

USING ROUTING SOFTWARE FOR ANALYZING RESIDENTIAL COLLECTION COSTS, DEFINING PROCUREMENT AREAS AND ROUTES

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ABSTRACT

Route optimization software is a sophisticated analytical tool for not only creating routes for collection vehicles, but also for analyzing collection costs and facilitating procurements for contract collection services. The traditional approach to analyzing collection costs and defining districts or procurement areas has been to use industry thumb rules, such as an average number of stops for a route per day. However, these industry thumb rules are typically not accurate on an individual route basis, as the number of stops and mileage can vary greatly based on the population density and distance from the depot and disposal facilities to the route. Routing software accurately defines individual routes, number of trucks required, and the mileage and labor required to service an area.

This paper reviews the experiences of using FleetRoute route optimization software for use in analyzing residential waste collection costs and planning procurements for contract collection services. Case studies include Nashville, Tennessee and an undisclosed county in the Mid-Atlantic. These projects were conducted by WasteBid.com, Inc. under sub-contract with Gershman, Brickner & Bratton, Inc.

INTRODUCTION

Route optimization software has typically been used as a planning tool for defining collection vehicle routes. However, routing software can also be used as a tool for local governments and haulers to analyze collection costs. Furthermore, routing software is a tool for defining procurement areas or districts to be used in a solicitation for moving from open market to franchise or contract collection.

Why is it advantageous to use routing software to define collection costs and procurement areas versus the traditional approach? Routing software is more accurate. The traditional way of assessing collection costs would use thumb rules for labor hours, mileage or fuel consumed to service a route for a particular type of truck and set-out method, such as an automated truck can collect 1200 carts in a ten hour day in high density residential area.

Collection costs defined with the assistance of routing software do not use averages for number of collections, labor and mileage, but use actual assessments of these values for each individual route.

Routing software can define the actual routes for the hauler to use in servicing the area. This improves the control over the contracted hauler, allowing customer service staff and government inspectors to know where the vehicle should be at any given time. The hauler also benefits by receiving optimized routes that typically reduce their costs.

TRADITIONAL APPROACH TO DEFINING COLLECTION COSTS AND ROUTES

Defining collection costs requires assessing the capital and operational expenses for a fleet to service a set of customers. Although local governments may incur additional costs for increased code enforcement, purchasing carts (if applicable), transfer/disposal fees, and public education, the primary or key cost factors for only the collection component are the:

- Annual Debt Service
- Annual Labor
- Annual Fuel
- Annual Maintenance

To deduce these costs, we must know the:

- Number of Trucks
- Number of Routes
- Hours to Service Each Route
- Mileage to Service Each Route

Some of the other factors that further complicate the cost model are:

- Types of Trucks (automated, semi-automated, or manual)
- Capacity of Trucks by Type
- Number of Spare Trucks Needed
- Crew Staffing (driver and 0-2 helpers)

- Set-out Types (carts, bag, blue bin, back door/handicapped)
- Set-out Weights That Vary by Area
- Distances From Depot and Disposal Facility to Route
- Multiple Depots or Disposal Facilities
- Collection Day Changes
- Collection Frequency
- Jurisdictional Boundaries That Constrain Route Areas

The old method of analyzing collection costs would use thumb rules for the number of customers per route to define the number of routes and trucks. For example, if a 20 cubic yard manual rear load truck could collect 600 homes in a nine hour workday and there were 27,000 homes evenly distributed over a five collection days, then we would need 9 trucks and 45 routes. For 45 routes at nine hour days with a 2 person crew, the labor requirement would be 900 hours/week. With an average 85 miles per route, the weekly mileage would be 3,825 to service all of the routes. The equations are:

$$\frac{[\text{stops/week}] / [\text{collection days/week}]}{[\text{stops/truck/day}]} = [\text{trucks/day}]$$

$$[\text{trucks/day}] * [\text{collection days/week}] = [\text{routes}]$$

$$[\text{routes}] * [\text{hours/route}] * [\text{crew persons}] = [\text{hours/week}]$$

$$[\text{routes}] * [\text{miles/route}] = [\text{weekly mileage}]$$

Use of these thumb rules is simple and convenient. The results on average and in aggregate are fairly accurate. However, the thumb rules are not typically accurate on the individual route level, which will vary based on the density of population and distances from the disposal facility and depot. A rural area will be more expensive than a densely populated area. An area further away from the disposal facility will be more expensive than an area adjacent to the disposal facility. Even though the average number of customers per route varies significantly on each individual route, this is the common target for manually designing routes, which is by counting the number of customer stops in an area.

USING ROUTING SOFTWARE FOR ASSESSING COLLECTION COSTS AND DEFINING PROCUREMENT AREAS

Figure 1 provides the statistics developed from the use of the FleetRoute software in assessing the collection costs

Area#	Hours Per Week	Total Weekly Labor Hours	Total Tons Per Week	Stops Per Week	Miles Per Week
1	45	90	66	2,641	602
2	47	94	69	2,767	637
3	46	92	72	2,888	535
4	44	88	94	3,750	163
5	44	88	90	3,595	220
6	43	86	69	2,751	490
7	43	86	74	2,969	400
8	45	90	82	3,279	382
9	38	75	55	2,193	451
Total	395	790	671	26,833	3,880

FIGURE 1 – COLLECTION STATISTICS FROM FLEETROUTE

Note: Calculations may be off by one (1), due to rounding.

and collection areas for a county that is considering moving from open market to contract collection. The County wanted to know what the private sector haulers would likely charge for waste and recyclables collection on a per household basis. The County was a mix of rural and high density residential communities. Areas 1-8 were targeted to consist of a 45 hour workload for one rear load collection vehicle with a two person crew. Area 9 consisted of an incorporated area that may not participate in the move to contract collection. Thus, Area 9 was not balanced on workload with the other eight areas.

The number of stops varied significantly in the first eight Areas. The Area with the most stops (Area 4) had 42% more stops than the area with the least number of stops (Area 1). The weekly mileage to service the first eight Areas also varied drastically from 163 miles to 637 miles per week. The reason for these variations are in the wide geographic distribution of the communities and their proximity to the landfill. As seen in Figure 2, the dense populations are clustered in the North and South of the county. Although the depot is in the middle of the County, the landfill is far in the South. Thus, the travel times and mileage is substantially less for the collecting the densely populated Southern area of the County.

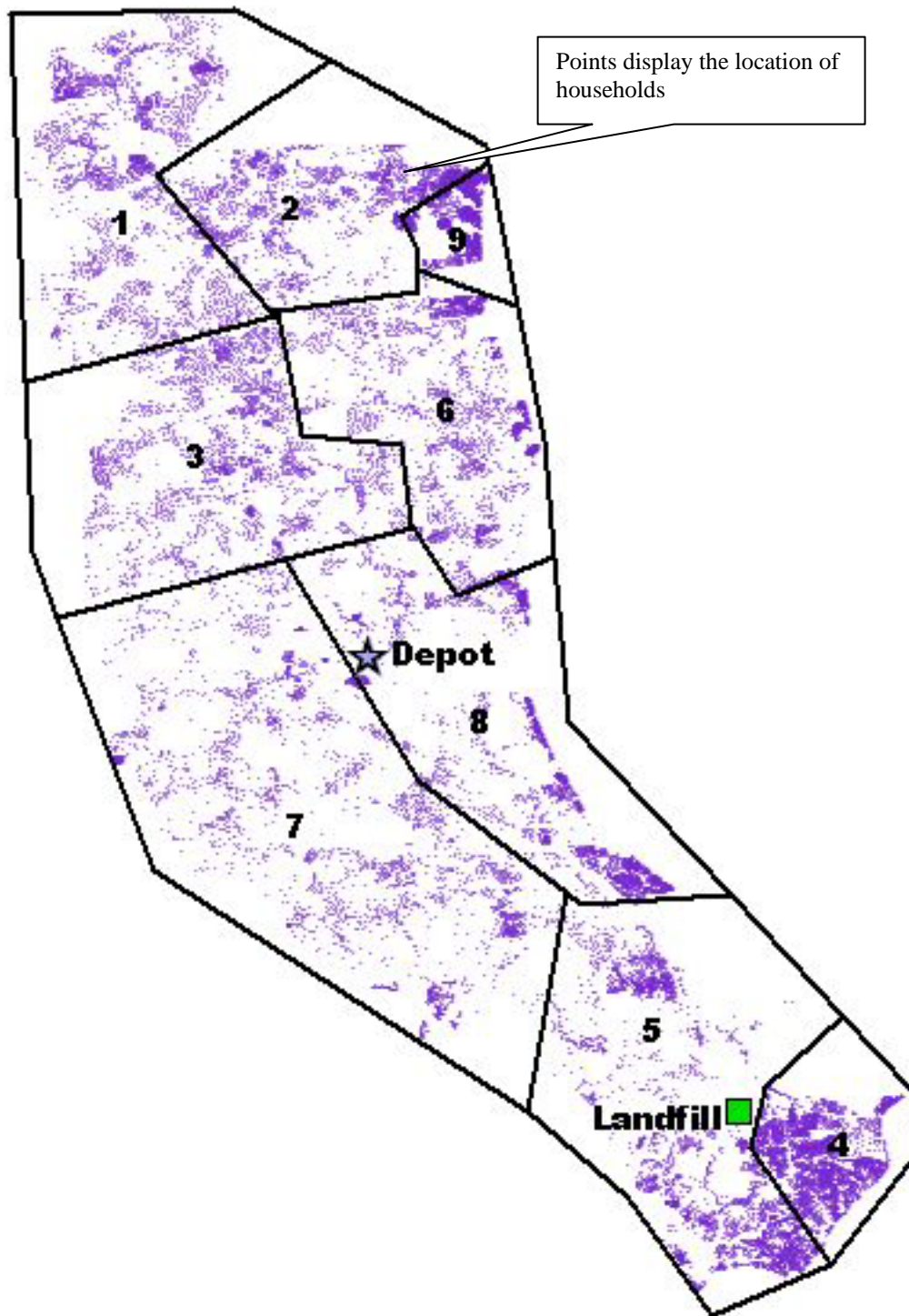


FIGURE 2 – SINGLE VEHICLE COLLECTION AREAS, FACILITIES AND HOUSEHOLD POINTS

Once an accurate assessment of the number of trucks, labor hours and mileage is developed from the FleetRoute routing software, these numbers may be input into a spreadsheet to factor in the debt service, labor, fuel and maintenance costs. Figure 3 provides the average cost per vehicle/crew for servicing all nine collection areas. Debt

service is based on the purchase price of the vehicle, the useful life of the vehicle, interest rate from financing, and the vehicle's salvage value. Collection crew labor is based on the labor hours from the FleetRoute model multiplied by the salary and fringe benefits of the driver and helper. Fuel is based on the mileage from the

Item	Units or Cost	Cost per Year
Vehicle Debt Service		\$28,671
Original Cost	\$165,000	
Years of Service	7	
Collection Crew Labor		\$86,420
Hours/Week	44	
Driver Wages & Benefits	\$48,011	
Helper Wages & Benefits	\$38,409	
Fuel		\$4,004
Miles/week	431	
Gallons/week	62	
Cost/gallon	\$1.25	
Truck Maintenance		\$24,590
Mechanic Wages & Benefits	\$7,240	
Parts	\$9,500	
Tires	\$5,600	
Outside Repair	\$2,250	
Sub-total Cost		\$143,684
Overhead (35%)		\$50,289
Sub-total Cost Plus Overhead		\$193,973
Profit (20%)		\$38,795
Total Annual Cost Plus Overhead and Profit		\$232,767

FIGURE 3 – AVERAGE VEHICLE COLLECTION COSTS

FleetRoute model divided by the vehicle’s average miles per gallon and multiplied by the cost per gallon. Truck maintenance is based on historical maintenance data, industry averages or thumb rules.

Collection costs are assessed for each individual route are shown in Figure 4. Although the number of collections per route varies by 42% in Areas 1-8, the annual costs per area only vary by about \$20,000. However, on a per household basis, the monthly costs vary from \$5.12 to \$7.60 per household.

The FleetRoute software is also used to identify the procurement areas that could be used if the County chose to implement the contract collection program. The County could also elect to provide the haulers with the actual routes for collection. By providing the proposing haulers with detailed information on the routes, their areas and the collection cost variables, it is theorized that the haulers will respond with more competitive bids and reduce problems

with the proposers being unclear about the parameters of the collection areas.

Analyzing Collection Costs for Carts Versus Bags

In order to assist the City of Nashville in understanding the collection cost savings from using wheeled carts versus bag collection, two FleetRoute models were developed. For 28 cubic yard automated and 18 cubic yard semi-automated collection with carts, a model was developed for 121,000 households and small businesses. A model was also developed for a mixed fleet of 18 cubic yard and 25 cubic yard manual collection vehicles servicing bag set-outs. Although the model did not factor additional costs for the program that are not specific to collection, such as public education and increased code enforcement, the results clearly demonstrated a savings, as seen in Figure 5.

The number of vehicles required varied significantly. With carts requires twenty-one automated trucks and fourteen semi-automated trucks. Without carts requires fifteen of the 18 cubic yard trucks and thirty-one of the 25 cubic yard trucks. Labor also varied significantly with approximately 1,600 hours per week with carts versus nearly 3,000 hours per week with two-person manual collection crews.

SUMMARY

The use of FleetRoute routing software in analyzing collection costs and identifying procurement areas

Area #	Operating Costs Per Year	Annual Costs (Costs & Profit)	Annual Cost Per HH	Monthly Cost Per HH
1	200,607	\$240,728	\$91.15	\$7.60
2	209,489	\$251,387	\$90.85	\$7.57
3	203,221	\$243,865	\$84.44	\$7.04
4	192,033	\$230,440	\$61.45	\$5.12
5	192,364	\$230,836	\$64.21	\$5.35
6	192,294	\$230,753	\$83.88	\$6.99
7	191,550	\$229,859	\$77.42	\$6.45
8	199,000	\$238,800	\$72.83	\$6.07
Avg. 1-8	\$197,570	\$237,084	\$76.98	\$6.41
9	165,199	\$198,238	\$90.40	\$7.53
Avg. 1-9	193,973	\$232,767	\$78.07	\$6.51

FIGURE 4 – COLLECTION COSTS BY AREA

	Manual (no carts)	Automated/Semi-automated (carts)
Number of Customers	121,239	121,239
Downtown (18CY manual, 18CY semi-automated)	\$3,055,528	\$2,844,935
Suburban (25CY manual, 28CY automated)	\$6,244,782	\$3,479,242
<i>Sub-total Cost w/Overhead & Profit</i>	<i>\$9,300,311</i>	<i>\$6,324,177</i>
Collection Monthly Cost Per Household	\$6.39	\$4.35
Annual Cost of Cart Purchase & Maintenance (1)	NA	\$6.49
<i>Sub-total Cost of All Carts</i>	<i>NA</i>	<i>\$786,381</i>
Total Collection and Cart Costs	\$9,300,311	\$7,110,558
Monthly Collection and Cart Cost per Household	\$6.39	\$4.89

Note: (1) Includes \$35/cart, financed over 10 years at 6% interest, plus \$2/cart/year for maintenance.

FIGURE 5 – COLLECTION COSTS FOR CART VERSUS BAG COLLECTION

provides another tool for municipal waste managers. Even for local governments that do not provide collection services, the routing software empowers contract managers to better understand their contractor's costs and to better control their performance by defining the collection areas and routes.

The traditional approach of using industry thumb rules for assessing average costs for collection (and collection procurement areas and routes) are often inaccurate on the individual route level. Although using routing software is a more complex and time-consuming process, the results are more useful, accurate and comprehensive.

REFERENCES

Discussions with consultants, Tim Bratton and Frank Bernheisel, who provided information on assessing collection procurement areas and districts.

Discussions with consultant, Walt Davenport, who provided information on analyzing collection costs using industry thumb rules.