LEAF WASTE COLLECTION TECHNOLOGY STUDY

I. Purpose

This study is an evaluation of the equipment and staffing for the collection of leaves. It is not an evaluation of the disposal of leaf waste, for the Town now composts that waste successfully at its own, permitted facility. Nor is it a consideration of the merits of volume reduction (e.g., by encouraging home composting), of collecting such waste at all, or of collecting the waste using private forces. To restate the purpose: the Town is in the business of collecting leaves. What technology is best used to do so?

II. The Existing Collection Program

A. What is Collected:

The Town collects both leaves and brush, using the same crews.

B. Quantities:

Some 22,500 cubic yards of leaves were collected in the 2010 season, and 22,900 C.Y. in the 2009 season. These quantities vary somewhat, year by year, but have been slowly growing by 1% or so annually.

C. Schedule:

Leaf collection begins in the third week of October, and continues until a permanent snow cover is established. This is usually in the second week of December, but in some years leaf piles remain to be collected in the following spring. The Town tries to follow a once-per-week collection schedule for all yard waste collection, but in the peak of the leaf season that schedule may fall to 2 or 3 week-long cycles.

D. Equipment:

The majority of the leaves collected are collected loose in bulk. A tractor with a push blade precedes the crew, to push piles up. A 2.5 CY payloader then loads the piles into open, six- and 10-wheeled dump trucks. The crew will usually have 3 trucks devoted to leaves, with a fourth used to receive brush piles. During peak operations, there may be 5 trucks hauling leaves and one hauling brush on each crew. A street sweeper trails the crew (and sometimes 2 crews) to clean up what leaves may remain on pavement. Thus, we have a total of 7 pieces of equipment on the typical crew.

E. Staff:

The above equipment is each staffed by a driver. The driver of the payloader doubles as the crew leader. The drivers are assisted by 2 to 3 laborers, who use backpack

blowers and rakes to clean up around the operation. The total crew size is, thus, 9 to 10.

F. Traffic and safety:

The payloader and crew will require at least one lane for operations, with a second lane blocked periodically for maneuvering. This requires the use of signs and flagging on main roads, and the blocking of residential streets altogether. In addition to the hazards of working in traffic, the crew is exposed to a somewhat higher risk if they are on the ground around the payloader.

G. Preparation Required By Citizens:

This operation requires very little of residents. They must keep piles away from wires, hydrants and driveway stakes. They must pile brush separately from their leaves and off of pavements. They should not park cars so as to block the piles. They must not use plastic bags.

H. Other impacts:

The tractor with the push blade and the payloader can both damage treelawns during collection. Further, pavements are marked (or even torn) by the 'clamming' of the piles by the payloader.

I. Where and How Disposed:

The leaves are transported to the Town's permitted facility at #444 Browncroft Blvd.. There they are composted, and then made available to contractors and residents.

J. Total Costs:

In 2010, leaf collection (including by refuse packer truck) cost $251,000 in labor and $290,000 for equipment, for a total of $541,000. In 2009, leaf collection (including by refuse packer truck) cost $314,000 in labor and $325,000 for equipment, for a total of $639,000.

K. Total Labor:

In 2010, some 7,000 man-hours were devoted to leaf collection, or approximately 3.4 full-time-equivalents. In 2009, some 8,200 MH were so used, or 3.9 FTEs.

L. Fuel Consumed and Carbon Dioxide Emissions:

Estimating from records of equipment hours, leaf collection consumes 4,800 (2010) to 5,400 (2009) gallons of diesel fuel annually. Using USEPA information, this would represent 53 to 60 tons of carbon dioxide emissions annually.

III. Problems with the Existing Method:

A. Costs:

The costs of leaf collection represent about 2.5% of the Town's 2012 budget. At a time of severe budget constraints, larger programs such as this must be the first to be reexamined for efficiency improvements.

B. Schedule compliance:

Despite these large commitments of labor and equipment, the weekly collection schedule cannot be maintained using the payloaders for collection during the peak of the leaf season.

C. Fuel consumed and emissions:

The fuel required to move the current leaf collection operation represents 3 to 4 percent of the annual fuel requirements for the Department. Fuel is subject to wide price swings.

The corresponding carbon dioxide emissions represent approximately eight-tenths of one percent of the carbon footprint of Town operations. This seems small, but sustainability can be approached only by such small steps.

IV. Alternative Collection Technologies

A. Earlier studies

This is not the first look at alternative technologies for the collection of all forms of yard debris, but is the first to use a time study in an attempt to quantify any differences in productivity.

In 1994, trials were made of the use of a Prentice loader for brush collection. It did not perform well.

In 1996, a focus group of residents was assembled to review the entire range of yard waste collection services. The group considered reduced collections during the summer and requiring that all refuse be bagged. They were unable to reach any agreement on any changes.

In 1998, the Commissioner proposed a trial program for automated collection of yard waste in a target neighborhood. The Town would have provided toters, would have required that all yard waste be placed in them, and would have collected the toters with an automated packer. The Public Works Committee did not support the trial, because of concerns with the added burdens on residents.

In 1999, a trial was made of a leaf shredder/vacuum machine. A demonstrator was provided by the Old Dominion Brush Co. for 3 days of work on leaf collection in the Town. The machine broke down repeatedly, and was withdrawn by the manufacturer for re-design.

In 2002, a trial of a side-loading packer (loaned by the City) was held over a two day period in the summer. The side loader would allow the driver to perform all the loading, and eliminate two laborers from the comparable rear-loading packer. The production gains were too modest to warrant the additional capital expense.

B. Other Towns

The chart attached as appendix ***X*** was prepared by Tim Anderson, Deputy Highway Superintendent, in January, 2011 and at the request of the Town Board. Of the 19 towns in Monroe County, six collect leaves using payloaders and open trucks. Seven use vacuum equipment, alone or with loaders and open trucks. Two use packers, as well. Some seven do not collect leaves at all. Based upon this, and upon my search of the literature, the current, viable alternatives to Brighton's reliance upon the 'loader and open truck' method are (1) to expand the use of packer trucks, and (2) to use vacuum equipment.

C. Current, viable alternatives

1. Expand use of refuse packer trucks

    a. Changes to what is collected:

    Leaves would be collected in compostable (usually paper) yard waste bags or cans. No bulk collection of loose leaves would be made. Brush collection would be suspended during leaf season (as in Pittsford), or collected using a separate crew with a loader and open trucks.

b. Staff per crew

The packer trucks would be staffed with a driver and two laborers, both of whom would gather cans and bags and load them into the hopper of the packer. Staffing could be reduced by using sideloaders with automated collection and toters, but this would not be feasible with the heavy loads during a short season. This could be re-visited as technology evolves.

For the number of crews required to completely replace the current operation, see section IV.C.

c. Equipment per crew

The same sort of unit could be employed as is now used on a limited basis by the Town for yard waste year-round: a truck with a rear-loading packer body of a 25 CY capacity.

d. Preparation Required By Residents

Citizens would be required to purchase leaf bags or containers for their leaves, and to provide the extra labor to fill those bags or cans. Those that use landscape services for their yards would see additional charges from their provider. Cleanup of spilled leaves or of small piles would have to be done by the residents, as Town staff would not have the time or equipment to do so.

They would see their brush collected on a separate schedule during leaf season, if at all.

One could reasonably expect that some residents would decline to use bags or containers, to avoid the work or from the belief that the leaves are from Town trees and should be packaged by the Town. Sharp enforcement of leaf regulations would be required if the Town is to avoid the hazards of piles of loose leaves remaining long uncollected on pavements.

e. How Disposed

The leaves collected by the use of packer trucks could still be composted at the Town's site. Due vigilance would be needed from the laborers to assure that garbage or hazardous wastes are not in the cans collected.

2. Leaf vacuum machines (tow-behind)

a. Changes to what is Collected

Bulk collection of loose leaves would continue. Brush collection would be suspended during leaf season (as in Pittsford), or collected using a separate crew with a loader and open trucks.

Pittsford reports that their units, unlike those in the past, can generally handle wet leaves in low temperatures without freezing up. A day's observation in wet conditions saw only 3 blockages, which were all quickly cleared by the operators. The only problem is seen in the collection of matted, wet leaves on pavement.

b. Staff per crew

The truck with enclosed body and a tow-behind vacuum unit would be staffed with a driver and two laborers. One laborer would operate the vacuum wand of the tow-behind 'sucker'. The other laborer would use a rake to shape the piles for easier vacuuming. A second truck would be filled while the first goes to the disposal site. On major roads, another truck (with arrowboard) may be required to screen the moving operation from following traffic. This function could also be served by the sweeper, as in the current operation.

For the number of crews required to completely replace the current operation, see section IV.C.

c. Equipment per crew

The most promising tow-behind unit is that used by the Town of Pittsford: model LCT650 of the Old Dominion Brush Company, described in appendix A, attached, and on the web at (http://www.odbco.com/specs/LCT650%20Literature.pdf. This has a capacity of ___ CFM and a ___" hose diameter on the intake.

These units are towed by a single-axle dump truck with an enclosed body. Such bodies are usually fabricated by the highway department. A second truck would be a part of the crew. After the first truck is filled and on its way to the composting site, the second would hook up and be filled. This would keep the vacuum machine working constantly.

Please note that dump trucks equipped with a leaf body could not quickly be transferred to hauling or salting.

d. Preparation Required By Residents

Residents would continue to rake their leaves to the curb in piles, without any further preparation. They would see their brush collected on a separate schedule during leaf season, if at all.

e. How Disposed

The leaves collected by the use of vacuum units could still be composted at the Town's site.

f. Truck-mounted vacuum equipment

The City of Rochester uses a truck-mounted vacuum unit with integral body. The Town of Pittsford has experimented with same. Both report that the units are slow. Both object to the capital investment required, by having that cab and chassis tied up under the vacuum unit year-round.

Pittsford observed problems with the units in traffic, as they had to hug or cross the centerline in order to keep the curbside vacuum hose near the leaf piles.

For these reasons, truck-mounted vacuum units were not the subject of a detailed time study.

V. Evaluation of existing against viable alternatives

A. Production rate per man-hour (from time studies)

The current method (loader and open trucks) and the alternative of a truck with tow-behind vacuum unit are equally efficient alternatives of the viable alternative leaf collection methods, as can be seen below:

1. Loader and open trucks: 1.06 man-hours per ton (range .64 to 2.5)

2. Packer 4.8 man-hours per ton (range 1.9 to 20.0)
3. Truck with Tow-behind Vacuum Unit
   1.08 man-hours per ton (range.65 to 1.6)

These are shown as ranges. These ranges are, in part, due to variations in the observed loading and travel times (a function of the size and separation of the stops or piles), as shown in the time studies.

These ranges are also due to variations in the reported weights of leaves collected by various methods. For example, the relative performance of the packer is limited by the amount of compaction that can be applied to leaves.

The detailed results and calculations for all three alternatives are shown in the attached Appendices ___, ___ and ___.

B. Cost per ton of leaves collected

The alternative of the use of a truck with tow-behind vacuum unit appears the most efficient, as can be seen below. However, the range of calculated costs overlaps with those of the current method.

1. Loader and open trucks: $90 per ton (range $55 to $211)
2. Packer: $267 per ton (range $107 to $1,110)
3. Truck with tow-behind vacuum unit: $74 per ton (range $44 to $109)

While the production rate is roughly equivalent between the two methods, the use of a loader with open trucks requires somewhat more expensive inputs (larger equipment and higher-titled labor).

C. Capital investment required

1. Loader and Open Trucks:

   The only equipment additionally required by this collection method is the fourth of four payloaders operated by the Department, at a current cost of $110,000 to $130,000 per unit. The other three would still be needed for landfill operations, brush collection and construction.

   The open trucks would still be needed for snow plowing, brush collection and materials hauling. The tractors, used for pushing up piles, would still be needed for sidewalk snow plowing and roadside mowing.

2. Packer

   The packers would handle an average of 5 tons per truck per day. To handle some 22,500 to 23,000 c.y. (2,300 to 2,900 tons) of leaves over an eight week period, some 10 additional packer trucks would be required (above the one now operated). The additional costs would be approximately $135,000 to $140,000 each, or $1.3 to $1.4 million .

3. Truck with tow-behind vacuum unit

   The vacuum unit would handle an average of 29.5 tons per unit per day. To handle some 22,500 to 23,000 c.y. (2,300 to 2,900 tons) of leaves over an eight week period, some 2 to 3 units (with truck bodies as well) would be required . During the season's peak in mid-November, as many as 4 units would be required. The additional costs per crew would be approximately $21,000 for each vacuum unit and $1,200 for each of two leaf boxes. The total, additional capital costs of this alternative thus would be $47,000 to $94,000 .

D. Fuel consumption and CO2 emissions per ton

The current method (loader and open trucks) and the alternative of a truck with tow-behind vacuum unit are equally sustainable alternative leaf collection methods, as can be seen below:

1. Loader with open trucks:
   a) average .63 gallons per ton (range .4 to 1.5 gpt)
   b) average 14 lbs. of CO2 per ton (range 8 to 33 lbs.)

2. Packer
   a) average 1.1 gallons per ton (range .4 to 4.5 gpt)
   b) average 24 lbs. of CO2 per ton (range 10 to 101 lbs.)

3. Truck with tow-behind vacuum unit
   a) average .67 gallons per ton (range .4 to 1.0 gpt)
   b) average 15 lbs. of CO2 per ton (range 9 to 22 lbs.)

E. Service changes required and other impacts:

1. Brush

   An exclusive reliance on packers for leaf collection could require the suspension of brush collection for residents, or at least the cutting and bundling of brush by residents. The use of vacuum units need not result in any change to brush collection during the leaf season.

2. Purchase of leaf bags or containers

   An exclusive reliance on packers would require residents to perform the extra work of placing the leaves in bags or containers, and would require them to purchase additional bags or containers. Some 164,000 bags would be required to handle the typical annual volume of leaves, at a cost to residents of some $72,000.

3. Treelawn and pavement damage

   Use of vacuum units and of packers would sharply reduce the damage to treelawns and pavements, now caused by the use of payloaders. This would reduce the labor, materials and equipment required to make the repairs by the Highway Department.

F. Traffic and safety:

1. Payloader and open trucks:

   The payloader and crew require at least one lane for operations, with a second lane blocked periodically for maneuvering. This requires the use of signs and flagging on main roads, and the blocking of residential streets altogether. In addition to the hazards of working in traffic, the crew is exposed to a somewhat higher risk if they are on the ground around the payloader.

2. Packer

   In the industry, work on refuse collection is the leading cause of worker compensation cases. Days of heavy lifting take a toll on backs. In addition, there are risks associated with riding on the steps at the rear of the packer, even within residential neighborhoods.

3. Truck with tow-behind vacuum

   This method will cause fewer traffic delays, as it takes up no more than one lane at a time. The only additional hazard posed to employees would be to their hearing, but these hazards can be avoided with ear protection.

VI. Recommendations

The use of a truck with a tow-behind vacuum trailer is 18% cheaper in costs , and competitive, in terms fuel consumption and production, with the current leaf collection program using payloaders and open trucks. A change to such use would not require any changes in services to residents, and could avoid the cost of replacing the fourth payloader when that time comes. Further, it would avoid damage to lawns and pavements.

In consideration of the above and of the severely constrained budget for highway equipment, I recommend that the Town begin a transition by purchasing one vacuum trailer and equipping two trucks with enclosed bodies, at a cost of $23,500 in the first year. Such a phased approach would also allow the Town to further test this method and to narrow that expected range of costs and production.

VII. Methodology

Time studies of each of the three, feasible alternatives were conducted. Each study embraced a full day of each operation, and was videorecorded. Productive and non-productive times were recorded, as were the number of loads collected.

A special note of thanks must go to Commissioner Schenkel of the Town of Pittsford for his cooperation in offering his vacuum unit and crew for observation.

The results were then analyzed to obtain the productive time required per load (for the loader and the vacuum trailer operations) or per stop (for the packer operation). Averages and standard deviations were then calculated for each operation over the one-day test period. These averages and standard deviations were then used to calculate an expected range of production for each alternative, in loads and cubic yards. The cubic yards calculated to be generated by each were then converted to tons using weight-to-volume ratios from two websites of the solid waste industry.

Costs were then calculated using current NYS equipment rental rates and 2012 Brighton wage scales. Fuel consumption rates were provided by the Departments. Carbon dioxide emissions were calculated using USEPA data on the carbon content of diesel fuel.