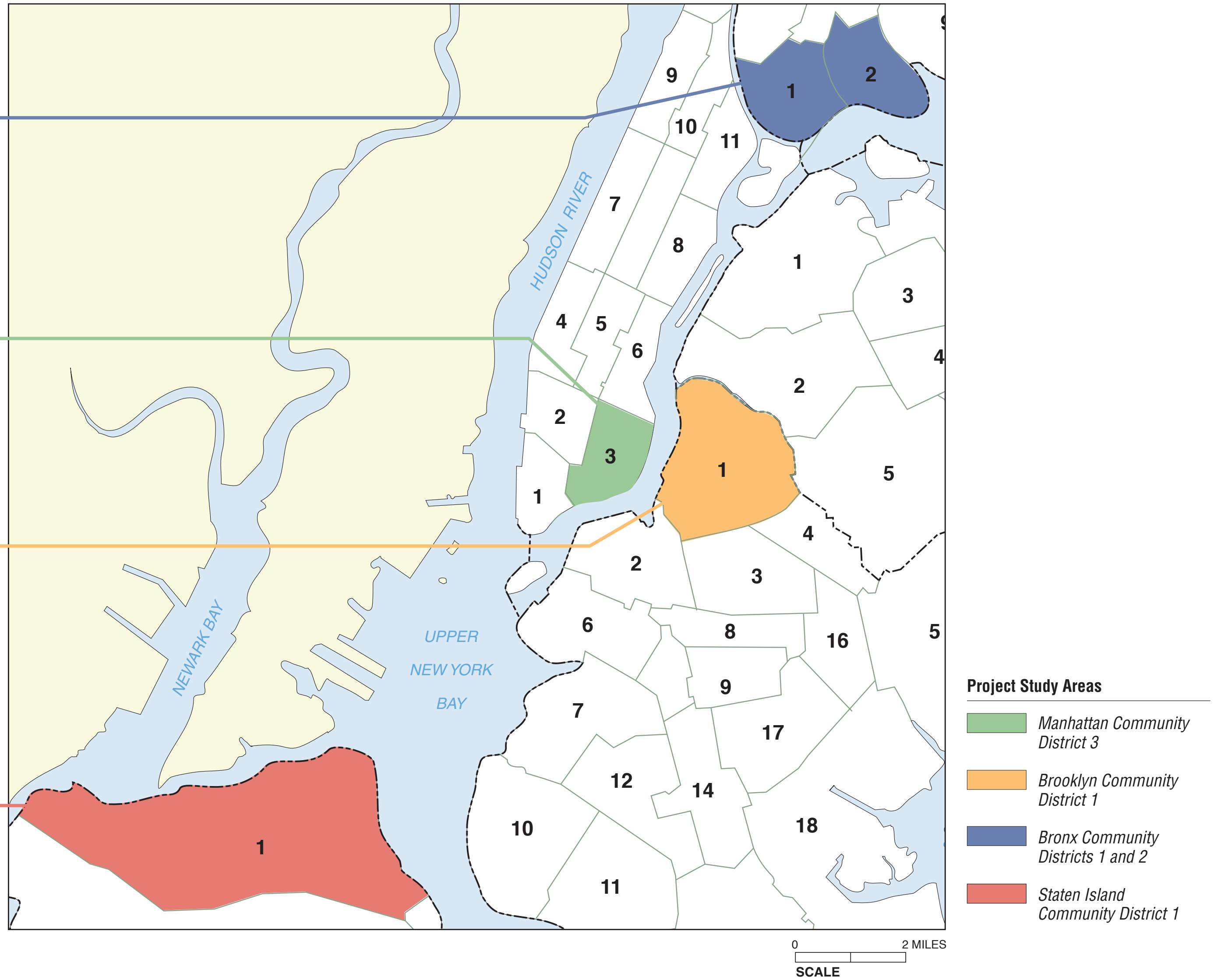

FIGURE S-6 Summary of Potential Effects in the Representative Study Areas

- Diverting 30 tpd from curbside collection could reduce up to three truck trips a day; however, due to the large number of haulers serving this area, it is likely that fewer trucks would be reduced.
- Even with grease interceptors, additional loadings, particularly of FOG from FWDs, would be considerable and could have the potential to constrain sewer capacity and also increase the potential for sewer backups and related maintenance and odors in the sewer system. Sewer backups occur throughout Manhattan CB 3, particularly on the Lower East Side.
- The 30 tpd of food waste would flow to the Newtown Creek WPCP in Brooklyn. Since Newtown Creek is a secondary treatment plant without primary tanks, the addition of food waste in the Newtown Creek drainage area would reduce the solids retention time, jeopardize secondary treatment, and likely require the construction of primary tanks. Newtown Creek WPCP has been undergoing a lengthy upgrade to maintain appropriate secondary treatment levels, constructing primary tanks would require years of additional construction which would greatly impact Brooklyn Community Board 1.

Case Study 2—Brooklyn Community Board 1 is a food waste generating community due to the high concentration of restaurants and retail food establishments in its residential and commercial districts and a receiving community due to the high concentration of transfer stations in its manufacturing districts. As a generating community, Brooklyn CB 1 could see the diversion of 15 tpd of food waste from curbside pickup at its FSEs to the sewer system. As a receiving community, Brooklyn CB 1 would see an approximate diversion of 140 tpd of food waste from the commercial putrescible transfer stations.

- There is not expected to be a substantial reduction in waste hauling trucks traveling *TO* the transfer stations from areas within or outside this community board. As discussed in Manhattan CB 3 above, trucks serving FSEs are not expected to be appreciably reduced because of the existing collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pick up, and therefore may not be able to reduce truck trips.
- The implementation of FWD would see the largest reduction in truck trips from the reduction in waste trucked *OUT* of New York City from private transfer stations. Given the average amount of commercial putrescible waste leaving transfer stations (approximately 1,600 tpd) over 2007, approximately 75 trucks serve these stations. Approximately 140 tpd could be diverted from the transfer stations, resulting in a reduction of six truck trips that leave the transfer stations for export. This represents a small fraction of the number of truck trips servicing the transfer stations in this community board.
- Approximately 224 tpd of food waste would be diverted to the Newtown Creek WPCP, which is located in Brooklyn CB1. The plant would require additional construction as described above. In addition, since Newtown Creek does not have a dewatering facility, the additional sludge produced from food waste would need to be shipped, typically to Wards Island or Hunts Point WPCP for processing, and two additional marine vessels per week would be needed to transport the additional sludge.
- Since Brooklyn CB 3 is at the end of the Newtown Creek WPCP drainage area, food waste from all communities served by Newtown Creek would travel through its combined sewers. Even with grease interceptors, additional loadings, particularly of FOG from FWDs, would be considerable and could have the potential to constrain sewer capacity and also increase the potential for sewer backups and related maintenance and odors in the swer system.

Case Study 3—Bronx Community Boards 1 and 2 is generally a waste receiving community due to the high concentration of transfer stations in its manufacturing districts; however, there are a few food waste generating neighborhoods north of Bruckner Boulevard. The food waste generating areas in Bronx CB 1 and 2 would see the diversion of approximately 10 tpd from curbside pickup to the sewer system. As a receiving community, Bronx CB 1and 2 would see an approximate diversion of 270 tpd from the commercial putrescible transfer stations.

- There is not expected to be a substantial reduction in waste hauling trucks traveling *TO* the transfer stations from areas within or outside this community board. As discussed in Manhattan CB 3 above, trucks serving FSEs are not expected to be appreciably reduced because of the existing collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pick up, and therefore may not be able to reduce truck trips.
- The implementation of FWD would see the largest reduction in truck trips from the reduction in waste trucked *OUT* of New York City from private transfer stations. Given the average amount of commercial putrescible waste leaving transfer stations (approximately 3,000 tpd) over 2007, approximately 140 trucks serve this area. Approximately 270 tpd could be diverted from the transfer stations, resulting in a reduction of 12 truck trips that leave the transfer stations for export.
- This reduction would be offset by the addition of five trucks for sludge disposal (see "Potential Adverse Impacts," below), for a total reduction of 7 truck trips. This represents a very small fraction of the number of truck trips servicing the transfer stations in these Community Boards.
- At 50 percent penetration, approximately 60 tpd of food waste would be diverted to the Hunts Point WPCP, which is located in Bronx CB 2. Bronx CB 2 would be impacted by additional construction needed to handle the additional flows and loads from FWD implementation.
- Hunts Point WPCP primarily dewaters sludge from Owls Head, North River, and/or Newtown Creek WPCPs. Three additional marine vessels per week would carry the sludge to Hunts Point WCPP to be dewatered. The dewatering facility would generate more biosolids and five additional trucks would leave each day.
- Since Bronx CB 2 is at the end of the Hunts Point WPCP drainage area, food waste from all communities served by Hunts Point WPCP would travel through its combined sewers. Even with grease interceptors, additional loadings, particularly of FOG from FWDs, would be considerable and could have the potential to constrain sewer capacity and also increase the potential for sewer backups and related maintenance and odors in the sewer system.

Case Study 4—Staten Island Community Board 1 is a food waste generating community. With the use of FWDs, Staten Island CB 1 could see the diversion of 10 tpd from curbside pickup to the sewer system.

- Diverting 10 tpd from curbside collection could reduce up to one truck trip a day; however, due to the large number of haulers serving this area, it is likely that this reduction would not be realized. Therefore, few benefits would be accrued in this study area from commercial FWD use.
- Sewers in this area would be impacted by additional FOG in the sewer system. Even with grease interceptors, additional loadings, particularly of FOG from FWDs, would be considerable and could have the potential to constrain sewer capacity and also increase the potential for sewer backups and related maintenance and odors in the sewer system.

- The 10 tpd of food waste would flow to the Port Richmond WPCP. There may be implications for meeting secondary treatment requirements and additional equipment could be needed. The plant would not be a good indicator of impacts from FWDs that would occur at most plants in the city since it is not constrained due to nitrogen or other limits. ✷

Chapter 1: Introduction

1.1 ABOUT THIS STUDY

The New York City Department of Environmental Protection (NYCDEP) has undertaken this study pursuant to requirements under the City's approved Comprehensive Solid Waste Management Plan for the period of 2006 through 2025 (SWMP). The SWMP tasks NYCDEP, with support from the Department of Sanitation (DSNY) and the New York City Economic Development Corporation (EDC), to study the economic, engineering, and environmental impacts that commercial food waste disposers (FWDs) could have on NYCDEP infrastructure and operations and on the current land-based commercial waste disposal system. This study evaluates the environmental and economic impacts of these two approaches to commercial food waste disposal.

Image 1.1—***An example of a commercial food waste disposer. This study looks at the effects of allowing restaurants and other food service establishments to use these units throughout New York City.***

Currently, residential households are allowed to use FWDs.[1] It is anticipated that restaurants; institutions, such as universities and hospitals; and other food service establishments (FSEs) may be interested in installing FWDs. Use of the public wastewater system for food waste disposal could provide a financial incentive for these entities as they would avoid costs associated with disposal through private carters. FWDs could also reduce impacts associated with the current commercial putrescible waste disposal system, such as truck traffic and related air, noise, and other environmental impacts.

At the same time, allowing commercial FWDs may have a negative impact on the ability of New York City to meet its legal mandates for improving the quality of its waterways. New York City is investing billions of dollars to upgrade its water pollution control plants (WPCPs) and sewer infrastructure to address nitrogen removal, secondary treatment at the Newtown Creek WPCP, combined sewer overflows (CSOs), sludge management and disposal, and sewer backups. Further, additional water use associated with FWDs would affect gains made by NYCDEP from its water conservation program.

1.2 PUTRESCIBLE COMMERCIAL WASTE IN NEW YORK CITY

Each year, commercial entities, including FSEs, generate about 1.5 million tons of putrescible commercial waste, the industry term for garbage that contains organic matter (e.g., food waste) and decomposes quickly.[2]

Many garbage trucks, operated by private companies (DSNY does not pick up commercial waste), haul away this waste every day to a network of transfer stations throughout the city or directly out of state. While commercial waste is hauled away by private carters, DSNY picks up waste from institutions and also delivers the waste to putrescible transfer stations. At putrescible transfer stations, waste is processed for disposal at facilities outside New York City.

Throughout New York City, approximately 13,000 tons of putrescible and non-putrescible commercial waste is generated each day, with much of this waste ending up in landfills.[3] Approximately 5,000 tons per day (tpd) is commercial putrescible waste; food waste accounts for 1,640 tpd.[4]

The costs associated with managing commercial food waste disposal are considerable. Based on estimates developed for this study, an FSE that could be a candidate for a FWD currently pays private carters an average of about $127 a week to collect, transport, and dispose of its food waste. In addition to the costs associated with the current commercial waste disposal practice, truck traffic, air quality, odor, noise, vermin, and other environmental impacts burden several communities, especially those situated closest to the transfer stations.

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[1] The City Council voted to rescind the ban on residential FWDs and the Mayor signed the measure into law effective October 11, 1997. To date, it is estimated that less than 1 percent of households in New York City have installed FWDs.

[2] *Source*: Final Comprehensive Solid Waste Management Plan, September 2006, New York City Department of Sanitation (Final SWMP 2006).

[3] Commercial waste in this study does not include fill material.

[4] *Source*: Table 1.4-2, DSNY Commercial Waste Management Study (2004).

DSNY has recognized the importance of addressing the environmental and public health concerns associated with commercial waste transfer facilities in New York City and the heavy reliance on trucks for exporting the waste, often for long distances outside the city. In both the 2004 Commercial Waste Management Plan (CWMP) and the SWMP, DSNY outlined approaches it has since begun to implement to enforce and strengthen procedures at the transfer stations to minimize their impacts.

1.3 POTENTIAL IMPLICATIONS OF FOOD WASTE DISPOSERS

Sink discharges from FWDs would be conveyed through sewer mains to the City's 14 WPCPs, which screen and treat the flow before it is released into waterbodies surrounding New York City.

This study considers the range of effects, both adverse and beneficial, that could result from allowing the installation of FWDs. As discussed in this report, these impacts include possible economic, engineering, and environmental effects from FWDs on sewage treatment infrastructure, water use and quality, and other conditions.

THE CONCERNS

WATER SUPPLY

When using a FWD, drinking water is necessary to flush food waste down the drain, using more of a precious natural resource for non-potable reasons.

CLOGGING

While FWDs remove food from garbage cans and dumpsters, they present challenges for restaurants and other FSEs, such as maintenance and buildup of grease and solids in drains and plumbing. They also have the potential to clog themselves.

SEWER SYSTEM

FWDs cannot be used with grease traps but can be used with grease interceptors. Grease interceptors are quite large; it could be difficult to find the required space necessary for them in New York City. Even with a grease interceptor, FWDs exacerbate the fats, oil, and grease (collectively referred to by the acronym FOG) in wastewater by discharging into the City's sewer system. Additional FOG results in increased sewer maintenance for the City and incidence of sewer backups. In addition, if commercial FWDs were allowed, food waste in the sewers en route to the WPCPs would be discharged into New York City waterbodies during rain that triggers a combined sewer overflow.

WATER POLLUTION CONTROL PLANTS

Food waste in wastewater treatment facilities would affect the City's ability to meet nitrogen limits and maintain secondary treatment. It would also increase the amount of sludge generated and, thus, required to be disposed. These effects would require the City to implement additional capital investments and result in increased operational costs to be paid by New York City's sewer ratepayers.

THE BENEFITS

FSE EFFICIENCY

As explored in Chapter 5, use of FWDs could garner benefits to the individual users of FWDs and to sections of the city. FWDs could provide an easier, more efficient way to deal with food waste as well as cost savings to certain FSEs since they reduce the amount of putrescible solid waste that must be stored and discarded. Further, potential odors, vermin, and mess near garbage dumpsters could decrease.

TRUCK TRIP REDUCTION

With less solid waste sent to putrescible transfer stations, truck trip reductions of solid waste could result with large-scale implementation of FWDs. Reduced truck traffic could have localized benefits on communities near transfer stations.

BENEFICIAL REUSE

With respect to the final end use, some of the food waste would be broken down biologically in the WPCPs, with some increases in digester gas. This gas could be used in the boilers of some WPCPs to provide heat for the treatment process. Food waste that is ultimately entrained in the sludge would also be reapplied as fertilizer and other beneficial end uses, in contrast to the food waste component of solid waste, which is usually landfilled or incinerated.

1.4 STUDY APPROACH

The overall study began with a food waste characterization study to analyze the amount and composition of food waste generated by potential commercial FWD users. As part of this initial task, the numbers, types, and locations of FSEs throughout New York City that could be candidates to use FWDs were determined. Information on commercial food waste generation, composition, and disposal practices was studied. The physical and chemical composition of food waste, including solids, grease, and nitrogen, was analyzed as well.

Based on the results of this assessment, the impacts on the City's ability to meet water quality standards and mandates, WPCP discharge quality, sewer system maintenance and backups, and water use and energy use were evaluated. The potential changes on the current and planned land-based disposal system were reviewed, as they relate to food waste disposal, to examine economic and environmental impacts.

The economic implications of the two disposal methods were evaluated to determine the relative cost savings for FSEs in comparison to potential increases to sewer ratepayers citywide that would need to bear the costs associated with wastewater infrastructure upgrades if commercial FWDs are permitted. Neighborhood-scale case studies were conducted to depict the advantages and disadvantages that FWDs would provide in specific areas of the city.

1.5 HOW THIS REPORT IS ORGANIZED

Following this Introduction, **Chapter 2** provides more background details on how commercial food waste is currently managed in New York City today, the costs and other effects of the current disposal practices, and any planned changes that may affect solid waste disposal practices.

Chapter 3 provides in-depth information on FWDs, including technical specifications of the units, how they work, and how they are used in other municipalities across the country along with the experiences of those users with the FWDs.

Chapter 4 describes the potential users of FWDs in New York City, the waste characterization of food waste, and the estimated amount of food waste generated by these FSEs.

Chapter 5 discusses the range of possible economic and environmental benefits that could accrue to FSEs and the City with FWD implementation.

In the subsequent group of chapters, the possible environmental impacts on the City's sewer system of allowing commercial FWDs are analyzed in detail, including assessments of potential adverse effects on water supply (**Chapter 6**); the sewer network and CSOs (**Chapter 7**); and nitrogen removal, treatment capacity, sludge management, and other issues at the City's 14 WPCPs (**Chapter 8**).

Finally, **Chapter 9** takes a closer look at the potential impacts, both positive and negative, that could result from using FWDs in different New York communities. The benefits (such as less truck traffic for solid waste disposal) and impacts on wastewater collection in four case study areas of the city are presented. ✷

Chapter 2: Commercial Food Waste Disposal in New York City Today and Plans for the Future

2.1 INTRODUCTION

To better evaluate the possible effects of allowing food service establishments (FSEs) throughout New York City to use food waste disposers (FWDs), it is important to first understand commercial food waste generation and disposal practices (especially for those FSEs more likely to install FWDs), both today and as planned in the future, including how much it costs FSEs to dispose of their food waste. These issues are discussed first in this chapter. Later, the chapter presents an overview of New York City communities most affected by private waste transfer stations and outlines planned changes in future land-based private waste disposal.

2.2 WHO GENERATES COMMERCIAL FOOD WASTE TODAY

WHAT IS COMMERCIAL FOOD WASTE?

Commercial waste comprises 75 percent of the total solid waste stream in New York City and, unlike residential waste, is collected and managed by private carters, not the New York City Department of Sanitation (DSNY). Specifically, commercial food waste is part of the overall commercial putrescible solid waste stream. Commercial putrescible solid waste is the waste generated by the city's businesses that contains organic matter with the tendency to decompose and cause unpleasant odors.

HOW MUCH COMMERCIAL FOOD WASTE IS GENERATED?

Of the approximate 13,000 tons per day (tpd) of New York City's commercial waste that is either recycled or disposed, about 1,640 tpd (or about 13 percent) is commercial food waste.[1] This food waste is generated by a diverse number of commercial business types, which include institutions. Compared with other boroughs, commercial uses in Manhattan discard significantly more putrescible waste than the other boroughs. Specifically, more than two-fifths of this waste (41 percent) is generated in Manhattan, 20 percent in Queens, 19 percent in Brooklyn, 14 percent in the Bronx, and 6 percent in Staten Island.

HOW MUCH OF THIS FOOD WASTE IS GENERATED BY FSES LIKELY TO INSTALL FWDS?

For the purposes of this study, an FSE is an establishment that generates food waste in volumes large enough to make the installation of a commercial FWD potentially cost-effective. These establishments include restaurants, hotels, supermarkets, colleges, universities, hospitals,

[1] DSNY Final Comprehensive Solid Waste Management Plan, 2006 (SWMP) and DSNY Commercial Waste Management Study, 2004.

medical facilities, private schools, group residential facilities, day care facilities, nursing homes, and various other facilities.

Essentially, FSEs for this study include food purveyors operating from a location with a kitchen sink, where FWDs can be installed. For this reason, street vendors who sell food from mobile carts citywide are *not* considered FSEs for this study, even though they are considered servers of food in the general sense. Ice cream and frozen yogurt shops and fast-food outlets were also not included in the study because they too would be unlikely to install FWDs with their limited food preparation.

Public schools were not included in this study, not only because DSNY collects their waste, but in most instances food is prepared off-site and not served on plates. In addition, the City's 12 correctional facilities were not included in the study because the greatest source among them that generates food waste is Rikers Island, where food waste is already composted.

Information on the estimated food waste generation for FSEs as determined by this study can be found in Chapter 4.

2.3 HOW COMMERCIAL FOOD WASTE IS DISPOSED TODAY

Figure 2-1 illustrates the commercial food waste management process—from generation to ultimate disposal—in New York City today. Typically, a private establishment has an agreement with a private hauler to pick up its refuse.[1] The FSE puts out all of its waste for collection, typically five or more times a week; the waste is picked up by the hauler and trucked to a transfer station in the city or directly out of state. From the transfer station, the waste is usually trucked in larger vehicles outside the state to be either landfilled or incinerated.

Pursuant to the City's approved Comprehensive Solid Waste Management Plan for the period of 2006 through 2025 (SWMP), the majority of the City's DSNY-managed waste will be transported from the City via barge or rail from a mix of public and private facilities. The four converted marine transfer stations (MTSs) that DSNY will construct will handle DSNY-managed waste and some commercial waste. The waste accepted at the MTSs will be containerized and barged directly to disposal facilities out of the city or to intermodal facilities where the containers would be transferred onto railcars or marine vessels for out-of-City disposal. Also pursuant to the SWMP, DSNY has awarded two long-term contracts for the use of private transfer stations for the containerization and rail transport/disposal of all DSNY-managed waste from the Bronx and a portion of Brooklyn. DSNY will also award a third contract to serve a portion of Queens beginning in 2011. All three contracts require that any commercial waste accepted at these facilities will, by a specified date, also be required to be exported by rail.

HOW IS WASTE COLLECTED?[2]

All commercial waste in New York City, including food and other waste from FSEs, is collected by private licensed carters, and not by DSNY. The type of commercial customers serviced by these haulers is diverse. In addition to food waste, haulers may pick up paper, plastic, metal, glass, or wood. There are about 99,500 customers or businesses that procure commercial waste hauling services in New York City. Based on the 2007 Customer Register for the New York City

[1] For this study, public institutions that currently have their waste removed by DSNY were included.

[2] Information provided by the Business Integrity Commission (BIC).

1 Food waste is generated by restaurants and other users

Of the approximate 5,000 tons per day (tpd) of New York City's commercial putrescible waste that is either recycled or disposed, about 1,640 tpd is commercial food waste.

2 It is collected by private haulers

All commercial entities must make arrangements with private waste haulers to have their waste picked up, which can cost up to $10.42 per 100 pounds, according to BIC's maximum allowable rate cap.

3 Haulers truck the waste to transfer stations or directly out of the City

Most putrescible commercial waste ends up at one of the City's transfer stations, concentrated along the Brooklyn-Queens border and in the Bronx. Some waste is taken directly out of state by truck for disposal.

4 At the transfer stations, waste is sorted and loaded onto larger vehicles to be shipped out of the City

The transfer stations are busy operations and the source of neighborhood traffic, noise, air, and other related impacts. Only two transfer stations ship out commercial waste by rail.

5 Food waste eventually ends up in landfills or burned in incinerators

Commercial food waste typically ends up in facilities west and south of the city.

FIGURE 2-1 Commercial Food Waste Management Process

12.29.08

Business Integrity Commission (BIC)[1], there are 191 haulers that hold a license to remove putrescible waste, and of these, 68 haulers were actively collecting putrescible commercial waste as of December 2006.

Many of the private hauling firms are small to midsized, averaging between one and 10 trucks with some larger firms owning 40 or more vehicles. Haulers in New York City commonly use diesel-powered trucks, typically a mix of front-end or rear-loading trucks and roll-off trucks.

The frequency of pickups (daily or less regularly) varies, depending on the arrangement the FSE makes with the hauler. Haulers typically operate up to six days a week and can work hours around the clock for pickups and disposal of putrescible solid waste. Food waste customers, such as restaurants and food retail outlets, typically have the greatest need for regular pickups and require at least five or more pickups per week.

HOW IS THEIR WASTE TRANSFERRED?

Thousands of private carters' trucks laden with commercial putrescible waste from the City's FSEs wend their way every day from the pickup location through residential neighborhoods to designated truck routes and one of the 18 private transfer stations dedicated to handling putrescible waste. [2] The transfer stations are required to be operated in accordance with City and State rules and regulations to make sure they are safe and environmentally responsible.

Currently, about 85 to 88 percent of the putrescible commercial waste collected by carters is taken to privately run transfer stations in the city. At the transfer station, waste is sorted (i.e., recyclables are removed), compacted, and processed for its transfer to larger vehicles that haul the waste outside New York City to landfills or incinerators. The balance of the waste, about 12 to 15 percent of the total, is directly transported out of New York State to other transfer stations for sorting and processing or directly to disposal.

Figure 2-2 depicts the location of licensed putrescible transfer stations. Private transfer stations are typically located in M3 heavy manufacturing zones and, as shown in the figure, are concentrated along the Brooklyn-Queens border and in the Bronx. There are no private putrescible transfer stations currently in operation in either Manhattan or Staten Island; however, a City-owned and operated truck-to-container-to-rail transfer station, for DSNY-managed Staten Island waste only, operates in Staten Island. The proposed four converted marine transfer stations and the three private transfer stations awarded long-term export contracts for DSNY-managed waste are discussed further in Section 2.6 below.

HOW IS WASTE TRANSPORTED OUT OF NEW YORK CITY?

Except for two transfer stations (one in the Bronx and one in Brooklyn) that export containerized waste by rail to points outside New York City, private putrescible transfer stations export their waste by trucks. The truck routes most commonly used on outbound trips from the city are shown in **Figure 2-3**. The major ultimate destination points for commercial waste are west and south of the city, as are the major truck routes to such destinations, as highlighted in Figure 2-3.

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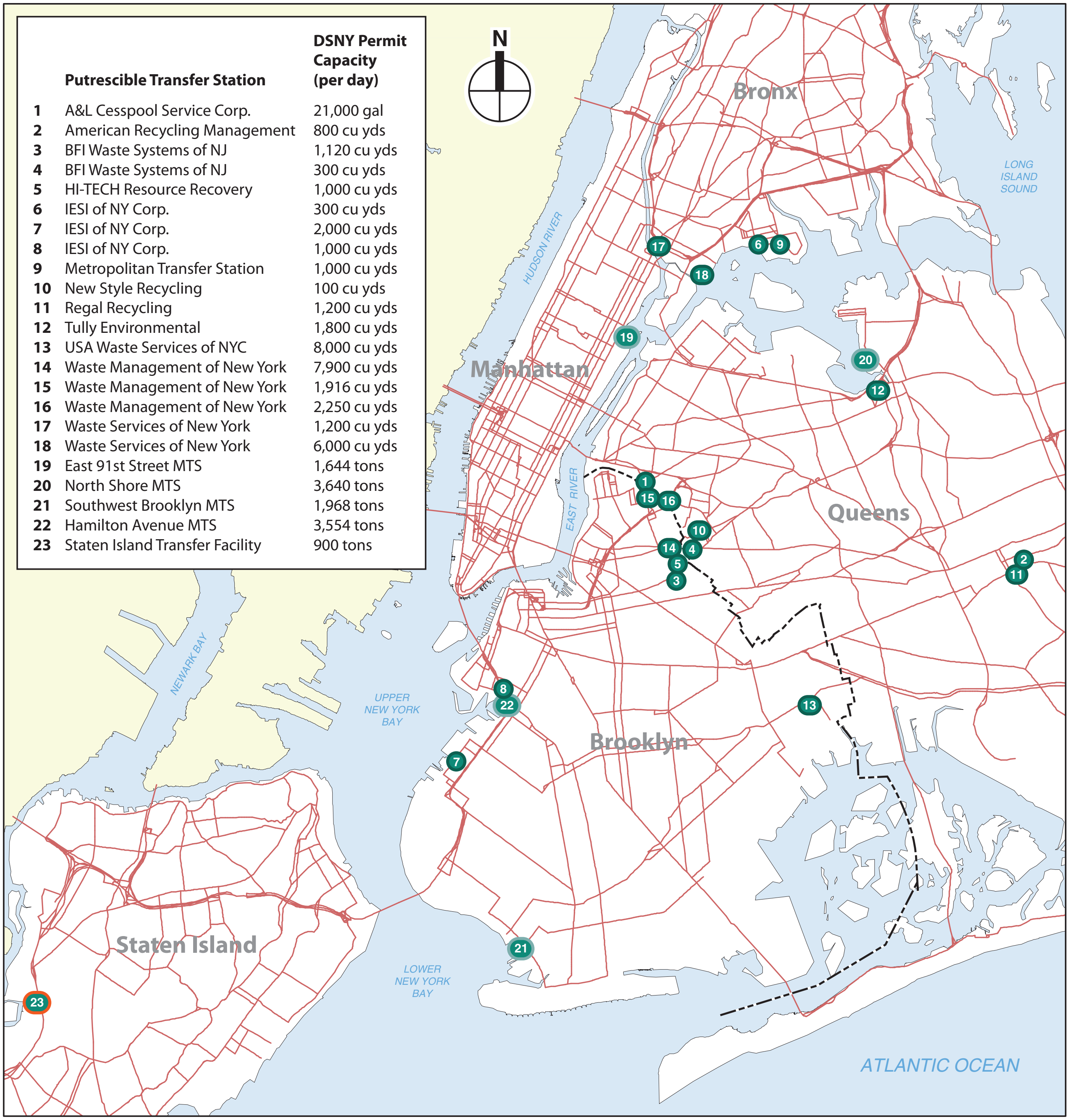
[1] BIC is the successor to the Trade Waste Commission created by New York City Local Law 42, Title 15-A, Title 17.

[2] Other waste transfer stations in the city handle non-putrescible waste or fill material from construction.



	Putrescible Transfer Station	DSNY Permit Capacity (per day)
1	A&L Cesspool Service Corp.	21,000 gal
2	American Recycling Management	800 cu yds
3	BFI Waste Systems of NJ	1,120 cu yds
4	BFI Waste Systems of NJ	300 cu yds
5	HI-TECH Resource Recovery	1,000 cu yds
6	IESI of NY Corp.	300 cu yds
7	IESI of NY Corp.	2,000 cu yds
8	IESI of NY Corp.	1,000 cu yds
9	Metropolitan Transfer Station	1,000 cu yds
10	New Style Recycling	100 cu yds
11	Regal Recycling	1,200 cu yds
12	Tully Environmental	1,800 cu yds
13	USA Waste Services of NYC	8,000 cu yds
14	Waste Management of New York	7,900 cu yds
15	Waste Management of New York	1,916 cu yds
16	Waste Management of New York	2,250 cu yds
17	Waste Services of New York	1,200 cu yds
18	Waste Services of New York	6,000 cu yds
19	East 91st Street MTS	1,644 tons
20	North Shore MTS	3,640 tons
21	Southwest Brooklyn MTS	1,968 tons
22	Hamilton Avenue MTS	3,554 tons
23	Staten Island Transfer Facility	900 tons

NYC DOT Truck Route

1 *Private Putrescible Transfer Station*

19 *Public Marine Transfer Station - Planned under DSNY Long-Term Solid Waste Export Plan*

23 *Public Putrescible Transfer Station*

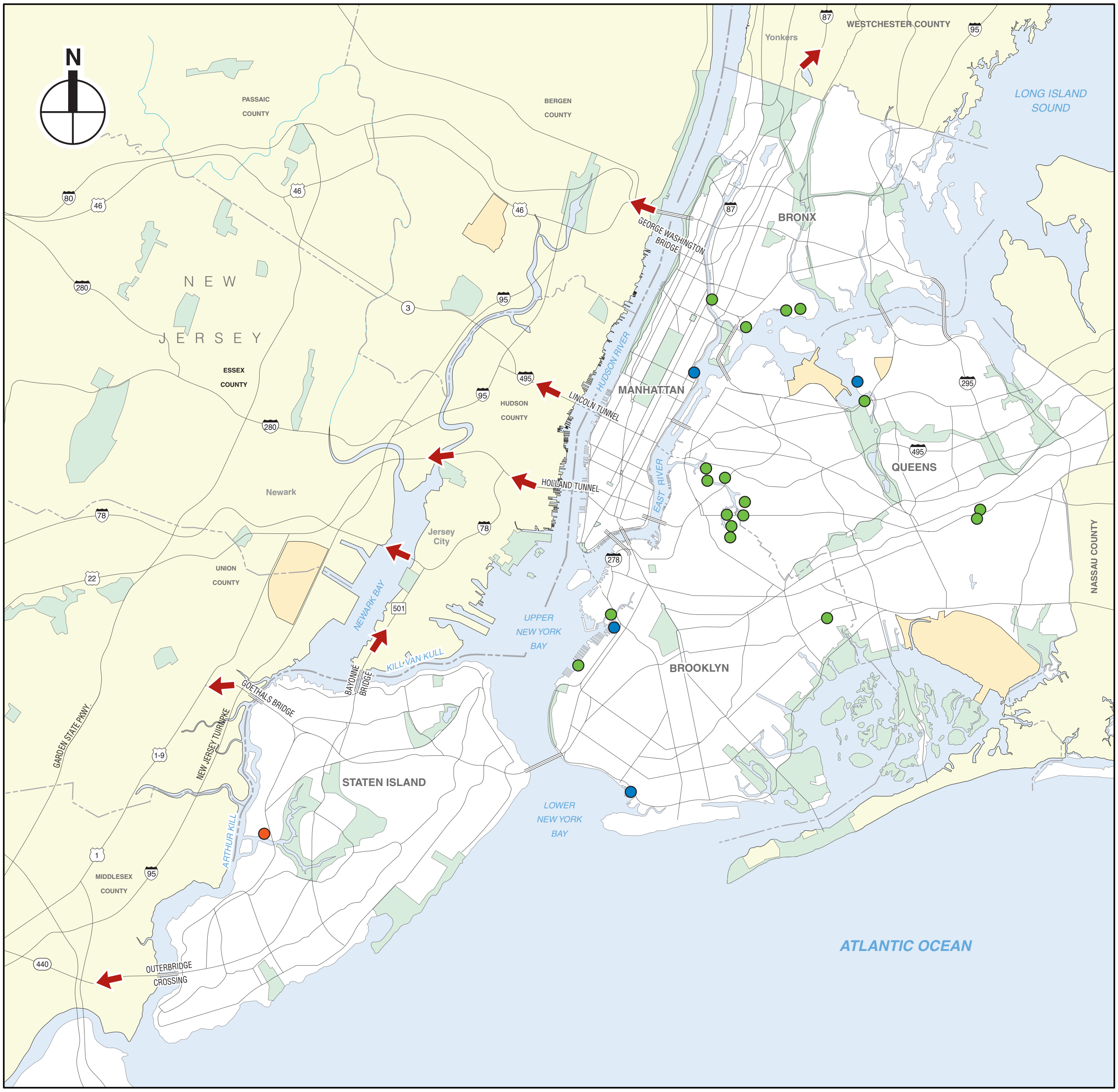
0 2 4 MILES

SCALE

FIGURE 2-2

Putrescible Waste Transfer Stations and Truck Routes in New York CIty

12.22.08



Truck Route Direction Leaving New York City

Private Putrescible Transfer Station

Public Marine Transfer Station - Planned under DSNY Long-Term Solid Waste Export Plan

Public Putrescible Transfer Station

0 2 5 MILES

SCALE

FIGURE 2-3 Truck Routes Leaving New York City

See Section 2.6 below for details on planned changes to the current practice of relying on trucks to transport commercial waste from transfer stations.

2.4 DISPOSAL COSTS OF COMMERCIAL FOOD WASTE[1]

Commercial establishments select a waste hauler, typically through word of mouth or by contacting the hauler directly. Larger businesses with procurement departments may use a bidding process in selecting a hauler. BIC surveys have shown that price charged is the biggest factor in choosing a hauler, followed by service frequency/quality, reputation, and an FSE's previous relationship with the hauler.

When selecting a hauler and negotiating a price, customers can request a waste stream survey at no cost to the customer; however, in practice a waste stream survey is rarely done.

Haulers may choose one of several pricing options for charging commercial waste customers. Food waste can be a relatively heavy form of putrescible waste; therefore, customers with food waste will typically pay toward the high end of the allowable solid waste disposal cost in New York City (i.e., currently $8 per 100 pounds, which equals $160 per ton). BIC recommended increasing the maximum allowable solid waste disposal costs in New York City to $10.42 per 100 pounds on December 26, 2008, and it is expected that FSEs would be charged toward this upper end after this rate change is put into effect.

2.5 EFFECTS ON COMMUNITIES FROM CURRENT LAND-BASED COMMERCIAL FOOD WASTE DISPOSAL

EFFECTS NEAR THE TRANSFER STATIONS

Transfer stations operating within the City are regulated and required to be permitted. Among other things, the permit process requires conducting an environmental review. The long-term export projects to be implemented pursuant to the SWMP are required to have permits to construct and operate and were the subject of a Final Environmental Impact Statement (April 2005) that found no potential significant adverse impacts that could not be mitigated.

DSNY's Commercial Waste Management Study (CWMS) analyzed three study areas (i.e., Bronx Community Boards 1 and 2, Brooklyn Community Board 1, and Manhattan Community Board 3) close to 43 transfer stations to determine the potential for overlapping environmental effects from the operation of these facilities. The study analyzed air quality, odor, noise, neighborhood character, and water quality, as well as traffic, air quality, and noise from off-site mobile sources and public health effects. The study recommended dust and odor-control systems for some types of transfer stations and enhanced enforcement by DSNY inspectors to prevent conditions at a transfer station that could lead to increased odors, dust, stormwater runoff, air, and noise pollution.

[1] Information provided by BIC.

*Image 2.1—**Truck traffic on the routes near waste transfer stations affects air quality, noise, and transportation.***

COMMUNITIES MOST AFFECTED BY TRANSFER STATIONS

The locations of transfer stations that handle putrescible waste are not evenly distributed across the city. As a result, a relatively small number of neighborhoods in New York City bear the burden of the environmental and other effects caused by the transfer stations that operate among them. At each of these areas, trucks ply the local roads at all hours, often traveling through otherwise quiet residential neighborhoods, to or from a nearby transfer station.

As shown in **Figure 2-4**, Brooklyn Community Board 1 has the highest concentration of putrescible transfer stations, with five stations located within its boundaries. Located nearby these five stations are two additional stations in the adjacent Queens Community Board 2 and one station in adjacent Queens Community Board 5. In addition to the putrescible stations, this area has a concentration of other waste transfer stations, with 12 in Brooklyn Community Board 1 and another three in the two Queens community boards. Bronx Community Boards 1 and 2 have four putrescible stations between them and an additional concentration of other waste transfer stations (see **Figure 2-5**). Brooklyn Community Board 2 and Queens Community Boards 2 and 12 have two putrescible stations located within their boundaries. Queens Community Boards 5 and 7, Brooklyn Community Boards 5 and 6, and Staten Island Community Board 2 have one putrescible station each.

Chapter 9 takes a closer look at the potential positive and negative effects that could result from using FWDs in four study areas: Brooklyn Community Board 1, Bronx Community Boards 1 and 2, Manhattan Community Board 3, and Staten Island Community Board 1.

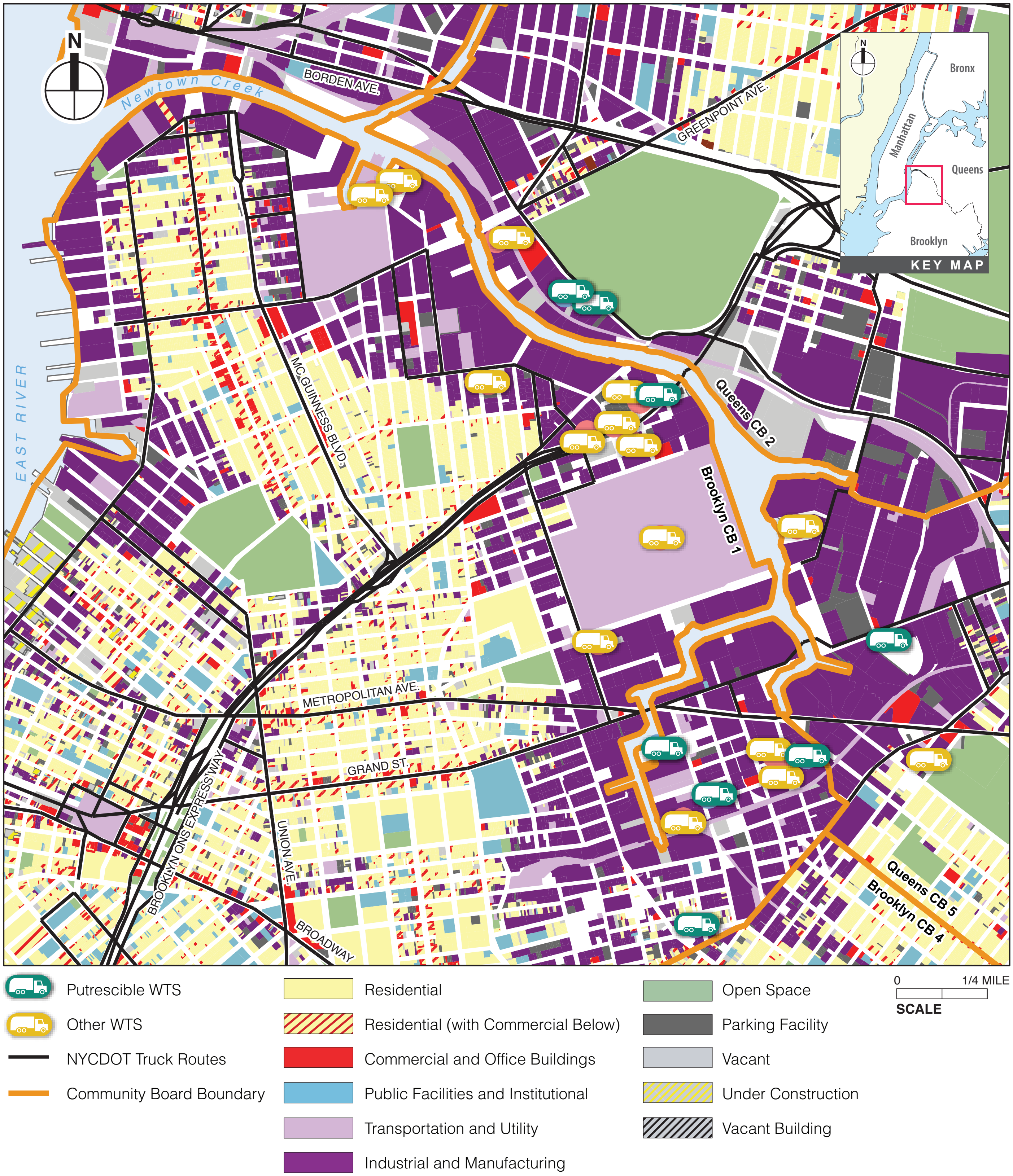
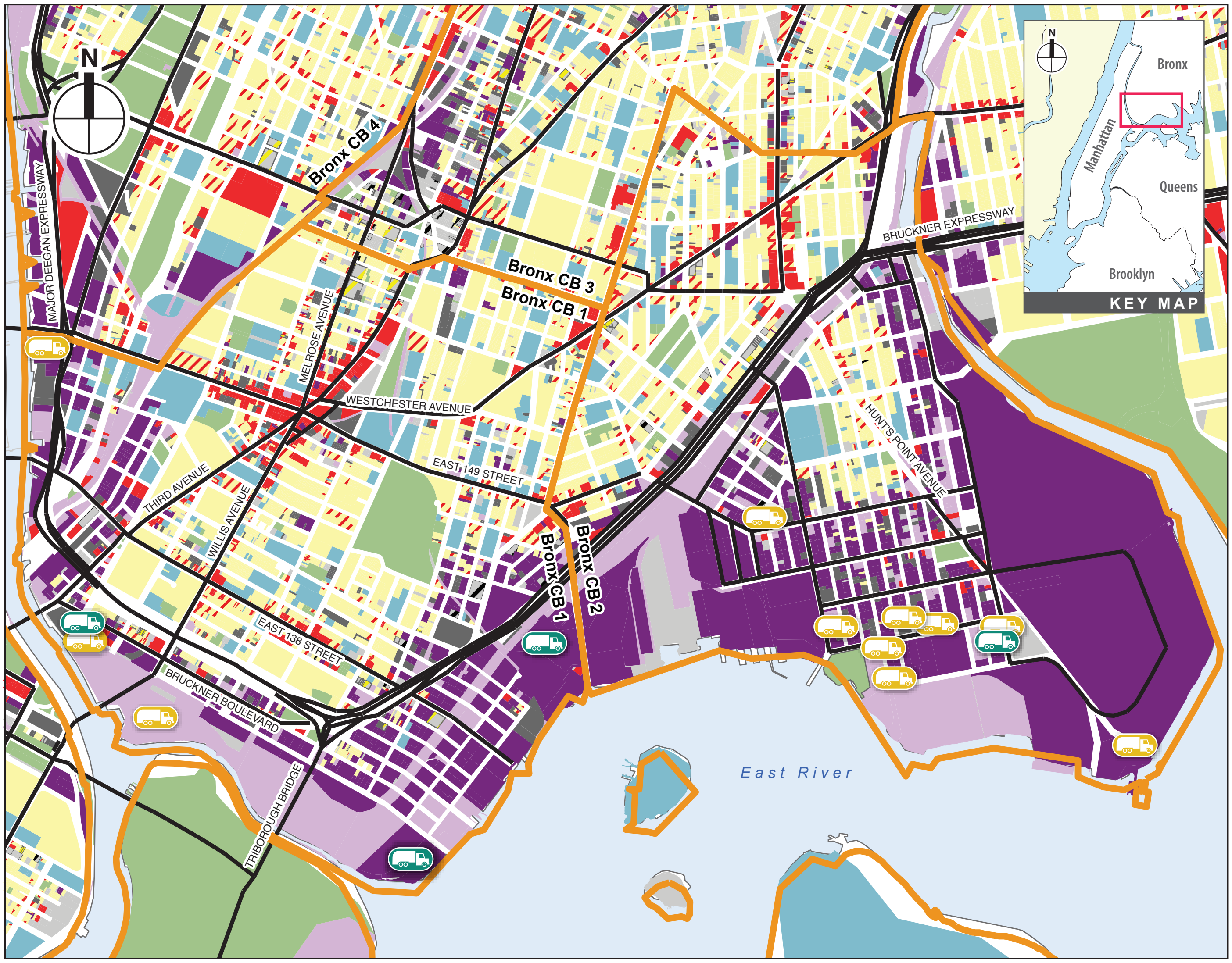


FIGURE 2-4 Brooklyn/Queens Border with a Concentration of Waste Transfer Stations



Putrescible WTS
Other WTS
NYCDOT Truck Routes
Community Board Boundary
Residential
Residential (with Commercial Below)
Commercial and Office Buildings
Public Facilities and Institutional
Transportation and Utility
Industrial and Manufacturing
Open Space
Parking Facility
Vacant
Under Construction
Vacant Building

0 1/4 MILE
SCALE

FIGURE 2-5 Bronx Community Boards with High Concentration of Waste Transfer Stations

2.6 PLANNED CHANGES IN FUTURE LAND-BASED PRIVATE WASTE DISPOSAL

DSNY is currently studying routing alternatives intended to lessen the effects of transfer station operations on local neighborhoods and address other effects associated with the current practice of land-based commercial waste disposal. To achieve the closure of the Fresh Kills landfill and implement the SWMP long-term export plan, DSNY entered into interim export contracts that involve trucking much of the waste collected by DSNY to disposal sites outside of the city. DSNY has and will continue to phase out these contracts as the long-term export plan, which is designed to maximize the transport of waste by barge and rail, is implemented. The long-term export plan is further described in the next section.

USING MARINE TRANSFER AND RAIL

Local Law 74, effective December 19, 2000, required a comprehensive assessment of how commercial solid waste is managed in New York City. DSNY issued a Commercial Waste Management Study in 2004 which formed the basis of the long-term export components of the SWMP. Pursuant to the SWMP, DSNY will construct converted MTSs, at which both DSNY-managed waste and some commercial solid waste would be put into sealed containers and transported by rail or barge directly to disposal facilities out of New York City or to intermodal sites where the barges would be transferred onto rail cars or marine vessels and transported for disposal. In addition, DSNY will award long-term service contracts for the use of private facilities in the Bronx, Brooklyn and Queens that will containerize and transport waste by rail to out-of-city disposal facilities. Any commercial waste accepted at these facilities will, by a specified date, also be required to be exported by rail. Finally, DSNY constructed, and has been operating since April 2007, the Staten Island transfer station—a truck-to-container-to-rail facility for DSNY-managed waste in Staten Island.

*Image 2.2—**DSNY will construct four marine transfer stations that will handle approximately 5,500 tons per day of the DSNY-managed waste generated in Manhattan, Queens and Brooklyn and some quantity of commercial waste. This MTS is the proposed Hamilton Avenue Converted Marine Transfer Station to be constructed in the Red Hook section of Brooklyn.***

The four MTSs to be constructed are the East 91st Street Converted MTS in Manhattan, the North Shore Converted MTS in Queens, and the Hamilton Avenue and Southwest Brooklyn Converted MTSs in Brooklyn. The projects that make up the SWMP long-term export program for DSNY-managed waste, including the four MTSs, the long-term service contracts for private facilities, and the Staten Island Transfer Station, are all expected to provide service by the end of 2012. The effect of this change on how DSNY-managed solid waste is transferred in and exported from the city will be dramatic in that it will greatly reduce the number of outbound trucks using local roads to export garbage to its final destination.

In addition to handling DSNY-managed waste, DSNY undertook studies and identified that the four converted MTSs could also handle up to approximately 3,900 tpd of commercial solid waste during between 8 PM and 8 AM daily (except Sundays), and, thus, a percentage of commercial food waste would likely be exported from these MTSs in the future.

ALTERING TRUCK ROUTES

As part of the SWMP, DSNY is also undertaking studies to determine alternative routes for trucks traveling to and from transfer stations to minimize impacts on surrounding neighborhoods. These studies are expected to be completed late in 2009. ✷

Chapter 3: About Commercial Food Waste Disposers

3.1 INTRODUCTION

An estimated 150,000 commercial food disposer units are currently used by the food service industry throughout the United States every day.[1] Notwithstanding their ease of use and benefits in reducing a food service establishment's (FSE) kitchen waste, as discussed earlier, commercial food waste disposers (FWDs) do present operational and maintenance issues for users. This chapter presents detailed information about commercial FWDs, including how they work, who uses them, and examples of where they are allowed.

3.2 WHAT ARE COMMERCIAL FOOD WASTE DISPOSERS?

Commercial FWDs are similar to disposers made for the residential market except they are larger, up to 10 times more powerful, and built for more intensive use. Mounted on their own or on a sink, the drum-shaped motorized units, commonly made of stainless steel, aluminum, cast iron, or metal alloys, grind up food waste (including bones, tough vegetable peelings, and more, according to manufacturer specifications) into small particles and enable it to be flushed away down the drain. **Figure 3-1** provides a conceptual step-by-step illustration of how commercial FWDs work.

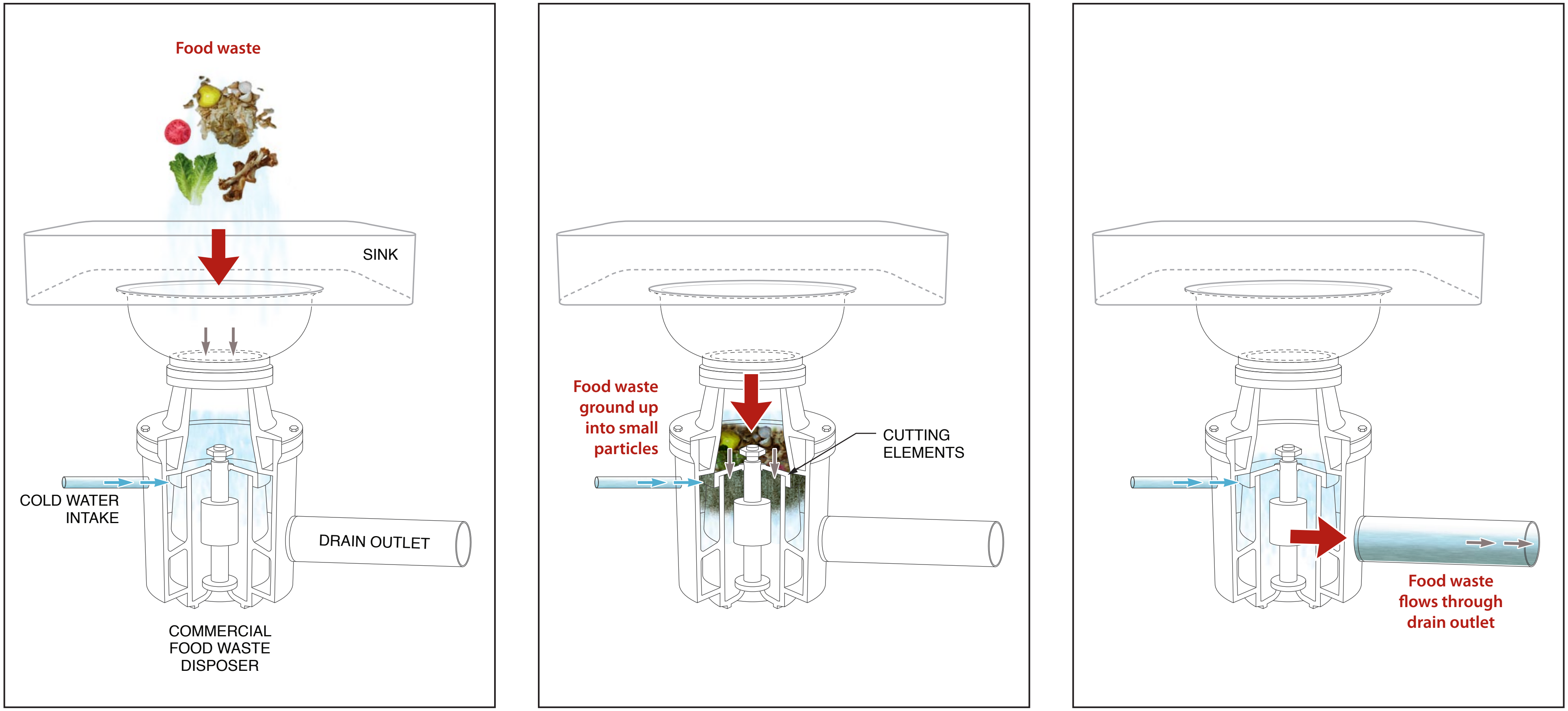
Commercial FWDs are available from manufacturers in a range of sizes. According to InSinkErator, one of the world's leading producers of disposers for the food service industry, smaller units, which are typically 0.5 to 1 horsepower (hp), can handle food waste generated by up to 100 people at a meal. Larger, 10-hp commercial FWDs can grind food waste—both in the kitchen trash and scraps left on the plates—of 2,500 diners. Manufacturers offer various options for the units as well, including electrical control panels, water-saving features, and other accessories.

The cost of commercial FWDs varies widely and depends on the power of the base unit. The cost of a FWD from InSinkErator and Salvajor, leading commercial disposer manufacturers, ranges from about $4,500 for a small 0.75-hp unit to over $8,000 for the largest unit with 10 hp, including water-saving controls. Complete FWD systems—including the base unit plus scrap basin, troughs, valves, pump, control panel, safety features, and other extras—run from $13,200 to $16,000, depending on the power of the base unit.[2] For this study, estimates of a basic unit with water-saving features and installation estimates are included in Chapter 5.

*Image 3.1—**A commercial food waste disposer**. Source: The Salvajor Company.*

[1] *Source*: The Salvajor Company, email communication, July 29, 2008.

[2] *Source*: www.salvajor.com, August 3, 2008; InSinkErator 2008 price list, fax in November, 2008.



1 Food waste disposed

Cold water is directed into the disposer's grind chamber when the unit is turned on. Fruit and vegetable peelings, bones, scraps, and food waste from dirty dishes and cookware are placed into the disposer.

2 Food waste ground up

Food waste is ground in the disposer's chamber into small particles.

3 Food waste flushed away

Food waste particles are flushed away with cold water to the sewer.

FIGURE 3-1 How Commercial Food Waste Disposers Work

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3.3 PLUMBING AND UTILITY CONSIDERATIONS FOR FOOD WASTE DISPOSERS

The conceptual illustration of how commercial FWDs operate (in Figure 3-1) depicts some of the primary components of a FWD in operation. In addition to the water supply, a nearby electrical supply to run the FWD is also required. Further, the discharge of the FWD has to be planned for within the plumbing constraints of the FSE.

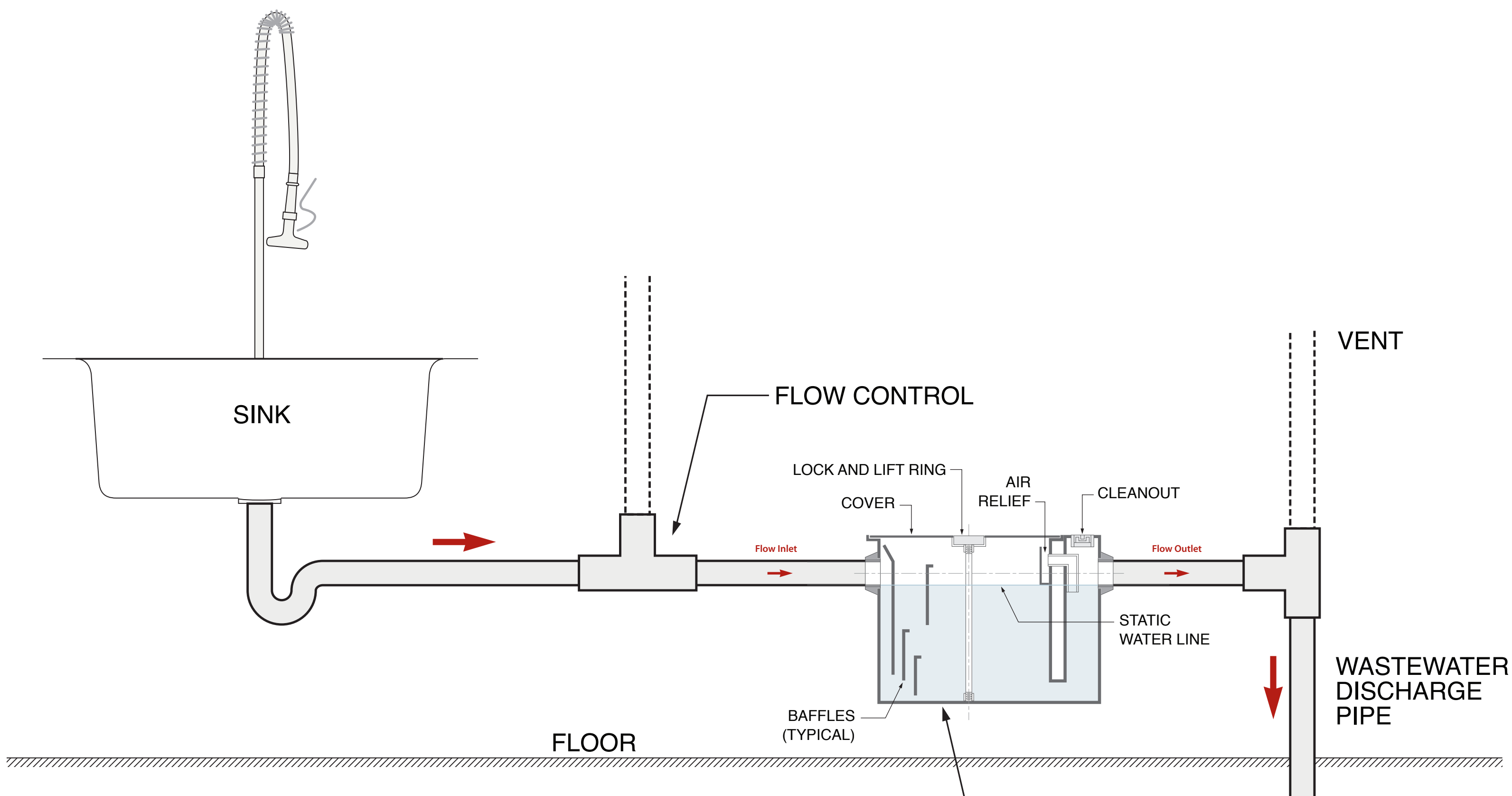
WATER CONSUMPTION

When using a commercial waste disposer, constantly flowing water is necessary before and after a disposer is turned on to keep it from clogging and to flush food particles through the sewer lines. Both InSinkErator and Salvajor have FWD models (the AS-101 and the ARSS models, respectively) with a time delay feature that can be set to automatically turn off the unit after a certain amount of time (usually up to 20 minutes) when not in use. In addition to this water-saving feature, InSinkErator also has a device called the AquaSaver that senses the load of the FWD and regulates the water flow to automatically provide the right amount of water. Similarly, all Salvajor FWDs have a water restriction on them. For units up to 2 hp, the FWDs have a 5 gallons per minute (gpm) flow control built in. For FWDs greater than 2 hp, the units have an 8 gpm flow control.

GREASE INTERCEPTORS

FSEs are a significant source of fats, oil, and grease (FOG) because of the amount of greasy ingredients used in cooking. FOG can clog sewers, causing sanitary sewer overflows and sewer backups, and can also interfere with the City's sewage treatment operations. Maintaining sewers that effectively carry wastewater to treatment facilities is one of the highest priorities for the New York City Department of Environmental Protection (NYCDEP). Since FOG causes such significant disruptions to the sewers, the City's Sewer Use Regulations mandated that FSEs install a grease control device to limit such discharges. NYCDEP mandates the proper sizing, installation, and maintenance of grease control devices. The New York City Commercial FOG Program was developed to assist restaurants and other FSEs with proper handling and disposal of their FOG.

The smaller grease control devices installed within buildings (which is the current common method used by FSEs in New York City) are referred to in this study as *grease traps*. Grease traps (as conceptually depicted in **Figure 3-2**), which must be installed by a licensed plumber in New York City, typically have a holding volume of 50 gallons and might retain grease from one or several fixtures, such as dishwashing sinks, mop sinks, floor drains, soaking sinks, and food preparation sinks. As shown in Figure 3-2, grease traps work by separating the FOG through the use of baffles that cause the FOG to settle at the top (and to be manually removed) and allow the remaining wastewater to discharge. Grease traps are typically maintained by building or FSE personnel. If FWDs are installed before grease traps, the FOG and solids from FWDs can quickly fill up the grease trap, creating plumbing problems in the FSEs.



Typical holding volume is 50 gallons.

FIGURE 3-2 Typical Grease Trap Layout

*Image 3.2—**Grease traps are small installed devices that remove grease from a sink's wastewater.***

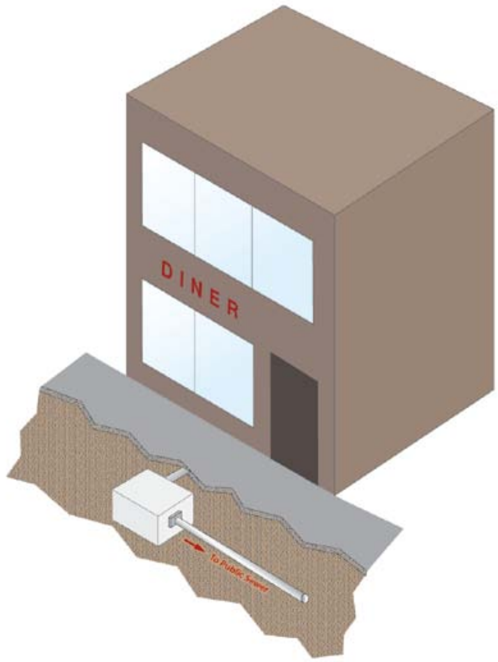
Larger grease control devices typically found in-ground outside the FSE are described in this report as *grease interceptors*. Grease interceptors often have 350 to 750 gallons of storage or greater and are typically installed outside the FSE and before the sewer connections to allow for easy inspection, cleaning, and removal of intercepted grease. On the small end (a capacity of 350 gallons), the grease interceptor would be 4 feet wide, 6 feet long, and 4 feet deep. Maintenance of grease interceptors is usually performed by a contractor, such as a septic hauler or recycler, and involves removing all of the liquids and solidified fats. While grease interceptors can be used with FWDs, costs for installation are approximately $4,000. Since the removal of FOG is essential to maintaining the sewers, as demonstrated from the results presented later in Chapters 7 and 8 and in accordance with the city's Sewer Use Regulations, it is anticipated that grease interceptors would be required if commercial FWDs were allowed in New York City.

PROBLEM FOODS

Even though commercial FWD manufacturers claim their products can handle all kinds of kitchen waste, certain foods have been known to cause jams or clogs. Large bones, eggshells, shells from clams and other shellfish, syrup, and fibrous fruits and vegetables like celery, artichokes, and corn cobs and husks can sometimes get stuck in the units and cause problems. Overloading the disposer may also cause problems.

TROUBLESHOOTING ISSUES

Besides getting clogged by grease and certain types of food, disposers can also get jammed up by other non-food waste commonly found in commercial kitchens—things like plastic cutlery and metal flatware, paper and cloth napkins, plastic cling film, and dish rags. Regular maintenance, including cleaning drains, is necessary to keep the disposers in good running order.



OPERATION AND MAINTENANCE COSTS

In addition to the initial outlay and utility expenses to run the units, disposers require regular maintenance, cleaning, and servicing to repair problems and keep the units in good working condition. The average life of a commercial FWD is at least 5 years, according to Salvajor.[1]

SYSTEM CONSTRAINTS

Commercial waste disposers are available in a range of total horsepower, as mentioned earlier in this chapter, and the right size unit must be used by a FSE to handle the amount and type of waste it generates. Since disposers have specific requirements for installation, the size of a drain, availability of utility connections, and other physical constraints are also important considerations when an FSE decides to install a disposer.

*Image 3.3—****Outdoor placement of grease interceptor. Typical holding volume is 350 to 750 gallons.***

3.4 WHO USES COMMERCIAL FOOD WASTE DISPOSERS AND WHERE?

COMMERCIAL FOOD WASTE DISPOSER USERS

Some 25,000 commercial FWDs are manufactured in the United States each year. Some of the biggest users of commercial waste disposers include such FSEs as university kitchens, hospitals, factories, hotels, and restaurants. According to Salvajor, a large banquet hall may have four or more disposers, used separately for meat prep, vegetable prep, pot and pan washing, and dish cleaning. For a typical installation at smaller facilities, only one unit may be used, with food brought from preparation areas to the sink with the grinder near the area where dirty plates are cleaned.

As discussed in Chapter 2, not all FSEs have a need for a disposer or would spend the money to install the units. Some might not generate enough food waste or large amounts of separate food waste (like at fast-food and take-out restaurants) to warrant the initial cost of a disposer. Chapter 4 presents an overview of the projected potential users of FWDs in New York City.

USE OF COMMERCIAL FOOD WASTE DISPOSERS IN OTHER MUNICPALITIES

Commercial FWDs are used in municipalities throughout the country, generally in areas served by advanced water treatment facilities with available capacity. It is important to note that treatment facilities in New York City, once upgraded under the Biological Nutrient Reduction

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[1] *Source*: The Salvajor Company, email communication, July 29, 2008.

(BNR) program, will have a very small margin of safety for compliance with permit limits. This is because in New York City, due to very tight site constraints, investments to reduce nitrogen loadings were undertaken through retrofits of existing tanks rather than through adding new tank capacity. In other municipalities where additional tank capacity was installed, FWDs may be able to be more readily accommodated.

As part of this study, 10 large municipalities in the United States were surveyed to learn more about their use of commercial FWDs and the impacts they have had. The purpose of the survey was to help New York City anticipate and learn more about potential problems associated with FWDs to inform any decision made to permit their use for FSEs. The surveyed cities were Chicago, Dallas, Denver, Detroit, Honolulu, Los Angeles, Philadelphia, San Antonio, San Diego, and San Jose.

In addition, nine cities (including six of the cities surveyed above) that permit commercial FWDs were contacted to find out how grease traps and interceptors must be connected. Those contacted were Baltimore, Boston, Chicago, Dallas, Denver, Detroit, Honolulu, Phoenix, and San Diego. Information on three additional cities—San Francisco, St. Louis, and Houston—was available based on previous surveys conducted by NYCDEP.

A summary of each city's regulations for FWD use in FSEs is presented in **Figure 3-3**.

Three of the cities surveyed mandate the use of FWDs: Denver, Detroit, and Philadelphia. Philadelphia exempts FSEs that recycle food waste and requires that the FWD be in a separate sink for kitchen scraps only. Several other cities allow, but do not mandate, FWDs.

Two surveyed cities, Los Angeles and San Diego, generally prohibit FWDs. However, FWDs connected to large grease interceptors are allowed in San Diego. San Jose prohibits FWDs by commercial and industrial facilities but allows them to be used by restaurants and institutions on a case-by-case basis. San Francisco prohibits FWDs and has passed a city ordinance requiring FSEs to disconnect all FWDs. In addition, San Francisco banned all FOG from drains.

Because of various potential problems, some cities, such as Denver, Phoenix, and San Diego, require FWDs to be connected to a grease interceptor. In addition, some municipalities surveyed, such as Chicago and Philadelphia, specifically prohibit grease traps from being connected to dishwashers and/or FWDs. To restrict FOG, St. Louis has encouraged some FSEs to disconnect their FWDs.

Installing grease interceptors in New York City requires substantial additional space, as discussed above, and warrants additional cost as well.

In this study's survey of U.S. cities and whether or not they permit commercial FWDs, several reasons why the units were preferred over traditional land-based disposal methods were identified. These included avoiding the mess, odor, vermin, and other unpleasant conditions commonly associated with having to discard and store food waste in garbage containers for pickup. Other benefits include a reduction in truck traffic and its associated air and noise emissions. Chapter 5 discusses the potential benefits of commercial food waste disposal in greater detail.

However, commercial FWDs are not without their limitations in the amount and type of waste they can handle and other negative issues associated with their use. One frequent—and particularly disagreeable—problem associated with commercial FWDs is that the additional grease can solidify and block sewers, which can result in backups, foul odors, and other public health concerns. By their very design, commercial FWDs allow significant volumes of raw

San Diego, CA

Mostly prohibits FWDs but allows them if used with a sufficiently large grease interceptor. Few exceptions to interceptor requirement for food prep areas that do not use meats.

Must be connected to an adequately sized grease interceptor.

Los Angeles, CA

Prohibits FWDs

Prohibited FWDs in 2001 due to blockages and sewer overflow issues backups.

San Francisco, CA

Prohibits FWDs

Passed a city ordinance requiring FSEs to disconnect all FWDs and banned all fat, oils, and grease from drains.

San Jose, CA

Prohibits FWDs in commercial and industrial facilities, including grocery stores and food processing establishments, but allows them in restaurants and institutions on a case-by-case basis.

Phoenix, AZ

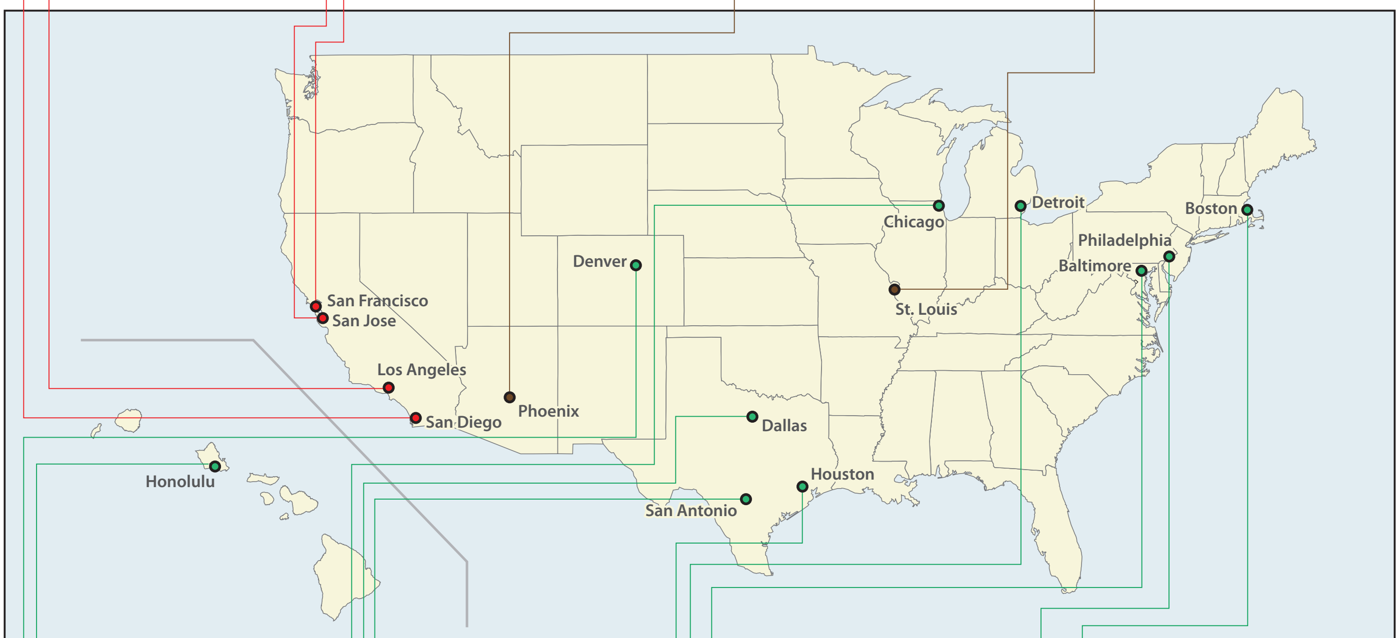
Allows FWDs but is currently considering prohibiting FWDS

Requires a grease interceptor with FWDs. FWDs could be banned from FSEs in the future.

St. Louis

Not recommended but allowed.

Has encouraged some FSEs to disconnect their FWDs to restrict fats, oils, and grease.



Honolulu, HI

Allows FWDs

Must install a properly sized grease interceptor, have all the fixtures that discharge fats, oil, and grease connected to the interceptor, including the FWD, and needs to be accessible for maintenance, sampling, cleaning, and inspection.

Denver, CO

Mandates FWDs in commercial food prep areas, with some exceptions.

Must have a grease interceptor. Must be a direct connection to plumbing system, not through a grease trap. Some clogs in buildings have been experienced.

San Antonio, TX

Allows FWDs

New commercial FWDs must be connected directly to a grease interceptor.

Dallas, TX

Allows FWDs

No FWD installation requirements. Conducting more inspections to monitor fats, oil, and grease.

Chicago, IL

Allows FWDs

Must be hard-wired and have a dedicated sink and grease interceptor.

Baltimore, MD

Allows FWDs

Grease interceptors are installed with or without FWDs but are not tied into the same line as the FWD.

Detroit, MI

Mandates FWDs

FSEs must reimburse the city to clean pipes or remove blockages.

Houston, TX

Allows FWDs

Must be approved by an independent organization, such as Underwriters Laboratories, and connected directly to sewer system. Cannot be piped into grease trap. Some blockages of sewer lines have been experienced.

Boston, MA

Allows FWDs

Grease interceptor must be an off-line unit (i.e., not connected to the FWD pipe).

Philadelphia, PA

Mandates FWDs or other means of recycling food waste. Fast food and others with minimal food prep waste excluded.

Typically needs to be in dedicated sink or part of automated dishwashing system. Cannot be connected to a grease trap. Must be connected directly to plumbing.

FIGURE 3-3 Commercial Food Waste Disposers in Select U.S. Cities

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organic matter to enter the sewer system, where they are conveyed to water pollution control plants (WPCPs) for treatment and eventual release to receiving waterbodies. Wastewater containing high levels of food waste adds strain to the limited capacity of the WPCPs and requires additional capital investments and operational costs to provide necessary treatment. ✷

Chapter 4: Food Waste Generation and Characterization in New York City

4.1 INTRODUCTION

Approximately 17,000 food service establishments (FSEs) operate in New York City today. Based on the analyses undertaken for this study, nearly 11,000 FSEs could be inclined to use commercial food waste disposers (FWDs) instead of having their food waste picked up by private haulers.

This chapter describes who these FSEs are and the chemical composition of their food waste. Section 4.2 defines FSEs and the universe of who would more likely install FWDs. Section 4.3 then describes the waste characterization study that was undertaken to understand food waste generation and characterization in New York City. A more detailed description of these analyses is provided in **Appendix A**.

4.2 FOOD SERVICE ESTABLISHMENTS IN NEW YORK CITY

IDENTIFYING FOOD SERVICE ESTABLISHMENTS LIKELY TO USE FWDS

For this study, an FSE is defined as an establishment that generates food waste in volumes large enough to make the installation of a commercial FWD potentially cost-effective. FSEs include restaurants, hotels, supermarkets, colleges, universities, hospitals, medical facilities, private schools, group residential facilities, day care facilities, nursing homes, and various other facilities that generate significant food waste.

Publicly available databases from City and State agencies, in combination with Dun and Bradstreet and Internet research, were obtained and merged to identify New York City's FSEs. The most inclusive database is from New York City's Department of Consumer Affairs, which records data for commercial kitchens permitted by the New York City Department of Health. For more information on this database and others used for this analysis, see Appendix A.

Based on a review of the databases and phone surveying conducted (as described below), it was determined that the following five categories of FSEs would be likely to consider installing a FWD:

- Colleges and universities;
- Medical facilities;
- Retail food establishments (supermarkets);
- Restaurants and hotels; and
- Other FSEs (e.g., caterers, shelters, senior centers, and non-public schools).

Other FSEs were initially considered, such as public schools, mobile food commissaries, and retail food manufacturers. Public schools were eliminated, not only because the Department of

Sanitation (DSNY) collects their waste, but in most instances food is prepared off-site and not served on plates. Mobile food commissaries and retail food manufacturers were eliminated as categories because the majority of these establishments reported that they receive pre-packaged food items and redistribute them, respectively, to mobile food vendors (i.e., street vendors) or retail food establishments (i.e., supermarkets), thus they do not generate food waste. In sum, because of their food and waste handling practices, public schools, mobile food commissaries, and retail food manufacturers are considered unlikely users of FWDs.

A random selection of records within each of the five FSE categories was contacted for phone and field surveying and waste collection sampling. The phone survey revealed that many of the entities were unlikely to install a FWD. These FSEs either generate small quantities of food waste (e.g., delis), have food waste that is not appropriate for use with a FWD (e.g., bakeries), or do not have operations conducive to use of FWDs (e.g., fast food restaurants). Many of these establishments are within the "restaurant and hotel" and "other" categories. The proportion of establishments identified from this additional review were used to proportion these results from the initial universe; a "revised universe" or "likely universe" of FSEs was established and used in the study.

For each category, **Table 4-1** presents the initial universe of records, the revised universe of records (i.e., FSEs more likely to install FWDs), and the number of waste samples collected in this study. It is estimated that approximately 11,000 FSEs could consider installing FWDs.

Table 4-1
FSE Universe

Category	Initial Universe	Revised Universe	No. of Waste Samples Collected
Colleges and universities	67	52	15
Medical facilities	355	345	32
Retail food establishments (supermarkets)	1,505	1,505	29
Restaurants and hotels	14,523	8,447	61
Other FSEs (caterers, shelters, non-public schools, and senior centers)	1,247	631	35
Total	**17,697**	**10,980**	**172**

ANECDOTAL INFORMATION ON FSES LIKELY TO INSTALL FWDS

The phone and field surveys also provided some qualitative information on which FSEs would likely use FWDs. Generally, it was found that the larger establishments—such as hospitals, colleges, and restaurants with prepared food and china plate service—expressed interest in installing the units.

In addition, data from a leading FWD manufacturer suggested the following market breakdown of the 25,000 FWDs sold annually in the United States: education and health care captured 30 percent of the market; corporate dining (business and industry), 15 percent; hotels and supermarkets, about 10 percent; and full-service establishments (restaurants), only about 5 percent of the market. However, this could change if given access to a large New York City market and installations were cost-effective.

4.3 COMMERCIAL FOOD WASTE CHARACTERIZATION

SAMPLING COLLECTION AND ANALYSIS

To determine the amount of food waste generation by category, a waste characterization study was performed. From the randomized lists, samples were obtained from 172 FSEs in late September to early October 2007, working around the clock to accommodate when food waste was available for pickup. After collection, the initial samples of waste were weighed, sorted into food waste and non-food waste, and weighed again at the DSNY North Shore Marine Transfer Station. A 3.5-gallon sample was taken from the food waste and, within 24 hours, was delivered to the City College of New York (CCNY) for further analysis. CCNY ground each sample through a FWD, weighed the sample before and after grinding, and analyzed the characteristics of the food waste. **Figure 4-1** illustrates some of the steps of the sampling study, and Appendix A provides more detailed information about the food waste characterization.

The samples were analyzed by CCNY using two different 2-horsepower (hp) commercial FWDs. CCNY put each food waste sample through the FWDs and the sample was ground up. CCNY recorded the amount of water consumed by the FWDs and also summarized some operational issues during the test procedures. At an independent laboratory, the food waste was analyzed for parameters that impact wastewater treatment and water quality, such as total kjeldahl nitrogen (TKN), soluble TKN, total nitrogen, biochemical oxygen demand (BOD), soluble chemical oxygen demand (COD), soluble carbonaceous biochemical oxygen demand (cBOD)[1], total solids, total suspended solids, oil and grease, and additional water demand. These parameters were subsequently used to develop the incremental pollutant loads and wastewater flows to each water pollution control plant (WPCP) and combined sewer overflow (CSO) catchment area as discussed below.

While the food waste was being ground, the FWD jammed on several occasions. Some of the items that caused jamming were plastic wrap, rags, and bottle covers that were inadvertently disposed as well as mussel shells and some cuts of meat. The drain clogged a few times; however, most items went through the grinder without significant problems.

FOOD WASTE GENERATED BY CATEGORY

To produce citywide projections of the amount of waste generated by FSEs that would likely use FWDs, detailed interviews were conducted with each participating FSE. Based on these interviews and the waste sampling, the following information was determined:

- An estimate of the weekly waste generated;
- The percentage of food waste in the sample;
- The estimate of weekly food waste generation per square foot for retail food establishments;

[1] Chemical oxygen demand (COD) is the amount of oxidizing agent needed to oxidize the organic and oxidizable inorganic matter in waste water. Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed to decompose the organic matter in waste water: a high BOD indicates heavy pollution with little oxygen remaining for fish. Carbonaceous biochemical oxygen demand (cBOD) means the quantity of oxygen utilized in the carbonaceous biochemical oxidation of organic matter present in the wastewater.

Weighing and Sorting Food Waste

First, the food waste sample was weighed at the FSE and placed in toters.

Once the 200 lb sample was brought to the transfer station, it was weighed again and separated into food waste and non-food waste.

The sorted sample was weighed again, and then a 3.5-gallon sample was prepared for delivery to the CCNY laboratory.

Detailed Laboratory Analysis

Food waste before grinding

Food waste after grinding

Items that got stuck or jammed in the FWD: plastics, rags, bottle covers, clam shells, forks and corks

FIGURE 4-1 How the Commercial Food Waste Sampling Study Was Conducted

- The number of transactions per day and days per week associated with the transactions per day basis for colleges and universities; and
- The estimate of the weekly food waste generation in pounds per week, which is the waste multiplied by the percentage of food waste.

After determining the waste generation rates for each sampled category, total food waste generation estimates were projected for each FSE category. **Table 4-2** includes a summary of the total waste generation by category based on the number of entities that may install FWDs.

Table 4-2
Projected Generation Estimate (in Tons/Day)

Colleges and Universities	Medical Facilities	Retail Food Establishments	Restaurants and Hotels	Other FSEs	Total
36	91	150	549	212	1,038

Based on the FSE universe of likely FWD candidates, the total amount of food waste for these FSEs was 1,038 tons per day (tpd). This compares well to the separately calculated food waste generation estimate of 1,640 tpd in DSNY's Commercial Waste Management Study (2004)[1] because the DSNY study included all food waste and not just food waste generated from FSEs likely to use FWDs.

GEOGRAPHIC PROJECTION OF FOOD WASTE

Geographical Information System (GIS) software was used to assign the FSEs in the revised universe by WPCP drainage basin and CSO catchment area. Each FSE was geocoded using GIS source files and ArcGIS 9.2 software. The FSEs were then overlaid with the drainage and CSO areas.

For each of the City's WPCP and CSO drainage areas, incremental waste generation rates and projected wastewater flows and pollutant loads were determined based on the number of FSEs to yield the total amount of waste generated in tons per year in each geographic area. ✷

[1] DSNY Commercial Waste Management Study, 2004.

Chapter 5: Potential Benefits of Commercial Food Waste Disposers

5.1 INTRODUCTION

This chapter discusses the range of economic and environmental benefits that would accrue to food service establishments (FSEs) and New York City if commercial food waste disposers (FWDs) are allowed.

This chapter describes potential solid waste and truck reductions as well as cost savings and convenience to FSEs that implement FWDs, followed by a description of the potential increased gas production at the City's water pollution control plants (WPCPs) and beneficial end-use of biosolids after sewage treatment.[1]

SUMMARY OF CONCLUSIONS

The main benefits of commercial FWDs include:

SOLID WASTE AND TRUCK TRIP REDUCTIONS

- At 50 percent penetration rate of commercial FWDs, it is estimated that 500 tons per day (tpd) of waste could be diverted from the commercial waste stream, representing 4 percent of the total commercial waste stream and 10 percent of the commercial putrescible waste stream.
- Nine trucks per day would be reduced citywide due to the implementation of FWDs at 50 percent penetration. The number of trucks reduced from the commercial waste sector would be offset by the need for additional trucks to transport sludge from the WPCPs.
- There would be some additional trucks reduced from curbside collection; however, trucks serving FSEs are not expected to be appreciably reduced due to the nature of the existing collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce truck trips.

POTENTIAL COST SAVINGS AND CONVENIENCE TO FSES

- For larger institutions, such as colleges, universities, and medical facilities, there could be a relatively short payback period given the large amounts of food waste they generate. Based on the costs of installing and operating a FWD compared with savings in disposal costs, many retail food establishments, restaurants, and hotels would not likely see a cost benefit to installing FWDs. However, larger restaurants that generate higher volumes of food waste

[1] See Chapter 8 for a more detailed discussion of gas production and biosolids. Biosolids is a term used to describe solids removed from the treatment process at the WPCPs, dewatered and treated for beneficial end-use disposal, such as direct land application or treated and made into compost or fertilizer.

could see a benefit. This is consistent with information provided by FWD manufacturers that purchasers of these units are typically larger institutions, rather than restaurants.

- In addition to cost savings for some FSEs, FWDs would make waste disposal quicker and easier. With the diversion of food waste from curbside pickup, there could be less curbside odor, vermin, and mess. Even without a financial benefit, many FSEs may choose to install FWDs for their convenience and due to space limitations in many restaurants and other FSEs.

5.2 SOLID WASTE AND TRUCK TRIP REDUCTIONS

HOW MUCH FOOD WASTE CAN BE DIVERTED FROM THE SOLID WASTE STREAM THROUGH THE USE OF COMMERCIAL FWDS?

Throughout New York City, approximately 13,000 tons of commercial waste—including 8,000 tons of non-putrescible and 5,000 tons of putrescible waste (that is, trash that contains food waste)—is generated each day, with much of this waste ending up in landfills. It is estimated that food waste accounts for 1,640 tpd of this waste,[1] which is generated by the tens of thousands of commercial FSEs, such as restaurants, hotels, supermarkets, medical facilities, colleges, bakeries, delis, and other places that serve food.

Based on a detailed survey and review of available data for FSEs in New York City, only 11,000 of the more than 17,000 FSEs would consider installing a FWD (see Chapter 4). There are many FSEs that either generate small quantities of food waste (e.g., delis), have food waste that is not appropriate for use with a FWD (e.g., bakeries), or do not have operations conducive to use of FWDs (e.g., fast food restaurants). Of the 11,000 FSEs that may consider installing a FWD if they were permitted, many would not be inclined to do so given the relatively high initial investment, large water consumption charges, and long payback periods entailed when compared to the costs of disposing the waste through the land-based system (see cost analysis in section 5.3 below). Other FSEs would elect not to install them because they would not see large advantages given that they would continue to require waste pickup for their remaining waste and due to potential clogging and other negative effects associated with FWDs. Even without a financial benefit, many FSEs may choose to install FWDs for their convenience due to space limitations in many restaurants and other FSEs.

The study assumes that 50 percent of the 11,000 FSEs, or about 5,500, would install FWDs (although analyses were also conducted of 25 percent, 75 percent, and 100 percent penetration rates). At this penetration rate, it is estimated that 500 tons per day of waste could be diverted from the commercial waste stream if commercial FWDs were allowed (total food waste generated by the FSEs that would consider using FWDs was estimated at 1,038 tons/day). This represents 4 percent of the total commercial waste stream and 10 percent of the commercial putrescible waste stream (see **Figure 5-1**).

[1] *Source*: Table 1.4-2, DSNY Commercial Waste Management Study (2004).

HOW MANY TRUCKS WOULD BE REDUCED THROUGH THE USE OF COMMERCIAL FWDS?

COMMERCIAL WASTE TRUCK TRIP REDUCTIONS

By diverting a portion of the food waste from the solid waste stream, FWDs would reduce the amount of putrescible waste transported within the city to transfer stations and transported out of the city to a landfill or incinerator. To some extent, these truck trip reductions would be offset by increased sludge disposal trucks at the WPCPs.

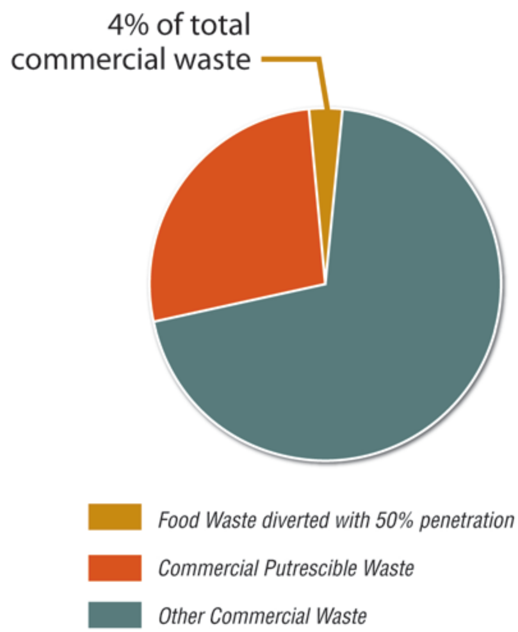


*Figure 5-1—**Food Waste Diverted at 50 Percent Penetration***

Curbside Collection Trucks

Current disposal practices discussed in Chapter 2 need to be considered to understand how truck trips would likely be reduced. As noted in Chapter 2, 68 hauling firms actively collect commercial putrescible waste. Since New York City does not franchise private solid waste collection services for regions of the city, these haulers' collection activities are dispersed and overlap throughout New York City. Thus, on a given street or in a local community, numerous haulers collect putrescible solid waste from FSEs.

As noted in Appendix A, about 55 percent of the waste generated by FSEs in this study is food waste. The other 45 percent includes waste that is likely in contact with food at the facility. The Business Integrity Commission (BIC) estimates that restaurants and food retail outlets tend to require at least five or more pickups per week, likely due to the sanitary needs and requirements related to putrescible waste. With FWD implementation, the food waste portion of an FSE's solid waste disposal would be reduced; however, FSEs would still likely need regular garbage pickups. There could be some reduction in truck trips to and from smaller FSEs, such as restaurants; however, larger FSEs, such as medical facilities and colleges, would not be expected to change their service schedules. Thus, trucks serving FSEs are not expected to be appreciably reduced due to the nature of the existing collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce truck trips. With wide-scale implementation of FWDs, there could be some efficiencies; however, due to the nature of New York City's decentralized commercial hauling industry, this change would slowly occur over many years.

Truck Reductions Leaving Transfer Stations for Export

Given that most haulers truck waste to putrescible waste transfer stations within the city, there would be a net reduction in the total amount of putrescible waste at transfer stations with FWD implementation. Thus, truck trips exporting compacted solid putrescible waste out of the city would also be reduced. Since transfer stations centralize the City's solid waste, these regional truck trip reductions would occur more readily than curbside collection trip reductions.

Based on the projected reduction of 500 tpd of food waste (at 50 percent penetration of FWDs), regional truck trips would reduce daily by approximately 24 truck round trips (leaving full and coming back empty) based on a typical truck leaving a solid waste transfer station, which carries about 22 tons of solid waste out of the city.

These truck reductions would mainly occur in communities with transfer stations and along major truck roadways departing the city with solid waste (see Chapter 2). Chapter 9 provides more details on specific reductions in Community Boards (CBs) 1 and 2 in the Bronx and CB 1 in Brooklyn.

Sludge Truck Trip Increases

Discharging food waste to the WPCPs, as discussed and analyzed in Chapter 8, would result in increased sludge at the WPCPs. Sludge produced at the 14 WPCPs is transported via barge or pipeline to one of eight dewatering facilities, namely: 26th Ward, Bowery Bay, Hunts Point, Jamaica Bay, Oakwood Beach, Red Hook, Tallman Island, and Wards Island WPCPs. After dewatering, the dewatered sludge is transported to New York Organic Fertilizer Company (NYOFCo) in the Bronx (for conversion into composting pellets), to a sludge treatment facility in New Jersey for beneficial reuse, or is composted out of state.

For the 50 percent FWD penetration scenario, an additional 296 wet tpd of dewatered sludge would be produced, requiring transport via trucks to the various processing facilities and/or for export. (NYOFCo exports via rail.) With each truck at a capacity of 20 tons, this would correlate to approximately 15 additional truck round trips (leaving full and coming back empty) every day from the City's dewatering facilities.

These truck increases would occur in the communities of the eight WPCPs with dewatering facilities and along major truck roadways departing the city or going to NYOFCo with biosolids, which are similar to the regional departing truck routes for solid waste (see Chapter 2).

It is estimated that an additional truck per week at each WPCP would be needed to transport grit and screenings removed in the primary and secondary treatment processes.

Conclusions

If 500 tpd were diverted to FWDs (at 50 percent penetration), it is expected that there would be a reduction of a nominal number of truck trips per day, particularly from trucks servicing putrescible waste transfer stations. These reductions would be offset by increases in trucks for sludge disposal. Estimates are that there would be:

- A reduction of 24 trucks per day leaving the waste transfer stations for export. The implementation of FWDs would see the largest reduction in truck trips from the reduction in waste trucked out of New York City from private transfer stations. These trucks represent approximately 4 percent of the total commercial waste trucks and 10 percent of the commercial putrescible waste trucks.
- An increase of 15 trucks per day leaving the WPCPs for processing and export. These trucks would be carrying the additional sludge produced from FWD use.

Based on these estimates, nine trucks per day would be reduced citywide due to the implementation of FWDs at 50 percent penetration. **Figure 5-2** shows this net change in daily truck round trips.

There would be some additional trucks reduced from curbside collection; however, trucks serving FSEs are not expected to be appreciably reduced due to the nature of the existing collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pick up, and therefore may not be able to reduce truck trips.

This reduction in trucks represents a very small fraction of the number of trucks servicing the commercial waste sector. The largest reductions would be expected to occur in communities with the largest concentrations of solid waste transfer stations, such as Brooklyn CB 1 and Bronx CBs 1 and 2.

Some ancillary benefits would accrue from the reduction in truck trips. There would be air quality benefits from the reduced regional truck trips and lower emissions of air, noise, and odor along truck routes in the local communities with transfer stations. However, because of the small changes that would result, the benefit may not be noticeable.

5.3 COST SAVINGS AND CONVENIENCE TO FSES

Estimates of the costs to dispose of solid waste were developed along with estimates of how much solid waste costs would be reduced for FSEs if they installed FWDs. In addition, costs to initially install, maintain, and operate a FWD were developed.

HOW MUCH DO FSES PAY FOR DISPOSAL OF FOOD WASTE TODAY?

Costs to dispose of solid waste were estimated based on the average waste generated by each FSE (see Chapter 4) and the fees charged to dispose of such waste by haulers. Given the dense nature of food, the upper-end allowable cost ($10.42 per 100 pounds)[1] was assumed. The smallest FSE generator—restaurants and hotel—averages about 120 pounds per day of food waste. At $10.42 per 100 pounds, average food waste disposal costs are about $6,600 per year. For colleges and universities, average food waste generation is around 1,400 pounds per day, equating to a disposal cost of around $53,000 per year. **Table 5-1** presents the average total waste estimates, total food waste estimates, and disposal costs per FSE category.

As discussed in Chapter 2 and above, FSEs highly value the frequent pickup service that they receive from their hauler, and it is assumed that pickup frequency would be maintained as the remaining garbage would still contain food remnants. FSEs may not see the 100 percent reduction assumed in the analysis. Charges to an FSE are typically based on waste hauler estimates, rather than actual weight of waste disposed of by the FSE. Therefore, absent requesting a specific waste stream audit, the charges may not change. Second, the hauler may switch from a price-per-ton basis to a price-per-cubic-yard basis to offset the loss of heavier waste.

[1] These charges are based on BIC's Maximum Allowable Rate Increase of December 26, 2008.

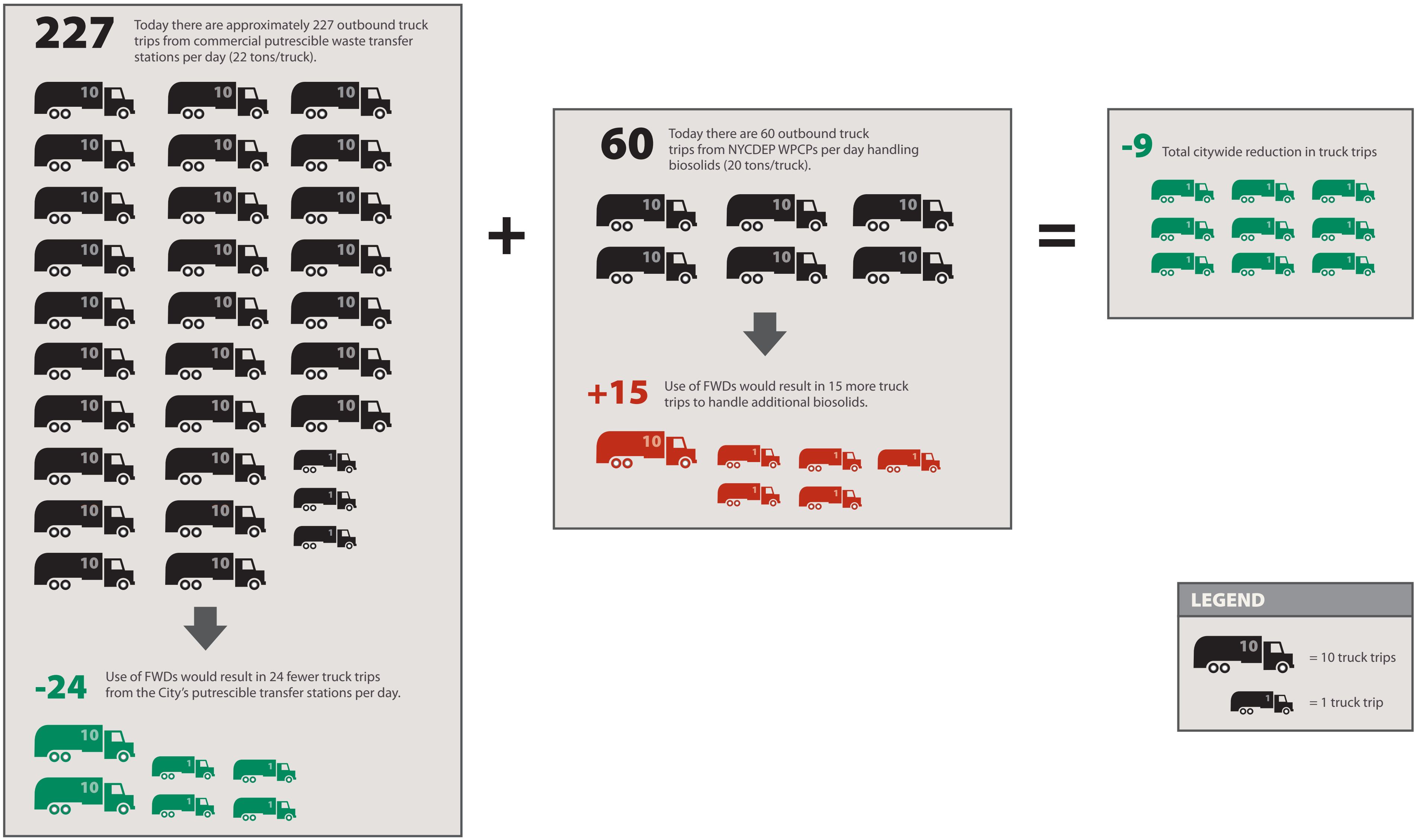


FIGURE 5-2 Changes in the Amount of Daily Truck Trips as a Result of FWDs

12.29.08

Table 5-1
Average Disposal Costs

Category	Average Total Kitchen Waste (lbs/yr) [1]	Average Total Food Waste (lbs/yr) [2]	Disposal Costs for Food Waste Disposal ($/year)[3]
Colleges and universities	815,167	511,890	$53,246
Medical establishments	381,374	191,635	$19,777
Retail food establishments	92,309	49,324	$5,325
Restaurants and hotels	81,738	47,412	$4,564
Other FSEs	484,556	245,123	$25,862

Notes:
[1] The average total waste is based on the estimated amount of kitchen waste generation collected for this study.
[2] The average total food waste is based on the estimated amount of food waste in the total kitchen waste collected for this study.
[3] Disposal costs were estimated based on the average waste generated by each FSE (see Chapter 4) and the costs to dispose of such waste by haulers is based on BIC's maximum allowable rate increase of December 26, 2008.

HOW MUCH WOULD IT COST TO INSTALL, MAINTAIN, AND OPERATE A FWD?

Initial fixed costs for an FSE that decides to buy a FWD includes the capital and installation costs of the FWD and a grease interceptor. For a typical commercial unit (such as those included in the sampling tests described in Chapter 4) with a water-saving shutoff feature, the installed cost was estimated at $5,000 although this could be higher if there are physical constraints, additional support equipment, and/or electrical hookups needed. These units typically have a limited life cycle and are replaced about every 5 years.

The size of a FWD can vary according to the size of the FSE. For example, an FSE can choose the size of the FWD based on the number of persons per meal. FWDs range between 0.75 hp and 10 hp, with average costs ranging from about $4,500 for the 0.75-hp unit to $8,000 for a 7.5-hp unit.[1] Based on the findings in this study, the following was assumed:

- For colleges and universities, based on an average of 1,700 transactions per day, the FWD size could range from 1.5 to 7.5 hp. For medical facilities, based on an average of 200 beds and three meals per day, the FWD size could range from 0.75 to 3 hp. Since both categories typically use cafeteria-style dining, costs were based on one 3-hp unit located in a heavy-use area and one 1-hp unit located in a less demanding area, like vegetable prep.
- For retail food establishments, restaurants and hotels, and other FSEs, an average user might install a 2-hp unit.

In addition, the FSE would need to install a grease interceptor. As discussed in Chapter 3, FSEs are required to have grease traps. However, these devices would not function with a FWD, and a costlier grease interceptor would be required at an approximate cost of $4,000.

Once installed, the largest operating cost would be additional water required by these units. Since the FWD would be run intermittently with water flowing before and after grinding food waste throughout a typical 16-hour day, it was assumed that each FSE would operate one 2- or 3-hp FWD for 6 hours a day and, for colleges, universities and medical facilities, a 1-hp FWD for 3 hours a day. Combined water supply and wastewater charges of $5.98 per 100 cubic feet of

[1] Costs from Salvajor 2008 cost lists, including water-saving controls and estimated installation costs.

water (or about $8 per thousand gallons of water supplied) were multiplied by the usage rates and hours of operation to calculate the average annual incremental water and wastewater charges.

WHAT WOULD BE THE TOTAL COSTS TO BENEFITS FOR FSES?

Certain FSEs would have more of a financial incentive than others to install FSEs. As shown in **Table 5-2**, for larger institutions, such as colleges and universities, there could be a relatively short payback period given the large amounts of food waste they generate. For colleges and universities, medical facilities, and "average" other FSEs, the payback period would be 0.4, 2.1, and 0.6 years, respectively. Based on the costs of installing and operating a FWD compared to savings in disposal costs, many retail food establishments, restaurants, and hotels would not likely see a cost-benefit to installing FWDs. However, larger restaurants that generate higher volumes of food waste could also see a benefit. This is consistent with information provided by FWD manufacturers that purchasers of these units are typically the larger institutions, rather than restaurants.

Table 5-2
Costs-Benefit for the FSE

FSE Category	Potential Reduction in Annual Disposal Costs for Average FSE[1]	Initial Cost for FWD(s)	Initial Cost for Grease Interceptor	Additional Annual Water and Sewer Costs[2]	Potential Annual Savings [3]	Payback Period (years)
Colleges and universities	$53,246	$11,876	$4,000	$8,592	$42,415	0.4
Medical establishments	$19,777	$11,876	$4,000	$8,592	$10,831	2.1
Retail food establishments	$5,325	$6,569	$4,000	$5,728	$(1,615)	NA
Restaurants and hotels	$4,564	$6,569	$4,000	$5,728	$(2,376)	NA
Other FSEs	$25,862	$6,569	$4,000	$5,728	$18,923	0.6

Notes:

1 The annual disposal fee assumes $10.42/100 lbs of solid waste per based on BIC's maximum allowable rate increase of December 26, 2008. The potential reduction in annual disposal costs due to reduction of food waste disposal is assumed to be 100 percent of the cost of current disposal of all the FSE's waste.

2 Annual water usage - 6 hours for a 2- or 3-hp FWD and 3 hours per 1-hp FWD

3 Includes costs for annual water usage and the cost for a FWD installation, assumed as $6,500, annualized over 5 years for a 2-hp unit with water saving device and $11,900 for a 1-hp and 3-hp unit with water saving device. It is assumed that units would be replaced every five years.

NA – There would be no cost savings.

In general, although the cost of a FWD, including installation, may be relatively modest for many businesses, there are a number of other significant expenses that would be incurred. The installation would require a grease interceptor rather than the much less expensive grease trap which is typically installed. Although water would be used intermittently throughout the day, water consumption and water charges would be considerable, even with the installation of a water conservation device. Further, the FWD would typically need to be replaced every 5 years, and larger institutions would require more than one to serve their operations.

WHAT OTHER CONVENIENCES WOULD FWDS PROVIDE FSES?

In addition to cost savings for some FSEs, FWDs would make waste disposal quicker and easier. Despite this convenience, FWDs do clog on occasion, resulting in the need for additional maintenance. With the diversion of food waste from curbside pickup, there could be less curbside odor, vermin, and mess. Even without a financial benefit, many FSEs may choose to install FWDs for their convenience and due to space limitations in many restaurants and other FSEs. In fact, FWDs are installed in residences throughout the United States, with little to no financial benefit.

5.4 BENEFICIAL BY-PRODUCTS GENERATED THROUGH THE WASTEWATER TREATMENT PROCESS

Food waste processed at the plant would provide beneficial by-products. There would be additional biosolids generated, which would then be applied to land directly if stringent Federal guidelines are met to improve vegetation or processed further to be sold as compost or fertilizer.

The introduction of FWDs would also yield additional digester gas production at the WPCPs (see Chapter 8), some of which would be reused in the boilers of WPCPs to provide heat for the treatment process. However, during summer months, these plants typically have more gas than they can use beneficially, so the excess gas is burned off. As noted in Chapter 8, approximately 40 percent of total digester gas produced is currently used at the WPCPs while the remaining 60 percent is flared. NYCDEP is exploring ways to capture and reuse this energy. ✷

Chapter 6: Potential Impacts of Commercial Food Waste Disposers On Water Supply and Conservation Efforts

6.1 INTRODUCTION

This chapter discusses the potential effects on the City's water supply network and conservation efforts that could result from allowing food service establishments (FSEs) in New York City to use commercial food waste disposers (FWDs).

A brief primer on the water supply network that provides New York City with drinking water is presented first followed by a discussion of current relevant New York City Department of Environmental Protection (NYCDEP) water supply programs. The impacts from commercial FWD use on water supply and conservation efforts are then summarized.

SUMMARY OF CONCLUSIONS

As described in more detail in this chapter, use of drinking water to operate commercial FWDs in New York City is expected to counter:

- The significant investment of more than $400 million that the City has made to reduce water demand by over 300 million gallons per day (mgd) since 1990;
- The future water conservation program targeted to reduce at least 60 mgd under PlaNYC; and
- The efforts being made to develop additional water supply sources to allow for the repair of the Rondout-West Branch segment of the Delaware Aqueduct and other water supply infrastructure.

It is estimated that the replacement cost for the 11 mgd of additional water use by FWDs would be $15 to $20 per gallon or $165 million to $220 million on top of the programs the City is currently implementing.

6.2 OVERVIEW OF NEW YORK CITY'S WATER SUPPLY NETWORK

NYCDEP operates and maintains one of the most extensive water supply systems in the world with reservoirs, aqueducts, and a grid of distribution pipes that deliver approximately 1.2 billion gallons of water a day to New York City. The City's water supply system provides drinking water to over 8 million customers in Manhattan, the Bronx, Brooklyn, Queens, and Staten Island as well as approximately 1 million customers in upstate communities.

Surface water is collected and stored in three upland reservoir systems: Croton, Catskill, and Delaware (see **Figure 6-1**). Water from these reservoirs flows to the Hillview Reservoir in Yonkers for the Catskill/Delaware System and Jerome Park Reservoir in the Bronx for the Croton System. Water is distributed via City Tunnel Nos. 1, 2, and 3 from Hillview and the New Croton Aqueduct from Jerome Park Reservoir to distribution mains in the five boroughs.

FIGURE 6-1 New York City Water Supply System

Within the city, a grid of underground water mains distributes water to residents and commercial users. Large mains, up to 96 inches in diameter, feed smaller (8-, 12-, and 20-inch) mains that distribute water locally.

*Image 6.1—**Croton Falls Reservoir in Putnam County, upstate New York.***

6.3 CURRENT NYCDEP PROGRAMS FOR THE WATER SUPPLY

Although New York City is fortunate in being located in a water-rich region, conserving water is of paramount importance. The region is faced with droughts on an intermittent basis. These drought periods are expected to be further exacerbated by climate change due to reduced snowmelt that feeds the reservoir as well as increased demand that comes with rising temperatures. At the same time, there is an ongoing need to reduce flows going to the City's wastewater treatment plants to remain below permit limits and enable treatment of greater quantities of wet weather flow.

Water conservation is even more critical given the need for NYCDEP to take critical, aging water supply infrastructure offline for repair. NYCDEP's Dependability Program addresses the need to provide redundancy in the City's water supply conveyance to allow for necessary repair and maintenance of key supply system infrastructure. First and foremost of the program's priorities is the repair of the Rondout-West Branch Tunnel, a critical component of the Delaware Reservoir system. The Delaware System has historically provided about 50 percent of the City's water supply needs with the Delaware Aqueduct transporting this supply to the city. Several leaks have been detected in the Rondout-West Branch portion of the Delaware Aqueduct; although it is not in danger of immediate failure, the City is preparing for an extensive repair program that will require closing the aqueduct. The City is exploring the development of additional water supply sources or the construction of a parallel tunnel that would need to be put in place before the repair work can begin. During any such period, it would be necessary for the City to implement measures to encourage conservation and decrease demand. An enhanced water conservation program is a cornerstone of the Dependability Program.

During the 1990s, NYCDEP initiated a series of water conservation efforts to reduce water demand and dry weather flow to the City's water pollution control plants (WPCPs). One of the key measures, the toilet rebate program, provided incentives to replace more than 1.3 million toilets and showerheads with more efficient low-flow fixtures. This successful program cost the City $290 million and reduced the City's water demand by 70 to 90 mgd. During that time period, the City invested millions of dollars in metering water customers and in repairing leaks in the distribution system.

Newer low-flow toilets may be able to save even more than the previous models that saved up to 3.5 gallons per flush. NYCDEP plans to initiate a new water conservation program to further reduce demand by 60 mgd with a rebate program on toilets, urinals, and washing machines. The City is also working to reduce water demand in City-owned buildings and developing a cost-sharing program for large industrial and commercial water efficiency modifications. The program is anticipated to cost $186 million. The City is also considering investing an additional $207 million (for a total of $393 million) on conservation efforts as part of the Dependability Program.

6.4 IMPACTS FROM COMMERCIAL FWD USE ON WATER SUPPLY AND CONSERVATION

As described in Chapter 3, FWDs require significant amounts of potable water to run the system. Water must run while the device grinds food and after grinding to flush the device. During normal operation, the FWD would be turned on and off to grind food during typical activities that generate food waste, such as prep and dishwashing. This study estimates that during 16 hours of typical food service establishment operation, water would run at a speed of 5.45 gallons per minute for a total of 6 hours for a 2- or 3-horsepower (hp) FWD unit and for a total of 3 hours for a 1-hp unit resulting in an additional demand of 11 mgd for 50 percent penetration of commercial FWDs at FSEs that may likely use them. These estimates are consistent with the 2000 American Water Works Association report on *Commercial and Institutional End Uses of Water* and are the mid-range for water saving devices that could be purchased with the FWD. Major FWD manufacturers offer a time delay feature that can be set to automatically turn off the unit after a certain amount of time (usually up to 20 minutes) when not in use. Further, InSinkErator has a device called the AquaSaver that senses the load of the FWD and regulates the water flow to automatically provide the right amount of water. Similarly, all Salvajor FWDs have a water restriction on them. For units up to 2 hp, the FWDs have a 5 gallons per minute (gpm) flow control built in. For FWDs greater than 2 hp, the units have an 8-gpm flow control.

This additional demand would diminish the benefits of the investments NYCDEP has made and will continue to make in its water conservation program at a time when saving water is becoming more critical. To balance the additional water demand from FWD use, additional, more expensive water conservation programs or other demand reduction or additional supply supplement projects would be required. The current 60 mgd water conservation program under PlaNYC is estimated to cost $3 per gallon while the next 20 mgd reduction would cost over $10 per gallon. If additional supply sources were required to offset the additional demand, the cost per gallon to offset this 11 mgd demand would be higher. It is estimated that the replacement cost for the 11 mgd of additional water use by FWDs would be $15 to $20 per gallon or $165 million to $220 million on top of the programs the City is currently implementing. ✷

Chapter 7: Potential Impacts of Commercial Food Waste Disposers On the Sewer Network and Combined Sewer Overflows

7.1 INTRODUCTION

This chapter discusses the potential effects on the City's sewer network that could result from allowing food service establishments (FSEs) in New York City to use commercial food waste disposers (FWDs).

A brief primer on the system of pipes and regulators that comprise New York's sewer network is presented first, followed by an introduction of issues associated with the sewer system: sewer backups; fats, oils, and grease (FOG); and combined sewer overflows (CSOs). These sections are followed by a discussion on regulatory issues along with current New York City Department of Environmental Protection (NYCDEP) and PlaNYC initiatives for improving the quality of New York City waterbodies. The impacts from commercial FWD use on the sewer system and CSOs are then summarized.

SUMMARY OF CONCLUSIONS

As described in more detail in this chapter, the use of commercial FWDs in New York City is expected to impact the sewer system and the City's CSO program. The City's aging combined sewer system can become overtaxed during rain events, resulting in sewer backups and flooding. Separate sewers can also experience problems when sanitary sewers become blocked or overtaxed by illegal connections, or when storm sewers become overtaxed from rain or blocked by debris. Sewers are designed to efficiently carry human waste and stormwater—not FOG, which has a different consistency and flow rate—away from residences and businesses. While it is illegal to discharge FOG into the sewer system, FOG is still a cause of capacity constraints within the system and can also cause sewer backups. FOG discharges can come from residences and FSEs.

In order to function properly, the sewers must be constantly maintained through tasks like cleaning catch basins and removing debris, grease, and other types of blockages, which can restrict flow in the system. FOG also impacts the treatment process at the water pollution control plants (WPCPs), as described in Chapter 8. In response, NYCDEP cleans problem sewers burdened by FOG, enforces against illegal grease dischargers, and has an education program to address FOG discharges from restaurants and other FSEs. Due to the high fat content of food waste, use of FWDs would discharge substantial amounts of FOG to the sewer system, which could lead to more sewer backups and corresponding maintenance needs. The use of grease interceptors, which would likely be required to accompany FWDs, would remove a portion of the FOG from the waste stream entering the system.

NYCDEP is investing approximately $2 billion in programs to build CSO retention facilities and on other CSO abatement measures. The Mayor's Office of Long Term Planning and Sustainability has recently issued the City's Sustainable Stormwater Management Plan, which calls for concerted efforts to increase on-site stormwater control and reduce CSOs. The additional sanitary flow from commercial FWDs is estimated to be 11 million gallons per day (mgd) citywide and 9.7 mgd in combined sewer areas; this additional flow would reduce the capacity of sewers and could potentially trigger additional CSOs in combined areas as well as more frequent problems related to capacity constraints in both combined and separate areas. These discharges would offset gains in CSO abatement. The additional flow from FWD use would counter stormwater management source control initiatives and PlaNYC initiatives currently underway to improve water quality and increase public access to over 90 percent of New York City tributaries.

7.2 OVERVIEW OF NEW YORK CITY'S SEWER SYSTEM

Every day, wastewater goes down drains and toilets in homes, schools, businesses, and factories and then flows into New York City's sewer system. These wastewater flows are known as dry-weather flows. During dry weather, this flow is transported by underground sewers to one of the City's 14 WPCPs for treatment. See Chapter 8 for more information on WPCPs.

Combined sewers convey both sanitary and stormwater flow. During dry weather, all of the sanitary flow is delivered to a WPCP for treatment. During wet weather, the volume of sanitary and stormwater flow can surpass a WPCP's ability to accept the flow. Approximately 49 percent of the City's area drains to combined sewers, portions of Queens and Staten Island have separate sanitary and storm sewers, most coastal areas drain stormwater directly to waterbodies, and, in the southern part of Staten Island, the Bluebelt area, natural drainage features in combination with piped conveyance are employed for stormwater.

NYCDEP is responsible for maintaining the City's approximate 6,600 miles of sewers. If wastes are disposed of correctly, the City's sewer system can typically convey the dry-weather flow with no problems. Sewers throughout most of the city flow by gravity and are designed to achieve flow velocities that make them self cleaning. However, even during dry-weather conditions, site-specific problems can arise from the buildup of debris or other materials. FOG is one cause of blockages and it can also contribute to capacity constraints. NYCDEP regulates against FOG discharges into the sewer for these reasons. Section 7.4 provides more detail on FOG.

Sometimes during rain or snow (wet-weather flows), the combined sewer system can fill to capacity and the mix of excess stormwater and untreated sewage flows directly into the city's waterways. This is called combined sewer overflow (CSO). Section 7.5 presents more detail on CSOs. Also during wet-weather events, especially extreme ones, sewer capacity can be exceeded, resulting in flooding and sewer backups.

This chapter highlights the City's efforts to improve water quality, specifically in the areas of sewer backups, CSO volume, and pollutant load. These citywide issues would be exacerbated by FWD implementation.

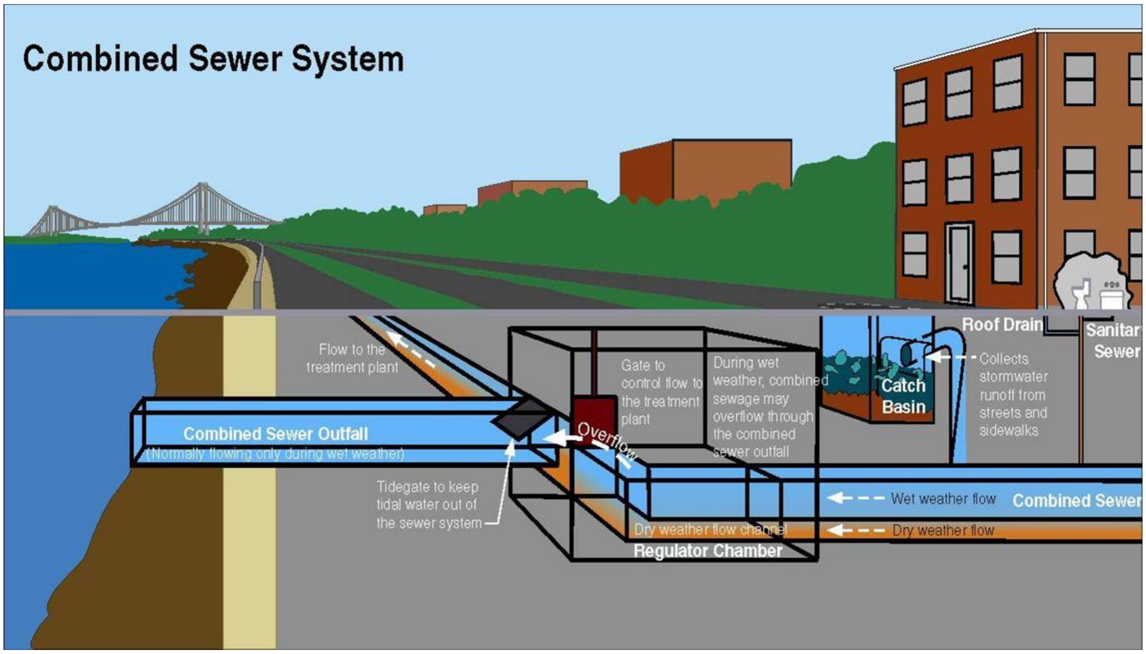


*Image 7.1—**A combined sewer overflow.***

7.3 SEWER BACKUPS

WHAT IS A SEWER BACKUP?

A sewer backup occurs when the discharge through a residential or commercial sewer line or city sewer segment is restricted to a degree significant enough to force discharges back to an individual property or sewer section. In many instances, this creates a condition referred to as surcharging.

Surcharged sewers can cause sewer backups in homes and other buildings. Sewer backups can occur when the level of sewer water is elevated to the level of below-street-grade fixtures. As the water seeks its own level, it will rise through the fixtures unless those fixtures are above the surcharge height or protective measures, such as backwater valves, are in place. Finally, and fortunately rarely, when a surcharged combined sewer encounters a bottleneck or a counter-flow, the internal pressure in the sewer may become so great that it will push up through catch basins and manholes. Sewer backups can be caused or exacerbated by blockages caused by grease and debris.

One sewer backup can impact many consumers since more than one residence or commercial establishment is connected to a sewer segment. One chronic location can repeatedly destroy personal belongings and cause health concerns and major damage. While NYCDEP attempts to regularly treat locations frequently impacted by illegal discharge of grease into the sewers, it is not always possible to address an area of concern before a backup occurs.

When residents see a sewer backup, they call 311 to report the disturbance. NYCDEP dispatches emergency crews 24 hours a day, 7 days a week to respond to all complaints. NYCDEP tracks all calls and resolutions to identify issues within the sewers. Information on grease-caused sewer backups is used to target programmatic degreasing operations for those areas impacted. **Figure 7-1** shows the distribution of sewer backups throughout the city and the locations of programmatic degreasing locations. Sewer backups exist in every borough.

HOW DOES NYCDEP MAINTAIN THE CITY'S SEWERS?

NYCDEP maintains the sewer system in several ways: cleaning catch basins, high-powered flushing and degreasing of sewers, inspecting sewers in person or with cameras, removing sewer debris and blockages, and excavating streets to repair broken sewers. Catch basins are cleaned in response to 311 calls and on a 3-year programmatic cycle. Repair, cleaning, and maintenance of the sewer system are required in the State Pollutant Discharge Elimination System (SPDES) permit requirements for CSO Maintenance and Collection System for Storage.

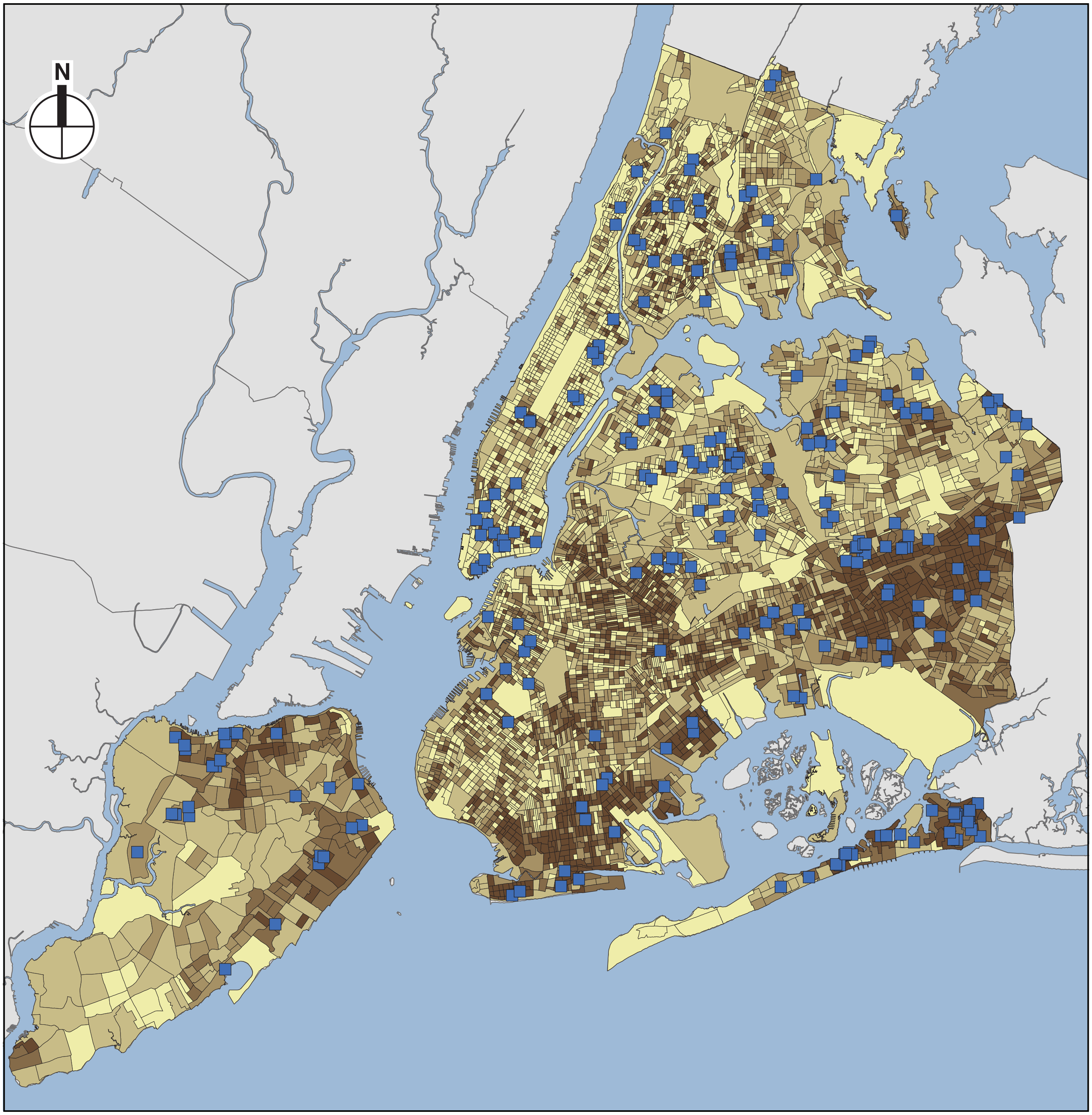
NYCDEP investigates all sewer backup complaints that are reported to 311. Upon investigation, it is typically determined that many of these complaints are actually another issue that manifests itself like a sewer backup, such as a problem within a particular development's internal plumbing lines.

7.4 FATS, OIL, AND GREASE

HOW DOES FOG IMPACT THE SEWERS?

The illegal discharge of grease into the sewer system by restaurants, other commercial and institutional FSEs, and residences is a cause of sewer backups within New York City. Not only does FOG in the sewer system constrain capacity of the sewer lines, it can also cause or contribute to backups and increase odor. In response, NYCDEP degreases problem sewers burdened by FOG, enforces against illegal grease dischargers, and has an education program to address grease discharges from restaurants and other FSEs. In addition, the sewer system was designed to efficiently carry human waste and stormwater—not FOG, which has a different consistency and flow rate—away from residences and businesses.

*Images 7.2 and 7.3—**The sewer on the left is clean while the sewer on the right has reduced capacity due to grease buildup.***



Source: Reported sewer backup data 1/2003 - 12/2007, NYCDEP

Sewer Back Up Complaints per Acre

MOST

LEAST

Degreasing Location

US Census Block Group

Borough	*Number of Degreasing Locations*
Manhattan	*28*
Bronx	*32*
Brooklyn	*27*
Queens	*143*
Staten Island	*27*

0 2 5 MILES

SCALE

FIGURE 7-1 Citywide Sewer Backup Complaints

HOW DOES NYCDEP ADDRESS THE FOG PROBLEM?

All FSEs that may introduce grease into the sewer system are required to install and properly maintain grease traps under New York City code in Chapter 19, Title 15, Section 19-11(a). The Grease Response Education and Strategic Enforcement Program approaches the problem of illegal discharge of grease with educational material (including communications in five languages) distributed to restaurants in target areas. Owners are encouraged to conduct self audits to bring their facility into compliance with City law. NYCDEP staff then conducts inspections to ensure that grease traps are properly sized and maintained.

Through 2005, over 8,000 restaurants were educated about the problems of grease and inspected. Over 60 percent of the restaurants inspected were found to have inadequately sized grease traps and were ordered to upgrade their equipment. This effort has resulted in the installation of over 16,500 grease traps. After a restaurant's equipment is brought into compliance, NYCDEP conducts random, unannounced inspections to ensure proper maintenance is being performed. **Figure 7-2** shows citywide Notices of Violation (NOVs) for FSEs that fail to install a grease trap, fail to maintain a grease trap, or fail to submit proof of proper disposal of grease. Re-inspections have found a 95 percent compliance rate for proper maintenance.

To address grease blockages in the city, NYCDEP maintenance crews respond to all sewer issues reported via 311 calls and also regularly degreases over 250 sewer segments throughout the five boroughs. All 311 calls are inspected by maintenance personnel; if grease is the cause, degreasing operations must occur. Figure 7-2 shows programmatic degreasing locations; these are locations where FOG build up is a known problem and NYCDEP proactively degreases the sewers attempting to address grease-related capacity constraints before sewer backups occur in nearby developments.

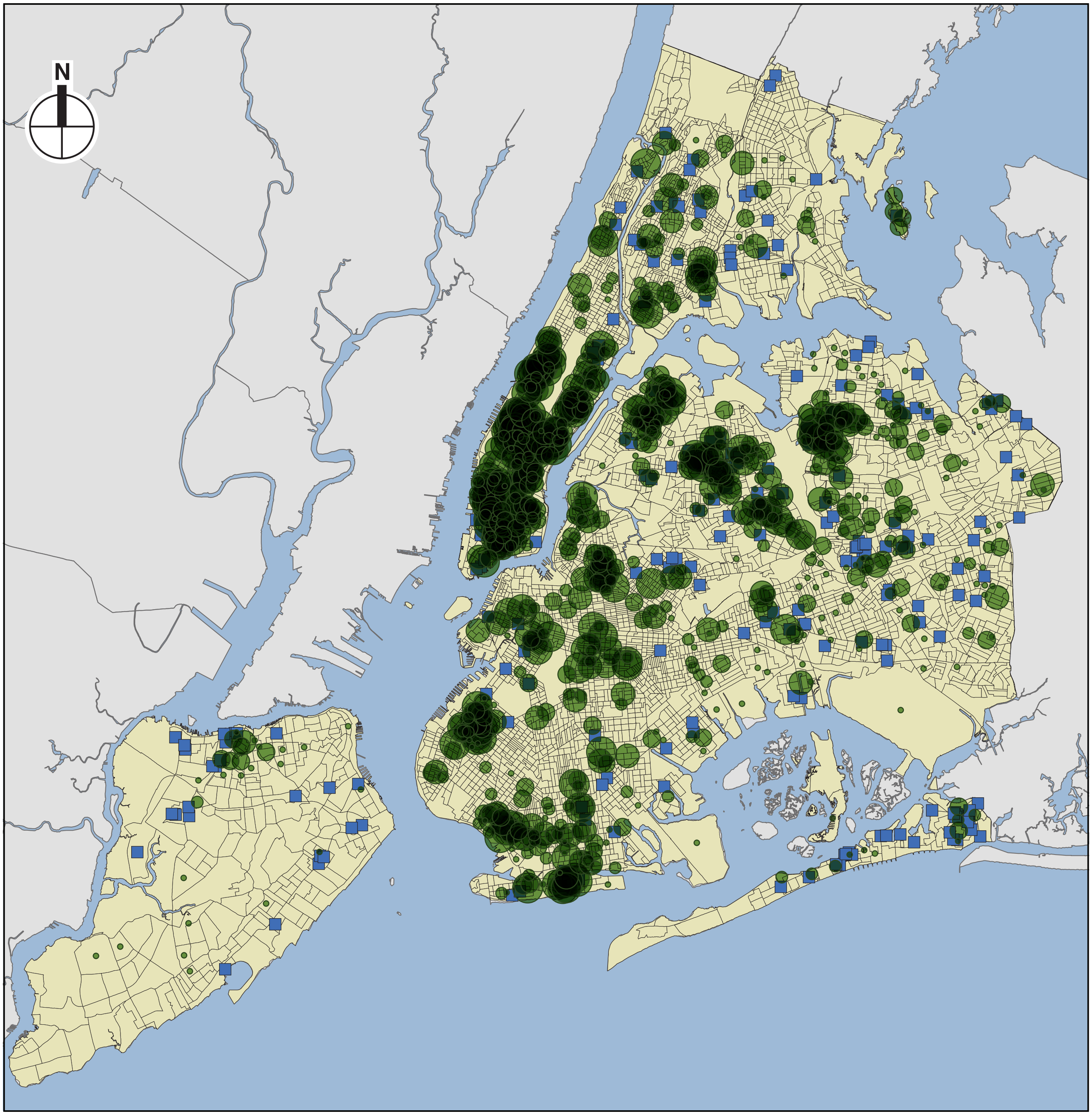
To address a grease condition, concentrated liquid degreaser is flushed through the sewer with a high-pressure hose attached to a 750-gallon "flushing" truck to clear the grease from the sewer. In severe cases, when a grease blockage is not responsive to liquid degreaser, a rodder and/or a vactor truck may be used. These difficult blockages may be attributable to grease and other materials. The rodder operation involves a truck with metal rods and an attached auger that spins within the sewer to break up grease and debris. If a significant amount of grease and debris remains within the sewer, a vactor truck is then used to remove the material.

Each year, NYCDEP uses approximately 2,500 gallons of concentrated liquid degreaser packaged in 5-gallon containers, costing a total of approximately $50,000. Accounting for personnel time, effort and equipment usage to inspect, diagnose, and address blockages by grease, NYCDEP estimates that the cost of degreasing operations is approximately $400 per job. Over fiscal year 2007, the City spent approximately $530,000 for programmatic degreasing and complaint-based degreasing, not including the cost for liquid degreaser.

7.5 COMBINED SEWER OVERFLOW

WHEN DO CSOS OCCUR?

As described above, CSOs occur when the combined sewer system is overloaded, such as during a heavy rainstorm, and a WPCP reaches its capacity. Regulator chambers control flows to the WPCPs. When the WPCP has reached its capacity, regulator chambers divert excess flows to



Source: Reported sewer backup data 1/2003 - 12/2007, NYCDEP

Borough	Number of Degreasing Locations
Manhattan	28
Bronx	32
Brooklyn	27
Queens	143
Staten Island	27

FIGURE 7-2 Citywide Notices of Violations

outfalls discharging to nearby waterways. When this occurs, the mix of excess stormwater and untreated sewage flows directly into the City's waterways.

As shown in **Figure 7-3**, there are over 430 CSO locations in New York City. Through the investment of billions of dollars over the past 20 years both at the WPCPs and in CSO retention facilities, the number of CSO events has dropped dramatically as the capture rate within NYCDEP's treatment and CSO facilities has increased from 30 percent in 1980 to 70 percent today. However, CSOs still occur during heavy storms and even moderate ones. In a typical year, 30 billion gallons can be released from the outfalls, with 90 percent of all CSOs (24 million gallons) discharged via 80 outfalls. New York City will continue to invest heavily in CSO infrastructure in the future and in stormwater management measures to control runoff.

WHAT ARE THE IMPACTS OF CSOS?

CSOs result in increased levels of fecal coliform and decreased levels of dissolved oxygen (DO) in waterbodies, thereby degrading water quality and potentially causing adverse impacts on marine life. While CSOs have little effect on open waters, confined tributaries, such as Flushing Bay and Creek, Alley Creek, Newtown Creek, Gowanus Canal, Paerdegat Basin, Coney Island Creek, the Bronx River, and Westchester Creek, are frequently impacted by CSOs and experience water quality problems, such as low DO levels, odors, and floating litter. Another potential effect of CSOs is the need to occasionally close significant parts of the harbor estuary, including locations along the Hudson and East Rivers, for swimming.

CSO REGULATIONS WITH THE STATE

Under the Clean Water Act, the New York State Department of Environmental Conservation (NYSDEC) and NYCDEP have entered into an agreement that requires NYCDEP to prepare a CSO Long-Term Control Plan (LTCP) to attain the highest reasonable water quality standards for New York City's harbors. These waterbody/watershed assessment plans are to be consistent with State-designated uses and water quality standards. NYCDEP is preparing 18 specific LTCPs, tailored to the individual conditions of each specified waterbody, prior to the development of a citywide LTCP to be submitted to NYSDEC in 2017.

7.6 CURRENT NYCDEP AND PLANYC INITIATIVES FOR ADDRESSING STORMWATER AND CSOS

DEVELOP AND IMPLEMENT LONG-TERM CONTROL PLANS

The LTCPs to abate CSOs rely on proven infrastructure upgrades to expand the capacity of the wastewater treatment plants, construction of tunnels, construction of holding tanks, and optimization of the sewer infrastructure. NYCDEP anticipates spending roughly $2 billion on CSO abatement measures, such as storage tanks and sewer expansion, over the next 10 years. Additional measures have been proposed and are currently under NYSDEC review. In addition to numerical standards that NYCDEC enforces to measure water quality, there is also a CSO Narrative Standard to protect aesthetics in all waters within its jurisdiction, regardless of classification. Unlike the numerical standards, which provide an acceptable concentration, narrative criteria generally prohibit quantities of items such as floatables and grease that would impair the designated use or have a substantial deleterious effect on aesthetics.

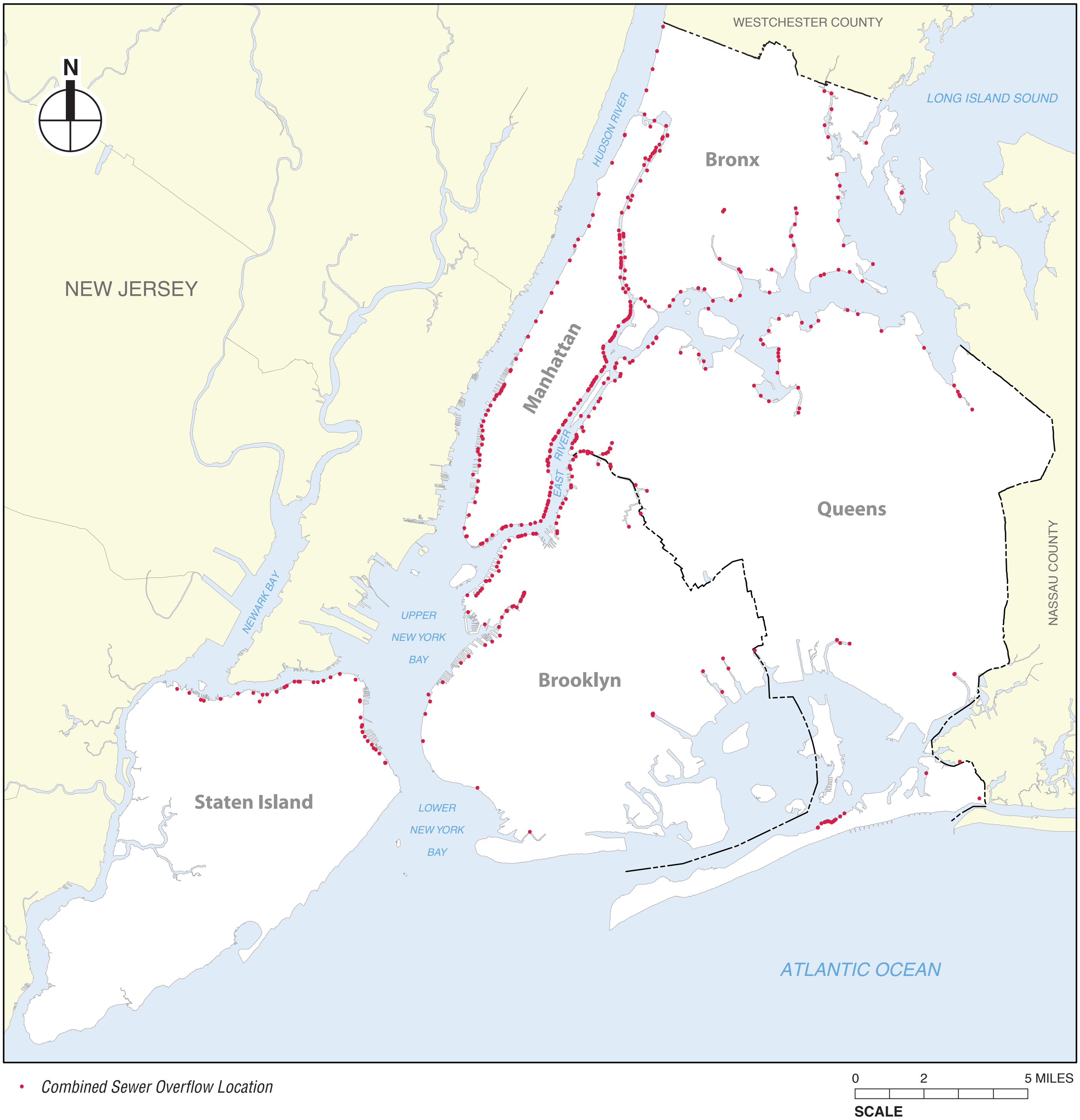


FIGURE 7-3 Combined Sewer Overflow Locations

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The purpose of many of NYCDEP's CSO storage facilities under the LTCP program is to capture CSOs that exceed system capacity. After the system overflow has subsided, the captured flow is diverted to the WPCP for treatment. Such facilities will be located at various locations around New York City.

*Image 7.4—**The City is planning to develop facilities to capture CSOs in Jamaica Bay (shown above) and other important waterbodies.***

NYCDEP has constructed several CSO retention facilities to date. Among these is the first CSO retention tank (Spring Creek Auxiliary WPCP) constructed in the 1970s to capture combined sewer overflow after storms and provide preliminary treatment until the capacity in the sewer system returns to normal levels and the water is discharged to the nearest treatment plant to complete the process. In addition, in May 2007, the Flushing Creek CSO Retention Facility became operational. This tank, constructed largely underground, captures wet-weather flow from the Kissena Corridor sewers, which currently discharge to Flushing Creek.

In addition to tanks, other strategies include aeration, which involves pumping oxygen into waterways to encourage aquatic life; destratification facilities, which churn areas of water to ensure that oxygen is being evenly distributed; sewer optimization, which maximizes the amount of wastewater conveyed to the treatment plant; force mains, which divert CSOs from tributaries with no natural flushing systems into larger waterbodies that can assimilate the sewage more easily; and dredging, which will begin to remove decades of biosolids that have settled onto the bottom of rivers and tributaries.

Preliminary projections estimate that the implementation of elements outlined in the Waterbody/Watershed Plans as well as the subsequent LTCPs as part of the Long Term Control program will result in an increase in CSOs captured (approximately 70 percent to 75 percent). In addition, the plans will specify other enhancements, including reducing floating debris such as bottles, bags, and other trash through netting facilities.

EXPAND WET-WEATHER CAPACITY AT TREATMENT PLANTS

In addition to upgrading its WPCPs to reliably comply with existing and emerging regulatory requirements, NYCDEP is maximizing the volume of water that the WPCPs can process during storms as part of the SPDES requirement – Maximize Flow to WPCP During Wet Weather. This requirement states that the sewer collection system be capable of delivering two times design flow to the WPCP during wet weather.

Today, all of the 14 WPCPs are equipped to handle twice the volume of flows that would occur on a normal day of dry weather. The 26th Ward WPCP is undergoing a $467.5 million upgrade to be able to capture an additional 50 mgd of wet-weather flow. At Newtown Creek and Jamaica Bay WPCPs, the wet-weather capacities will be further expanded, which will reduce the CSO discharges in these sewersheds by more than 185 mgd during rainstorms.

FLOATABLE ABATEMENT PLAN

NYCDEP developed and NYSDEC approved the updated Floatables Plan on March 17, 2006. The objectives of the Plan are to provide substantial control of floatables discharges from CSOs throughout the City, and the Plan is expected to control roughly 96 percent of the floatable litter generated in New York City. The Plan consists of numerous action elements, including inspection of catch basins for missing hoods and replacement of missing hoods to prevent floatables from entering the sewer system. In addition, capturing floatables at wet-weather CSO storage/treatment facilities and capturing floatables at end-of-pipe and in-water facilities are key elements. In-water facilities include the Interim Floatables Containment Program designed to capture debris in the City's waterways. To trap the debris before it reaches the water, floating containment barriers have been installed across major combined sewer outfalls in the tributaries that surround the City. Another key element to removing floatables from the sewer system is street cleaning by the Department of Sanitation.

PLANYC INITIATIVES

PlaNYC, the Mayor's sustainable plan for New York City, strikes a balance between infrastructure solutions and low-impact strategies to improve the quality of New York City waterbodies, especially its most polluted tributaries affected by CSOs. Under PlaNYC, the City is pursuing a range of proven strategies to keep storm water from entering the combined sewer system. PlaNYC sets goals that, by 2030, public access to New York City tributaries will increase from 48 percent to over 90 percent, 98 percent of the waterways will be open for recreational use, and larger waterbodies will be less susceptible to storm-generated pollution. To meet these goals, PlaNYC recommends a series of initiatives to continue implementing mandated infrastructure upgrades, pursuing proven strategies to prevent stormwater from entering the system, and expanding, tracking, and analyzing new best management practices (BMPs) on a broad scale.

NEW YORK CITY'S SUSTAINABLE STORMWATER MANAGEMENT PLAN 2008

PlaNYC's Water Quality goals call for an Interagency BMP Task Force to coordinate stormwater planning issues and create a Sustainable Stormwater Management Plan pursuant to Local Law 5 of 2008 for New York City released in December 2008. The Sustainable Stormwater Management Plan sets forth an analytical framework for assessing alternatives for controlling stormwater and provides relevant information about potential costs and benefits.

The plan aims to continue or initiate programs that control stormwater on-site or “source controls.” These controls continue programs already in place on buildings or lots, such as green roofs, green parking lots and rain barrels; in the public right-of-way, such as street trees, Greenstreets, and high-level storm sewers; and in open space, such as Bluebelt programs and porous ballfields. The plan also discusses potential future initiatives, such as performance standards for new development and existing buildings and incorporating source controls into major roadway reconstruction.

7.7 IMPACTS FROM COMMERCIAL FWD USE ON CSOS AND ON SEWERS

IMPACTS FROM FOG ON SEWER OPERATIONS

Based on other municipalities experience with the effect of FWDs on sewers as well as NYCDEP’s experience with the effect of FOG on sewers, FWD implementation would increase the FOG in the system and thereby exacerbate grease-caused capacity constraints and associated sewer backups already experienced throughout the city. Most municipalities (as discussed in Chapter 3) that allow FWDs require stringent grease controls.

As discussed earlier, sewers are designed to efficiently carry human waste and stormwater, not FOG. NYCDEP has made a significant effort to stem grease discharges into the sewer system from restaurants and other FSEs. Since FWDs cannot be used with the grease traps that are currently required by NYCDEP, allowing FWDs for commercial use would counter the City resources that have been spent on educating businesses about proper grease disposal. As discussed in Chapter 3, FWDs can be connected to grease interceptors, which are much larger and costlier than typical grease traps in New York City today. However, even with the use of grease interceptors, the grease loadings due to the high liquid and solid FOG content of food waste would have a substantial impact on the sewer system.

Some municipalities, such as San Francisco, are striving to eliminate the use of FWDs within the food service industry. It has been San Francisco’s experience that FWDs contribute to the FOG problem in the wastewater flow and sewers. As reported by San Francisco’s Public Utility Commission, FWDs cause an excessive buildup of organic matter in grease traps, maintenance issues within the sewers, and serious odor problems. The City of San Francisco’s analysis is that it costs far more to treat food waste once in the sewer as opposed to a composting program.

NYCDEP has received over 21,000 complaints of sewer backups in each of the past five fiscal years. NYCDEP inspects each sewer backup complaint to determine the cause, and this complaint number includes many issues that after investigation turn out not to be issues in the City’s sewers. As described, sewer backups can occur as a result of many conditions, such as when the system is overtaxed by rain or when blockages occur in the sewers, the last of which can be caused or exacerbated by grease. Since a portion of the sewer maintenance issues that NYCDEP faces are caused or exacerbated by grease, the additional FOG from FWDs could quickly multiply maintenance issues and costs. This additional FOG can also contribute to significant increases in odors in the sewer system. Confirmed sewer backups are shown on Figure 7-1.

In addition to the thousands of 311 calls that NYCDEP responds to annually, various inspections, repairs, and programmatic cleaning of catch basins all must be accomplished.

NYCDEP sewer maintenance abilities are constrained due to the volume of issues that must be investigated and addressed with a generally finite set of labor resources. Additional FOG in the sewers could increase sewer backups and the demands on NYCDEP limited maintenance resources.

To reduce illegal grease discharges in the sewer system, NYCDEP has issued almost 4,000 NOVs for grease-related issues from 2002 to 2007. The high concentrations of FSEs in Manhattan and Queens have the highest number of incidents, with over 1,000 NOVs in each borough over the past 5 years. NOVs and some sewer backup instances are caused or exacerbated by improper grease handling by FSEs and residents. Permitting FWDs could increase these violations and sewer maintenance issues.

Chapter 9 takes a closer look at four case studies and identifies sewer backups treated by programmatic and complaint-driven degreasing along with NOVs and FSE concentrations. While the considerable effort on the part of the NYCDEP to reduce grease loadings from FSEs has largely been successful, the sewer backups caused or exacerbated by grease continue. Sewer maintenance needs could increase with additional FOG throughout the sewer system; however, as discussed maintenance resources are already constrained, and thus would not easily be able to accommodate this additional burden.

IMPACTS ON COMBINED SEWER OVERFLOWS

As discussed above, water quality in the City’s waterways has improved greatly in the past 20 years, and the harbor is cleaner than it has been in over 100 years. These improvements have taken decades of work and billions of dollars funneled to the sewer infrastructure.

One of the biggest remaining water quality challenges today is stormwater runoff, which contributes to CSOs and other untreated discharges. Stormwater runoff is a major reason that many of the City’s tributaries still do not meet standards for recreational use. The City is employing four basic strategies to improve water quality: removing remnant pollution by dredging, increasing the capacity or throughput at the WPCPs, reducing CSOs, and reducing other untreated runoff. NYCDEP is investing in effective “end of pipe” solutions and source controls to abate CSOs. End of pipe solutions are costly to construct, operate, and maintain; take years to complete; and are ultimately limited by physical constraints in the sewer infrastructure below city streets. By increasing sanitary flow with FWD implementation, not only could CSOs increase, but the solids expelled during a CSO could also increase.

Through PlaNYC and the City’s recently released Sustainable Stormwater Management Plan, the City is promoting source controls to meet the many challenges of stormwater management in the City. These challenges include an aging and constrained system and stringent regulatory requirements for capturing wet-weather flow. The many initiatives proposed in the plan include tracking, monitoring, and reporting on the performance of source controls; developing information to support source control implementation; providing public education and professional training for green job growth; and continuing and improving ambient water quality monitoring. Allowing FWD implementation would work counter to the objectives of creating a more sustainable stormwater management approach for the City.

The additional sanitary flow from commercial FWDs, estimated to be 11 mgd citywide and 9.7 mgd in combined sewer areas, would reduce the wet-weather capacity of sewers and could potentially trigger additional CSOs. The discharges would also offset gains in CSO abatement and stormwater management source control initiatives, and thus would run counter to numerous

City initiatives currently underway to improve water quality and increase public access to over 90 percent of New York City tributaries.

Further, the additional FOG and food waste particles from FWD use could be discharged with CSOs into the City's waterways. The additional food waste particles would increase floatables, which would work counter to NYSDEC's CSO Narrative Standards and NYCDEP's Floatables Abatement Plan. As mentioned above, implementing the Floatables Abatement Plan is expected to capture 96 percent of floatables within NYCDEP's sewer infrastructure. The additional FOG would increase the probability of visible grease slicks in the waterways near CSOs, which would be counter to PlaNYC's water quality goals.

The cost of installing stormwater best management practices (BMPs) to offset the 9.7 mgd of additional discharges from FWDs within combined sewer areas would average $20 per gallon, or $194 million on top of the programs the City is currently implementing. Hard infrastructure, such as CSO retention tanks and tunnels, cost between $6 and $40 per gallon captured; to offset the additional 9.7 mgd from FWDs would cost between $58.2 and $388 million. This investment would not mitigate the sewer problems associated with FOG discussed above. ✷

Chapter 8: Potential Impacts of Commercial Food Waste Disposers At the Water Pollution Control Plants

8.1 INTRODUCTION

This chapter discusses the potential impacts at the City's water pollution control plants (WPCPs) that could result from allowing food service establishments (FSEs) in New York City to use commercial food waste disposers (FWDs).

Section 8.2 provides an overview of the City's 14 WPCPs (also called sewage or wastewater treatment plants). Sections 8.3 through 8.10 address the potential impacts of commercial food waste disposal on the City's WPCPs and summarize the equipment and associated costs needed to handle commercial food waste disposal. Specifically, Section 8.3 discusses the increases in flows and loads from commercial FWD use. Section 8.4 discusses how commercial FWD use would impact biological nutrient removal (BNR) at the BNR plants. Section 8.5 focuses on the potential impacts at the Newtown Creek WPCP, which has been chosen for more detailed analysis because of the enormity of the potential impacts and their effects on the upgrade of the plant and future planned operational design. Section 8.6 discusses impacts on solids handling. Section 8.7 discusses impacts on secondary treatment at the remaining WPCP plants. Section 8.8 discusses the impact of fats, oils, and grease (FOG) at the plants. Section 8.9 discusses permitting challenges and additional environmental impacts. Finally, Section 8.10 provides a summary of the cumulative costs.

All analyses presented in this chapter assume 50 percent penetration of FWDs unless stated otherwise. Results of the analyses for 25, 75, and 100 percent penetration are included in **Appendix C**. Analyses were conducted for the years 2008, 2017, and 2030. Analyses presented below are for the year 2030 (unless otherwise stated); the year 2030 was selected because of the long lead time required to design and construct infrastructure projects to address potential FWD impacts. Due to these long lead times, the City could not wait for the impacts of FWD use to make themselves known; construction would need to begin well in advance of known impacts. There is no funding available for these investments, and it is anticipated that the funding could not be put in place for many years. However, some of the investments resulting from the use of FWDs would need to be accelerated to meet regulatory mandates.

SUMMARY OF CONCLUSIONS

The additional wastewater flow and pollutant load from the use of commercial FWDs would result in significantly greater treatment demands at the City's WPCPs. In particular, use of FWDs could jeopardize billions of dollars of investments made by the City in BNR and at the Newtown Creek WPCP to upgrade the plant to meet secondary treatment requirements under the Clean Water Act. As described in detail later in this chapter, the following are the principal conclusions from this chapter.

- **Biological Nutrient Removal.** To remain in compliance with New York State Department of Environmental Conservation (NYSDEC) nitrogen limits in the East River, at penetration rates over 25 percent, an alternate BNR process would need to be constructed at either the Wards Island or Bowery Bay WPCP. This alternate process, such as biological denitrification filters, would be more effective and significantly more costly than the current treatment process. In Jamaica Bay, it is expected that denitrification filters would be required at the 26th Ward WPCP.
- **Newtown Creek WPCP.** Newtown Creek has limited excess organic loading capacity, and the additional loadings from FWDs could jeopardize permit limits and secondary treatment requirements. Should this loading capacity be exceeded, primary tanks would be required at an enormous cost to the City. Severe space limitations at the plant would potentially dictate that the primary tanks be decked over the existing plant process, which would add considerably to these costs.
- **Solids and Sludge.** Other WPCP impacts would include increased sludge production and solids handling needs. To accommodate this added demand, additional equipment (i.e., thickeners, centrifuges, and sludge storage tanks) would be required. The additional sludge would require additional processing and transport.
- **Fats, Oils, and Grease**. FOG contained in the food waste would increase the FOG loadings at the plants and affect both primary and secondary treatment. At the Newtown Creek WPCP alone, FOG loadings could increase tenfold.

A summary of the total additional investments (capital costs) and annual operating and maintenance costs with the implementation of FWDs in 2008 dollars is presented in **Table 8-1**. Use of commercial FWDs at a 50 percent penetration rate would result in the need for very costly investments of $1.0 billion at the treatment plants. Should primary tanks be required at the Newtown Creek WPCP, an additional investment of $1.7 billion would be required, for a total of $2.7 billion. Annual O&M costs would be approximately $34 to $35 million a year.

Table 8-1
Summary of WPCP Costs with Implementation of Commerical FWDs

FWD Tactic	Capital Costs	Annual O&M Costs
Newtown Creek (without and with primary tanks)	$2.6 million to $1.7 billion	$1.2 million to $2.2 million
Wards Island denitrification filters	$650 million	$3.8 million
26th Ward denitrification filters	$240 million	$2.1 million
Solids handling upgrades and disposal	$128 million	$23.3 million
Secondary treatment upgrades	$5.2 million	$3.2 million
Total	**$1.0 to $2.7 billion**	**$33.6 to $34.6 million**
Note: All costs are in 2008 dollars.		

The costs presented are likely to be underestimated due to numerous unknowns at this time. All costs are based on conceptual-level designs. When more detailed design is done, costs often increase significantly due to new needs that are identified related to limited space, electricity constraints, and other miscellaneous costs that become apparent. In addition, land acquisition and/or landfilling costs were not included in the estimates. Lastly, the costs do not include severe penalties that would be incurred by the City for violations of Consent Orders, Consent Judgments, and permit limits as discussed in Section 8.9.

8.2 THE WASTEWATER TREATMENT PROCESS

DRAINAGE AREAS

The City is divided into 14 sewage drainage basins, each of which is served by a sewer network and a WPCP. Figure 8-1 shows the City's 14 sewage drainage basins and the location of each of the WPCPs. Each WPCP serves a complex and diverse mix of residential, commercial, and industrial uses and consists of a network of catchment basins and sewer pipes that direct wastewater flow to each of the WPCPs.

WASTEWATER FLOWS

Wastewater flows that arrive at the WPCPs are treated to remove pollutants before the wastewater is discharged to local waterbodies. Dry weather flows, or sanitary flows, consist of wastewater from toilets and drains in homes, schools, businesses, and factories that then flows into New York City's sewer system. Such flows are dependent on population—both the residential population and the population of the City's businesses. In addition to dry weather flows, the WPCPs are designed to capture two times dry weather flow to treat wet weather flows generated by runoff from rain and melting snow.

TREATMENT PROCESS

Wastewater treatment plants remove most pollutants from wastewater before it is released to local waterways. At the plants, physical and biological processes closely duplicate how wetlands, rivers, streams, and lakes naturally purify water. Treatment at these plants is relatively quick, taking only about 7 hours to remove most of the pollutants from the wastewater. Each of the City's 14 WPCPs is governed by a State Pollutant Discharge Elimination System (SPDES) permit permitted by the NYSDEC. Figure 8-2 illustrates the treatment process.

This section provides an overview into the typical New York City wastewater treatment process. For detailed information, see **Appendix B**.

- **Preliminary Treatment.** In preliminary treatment, raw wastewater first passes through primary screens to remove large objects in the wastewater stream. The wastewater then flows by gravity into a wet well, where it is collected before being pumped by main sewage pumps to the secondary screens. Secondary screens remove smaller objects.
- **Primary Treatment.** In primary treatment, wastewater is held in primary settling tanks to allow heavier solids to settle to the bottom of the tank while grease and oil float to the water's surface. (The Newtown Creek WPCP does not have primary tanks.) At the end of the process, the floatable trash that contains FOG (or "scum") is skimmed off the surface and trucked to a landfill off-site.

  The settled solids, called primary sludge, are pumped to a cyclone degritter to separate out sand, grit (e.g., coffee grinds), and gravel. The grit material is removed, washed, and trucked off-site for disposal while the degritted sludge is pumped to the plant's sludge handling facilities (i.e., thickeners and digesters) for further processing.
- **Secondary Treatment.** This process adds air and "seed" sludge to wastewater to further break down the remaining organic materials in the water. Air is pumped into large aeration tanks to mix the wastewater and sludge, thereby stimulating the growth of oxygen-using

Water Pollution Control Plant

WPCP Drainage Area Boundary

1 Community District

0 2 5 MILES

SCALE

FIGURE 8-1 New York City WPCP Drainage Areas and WPCPs

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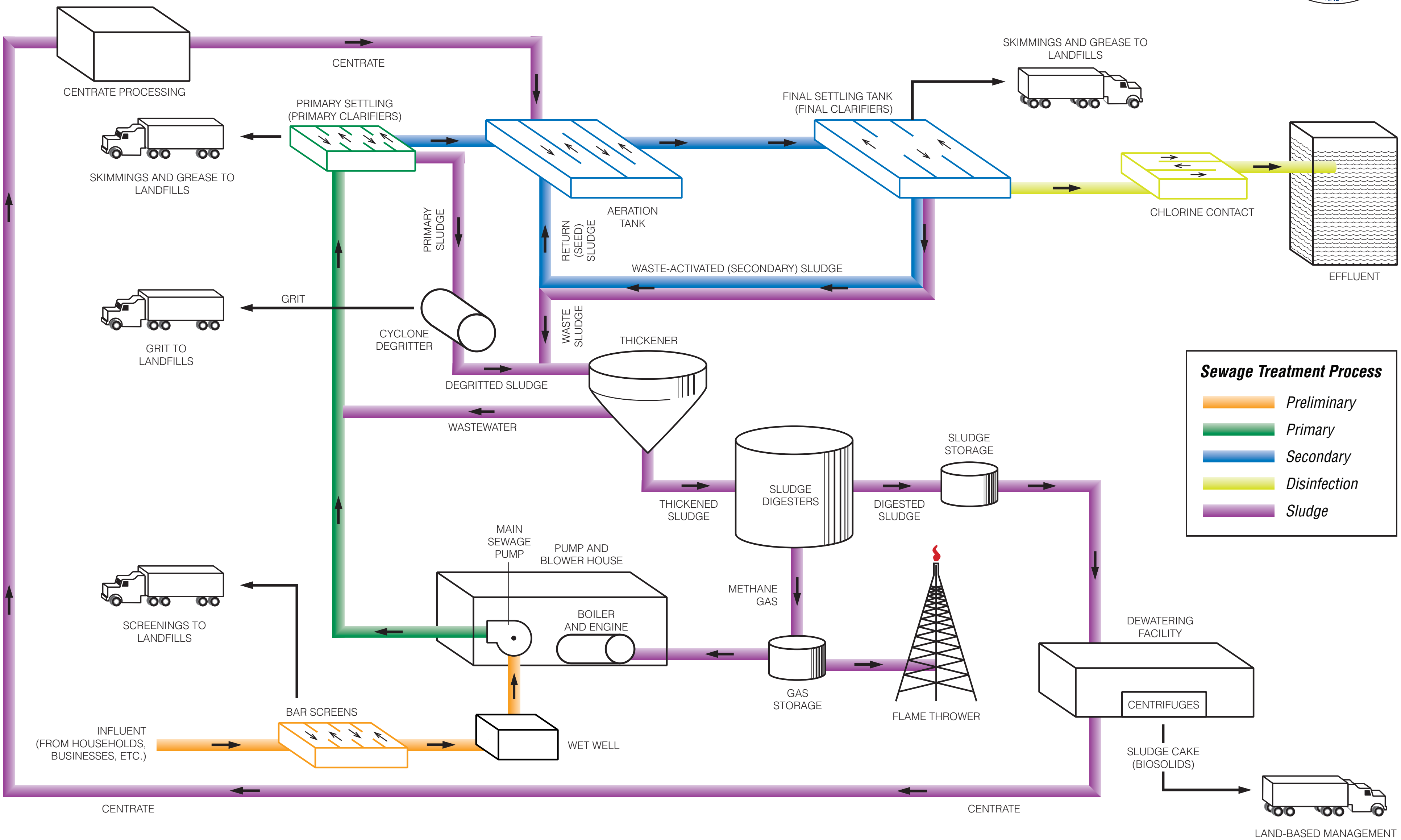


FIGURE 8-2 Typical Sewage Treatment Plant Process

bacteria and other tiny organisms that are naturally present in the sewage. Wastewater passes through these bubbling tanks in 3 to 6 hours.

The aerated wastewater then flows to the final settling tanks, where heavy particles and other solids settle to the bottom as secondary sludge (or “waste-activated sludge”). Some of this sludge is re-circulated back to the aeration tanks. The remaining secondary sludge is removed from the settling tanks and added to the degritted primary sludge for further processing. Wastewater passes through the settling tanks in 2 to 3 hours and then flows to a disinfection tank.

NYSDEC requires that a minimum of 85 percent of biochemical oxygen demand (BOD) and total suspended solids (TSS) of dry weather flow is removed before the plant’s effluent is released.

The secondary treatment process has been modified at several of the WPCPs that discharge to waters that enter the Long Island Sound to incorporate features to remove total nitrogen (see “Impacts on BNR,” below).

- **Disinfection.** To disinfect and kill harmful organisms, wastewater spends a minimum of 15 to 20 minutes in chlorine-contact tanks mixing with sodium hypochlorite. The treated wastewater, or effluent, is then released into local waterways.
- **Solids Handling and Sludge Management.** Sludge is processed through thickeners and digesters before being dewatered and converted to biosolids, which are beneficially reused. See discussion below (“Impacts on Solids Handling and Sludge Management”) for more information on this process.

ENERGY USE IN THE WASTEWATER TREATMENT PROCESS

The City’s WPCPs use energy to heat and light their buildings; operate pumps, blowers, and motors; and provide heat for the sludge digestion process. As part of the PlaNYC initiative, the City is committed to reducing the amount of energy consumed in its WPCPs and other City-owned facilities through various energy-saving measures, such as better management of energy use and retrofitting buildings to ensure efficiency. The City is aiming for a 30 percent reduction in greenhouse gas emissions by 2017 as a result of these efforts.

With these improvements and pending additional funding, future WPCP operations will likely be more energy efficient in the future. Wastewater treatment processes are energy intensive with aeration systems generating the highest demand for electricity, and pumping and dewatering operations also requiring significant amounts of power. The WPCPs use digester gas to meet a percentage of their total heating needs, with natural gas, fuel oil, and electricity purchased from electrical utilities providing the rest. During colder months, natural gas is used to supplement the digester gas when a plant’s demand is greater than its digester gas production. During the warmer months, the excess digester gas is sent to gas burners. Today, approximately 40 percent of digester gas produced is used while the remaining 60 percent is flared annually. NYCDEP is evaluating ways to use this gas more efficiently. Capital improvements are currently being designed for the Rockaway and Port Richmond WPCPs to improve efficiency of biogas reuse.

NYCDEP also uses fuel cells at four of its plants (26th Ward, Red Hook, Oakwood Beach, and Hunts Point). These fuel cells convert the methane gas created during the digestion process and carbon dioxide into heat and electricity that is then used to operate the plants.

AIR QUALITY REQUIREMENTS

For each plant, use of its emergency generators, boilers, exhaust stacks, and other emissions-producing equipment is undertaken in accordance with applicable permits and registrations under the NYSDEC's Air Permitting and Registration program.

The WPCPs have odor control systems that vary by plant, but all are designed to cover, collect, and treat process air. At some plants, processed air is treated with a mixture of sodium hypochlorite and sodium hydroxide, and then funneled through active carbon filters, which absorb odors and chemicals and remove the remaining odor-producing particles. For some plant processes, only carbon filters are applied. In the final process, treated air is released through emissions stacks.

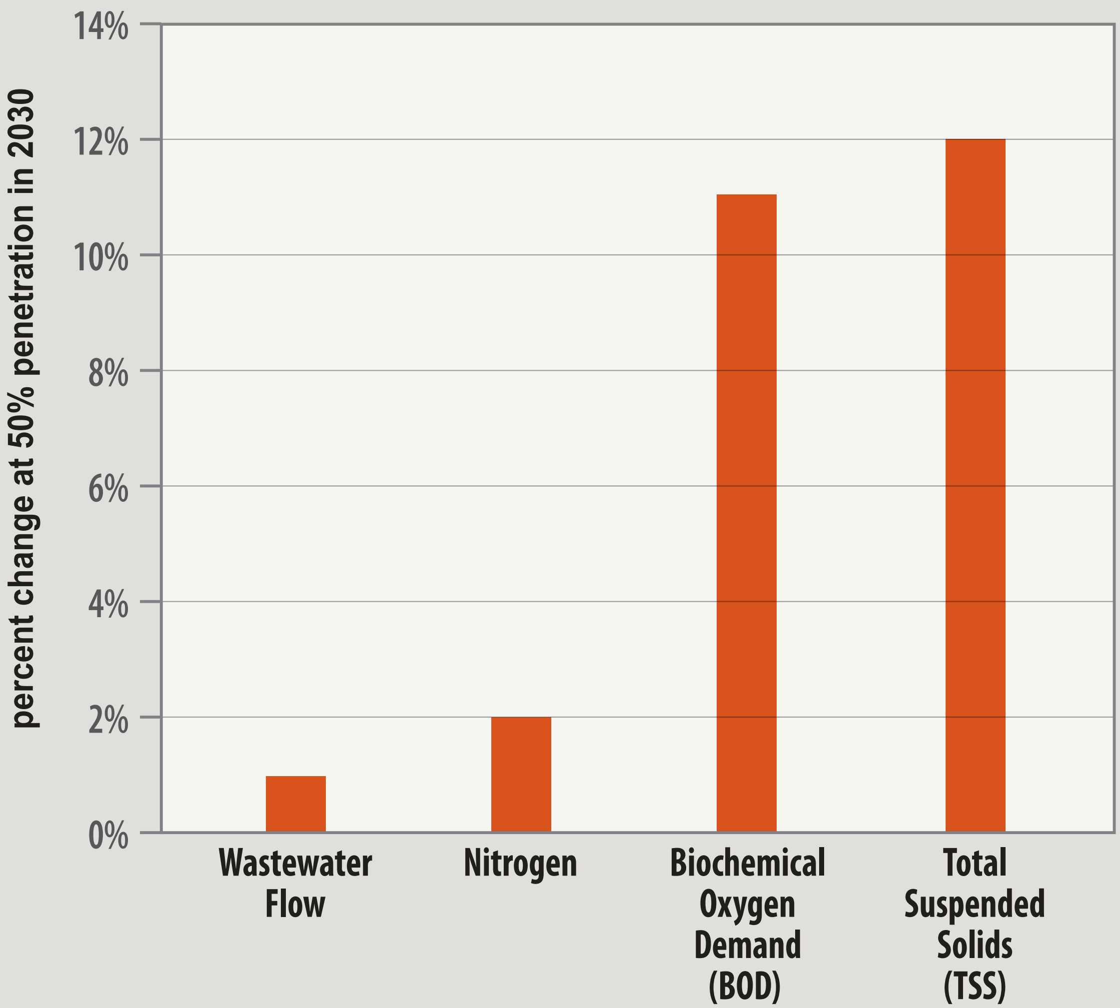
8.3 INCREASES IN FLOWS AND LOADS FROM COMMERCIAL FWD USE

Allowing the use of commercial FWDs would result in increased wastewater flows and pollutant loads to the City's WPCPs that would change both the volume and the characteristics of the influent to these plants (see **Figure 8-3**). Overall, flows to the plants would increase, and these flows would contain higher levels of BOD, TSS, and nitrogen. **Table 8-2** provides a comparative summary of projected maximum increases at 50 percent FWD penetration in flows and loads (i.e., BOD, TSS, and nitrogen) at each WPCP over baseline conditions in the year 2030.

Table 8-2
Incremental Increase in Flows and Loads with FWD in 2030 (50 Percent Penetration)

	Flow (mgd)			Nitrogen (lbs/day)			BOD (lbs/day)			TSS (lbs/day)		
	0	50	% Diff	0	50	% Diff	0	50	% Diff	0	50	% Diff
26th Ward	62.8	63.05	0.40%	10,880	11,045	1.52%	83,200	91,305	9.74%	71,110	77,435	8.89%
Bowery Bay	136.8	137.15	0.26%	30,700	30,965	0.86%	179,400	191,135	6.54%	137,700	146,990	6.75%
Coney Island	99	99.7	0.71%	23,280	23,685	1.74%	141,290	162,505	15.02%	149,600	165,960	10.94%
Hunts Point	132.2	132.95	0.57%	22,890	23,355	2.03%	123,700	147,715	19.41%	121,950	140,585	15.28%
Jamaica	89.9	90.1	0.22%	21,870	22,015	0.66%	131,180	137,760	5.02%	104,870	109,925	4.82%
Newtown Creek	250.7	253.9	1.28%	51,620	53,190	3.04%	361,280	450,100	24.58%	354,650	420,870	18.67%
North River	140.6	142.4	1.28%	36,440	37,345	2.48%	260,340	310,985	19.45%	268,990	307,140	14.18%
Oakwood Beach	36.5	36.8	0.82%	8,590	8,750	1.86%	59,310	67,855	14.41%	57,900	64,230	10.93%
Owls Head	109.4	110.45	0.96%	27,670	28,230	2.02%	180,500	210,300	16.51%	172,630	195,535	13.27%
Port Richmond	40.2	40.45	0.62%	8,110	8,235	1.54%	75,890	83,175	9.60%	61,510	66,755	8.53%
Red Hook	34.9	35.4	1.43%	8,610	8,855	2.85%	52,680	66,235	25.73%	52,100	62,390	19.75%
Rockaway	22.9	22.95	0.22%	3,600	3,665	1.81%	18,130	21,795	20.22%	21,520	24,200	12.45%
Tallman Island	62.8	62.95	0.24%	14,060	14,185	0.89%	82,680	88,970	7.61%	67,670	72,285	6.82%
Ward Island	220.7	222.05	0.61%	36,150	36,975	2.28%	244,580	287,125	17.40%	214,700	247,730	15.38%

All analyses presented in this chapter assume 50 percent penetration of FWDs unless stated otherwise. Results of the analyses for 25, 75, and 100 percent penetration are included in Appendix C. Analyses were conducted for the years 2008, 2017, and 2030. Analyses presented below are for the year 2030 unless otherwise stated. The year 2030 was selected because of the long lead time needed to design and construct infrastructure projects to address potential FWD impacts. Due to these long lead times, the City could not wait for the impacts of FWD use to make themselves known; construction would need to begin well in advance of known impacts. There is no funding available for these investments and it is anticipated that the funding could



Wastewater Flow
+ 10.9 millions of gallons per day

Nitrogen
+ 6,025 pounds per day

Biochemical Oxygen Demand (BOD)
+ 322,800 pounds per day

Total Suspended Solids (TSS)
+ 245,130 pounds per day

FIGURE 8-3 Flow and Load Increases from Commercial Food Waste Disposers (2030, 50% penetration) not be put in place for many years. However, some of the investments resulting from the use of FWDs may need to be accelerated to meet regulatory mandates.

The largest increases in influent nitrogen from implementation of FWDs would occur at the Newtown Creek, North River, Red Hook, and Wards Island WPCPs due to high concentrations of FSEs in these areas.

8.4 IMPACTS ON BIOLOGICAL NUTRIENT REMOVAL (BNR) FROM COMMERCIAL FWD USE

OVERVIEW

Due to the high nitrogen content of food waste, allowing use of commercial FWDs would impact nitrogen loadings and the BNR treatment process at the WPCPs and jeopardize the City's BNR program. Excessive nitrogen discharges contribute to hypoxia, a condition in which water does not have enough oxygen to support fish and other aquatic life. Nitrogen discharges contribute to hypoxia by encouraging the growth of planktonic algae, which consumes oxygen during the decaying process. Both the Long Island Sound and Jamaica Bay suffer from hypoxia. Through various studies and Consent Orders with New York State, stringent nitrogen discharge limits have been or are currently being established for WPCPs in the East River and Jamaica Bay (see "Regulatory Context," below).

Implementation of BNR will enable NYCDEP to substantially reduce the amount of nitrogen discharged from WPCP effluents. BNR is accomplished by modifying the secondary treatment process to grow specialized organisms that can convert ammonia to nitrogen gas and remove it from the wastewater. This requires a larger solids inventory in the aeration basins, achieved by running at a higher solids concentration in the basins or by increasing the aeration volume, and compartmentalization of the aeration tanks into zones that are aerated (aerobic) and zones that are not aerated (anoxic). In addition, special processes have been added to remove the ammonia from the liquids recycled from sludge processing. At present, NYCDEP is spending over $1.4 billion to comply with these stringent limits with upgrades, such as aeration system upgrades, froth control systems, alkalinity addition systems, and return activated sludge upgrades, at the East River and 26th Ward WPCPs.

The most significant impact of FWDs on the process performance at BNR plants would be decreased nitrification due to lower solids retention time (SRT). To remain in compliance with NYSDEC nitrogen limits in the East River, at penetration rates over 25 percent, either the Wards Island or Bowery Bay WPCP would need to construct an alternate BNR process, such as biological denitrification filters, that would be more effective than the current planned treatment process. Biological denitrification filters at the Wards Island or Bowery Bay WPCP would cost approximately $650 million or $310 million, respectively. Nitrogen limits for Jamaica Bay are expected to be required in the near future, and, with FWDs, denitrification filters at 26th Ward (at a cost of $240 million) would likely be required. Capital improvements at these plants would be extremely difficult due to lack of available land. At Bowery Bay WPCP, facilities would need to be built in filled-in waterways or constructed vertically, and it would be difficult to obtain permits to construct. The costs presented above do not include costs for land acquisition or landfilling.

REGULATORY CONTEXT

To regulate the amount of nitrogen leaving treatment plants, limits have been or are currently being established for WPCPs in the East River and Jamaica Bay. These limits are aggregate discharge limits for each waterbody and are set forth in the applicable SPDES permits.

- In the **East River**, a Judicial Consent Order requires an effluent nitrogen load of no more than 44,325 pounds per day (lbs/d) starting January 2017.[1] This number reflects the combined effluent nitrogen limits of six WPCPs—the Upper East River plants (Tallman Island, Bowery Bay, Hunts Point, and Wards Island) and the Lower East River plants (Newtown Creek and Red Hook). Note, only one-quarter of the effluent nitrogen from the Lower East River plants is used to calculate the combined East River discharge as it was shown that 4 pounds of nitrogen discharged in the Lower East River has an equivalent impact to 1 pound of nitrogen discharged in the Upper East River.[2]
- **Jamaica Bay** is subject to an effluent nitrogen limit of 45,300 lbs/d starting January 1, 2009. This number reflects the combined effluent nitrogen limits of the four WPCPs that discharge effluent to Jamaica Bay: Rockaway, Jamaica, 26th Ward, and Coney Island. However, discussions with the NYSDEC are ongoing and will likely result in more stringent nitrogen limits.

BNR TREATMENT PROCESS

In addition to the normal treatment process requirements, NYCDEP has already completed or is in the process of constructing systems to implement BNR processes at five WPCPs: 26th Ward, Bowery Bay, Hunts Point, Tallman Island, and Wards Island. BNR is accomplished by modifying the secondary treatment process to grow a specialized biomass capable of oxidizing ammonia to nitrate, which can be reduced to nitrogen gas and removed from wastewater. This requires a larger solids inventory in the aeration basins, achieved by running at a higher solids concentration in the basins or by increasing the aeration volume, and compartmentalization of the aeration tanks into zones that are aerated (aerobic) and zones that are not aerated (anoxic). In addition, special processes have been added to remove the ammonia from the liquids recycled from sludge processing. Implementation of BNR will enable NYCDEP to substantially reduce the amount of nitrogen discharged from WPCP effluents.

To remove both nitrogen contained in the plant influent and ammonia-rich centrate from dewatering operations, the BNR plants have been modified from typical secondary treatment to follow the steps below:

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[1] The current nitrogen limit is 108,375 lbs/d. By January 2017, the nitrogen limit will be 44,325 lbs/d. The April 2002 Nitrogen Consent Order required that the City design and implement BNR upgrades in accordance with United States Environmental Protection Agency-approved TMDL requirements and based on recommendations of the Long Island Sound Study. The 2006 Nitrogen Consent Judgment modified the 2002 Nitrogen Consent Order and includes nitrogen upgrade activities, construction schedules and limits that collectively represent a reasonable and appropriate program to meet the long-term nitrogen reduction goals of the original Nitrogen Consent Order and the Long Island Sound TMDL. As set forth in the 2006 Nitrogen Consent Judgment, effluent nitrogen limits will become increasingly stricter as construction of BNR improvements are completed.

[2] The specific formula is Upper East River WPCPs Nitrogen Discharge + (Lower East River WPCPs Nitrogen Discharge/4) = Combined Nitrogen Discharge

- **Nitrification.** This process reduces ammonia concentrations by oxidizing ammonia to nitrite and then nitrate by growing two biomass populations: ammonia oxidizing biomass (AOBs), which oxidize ammonia to nitrite, and nitrite oxidizing biomass (NOBs), which oxidize nitrite to nitrate. Ammonia-rich centrate from dewatering is treated first in a separate centrate treatment (SCT) tank before reaching the aeration tanks.
- **Denitrification.** After nitrification, nitrate is reduced to nitrogen gas by other bacteria commonly found in wastewater under anoxic conditions in the denitrification process.

The nitrification process is highly dependent on the SRT, a measure of the amount of time that solids reside in the aeration process. BNR operations require a higher SRT than traditional secondary treatment plants to achieve nitrification as the nitrifying biomass (AOB and NOB) populations are a slower growing biomass than the microorganisms used to remove BOD.

IMPACTS FROM ADDITIONAL LOADINGS ASSOCIATED WITH FWDS

Additional food waste loadings would affect BNR processes and result in increases in effluent loadings on the receiving waters. A computer modeling analysis was undertaken to determine the impact of food waste disposal on effluent nitrogen discharges. The analysis, utilizing *BioWin* process modeling software, concluded that allowing the use of commercial FWDs in New York City would result in increased effluent nitrogen discharges to the East River and Jamaica Bay. The increased nitrogen discharges would result from both the increased influent loadings to the WPCPs as well as additional centrate from an increased volume of dewatered sludge.

As discussed above, BNR operations require increased retention time to achieve nitrification in the mainstream treatment system. With the additional loadings associated with FWDs, retention time would be reduced, which would likely lead to a washout of the nitrifying biomass (the AOBs and NOBs, described above) and the subsequent loss of nitrification. This loss would be significant at the plants that are subject to effluent nitrogen limits because it would take several months to completely re-establish a nitrifying biomass and restart the BNR process at a plant. During the time it takes to re-establish the nitrifying biomass, nitrogen levels in the plant effluent would be elevated and could result in exceedances of permit limits, violations of Consent Order mandates, and significant penalties associated with these violations. Even if a washout were avoided, the lower SRT would result in unstable plant operations. It should be noted that the cost estimates reported in this section conservatively assume that no washout of the nitrifying biomass occurs and that there is no subsequent loss of nitrification.

Washouts from FWD use are predicted to occur at the Jamaica WPCP in 2017 and 2030 at less than 25 percent penetration during fall and winter. Losses or partial loses of nitrification are also predicted to occur in all years at the 26th Ward, Coney Island, Hunts Point, Red Hook, and Wards Island WPCPs.

IMPACTS FROM FWDS ON THE EAST RIVER BNR PROGRAM

NYCDEP is investing nearly $1.3 billion in BNR infrastructure at the Bowery Bay, Hunts Point, Tallman Island, and Wards Island WPCPs to reduce effluent nitrogen loads by 58.5 percent to below 44,325 lbs/day by 2017. As shown in **Table 8-3 and** Figure 8-4, with the use of FWDs, the combined East River effluent nitrogen load would increase from 90,200 lbs/day to 95,600 lbs/day in 2008, from 41,300 lbs/day to 44,100 lbs/day in 2017, and from 43,200 lbs/day to 46,300 lbs/day in 2030. The effluent nitrogen levels estimated for 2017 and 2030 without the addition of food waste reflect the extensive investments being made to meet the Judicial Consent

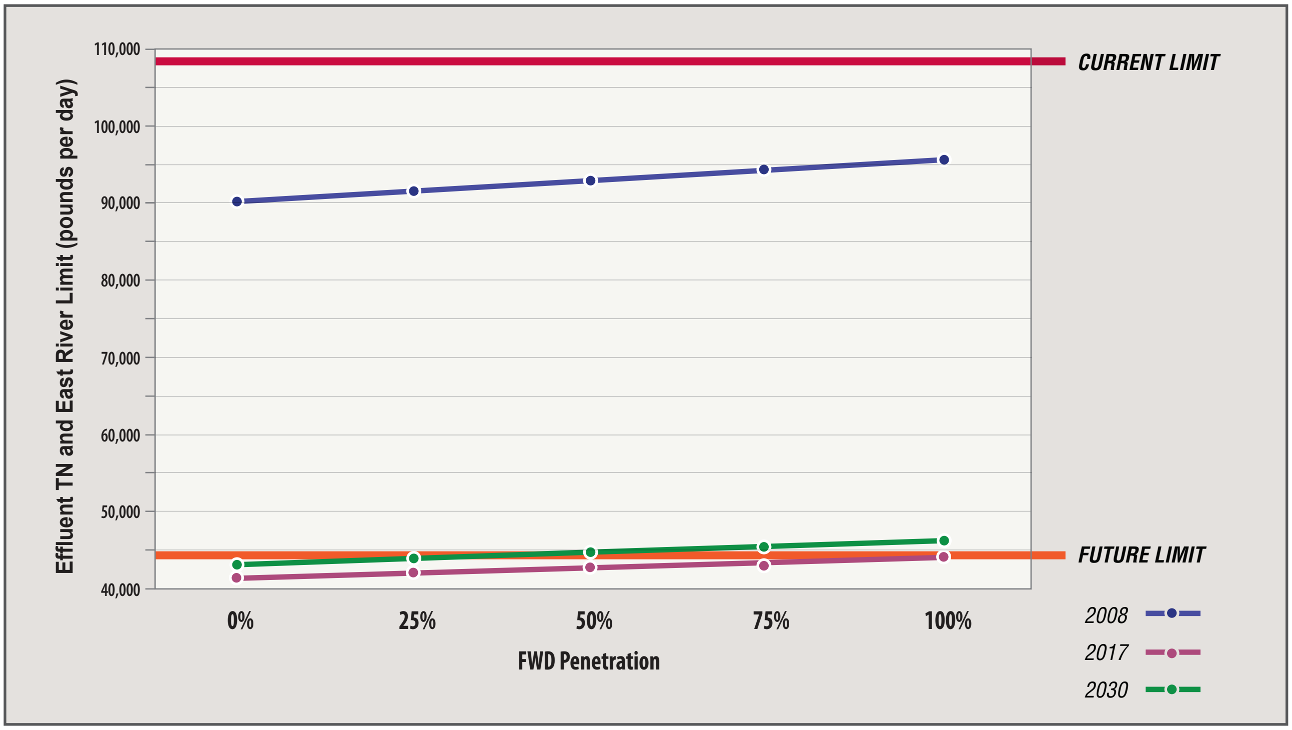

FIGURE 8-4 Effect on East River Nitrogen Limits

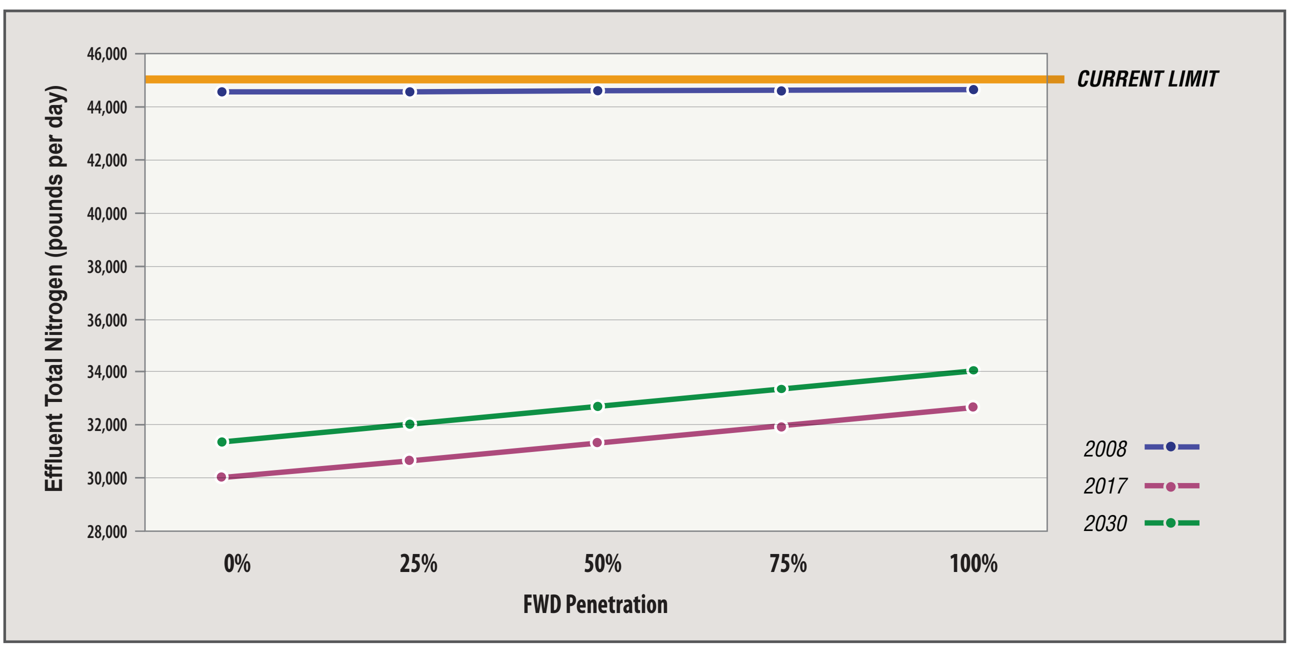

FIGURE 8-5 Effect on Jamaica Bay Nitrogen Limits

Order, which requires an effluent nitrogen load of no more than 44,325 lbs/day beginning in 2017.

These increases in effluent nitrogen load due to the treatment of food waste would be significant in the East River, and, after extensive investments are in place in 2017, FWDs would jeopardize the ability to meet nitrogen limits. The margin for compliance would be such that loss of nitrification or repair work exacerbated by additional FWD loads, and not accounted for in this analysis, could jeopardize the City's ability to comply with NYSDEC regulations. By 2030, it is estimated that nitrogen limits would clearly be exceeded with the additional loads between 25 and 50 percent market penetration.

Table 8-3
Effluent Nitrogen Load (lb/d) to the East River (Varying Market Penetrations)

Penetration Rate	2008	2017	2017 lbs/d under regulatory limit (44,325 lbs/d)	2030	2030 lbs/d under regulatory limit (44,325 lbs/d)
Without food waste	90,200	41,300	3,000	43,200	1,100
25 percent	91,500	42,000	2,300	43,900	400
50 percent	92,900	42,700	1,600	44,700	(400)
100 percent	95,600	44,100	200	46,300	(2,000)
Note: Gray cells indicate exceeding the East River nitrogen limit.					

It is important to note that once upgraded under the BNR program, the plants will have a very small margin of safety for compliance with permit limits. This small margin is a result of very tight site constraints in New York City where investments to reduce nitrogen loadings were undertaken through retrofits of existing tanks rather than adding additional tank capacity. In other municipalities, where additional tank capacity was installed, FWDs may be more readily accommodated.

IMPACTS FROM FWDS ON THE JAMAICA BAY BNR PROGRAM

As discussed previously, Jamaica Bay is subject to a discharged effluent total nitrogen limit of 45,300 lbs/d starting January 1, 2009. However, it is expected that significantly more stringent total nitrogen (TN) limits will be put in place. As shown in **Table 8-4** and Figure 8-5, with 50 percent FWD penetration in 2030, effluent nitrogen limits would be increased by nearly 1,500 lbs/day.

Table 8-4
Effluent Nitrogen Load (lb/day) to Jamaica Bay (Varying Market Penetrations)

Penetration Rate	2008	2017	2030
Without food waste	44,600	30,000	31,300
25 percent	44,600	30,600	32,000
50 percent	44,600	31,300	32,700
100 percent	44,600	32,600	34,000

INVESTMENTS NEEDED TO ADDRESS IMPACTS FROM FWDS

NYCDEP is currently investing $1.4 billion at plants throughout the city to lower effluent nitrogen levels. The introduction of commercial FWD use would undermine this effort and jeopardize NYCDEP's ability to meet future nitrogen effluent limits. As discussed above, the long-term East River nitrogen limit is predicted to be exceeded in 2030 between 25 and 50 percent market penetration of FWDs in Upper East River drainage basins. Also, with decreased SRT and without additional improvements, there would be a significant increase in the risk for some WPCPs to properly remove nitrogen, thus detrimentally impacting the plants' ability to meet the nitrogen limits. This would require an additional treatment process for Upper East River and Jamaica Bay WPCPs.

The installation of denitrification filters is an option for increasing nitrogen removal from plants within drainage basins with strict effluent nitrogen limits. Nitrified secondary effluent is sent for tertiary treatment in the denitrification filters, which would be placed downstream of (after) the final settling tanks. The addition of denitrification filters would achieve lower levels of nitrogen and provide filtration to remove additional particulate matter from the waste stream. The possibility of incorporating denitrification filters was assessed for the plants that are being upgraded to BNR treatment: 26th Ward, Bowery Bay, Hunts Point, Tallman Island, and Wards Island WPCPs. Denitrification filters would result in performance benefits, as shown in **Table 8-5**.

Table 8-5
Performance Benefit from Denitrification Filters at BNR Plants

Plant	No Denitrification Filters		With Denitrification Filters		Difference
	Effluent Nitrogen mg/L	Effluent Nitrogen lb/d	Effluent Nitrogen mg/L	Effluent Nitrogen lb/d	Nitrogen lb/d
26th Ward	12.0	6,200	4.5	2,400	3,800
Bowery Bay	9.7	11,100	4.5	5,200	5,900
Hunts Point	6.5	7,300	4.5	5,000	2,300
Tallman Island	8.6	4,500	4.5	2,400	2,100
Wards Island	7.2	13,200	4.5	8,300	4,900

For the Upper East River plants to offset the impacts of FWD use, denitrification filters would be strategically placed at either the Bowery Bay or Wards Island plants. In addition, denitrification filters would be needed at the 26th Ward WPCP for the Jamaica Bay watershed to offset the increases in effluent nitrogen from the treatment of food waste.

To maintain the efficiency of the denitrification filters, periodic backwashing must be performed to remove the accumulated solids from between the media particles. A blower system is also needed for air scouring of the media during the backwash process.

Capital Costs

As shown in **Table 8-6**, the projected cost to install denitrification filters at the Bowery Bay, Wards Island, and 26th Ward WPCPs is $310 million, $650 million, and $240 million in 2008 dollars, respectively. As the construction of denitrification filters would not begin for several years, the projected cost to install denitrification filters in 2025 dollars (escalated to the midpoint of construction) is estimated to be $1.1 billion, $2.0 billion, and $740 million, respectively. Note that in the Upper East River, denitrification filters would be needed at either the Bowery Bay or Wards Island WPCP, not both. Costs do not include land acquisition or landfilling.

Table 8-6
Estimated Capital Cost of Denitrification Filters

	Bowery Bay	Wards Island	26th Ward
2008 dollars	$310 million	$650 million	$240 million
2025 dollars	$1.1 billion	$2.0 billion	$740 million

Note: 2025 dollars are escalated to the midpoint of construction. Estimates do not include land acquisition or landfilling.

Operation and Maintenance Costs

Operation and maintenance costs are estimated to range from $2.1 to $3.8 million per year per plant (see **Table 8-7**). Note that in the Upper East River, denitrification filters would be needed at either the Bowery Bay or Wards Island WPCP, not both.

Table 8-7
Estimated Operation and Maintenance Costs (in 2008 dollars)

	Bowery Bay	Wards Island	26th Ward
Chemical (millions of $)	$2.1	$1.7	$1.3
Labor (millions of $)	$1.1	$1.6	$0.5
Electricity (thousands of $)	$23.2	$42.6	$13.2
Maintenance (millions of $)	$0.3	$0.5	$0.2
Total O&M estimate (millions of $)	**$3.4**	**$3.8**	**$2.1**

Notes:
Chemical costs assume methanol, 3.5 lb methanol/lb nitrate-N removed; cost of 100 percent methanol is $1.82/gallon.
Labor costs assumed one worker at all times at $60/hour/every 40 mgd of design dry-weather flow.
Electricity costs assume $0.057/kWh.
Maintenance costs assume $1,500 per mgd at each plant plus ½ the time of one maintenance personnel per year.

Land Requirements

A preliminary siting analysis for the denitrification filters was undertaken. As discussed above, the denitrification filters would be located after the final settling tanks and before the disinfection processes at each plant. At the Bowery Bay WPCP, the filter size would be approximately 250,000 cubic feet, and would therefore require approximately one acre of land. At the Wards Island WPCP, substantially larger filters would be needed (approximately 500,000 cubic feet), requiring an area of almost two acres. At both the Bowery Bay and Wards Island WPCPs, no land is available within the plant site to make these improvements

At the Bowery Bay WPCP, the implementation of denitrification filters could require filling in and construction within the bay to the northeast or demolishing the existing aeration tanks and installing denitrification. The costs for filling in the bay are lower, but the required approvals would be difficult to obtain. The costs for replacing the existing aeration facility and replacing with denitrification would be significantly higher as secondary treatment would need to be maintained during construction. Due to the anticipated challenges in obtaining approvals and the significant costs for alternative construction options at the Bowery Bay WPCP, denitrification filters at the Wards Island WPCP would be more likely.

At the Wards Island WPCP, the filters could be located on land that would need to be acquired at the north end of the plant.

At the 26th Ward WPCP, the filters could be located on the south end of the plant, and additional land needs for pumping can be accommodated on the existing plant site. However, this would use land that could be needed for other future plant needs.

8.5 IMPACTS ON THE NEWTOWN CREEK WPCP FROM COMMERCIAL FWD USE

OVERVIEW

The City has invested almost $4 billion to bring the Newtown Creek WPCP up to federally mandated secondary treatment requirements and implement other improvements. The upgrade, taking over a decade of construction, will be completed in 2013. The Newtown Creek WPCP serves lower Manhattan and areas of Brooklyn and Queens that contain high concentrations of FSEs.

With substantial penetration of FWDs in the Newtown Creek service area, organic loadings to the plant would increase, jeopardizing secondary treatment. Loadings of TSS would increase by 19 percent and BOD by 25 percent. The most significant impact would be the lower SRT from the addition of food waste. The Newtown Creek WPCP is extremely land constrained and as a result will not be constructing primary tanks; thus, its secondary treatment process operates with a low SRT of 2.2 days on average and 1.8 days under maximum month conditions (conventional secondary process requires a 4-6 day SRT). It is projected that the food waste loading associated with a 50 percent FWD penetration rate would drop the SRT to 1.6 days and likely jeopardize attaining secondary treatment standards.

At the Newtown Creek WPCP, which does not have primary sedimentation tanks, much of the food waste solids would be incorporated directly into the aeration tank portion of secondary treatment. This would result in an increase in the amount of waste-activated sludge to be pumped from secondary treatment and also increase demand for blowers. In addition, scum associated with the FWD would collect and become entrapped in the baffled aeration tank, where it could result in foam levels that could adversely affect the secondary treatment process and carry over into the anaerobic digesters.

The Newtown Creek WPCP has limited excess organic loading capacity; thus, the additional loadings from FWDs could jeopardize permit limits and secondary treatment requirements. Should this loading capacity be exceeded, primary tanks would be required at an enormous cost to the City. Severe space limitations at the plant would potentially dictate that the primary tanks be decked over existing plant process, which would add considerably to these costs.

At the Newtown Creek WPCP, the increase in scum volume due to commercial FWD use would be many times what the plant currently handles. FOG inputs could increase ten-fold. In addition to labor and operational concerns, additional costs would be associated with carting and disposing of the scum removed from the plants.

REGULATORY CONTEXT

The Newtown Creek WPCP is the last plant in the city to be upgraded to meet secondary treatment requirements. The plant is undergoing an extensive upgrade to meet these requirements and other improvements, which will be completed in 2013. On completion, the plant will be required to achieve permitted effluent limits, which as of May 1, 2013, will be 25mg/L BOD and 30mg/L TSS or 85 percent removal, whichever is stricter.

NEWTOWN CREEK WPCP TREATMENT PROCESS

The Newtown Creek WPCP's treatment process differs from the typical treatment process, both in its current and planned future operations as it does not have primary settling tanks. The absence of primary tanks forces all influent solids through secondary treatment and the SRT at Newtown Creek is very low compared with other City plants.

IMPACTS FROM ADDITIONAL LOADINGS ASSOCIATED WITH FWDS

Since the Newtown Creek WPCP does not have primary settling tanks, much of the food waste solids would be incorporated directly into the aeration tank portion of secondary treatment. With food waste discharges to the Newtown Creek WPCP, loadings of TSS would increase by 19 percent and BOD by 25 percent. As a result of the increase in BOD at the aeration tanks due to commercial FWD use, there would be an increase in the overall observed biomass yield, requiring an increase in the amount of waste-activated sludge to be pumped from secondary treatment. Further, with the increased organic loading, there would be an increased demand for oxygen to remove these organics in secondary treatment. This would translate to higher demands on blowers that provide the air for the oxidation process.

Prior to completion of the upgrade, modeling results indicate that adding commercial food waste at the WPCP would result in a 3,800 pound per day increase in effluent nitrogen load and reduce the bacterial population responsible for removing carbonaceous biochemical oxygen demand (cBOD) by 70 to 90 percent. Without these cBOD-removing bacteria, the removal of cBOD to meet effluent permit limits would be threatened.

At 2017 and 2030 flows and loads, model results suggest that the addition of food waste would have essentially no impact on either effluent nitrogen or effluent cBOD since the new construction configuration of the secondary treatment system would be large enough to handle the projected loads. However, the addition of food waste would reduce the SRT from 2.2 days to 1.6 days. This reduction would drop the Newtown Creek WPCP's SRT below its design, thus jeopardizing secondary treatment. With this estimated SRT, NYCDEP would likely need to construct primary tanks to effectively treat the pollutant load in its drainage area. The reduced SRT from commercial food waste could also lead to other operational difficulties, including froth and bulking issues.

In addition, food waste discharges could increase influent FOG loadings to the plant by 947 percent. FOG can create a variety of debilitating operational problems in the secondary treatment process, including the aeration system mechanics and sludge bulking. In addition, FOG could affect the plant's odor control systems. Currently, the aeration tanks are covered to contain odors. With the use of FWDs, excess scum could accumulate under the covers and incapacitate the odor control system.

INVESTMENTS NEEDED TO ADDRESS IMPACTS FROM FWDS

Newtown Creek has limited excess organic loading capacity and the additional loadings from FWDs could jeopardize permit limits and secondary treatment requirements. Should this loading capacity be exceeded, primary tanks would be required at an enormous cost to the City. Severe space limitations at the plant would potentially dictate that the primary tanks be decked over the existing plant and would add considerably to these costs.

With primary tanks, a portion of the food waste solids would be removed in the primary tanks and would not dilute the active biomass in the aeration tanks. The primary tanks would also reduce the loading to the aeration tank, which would reduce the amount of biomass needed for treatment. The significant increases in FOG may also contribute to the decision to require primary tanks at Newtown Creek as primary tanks would provide more adequate removals of scum due to FOG.

Based on the assessment of potential impacts, two investment scenarios were analyzed to address the potential impacts of FWDs:

- **Scenario 1: No Primary Tanks**. In Scenario 1, the Newtown Creek WPCP would require an additional aeration blower to address FWD use.
- **Scenario 2: With Primary Tanks**. In Scenario 2, primary tanks would be constructed at the plant to address the additional loads from FWD use.

Capital Costs

In Scenario 1, the costs for an additional blower would be $2.6 million. In Scenario 2, primary tanks at the Newtown Creek WPCP would cost $1.7 billion in 2008 dollars.

Operation and Maintenance Costs

In Scenarios 1 and 2, the additional operation and maintenance costs are estimated at $1.2 and $2.2 million per year, respectively. Additional costs for solids handling and disposal from increased secondary treatment with commercial FWDs are included in the costs for Section 8.6.

Land Requirements

As noted above, severe space limitations at the plant would potentially dictate that the primary tanks are decked over the existing plant, contributing to the significant cost (see **Figure 8-6**).

8.6 IMPACTS ON SOLIDS HANDLING AND SLUDGE MANAGEMENT FROM COMMERCIAL FWD USE

OVERVIEW

The increase in flows and loads from using commercial FWDs would result in increased sludge production and solids handling. To accommodate this added demand, additional equipment (i.e., thickeners, centrifuges, and sludge storage tanks) would be required. The additional sludge would require additional processing needs and transport.

REGULATORY CONTEXT

In 1988, ocean disposal of biosolids was banned by the federal government and New York City was required to find alternative land-based use for this material. NYCDEP undertook an extensive planning process of its Sludge Management Plan and developed short-term, intermediate, and long-term strategies for the disposal of biosolids. Today, the City’s biosolids are used to fertilize crops and improve soil conditions for plant growth.

If sludge satisfies the criteria established in the EPA Processes to Significantly Reduce Pathogens (PSRP) regulations, the biosolids are suitable for land application. If the sludge from

FIGURE 8-6

Incremental Equipment Requirements
for Newtown Creek WPCP (2030, 50% penetration)

one or all the digesters at a plant are not able to meet PSRP requirements, the sludge production as a whole is considered to have failed PSRP requirements (i.e., the whole day's volume) and must be further treated to be used for direct land application.

SOLIDS HANDLING AND SLUDGE MANAGEMENT PROCESS

Sludge is processed through thickeners and digesters before being dewatered and converted to biosolids, which are beneficially reused. Thickening tanks allow the sludge to collect, settle, and separate from the water for up to 24 hours. The sludge is then placed in oxygen-free tanks, called digesters, and heated to at least 95 degrees Fahrenheit for up to 15 to 20 days. The digestion process stabilizes the thickened sludge by converting much of the material into water, carbon dioxide, and methane gas. Digested sludge is then pumped or transported by barge from sludge storage tanks to a dewatering facility; this is known as transshipment.

New York City operates dewatering facilities at eight of its 14 treatment plants.[1] Dewatering reduces the liquid volume of sludge by about 90 percent, creating a substance known as sludge cake, dewatered sludge, or biosolids. Centrate, the water drawn from the spinning process is returned to the plant for reprocessing. The biosolids are beneficially reused.

New York City's biosolids are managed by companies that have been awarded long-term contracts. Biosolids are typically trucked off-site for disposal. If the biosolids does not satisfy PSRP regulations, it is processed in one of the following ways for beneficial reuse:

- **Drying**. Biosolids are heated to dry the material and form fertilizer pellets to be used directly on the land or mixed with other materials to make special fertilizer blends. New York City's biosolids are made into pellets at a facility in the Bronx.
- **Composting**. Biosolids are mixed with a bulking agent, such as wood chips, to allow more oxygen to penetrate the mixture, which creates compost, similar to peat moss. New York City's biosolids are being composted at a facility in Pennsylvania.
- **Lime Stabilization and Treatment**. Biosolids are mixed with a highly alkaline material, such as lime or Portland cement. New York City's biosolids are alkaline stabilized at a facility in New Jersey.

All of these processes destroy disease-causing organisms and reduce moisture content, resulting in products that are easy to handle with similar characteristics to typical agricultural products. Currently, NYCDEP processes all of the sludge produced at the WPCPs for beneficial reuse, and none is landfilled or incinerated.

IMPACTS FROM ADDITIONAL LOADINGS ASSOCIATED WITH FWDS

The additional sludge resulting from commercial FWDs (see **Figure 8-7**) would need to be processed through thickeners and digesters before being dewatered and disposed of appropriately. Additional shipment and disposal costs would result from the additional solids generated from commercial FWDS. The eight WPCPs that operate dewatering facilities would

[1] The 26th Ward (which typically handles Coney Island and a portion of Jamaica sludge), Bowery Bay, Hunts Point (which typically handles North River and Owls Head sludge), Jamaica, Oakwood Beach (which typically handles Port Richmond sludge), Red Hook, Tallman Island, and Wards Island WPCPs (which typically handles Newtown Creek sludge) have dewatering facilities.

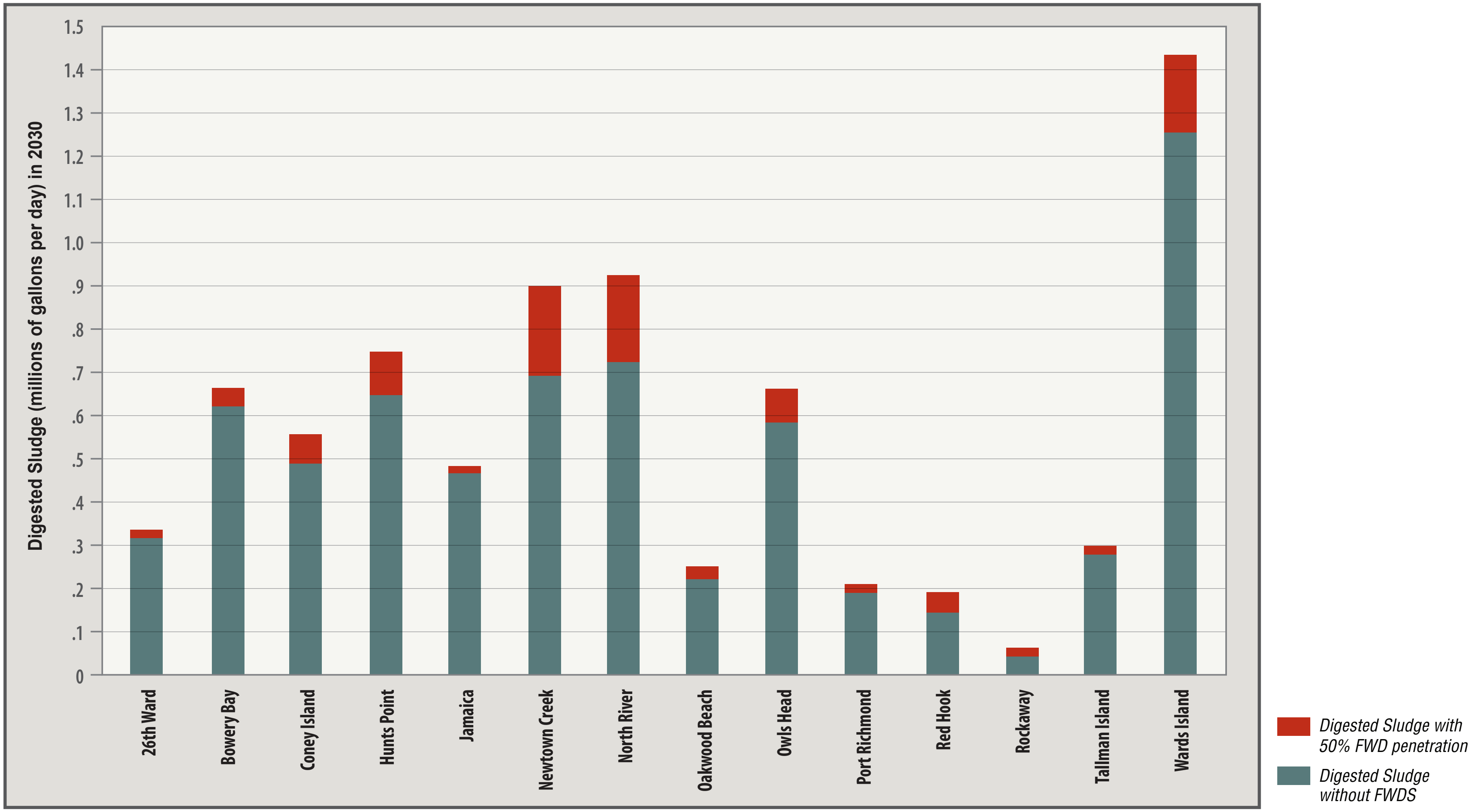

FIGURE 8-7 Increase in Sludge Production from Food Waste Disposers (2030, 50 percent penetration)

receive increased sludge for dewatering. In addition, significant additional amounts of dewatered sludge (296 wet tons per day) would be produced and need to be processed for beneficial reuse.

INVESTMENTS NEEDED TO ADDRESS IMPACTS FROM FWDS

As a result, additional capacity for thickening, heating, storage, dewatering, and digestion would be needed. This equipment would be accompanied by increased annual operation and maintenance costs. **Table 8-8 and Figure 8-8** provide a summary of the incremental requirements for thickeners, heat exchange capacity, sludge storage volume, and centrifuges (for sludge dewatering).

Table 8-8
Incremental Equipment Requirement for 2030 (50 Percent Penetration)

Plant	Thickeners (# of units) [1]	Heat Exchanger Capacity (MBTU/hr)	Storage Tank Volume (cu ft)	Centrifuges (# of units)[1]
26th Ward	1	0.7	0	0
Bower Bay	0	0.9	0	1
Coney Island	0	1.7	0	0
Hunts Point[2]	0	2.4	0	2
Jamaica	1	0.5	0	0
Newtown Creek	0	0	0	0
North River	0	5.0	161,528	0
Oakwood Beach	0	0.7	1,775	0
Owls Head	0	1.9	60,911	0
Port Richmond	0	0.5	16,701	0
Red Hook	0	0.8	0	1
Rockaway	0	0	0	0
Tallman Island	0	0.5	0	1
Ward Island	0	4.2	133,432	0

Notes:
[1] Based on existing capacity/size of on-site thickeners, primary digesters, and/or centrifuges.
[2] In order to accommodate the sludge received at the Hunts Point WPCP, a transfer pumping station will be required in lieu of additional sludge storage.

The additional loadings from commercial FWDs would result in an exceedance of the thickening capacity at the 26th Ward and Jamaica WPCPs. Additional heat exchangers to support the digestion process would also be required at most plants, and, at several plants with dewatering facilities, additional centrifuges would be required. Five plants would also require increases in sludge storage facilities while the Hunts Point WPCP would require a transfer pumping station instead of increased storage facilities.

The use of FWDs would exacerbate the limited digester capacity and the inability to meet PSRP at a number of the plants. To ensure beneficial reuse, sludge is dewatered and processed at private facilities, such as NYOFCo, as discussed above. Due to the considerable expense of constructing digesters and space limitations at the WPCPs, new digesters were not analyzed for this study. Rather, it was assumed that the significant additional amounts of dewatered sludge would need to be further processed at locations, such as NYOFCo, before it could be beneficially reused. Even with this assumption, certain plants with limited digestion capacity, such as the North River and Owls Head WPCPs, would require a significant capital expenditure since the additional loadings could cause the

Thickeners:	+2
Digesters*:	
Centrifuges**:	+5
Aeration Blowers:	+7
Primary Sludge Pumps:	+1

* While no new digesters are assumed, additional heat exchangers and associated boiler capacities will need to be increased to accommodate additional sludge from food waste.

** The centrifuges proposed for Bowery Bay, Red Hook, and Tallman Island are replacements with larger capacity units.

FIGURE 8-8

Investments Needed to Address Impacts from Food Waste Digestors (2030, 50% penetration)

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current digestion process to fail. Further, the increased sludge production would require additional marine vessels for transshipment, which may not be available.

Capital Costs

As shown in **Table 8-9**, capital costs were estimated based on the equipment needs identified above. These capital costs are specific to equipment needs that are necessary to handle the incremental increase attributable to commercial food waste at the plants. The costs do not reflect any additional equipment needs that were identified at each plant due to future population projections.

Operation and Maintenance Costs

Estimated annual operation and maintenance costs associated with the capital improvements, increased loads, additional transshipment, increased sludge processing, and additional transportation/disposal for beneficial reuse are shown in **Table 8-10**. Costs are reported in 2008 dollars.

The introduction of commercial food waste to the wastewater stream would result in increases in electrical demand as it relates to sludge handling because of increases in the amount of primary sludge that must be pumped to downstream processes and the operation of additional dewatering centrifuges. While the aeration systems have the highest electricity consumption of all plant processes, wastewater pumping and dewatering operations are also energy intensive. The additional electrical demand is included in the operations and maintenance costs as well as discussed in more detail in Section 8.9.

Table 8-9

Estimated Project Capital Costs (50 Percent Penetration, 2030)

Plant	Thickening	Digestion	Storage	Dewatering	Total
26th Ward	$11,118,000	$939,000	-	-	$12,057,000
Bowery Bay	-	$1,017,000	-	$4,511,000	$5,528,000
Coney Island	-	$1,227,000	-	-	$1,227,000
Hunts Point	-	$1,441,000	-	$9,022,000	$10,463,000
Jamaica	$11,263,000	$903,000	-	-	$12,166,000
Newtown Creek	-	-	-	-	$0
North River [1]	-	$2,181,000	$32,257,000	-	$34,438,000
Oakwood Beach	-	$951,000	$223,000	-	$1,174,000
Owls Head	-	$1,294,000	$17,112,000	-	$18,406,000
Port Richmond	-	$903,000	$2,057,000	-	$2,960,000
Red Hook	-	$981,000	-	$4,511,000	$5,492,000
Rockaway	-	-	-	-	$0
Tallman Island	-	$900,000	-	$4,511,000	$5,411,000
Ward Island	-	$1,937,000	$16,511,000	-	$18,448,000
Total	**$22,381,000**	**$14,674,000**	**$68,160,000**	**$22,555,000**	**$127,770,000**

Note:
[1]Costs do not reflect additional land required to accommodate sludge storage at the North River.

Table 8-10
Estimated Incremental Annual Operation and Maintenance Costs
(50 Percent Penetration, 2030)

Plant	Thickening	Digestion	Dewatering	Disposal	Transshipment	Total
26th Ward	$2,500	$39,000	$55,500	$717,500	$0	$814,500
Bowery Bay	$2,500	$54,500	$66,500	$727,500	$0	$851,000
Coney Island	$3,500	$103,000	$133,500	$1,205,500	$0	$1,445,500
Hunts Point	$5,500	$155,500	$543,000	$1,863,500	$0	$2,567,500
Jamaica	$2,000	$37,500	$49,000	$402,500	$0	$491,000
Newtown Creek	$11,500	$263,500	$378,500	$4,436,000	$76,500	$5,166,000
North River	$498,500	$270,000	$339,000	$2,787,000	$76,500	$3,971,000
Oakwood Beach	$2,500	$44,500	$51,000	$533,500	$0	$631,500
Owls Head	$5,500	$127,000	$160,500	$1,497,000	$32,000	$1,822,000
Port Richmond	$1,500	$32,500	$35,500	$347,500	$0	$417,000
Red Hook	$2,500	$57,500	$50,000	$841,000	$0	$951,000
Rockaway	$500	$16,000	$19,000	$156,500	$3,500	$195,500
Tallman Island	$2,500	$37,500	$38,000	$371,500	$0	$449,500
Ward Island	$11,500	$274,500	$462,500	$2,809,000	$0	$3,557,500
Total	**$552,500**	**$1,512,500**	**$2,381,500**	**$18,695,500**	**$188,500**	**$23,330,500**

Note: Costs are reported in 2008 dollars.

Land Requirements

At the North River and Owls Head WPCPs, more land would be required to site the additional infrastructure necessary to accommodate commercial food waste. For the Owls Head WPCP, the additional storage could require construction within the water; the above costs include construction of piers to support the additional storage at the Owls Head WPCP. No costs associated with the additional land or landfilling are included in these estimates.

8.7 IMPACTS ON SECONDARY TREATMENT FROM COMMERCIAL FWD USE AT THE REMAINING WPCP PLANTS

OVERVIEW

This section discusses the capital improvements and operation costs that would be necessary to ensure that secondary treatment is met at the remaining WPCPs in the City (the Newtown Creek WPCP was addressed earlier in Section 8.5 and the improvements necessary to meet BNR requirements described in Section 8.4 encompass achieving secondary treatment requirements at the BNR plants). Evaluations of the potential impacts from commercial FWDS on secondary treatment at the North River, Red Hook, Owls Head, and Port Richmond WPCPs were analyzed. The analysis concludes that allowing the use of commercial FWDs in New York City would result in the need for significant additional capital investments in the form of new and increased capacity for aeration blowers and sludge pumping from secondary treatment tanks.

REGULATORY CONTEXT

Secondary treatment requirements mandate that a minimum of 85 percent of BOD and TSS of dry weather flow is removed before the plant's effluent is released. In coordination with NYCDEP's Long Term Control Plan for combined sewer overflows (CSOs), all of the 14 WPCPs are equipped to handle twice the volume of flows that would occur on a normal day of dry weather (see Chapter 7).

SECONDARY TREATMENT PROCESS

See Section 8.2 above for a discussion of the secondary treatment process.

IMPACTS FROM ADDITIONAL LOADINGS ASSOCIATED WITH FWDS

With the increased organic loading, there is an increased demand for oxygen to remove these organics in secondary treatment, thereby resulting in higher demands for blowers providing air for the oxidation process. Each pound of organic matter that enters the secondary treatment process requires a certain amount of oxygen to allow the microbiology in the tank to remove that organic matter. Since the amount of organic matter would increase with the use of commercial FWDs, the amount of air needed in the tank would increase as well.

The introduction of commercial food waste to the wastewater stream would result in increases in electrical demand as it relates to secondary treatment from:

- Increases in the amount of flow (11 mgd) that would need to be pumped;
- Increases in the amount of biomass produced in the secondary treatment that require more pumping to solids processing streams; and
- Increases in the amount of aeration required to oxidize the incremental BOD in the commercial food waste.

As stated above, the wastewater treatment process is energy intensive, with the aeration systems having the highest electricity consumption of all plant processes.

With use of FWDs, the increase in sludge and the difference in the sludge loading would affect the secondary treatment process at the plants. A larger portion of the solids inventory in secondary treatment would be inert or slowly biodegradable solids instead of solids that are readily biodegradable, and would not contribute to treatment. As a result, it may be necessary to maintain a higher inventory of solids in the aeration tank to provide effective treatment, which in turn would result in a higher solids loading to the secondary sedimentation tanks. The reduction in biomass concentration may be significant enough to negatively impact secondary treatment (i.e., the removal of cBOD).

The increased loadings from FWD would also increase the sludge quantity that would be pumped daily from the primary settling tanks and the secondary sedimentation tanks. An analysis of the pumping capacity to handle the increase in primary and secondary sludge at the Owls Head, Red Hook, North River, and Port Richmond WPCPs showed that all plants would have more than adequate secondary pumping capacity. The Red Hook WPCP is the only plant that would need an additional primary pump to handle the additional food waste.

The impact on primary and secondary pumping for plants not included in the secondary treatment analysis is assumed to be minimal as all plants are designed to similar standards, but an additional investigation would be necessary to determine actual pumping needs at these facilities. Should additional primary or secondary pumps be required, these pumps typically have minimal capital costs and spatial requirements and could likely be accommodated at most facilities.

INVESTMENTS NEEDED TO ADDRESS IMPACTS FROM FWDS

Table 8-11 presents the additional blowers required as a result of commercial FWDs at the remaining plants. While not shown in this table and as discussed in Section 8.5, an additional blower would be required at the Newtown Creek WPCP in Scenario 1.

Table 8-11
Incremental Equipment Requirement for Secondary Treatment at the Remaining WPCPs in 2030 (50 Percent Penetration)

Plant	Aeration Blowers	Primary Sludge Pumps
North River	2	0
Oakwood Beach	1	0
Owls Head	1	0
Port Richmond	1	0
Red Hook	1	1

In addition to the blowers, air headers to transport air to the tanks and diffusers to disperse the air may be required to be upgraded at each plant. Upgrades to this system may be included in the capital programs already existing for these plants without the addition of food waste since diffusers usually have a 10-year life span, so costs associated with this upgrade are not included. Table 8-11 also includes a summary of the incremental requirements for primary sludge pumps (one pump required at the Red Hook WPCP).

Capital Costs

Capital costs were estimated based on the equipment needs identified above. Total costs for additional blowers and one additional sludge pump are $5.2 million in 2008 dollars. These capital costs are specific to equipment needs to handle the incremental increase from commercial food waste at the plants. The costs do not reflect any additional equipment needs that were identified at each plant due to future population projections.

Operational and Maintenance Costs

The operation and maintenance costs are estimated at $3.2 million per year in 2008 dollars for the additional secondary treatment requirements at these WPCP plants.

Land Requirements

Blowers take up significant land area and detailed analyses would be needed to determine if they could be accommodated on-site. At the North River and Owls Head WPCPs, it is clear that blowers could not be accommodated on-site and additional land would need to be acquired.

8.8 IMPACTS OF FATS, OILS, AND GREASE (FOG) FROM COMMERCIAL FWD USE

In addition to the potential problems from increased FOG in the sewers, as described in Chapter 7, the organic matter characterizing commercial food waste contains significant quantities of FOG, which would also create significant operational problems in conventional wastewater treatment processes if not removed from the raw wastewater stream. The use of grease interceptors, which would likely be required to accompany FWDs, would remove a portion of the FOG from the waste stream entering the system. Since the actual reduction of FOG from grease interceptors is unknown, the additional FOG presented in this chapter is based on the results of the food waste characterization described in Chapter 4 and Appendix A.

FOG contained in food waste would increase the FOG loadings at the plants and affect both primary and secondary treatment. The additional FOG would increase the amount of scum that would accumulate and need to be removed from the surface of the primary sedimentation tank. At the Newtown Creek WPCP alone, FOG loadings would increase tenfold.

FOG can affect the following:

- **Primary Treatment**. FOG entering a plant via the raw wastewater stream first encounters screening and pumping equipment in the headworks facility. Grease can accumulate on equipment within the headworks facility (e.g., screens, conveyors, and grit washers). Depending on the scum removal process, additional impacts on the primary treatment process (e.g., clogging due to solidifying grease) would be anticipated.
- **Secondary Treatment**. Any FOG not removed in the primary tanks will accumulate at the surface of the aeration tanks as scum or foam. This foam provides an ideal environment for the growth of filamentous microorganisms. The proliferation of these organisms can result in solids that do not settle in the secondary sedimentation tanks and are washed out in the effluent, which results in poor treatment. The scum or foam can overwhelm scum removal systems both within the aeration tanks and in the final settling tanks, potentially causing a failure of the anaerobic digesters.
- **Odors**. FOG can contribute to significant increases in odors at the headworks facility.

An analysis of the impacts from scum increases was conducted for the North River, Red Hook, Port Richmond, and Owls Head WPCPs. **Table 8-12** presents the percent increase in scum removal that would result from the introduction of commercial FWD use. Scum handling systems are a sidestream process that can be overloaded if not carefully watched and maintained. When a scum tank overloads, it automatically overflows to the front of the plant. Instead of being removed, this scum continues to cycle through the system. The actual volume of material would increase the labor required to remove the scum, especially at the North River WPCP, where the increases would be many times what the plant currently handles. In addition to labor and operational concerns, additional costs would be associated with carting and disposing of the scum removed from the plants.

Table 8-12
Increases in Scum Quantities Due to FOG in FWD at 50 Percent Penetration

Plant	Current Scum Removed, lbs/yr x 1000	FOG[1] Addition, lbs/yr x 1000	Total Scum with FWD, lbs/yr x 1000	Percent Increase Due to FWD
North River	273	992	1,264.5	363%
Red Hook	51	267	318	524%
Port Richmond	205	133	338	165%
Owls Head	102	586	688	575%

Note: [1] Assumes 1 pound of FOG from FWD would result in 1 pound of scum.
Source: CCNY

8.9 PERMITTING CHALLENGES AND ADDITIONAL ENVIRONMENTAL IMPACTS

PERMITTING CHALLENGES AND LAND AVAILABILITY

Many of the capital improvements identified in the preceding sections would have difficulties obtaining approvals and permits. In the case of those that would require additional adjacent land, such as at the Wards Island WPCP, properties would need to be secured. For additional facilities requiring placement in water, such as denitifrication filters at the Bowery Bay WPCP, significant adverse environmental impacts from the construction and final placement of in- or over-water facilities could result, requiring mitigation. For such facilities, there would be challenges in obtaining environmental permits and approvals.

Use of available land for improvements necessary by FWD implementation could remove the land availability for other beneficial programs. For example, the additional land required at the south end of the 26th Ward WPCP for denitrification filters is also under consideration for other programs studied by NYCDEP. Use of this property for denitrification filters would remove the land available for other beneficial programs under consideration in NYCDEP's Jamaica Bay program.

INCREASES IN ENERGY DEMAND

As shown in **Table 8-13**, in 2030 at 50 percent penetration, the additional energy demand for secondary treatment of wastewater in New York City would total more than 59 million kilowatt hours (kWhs) a year with primary treatment and over 72 million kWh each year without primary treatment at the Newtown Creek WPCP. Other processes at the WPCPs would have the following additional annual electrical requirements: thickening, more than 1.1 million kWhs; digestion heating, approximately 27 million kWhs; dewatering, approximately 6 million kWhs; and BNR, approximately 138 million kWhs with the addition of denitrification filters at the 26th Ward and Wards Island WPCPs.

Table 8-13
Projected Energy Demand at WPCPs in 2030

50 Percent FWD Penetration	Secondary Treatment[1] Electrical (kwh/yr)	Thickening Electrical (kwh/yr)	Digestion Heating (kwh/yr)	Dewatering Electrical (kwh/yr)	BNR[2] Electrical (kwh/yr)
26th Ward	N/A	21,795	706,399	152,509	10,639,085
Bowery Bay	N/A	20,814	996,166	115,913	23,078,146
Coney Island	N/A	37,224	1,880,703	435,525	16,406,738
Hunts Point	N/A	55,538	2,833,506	532,822	21,908,795
Jamaica	N/A	21,634	679,737	150,630	14,898,643
Newtown Creek - with PT	13,260,634	--	--	--	N/A
Newtown Creek – w/o PT	26,325,298	105,086	4,817,928	1,229,503	N/A
North River	9,994,468	619,025	4,932,194	1,228,897	N/A
Oakwood Beach	8,361,385	23,457	809,824	137,563	N/A
Owls Head	8,426,708	52,548	2,322,532	512,324	N/A
Port Richmond	8,361,385	11,276	588,910	105,547	N/A
Red Hook	10,615,040	19,064	1,039,236	254,913	N/A
Rockaway	N/A	5,444	295,041	63,693	3,795,094
Tallman Island	N/A	20,477	683,253	109,675	10,407,506
Ward Island	N/A	104,382	4,999,581	1,031,669	37,322,792
Total NYC - with PT	**59,019,620**	**1,117,766**	**27,585,009**	**6,061,182**	**138,456,799**
Total NYC - without PT	**72,084,284**	**1,117,766**	**27,585,009**	**6,061,182**	**138,456,799**

Notes:
[1] Secondary treatment electrical demand includes primary pumping, secondary pumping, and blowers.
[2] BNR electrical demand for denitrification filters at 26th Ward, Bowery Bay, and Wards Island was based on the O&M electrical costs and an estimate of $0.057/kWh. Electrical demand for the BNR plants were estimated using the average kWh/mgd for the Secondary Treatment energy demand and applying it to the BNR plants.
N/A = not applicable.
Electrical demands are for 2030 and 50 percent penetration rate.

While fuel costs associated with FWDs are high, the additional fuel needs represent a small change in emissions at the WPCPs; therefore, no significant air quality or other related impacts would be expected at the WPCPs after these improvements are implemented. Modifications to current air permits could be reasonably attained with the potential improvements.

As described above, PlaNYC is calling for 30 percent reduction by 2017. By increasing the amount of fuel required to run the treatment processes, further reductions would need to be found to achieve the 30 percent reduction.

CONSENT JUDGMENTS AND ASSOCIATED PENALTIES

Severe penalties would be incurred by the City for violations of Consent Orders, Consent Judgments, and permit limits. The stipulated penalties are shown in **Tables 8-14 and 8-15** for Newtown Creek and nitrogen. In addition, the Newtown Creek WPCP is in the process of being upgraded under the "Track 3 Upgrade," which will not be completed until 2013. If primary tanks are required at the plant as a result of FWD implementation, this would result in several more years of construction at this facility.

Table 8-14
Newtown Creek Consent Judgment and SPDES Penalties

Consent Judgment Requirement	Stipulated Penalty
Interim Daily and Weekly Limits (Exceedance of a weekly limit = 7 separate violations)	\$500 per violation for 1-2 per month \$2,000 per violation for 3-5 per month \$4,000 per violation for 6-10 per month \$7,500 per violation for 11-20 per month \$10,000 per violation for 21-30 per month
Interim Monthly Effluent Limits	\$15,000 per violation per month
Citywide Aggregate Secondary Limits	\$150,000 per violation per month
SPDES Permit Limits (by January 2010)	Up to \$37,500 per violation per day

Table 8-15
Nitrogen Consent Judgment and SPDES Penalties

Consent Judgment Requirement	Stipulated Penalty
Interim and Final Combined Nitrogen Effluent Limits for East River and Jamaica Bay	\$50,000 per violation per month
SPDES Permit Limits for Nitrogen (as of January 2017)	Up to \$37,500 per violation per day

8.10 SUMMARY OF CUMULATIVE COSTS

As shown in **Table 8-16 and Figure 8-9**, use of commercial FWDs at a 50 percent penetration rate would result in the need for very costly investments at the treatment plants. These investments would total approximately \$1.0 billion. Should primary tanks be required at the Newtown Creek WPCP, an additional investment of \$1.7 billion would be required, for a total of approximately \$2.7 billion. None of these costs are funded. In the current economic climate, and with NYCDEP already struggling to meet its regulatory mandates and repair needs with an increasingly constrained budget, NYCDEP can ill-afford these investments.

Substantial investment would also be required at the Wards Island (\$650 million) and 26th Ward (\$240 million) plants, where denitrification filters would be required. Note that instead of constructing these facilities at the Wards Island WPCP, they could be constructed at the Bowery

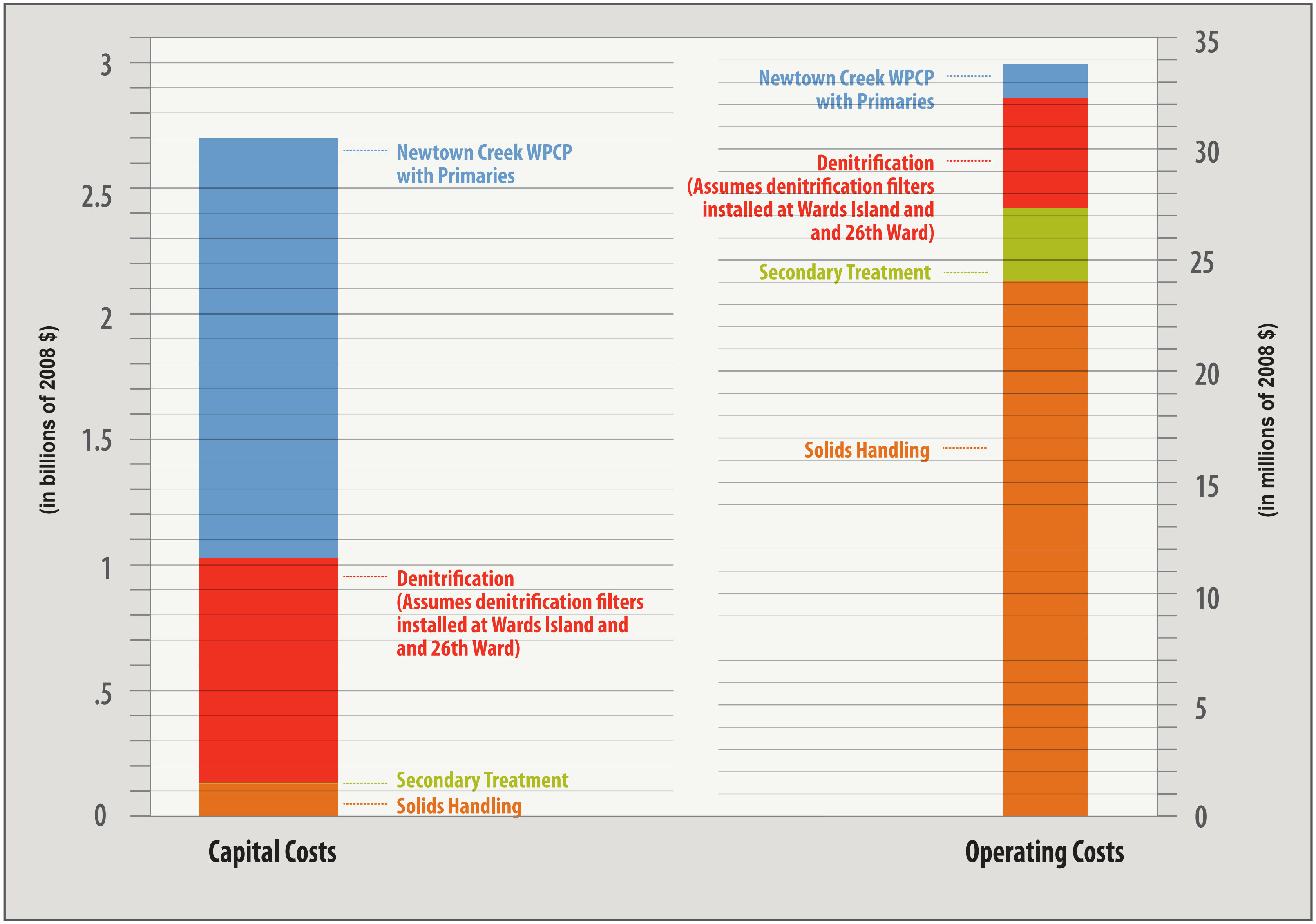


FIGURE 8-9 Summary of Capital Investment and Operational Costs with Food Waste Digestors (2030, 50 percent penetration)

Bay WPCP. However, obtaining permits for filling in of the bay would be extremely difficult, and the other alternative of demolishing existing tanks and replacing them would be extremely costly. Therefore, construction at the Wards Island WPCP is more likely.

Solids handling upgrades at the various plants, which includes thickeners, storage tanks, and centrifuges, would also require a substantial investment ($172 million). Annual operating and maintenance costs would be approximately $34 to $35 million a year, with the predominant cost related to the solids handling and disposal ($23 million).

Table 8-16
Summary of WPCP Costs with Implementation of Commerical FWDs

FWD Tactic	Capital Costs	Annual O&M Costs
Newtown Creek (without and with primary tanks)	$2.6 million to $1.7 billion	$1.2 million to $2.2 million
Wards Island denitrification filters	$650 million	$3.8 million
26th Ward denitrification filters	$240 million	$2.1 million
Solids handling upgrades and disposal	$128 million	$23.3 million
Secondary treatment upgrades	$5.2 million	$3.2 million
Total	**$1.0 to $2.7 billion**	**$33.6 to $34.6 million**
Note: All costs are in 2008 dollars.		

The costs presented are likely to be underestimated due to numerous unknowns at this time. All costs are based on conceptual level designs. When more detailed design is done, costs often increase significantly due to new needs that are identified related to limited space, electricity constraints, and other miscellaneous costs that become apparent. In addition, land acquisition and/or landfilling costs were not included in the estimates. Lastly, the costs do not include severe penalties that would be incurred by the City for violations of Consent Orders, Consent Judgments, and permit limits as discussed in Section 8.9.

These costs would be borne by New York City's sewer ratepayers at an increase up to 3-6 percent per year. Considerable public opposition to NYCDEP's rate increases already exists. Burdening the rate payers with an increased charge to offset the costs of private enterprise requires consideration.

Alternatively, these investments could be paid for by FSEs through a user surcharge. With approximately 5,500 FSEs that may install these devices (at 50 percent penetration), this would amount to up to an additional $25,000 to $45,000 per FSE per year, which would make installation of FWDs prohibitive for most FSEs and offset most, if not all, financial incentives they could provide. ✷

Chapter 9: Commercial Food Waste Disposal in New York City's Neighborhoods: Four Case Studies

9.1 INTRODUCTION

Previous chapters of this report have explored the potential overall citywide benefits and impacts that could result from using food waste disposers (FWDs). This chapter takes a closer look at potential benefits and adverse impacts in several New York City communities. On the benefits side, these include less truck traffic and associated air and noise emissions from solid waste disposal. On the other hand, impacts could include additional capacity constraints in the sewers, additional sewer backups in these communities, discharges into local waterbodies, and additional sludge trucks and construction at water pollution control plants (WPCPs).

Four representative study areas are discussed in this chapter—Manhattan Community Board 3, Brooklyn Community Board 1, Bronx Community Boards 1 and 2, and Staten Island Community Board 1 (see **Figure 9-1**). The information presented in this chapter is based on a 50 percent penetration rate. **Figure 9-2** provides a summary of the principal conclusions.

The study areas were selected because they are food waste generating and/or receiving areas:

- A food waste generating area is an area that contains a high concentration of food service establishments (FSEs). These communities could benefit from FWDs through potential reductions in trucks that pick up waste. On the other hand, these communities would face increased discharges into the sewer system.
- Receiving areas are communities with commercial putrescible transfer stations that could benefit from FWDs through a reduction in truck traffic to and from these transfer stations and a potential reduction in waste volumes being processed at these transfer stations.

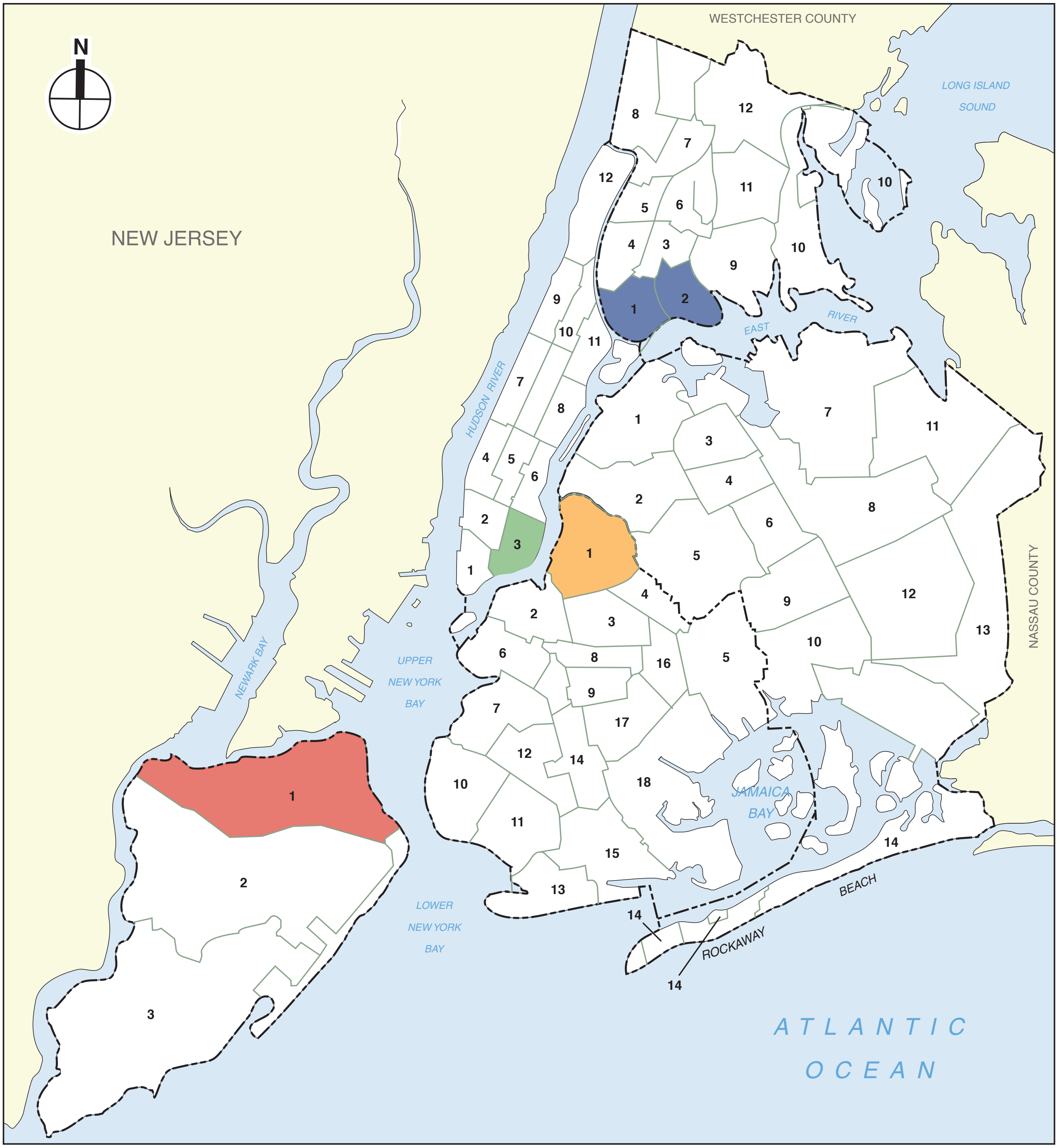
Community Board 3 in Manhattan was selected due to the high concentration of restaurants and retail food establishments in the area. It is considered to be a food waste generating area. The area discharges to the Newtown Creek WPCP.

Community Board 1 in Brooklyn is both a generating and receiving area due to its concentration of FSEs in residential and commercial neighborhoods and the concentration of transfer stations in manufacturing areas. The Newtown Creek WPCP is located in this community board.

Community Boards 1 and 2 in the Bronx are mainly a receiving area, with its transfer stations located in Hunts Point and Port Morris south of Bruckner Boulevard; however, there are also a few waste generating communities north of Bruckner Boulevard. The Hunts Point WPCP is located in Community Board 2.

Community Board 1 in Staten Island is a generating area. The Port Richmond WPCP is located in this community board.

As documented in the case studies provided below, even if FWDs were to be implemented in a limited area of the city, there would be few benefits expected, with a high risk to the wastewater



Project Study Areas

- Manhattan Community District 3
- Brooklyn Community District 1
- Bronx Community Districts 1 and 2
- Staten Island Community District 1

0 2 5 MILES

SCALE

FIGURE 9-1 Study Area Locations

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Bronx Community Board 1 and 2

- Potential FSEs that could use FWDs = 213
- Estimated Food waste generation from likely FSEs
  50% penetration = 11 tpd
- Truck trip reduction from transfer station
  50% penetration = 12
- Sewer Backups and Notices of Violations would be exacerbated

Manhattan Community Board 3

- Potential FSEs that could use FWDs = 642
- Estimated Food waste generation from the FSEs
  50% penetration = 30 tpd
- Sewer Backups and Notices of Violations would be exacerbated

Brooklyn Community Board 1

- Potential FSEs that could use FWDs = 312
- Estimated Food waste generation from likely FSEs
  50% penetration = 13 tpd
- Truck trip reduction from transfer station
  50% penetration = 6
- Sewer Backups and Notices of Violations would be exacerbated

Staten Island Community Board 1

- Potential FSEs that could use FWDs = 212
- Estimated Food waste generation from likely FSEs
  50% penetration = 10 tpd
- Sewer Backups and Notices of Violations would be exacerbated

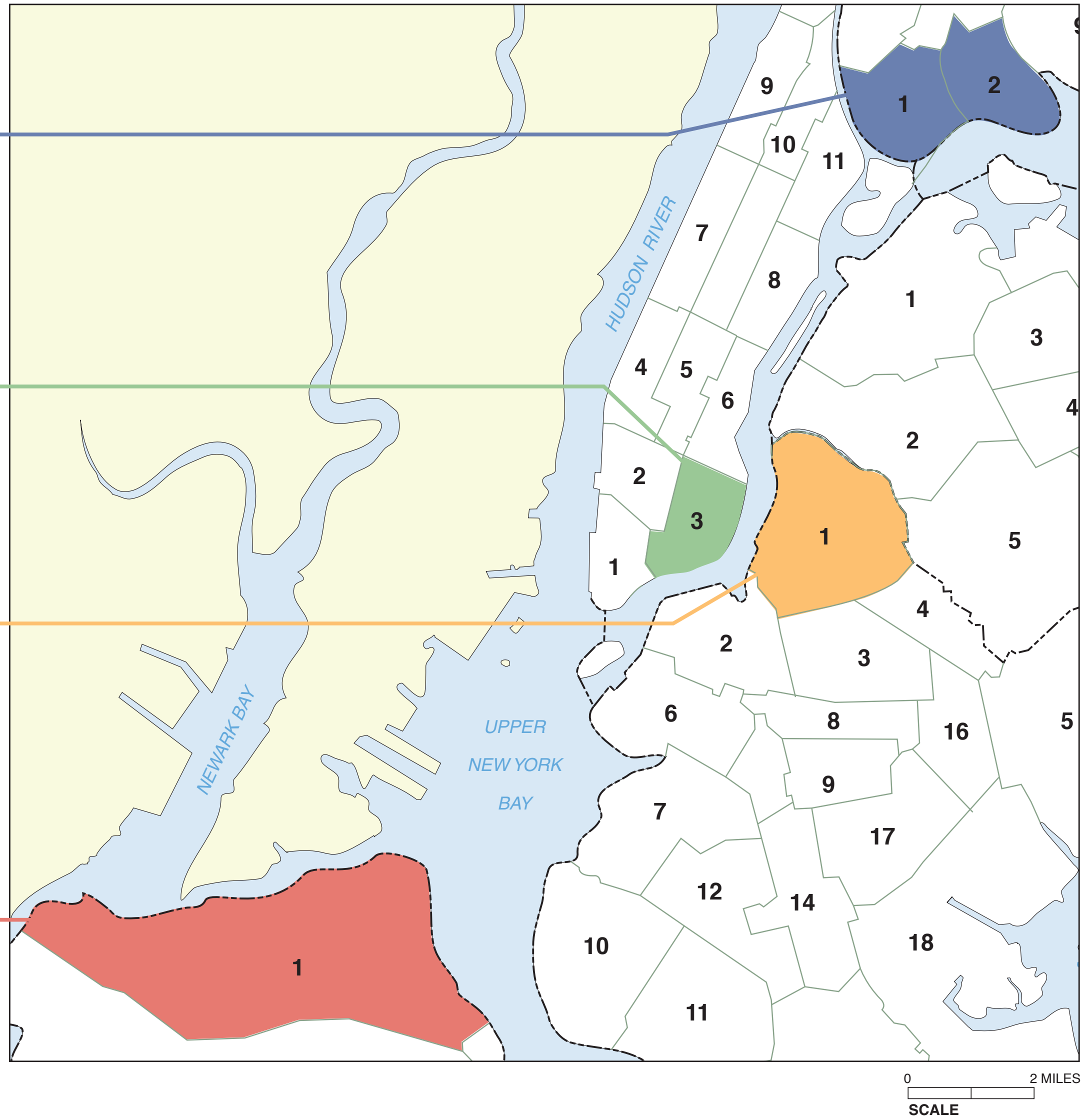

FIGURE 9-2 Summary of Potential Effects in the Representative Study Areas

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system. A limited area implementation would demonstrate few, if any, truck trip and solid waste volume reductions. Further, due to the current and future constraints and stringent regulatory requirements placed on the City's wastewater infrastructure, even small contributions could present considerable risks of violating standards and mandates at many of the City's WPCPs. Moreover, it would be difficult to trace the cause and effect to FWDs in such a large system. By the time the adverse effects make themselves known, it could be too late to make the infrastructure investments needed to address the problems, especially given the long lead times—often 10 years or more—necessary to design, permit, and construct the infrastructure. Lastly, while there are a few WPCPs that are not as heavily constrained, they are typically located in areas with far fewer FSEs, hence fewer benefits would be derived from FWD implementation, and they would not be representative of implementation at most of the other City plants.

The specific reasons for why a limited area implementation would not provide adequate information on environmental benefits and impacts include:

- Environmental benefits from a FWD implementation pilot would be negligible. Since many private haulers pick up from a given neighborhood or a given street, local truck trips would not appreciably decrease. Solid waste reductions from a limited area could be spread out among many transfer stations. Any truck trips reduced would at least be partially offset by additional sludge disposal trucks. Thus, truck trips would not be appreciably reduced.
- Many of the city's WPCPs are highly constrained and implementation in the areas served by these plants could trigger the need for expensive infrastructure investments. In areas with less constrained systems, a limited area implementation would not be indicative of impacts in most other areas of the city. WPCPs with fewer constraints tend to have fewer FSEs.
- Furthermore, the effects of implementation in a limited area would be difficult to detect given the large areas the WPCPs serve. Facility upgrades often need to be planned at least 10 years in advance to allow time to design and construct the facility while remaining in compliance with current and future regulations. Without early detection of problems, investments would not be in place before potential problems could arise.
- As described in this study, treatment facilities and sewers were designed to carry sanitary flow and stormwater away from properties, and were not designed to handle grease. Implementation of FWDs in a concentrated area could have localized impacts on the sewer system and could exacerbate sewer back ups and combined sewer overflows (CSOs).

9.2 MANHATTAN COMMUNITY BOARD 3

DESCRIPTION OF MANHATTAN CB 3

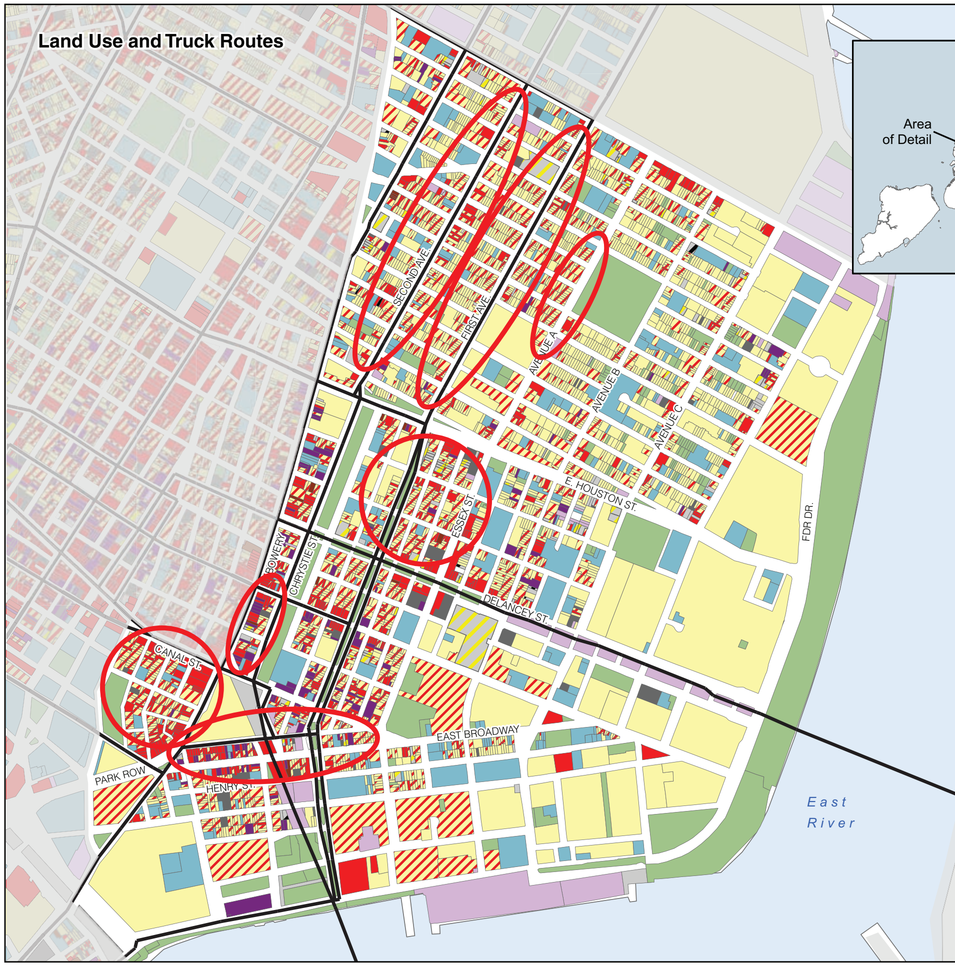
Manhattan Community Board (CB) 3 encompasses the neighborhoods of the East Village, the Lower East Side, and Chinatown (see **Figure 9-3**). These three neighborhoods are predominantly residential with many ground-floor commercial uses (restaurants, bars, and shops) (see **Figure 9-4**). This study area is a food waste generating area; there are no waste transfer stations (putrescible or other). Manhattan CB 3 is served by Newtown Creek WPCP in Brooklyn.

0 1/4 MILE
SCALE

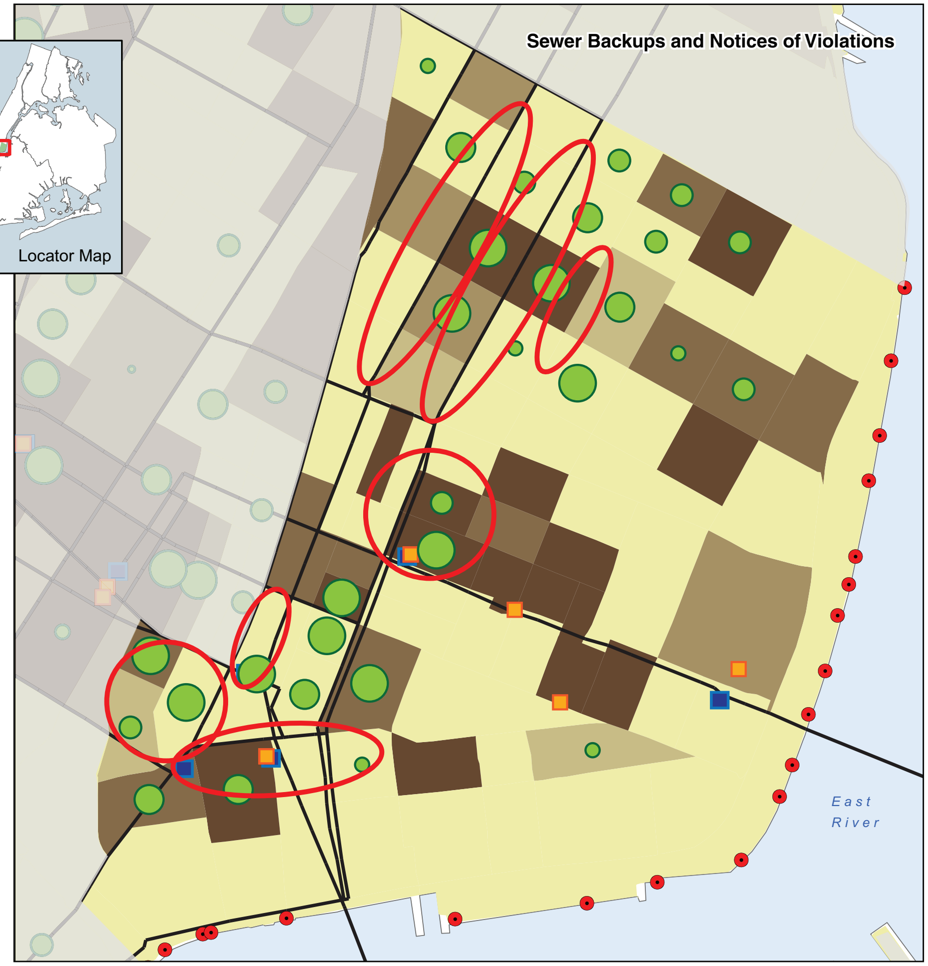
Manhattan Community District 3

FSE Concentration

FIGURE 9-3 Manhattan Community District 3



- NYCDOT Truck Routes
- FSE Concentration
- Residential
- Residential (with Commercial Below)
- Commercial and Office Buildings
- Public Facilities and Institutional
- Transportation and Utility
- Industrial and Manufacturing
- Open Space
- Parking Facility
- Vacant
- Under Construction
- Vacant Building



- NYCDOT Truck Routes
- Combined Sewer Outfall
- FSE Concentration
- Programmatic Degreasing Location
- 2007 Complaint-based Degreasing Location

Sewer Back Up Complaints per Acre (MOST – LEAST)

Notices of Violations per Acre (MOST – LEAST)

0 1/4 MILE
SCALE

SOURCE: Reported sewer backups and notice of violations data 1/2003 - 12/2007, NYCDEP

FIGURE 9-4

Manhattan Community District 3 - Land Use, FSE Concentrations, Sewer Backups, and Notices of Violations

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Borough Boundary

FSES IN MANHATTAN CB 3

Of the FSEs that could use FWDs, restaurants and hotels (552) make up the majority in Manhattan CB 3, with a concentration of retail food establishments (55) and other FSEs (caterers, shelters, senior centers, non-public schools) (25). The area also contains nine medical facilities and one college and university. As shown in Figure 9-4, the FSEs are predominantly concentrated in the East Village along First and Second Avenues and Avenue A, on the Lower East Side west of Essex Street, and in Chinatown between the Bowery and Chrystie Street, between Canal Street and Park Row, and along East Broadway. In addition to these concentrations, there are a number of FSEs at other locations throughout all three neighborhoods. As discussed in more detail below, this food waste is picked up and transported to waste transfer stations in other community boards, which receive waste.

POTENTIAL EFFECTS OF FWD IN MANHATTAN CB 3

With FWD implementation, the food waste portion of an FSE's solid waste disposal would be reduced. In Manhattan CB 3, the estimated food waste reduction would be approximately 30 tons per day (tpd) with 50 percent penetration.

POTENTIAL BENEFITS

Because of the high concentration of FSEs (including those that are not likely to use FWDs, such as bakeries and delis), there is a substantial amount of trucks picking up waste throughout the neighborhood on local streets. If 30 tpd was diverted by FWDs (at 50 percent penetration), there could be a reduction of up to three truck trips per day. This estimate is highly conservative; the reduction would likely be lower because the existing collection system has numerous haulers serving this area. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce any truck trips.

With this diversion of food waste from curbside pickup, there could be ancillary benefits, including less potential for curbside odor, vermin, and mess. In addition to these benefits, the FSEs of this community could potentially realize some cost savings from the implementation of FWDs (see Chapter 5).

POTENTIAL ADVERSE IMPACTS

This study area is served by the Newtown Creek WPCP, located in Brooklyn. The 30 tpd of food waste from this study area that could be diverted by FWDs to the plant would be combined with food waste diverted from other neighborhoods in the Newtown Creek WPCP service area (such as the Financial District, Murray Hill, Greenwich Village, Williamsburg, and Bedford Stuyvesant). As discussed in Chapter 8, the City has made a huge investment in the plant over the last decade, and the addition of food waste to Newtown Creek WPCP could jeopardize its permit requirements and trigger the need for further investments.

As discussed in Chapter 8, since Newtown Creek is a secondary treatment plant without primary tanks, the addition of food waste in the Newtown Creek drainage area would reduce the solids retention time, jeopardize secondary treatment, and likely require the construction of primary tanks. Newtown Creek WPCP has been undergoing a lengthy upgrade to maintain appropriate secondary treatment levels. Constructing primary tanks would require years of additional construction which would greatly impact Brooklyn Community Board 1 at a cost of $1.7 billion.

Figure 9-4 shows sewer backups over a five year period from 2002-2007 as well as sewer backups that required degreasing in 2007. This map also includes notices of violations (NOVs) and FSE concentrations. NOV concentrations are often close to FSE concentrations while sewer backups that required degreasing are dispersed throughout the study area. Even with grease interceptors, additional loadings, particularly of fats, oil, and grease (FOG) from FWDs, could be considerable and have the potential to constrain sewer capacity and also increase the potential for sewer backups and related maintenance and odors in the sewer system.

Within Manhattan CB 3, there are a number of combined sewer outfalls along the East River (see Figure 9-4). Promoting increases in sanitary or stormwater flow to the combined sewer system would be contrary to numerous New York City Department of Environmental Protection (NYCDEP) initiatives currently underway and others planned under PlaNYC goals to reduce CSOs and increase public access to over 90 percent of New York City tributaries.

9.3 BROOKLYN COMMUNITY BOARD 1

DESCRIPTION OF BROOKLYN CB 1

Brooklyn CB 1 encompasses the neighborhoods of Greenpoint and Williamsburg and is bounded by Newtown Creek to the north and east, Flushing and Kent Avenues to the south, and the East River to the west (see **Figure 9-5**). The area contains a mix of uses, with a concentration of heavy industrial uses in the eastern portion of CB 1 along Newtown Creek (see **Figure 9-6**). Industrial uses include numerous manufacturing and warehousing facilities, transfer stations, and the Newtown Creek WPCP. The non-manufacturing areas of Brooklyn CB 1 contain a mix of residential, commercial, institutional, and open space uses with some vacant land. In 2005, a large portion of the Greenpoint and Williamsburg neighborhoods was rezoned to provide opportunities for new residential and commercial development, including enhancement and upgrade of the waterfront areas along the East River and a portion of Newtown Creek. This study area is both a food waste generating area and a receiving area given the large number of restaurants and transfer stations.

Brooklyn CB 1 is served by the Newtown Creek WPCP, which, as noted above, is located within the community board.

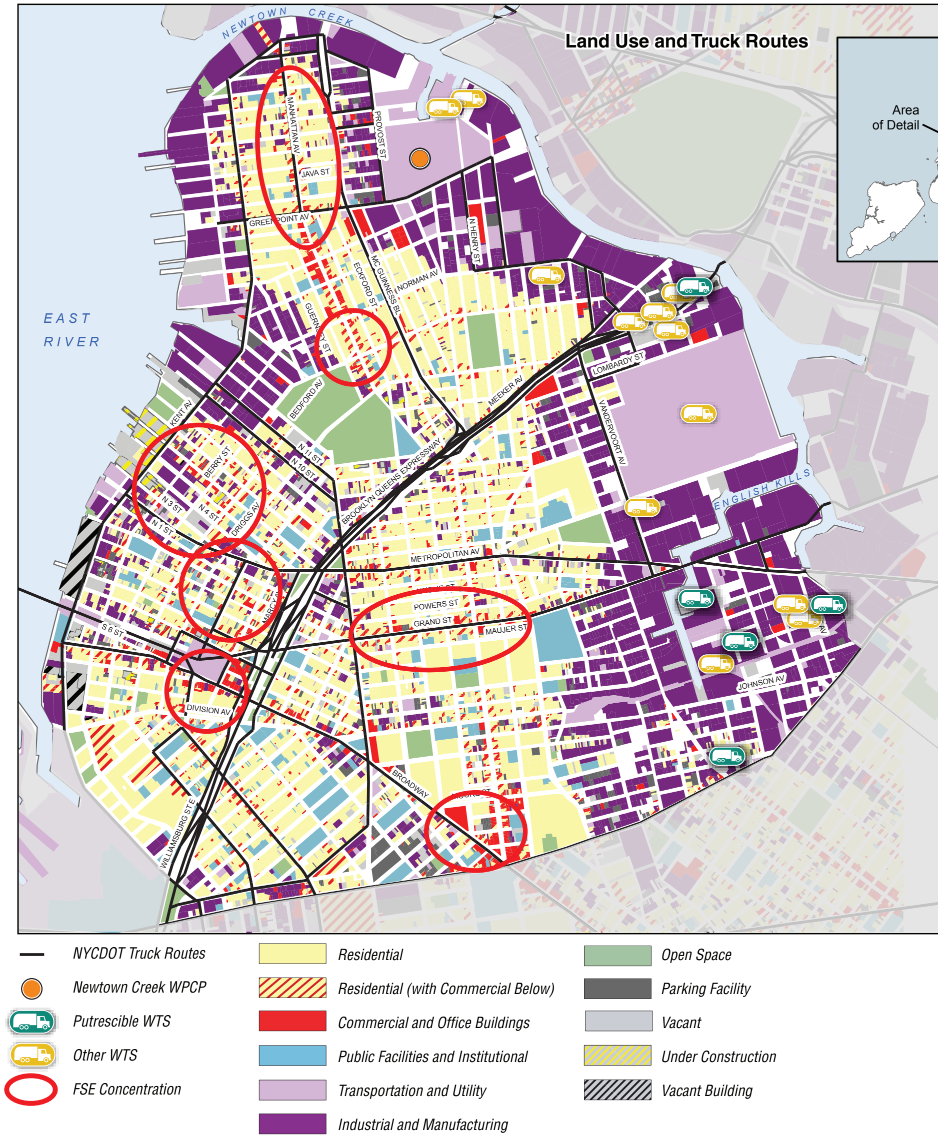
FSES IN BROOKLYN CB 1

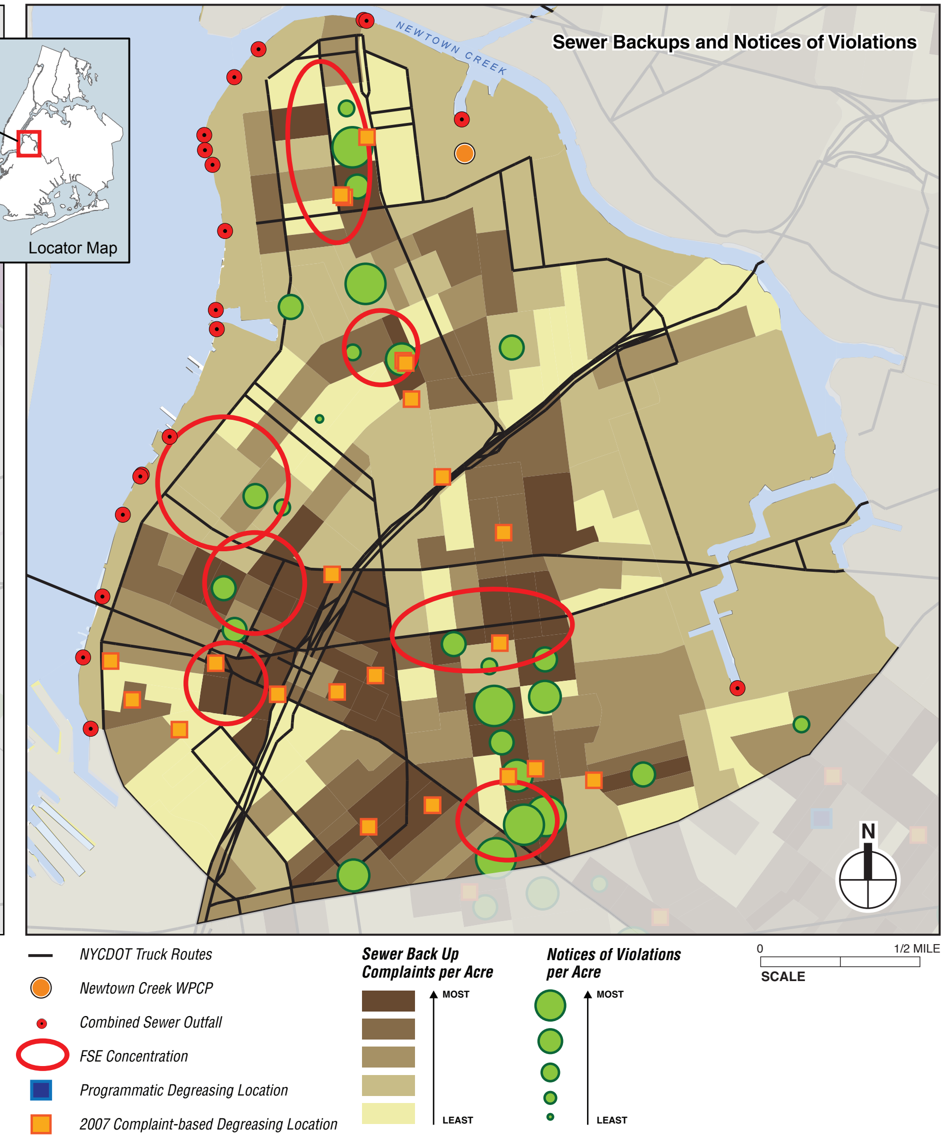
Of the FSEs that could use FWDs, restaurants and hotels (243) make up the majority in Brooklyn CB 1, with retail food establishments (40) and other FSEs (caterers, shelters, senior centers, non-public schools) (28) making up the rest with the exception of one medical facility. As shown in Figure 9-6, the FSEs are predominantly concentrated along Greenpoint's major commercial thoroughfare—Manhattan Avenue—and along Bedford Avenue, Grand Street, and Graham Avenue in Williamsburg, although there are a number of FSEs at other locations throughout both neighborhoods.

TRANSFER STATIONS IN BROOKLYN CB 1

Within the manufacturing area along Newtown Creek, as of August 2008, there are 17 waste transfer stations, five of which are for putrescible waste. This is the highest concentration of waste transfer stations in the city, and Brooklyn CB 1 receives a substantial amount of waste from other areas of the city. (As shown in Figure 9-6, 12 other transfer stations are also located

FIGURE 9-5 Brooklyn Community District 1





SOURCE: Reported sewer backups and notice of violations data 1/2003 - 12/2007, NYCDEP

FIGURE 9-6 Brooklyn Community District 1 - Land Use, FSE Concentrations, Sewer Backups, and Notices of Violations

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with Brooklyn CB 1; these transfer stations handle non-putrescible waste, fill material, and recyclable materials.)

POTENTIAL EFFECTS OF FWD IN BROOKLYN CB 1

POTENTIAL BENEFITS

Brooklyn CB 1 has the highest concentration of putrescible transfer stations, with five stations located within its boundaries. Because of this concentration of waste transfer stations, trucks travel through Brooklyn CB 1 at all hours, to and from the transfer stations.

A substantial reduction in waste hauling trucks traveling *TO* the transfer stations is not expected. As discussed in Section 9.2, above, trucks serving FSEs are not expected to be appreciably reduced because of the existing decentralized collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce truck trips.

As discussed in more detail in Chapter 2, the implementation of FWDs would see the largest reduction in truck trips from the reduction in waste trucked *OUT* of New York City from private transfer stations. Given the average amount of commercial putrescible waste leaving transfer stations (1,600 tpd) over 2007, approximately 75 trucks serve these stations. With 50 percent penetration of FWDs, approximately 140 tpd could be diverted from the transfer stations, resulting in an estimated reduction of six round trip truck trips per day *LEAVING* the waste transfer stations for export. This represents a small fraction of the number of truck trips servicing the transfer stations.

The New York City Department of Sanitation (DSNY) along with the New York City Department of Transportation (NYCDOT) is conducting a feasibility study to determine alternative routes for commercial waste trucks to reduce impacts of truck traffic. As part of the feasibility study, routing trucks away from Metropolitan and Grand Avenues was examined (with truck traffic directed to Vandervoort and Meeker Avenues) to reduce potential impacts on sensitive receptors along Grand and Metropolitan Avenues. Therefore, the reduction in truck traffic from the implementation of FWD may not provide substantial additional benefits to local residents. However, on a neighborhood scale, there would be a corresponding reduction in air and noise pollution from the reduction in truck trips.

While food waste from FSEs located in Brooklyn CB 1 would be reduced with the use of FWDs, it is not expected that there would be a reduction in truck trips due to the relatively small volumes diverted and the existing system of collection noted above. With this diversion of food waste from curbside pickup, there could be ancillary benefits, including less potential for curbside odor, vermin, and mess. In addition to these benefits, the FSEs of this community could potentially realize some cost savings from the implementation of FWDs (see Chapter 5).

POTENTIAL ADVERSE IMPACTS

As discussed above in Section 9.2, there would potentially be enormous, costly investments required at the Newtown Creek WPCP should FWDs be permitted in the service area. These capital improvements would result in several years of additional construction beyond the many years of construction that have already occurred at the plant, and is still ongoing. Construction activities would result in additional construction related trips through Brooklyn CB 1, including vehicular trips as construction workers arrive and depart at the site, and truck trips for the delivery of materials and equipment and the removal of construction waste.

In addition, since Newtown Creek WPCP does not have a dewatering facility, the additional sludge produced from food waste would be transported by barge typically to the Wards Island or Hunts Point WPCP; two additional barges per week would be required with 50 percent FWD implementation. The Newtown Creek WPCP drainage area could see an almost tenfold increase in FOG, assuming a 50 percent penetration rate for FWDs.

Figure 9-6 shows sewer backups over a five year period from 2002-2007 as well as sewer backups that required degreasing in 2007. This map also includes NOVs and FSE concentrations. NOV concentrations are often close to FSE concentrations while sewer backups that required degreasing are dispersed throughout the study area. Even with grease interceptors, additional loadings, particularly of FOG from FWDs, could be considerable and could have the potential to constrain sewer capacity and also increase the potential for sewer backups and related maintenance and odors in the sewer system.

Within Brooklyn CB 1, there are a number of combined sewer outfalls along the East River (see Figure 9-6). Additional combined sewer outfalls are also located along Newtown Creek and the English Kills. Newtown Creek is one of the confined waterways that is frequently impacted by CSOs and that experiences water quality problems. Additional discharges into this waterbody from FWD discharges during stormwater events would occur.

Promoting increases in sanitary or stormwater flow to the combined sewer system would be contrary to numerous NYCDEP initiatives currently underway and others planned under PlaNYC goals to reduce CSOs and increase public access to over 90 percent of New York City tributaries. In addition, any increase in CSOs would offset efforts to improve water quality in the confined waterways, such as Newtown Creek. Newtown Creek is an important waterway that, as of September 2007 with the opening of NYCDEP's Newtown Creek Nature Walk, is accessible to the public for the first time in decades. As part of the Newtown Creek Waterbody/Watershed Facility Plan Report (June 2007), NYCDEP has identified several CSO abatement measures that go beyond those already implemented, such as regulator improvement and floatables abatement. Depending on the alternative, these measures range in cost from $180 million to over $2 billion.

9.4 BRONX COMMUNITY BOARDS 1 AND 2

DESCRIPTION OF BRONX CB 1 AND CB 2

Bronx CBs 1 and 2 encompass the neighborhoods of Melrose, Mott Haven, Port Morris, Longwood, and Hunts Point. These neighborhoods extend from the Harlem River to the west, the East River to the south, and the Bronx River to the east (see **Figure 9-7**).

These five areas contain a mix of uses, with a concentration of heavy manufacturing uses in Port Morris and Hunts Point south of the Bruckner Expressway with the exception of the Hunts Point residential neighborhood on the Hunts Point peninsula and limited residential uses in Port Morris (see **Figure 9-8**). Within the waterfront industrial areas, uses include numerous manufacturing and warehousing facilities, oil storage facilities, transfer stations, transportation-related uses, food distribution uses, and the Hunts Point WPCP. The remainder of Bronx CB 1 and CB 2 contains a mix of residential, commercial, institutional, and open space uses. This study area is predominantly a receiving area given the large number of transfer stations, although there are some food waste generating communities located north of Bruckner Boulevard.

FIGURE 9-7 Bronx Community Districts 1 and 2

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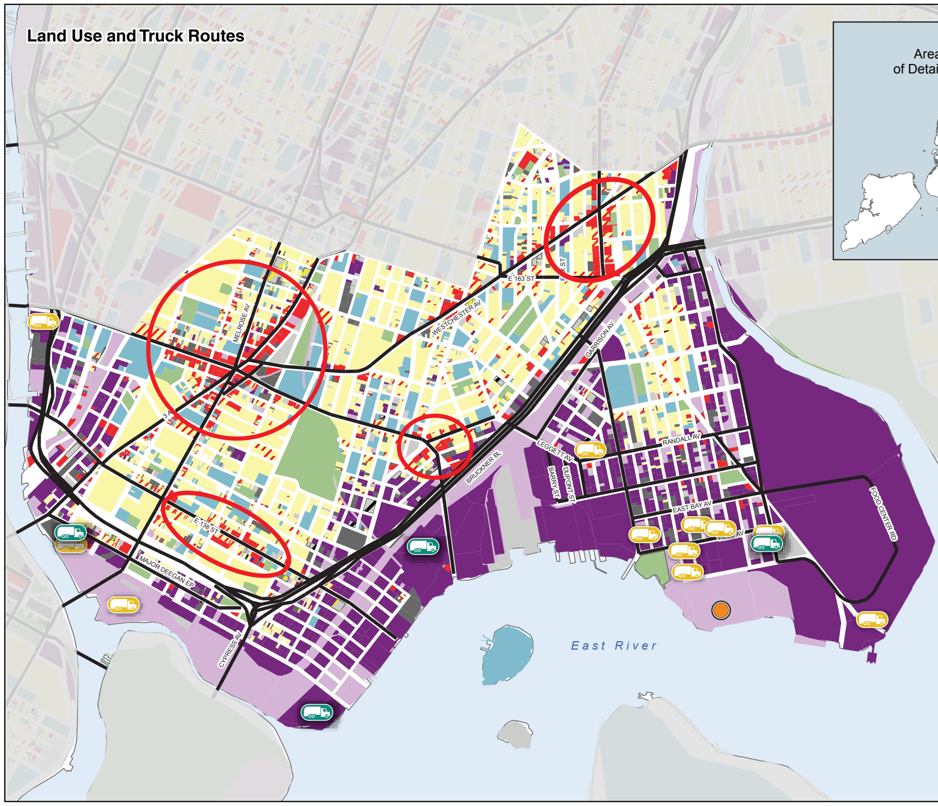
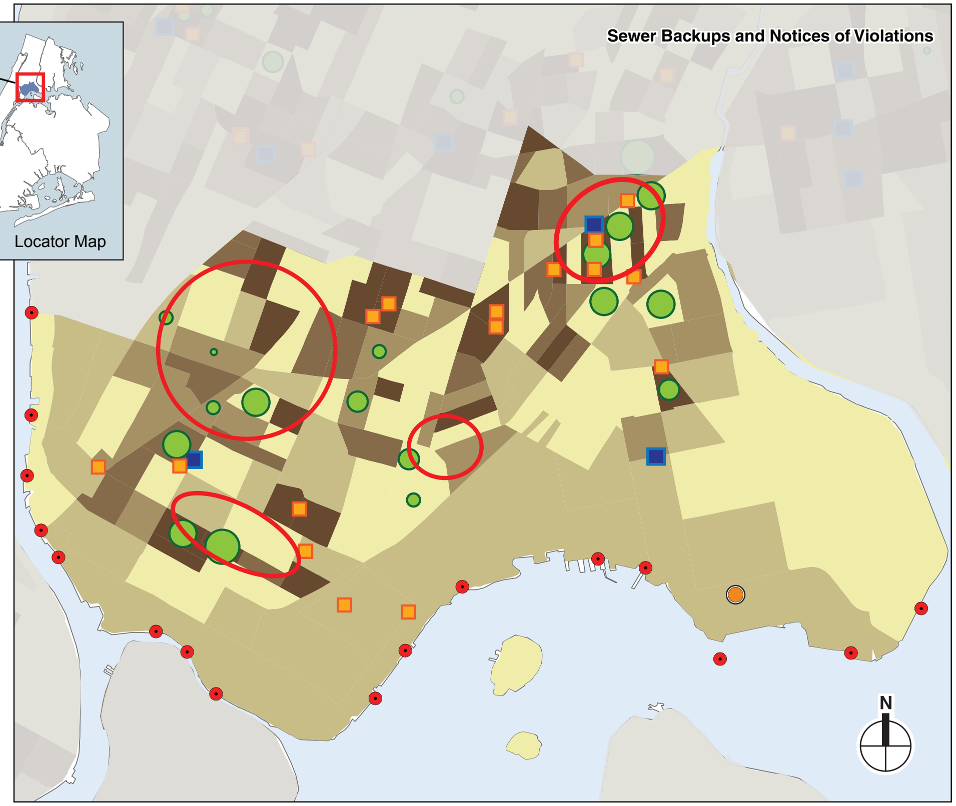


- NYCDOT Truck Routes
- Hunts Point WPCP
- Putrescible WTS
- Other WTS
- FSE Concentration
- Residential
- Residential (with Commercial Below)
- Commercial and Office Buildings
- Public Facilities and Institutional
- Transportation and Utility
- Industrial and Manufacturing
- Open Space
- Parking Facility
- Vacant
- Under Construction
- Vacant Building



- NYCDOT Truck Routes
- Hunts Point WPCP
- Combined Sewer Outfall
- FSE Concentration
- Programmatic Degreasing Location
- 2007 Complaint-based Degreasing Location

Sewer Back Up Complaints per Acre: MOST – LEAST

Notices of Violations per Acre: MOST – LEAST

0 – 1/2 MILE
SCALE

SOURCE: Reported sewer backups and notice of violations data 1/2003 - 12/2007, NYCDEP

FIGURE 9-8

Bronx Community Districts 1 and 2 - Land Use, FSE Concentrations, Sewer Backups, and Notices of Violations

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FSES IN BRONX CB 1 AND CB 2

Of the FSEs that could use FWDs, restaurants and hotels (155) make up the majority of the FSEs in Bronx CB 1 and 2, with retail food establishments (29) and other FSEs (caterers, shelters, senior centers, non-public schools) (25) making up the rest except for three medical facilities and one college and university. As shown in Figure 9-8, the FSEs are predominantly concentrated within The Hub and along the 138th Street commercial corridor, and Westchester Avenue, although there are a number of FSEs at other locations throughout the neighborhoods.

TRANSFER STATIONS IN BRONX CB 1 AND CB 2

As of August 2008, there are 15 waste transfer stations, four of which are for putrescible waste (see Figure 9-8). Of these transfer stations, one (the station located on East 132nd Street in Port Morris) exports its sorted and processed waste by rail to points outside New York City. (As shown in Figure 9-8, 11 other transfer stations are also located with Bronx CB 1 and 2; these transfer stations handle non-putrescible waste, fill material, and recyclable materials.)

POTENTIAL EFFECTS OF FWD IN BRONX CB 1 AND CB 2

POTENTIAL BENEFITS

As discussed above, Bronx CB 1 and CB 2 have a high concentration of putrescible transfer stations, with four stations located within their boundaries.

There is not expected to be a substantial reduction in waste hauling trucks traveling *TO* the transfer stations. As discussed above, trucks serving FSEs are not expected to be appreciably reduced because of the existing decentralized collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce truck trips.

As discussed in more detail in Chapter 2, the implementation of FWDs would see the largest reduction in truck trips from the reduction in waste trucked *OUT* of New York City from private transfer stations. Given the average amount of commercial putrescible waste leaving transfer stations (approximately 3,000 tpd) over 2007, approximately 140 trucks serve these stations. With 50 percent penetration of FWDs, approximately 270 tpd could be diverted from the transfer stations, resulting in an estimated reduction of 12 round trip truck trips per day *LEAVING* the waste transfer stations for export. This represents a small fraction of the number of truck trips servicing the transfer stations.

This reduction would be offset by the addition of five trucks for sludge disposal (see "Potential Adverse Impacts," below), for a total reduction of seven truck trips. This represents a very small fraction of the number of truck trips servicing the transfer stations in these community boards.

NYCDOT has recently changed the designated truck routes in the Hunts Point peninsula to route trucks away from residential streets. This was done as part of a broader effort—as articulated in the Hunts Point Vision Plan (Fall 2004)—to improve traffic safety and efficiency. The City is continuing to explore and implement measures to meet these goals. The reduction in trucks along these routes may not provide substantial additional benefits to local residents. However, on a neighborhood scale, there would be corresponding reduction in air and noise pollution from the reduction in trips. (As stated above, the waste transfer station located on East 132nd Street transports waste by rail.)

While food waste from FSEs located in Bronx CB 1 and 2 would be reduced with the use of FWDs, it is not expected that there would be a reduction in truck trips servicing these FSEs due to the relatively small volumes diverted and the existing system of collection noted above. With this diversion of food waste from curbside pickup, there could be ancillary benefits, including less potential for curbside odor, vermin, and mess. In addition to these benefits, the FSEs of this community could potentially realize some cost savings from the implementation of FWDs (see Chapter 5).

POTENTIAL ADVERSE IMPACTS

The Hunts Point WPCP treats wastewater from the eastern portion of the Bronx. In addition to the food waste within the study area, with the use of commercial FWDs, food waste from the remainder of the wastewater service area would also be diverted to the plant. As discussed in Chapter 8, these diversions would necessitate substantial upgrades at Hunts Point. These capital improvements would result in additional construction at Hunts Point, thereby resulting in additional construction-related trips through the study area. This additional construction could extend the ongoing construction efforts by several more years.

Sludge from the North River, Owls Head, and/or Newtown Creek WPCPs is dewatered at the Hunts Point WPCP; therefore, there would be an increase of three marine sludge vessel deliveries at the plant each week and approximately five truck trips per day leaving Hunts Point WPCP with biosolids from the increase in solids dewatered at the plant resulting from implementation of FWD use. A limited number of additional truck trips (less than one per week) could be required to remove additional FOG from operations at Hunts Point.

As discussed in Chapter 8, as of August 2008, 46 percent of the City's dewatered sludge is pelletized through drying, which occurs at the New York Organic Fertilizer Company (NYOFCo) facility in Hunts Point. Sludge to be pelletized and the finished project are transported to and from NYOFCo by truck. Therefore, the increase in sludge due to FWD would result in an increase in truck trips to and from the NYOFCo facility.

Figure 9-8 shows sewer backups over a five year period from 2002-2007 as well as sewer backups that required degreasing in 2007. This map also includes NOVs and FSE concentrations. NOV concentrations are often close to FSE concentrations while sewer backups that require degreasing are dispersed throughout the study area. Even with grease interceptors, additional loadings, particularly of FOG from FWDs, could be considerable and could have the potential to constrain sewer capacity and also increase the potential for sewer backups and related maintenance and odors in the sewer system. Since Bronx CB 2 is at the end of the Hunts Point WPCP drainage area, food waste from all communities served by Hunts Point WPCP would travel through its combined sewers. Thus, it is likely that sewer backups would increase.

Within Bronx CB 1 and 2, there are a number of combined sewer outfalls along the Harlem and East Rivers (see Figure 9-8). As discussed above, the Bronx River forms the eastern boundary of this study area. As part of the Bronx River Waterbody/Watershed Facility Plan Report (June 2007), NYCDEP has identified measures to reduce floatable inputs from CSOs and improve associated aesthetic impairments found in the Bronx River. A number of the plan actions have already been initiated through NYCDEP's ongoing CSO planning activities while others are to be initiated. The total cost for these measures is $14.8 million.

Promoting increases in sanitary or stormwater flow to the combined sewer system would be contrary to numerous NYCDEP initiatives currently underway and others planned under PlaNYC goals to increase public access to over 90 percent of New York City tributaries.

9.5 STATEN ISLAND COMMUNITY BOARD 1

DESCRIPTION OF STATEN ISLAND CB 1

Staten Island CB 1 encompasses the northern portion of Staten Island, including a number of different neighborhoods (Saint George, Stapleton, New Brighton, Livingston, Port Richmond, Mariners Harbor, Arlington, Port Ivory, Elm Park, Westerleigh, among others) (see **Figure 9-9**). These neighborhoods are predominantly residential with commercial uses located along the main thoroughfares and an industrial zone on the western end (see **Figure 9-10**). This study area is a food waste generating area; there are no waste transfer stations (putrescible or other). Staten Island Community Board 1 is served by the Port Richmond WPCP located in Port Richmond along the Kill Van Kull waterfront.

FSES IN STATEN ISLAND CB 1

Of the FSEs that could use FWDs, restaurants and hotels (176) make up the majority in Staten Island CB 1, with some retail food establishments (21), medical facilities (nine), other FSEs (caterers, shelters, senior centers, non-public schools) (four), and colleges and universities (two). As shown in Figure 9-10, the FSEs are predominantly concentrated along the main thoroughfares, such as Forrest Avenue, Victory Boulevard, John Street, and Front Street. There is also a concentration of FSEs in Saint George. In addition to these concentrations, there are some FSEs at other locations throughout the community board. As discussed in more detail below, this food waste is picked up and transported to waste transfer stations in other community boards, which receive waste.

POTENTIAL EFFECTS OF FWD IN STATEN ISLAND CB 1

With FWD implementation, the food waste portion of an FSE's solid waste disposal would be reduced. In Staten Island CB 1, the estimated food waste reduction would be approximately 10 tpd with 50 percent penetration.

POTENTIAL BENEFITS

There are numerous trucks picking up waste throughout the neighborhood on local streets. However, if 10 tpd were diverted by FWDs (at 50 percent penetration), it is expected that there could be a reduction of only one truck trip per day. This estimate is conservative as the current truck trips may be higher and the reduction may be lower because the existing collection system has numerous haulers serving this area. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce truck trips. Therefore, few benefits would be accrued in this study area from commercial FWD use.

With this diversion of food waste from curbside pickup, there could be ancillary benefits, including less potential for curbside odor, vermin, and mess. In addition to these benefits, the FSEs of this community could potentially realize some cost savings from the implementation of FWDs (see Chapter 5).

FIGURE 9-9 Staten Island Community District 1

12.30.08

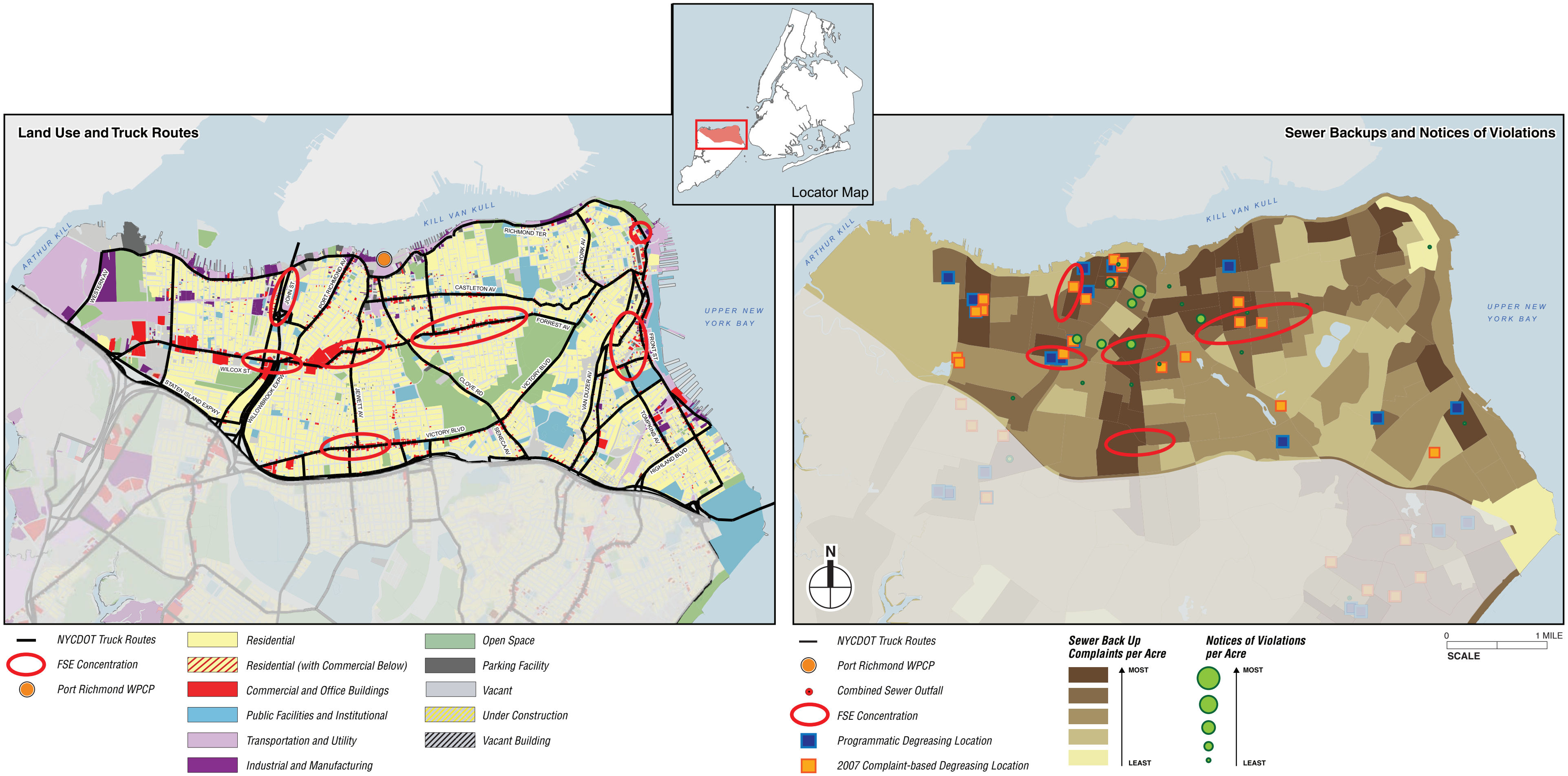

FIGURE 9-10

Staten Island Community District 1 - Land Use, FSE Concentrations, Sewer Backups, and Notices of Violations

POTENTIAL ADVERSE IMPACTS

This study area is served by the Port Richmond WPCP, located in the Port Richmond neighborhood of CB 1. The 10 tpd of food waste from this study area that could be diverted by FWDs to the plant would be combined with food waste diverted from other neighborhoods in the Port Richmond WPCP service area (this area includes the northern section of Staten Island CB 2). As discussed in Chapter 8, with FWD implementation, there could be implications in meeting secondary treatment requirements and additional equipment would be required (heat exchange capacity, sludge storage capacity, and an additional aeration blower). The plant would not be a good indicator of impacts from FWDs that would occur at most plants in the city since it is not constrained due to nitrogen or other limits.

Figure 9-10 shows that sewer backups over a five year period from 2002-2007 as well as sewer backups that required degreasing in 2007. This map also includes NOVs and FSE concentrations. NOV concentrations are often close to FSE concentrations while sewer backups that require degreasing are dispersed throughout the study area. Even with grease interceptors, additional loadings, particularly of FOG from FWDs, could be considerable and could have the potential to constrain sewer capacity and also increase the potential for sewer backups and related maintenance and odors in the sewer system.

Within Staten Island CB 1, there are a number of combined sewer outfalls along the Kill Van Kull and Upper New York Bay (see Figure 9-10). Promoting increases in sanitary or stormwater flow to the combined sewer system would be contrary to numerous NYCDEP initiatives currently underway and others planned under PlaNYC goals to reduce CSOs and increase public access to over 90 percent of New York City tributaries. ✷

A.1 INTRODUCTION

This appendix describes the likely universe of food service establishments (FSEs), how they were identified and categorized for this study, and their geographic location throughout the City. In addition, this chapter presents estimates of their food waste generation and the constituents of food waste after grinding are also presented.

A.2 FOOD SERVICE ESTABLISHMENTS IN NEW YORK CITY

DEFINING FOOD SERVICE ESTABLISHMENTS

To assemble a "universe" of FSEs likely to use commercial food waste disposers (FWDs) for this study, specifically defining an FSE was important. For this study, an FSE is defined as an establishment that generates food waste in volumes large enough to make the installation of a commercial FWD potentially cost-effective. **Figure A-1** provides an overview of how FSEs in New York City were defined.

To identify New York City's FSEs that may use FWDs, a number of databases were obtained and merged to create the initial universe of FSEs for this study. These databases are summarized below:

- **Department of Consumer Affairs (NYCDCA) Database**. NYCDCA's database—which was used as a primary foundation of the universe of FSEs—includes records for approximately 33,000 establishments with commercial kitchens that are currently permitted by the New York City Department of Health (NYCDOH). The establishments in the NYCDCA database include restaurants, private schools, caterers, mobile food vendors, and hospitals with a street level cafeteria that may be frequented by the general public. The database is constantly changing as new locations are added and others are removed, but in general, the total number of records has not changed appreciably over recent history. The NYCDCA maintains the database for the NYCDOH.

  The NYCDCA database does not include hospitals with cafeterias on a floor other than street level, residential care facilities, or adult health care facilities, which are permitted by the New York State Department of Health (NYSDOH). The database does not include supermarkets, other retail food outlets (such as bakeries and produce markets) and food processors, which are permitted by the New York State Department of Agriculture and Markets (NYSDAM).
- **Dun & Bradstreet (D&B) Database.** This database of 34,820 records focuses on ownership and corporations of businesses that may generate commercial food waste in the city, rather than food handling and kitchens. The D&B database was used to supplement the NYCDCA database, and at times, used to cross-check information in the NYCDCA database.

Compiling the Universe of FSEs

NYCDCA Database • D&B Database • NYSDAM Database • NYSDOH Database • Internet databases
Databases were merged to refine the initial universe of FSEs.

Separation of Initial Universe of FSEs into Five Categories

Colleges and universities • Medical facilities • Retail food establishments (supermarkets) • Restaurants and hotels • Other FSEs (caterers, shelters, senior centers, and non-public schools)
Categories were based on FSEs representing a distinct type of establishment, an efficient means of aggregating the FSEs, and FSEs with a common estimating metric (i.e., square footage).

Randomization of FSEs for the Sampling Study

From each category, initial target FSEs were randomly selected and surveyed; a subset was selected for sampling.

FSEs Removed from the Initial Universe of FSEs

Based on initial screening and survey results, several FSEs were removed from the initial universe since they were considered unlikely to install an FWD.

FSEs Unlikely to Install an FWD

Public schools (waste is collected by DSNY)
Mobile food commissaries that handle prepackaged food
Retail food manufacturers that handle prepackaged food
Establishments with no prepared food
FSEs with no kitchens or limited food service, such as:
- Mobile food vendors
- Retail frozen food manufacturers (e.g., ice cream shops)
- Fast food restaurants
- Delis
- Coffee and tea shops
- Bars
- Donut sellers and bakeries
- Dairy/ice cream shops
- Confectionary concession marts

FSEs Likely to Install an FWD

Restaurants with prepared food and china plate service
Hotels
Colleges and universities
Medical facilities, such as hospitals and nursing homes
Supermarkets
Caterers
Senior centers
Non-public schools

Revised Universe of FSEs

FSEs unlikely to install FWDs were removed from the initial universe, and a revised universe was created for waste generation estimates.

FIGURE A-1 The Universe of Food Service Establishments

- **New York State Department of Agriculture and Markets (NYSDAM) Database.** NYSDAM's database has a total of 1,598 records of retail food establishments (food markets) and retail food manufacturers (food processors) permitted in New York City.
- **New York State Department of Health (NYSDOH).** This database, with a total of 355 records, includes operating hospitals, residential care facilities, and adult health care facilities.

In addition to these databases, the Internet was also used as a source of information on colleges and universities.

COMPILING THE INITIAL UNIVERSE OF FOOD SERVICE ESTABLISHMENTS

Initially, all establishments were considered in the universe of FSEs. The NYCDCA database was selected as the starting point for the development of the universe of FSEs because it focuses on food handling operations permitted in New York City. Records from the NYSDAM database were used to identify such FSEs as retail food establishments (supermarkets) and retail food manufacturers (food processors). Records from the NYSDOH database were used to identify FSEs related to the health care industry.

Since there were over 17,000 records in the initial database, the initial universe of FSEs needed to be separated into common categories for inclusion in the sampling study. As a result of these efforts, the most likely FSE candidates for FWDs were organized in the following categories: restaurants/hotels, supermarkets, medical facilities, colleges, and other FSEs (such as caterers, shelters, senior centers, and non-public schools).

These categories were chosen since each represented a distinct type of establishment, and FSEs with a common estimating metric (i.e., retail food establishments with square footage) were grouped.

IDENTIFYING FSES UNLIKELY TO INSTALL FWDS

Other FSEs were initially considered as additional categories, such as public schools, mobile food commissaries, and retail food manufacturers. Public schools were eliminated, not only because the Department of Sanitation (DSNY) collects their waste, but in most instances food is prepared off-site and not served on plates. Mobile food commissaries and retail food manufacturers were eliminated as categories because the majority of these establishments reported that they receive pre-packaged food items and redistribute them, respectively, to mobile food vendors (i.e., street vendors) or retail food establishments (i.e., supermarkets), thus they do not generate food waste. In sum, because of their food and waste handling practices, public schools, mobile food commissaries, and retail food manufacturers are considered unlikely users of FWDs.

Each of the records within the five FSE categories were then randomized to determine which FSEs would be contacted for field surveying, sampling, and data collection. From within each FSE category, an initial random selection of target FSEs was made. The initial FSE selections were then contacted and surveyed both in person and by phone to confirm that the FSE was still in business, were placed in the appropriate category, and were willing to participate in the study. From the initial random selection, a subset of FSEs was selected for sampling.

Based on a review of the databases, initial survey screening of the randomized lists, and after contacting the randomly selected FSEs, it was discovered that many of the entities were unlikely to install an FWD. These were establishments that had no kitchens or limited food service with no prepared food, including mobile food vendors, retail frozen food manufacturers (e.g., ice cream shops), fast-food restaurants, delis, coffee and tea shops, bars, donut sellers and bakeries, and dairy/ice cream and confectionery concessions. Many of these establishments fell within the "restaurant and hotel" and "other" categories. The proportion of establishments identified from this additional review were used to proportion these results to the initial universe, and a "revised universe" of FSEs was established and used in the study.

For each category, **Table A-1** presents the initial universe of records, the revised universe of records (i.e., FSEs more likely to install FWDs), and the number of samples collected in this study.

Table A-1
FSE Universe

Category	Initial Universe	Revised Universe	No. of Samples
Colleges and universities	67	52	15
Medical facilities	355	345	32
Retail food establishments (supermarkets)	1,505	1,505	29
Restaurants and hotels	14,523	8,447	61
Other FSEs (caterers, shelters, non-public schools, and senior centers)	1,247	631	35
Total	**17,697**	**10,980**	**172**

A.3 COMMERCIAL FOOD WASTE SURVEY AND SAMPLING

To determine the amount of food waste generation by category, a sampling study was performed. From the randomized lists, samples were obtained at each targeted FSE; weighed, sorted, separated, and weighed again at the DSNY North Shore Marine Transfer Station; and then sent to the City College of New York (CCNY) laboratory for further analysis.

Before the sampling actually began, each of the target FSEs was contacted by telephone, personal visit, and/or e-mail to inform the FSE of the project and to solicit information to be used during sample acquisition and in projecting the food waste they generate.

The following information was requested from each FSE:

- Confirmation of name, address, telephone number, and e-mail address;
- Willingness to participate in the study;
- Name, address, and contact person of hauler that serves FSE;
- Location of waste when it is collected (e.g., curb, dumpster, or compactor);
- Estimate of amount of waste set out for each collection; and
- Additional information regarding kitchen operations collected during the interview process.

The information from the survey along with the information from the database of FSEs was compiled into a profile for each FSE.

Food waste samples were collected from the 172 randomly selected FSEs across the city during September and October 2007. Samples were collected before the hauler arrived to pick it up at varying times throughout the day depending on the schedule of waste pick-up at each FSE. Each sample was initially weighed and brought to the DSNY transfer station. If the waste was bagged and placed on the curb, the entire amount of the waste set out for collection was weighed. If the waste was bagged and placed in a dumpster or compactor, a random 200-pound sample of the waste was collected during the day and the percentage of the FSE's total waste for that day was estimated using information provided by the FSE. If the total amount of waste was 200 pounds or less, it was placed in a toter for transport to the transfer station. If the total amount of waste was greater than 200 pounds, a random sample of the waste totaling approximately 200 pounds was selected and placed in the toter. One sample was collected at each FSE.

The samples at the transfer station were then weighed and sorted into either food waste or non-food waste. Food waste consisted of all waste that might appropriately be disposed in an FWD, including fruits and vegetables, meat and poultry, dairy products, bread and grain products, bones, and seafood. Non-food waste included waste that should not be disposed in an FWD, including paper products, plastics, disposable utensils, flatware, ceramic plates, glass, wood, and metal.

The percentage of food waste in the total amount of waste was then calculated for each sample. This was used to generate the percentage of commercial waste from FSEs that is food waste, which was determined as an average of 55 percent (from all five categories of FSEs).

A random sample of the food waste was placed into a 3.5-gallon container and sent to the CCNY laboratory for analysis. The non-food waste was put into a roll-off container and disposed.

A.4 COMMERCIAL FOOD WASTE GENERATION

METHODOLOGY

Waste generation estimates were made from the following information collected at each FSE during the sampling study:

- **The number of bags of waste generated per day.** Given the variability in food waste density per bag, the number of bags was multiplied by the average weight of a bag from the FSE category. For example, the average weight of bags from the retail food establishments (supermarkets) was 26 pounds. The estimate for a supermarket generating 10 bags of waste per day would therefore be 260 pounds per day.
- **The percentage of the day's waste represented by the sample.** For example, if the FSE estimated that the sample represented 50 percent of a full day's generation, the estimate of daily generation of waste for the FSE would be two times the weight of the sample.
- **The capacity of the dumpster or compactor and the frequency of collection.** In this case, the capacity of the dumpster or container was multiplied by the density of the waste (uncompacted or compacted) and divided by the number of days between collections. For example, if a 2-cubic-yard dumpster that was picked up every other day held 500 pounds of waste, the estimate of daily generation of waste for this FSE would be 250 pounds.
- In a few cases, the FSE provided **the average daily tonnage of waste disposed** to the surveyor or the sample manager.

For each sampled FSE, the following information was determined:

- An estimate of the weekly waste generated;
- The percentage of food waste in the sample;

- The estimate of weekly food waste generation per square foot for retail food establishments;
- The number of transactions per day and days per week associated with the transactions per day basis for colleges and universities; and
- The estimate of the weekly food waste generation in pounds per week, which is the waste multiplied by the percentage of food waste.

The sample mean, standard deviation, upper boundary, and lower boundary[1] of weekly food waste generation in pounds were determined for each FSE category. Food waste generation per square foot was also determined for the retail food establishments.

Three different methods were used to calculate food waste generation for the non-sampled FSEs. Waste generation estimates for each FSE category were then developed.

- For medical facilities, other FSEs, and restaurants and hotels, the sample mean of weekly food waste generation for the sampled establishments in each category was calculated directly and applied to all the records in these categories.
- For retail food establishments (supermarkets), the sample mean of weekly food generation included a per-square-foot metric. The food waste generated per square foot was then multiplied by the total square footage of each supermarket record in the FSE universe.
- For colleges and universities, weekly food waste generation estimates were developed using both facility and institutional transactions and applied to all the records in this category.[2]

FOOD WASTE GENERATED IN THE CITY BY CATEGORY

Using the methodology above to determine the waste generation rates, total food waste generation estimates were made for each FSE category. **Table A-2** includes a summary of the average waste generation by category and the extrapolated total for the category (based on the number of entries in revised universe).

Table A-2
Waste Generation by Category

	Generation Estimate (tons/day)					
	Colleges and Universities	**Medical Facilities**	**Retail Food Establishments**	**Restaurants and Hotels**	**Other FSEs**	**Total**
Average Sampled FSE	0.70	0.26	0.07	0.06	0.34	1.43
Total for category	36	91	150	549	212	1,038

[1] Sample mean is the average of the population that has been sampled.

Standard deviation is a measure of the differences from the sample mean in the sampled population.

Upper 90 percent confidence interval is a calculation that indicates, within a certain level of confidence, the largest mean that might occur within the population, sampled and un-sampled.

Lower 90 percent confidence interval is a calculation that indicates, within a certain level of confidence, the smallest mean that might occur within the population, sampled and un-sampled.

[2] "Facilities" refer to the specific establishment that was sampled; "Institution" refers to the larger organization that may include several facilities. For example, the Al Lerner Café is a facility that is part of Columbia University. "Transactions" refer to any item(s) of food that is provided by the facility to a student customer, from a full meal to a cup of coffee.

Based on the revised FSE universe of likely FWD candidates, the total amount of food waste for these FSEs was 1,038 tons per day (tpd). This compares well to the separately calculated food waste generation estimate of 1,640 tpd in DSNY's Commercial Waste Management Study (2004) because the DSNY 2004 study included the uses eliminated from the initial universe in this study because they would not likely use FWDs.

A.5 CHARACTERISTICS OF FOOD WASTE

CCNY ANALYSIS

As mentioned above, food waste samples for this study were collected, sorted, and delivered to CCNY in upper Manhattan, where the samples were subjected to FWD grinding and more detailed analyses. The samples were analyzed by CCNY using two different 2-horsepower (hp) commercial FWDs. CCNY put each food waste sample through the FWDs and the sample was ground up.

CCNY recorded the amount of water consumed by the FWDs and also summarized some operational issues during the test procedures. The food waste was analyzed for parameters that impact wastewater treatment and water quality, such as total kjeldahl nitrogen (TKN), soluble TKN, total nitrogen, biochemical oxygen demand (BOD), soluble chemical oxygen demand (COD), soluble carbonaceous biochemical oxygen demand (cBOD)[3], total solids, total suspended solids (TSS), oil and grease, and additional water demand. These parameters were subsequently used to develop the incremental pollutant loads and wastewater flows to each water pollution control plant (WPCP) and combined sewer overflow (CSO) catchment area. See **Table A-3** for sample data.

While the food waste was being ground, the FWD jammed on several occasions. Some of the items that caused jamming were plastic wrap, rags, and bottle covers that were inadvertently included in the food waste as well as mussel shells and some cuts of meat. The drain clogged a few times; however, most items went through the grinder without significant problems.

GEOGRAPHIC ALLOCATION OF FOOD WASTE

Geographical Information System (GIS) software was used to assign the FSEs in the revised universe by WPCP drainage basin and CSO catchment area. Each FSE was geocoded using GIS source files and ArcGIS 9.2 software. The FSEs were then overlaid with the drainage and CSO areas.

[3] Chemical oxygen demand (COD) is the amount of oxidizing agent needed to oxidize the organic and oxidizable inorganic matter in waste water. Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed to decompose the organic matter in waste water: a high BOD indicates heavy pollution with little oxygen remaining for fish. Carbonaceous biochemical oxygen demand (cBOD) means the quantity of oxygen utilized in the carbonaceous biochemical oxidation of organic matter present in the wastewater.

Table A-3
CCNY Data by Category

Parameters	Colleges and Universities (g/kg Food Waste)	Medical Facilities (g/kg Food Waste)	Retail Food Establishments (g/kg Food Waste)	Restaurants and Hotels (g/kg Food Waste)	Other FSEs (g/kg Food Waste)
Hardness (total)	3.02	3.46	6.18	4.05	7.81
Potassium	2.67	2.83	6.75	2.41	5.15
Sodium	2.54	3.32	1.90	2.63	6.85
Ammonia	0.35	0.35	2.85	1.12	0.76
Soluble COD	109.63	117.32	111.97	127.74	116.75
Soluble cBOD	74.55	79.78	76.14	86.86	79.39
Chloride	3.22	6.81	4.07	3.03	3.89
COD	589.65	547.45	491.87	714.60	510.17
cBOD (Total)	245.89	228.29	205.11	297.99	212.74
Nitrate	0.04	0.01	0.03	0.03	0.07
Nitrite	0.00	0.00	0.00	0.00	0.00
Total Nitrite/Nitrate	0.03	0.01	0.02	0.03	0.06
1664-Oil and Grease	14.83	16.03	6.16	18.59	18.21
Total Phosphorous	0.97	0.99	1.49	1.53	1.51
Soluble Phosphorous	0.53	0.44	0.74	0.75	0.71
Sulfate	1.69	1.35	1.60	1.61	0.93
TKN	4.62	3.96	6.60	5.39	7.31
Soluble TKN	1.96	1.15	4.03	2.35	3.05
Total Nitrogen	4.65	4.02	6.62	5.32	7.66
1664 Non-Polar Material (TPH)	8.76	10.02	8.79	9.73	6.99
RB COD1	5.02	19.72	15.57	6.26	10.26
Total Solids	250	280	220	320	310
Total Suspended Solids	202	196	183	254	251
Total Volatile Suspended Solids	154	154	161	212	225
pH	5.18	4.99	5.29	5.31	5.34
Water Flow from Food Waste (%)[1]	75%	72%	78%	69%	69%
Total Solid Food Waste (%)	25%	28%	22%	31%	31%

Notes: [1]Water Flow from Food Waste (%) = 1 - Average percent solids for each food waste sample.
g/kg = grams per kilogram

For each of the City's WPCP and CSO drainage areas, incremental waste generation rates and projected wastewater flows and pollutant loads were determined based on the number of FSEs to yield the total amount of waste generated in tons per year in each geographic area. The incremental increase in flow would be relatively small compared with the incremental pollutant increases. For example, for Newtown Creek, the increase in flow at 50 percent penetration would be only 1.3 percent; however, the increase in nitrogen, BOD, and TSS would be 3 percent, 18 percent, and 19 percent, respectively. Similarly, for Wards Island, the incremental increase in flow would be only 0.6 percent, while the increases for nitrogen, BOD, and TSS would be 2.3 percent, 35 percent, and 15 percent, respectively. The increases are not similarly proportioned since each of the plants has a different BOD to TSS to total nitrogen ratio and the loads and ratios from the FWDs may also be different for each drainage area. Chapter 8 discusses this in more detail. ✷

B.1 INTRODUCTION

This appendix profiles New York City's wastewater pollution control plants (WPCPs) and describes the general wastewater treatment process in New York City.

B.2 WPCP PROFILE

The City is divided into 14 sewage drainage basins, each of which is served by a sewer network and a WPCP. Each WPCP serves a complex and diverse mix of residential, commercial, and industrial uses and consists of a network of catchment basins and sewer pipes that direct wastewater flow to each of the WPCPs. **Table B-1** summarizes general drainage-related information for each plant—the total population currently served, the receiving waterbody of the plant's effluent, and the drainage area in acres.

Table B-1
Profiles of New York City's WPCPs

WPCP	Population Served	Receiving Waterbody	Drainage Area
26th Ward	283,428	Jamaica Bay	5,907 acres, eastern section of Brooklyn, near Jamaica Bay
Bowery Bay	848,328	Upper East River	15,203 acres, northeast section of Queens
Coney Island	596,326	Jamaica Bay	15,087 acres, south and central Brooklyn
Hunts Point	684,569	Upper East River	16,664 acres, eastern section of the Bronx
Jamaica	728,123	Jamaica Bay	25,313 acres, southern section of Queens
Newtown Creek	1,068,012	East River	15,656 acres, south and eastern Midtown sections of Manhattan, northeast section of Brooklyn, and western section of Queens
North River	588,772	Hudson River	6,030 acres, West Side of Manhattan above Bank Street
Oakwood Beach	244,918	Lower New York Bay	10,779 acres, southern section of Staten Island
Rockaway	90,474	Jamaica Bay	6,259 acres, Rockaway Peninsula
Owls Head	758,007	Upper New York Bay	12,947 acres, western section of Brooklyn
Wards Island	1,061,558	Upper East River	12,056 acres, western section of the Bronx and Upper East Side of Manhattan
Tallman Island	410,812	Upper East River	16,860 acres, northeast section of Queens
Port Richmond	198,128	Kill Van Kull	9,665 acres, northern section of Staten Island
Red Hook	192,050	Lower East River	3,200 acres, northwest section of Brooklyn and Governor's Island

B.3 OPERATIONS AT THE WPCPS

WASTEWATER FLOWS

Wastewater flows that arrive at the WPCPs are treated to remove pollutants before the wastewater is discharged to local waterbodies. Dry weather flows, or sanitary flows, consist of wastewater from toilets and drains in homes, schools, businesses, and factories that then flows into New York City's sewer system. Such flows are dependent on population—both the residential population and the population of the City's businesses.

In addition to dry weather flows, the WPCPs are designed to capture two times dry weather flow and to treat wet weather flows generated by runoff from rain and melting snow. To expand wet weather capture, the 26th Ward WPCP is undergoing a $467.5 million upgrade to be able to capture an additional 50 million gallons a day (mgd) of wet weather flow.

TREATMENT PROCESS

OVERVIEW

Wastewater treatment plants remove most pollutants from wastewater before it is released to local waterways. At the plants, physical and biological processes closely duplicate how wetlands, rivers, streams, and lakes naturally purify water. Treatment at these plants is relatively quick, taking only about 7 hours to remove most of the pollutants from the wastewater. In the natural environment, this process can take many weeks, and nature alone cannot handle the volume of wastewater that New York City produces. Each of the City's 14 WPCPs is governed by a State Pollutant Discharge Elimination System (SPDES) permit permitted by the New York State Department of Environmental Conservation (NYSDEC).

With the exception of the Newtown Creek WPCP, wastewater currently undergoes five major processes at the City's WPCPs:

- Preliminary treatment;
- Primary treatment;
- Secondary treatment;
- Disinfection; and
- Sludge treatment.

Primary and secondary treatment remove about 85 to 95 percent of pollutants from the wastewater before the treated wastewater is disinfected and discharged into local waterways. In addition, the secondary treatment process has been modified at several of the WPCPs that discharge to waters that enter the Long Island Sound to incorporate features to remove total nitrogen. Sludge, the byproduct of the treatment process, is digested for stabilization and then dewatered for easier handling. The resulting material, known as biosolids, is then applied to the land as fertilizer to improve vegetation or processed further to be used as compost by adding wood chips or wood ash and heat cured for an extended period of time. Figure B-1 illustrates the treatment process.

Unlike the other 13 WPCPs, the Newtown Creek WPCP does not currently have primary settling tanks, nor are primary settling tanks being constructed at this plant; an enormous upgrade is ongoing at the plant to achieve secondary standards.

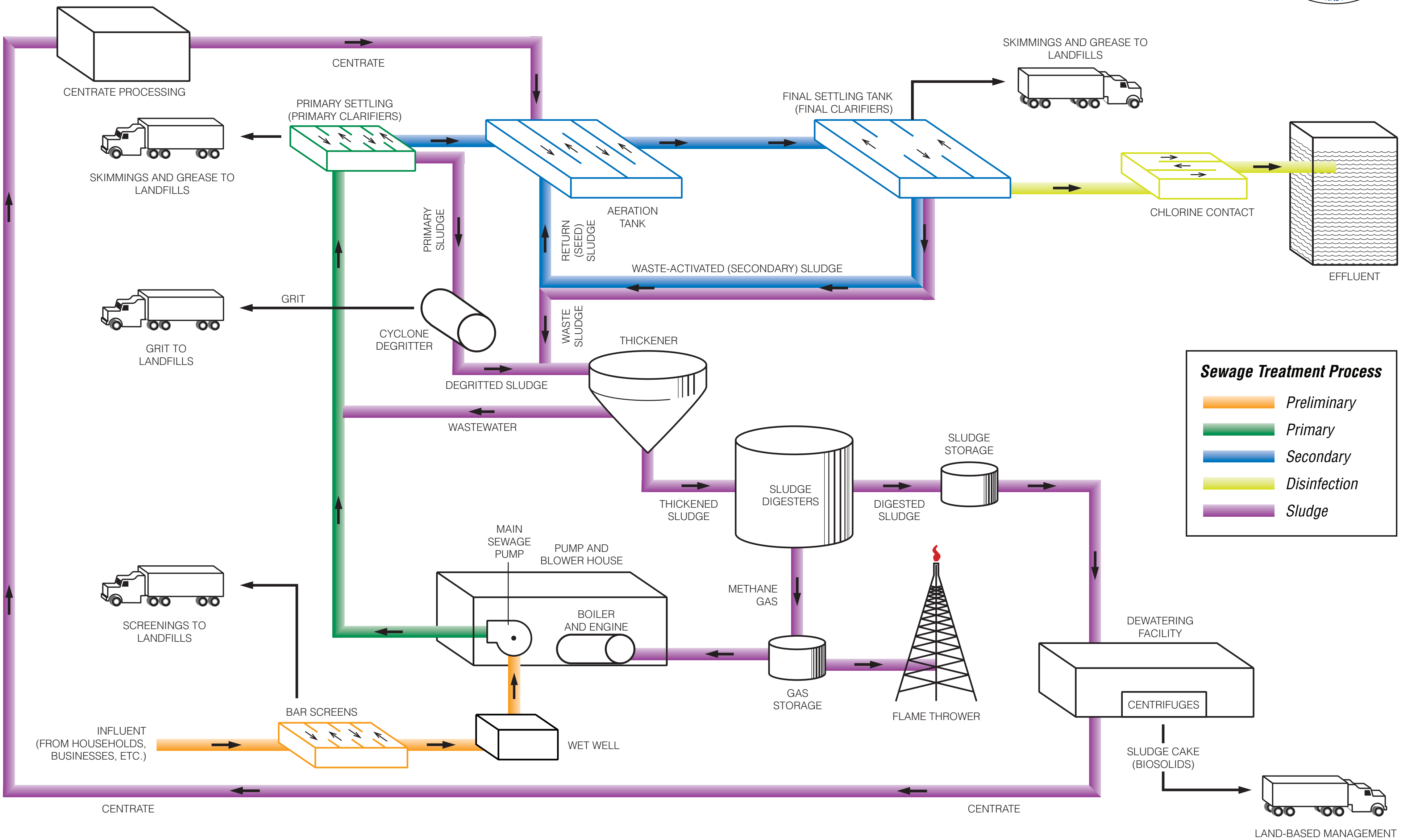

FIGURE B-1 Typical Sewage Treatment Plant Process

PRELIMINARY TREATMENT (PRIMARY AND SECONDARY SCREENING)

Raw wastewater from the plant's service area (influent) typically enters the WPCP several stories underground and passes through primary bar screens (upright bars spaced 1 to 3 inches apart) in a screening chamber. The primary screens remove larger waste objects that have entered the wastewater stream (e.g., rags, sticks, newspaper, bottles, and other debris), thus protecting the main sewage pumps. The wastewater flows by gravity into a wet well, where it is collected before being pumped by main sewage pumps to the secondary screens.

The secondary screens are located at the ground level of the plant, where smaller objects are removed. The solid items removed during the screening processes (referred to as "screenings") are collected and trucked off-site for disposal. Since the Newtown Creek WPCP does not have primary sedimentation tanks, the raw wastewater is pumped to secondary screens (3/8-inch opening) to remove smaller solid particles.

PRIMARY TREATMENT (PRIMARY SETTLING)

The wastewater is then pumped from the screening chamber to the plant's primary settling tanks (also known as sedimentation tanks or primary clarifiers) where it is held for an average detention time of 1 to 2 hours. During primary settling, the flow of the water is slowed, allowing heavier solids (including sludge and grit) to settle to the bottom of the tank while grease and oil float to the water's surface. At the end of the process, the floatable trash that contains fats, oil, and grease (also called "scum") that has risen to the tank surface is skimmed off and trucked to a landfill off-site.

The settled solids, called primary sludge, are pumped to a cyclone degritter, a device that uses centrifugal force to separate out sand, grit (such as coffee grinds), and gravel. The grit material is removed, washed, and trucked off-site for disposal while the degritted sludge is pumped to the plant's sludge handling facilities (i.e., thickeners and digesters for further processing). The partially treated wastewater from the primary settling tanks then flows to the secondary treatment system (aeration tanks).

Since the Newtown Creek WPCP does not have primary sedimentation tanks, separate detritor tanks remove the grit. The detritor tanks are much smaller then the primary tanks and are designed to capture just the grit particles. The grit removed from the detritor tanks is processed in cyclones similar to those used at the other WPCPs to remove organics and clean the grit.

SECONDARY TREATMENT (ACTIVATED SLUDGE PROCESS)

Secondary treatment is called the activated sludge process because air and "seed" sludge from the plant treatment process are added to the wastewater to further break down the remaining organic materials in the water. Air is pumped into large aeration tanks to mix the wastewater and sludge, thereby stimulating the growth of oxygen-using bacteria and other tiny organisms that are naturally present in the sewage. These beneficial microorganisms remove and consume most of the remaining dissolved organic materials that pollute the water, converting them to solids that settle and can be removed in the secondary sedimentation tanks later in the treatment process. Wastewater passes through these bubbling tanks in 3 to 6 hours. Blowers, air mains, and diffusers to bubble the air are essential equipment for this part of the process.

The aerated wastewater then flows to the final settling tanks, which perform a similar function to the primary settling tanks. Here, heavy particles and other solids settle to the bottom as secondary sludge (or "waste-activated sludge"). Some of this sludge is re-circulated back to the aeration tanks as seed to stimulate the activated sludge process. The returned sludge contains millions of microorganisms that help maintain the right mix of bacteria and air in the tank and contribute to the removal of as many pollutants as possible.

The remaining secondary sludge is removed from the settling tanks and added to the degritted primary sludge for further processing in the sludge handling facilities. Wastewater passes through the settling tanks in 2 to 3 hours and then flows to a disinfection tank.

DISINFECTION (CHLORINATION)

Even after primary and secondary treatment, disease-causing organisms may remain in the treated wastewater. To disinfect and kill harmful organisms, the wastewater spends a minimum of 15 to 20 minutes in chlorine-contact tanks mixing with sodium hypochlorite, the same chemical found in common household bleach. The treated wastewater, or effluent, is then released into local waterways. Disinfection is an essential step because it protects the health of people who use local beaches and enjoy other recreational activities on or near the water.

SLUDGE TREATMENT

Sludge that does not return to the aeration tank is processed through thickeners and digesters before being dewatered and converted to biosolids which are beneficially reused.

Thickening

The sludge produced by primary and secondary treatment is approximately 99 percent water and 1 percent solids, and must be concentrated to enable further processing. Thickening tanks allow the sludge to collect, settle, and separate from the water for up to 24 hours. The water is then sent back to the head of the plant or to the aeration tanks for additional treatment, while the thickened sludge is pumped from the bottom of the thickener to sludge digestion tanks.

Digestion

After thickening, the sludge is further treated to make it safer for the environment. The sludge is placed in oxygen-free tanks, called digesters, and heated to at least 95 degrees Fahrenheit for up to 15 to 20 days. This stimulates the growth of anaerobic bacteria, which consume organic material in the sludge. Unlike the bacteria in the aeration tanks, these bacteria thrive in an anaerobic (oxygen-free) environment. The digestion process stabilizes the thickened sludge by converting much of the material into water, carbon dioxide, and methane gas. The black sludge that remains after digestion has the consistency of pea soup and has little odor. This is called digested sludge. Digested sludge is then pumped or transported by barge from sludge storage tanks to a dewatering facility.

The digestion process produces methane gas, which is used as an energy source at the City's WPCPs.

Dewatering

New York City operates dewatering facilities at eight of its 14 treatment plants; digested sludge from plants without a dewatering facility is transported through a pipeline or by a sludge barge to a plant that has a dewatering facility. Dewatering reduces the liquid volume of sludge by about 90 percent.

The dewatering process begins with large centrifuges that operate like the spin cycle of a washing machine. The force from the centrifuges separates most of the water from the solids in the sludge, creating a substance known as sludge cake, or biosolids. Centrate, the water drawn from the spinning process is returned to the head of the plant for reprocessing. The biosolids are further processed to be beneficially reused.

Organic polymer can be added to extremely wet sludge to improve the consistency of the biosolids cake, resulting in a firmer, more manageable product, if necessary. The biosolids cake is approximately 25 to 27 percent solid material.

Biosolids Management

New York City's biosolids are managed by companies that have been awarded long-term contracts. Biosolids are typically trucked off-site for disposal. If the biosolids satisfy the criteria established in the United States Environmental Protection Agency (EPA) Processes to Significantly Reduce Pathogens (PSRP) regulations, the biosolids can be directly land applied.[1] Through the following processes, these companies can either directly apply biosolids to the land or convert them into such products as compost, liming agents, or pellets (pelletization and liming of dewatered sludge described below does not require dewatered sludge to meet PSRP, because it undergoes additional treatment to turn it into pellets or liming agents):

- *Drying*. Biosolids are heated to dry the material. Fertilizer pellets are formed during the process. These pellets can be used directly on the land or mixed with other materials to make special fertilizer blends. New York City's biosolids are made into pellets at a facility in the Bronx. The pellets are sold across the country. Many of them are used on citrus groves in Florida.
- *Composting*. Biosolids are mixed with a bulking agent, such as wood chips. The bulking agent allows more oxygen to penetrate the mixture, providing an ideal environment for decomposition of the biosolids. The resulting product, compost, is similar to peat moss and used as mulch or soil conditioner at golf courses, nurseries, home gardens, lawns, etc. New York City's biosolids are being composted at a facility in Pennsylvania.
- *Lime Stabilization*. Biosolids are mixed with a highly alkaline material, such as lime or Portland cement. This process results in a product that resembles soil and is used as an agricultural liming agent. New York City's biosolids are alkaline stabilized at a facility in New Jersey.
- *Lime Treatment.* Similar to lime stabilization, except heat is not applied to the sludge. This is not as robust a treatment as lime stabilization and therefore has limited application uses in comparison.

All of these processes destroy disease-causing organisms and reduce moisture content, resulting in products that are easy to handle with similar characteristics to typical agricultural products. Currently, NYCDEP processes all of the sludge produced at the WPCPs for beneficial reuse, and none is landfilled or incinerated. As of August 2008, 46 percent of the dewatered sludge is pelletized through drying, 19 percent undergoes lime stabilization, 14 percent is lime treated, and 10 percent is composted. The additional 11 percent is not dewatered, but transferred as a

[1] Land application consists of applying biosolids obtained after the dewatering process directly to land. To do so, such biosolids must meet PSRP regulations at the end of the dewatering process. None of the current New York City sludge is land applied but is instead further treated, as described in this section.

liquid sludge to the Passaic Valley Sewage Commission in New Jersey to treat with their sludge through an interstate agreement. Many options are utilized by NYCDEP due to the variability of volume of sludge produced and the availability of each type of facility to accept sludge volumes.

BIOLOGICAL NUTRIENT REDUCTION

In addition to the normal treatment process requirements, NYCDEP has already completed or is in the process of constructing systems to implement biological nutrient reduction (BNR) processes at five WPCPs: 26th Ward, Bowery Bay, Hunts Point, Tallman Island, and Wards Island WPCPs. The other WPCPs are not implementing BNR, but some plants may remove nitrogen because of the way they are operated (e.g., Red Hook WPCP). BNR is accomplished by modifying the secondary treatment process to grow special organisms that can convert ammonia to nitrogen gas and remove it from the wastewater. This requires larger aeration tanks and compartmentalization of the aeration tanks into zones that are aerated (aerobic) and zones that are not (anaerobic). In addition, special processes have been added to remove the ammonia from the liquids recycled from sludge processing. Implementation of BNR will enable NYCDEP to substantially reduce the amount of nitrogen discharged from WPCP effluents.

Nitrogen discharges from WPCPs into receiving waters could contribute to hypoxia, a condition in which water does not have enough oxygen to support fish and other aquatic life. Through various studies and agreements, limits on the nitrogen content of effluent have already been established or are under evaluation for certain WPCPs.

To remove nitrogen contained in the plant influent and any nitrogen remaining in the centrate, the secondary wastewater treatment process at those treatment plants providing BNR treatment has also been modified to remove nitrogen.

To achieve the nitrogen effluent limits, certain plants have been or are being upgraded with additional BNR capacities. Major elements of the BNR upgrades at the WPCPs include:

- **Aeration System Upgrades**. New blowers and improvements to the air headers and diffuser systems to ensure better nitrification through enhanced process air distribution.
- **Aeration Tank Upgrades**. Separate oxic and anoxic zones (created by baffle walls) to allow flexibility for the nitrification/denitrification processes.
- **Froth Control Systems**. These systems reduce the population of foam-producing bacteria.
- **Alkalinity Addition Systems**. Provides alkalinity required for nitrification and pH maintenance to enhance the BNR process.
- **Return Activated Sludge Upgrades**. Allows the aeration tanks to carry a higher solids inventory.
- **Separate Centrate Treatment**. Because the sludge dewatering process results in discharges of centrate, which contains elevated nitrogen levels that add to the overall nitrogen loadings to the WPCP, a separate tank (an aeration tank) treats the centrate.
- **Improved Flow Splitting and Control**. If plant hydraulics tend to favor one aeration tank over the others, excessive loading can occur in that tank. By throttling gates and verifying flows, the flows can be split so that all aeration tanks see similar flows and loadings.
- **Carbon Addition**. Provides additional carbon in the form of methanol to assist in denitrification.

As described above, plants with dewatering facilities generate centrate, which has elevated levels of both nitrogen and ammonia, as a byproduct to producing biosolids. To remove both nitrogen contained in the plant influent and ammonia-rich centrate from dewatering operations, the BNR plants have been modified from typical secondary treatment to follow the steps below:

- **Nitrification.** This process reduces ammonia concentrations by oxidizing ammonia to nitrite and then nitrate by growing two biomass populations: ammonia oxidizing biomass (AOBs), which oxidize ammonia to nitrite, and nitrite oxidizing biomass (NOBs), which oxidize nitrite to nitrate. Ammonia-rich centrate from dewatering is treated first in a separate centrate treatment (SCT) tank before reaching the aeration tanks.
- **Denitrification.** After nitrification, nitrate is reduced to nitrogen gas by other bacteria commonly found in wastewater under anoxic conditions in the denitrification process.

The nitrification process is highly dependent on the SRT, a measure of the amount of time that solids reside in the aeration process. BNR operations require a higher SRT than traditional secondary treatment plants to achieve nitrification as the nitrifying biomass (AOB and NOB) populations are a slower growing biomass than the microorganisms used to remove BOD.

OTHER WPCP OPERATIONS

In support of the treatment and BNR operations, the plants require energy and heat for the plant processes. In addition, odor control is also implemented at the WPCPs.

ENERGY USE IN THE WASTEWATER TREATMENT PROCESS

The City's WPCPs use energy to heat and light their buildings; operate pumps, blowers, and motors; and provide heat for the sludge digestion process. The wastewater treatment process is energy intensive, with the aeration systems having the highest electricity requirements of all plant processes. Wastewater pumping and dewatering operations are also energy intensive.

The WPCPs use digester gas to meet a large percentage of their total heating needs, with natural gas, fuel oil, and electricity purchased from electrical utilities to provide the rest. The digestion process produces methane gas, which is used as an energy source at the City's WPCPs. The degree to which the plants' boilers and waste gas burners are used depends on the plants' heat load, which varies throughout the year. During cold months, digester gas is typically used to meet the heating demands of the plant. During these months, the digester gas is collected and used to fuel the plant boilers. The plant boilers in turn provide hot water for the sludge digester operations and the building heating systems. Natural gas is used to supplement the digester gas when additional demand exists. During the warmer months, the excess digester gas is sent to the gas burners. Currently, 42 percent of total the digester gas produced is used, while the remaining 58 percent is flared. NYCDEP is evaluating ways to more efficiently use this gas. Capital improvements are currently being designed for the Rockaway and Port Richmond WPCPs to improve efficiency of biogas reuse.

NYCDEP also uses fuel cells at four of its plants (26th Ward, Red Hook, Oakwood Beach, and Hunts Point); these fuel cells convert the methane gas created during the digestion process and carbon dioxide into heat and electricity that is then used to operate the plants.

ODOR CONTROL

The WPCPs have odor control systems that vary by plant, but all are designed to cover, collect, and treat process air. At some plants, processed air is treated with a mixture of sodium hypochlorite and sodium hydroxide, and then funneled through active carbon filters, which absorb odors and chemicals and remove the remaining odor-producing particles. For some plant processes, only carbon filters are applied. In the final process, air is released through emissions stacks. ✷

Appendix C: Potential Impacts of Commercial Food Waste Disposers At Various Penetration Rates and Analysis Years

C.1. INTRODUCTION

Analyses presented in the overall study focused on 50 percent penetration of food waste disposers (FWDs). The study found that 50 percent is a likely penetration based on cost estimates and convenience available to food service establishments (FSEs). This Appendix presents the beneficial and adverse impacts from 25, 50, 75 and 100 percent penetration of the likely universe, including the change in truck trips and impacts to the water supply, water conservation efforts, the combined sewer overflow (CSO) program, and the water pollution control plants (WPCPs).

C.2. SOLID WASTE AND TRUCK TRIP REDUCTIONS

Chapter 5 presented truck trip reductions at a 50 percent penetration rate. Since 50 percent penetration would divert 519 tons per day (tpd), nine daily truck trips would be reduced citywide. The number of trucks reduced from the commercial waste sector would be offset by the need for additional trucks to transport sludge from the WPCPs. There would be some additional trucks reduced from curbside collection; however, trucks serving FSEs are not expected to be appreciably reduced due to the nature of the existing collection system. The reduction in waste from FWDs may represent only a small fraction of a given hauler's waste pickup, and therefore may not be able to reduce truck trips. **Table C-1** presents the solid waste diversion and truck trip reductions for 25, 50, 75 and 100 percent penetration.

Table C-1
Total Truck Trip Reductions

Penetration Rate	Solid Waste Diverted (tpd)	Truck Reductions Leaving Transfer Stations for Export[1]	Additional Sludge (wet tpd)	Sludge Truck Trip Increases[2]	Total Truck Trip Reductions
25%	259	-12	148	+8	-4
50%	519	-24	296	+15	-9
75%	778	-35	444	+22	-13
100%	1,038	-47	592	+30	-17

Notes:
[1] Based on a typical truck leaving a solid waste transfer station, which carries about 22 tons of solid waste out of the city.
[2] Based on 20 tons per truck.

C.3. IMPACT ON WATER SUPPLY AND WATER CONSERVATION EFFORTS

Chapter 6 presented the impact from the additional water flow in million gallons per day (mgd) on New York City's water supply and conservation efforts with an estimated replacement cost of $15 to 20 per gallon. **Table C-2** presents the replacement cost of finding additional water supply sources and funding water conservation efforts at 25, 50, 75 and 100 percent penetration.

Table C-2
Additional Water Use

Penetration Rate	Additional Water Use (mgd)	Estimated Replacement Cost @ $15 - $20 per gallon
25%	5.5	$82.5 – 110 M
50%	11.0	$165 – 220 M
75%	16.5	$248 – 330 M
100%	22.0	$330 – 440 M
Note: M = million		

C.4. IMPACT ON THE SEWER NETWORK AND COMBINED SEWER OVERFLOWS

Chapter 7 presented the impact from the additional water flow on New York City's sewer network and combined sewer overflows. It is anticipated that the additional fats, oils, and grease (FOG) entering the system from any level of FWD implementation would increase the maintenance associated with grease-related sewer constraints, blockages, and backups. These costs have not been developed. **Table C-3** presents the offsets that would be required to balance the additional flow in combined sewers from best management practices (BMPs) or hard infrastructure, such as CSO tanks or tunnels, at 25, 50, 75 and 100 percent penetration.

Table C-3
Additional Wastewater Flow in Combined Sewer Areas

Penetration Rate	Additional Flow in Combined Sewer Areas (mgd)	Estimated Replacement Cost to Offset with BMPs @ $20 per gallon	Estimated Replacement Cost to Offset with Hard Infrastructure @ $6 - $44 per gallon
25%	4.9	$98 M	$29 – 215 M
50%	9.7	$194 M	$58 – 427 M
75%	14.8	$296 M	$89 – 651M
100%	19.7	$394 M	$118 – 867 M
Note: M = million			

C.5. IMPACT ON THE WATER POLLUTION CONTROL PLANTS

Chapter 8 presented the impact on New York City's WPCPs in 2030 at a 50 percent penetration rate. **Table C-4** provides a summary of the total additional investments (capital costs) and annual operating and maintenance (O&M) costs with the implementation of FWDs in 2008 dollars. The information in this appendix presents data from 2030 due to the considerable lead time required to design and construct necessary equipment upgrades.

Table C-4
Summary of WPCP Costs with Implementation of Commerical FWDs
Analysis Year 2030

Investment	25 Percent		50 Percent		75 Percent		100 Percent	
	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M
Newtown Creek (without and with primary tanks)	$0 to $1.7 B	$1.1 M	$2.6 M to $1.7 B	$1.1 M to $2.2 M	$5.3 M to $1.7 B	$2.2 M to $3.4 M	$5.3 M to $1.7 B	$2.3 M to $3.4 M
Wards Island Denitrification Filters	$650 M	$3.8 M	$650 M	$3.8 M	$650 M	$3.8 M	$650 M	$3.8 M
26th Ward Denitrification Filters	$240 M	$2.1 M	$240 M	$2.1 M	$240 M	$2.1 M	$240 M	$2.1 M
Solids Handling Upgrades and Disposal	$95 M	$11.7 M	$128 M	$23.3 M	$209 M	$35.0 M	$344 M	$46.7 M
Secondary Treatment Upgrades	$3.4 M	$1.4 M	$5.2 M	$3.2 M	$8.5 M	$5.6 M	$8.6 M	$5.6 M
Total	**$98.8 M to 1.8 B**	**$14.2 M**	**$1.0 B to $2.7 B**	**$33.5 M to $34.6 M**	**$1.1 B to $2.8 B**	**$48.7 M to $49.9 M**	**$1.2 B to $2.9 B**	**$60.5 M to $61.6 M**

Note: All costs are in 2008 dollars. M=million; B=billion.

ADDITIONAL EQUIPMENT NEEDS

As presented above in Table C-4, denitrification filters would be required at 26th Ward and Wards Island WPCPs at penetration rates above 25 percent and are included in the costs for 25 percent penetraton as NYCDEP would need to ensure that nitrogen effluent remains within limits set by the New York State Department of Environmental Conservation. As the future limit for nitrogen effluent in Jamaica Bay is still unknown, denitrification filters were assumed to be required for 26th Ward WPCP at approximately the same penetration rate as the East River plants.

Also presented in Table C-4 and discussed in detail in Chapter 8, the addition of food waste in the Newtown Creek WPCP drainage area could threaten the plant’s ability to meet secondary treatment requirements, thus requiring the construction of primary tanks. Capital costs for Newtown Creek WPCP are presented in Table C-4 with and without primary tanks; the additional equipment required at Newtown Creek WPCP without primary tanks is presented in **Tables C-5a and 5b.**

Tables C-5a and 5b present the additional equipment needed to meet the secondary treatment and sludge handling demands of treating commercial food waste at each of the City’s WPCPs in 2030 at 25, 50, 75, and 100 percent. In addition to the equipment presented in these tables, one primary sludge pump would be required at Red Hook WPCP at penetration rates above 25 percent in 2030. At 100 percent penetration, Red Hook would require two pumps.

Figure C-1 presents an illustrative comparison of the relative costs at the different penetration rates in 2030 with capital cost ranges indicated by differently colored blocks and O&M costs represented by proportionately sized circles.

The matrix below presents a visual comparison of the capital costs and operation and maintenance costs that would be required to meet the secondary wastewater treatment demands of food waste from commercial food waste disposers at the various penetration rates in 2030.

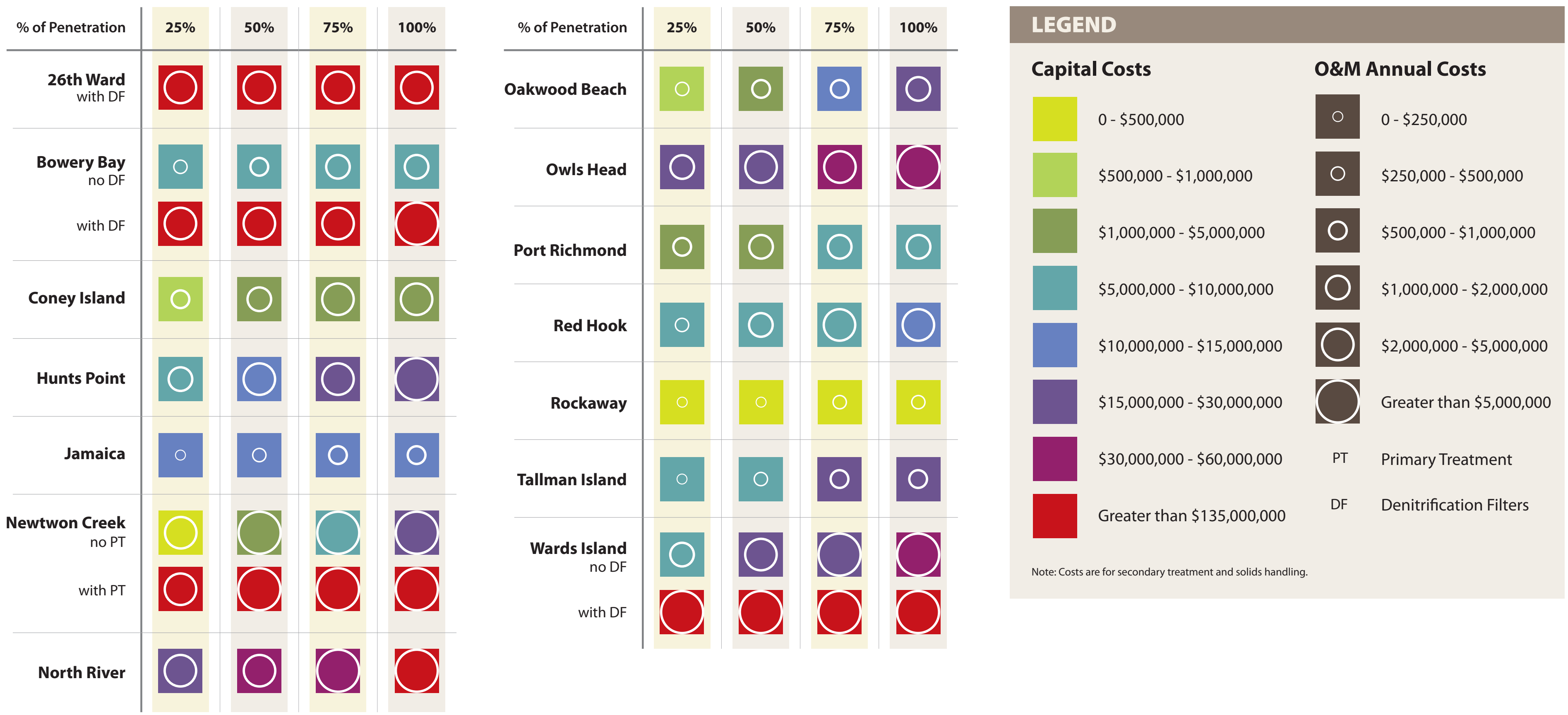

FIGURE C-1 Comparison of Total Capital and O&M Costs at the City's WPCPs

Table C-5a
Number of Additional Equipment Required Due to FWDs

Penetration Level		25 Percent					50 Percent				
WPCP	**Year**	**Aeration Blowers**	**Thickeners**	**Storage**	**Centrifuges**	**Heat Exchangers**	**Aeration Blowers**	**Thickeners**	**Storage**	**Centrifuges**	**Heat Exchangers**
26th Ward	2030		1			1		1			1
Bowery Bay	2030				1	1				1	1
Coney Island	2030					1					1
Hunts Point	2030				1	1				2	1
Jamaica	2030		1			1		1			1
Newtown Creek	2030-no PT						1				
	2030-with PT										
North River	2030			1		1	1		1		1
Oakwood Beach	2030					1			1		1
Owls Head	2030	1		1		1	1		1		1
Port Richmond	2030	1		1		1	1		1		1
Red Hook	2030				1		1			1	
Rockaway	2030					1					1
Tallman Island	2030				1	1				1	1
Wards Island	2030					1					1
NYC Total	**2030-no PT**	**2**	**2**	**4**	**4**	**12**	**5**	**2**	**5**	**5**	**12**
	2030-with PT	**2**	**2**	**4**	**4**	**12**	**4**	**2**	**5**	**5**	**12**

Notes:
PT = primary tanks
[1] At 100 percent penetration, North River would change from gravity thickeners to gravity belt thickeners. With no land availability, the existing thickeners would need to be demolished and 12 new thickeners would need to be constructed.

Table C-5b
Number of Additional Equipment Required Due to FWDs

Penetration Level		75 Percent					100 Percent				
WPCP	**Year**	**Aeration Blowers**	**Thickeners**	**Storage**	**Centrifuges**	**Heat Exchangers**	**Aeration Blowers**	**Thickeners**	**Storage**	**Centrifuges**	**Heat Exchangers**
26th Ward	2030		1			1		1			1
Bowery Bay	2030				1	1				1	1
Coney Island	2030					1					1
Hunts Point	2030				3	1				3	1
Jamaica	2030		1			1		1			1
Newtown Creek	2030-no PT	2		1			2		1		
	2030-with PT			1					1		
North River	2030	2		1		1	2	12[1]	1		1
Oakwood Beach	2030		1	1		1		1	1		1
Owls Head	2030	2	1	1		1	2	1	1		1
Port Richmond	2030	1		1		1	1		1		1
Red Hook	2030	2		1	1		2		1	1	
Rockaway	2030					1					1
Tallman Island	2030		1		1	1		1		1	1
Wards Island	2030				1	1		1	1	1	1
NYC Total	**2030-no PT**	**9**	**5**	**7**	**6**	**12**	**9**	**18**	**7**	**7**	**12**
	2030-with PT	**7**	**5**	**7**	**6**	**12**	**7**	**18**	**7**	**7**	**12**

Notes:
PT = primary tanks
[1] At 100 percent penetration, North River would change from gravity thickeners to gravity belt thickeners. With no land availability, the existing thickeners would need to be demolished and 12 new thickeners would need to be constructed.