Reducing the Environmental Impacts of First-Mile Urban Freight

The Feasibility and Projected Costs and Benefits of Pneumatic Waste Collection in Three Specific New York City Cases

Benjamin Miller
Juliette Spertus
Camille Kamga

University Transportation Research Center, Region 2
Waste is freight.
Zero Waste?
First-Mile Effects

• Truck-mile impacts:
  • Congestion, emissions, fuel use, noise, accidents, pavement wear

• Issues associated with staging/collection:
  • Use of time and space, visual and olfactory nuisances, litter, rats

• Effects on larger solid-waste system:
  • Potential for waste reduction, effectiveness of recycling, efficiency of separate food-waste collection for composting or anaerobic digestion, transfer station operations, long-haul transport and landfill-disposal volume.

• All of which have direct consequences for BTU use, GHG emissions, and other environmental and economic factors.
Garbage trucks can be pretty efficient.
Influences on Efficiency

• Infrequent service: sizeable accumulations: few miles per load

• Manual handling—storage; set-out; loading—means filling a truck takes relatively little energy

Overall efficiency depends on such factors as:
• Truck type; route density; distance between garage and start of the collection route, collection route and “first-dump”, dump site and garage;
• Material types
But they impose economic and environmental costs.
Other Public Health Impacts

• Worker safety
  • More injuries/fatalities than firefighting, policing; fatality rate 10x overall rate

• Traffic accidents (pedestrian fatalities 8x more likely than with other heavy trucks)

• Noise associated with truck movements, idling, and compaction reduce sleep and produce stress:
  • New Yorkers file more noise complaints related to garbage trucks than any other source.
Pneumatic tubes offer an alternative to trucks.
A Low-Fat Diet That Can Reverse Heart Disease
The James Dean Myth Enters Middle Age
The Lessons of 'Blind Ambition,' by J. K. Galbraith

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No Traffic Or Noise
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You'll hardly see it. You won't hear it. But you'll be very glad it's there. Manhattan's Other Island handles the big-city problem of refuse collection the way only the city of the future can: with Automated Vacuum Collection—the AVAC system.

AVAC starts in every apartment building on Roosevelt Island with the familiar chute for refuse collection. But that's the end of all similarities to the old-fashioned collection system you've been putting up with all your life.

Once the refuse fills the AVAC storage hopper at the bottom of the chute, it starts to travel. First, thru a valve into a transport tube. Then, with the help of a pair of 300 horsepowetr boosters, it's sent at 30 m.p.h. to a cyclone separator. Here, waste goes into a compactor and is sent on its way, in 50-cubic-yard containers, to a handling mechanism. And even the air is filtered before being exhausted. And finally, the Department of Sanitation will pick it up in a sealed container at our Motorgate complex and carry it off your Island.

With AVAC, bulk items will be picked up, shredded or ground, and then fed into the collection system. So you'll be free from piles of refuse stored in your apartment building. And free from the clutter of 60 to 80 sanitation trucks grinding past your apartment every week.

AVAC is all-electric. Automatic. Reliable, with a control board to register any problems. It's virtually fireproof, because the transport tubes have a 60 mile-an-hour air flow, and every hopper has its own sprinkler. In case of excessive heat, the entire system stops automatically.

And in the event of interruption of collection service, Motorgate has enough storage capacity for an entire week.

AVAC came to our Island from Sweden. It's been proven at Disney World, and it will save you from one more unpleasant city problem.
Gravity fed garbage chutes inside buildings
This is what a typical modern system looks like.
Most systems are installed in new greenfield developments.

Hammarby Sjöstad, Sweden
But many systems have been retrofits in existing city centers.
Least-cost retrofits?
Three Case Studies
Roosevelt Island
Second Avenue Subway
Findings: Environmental Impacts

For Manhattan projects: Savings in Truck Miles Travelled (TMT), BTUs (60% reduction) and GHGs (50% reduction)

For Roosevelt Island: Lesser reductions in TMT, somewhat higher BTUs (25-70% more) and GHGs (up to 2x) (Due to length of tube, tonnage collected, characteristics of truck route, and of dray route)

In all 3 cases: A major difference: carbon-based transport fuel vs. electricity.

Significant differences in service frequency and quality, and externality benefits (e.g., space, public health, congestion delay, roadway maintenance, aesthetics, reliability, resilience re climate change)
Findings: Economic Impacts

Direct **Operating Expense savings** in every Pneumatic case.

Significant **Capital Expenses** (as in the case of sewers), ($11m for Manhattan cases, vs. $1m-$2m for trucks) producing **NPV** costs about 2-9x higher than Manual

NPV could be equalized with **private-sector savings** and by accounting for **externalities**

Externality benefits of $250k-$1.1m/yr would equalize NPV costs of Manual collection

Externality benefits may exceed this threshold
Systemic Impacts of Front-End Waste Management Alternatives

Pipeline

Manual/Truck-based
Everything is exported out of the city

Via **transfer stations**

Logistically clumsy, very expensive

Pipes would not need them
Despite railroading all residential waste from Staten Island and the Bronx, NYC still puts **917 tractor-trailer trucks/day** onto the city’s streets—the slowest roads in the country.
Each one then travels an average of 630 miles to other states.

Long-haul trucks (yellow) and railcars (red) send NYC waste as far as South Carolina.
They drive a cumulative 531,762 miles/day

The equivalent of 192 trips to LA
Pipes v. Trucks

Potential reduction in waste volumes requiring long distance transport and disposal
Potential High Line Scenario

Address impacts of MSW collection from High Line Park (1.2 TPD)

Chelsea Market (9.6 TPD)
Primary trunk tube, steel, 20” interior dia., strapped to side or between HL structure.
As expected, direct operating expenses (red) are less but when debt service (pink) is included costs are higher.
Potential Second Avenue Subway Scenario

Address street-level access for MSW collection/congestion/quality of life issues during construction of 96th St. Station 2007-2016
Total by Source:
Residential  5.5 TPD
Litter Bins:   0.6 TPD
Businesses: 2.9 TPD
NYCHA
Washington Houses
1500 units, 4.3 TPD

Metropolitan Hospital
350 beds, 5.2 TPD
Address impacts of exterior compactor yards and improve recycling rate
Also opportunity to address MSW collection inside the 96th St. station (0.2 TPD)
Temporary terminal (for both networks) at 96th St. staging area. Permanent terminal built under playground.
As expected, direct operating expenses (red) are less but when debt service (pink) is included, costs are 25% higher.
Explaining Variation in Relative Pneumatic Costs/Benefits
Elon Musk’s Magic Bullet

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