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DEPARTMENT OF
PUBLIC WORKS

SOLID WASTE DIVISION

CITY OF SACRAMENTO
CALIFORNIA

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SUITE 500
SACRAMENTO, CA
95814-2715

916-449-5757

May 23, 1994

APPROVED
BY THE CITY COUNCIL

JUN 8 1994

OFFICE OF THE
CITY CLERK

City Council
Sacramento, California

Honorable Members in Session:

SUBJECT: **COMMERCIAL COLLECTION STUDY**

LOCATION and COUNCIL DISTRICT: City

RECOMMENDATION: This report recommends that the City Council adopt a Reolution authorizing staff to develop an implementation plan for the Commercial Collection Study completed in April, 1994.

CONTACT PERSON: Reina J. Schwartz
Acting Solid Waste Division Manager
264-7043

FOR COUNCIL MEETING OF: June 8, 1994

SUMMARY

The Solid Waste Division has completed a study of its commercial collection system. This report transmits the attached study for Council's information. The study makes a number of recommendations for improvements in commercial collection service and efficiency including:

- Reduce crew size from two to one person on the majority of City commercial routes.

- Convert existing rearloader routes to frontloader routes and shift 32-gallon cans currently serviced manually to larger auto-lift cans.

Implementation of the recommendations in the study will save the City between $300,000 and $600,000 annually resulting in reductions in commercial collection rates of 10 to 20 percent.

COMMITTEE/COMMISSION ACTION

None Required.

BACKGROUND INFORMATION

On June 23, 1993, the City Council adopted rate increases of 20 to 40 percent for solid waste commercial collection for 1993-94. The rate increases were the result of mandated programs including:

- Landfill closure
- Increased direct haul of the City's solid waste to the County landfill
- Increased composting
- Groundwater remediation

At the time the rate increases were adopted, the City Council requested that staff analyze whether there were any efficiency improvements that could be made in order to reduce the size of the commercial rate increase. In response to this request, the Solid Waste Division analyzed the City's commercial collection system and subsequently rerouted to improve efficiency. On September 20, 1993, the Solid Waste Division returned to City Council for approval of a 10 percent rate **decrease** to reflect the improved efficiency from rerouting.

At that time, City staff also committed to conduct a comprehensive analysis of commercial collection in the City. Among other items, this study was to include analyzing the impacts of converting the present two-person commercial collection crews to a one-person operation. The purpose of this collection study would be to look for more efficiencies which would also result in greater reduction of commercial rates.

The attached Commercial Collection Study makes several recommendations for improved efficiency of collection. The table below represents the proposed timeline for implementation:

COMMERCIAL COLLECTION STUDY
May 23, 1994

TASK	TIMELINE
City Council Report on Study	June 8, 1994
Implement Short-term Operational Changes	June-August 1994
Develop Long-Term Implementation Plan Develop management Upgrade existing data base Analyze existing workload data Train supervisors and auditors Conduct route audits Identify system revisions Determine revised system workload Determine required number of routes Identify staffing & financial impacts of changes Distribute workload among routes	June-December 1994
Return to Council for Approval of Changes	January 1995
Implement Long-term Operational Changes	July 1995

FINANCIAL CONSIDERATIONS

Implementation of the recommendations for improved efficiency would result in the elimination of 10 to 15 currently filled positions within the Solid Waste Division for a savings in the range of $300,000 to $600,000 annually. This would reduce commercial rates by 10 to 20 percent, related to this program change only. Other program changes that will likely increase rates include direct haul of all commercial waste to Kiefer landfill beginning in 1994-95 and increased tipping fees. Staff will report back on the exact rate impacts when the overall implementation plan is brought back to Council in January, 1995.

POLICY CONSIDERATIONS

Implementation of the study's recommendations will result in improved efficiency which will lead to either a rate reduction or an offset of increased costs related to direct haul. This result is consistent with the following policy considerations:

- Improved efficiency of commercial collection will serve Council's established priority for reinventing government through fiscally sound and service oriented operation.

COMMERCIAL COLLECTION STUDY
May 23, 1994

- The study concluded that worker safety will not be compromised by converting selected routes to one-person crews. However, every truck converted to a one person crew will require the installation of a back-up camera.

- Improved efficiency of collection will not result in job loss. Reductions in staffing will be made through attrition or through transfer opportunities for affected workers.

MBE/WBE

There are no goods or services being purchased as a direct result of this action.

Respectfully Submitted,

Reina J. Schwartz

REINA J. SCHWARTZ
Acting Solid Waste Division Manager

RECOMMENDATION APPROVED:

for

WILLIAM H. EDGAR
City Manager

APPROVED:

ROBERT L. LEE
Deputy Director of Public Works

Attachment: Commercial Collection System Study

Folder 4.2

Amended (6/10/94)

RESOLUTION NO. 94-359

ADOPTED BY THE SACRAMENTO CITY COUNCIL

ON DATE OF JUN 8 1994

RESOLUTION AUTHORIZING DEVELOPMENT OF
COMMERCIAL COLLECTION STUDY IMPLEMENTATION PLAN

BE IT RESOLVED BY THE COUNCIL OF THE CITY OF SACRAMENTO that staff be authorized to develop prior to January 1995, an implementation plan for the Commercial Collection Study completed in April, 1994.

MAYOR

ATTEST:

CITY CLERK

FOR CITY CLERK USE ONLY

RESOLUTION NO.: 94-359

DATE ADOPTED: JUN 8 1994

CITY OF SACRAMENTO

STUDY OF COMMERCIAL COLLECTION SYSTEM

FINAL REPORT
April 21, 1994

Prepared for
City of Sacramento
Solid Waste Division
920 10th Street, Suite 500
Sacramento, California 95814

Prepared by
Brown, Vence & Associates
120 Montgomery Street, Suite 1000
San Francisco, California 94104

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EXECUTIVE SUMMARY

PROJECT OBJECTIVE

The objective of this project is to identify ways of increasing the collection efficiency and productivity of Sacramento's commercial collection system, with the focus on reducing commercial crew size from two persons to one.

BACKGROUND

The City's Solid Waste Division currently operates 12 commercial collection routes, Monday through Saturday, all with two-person crews. These routes consist of four front-loader commercial routes, four rear-loader commercial routes, and four rear-loader routes that are a mix of commercial and residential accounts. The City also operates one roll-off route. With the exception of a single two-person front-loader route for hard-to-access bins, all of the major private commercial collectors operating in the City (Waste Management, Inc., Browning-Ferris Industries, and Sac Val Recycling) use one-person front-loader routes, and many of the accounts on these routes require the driver to position the container prior to collection.

In the past, a portion of the City's commercial collection system was serviced by one-person crews. However, the City began to assign an extra worker to each of the commercial routes in response to a concern regarding the daily workload of each route and dumpster and the attendant awkwardness of moving the dumpsters to a position accessible to the truck. Enclosure requirements established by the City Code contribute to the extent to which commercial containers require manual maneuvering into accessible collection positions.

ASSESSMENT OF EXISTING SYSTEM

Brown, Vence & Associates (BVA) project staff met with City staff, route supervisors, and route drivers; reviewed existing data; and conducted field work to assess current conditions. In general, BVA found the existing commercial collection system to be very compatible with both one-person crews and front-loading vehicles; we also found that significant potential exists for the widespread implementation of one-person front-loader routes. Private operators currently operate one-person front-loader routes throughout the City, with a few exceptions, and there appears to be no technical reason why the City cannot implement a similar system, given allowances for certain "restricted accounts" that may warrant two-person crews and/or rear-loader routes. The current practice of assigning two-person crews to each commercial route and the continued widespread use of rear-loading vehicles significantly limits the productivity of the existing commercial collection system.

RECOMMENDATIONS

Based upon BVA's assessment of the existing commercial collection system, we offer the following three primary recommendations for improving system efficiency:

- Convert existing rear-loader routes to front-loader routes
- Reduce crew size from two persons to one
- Shift existing residential and commercial 32-gallon can accounts from commercial rear-loader routes to residential side-loader routes.

Inherent in these recommendations is the need to redesign and balance the commercial collection system. An Action Plan comprised of 15 major tasks is provided to guide the implementation process. The key elements of this Action Plan are upgrading of the existing system database and complete field auditing of the existing commercial collection system, leading to the reorganization of the system.

Implementation of these recommendations is projected to result in a decrease in the number of required commercial collection staffing positions. Some of this reduction in commercial staffing requirements may be offset by additional residential collection positions necessary to accommodate the shifting of can accounts from the commercial collection system to the residential collection system. Overall, however, a net reduction in staffing in the range of plus or minus ten positions is projected. The actual number will depend upon the extent to which the commercial collection system can be revised to incorporate one-person front loader routes, the actual productivity achieved by these one-person crews, and the need for additional residential collection system staffing positions. The City has indicated, however, that improved efficiency of collection will not result in job loss. Reductions in staffing will be made through attrition or through transfer opportunities for affected workers.

In addition to the three primary recommendations, a number of secondary recommendations are also presented. These secondary recommendations include revising collection time restrictions where appropriate, and requiring or encouraging customers to move heavy containers into a position that is accessible by a one-person front loader vehicle. Implementation of these as well as a number of other secondary recommendations will require appropriate changes to existing City policy and codes.

The reorganization of the commercial collection system will require an organized and concerted effort on the part of both Solid Waste Division operation and administration staff. Capable and trained supervisory staff will be necessary to effectively manage the system reorganization process, and it is critical that operations management staff be provided with the necessary

resources. In addition, continuity will need to be maintained in operations management following the retirement of the current collection supervisor in 1995; the City should begin planning for that eventuality as part of the system reorganization process.

CITY OF SACRAMENTO
STUDY OF COMMERCIAL COLLECTION SYSTEM

PROJECT OBJECTIVE

The objective of this project is to identify ways of increasing the collection efficiency and productivity of Sacramento's commercial collection system, with the focus on reducing commercial crew size from two persons to one.

BACKGROUND

Under Chapter 19 of the City Code, all putrescible waste ("wet" garbage) produced in the city of Sacramento (City) must be collected by municipal crews. This includes "wet" garbage produced by multifamily residences, restaurants, and other businesses that produce putrescible materials. Collection of the remaining commercial waste stream is handled largely by the private sector. The City does not actively seek commercial accounts other than those producing putrescibles but does provide service to a limited number of commercial accounts that do not produce putrescibles.

The City's Solid Waste Division currently operates 12 commercial collection routes, Monday through Saturday, all with two-person crews. These routes consist of four front-loader commercial routes, four rear-loader commercial routes, and four rear-loader routes that are a mix of commercial and residential accounts. The City also operates one roll-off route. With the exception of a single two-person front-loader route for hard-to-access bins, all of the major private commercial collectors operating in the City (Waste Management, Inc., Browning-Ferris Industries, and Sac Val Recycling) use one-person front-loader routes, and many of the accounts on these routes require the driver to position the container prior to collection.

In the past, a portion of the City's commercial collection system was serviced by one-person crews. However, the City began to assign an extra worker to each of the commercial routes in response to a concern regarding the daily workload of each route and dumpster and the attendant awkwardness of moving the dumpsters to a position accessible to the truck. Enclosure requirements established by the City Code contribute to the extent to which commercial containers require manual maneuvering into accessible collection positions.

SCOPE OF SERVICES

The scope of services for this project is summarized below:

- Conduct an independent objective analysis of the existing commercial collection system and provide an overall assessment

- Prepare recommendations for improved efficiency

- Develop standards and guidelines for future routing of the commercial system

- Analyze the need for additional equipment and labor associated with any project recommendations

- Conduct a survey of regional and national organizations to determine if any information is available on the impact on worker safety resulting from reducing commercial routes from two-person assignments to one.

- Conduct a survey of jurisdictions and private collection companies to obtain information on the size of commercial collection crews and related issues.

Each of these services is discussed in the following sections. The City will perform all economic analyses associated with the project recommendations.

ASSESSMENT OF EXISTING SYSTEM

Brown, Vence & Associates (BVA) project staff met with City staff, route supervisors, and route drivers; reviewed existing data; and conducted field work to assess current conditions. Field work included observing City front- and rear-loader commercial routes and numerous additional commercial storage points and containers throughout Sacramento. We also observed a number of Browning-Ferris and Waste Management front-loader routes in the field.

In general, BVA found the existing commercial collection system to be very compatible with both one-person crews and front-loading vehicles; we also found that significant potential exists for the widespread implementation of one-person front-loader routes. Private operators currently operate one-person front-loader routes throughout the City, with a few exceptions, and there appears to be no technical reason why the City cannot implement a similar system, given allowances for certain "restricted accounts" that may warrant two-person crews and/or rear-loader routes. The current practice of assigning two-person crews to each commercial route and the continued widespread use of rear-loading vehicles significantly limits the productivity of the existing commercial collection system.

Certain conditions in the City contribute to the need for two-person commercial collection crews: excessive daily workloads for some individual routes, heavy containers (including accounts with vertical compaction units), and accounts whose containers are on soft surfaces (e.g., gravel), or require maneuvering up or down inclines. It is reasonable, however, to expect a one-person crew to pull and push containers from enclosures to collection points if other conditions at an account are consistent with one-person collection. In other words, enclosures by themselves

should not be a factor in determining the need for a two-person crew. It should also be noted that opportunities exist for modifying the existing collection system to mitigate many of the above factors to allow for one-person crews.

RECOMMENDATIONS FOR IMPROVED EFFICIENCY

Primary Recommendations

Based upon BVA's assessment of the existing commercial collection system, we offer the following three primary recommendations for improving system efficiency:

- Convert existing rear-loader routes to front-loader routes
- Reduce crew size from two persons to one[1]
- Shift existing residential and commercial 32-gallon can accounts from commercial rear-loader routes to residential side-loader routes.

Inherent in these recommendations is the need to redesign and balance the commercial collection system. A brief discussion of the basis for the three primary recommendations is provided below. Before these changes can be made to the existing system, however, verification of current activity must be obtained through a comprehensive commercial route audit process. In addition, the existing commercial collection system database needs to be upgraded to give operations management the data necessary to effectively assess and revise the existing system and provide ongoing monitoring of the revised system. The route audit process and data system upgrade, which are discussed in detail as part of the Action Plan described later in this report, will provide the basis for the reorganization of the City's commercial collection system, and will be a critical first step toward implementation of these recommendations.

Convert existing rear-loader routes to front-loader routes. Front-loader routes are the choice of the industry for the commercial sector. Their widespread use within Sacramento's commercial sector has been shown to be highly effective by both the City and private industry. Continued use of rear-loading vehicles, where not required, will significantly limit system productivity. Accordingly, the conversion of 1- and 2-cubic-yard bins to accommodate front-loader collection should be a priority.

Reduce crew size from two persons to one. Collection efficiency generally is significantly increased with reduced crew size. Therefore, it does not make sense to run rear-loader routes

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[1] All route vehicles with one-person crews should have on-board camera systems installed to assist with backing.

if front-loaders are possible, or run two-person crews for either rear-loader or front-loader routes if one-person crews are possible. Our analysis indicates that one-person front-loader routes should be the standard for the City's commercial collection system. Continued use of two-person rear- or front-loader routes, where one-person front-loader routes are possible, will significantly limit system productivity.[2] Standards for determining whether an account warrants a one- or two-person crew are included in Appendix A.

Shift residential and commercial 32-gallon can accounts from commercial rear-loader routes to residential side-loader routes.[3] Shifting existing residential 32-gallon can accounts from the existing two-person commercial rear-loader routes to one-person residential side-loader routes will result in significant overall operational efficiencies. Under the current system, various commercial rear-loader routes collect significant numbers of 32-gallon cans from both residential and commercial customers. This requires these commercial routes to cover the same area already serviced by the residential side-loader routes and requires two people rather than one. This practice is inefficient; all of these residential accounts should be modified as necessary to provide for their collection as part of the existing residential side-loader routes. Shifting these accounts to the residential system could be accomplished by converting the 32-gallon cans to automated 90-gallon cans.[4]

A large number of commercial customers also have 32-gallon cans, and these accounts are also currently serviced by two-person rear-loader routes. These accounts should also be provided with cans that are compatible with automated collection and incorporated into the residential side-loader collection system. If this is not feasible, it may be possible to collect these accounts with a one-person rear-loader route.

In cases where accounts have multiple 32- or 90-gallon cans, the possibility of replacing these cans with a 1-cubic-yard or larger front-loader bin should be evaluated.

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[2] It is often the case that running front-loader routes 10 or even 12 hours a day is economically preferable to adding an additional route, given the associated capital and operations and maintenance costs. The City should track overtime and carefully consider opportunities to incur front-loader route overtime to improve operational efficiency. Having drivers who are willing to work potentially large amounts of overtime is a critical element of this type of strategy.

[3] When we refer to 32-gallon can accounts we are really referring to all the various size can accounts collected by the commercial system, the vast majority of which are 32 gallons.

[4] The manufacturer of the City's residential side-loaders (Heil-Rapid Rail) offers an optional "hugger-grabber"arm, which is advertised as capable of handling virtually all sizes and shapes of automated and semiautomated containers from 30 to 110 gallons. Use of this mechanism would potentially allow the City to offer its customers various size containers in conjunction with their automated system. The City has conducted a preliminary analysis of the "hugger-grabber" arm and found that there are still some significant problems serving various sized containers on the same route. The City is continuing to explore this option, however, and is planning on purchasing a number of "hugger-grabber" attachments in the near future to test in the field.

Secondary Recommendations

In addition to the three primary recommendations noted above, we also offer the following secondary recommendations.

Training. Training programs must be held regularly and documented for both drivers and supervisors. BVA recommends training for supervisors responsible for implementing the Action Plan and cross-training of all route drivers to provide effective route coverage in the case of driver absence.[5] Training measures should be instituted to ensure that, following the collection supervisor's retirement (anticipated December 1995), adequate understanding of the rerouting process, the basis for the revised system, and daily system management and upgrading capabilities are maintained within the operational ranks.

Improve system database. Information on cubic yardage, number of lifts, employee hours, engine hours, and mileage should be tracked daily, and weekly reports should be generated for review by operations management staff.

GIS mapping system upgrade. Opportunities for maintaining mapping of commercial accounts using the existing GIS system should be evaluated. Such mapping would include each account location along with number and size of bins, days of collection, and the route(s) that services the account on each collection day.

Update/audit route books. Sequence route books in order of pickup, include weekly collection schedule on each account entry, and periodically reconcile with billing through a formal audit process.

Improve communications between operators and administration. Collection supervisors must be in the information loop. Administration currently generates a range of information (some of which needs to be upgraded) including labor hours per route and cubic yards, which should be reported to operations management weekly.

Leased containers. Private companies that lease containers to customers serviced by City routes should be required to work through the City for all leasing activities. The City should specify size and frequency of collection of all leased containers prior to their placement by private firms.

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[5] Sequencing of route books in order of collection is another critical aspect of providing effective coverage of routes. Absences should also be tracked, incentives for reducing absences instituted and the issue of chronically absent employees addressed. One of the private haulers surveyed indicated that it rotates their drivers among routes every three months. This provides effective cross-training, while also helping to balance the system work load among drivers and offset workload differences among individual routes.

Stricter enforcement of the wet waste ordinance. Require private companies to provide the City with a master key for all locked containers for easier enforcement of the ordinance.

Accurate accounting for all overtime worked. Once route standards are established, all overtime should be tracked and accounted for against the established standards for each route. Route standards are established during the route audit process. The hours worked per route are evaluated by the route auditor (preferably an experienced commercial route supervisor). The hours of work verified by the audit become a performance measure that must be tracked each week. Any deviation in hours worked must be accounted for by some unusual activity, (e.g., breakdown, traffic jam, landfill delays, etc). The reference material used to check actual hours against route audit information is the daily activity sheet (Appendix B). This gives the worker an opportunity to document any variation in hours worked.

Accurate tracking of special pickups. The City uses different forms for different activities, such as starts, stops, missed pickups, complaints, and special service. All these forms can be consolidated into one generic form and should be numerically sequenced and tracked daily. Special pickups are revenue, and a signed copy of work completed must be reconciled to the control copy in utility billing.

Reassess need/cost/rates for Saturday collections. The practice of providing collection services on Saturday should be reviewed to determine if it results in excess overtime or other additional costs. It may be desirable to limit or eliminate some and/or revise rates for Saturday collection to reflect any additional costs.

Alter hours of collection. The current system has a wide range of accounts that "require" collection after a designated time, generally to mitigate noise concerns. The City should be aware that requirements mandating collection of certain accounts or areas at certain hours of the day significantly reduce collection efficiency. Such instances should be reviewed to determine if they are warranted or if the existing collection system can be revised in some way to eliminate the need for such time restrictions (e.g., noise mitigation measures). In downtown areas where blind backing must occur, the hours of service should be as early as possible. Route books should reflect a sequence of pickups to avoid congestion.

ACTION PLAN

The objective of the Action Plan is to (1) convert existing rear-loader to front-loader routes, (2) reduce crew size from two persons to one, and (3) shift existing residential and commercial 32-gallon can accounts from commercial rear-loader routes to residential side-loader routes.

The reorganization of the commercial collection system will require an organized and concerted effort on the part of both Solid Waste Division operation and administration staff. Capable and trained supervisory staff will be necessary to effectively manage the system reorganization process, and it is critical that operations management staff be provided with the necessary resources. In addition, continuity will need to be maintained in operations management following the retirement of the current collection supervisor in 1995; the City should begin planning for that eventuality as part of the system reorganization process.

The Action Plan is comprised of 15 major tasks:

1. Develop management team
2. Review policy options/institute appropriate policy changes
3. Upgrade existing database
4. Analyze existing system workload
5. Identify and implement short-term operational changes
6. Train route supervisors and route auditors
7. Conduct route audits
8. Identify appropriate system revisions
9. Determine revised system workload
10. Determine required number of routes
11. Distribute workload among routes
12. Train collectors
13. Institute long-term operational changes
14. Monitor and evaluate routes and revise as necessary
15. Analyze residential solid waste and recycling collection systems

The specifics of each of these tasks is provided below. A proposed implementation schedule is provided in Figure 1.

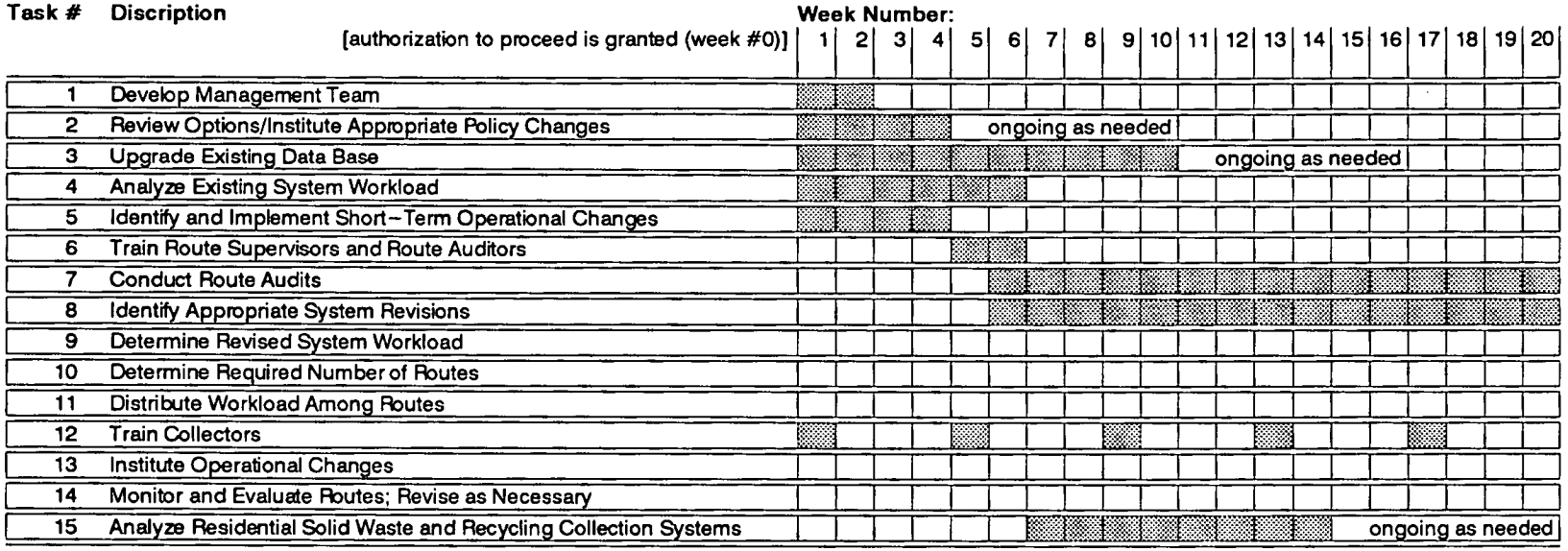
Task 1: Develop Management Team

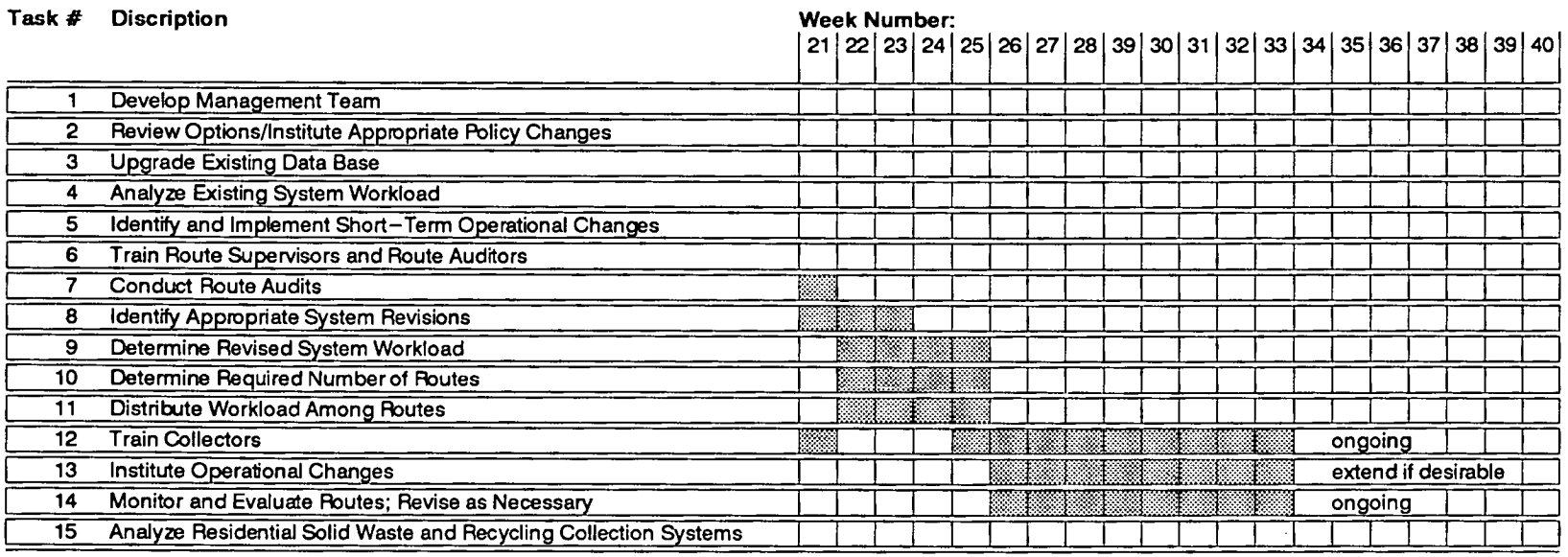
- Determine administration and operations management staff responsibilities
- Determine participating operations staff and identify specific responsibilities
- Develop transition plan and team.

Task 2: Review Policy Options/Institute Appropriate Policy Changes

- Regulate private-sector container rental for City-collected accounts

FIGURE 1
IMPLEMENTATION SCHEDULE





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- Obtain keys to private-hauler bins for more effective enforcement of wet waste ordinance

- Review/revise collection time restrictions, as appropriate

- Review/revise services and/or generator responsibilities, as appropriate

- Review/revise commercial rates, as appropriate, following system reorganization.

The review of policy options that may impact the routing process, such as requiring generators to position containers so they are accessible to a one-person front-loader, ideally should occur before the route audit process begins. This will allow any desired changes to be factored into the route audit process. In the case of requiring customers to reposition containers, this would allow the auditor to determine where such changes might be implemented to allow for one-person collection in cases where two-person collection would otherwise be required. It should be noted that implementation of a number of the above recommendations will require appropriate changes to City policy and codes.

Task 3: Upgrade Existing Database

- Institute the practice of all employees punching in and out on an electronic time card

- Track cubic yards, labor hours, engine hours, vehicle miles, and lifts for all routes (see Appendix B for a sample Daily Activity Sheet, an upgraded version of which can be developed by the City to track the necessary route information)[6]

- Develop cubic/yard/per hour per route standards for all existing routes using data from electronic time cards. Confirm or revise these standards based on the results of the route audit.

- Update route books to reflect sequence of collection and service schedule for each account.

- Establish electronic link between administration offices and corporation yard to facilitate database management.

- Determine opportunity to upgrade GIS commercial mapping system to produce maps with account location and service level information clearly indicated.

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[6] The City may wish to consider the use of "TAC-O-GRAPHS" for tracking vehicle tachometer readings as a possible mechanism for monitoring vehicle activity.

Task 4: Analyze Existing System Workload

Workload distribution among collection days. To determine how best to revise the existing system, it is first necessary to understand its characteristics. This is accomplished by developing a "Commercial System Workload Distribution." This distribution should reflect the total daily and weekly system workload, as measured in cubic yards and pickups, and the distribution of the daily workload among each of the collection routes. As part of this project, the City generated a "Daily Commercial Route Breakdown" printout, which reflects the total number of each of the various service types by route, for each day of the week. Using this information, a preliminary Commercial System Workload Distribution (CSWD) was developed (Appendix C).[7] A summary of the daily CSWD is provided in Table 1. As this table indicates, there is an imbalance of work among the various collection days from a high on Monday of 4,221 cubic yards to a low on Wednesday of 2,039 cubic yards. Such an imbalance is not uncommon within commercial collection systems; however, it tends to increase overtime requirements and worker fatigue. Management should actively seek to redistribute the weekly workload among the collection days, where possible, to minimize the daily imbalance. This should help to minimize related overtime and allow operations to better utilize available resources.

To balance the work, redistribute Monday and Friday work (heavy days) to Tuesday, Wednesday, and Thursday, where possible. Start with Monday and move all once-weekly stops to another day the route is in the service area. Next, identify multiple pickup accounts that can be reduced to once-per-week, and shift to another day. Example: a customer has a 2-cubic-yard container picked up on Monday and Thursday. It may be possible that this container could be replaced with a 4-cubic-yard container and the collection scheduled for Thursday only. After all opportunities for shifting Monday work are exhausted, the same type of analysis would be conducted for Friday.

Another important characteristic of the system highlighted in Table 1 is the predominance of can accounts within the commercial collection system. Of the 10,378 total weekly commercial system lifts, 46 percent (4,796) are can accounts. This illustrates the magnitude of the potential inefficiency currently associated with the collection of can accounts, particularly residential can accounts, by the commercial collection system.

Workload distribution among collection routes. The analysis of the commercial collection system workload should also include a review of the daily and weekly workload distribution

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[7] The Daily Commercial Route Breakdown provided by the City and the preliminary CSWD which was developed does not account for City department accounts handled by the Solid Waste Division (e.g., City offices and parks). These accounts need to be identified and accounted for as part of further review of the CSWD.

Table 1
Daily Workload Distribution Summary[a]

	Cubic Yards	Total Lifts	Can Lifts
Monday	4,221	2,617	1,124
Tuesday	2,540	2,157	1,216
Wednesday	2,039	1,495	695
Thursday	2,453	1,587	641
Friday	3,412	2,317	1,048
Saturday	420	201	72
Sunday	0	0	0
TOTAL	15,086	10,378	4,796[b]

[a] Does not include City department accounts.

[b] 3,457 residential and 1,339 commercial can account weekly pickups.

among the individual routes. The CSWD spreadsheets in Appendix C provide a daily and weekly breakdown by route. For purposes of illustration, a summary of the workload distribution among the existing front-loader routes is provided in Table 2.

This level of analysis of the CSWD is a particularly useful tool for identifying routes that are underutilized or overutilized. The preliminary analysis brings to light the following system characteristics:[8]

- Route 51 picks up a total of 92 yards on Monday and 12 yards on Wednesday, and does not operate on other days.[9]

- Five front-loader routes operate on Saturday but total only 52 pickups and 189 yards.

- The workload distribution among the front-loader routes 52 through 56 varies widely from a high of 664 cubic yards for route 54 on Monday, to a low of 79 for route 52 on Wednesday.

Management can use this type of information to determine how best to redistribute the daily workload among each of the collection routes. The objective, as with the redistribution of the total weekly workload among the collection days, is to better utilize available resources and

[8] These findings may be impacted by changes to the preliminary CSWD resulting from the addition of City Department accounts to the workload distribution as well as any other appropriate revisions which may be identified.

[9] These data would indicate that either the route is extremely underutilized or that the data are incorrect, which reinforces the need to update the commercial collection system database.

Table 2
Front-Loader Workload Distribution Summary
(cubic yards/lifts)[a]

	Route Number					
	51	52	53	54	55	56
Monday	92/26	325/93	428/132	664/198	521/141	544/148
Tuesday	0/0	274/74	261/91	394/120	171/48	305/97
Wednesday	12/4	79/23	211/63	317/99	163/47	183/52
Thursday	0/0	206/54	186/58	305/85	269/78	493/141
Friday	0/0	346/98	414/131	513/160	262/74	408/125
Subtotal		1,230/342	1,500/475	2,193/662	1,386/388	1,933/563
Yards/hour[b]		31	38	55	35	48
Saturday	0/0	3/1	50/14	29/8	28/7	79/22
Sunday	0/0	0/0	0/0	0/0	0/0	0/0
Total	156/46	1,233/343	1,550/489	2,222/670	1,414/395	2,012/585

[a] Does not include City department accounts.
[b] The cubic-yard-per-hour calculation is based on a 40-hour week and may not be completely accurate due to overtime.

minimize overtime. It is important to note that the reorganization process should make use of the existing routes to the extent possible, provided efficiency is not sacrificed.

Before any analysis of the existing system workload can be completed, it is critical that the preliminary CSWD provided in Appendix C be reviewed, and appropriate revisions made, including the addition of City department accounts to the CSWD. The review of the CSWD should be one of the first tasks undertaken as part of the implementation schedule and is assumed to be completed within the first two weeks to the implementation process.

Task 5: Identify and Implement Short-Term Operational Changes

The Action Plan is geared toward implementing comprehensive long-term changes to the existing commercial collection system. It may be possible, however, to implement some temporary operational changes, which may result in reduced costs in the short-term. For example, based on the existing route statistics, it should be possible to redistribute workload and reduce the number of trucks operating on Saturday and possibly on other days of the week.

It should be noted that there is a tradeoff between short-term gain and the effort involved to realize this gain as well as the impact of any short-term changes on the route audit process. The realization of any short-term gains will depend upon the ability of the management team to effectively analyze and implement such gains without adversely impacting or delaying the overall

reorganization process. If accounts from any existing routes that are significantly underutilized can be efficiently shifted to other routes without an offsetting increase in overtime for these routes, then such short-term changes may be worth pursuing. If significant effort is required to implement such changes, the City should forego such short-term gains and focus efforts on implementing long-term changes as efficiently and quickly as possible.

Before the potential for short-term route consolidation can be fully determined, the accuracy of the existing CSWD needs to be confirmed as noted in Task 4 above. This confirmation is expected to take place during Tasks 3 and 4 of the Action Plan, which are scheduled to begin immediately upon authorization to proceed with the implementation process. To maintain the schedule shown in Figure 1 confirmation/revision of the existing CSWD would need to occur no later than week 2 of the schedule. Analysis and implementation of short-term options would then occur during weeks 3 and 4, with revised route books reflecting all changes available by the end of week 5.

Task 6: Train Route Supervisors and Auditors

Supervisors must understand the activities on all routes under their supervision. Management must develop specific criteria, measure performance, provide performance feedback, and clearly explain the rationale behind all decisions. In addition, supervisors must convey specific performance guidelines for the routes to the collectors and understand how to measure performance. BVA recommends training for supervisors so they understand how to use the information included in this report, and how to convert recommendations into actions. Route auditors will also require specific training to ensure that they understand the objectives of the route audit process and are capable of providing the appropriate analysis of each account. Ideally, the route supervisor would conduct the route audits.

Task 7: Conduct Route Audits

Before any changes can be made to the existing system, a verification of current activity must be obtained from the route audits. Information obtained from route audits will give the City a clear picture of route activity. The route audit should be comprehensive, addressing all accounts on all routes and should be conducted by trained auditors who have a clear understanding of the objective of the audit and how the information will be used.

A worksheet should be designed for the route audits to accomplish the following:

- Reconcile billing information with actual route pickup (billing information should be reflected in route books.)

- Evaluate size of container, frequency of service, and collection schedule

- Evaluate the location of the containers and provide recommendations for relocation to provide direct or more accessible front loader access

- Evaluate container condition/develop container inventory tracking system and replacement list

- Evaluate the sequence of pickup to ensure productive paths between accounts (e.g., most congested areas to less congested)

- Evaluate hours of collection, and determine if a different start time would positively impact productivity

- Identify work that can be converted from rear-loader to front-loader and containers requiring modification to accommodate front-loader collection

- Identify all accounts that cannot be picked up with front-loader

- Identify all accounts warranting two-person crew

- Track actual time on route and record time and motion data

- Observe driver safety habits/document for personnel file

- Establish cubic-yard-per-hour standard.[10]

A sample commercial route audit form is provided in Appendix D. This form will need to be modified as necessary to meet the City's needs.

Task 8: Identify Appropriate System Revisions

Based on the results of the route audit operations management should:

- Make appropriate frequency and scheduling changes

- Modify 1- and 2-cubic-yard bins for front-loader collection, as necessary

[10] Establishment of an hourly standard can be based on a qualitative judgement, or could involve a more quantitative assessment based on time and motion studies.

- Identify all accounts that are not compatible with front-loading vehicles
  - Modify to provide compatibility, as possible
  - Develop targeted collection system for remaining incompatible accounts

- Identify all accounts warranting two-person crews
  - Modify to provide compatibility, as possible
  - Develop targeted collection system for remaining incompatible accounts

- Identify locations of 32-gallon can accounts
  - Determine method of collection for 32-gallon can accounts (provide 32-gallon automated cans, convert to 90-gallon automated cans, other).
  - Evaluate/revise existing residential routing system to accommodate commercial can accounts by determining the need for additional residential routes and the redistribute system workload to accommodate additional accounts.

The identification of appropriate system revisions is expected to occur in conjunction with the route audit process, with the route auditor reviewing all options and preliminary recommendations with the driver at each account.

Task 9: Determine Revised System Workload

Changes to the existing commercial collection system, including increasing container sizes and decreasing collection frequency, altering collection schedule, and shifting of can accounts to residential routes will alter the system workload. Once all of the desired changes have been identified, it will be necessary to develop a revised CSWD (Appendix C). The revised CSWD will form the basis for determining the number of routes required to handle the associated workload. When developing the revised system workload two distinctions need to be made. First, all accounts that can be serviced with one-person front-loading vehicles need to be distinguished from those requiring some other form of collection, and within this distinction all accounts scheduled during the week need to be identified separately from those scheduled on the weekend.

Determination of the revised system workload is expected to occur in conjunction with Tasks 9 and 10 immediately following the route audit process. In practice it may be possible to organize the route audit process to complete the auditing of routes in specific areas of the city (e.g., the downtown area) to allow for analysis of the revised system prior to completion of the entire route audit process. This would then allow the institution of operational changes to occur in these areas on an earlier time frame.

Task 10: Determine Required Number of Routes

Once the revised system workload has been determined (Task 8), the next step is to determine the total number of routes required to handle the associated workload. When determining the number of routes we consider accounts that can be serviced with one-person front-loading vehicles separately from those requiring some other form of collection.

The number of routes is determined by dividing the total weekday system workload (cubic yards) associated with front-loader-compatible accounts by a weekly cubic-yard standard for a typical route. Based on our observations, it appears reasonable to expect a standard of 35 to 40 cubic yards per hour for a front-loader with one operator. Based on an eight-hour day, a reasonable workload would be 280 to 320 cubic yards per day (1,400 to 1,600 cubic yards per week).

For purposes of illustration, let us assume that all can accounts are shifted to the residential waste stream and that all container accounts are compatible with one-person front-loader collection. Let us also assume we are dealing with the existing system. The total weekday system workload is 12,800 cubic yards (not including can accounts, commercial blankets and carts, and roll-off accounts). The number of front-loader routes required to service this workload varies from 8.0 route (8 routes) to 9.1 routes (9 routes) depending upon whether the standard is 35 or 40 cubic yards per hour. A key aspect of the route audit and the institution of an electronic timeclock is to more accurately track the number of cubic yards per hour collected by the existing rear-loader routes. This information can be used to help determine an appropriate cubic-yard-per-hour standard for the City's commercial front-loader system. Once the revised routes are implemented, a reaudit should be conducted to finalize the route standard. Routes should then be audited periodically (e.g., every 18 months).

In addition to the 8 or 9 weekday front-loader route requirement projected in our example Saturday coverage is projected to require from 1.0 to 1.1 front-loader routes based on a standard of 40 and 35 cubic yards, respectively.[11] Special routes may also need to be operated to handle atypical accounts such as commercial cart and blanket accounts and accounts requiring two-person crews. Special routes should be audited just like regular routes to ensure that they are operated efficiently and establish an appropriate productivity standard.

[11] In practice, providing citywide Saturday coverage will require increased drive time for routes that are operating and a lower productivity standard can be expected.

Task 11: Distribute Workload among Routes

Once the total number of required routes is determined (Task 10), the next step is to distribute the daily workload among the required number of routes. The main objective of the distributing process is to develop "saturated routes" by concentrating each route in a distinct geographic area on any given day. As noted in Task 4, the reorganization process should make use of the existing routes to the extent possible, provided efficiency is not sacrificed. The revised CSWD will be organized the same as the existing CSWD shown in Appendix C, with accounts shown as distributed among the existing routes. Management will want to review this distribution in light of the required number of routes and note particular system characteristics, as was illustrated for the existing system in Task 4. Based on this overview, management can then determine how best to consolidate the revised workload among the required number of routes.

It is not necessary that all routes consist of equal daily or even weekly workloads. It is, however, important that all routes be tracked according to the established standard, and that drivers be compensated with overtime for more than 8 hours work. The key to success is to develop and maintain a reasonable performance standard for each route, and to monitor daily collector performance with respect to the established standard.

Once the daily geographic service area is established, drivers and supervisors should work together to develop daily microroutes to ensure efficient sequencing and routing. Microroutes are the specific path a vehicle will follow from one account to the next.

Task 12: Train Collectors

The shifting of routes from rear-loading to front-loading vehicles will require additional trained front-loader drivers, and, with any reductions in crew size, all front-loader drivers will need to be trained to use the on-board monitoring systems for safe backing. In addition, the shift from two-person to one-person routes should be accompanied by an aggressive training program to make drivers aware of the standards to be used to judge when a account is deemed too heavy and provide proper training for moving of containers by one person. A cross-training program should also be implemented once the final routing system is in place to ensure backup coverage on all commercial routes (e.g., rotate drivers among routes every three months). Monthly safety training related to one-person collection issues should be instituted at the start of the implementation process as shown on the schedule. The training of collectors with respect to the revised routing system is expected to occur in conjunction with the institution of operational changes. Cross-training of drivers is then expected to occur on an ongoing basis.

Task 13: Institute Operational Changes

Once the workload has been distributed among the required routes and individual microroutes developed, and drivers have been trained, the revised system is ready for implementation. As

noted above it may be possible to organize the route audit process to complete the auditing and redistribution of the existing workload among routes in specific areas of the city prior to completion of the entire route audit process. This would then allow the institution of operational changes to occur in these areas on an earlier time frame. The proposed schedule provides for a two-month implementation time frame for operational changes. This schedule can be adjusted if desired.

Task 14: Monitor and Evaluate Routes and Revise as Necessary

After the revised routes are implemented management should reaudit the system to make sure that workloads are fair and reasonable and, if not, revise the routing system as necessary. Final standards for each of the routes (cubic yards/hour) should be established at this time, and the Daily Activity Sheet used to track route productivity and overtime. The City may want to consider collecting general time and motion data as part of this reauditing of routes to provide another tool for balancing the routes.

Task 15: Analyze Residential Solid Waste and Recycling Collection Systems

Analysis of the residential solid waste collection system will need to occur before the commercial route audit process is complete. This needs to be done to determine the impact of shifting can accounts from the commercial to the residential system. Appropriate revisions to the residential system will need to occur in conjunction with the revision of those commercial routes which currently handling can accounts. We suggest that this analysis occur early in the route audit process. The schedule shows this activity as beginning in week 5; however, there is no reason this activity could not begin earlier. We also strongly recommend analysis of the recycling system and we suggest that a preliminary analysis of the recycling system be conducted in conjunction with the analysis of the residential solid waste collection system.

ANALYSIS OF ADDITIONAL EQUIPMENT AND LABOR NEEDS

Any changes (additions/reductions) in equipment and labor will depend upon the type and extent of changes made to the existing commercial collection system. The basic issue analyzed is what is the revised daily/weekly system workload, and what equipment and labor resources will be required to effectively handle that workload given revised operational conditions. The need for additional equipment and/or labor will depend upon a range of factors, including:

- Additional haul time for commercial routes currently delivering waste to the 28th Street Landfill once they start direct hauling to the County's North Area Transfer Station or to Kiefer Landfill

- Extent of shifting from rear-loader to front-loader routes and from two- to one-person crews

- Extent of shifting of commercial and residential 32-gallon can accounts from commercial rear-loader routes to residential side-loader routes, and the ability of the existing residential system to handle the increased workload with available resources

- Potential for incurring front-loader route overtime to reduce the number of required routes.

Although it will not be possible to determine the final number of routes required until the route audit has been completed; we can make a preliminary projection. If we assume that all of the can accounts are shifted to the residential system, and all container accounts are compatible with front-loader collection, a total of 9 front-loader routes will be required, assuming a route productivity standard of 35 cubic yards per hour. The City currently operates five front-loader routes (including route 51); therefore, five additional front-loader routes, and related primary and backup vehicles, would be required (assume an additional five primary and one backup front-loader). Given that this calculation is based on an eight-hour day, there is capacity within these 9 routes in the form of overtime to account for a somewhat lower hourly standard without requiring an additional route. If the actual standard is significantly lower, additional routes would be expected.

This projection of 9 front-loader routes represents fewer routes than the existing system, and it is expected that, given no reassignment, the net labor force would be reduced by the number of general helpers currently providing on-route collection support, and possibly a number of rear-loader drivers. More or less reduction may be necessary depending on the final route productivity standard set for the collection system and the extent to which two-person collection crews are required.

The shift of cans from the commercial to the residential collection system is projected to require one or two additional side-loader routes. This assumes that there is insufficient capacity within the existing residential system to handle the associated increase in workload. The commercial system currently handles roughly 4,800 weekly can pickups. Operations management cited a residential productivity standard of roughly 650 residential accounts per route per day. Based on this standard, 1.5 routes are projected to be required on a 40-hour per week basis to collect this many accounts. Accordingly, one or two additional side-loaders and route drivers would need to be put into service if the existing residential collection system capacity cannot accommodate this increased workload.

It is expected that with the new system the need for rear-loading vehicles will decrease significantly. It is expected, however, that the City will need to maintain some rear-loaders to accommodate certain types of collection.

Additional equipment requirements may include:

- Backup monitoring equipment on all one-person route vehicles
  (assume 12 units @ $2,500 = $30,000)

- Additional 30- or 90-gallon fully-automated compatible containers
  (4,553 total weekly can lifts = assume 3,000 total accounts @ $60 = $180,000)

- Rapid Rail "hugger grabber" attachment [12]

- Materials to convert rear-loader bins to provide front-loader compatibility

- Additional container inventory (depending on the extend to which existing bin sizes are adjusted throughout the system).

SURVEYS

Worker Injury Survey

The objective of this survey was to gather information related to the risk of worker injury when reducing commercial collection routes from two- to one-person crews. To achieve this objective, we surveyed 15 different associations, publications, agencies, and truck manufacturers dealing with solid waste issues. The goal was to obtain any surveys, studies, reports, regulations, or other information pertaining to the level of risk collection workers experience on one-person commercial routes. The following is a summary of the information provided by respondents.

Of the 15 sources surveyed, none were familiar with any studies specifically focusing on worker safety issues for one-person collection crews. However, truck manufacturers and solid waste associations stated that front-loader trucks are designed to be operated by one person. Truck companies noted that there are single-point triangle coupler front-end loaders, which can be operated by one person and have the capability to dump bins up to 30 degrees out-of-phase with the truck. This reduces the need for drivers to push/pull dumpsters. Heil Truck Company noted that it sells front-loaders that can collect plastic containers. Plastic containers do not rust from wet loads and are lighter and easier to move.

OSHA staffer Bob Nokamura stated that his agency has not conducted any studies of the health and safety aspects of solid waste collection. OSHA recently developed draft general ergonomics

[12] The City expects to purchase several new trucks with hugger grabber arms within the next few months.

standards, which should be final regulations within a year. The regulations will require employers to conduct an ergonomics evaluation and develop an ergonomics program. These regulations will likely impact the City of Sacramento operations and require the working conditions to be evaluated for repetitive injury risk.

The National Safety Council provided two articles concerning the safety of solid waste collection workers. One article discusses the safety of backing up front-loaders and the other discusses safety aspects of collecting bags instead of cans. Both articles are included in Appendix E as informational material but do not directly pertain to the safety aspects of one-person commercial collection crews.

The American National Standards Institute (ANSI) has prepared the "Mobile Refuse Collection and Compaction Equipment Safety Requirements". Use of ANSI safety requirements is voluntary and does not preclude anyone from purchasing or using products or procedures not conforming to the standards. However, ANSI proposes use of these standards to establish safety requirements with respect to mobile collecting and compacting equipment. Recommendations are made on operational requirements, safeguards, and procedures.

In summary, the survey was not successful in gathering information relating to the worker safety issues of commercial collection vehicles operated by one-person crews. The information provided is general safety guidelines for operation of commercial collection vehicles as well as future ergonomics standards. To reduce the risk of worker injury, there is the option of purchasing single-point triangle-coupler front-loaders with which one-person crews can collect bins 30 degrees out-of-phase with the truck without moving them. The associated cost and benefit of this option; however, would need to be evaluated relative to other alternatives.

Industry Survey

The objective of the industry survey was to gather information related to commercial solid waste collection crew size. The goal was to determine conditions under which other California commercial operations collecting wet wastes ensure worker safety and promote the ability to use one-person crews. To obtain the desired information, we surveyed 13 different cities and solid waste collection companies. The following is a summary of the information collected during the survey.

Of the 13 jurisdictions and haulers surveyed, only three still use two-person crews to collect wet commercial wastes—the cities of Clovis, Berkeley, and Fresno. According to Clovis and Berkeley, the physical layout of older neighborhoods with their very small alleys makes it impossible to run one-person crews, mainly because in tight areas drivers need assistance in guiding vehicles to avoid buildings, fences, and overhead wires. The city of Fresno reported

that it tried one-person crews, but the costs were higher and drivers had trouble backing up trucks without assistance.

For the other 10 haulers, the wet commercial routes are being collected using one-person crews without any adverse effects on worker health and safety. However, only three haulers are still using rear-loaders and all three are phasing them out of service due to inefficiencies. The city of Santa Cruz has determined that because the rear-loaders can only collect 1- to 2-cubic-yard bins and the front-loaders can collect up to 8-cubic-yard bins, front-loaders on their routes average 1.5 to 2 tons of solid waste per labor hour more than the rear-loaders.

The city of Redding is also phasing out rear-loader trucks; it currently operates five front-loaders and two rear-loaders. Changing out the first rear-loaders eliminated three positions. Two staffers were reassigned to the newly created container maintenance program, and the third staffer is used as a "floater" between the two rear-loaders and goes on the route with the most traffic problems or hard-to-service accounts.

Two respondents noted that there are no conditions warranting having two-person crews on trucks, while 11 stated that there are such conditions. Those respondents stating that certain conditions did warrant two-person crews noted the following conditions: apartment buildings where dumpsters were below the building in the parking garage, construction demolition debris, compacted and other extremely heavy loads, hilly areas, and backing up in high traffic areas.

Most respondents noted that they did not have unions and kept their staff happy through various benefit programs and allowing collectors to clock out after finishing their route even if they did not work an eight-hour day. Also, the most common container sizes by far are the 3- and 4-cubic-yard bins. Most responses noted that, on average, 40 percent of the accounts required drivers to move bins and return bins to enclosures.

Respondents gave suggestions on how Sacramento can convert from two-person to one-person crews. They are:

- Phase out use of rear-loader trucks
- All trucks should be retrofitted with cameras for easier and safer backups
- Require bins to be placed on hard surfaces (concrete or asphalt) for easier movement
- Require that any building being renovated or remodeled must locate the bin enclosure in an area where trucks can "stab" bins without moving them

- All new buildings must locate enclosures/bins where truck can directly stab the bin
- Collect downtown commercial accounts between 4 and 7 a.m. only to avoid traffic congestion
- Require wet waste of significant weight to be placed in bins of 3 cubic yards or less
- Allow larger bins only in areas where the truck can stab it without moving it;
- Do not allow, or increase rates for, those customers who have push/pulls of greater than 20 feet
- Run one route with two-person crew for the hard-to-access bins or run a scout route with a bobcat for extremely heavy bins
- Work with customers individually to better position the bins
- Buy only bins with high-quality wheels for easier push/pulls or replace old wheels that make push/pulls difficult
- Have drivers of front-loaders go on rear-loader routes and give supervisors suggestions on which accounts could be serviced by front-loaders, what size bin should be provided, and where the bin should be located.

Respondents also offered suggestions on how to maintain and ensure the health and safety of collection staff while converting to one-person crews. They are:

- Do not allow staff to push/pull any bins larger than 5 cubic yards
- Provide instruction by certified physical therapist on proper warm-up, lifting, and push/pull techniques
- Provide back braces for collection staff
- Teach staff to only use 75 percent of their strength at any time because accidents happen most often when exerting 100 percent of effort.

Generally, haulers try to encourage customer cooperation with bin placement and increasing bin size (to reduce frequency of pickups) using individual account reviews and rate structure incentives. Several respondents noted that their cities are currently developing enclosure

standards and require solid waste staff review of site plans for new buildings to ensure that bins are not visible and are located in areas where trucks can directly stab bins by having enough turning radius.

In summary, the industry standard for commercial solid waste collection is to use front-loader trucks with one-person crews. If the proper infrastructure and equipment is in place, there has been no increase in worker injuries identified by survey respondents. Other communities have phased out rear-loader trucks and replaced them with front-loaders to increase collection efficiency. Most survey respondents noted that by encouraging truck drivers to work with individual customers to better position bins and change bin sizes (e.g., smaller bins for heavy wet loads, larger bins for lighter loads) the entire system can be made more efficient and both the customer and collector will benefit.

A list of industry survey contacts is provided in Appendix F. Appendix G contains information on detachable container body transfer systems.

APPENDIX A

STANDARDS FOR DETERMINING CREW SIZE

APPENDIX A
STANDARDS FOR DETERMINING CREW SIZE

The following standards (criteria) are provided for use by the City of Sacramento in conjunction with the recommended "route audits" outlined in the Action Plan in the body of the report to determine if an account warrants a two-person crew. These guidelines represent general criteria. For any given account conditions, criteria other than those noted below may exist that mandate two-person collection. It will be up to route supervisors and drivers to evaluate each account individually.

We suggest that the initial decision as to which accounts warrant two-person crews rest with the route auditor/supervisor. Each route driver should then review the assessment with the supervisor and confirm or revise the assessment as appropriate. A two-person crew should be used for an individual account if any of the following conditions exist, unless direct access with a front-loader is possible:

- Accounts with vertical compactor units
  (Recommended mitigation: If customers choose to purchase a compactor, it becomes their responsibility to move the container into a position where the driver does not have to move it. This is a common practice in the industry)

- Bins over 4 cubic yards[1]

- Bins on soft surface (e.g., gravel)
  (Recommended mitigation: Relocate the container to a hard, level surface.

- Container must be pushed up or down an incline
  (Recommended mitigation: Relocate the container to a hard, level surface).

[1] No container over 4 cubic yards should have wheels. If a 5-cubic-yard or larger container is sited (or if a smaller container is too heavy for one person to move), it must have direct front-loader access to eliminate manual maneuvering. Except in extreme conditions, it is reasonable to expect one man to move a 4-cubic-yard container. In cases where a 4-cubic-yard container is too heavy to move by one person, the container should be replaced with a smaller container(s) and collection frequency adjusted, if necessary.

- Excessively heavy bins[2]
  (Recommended mitigation: In situations where existing containers may be too heavy for one person to move it may be possible through modification of the container with hard plastic wheels to provide a safe and reasonable situation for one-person collection. If a container is still too heavy to move by one person the container should be replaced with a smaller container(s), and collection frequency adjusted, if necessary. This option may require increased collection frequency.

- Excessive daily route workloads
  (Recommended Mitigation: Redistribute accounts among days of the week and/or among routes on any given day).

[2] Appropriate standards need to be developed for drivers to follow for determining overweight containers (e.g., if a container requires driver to exert more than 75 percent of his strength to move, it is considered to be too heavy). The switch from two- to one-person front-loader routes must be accompanied by a comprehensive safety training program. Daily warm up/stretching exercises by drivers should also be encouraged.

APPENDIX B

DAILY ROUTE ACTIVITY SHEET

DAILY ACTIVITY SHEET

DATE_____ ROUTE_____ TRUCK#_____

DAY OF THE WEEK_____ DRIVER_____

HELPER_____

CLOCKED IN_____ CLOCKED OUT_____ BREAK TIME_____

DOWN TIME_____ TOTAL HOURS WORKED_____

TOTAL YARDS_____ YARDS PER HOUR_____

LOADS TO LANDFILL_____ TONS PER LOAD 1._____
2._____
3._____

TOTAL MILES_____

REASON FOR OVERTIME_____

_____

_____

_____

_____

_____

_____

☐ TRUCK FUELED

☐ CLEAN BLADE

APPENDIX C

COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

TABLE OF CONTENTS

SOLID WASTE DIVISION
ROUTE LISTING SHEET

Breakdown of ROUTE

Residential Side Loaders

13 :	15 :	16 :	17 :
18 :	19 :	20 :	21 :
24 :	28 :	30 :	31 :
32 :	33 :	34 :	35 :
36 :	38 :	39 :	41 :
44 :	45 :	46 :	47 :
48 :	50 :	57 :	58 :
59 :	60 :	61 :	62 :
63 :	~~68~~ 67 :		

Residential Rear Loaders

~~3~~ :	~~4~~ :	~~5~~ :	~~7~~ :
~~8~~ :	12 :		

Early Morning Commercial Routes-Rear Loader

2 :	22 :	26 :	27 :
37 :	~~49~~ :		

Residential Bin Routes

14 :	23 :	~~25~~ :	43 :

Front Loader Routes

29 :	~~51~~ :	52 :	53 :
54 :	55 :	56 :	

Hot Spot - Neighborhood Cleanup - Special Kick Trucks

6 :	71 :	42 :

Recycle Routes

901 :	902 :	903 :
904 :	905 :	906 :
907 :	908 :	909 :

Breakdown of PICKUP DAY

A-MONDAY :	B-TUESDAY :	C-WEDNESDAY :
D-THURSDAY :	E-FRIDAY :	F-M TH :
G-TU F :	H-M W F :	I-M TU W TH :
J-M T W T F :	K-M THRU SAT:	L-M F :
M-TU S :	N-M W :	O-TU F S :
P-M TH S :	Q-M W S :	R-TU TH S :
S-M W TH F S:	T-M T TH F S:	U-M TU W F S:
V-M T W T S :	W-T W T F S :	X-OTHER :
Y-OTHER :	0-ZERO VALUE:	

Breakdown of REV CLASS

R NON-CURB : 600-603	R CURBSIDE : 604-607	R MECH LIFT : 608
R MULTIPLE : 609-610	R 1 YARD : 611-614	R 2 YARD : 615-618
R 3 YARD : 619-621	R 4-6 YARD : 623-627	R MOBIL/TRLR: 672
C 32-60 GAL : 630-633	C 1 YARD : 634-637	C 2 YARD : 638-641
C 3 YARD : 642-644	C 4-40 YARD : 646-665	C BLANKET : 666-670
C CART : 671	RECYCLE : 675	6 YD OLD SAC: 680

Breakdown of DISABLED

YES :

Route.lst

(Appendix C)
WEEKDAY TOTALS: COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

Code: Yd3		Route #:	2	6	11	12	22	23	25	26	27	29	37	42	43	51	52	53	54	55	56	Total	Code:
		Route Type:	EMCRL	Hotspot	?	RRL	EMCRL	RBIN.x	RBIN	EMCRL	EMCRL	Rolloff	EMCRL	SpecialKick	RBIN	FL.x	FL	FL	FL	FL	FL	Lifts	
600	0.2		46	9	222	151	2	65	0	0	26	0	13	0	249	0	0	0	0	0	0	783	600
601	0.2		10	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	601
602	0.2		0	0	3	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	11	602
603	0.3		0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4	603
604	0.2		15	6	307	290	0	1449	10	2	59	0	83	2	123	0	0	0	0	0	0	2326	604
605	0.2		0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	605
606	0.2		0	0	1	21	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	27	606
608	0.4		0	0	4	6	1	206	1	0	0	2	0	15	8	0	0	0	0	0	0	243	608
611	1		62	16	119	63	9	21	1	28	42	0	49	0	54	0	0	0	0	0	0	462	611
612	1		0	2	7	6	0	0	0	0	2	0	0	0	0	0	1	3	0	0	1	22	612
614	1		9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	614
615	2		166	22	129	77	57	11	2	110	79	0	99	0	97	0	0	2	0	0	7	858	615
616	2		0	0	56	5	2	3	0	0	8	0	5	0	65	0	10	66	34	11	11	276	616
617	2		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	617
618	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3	618
619	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	9	32	23	105	619
620	3		0	0	0	0	0	0	0	0	13	0	0	0	0	19	74	139	266	91	187	789	620
622	4		0	0	0	1	0	0	0	0	0	0	0	0	0	0	60	1	17	22	5	106	622
623	4		0	0	0	0	0	2	0	0	3	0	0	0	0	10	72	113	184	105	127	616	623
625	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	6	0	22	625
627	6		0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2	20	9	37	627
630	0.2		152	6	271	200	45	40	16	44	141	0	78	0	114	0	0	0	0	0	0	1107	630
631	0.2		37	0	9	13	53	1	0	0	8	0	0	0	13	0	0	0	0	0	0	134	631
632	0.2		12	0	9	8	0	7	0	0	0	0	4	0	10	0	0	0	0	0	0	50	632
633	0.3		10	0	0	0	0	0	0	0	0	0	5	0	2	0	0	0	0	0	0	17	633
634	1		112	6	27	37	10	9	3	24	48	0	38	0	32	0	0	0	0	0	0	348	634
635	1		0	0	2	0	0	0	0	0	7	0	10	0	0	1	0	3	0	0	1	24	635
638	2		105	25	25	20	92	8	3	112	128	0	57	0	52	0	1	7	8	10	3	652	638
639	2		2	9	0	0	17	0	0	27	28	0	29	0	0	2	8	7	22	5	5	161	639
640	2		0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	640
642	3		0	0	0	1	0	0	0	0	1	0	0	0	2	2	34	31	81	37	67	236	642
643	3		0	0	0	0	0	0	0	0	1	0	0	0	0	3	15	11	9	3	14	56	643
644	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	8	1	12	26	644
645	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	6	11	3	36	69	645
646	4		0	0	0	0	0	0	0	0	0	0	0	0	0	8	22	29	17	36	35	147	646
647	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	9	2	4	0	20	647
649	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	10	0	8	21	649
652	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	2	10	17	652
653	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	653
657	20		0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	657
659	25		0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	659
661	30		0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	11	661
663	35		0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	6	663
664	40		0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	664
665	40		0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	665
666	0.2		9	0	0	3	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	17	666
667	0.3		6	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	667
668	0.5		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	668
669	0.6		0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	669
671	0.4		295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	295	671
TOTAL (yd3):			913	139	704	428	372	410	18	555	677	931	509	7	605	155	1,230	1,500	2,193	1,386	1,933	14,665	
TOTAL (pickups):			1,058	101	1,194	911	290	1,829	36	345	609	31	453	17	825	46	342	475	662	388	563	10,173	

Total (yd3):	(w/o Cans 600–608, 630–633; Roll-off 657–665; Blankets 666–670; Carts 671)	12,600
Total (pickups):	(w/o Cans 600–608, 630–633; Roll-off 657–665; Blankets 666–670; Carts 671)	5,089
Total (pickups):	(Cans 600–608, 630–633)	4,724
Total (pickups):	(Blankets 666–669; Carts 671)	331
Total (pickups):	(Roll-off 657–665)	29
Number of front loader routes required:	(based on 12,800 yd3)	
	(40 yd3/hr; 8 hrs/saturday)	8.0
	(35 yd3/hr; 8 hrs/saturday)	9.1
	(30 yd3/hr; 8 hrs/saturday)	10.7
	(25 yd3/hr; 8 hrs/saturday)	12.8
Number of side loader routes required:	(based on 4,724 yd3)	
	(650 accounts/day; 5 days/week)	1.5

(Appendx C)
SATURDAY: COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

Code:	Yd3	Route #:	2	6	11	12	22	23	25	28	27	29	37	42	43	51	52	53	54	55	56	Total	Code:
		Route Type:	EMCRL	Hotspot	?	RRL	EMCRL	RBIN.x	RBIN	EMCRL	EMCRL	Rolloff	EMCRL	Special	RBIN	FL.x	FL	FL	FL	FL	FL	Lifts	
600	0.2		8								9											17	600
601	0.2		2																			2	601
602	0.2										1											1	602
603	0.3										2											2	603
604	0.2		3								16											19	604
605	0.2																					0	605
606	0.2																					0	606
608	0.4																					0	608
611	1		5								10											15	611
612	1																					0	612
614	1																					0	614
615	2		11							1	4											16	615
616	2										2											2	616
617	2																					0	617
618	2																					0	618
619	3																					0	619
620	3																					0	620
622	4																					0	622
623	4																					0	623
625	5																					0	625
627	6																					0	627
630	0.2		15								7											22	630
631	0.2		6								3											8	631
632	0.2																					0	632
633	0.3																					0	633
634	1		14																			14	634
635	1										4											4	635
638	2																					0	638
639	2		11				1				11								1			24	639
640	2																					0	640
642	3																1	3			6	10	642
643	3																	3	1		1	5	643
644	3																		1		3	4	644
645	4																	1	1	1	5	8	645
646	4																	6	3	5	6	20	646
647	4																	1		1		2	647
649	5																		1		1	2	649
652	6																					0	652
653	6																					0	653
657	20																					0	657
659	25																					0	659
661	30											1										1	661
663	35											1										1	663
664	40											1										1	664
665	40																					0	665
666	0.2																					0	666
667	0.3																					0	667
668	0.5																					0	668
669	0.6																					0	669
671	0.4																					0	671
TOTAL (yd3):			68	0	0	0	2	0	0	2	54	105	0	0	0	0	3	50	29	28	79	420	
TOTAL (pickups):			75	0	0	0	1	0	0	1	69	3	0	0	0	0	1	14	8	7	22	201	

Total (yd3):	(w/o Cans 600-608, 630-633; Roll-off 657-665; Blankets 666-670; Carts 671)	304
Total (pickups):	(w/o Cans 600-608, 630-633; Roll-off 657-665; Blankets 666-670; Carts 671)	126
Total (pickups):	(Cans 600-608, 630-633)	72
Total (pickups):	(Blankets 666-669; Carts 671)	0
Total (pickups):	(Roll-off 657-665)	3

Number of front loader routes required:	(based on	304 yd3)	
(40 yd3/hr; 8 hrs/saturday)			1.0
(35 yd3/hr; 8 hrs/saturday)			1.1
(30 yd3/hr; 8 hrs/saturday)			1.3
(25 yd3/hr; 8 hrs/saturday)			1.5
Number of side loader routes required:	(based on	72 yd3)	
(650 accounts/day; 8 hrs/saturday)			0.0

(Appendix C)
WEEKLY TOTALS: COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

Code:	Yd3:	Route #: / Route Type:	2 EMCRL	6 Hotspot	11 ?	12 RRL	22 EMCRL	23 RBIN(X)	25 RBIN	26 EMCRL	27 EMCRL	29 Rolloff	37 EMCRL	42 Special	43 RBIN	51 FL (X)	52 FL	53 FL	54 FL	55 FL	56 FL	Total Lifts	Code:
600	0.2		54	9	222	151	2	65	0	0	35	0	13	0	249	0	0	0	0	0	0	800	600
601	0.2		12	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	601
602	0.2		0	0	3	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	12	602
603	0.3		0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	6	603
604	0.2		18	6	307	290	0	1449	10	2	75	0	63	2	123	0	0	0	0	0	0	2,345	604
605	0.2		0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	605
606	0.2		0	0	1	21	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	27	606
608	0.4		0	0	4	6	1	206	1	0	0	2	0	15	8	0	0	0	0	0	0	243	608
611	1		67	16	119	63	9	21	1	26	52	0	49	0	54	0	0	0	0	0	0	477	611
612	1		0	2	7	6	0	0	0	0	2	0	0	0	0	0	1	3	0	0	1	22	612
614	1		9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	614
615	2		177	22	129	77	57	11	2	111	63	0	89	0	97	0	0	2	0	0	7	874	615
616	2		0	0	56	5	2	3	0	0	10	0	5	0	65	0	10	66	34	11	11	278	616
617	2		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	617
618	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3	618
619	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	9	32	23	105	619
620	3		0	0	0	0	0	0	0	0	13	0	0	0	0	19	74	139	266	91	187	789	620
622	4		0	0	0	1	0	0	0	0	0	0	0	0	0	0	80	1	17	22	5	106	622
623	4		0	0	0	0	0	2	0	0	3	0	0	0	0	10	72	113	184	105	127	616	623
625	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	6	0	22	625
627	6		0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2	20	9	37	627
630	0.2		167	6	271	200	45	40	16	44	148	0	78	0	114	0	0	0	0	0	0	1,129	630
631	0.2		43	0	9	13	53	1	0	0	11	0	0	0	13	0	0	0	0	0	0	143	631
632	0.2		12	0	9	8	0	7	0	0	0	0	4	0	10	0	0	0	0	0	0	50	632
633	0.3		10	0	0	0	0	0	0	0	0	0	5	0	2	0	0	0	0	0	0	17	633
634	1		126	6	27	37	10	9	3	24	48	0	38	0	32	0	0	0	0	0	0	360	634
635	1		0	0	2	0	0	0	0	0	11	0	10	0	0	1	0	3	0	0	1	28	635
638	2		105	25	25	20	92	8	3	112	126	0	57	0	52	0	1	7	8	10	3	652	638
639	2		13	9	0	0	18	0	0	27	39	0	29	0	0	2	8	7	23	5	5	185	639
640	2		0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	640
642	3		0	0	0	1	0	0	0	0	1	0	0	0	2	2	35	34	61	37	73	246	642
643	3		0	0	0	0	0	0	0	0	1	0	0	0	0	3	15	14	10	3	15	61	643
644	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	9	1	15	30	644
645	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	7	12	4	41	77	645
646	4		0	0	0	0	0	0	0	0	0	0	0	0	0	8	22	35	20	41	41	167	646
647	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	10	2	5	0	22	647
649	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	11	0	9	23	649
652	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	2	10	17	652
653	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	653
657	20		0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	657
659	25		0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	659
661	30		0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	12	661
663	35		0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	7	663
664	40		0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	664
665	40		0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	665
666	0.2		9	0	0	3	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	17	666
667	0.3		8	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	667
668	0.5		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	668
669	0.6		0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	669
671	0.4		295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	295	671
TOTAL (yd3):			981	139	704	428	374	410	18	557	732	1,036	509	7	605	155	1,233	1,550	2,222	1,414	2,012	15,086	
TOTAL (pickups):			1,131	101	1,194	911	291	1,829	38	346	678	34	453	17	825	46	343	469	670	395	585	10,374	

Total (yd3):	(w/o Cans 600–608, 630–633; Roll-off 657–665; Blankets 666–670; Carts 671)	13,104
Total (pickups):	(w/o Cans 600–608, 630–633; Roll-off 657–665; Blankets 666–670; Carts 671)	5,215
Total (pickups):	(Cans 600–608, 630–633)	4,796
Total (pickups):	(Blankets 668–669; Carts 671)	331
Total (pickups):	(Roll-off 657–665)	32

Number of front loader routes required:	(based on	13,104 yd3)	
(40 yd3/hr; 8 hrs/saturday)			8.2
(35 yd3/hr; 8 hrs/saturday)			9.4
(30 yd3/hr; 8 hrs/saturday)			10.9
(25 yd3/hr; 8 hrs/saturday)			13.1
Number of side loader routes required:	(based on	4,796 yd3)	
(650 accounts/day; 5 days/week)			1.5

(Appendix C)
MONDAY: COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

Code:	Yd3:	Route #:	2	6	11	12	22	23	25	26	27	29	37	42	43	51	52	53	54	55	56	Total	Code:
		Route Type:	EMCRL	Hotspot	?	RRL	EMCRL	RBIN.x	RBIN	EMCRL	EMCRL	Rolloff	EMCRL	Special	RBIN	FL.x	FL	FL	FL	FL	FL		
600	0.2		15	3	42	22		27			2		2		47							160	600
601	0.2		2		2																	4	601
602	0.2				3						2											5	602
603	0.3																					0	603
604	0.2		3		100	85		305	5		17				35							550	604
605	0.2				1																	1	605
606	0.2					7																7	606
608	0.4					1	1	116	1			2		4	2							127	608
611	1		17	7	39	13	4	9	1	7	7		15		15							134	611
612	1				2	2					1											5	612
614	1		3																			3	614
615	2		52	8	27	15	23	4		38	25		21		26							239	615
616	2				3	1	1				1		2		1		4	13	16	1	1	44	616
617	2		1																			1	617
618	2																	1			1	2	618
619	3																	9	3	8	4	24	619
620	3										13					7	32	41	70	36	34	233	620
622	4					1											2		4	12	1	20	622
623	4							2			3					10	15	40	68	49	50	237	623
625	5																7			3		10	625
627	6															1	1	1	1	7	5	16	627
630	0.2		23	2	68	58	21	2	2	8	15		7		16							222	630
631	0.2		10		5	3	11															29	631
632	0.2		2		2	4		7														15	632
633	0.3		3										1									4	633
634	1		28	3	8	13	3	1	3	4	7		8		13							91	634
635	1				1						1		2			1		1				6	635
638	2		26	4	10	5	18	2	3	27	23		12		17		1	3	2	2	1	156	638
639	2			1			5			5	8		8			1		3	2		1	32	639
640	2												1									1	640
642	3										1				2	1	11	6	16	8	16	61	642
643	3										1					1	5	3	3	1	3	17	643
644	3																1		3	1	3	8	644
645	4																4	1	3	1	10	19	645
646	4															4	6	8	2	11	12	43	646
647	4																2	2	1	1		6	647
649	5																1		3		2	6	649
652	6																		1		4	5	652
653	6																1					1	653
657	20																					0	657
659	25											1										1	659
661	30											4										4	661
663	35											2										2	663
664	40																					0	664
665	40											1										1	665
666	0.2		1			1					1											3	666
667	0.3						2															2	667
668	0.5		1																			1	668
669	0.6																					0	669
671	0.4		59																			59	671
TOTAL (yd3):			241	37	164	103	107	132	11	152	189	256	115	2	138	92	325	428	664	521	544	4,221	
TOTAL (pickups):			246	28	313	231	89	475	15	89	126	10	79	4	174	26	93	132	198	141	148	2,617	

Total (yd3):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	3,730
Total (pickups):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	1,420
Total (pickups):	(Cans 600–608, 630–633)	1,124
Total (pickups):	(Blankets 666–669; Carts 671)	65
Total (pickups):	(Roll–off 657–665)	8

(Appendix C)
TUESDAY: COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

Code:	Yd3	Route #:	2	6	11	12	22	23	25	26	27	29	37	42	43	51	52	53	54	55	56	Total Lifts	Code:
		Route Type:	EMCRL	Hotspot	?	RRL	EMCRL	RBIN.x	RBIN	EMCRL	EMCRL	Rolloff	EMCRL	Special	RBIN	FLx	FL	FL	FL	FL	FL		
600	0.2		8		45	42		18			9				70							192	600
601	0.2		2																			2	601
602	0.2										1											1	602
603	0.3										2											2	603
604	0.2		3	6	52	62		547			16				18							705	604
605	0.2							1														1	605
606	0.2				1			2														3	606
608	0.4				1			33						11	1							46	608
611	1		6	2	16	3				3	13		4		8							55	611
612	1			2	1													3			1	7	612
614	1																					0	614
615	2		12	1	33	16	1	1	1	2	7		17		22			1			3	117	615
616	2				24			3			3				32			25	1	3	2	93	616
617	2																					0	617
618	2																					0	618
619	3																	8	2	7	4	21	619
620	3																6	24	58	7	45	140	620
622	4																28		5		1	34	622
623	4																22	13	25	10	13	83	623
625	5																1					1	625
627	6																			6		6	627
630	0.2		39	3	27	56	4	1	1	5	49		13		31							229	630
631	0.2		6				10				3				5							24	631
632	0.2		2												7							9	632
633	0.3		1										1									2	633
634	1		19		1	5	1	1		6	14		4		3							54	634
635	1										2		2									4	635
638	2		16	6	2	6	19	2		18	31		12		11					2	1	126	638
639	2		1	3			1			6	5		3				4	1	8	2	1	35	639
640	2																					0	640
642	3																8	5	10	7	11	41	642
643	3																1	2	2		4	9	643
644	3																	1			3	4	644
645	4																1	2	1		4	8	645
646	4																3	4	5	2	3	17	646
647	4																	2		1		3	647
649	5																		2		1	3	649
652	6																		1	1		2	652
653	6																					0	653
657	20											1										1	657
659	25																					0	659
661	30											2										2	661
663	35											1										1	663
664	40											1										1	664
665	40																					0	665
666	0.2		4								1											5	666
667	0.3		4																			4	667
668	0.5		1																			1	668
669	0.6														4							4	669
671	0.4		59																			59	671
TOTAL (yd3):			120	25	156	76	45	114	2	62	134	155	76	5	165	0	274	261	394	171	305	2,540	
TOTAL (pickups):			183	23	203	190	36	609	2	40	156	5	56	11	213	0	74	91	120	48	97	2,157	

Total (yd3):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	2,155
Total (pickups):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	863
Total (pickups):	(Cans 600–608, 630–633)	1,216
Total (pickups):	(Blankets 666–669; Carts 671)	73
Total (pickups):	(Roll–off 657–665)	5

(Appendix C)
WEDNESDAY: COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

Code:	Yd3	Route #: / Route Type:	2 EMCRL	6 Hotspot	11 ?	12 RRL	22 EMCRL	23 RBIN.x	25 RBIN	26 EMCRL	27 EMCRL	29 Rolloff	37 EMCRL	42 Special	43 RBIN	51 FLx	52 FL	53 FL	54 FL	55 FL	56 FL	Total Lifts	Code:
600	0.2		5	3	49	27	2						5		109							200	600
601	0.2		2																			2	601
602	0.2										2											2	602
603	0.3																					0	603
604	0.2		3		65	40			5		3		16	2	62							196	604
605	0.2																					0	605
606	0.2																					0	606
608	0.4				1	2		24							2							29	608
611	1		16		22	13	1			3	5		6		3							69	611
612	1					2																2	612
614	1		3																			3	614
615	2		42	4	23	14	12	1		29	16		23		5			1				170	615
616	2				2	1					1		1				2	7	7	2	3	26	616
617	2		1																			1	617
618	2																					0	618
619	3																	8	1	3	5	17	619
620	3															4	5	11	42	9	4	75	620
622	4																		2	1	2	5	622
623	4																	18	20	10		48	623
625	5																			1		1	625
627	6																	1		2	1	4	627
630	0.2		23	1	80	20	3	27			20		27		28							227	630
631	0.2		10		2	1	11	1														25	631
632	0.2		4			4									2							10	632
633	0.3		3										1									4	633
634	1		21	1	7	4	2	5		3	10		9		3							65	634
635	1										1		2									3	635
638	2		20	4	2	1	17	1		21	23		8		4				2	2		105	638
639	2			1			5			5	6		7					1	2	1		28	639
640	2												1									1	640
642	3					1											4	6	13	7	14	45	642
643	3																2	2	2	1	2	9	643
644	3																1		2		3	6	644
645	4																2	1	1	1	8	13	645
646	4																4	5	3	6	6	24	646
647	4																1	1		1		3	647
649	5																1		1		1	3	649
652	6																	1	1		3	5	652
653	6																1					1	653
657	20																					0	657
659	25																					0	659
661	30											1										1	661
663	35											1										1	663
664	40											1										1	664
665	40											2										2	665
666	0.2		1			1					1											3	666
667	0.3																					0	667
668	0.5		1																			1	668
669	0.6																					0	669
671	0.4		59																			59	671
TOTAL (yd3):			200	20	113	69	74	24	1	116	112	185	105	0	55	12	79	211	317	163	183	2,039	
TOTAL (pickups):			214	14	253	131	53	59	5	61	88	5	108	2	218	4	23	63	99	47	52	1,495	

Total (yd3):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	1,712
Total (pickups):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	732
Total (pickups):	(Cans 600–608, 630–633)	695
Total (pickups):	(Blankets 666–669; Carts 671)	63
Total (pickups):	(Roll–off 657–665)	5

(Appendix C)
THURSDAY: COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

Code:	Yd3	Route #:	2	6	11	12	22	23	25	26	27	29	37	42	43	51	52	53	54	55	56	Total Lifts	Code:
		Route Type:	EMCRL	Hotspot	?	RRL	EMCRL	RBIN.x	RBIN	EMCRL	EMCRL	Rolloff	EMCRL	Special	RBIN	FL.x	FL	FL	FL	FL	FL		
600	0.2		12		59	42					9				9							131	600
601	0.2		2			7																9	601
602	0.2										1											1	602
603	0.3										2											2	603
604	0.2		3		58	87		13		2	16				7							184	604
605	0.2																					0	605
606	0.2					14																14	606
608	0.4					3		25														28	608
611	1		7	6	27	21	3	10		9	9		15		22							129	611
612	1				3	2					1						1					7	612
614	1																					0	614
615	2		15	3	19	19	6	4		13	12		19		24						1	135	615
616	2				2	2	1				2		2				2	5	3	2	1	22	616
617	2																					0	617
618	2																					0	618
619	3																	7	2	6	1	16	619
620	3																6	9	24	27	58	124	620
622	4																2	1	3	5		11	622
623	4																22	14	40	19	50	145	623
625	5																7			1		8	625
627	6																1		1	2	3	7	627
630	0.2		25		73	40	12	2	3	28	17		6		20							226	630
631	0.2		6		2	9	10				3				1							31	631
632	0.2		2		7								3									12	632
633	0.3												1		2							3	633
634	1		18		10	6	1	1		4	7		8		10							65	634
635	1										1		2					1			1	5	635
638	2		18	3	9	6	10	1		17	17		8		11			3		2		105	638
639	2			1			1			5	4		4					1			1	17	639
640	2																					0	640
642	3																4	6	5	7	10	32	642
643	3																2	3	1		1	7	643
644	3																					0	644
645	4																2		3	1	6	12	645
646	4																4	6	1	6	6	23	646
647	4																1	2	1			4	647
649	5																		1		2	3	649
652	6																					0	652
653	6																					0	653
657	20											1										1	657
659	25											1										1	659
661	30											2										2	661
663	35											1										1	663
664	40																					0	664
665	40																					0	665
666	0.2		2			1					1											4	666
667	0.3																					0	667
668	0.5		1																			1	668
669	0.6																					0	669
671	0.4		59																			59	671
TOTAL (yd3):			125	20	131	116	44	34	0	88	98	140	93	0	108	0	206	186	305	269	493	2,453	
TOTAL (pickups):			170	13	267	259	44	56	3	78	102	5	68	0	106	0	54	58	85	78	141	1,587	

Total (yd3):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	2,178
Total (pickups):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	877
Total (pickups):	(Cans 600–608, 630–633)	641
Total (pickups):	(Blankets 666–669; Carts 671)	64
Total (pickups):	(Roll–off 657–665)	5

(Appendix C)

FRIDAY: COMMERCIAL SYSTEM WORKLOAD DISTRIBUTION

Code:	Yd3	Route #:	2	6	11	12	22	23	25	26	27	29	37	42	43	51	52	53	54	55	58	Total Lifts	Code:
		Route Type:	EMCRL	Hotspot	?	RRL	EMCRL	RBIN.x	RBIN	EMCRL	EMCRL	Rolloff	EMCRL	Special	RBIN	FL.x	FL	FL	FL	FL	FL		
600	0.2		6	3	27	18		20			6		6		14							100	600
601	0.2		2																			2	601
602	0.2										2											2	602
603	0.3																					0	603
604	0.2		3		34	16		584			7		47									691	604
605	0.2							1														1	605
606	0.2							3														3	606
608	0.4				2			8							3							13	608
611	1		16	1	15	13	1	2		4	8		9		6							75	611
612	1				1																	1	612
614	1		3																			3	614
615	2		45	6	27	13	15	1	1	28	19		19		20						3	197	615
616	2				25	1					1				32		2	16	7	3	4	91	616
617	2		1																			1	617
618	2																				1	1	618
619	3																	9	1	8	9	27	619
620	3															8	25	54	72	12	46	217	620
622	4																28		3	4	1	36	622
623	4																13	28	31	17	14	103	623
625	5																1			1		2	625
627	6																	1		3		4	627
630	0.2		42		23	26	5	8	10	3	40		25		21							203	630
631	0.2		5				11				2				7							25	631
632	0.2		2										1		1							4	632
633	0.3		3										1									4	633
634	1		26	2	1	9	3	1		7	10		9		3							71	634
635	1				1						2		2					1				6	635
638	2		25	8	2	2	28	2		29	32		17		9			1	2	2	1	160	638
639	2		1	3			5			6	7		7			1	4	1	10	2	2	49	639
640	2												1									1	640
642	3															1	7	8	17	8	16	57	642
643	3															2	5	1	1	1	4	14	643
644	3																1	1	3		3	8	644
645	4																4	2	3		8	17	645
646	4															4	5	6	6	11	8	40	646
647	4																1	2		1		4	647
649	5																1		3		2	6	649
652	6																		1	1	3	5	652
653	6																1					1	653
657	20											1										1	657
659	25																					0	659
661	30											2										2	661
663	35											1										1	663
664	40											1										1	664
665	40											1										1	665
666	0.2		1								1											2	666
667	0.3		2			2																4	667
668	0.5		1																			1	668
669	0.6																					0	669
671	0.4		59																			59	671
TOTAL (yd3):			226	37	140	84	103	107	4	137	147	195	120	0	139	51	348	414	513	262	408	3,412	
TOTAL (pickups):			243	23	158	100	68	630	11	77	137	6	144	0	116	16	98	131	160	74	125	2,317	

Total (yd3):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	3,025
Total (pickups):	(w/o Cans 600–608, 630–633; Roll–off 657–665; Blankets 666–670; Carts 671)	1,197
Total (pickups):	(Cans 600–608, 630–633)	1,048
Total (pickups):	(Blankets 666–669; Carts 671)	68
Total (pickups):	(Roll–off 657–665)	6

APPENDIX D

ROUTE AUDIT FORM

COMMERCIAL ROUTE AUDIT

ROUTE #_____ DAY_____ DRIVER_____

STARTING TIME- FINISH TIME-

CUSTOMER NAME	ADRESS	BIN #	BIN SIZE	PUSH/RETURN	COMMENTS

ROUTE #:
DRIVER:

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
1YD					
1.5YD					
2YD					
3YD					
4YD					
6YD					
8YD					
ODD SIZES					
TOTAL YDS					
TOTAL HRS					
YDS/HR.					

APPENDIX E

SAFETY ARTICLES

BRINGING BACK-UP SAFETY TO ONE-MAN COLLECTION TRUCKS

87 0288

MICHAEL PETTENGILL

Mr. Pettengill is the Maintenance Manager for ERS, Inc., Bristol, Pennsylvania.

UNLIKE residential rear-loading refuse trucks whose crew members are almost always located behind the truck to assist backing operations, front-end loaders servicing commercial or industrial customers have only a one-man crew — the driver. These trucks do a lot of backing up down alleys between buildings and cars, and their potential for backing accidents was a major safety concern.

ERS, a division of Waste Management, Inc., is a hauling company that collects residential, commercial, and industrial refuse within a 40-mile radius around Bristol, extending into western New Jersey. Our hauling equipment includes 55 refuse collection vehicles, including rear loading residential pick up trucks, roll-offs for construction sites, and 13 front loaders.

Operation of the front loaders is all automatic; the truck engages the container with forks and dumps it overhead. There is no helper and the driver normally does not get out of the truck — unless he hits something.

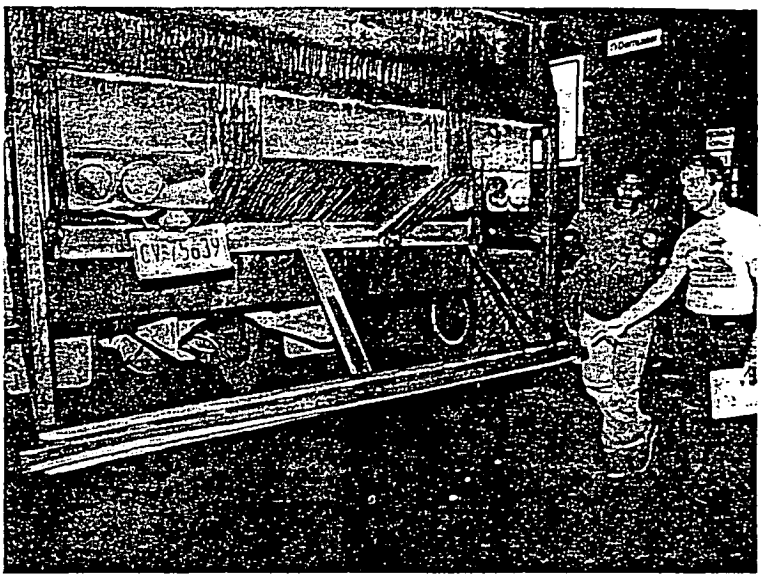
"Hitting something" has happened more frequently than we would like. Most of our backing accidents happen on our front loaders. Once a front loader backed down an alley and ripped 15 lights off the side of a building. The building was put out of service and the repairs cost us $10,000.

Troublesome Truck

Of particular concern to us was our front loader No. 223. The truck's route is in a very dense area of Philadelphia. It does a lot of backing up in tight, precarious alleys where there is the additional concern of playing children.

We are innovators in safety, have an excellent preventive maintenance program, and pride ourselves on staying abreast of changes in technology. We have a driver safety program that includes training videotapes, quarterly safety meetings, and weekly drivers' meetings to reinforce safe driving practices. We also have a safety bonus program whereby a driver can earn a $500 bonus if he goes without an accident for a year.

Knowing that our safety-minded drivers would be receptive, we began looking for a backup safety device for our front loaders. A few trucks had been equipped with photocell proximity sensing devices, but we found they were too sensitive. Too often they stopped the truck for false alarms as trivial as a newly-waxed bumper or a dust plume.



■ SLIGHTEST touch on sensor bar applies brakes instantly if vehicle is backing. Device is easily tested by hitting it while truck is in reverse.

We heard about BackStop from BackStop Inc., Northvale, New Jersey, and decided to give it a try. This equipment is a touch-sensitive reverse-backing system that functions only when the truck actually touches an object as it is backing up. Then it responds so quickly that the truck stops on a dime — often before the sensor bumper is fully compressed — so the actual truck body never touches the object that has stopped it. On the slightest touch the brakes are applied, and they stay applied until the driver shifts into neutral or a forward gear.

The sensor bumper is made of neoprene rubber and is fitted to an extended ICC bar or installed directly on the back of the truck. The control unit connects to the service air line and the emergency line. We installed the equipment on truck No. 223 in March 1986. Installation took us about four hours, but we can probably do the next one in half the time now that we know exactly how it is done.

The BackStop-equipped truck has been driven by three different men, none of whom have had any problems with the device. One driver was stopped while backing into a concrete pole. Another driver backed into a parked car, hitting it right in the middle, but the system operated so quickly there was no damage to the car. Ordinarily, damage to our truck would be minimal in a case like this, but we wanted the backup system as a safety liability factor.

The sensor bar is mounted directly on the truck's tailgate about 30 in. off the ground — a good height for childproofing. We are thinking of putting another sensor higher up on the truck to protect against above-ground level projections from buildings.

Testing the Equipment

We have tested the equipment ourselves by backing into a steel column outside our building at 7 to 8 mph. As we hit, the device stopped the truck with very little shakeup and no damage. We do not always ram columns, but we do test the equipment regularly as part of our routine shop inspection, which occurs on each truck every 13 days or 100 hours of operation. To test the system, you just hit the bar with your hand while the truck is backing up.

We are happy with the system so far. It has not caused us any problems, it has needed no maintenance, and it has saved us a few accidents. Our drivers are glad to have it installed, but they do not rely on it. The safety training we have given them makes them realize that their own careful driving is the primary ingredient of a good safety record. But BackStop does help, and our insurance statement proves its value. □□□

garbage collectors

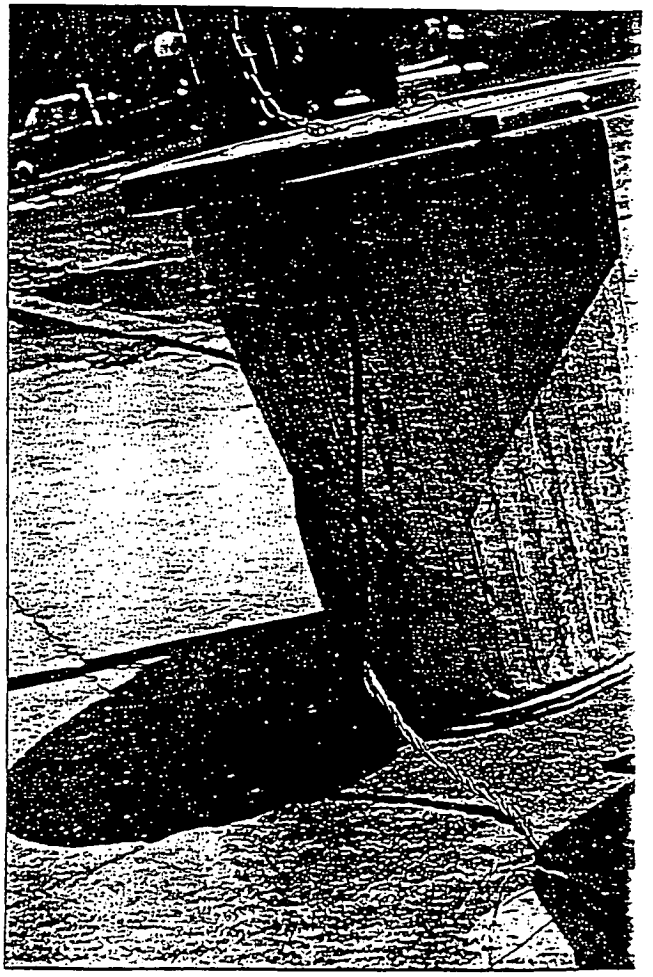
An Analysis of Policies For Trash Containers: Can It or Bag It?

by Charles K. Anderson, Ph.D., and Mark R. Ferraro

Garbage collectors have the second highest back injury rate of all occupations (Klein, et. al., 1984). A survey of 26 states showed a rate of 11.1 back sprains/strains per 100 workers for garbage collectors, compared to 0.75 back sprains/strains per 100 workers across all industries. The high rate of injuries is not unexpected due to the the physically demanding nature of the job. In a major U.S. city, a garbage collector would manually handle at least seven tons of garbage per day. Clearly, the municipal risk manager is interested in any policy change that might impact the physical demand of the garbage collector's job. This would include changes in route size and the type of trucks used for collection.

The city's sanitation department proposed a policy of only accepting garbage in bags, not in cans. The "bags-only" policy, it was felt, would create significant savings due to the increased efficiency of garbage bag collection. The department estimated a 10 percent reduction in workforce and trucks if the same amount of residential garbage was in bags. Additional support for the proposal was the fact that other cities with a bags-only policy had reported a significant drop in the number of back injuries.

Automatic-loading trucks were also discussed as another alternative for reducing the hazards and costs of sanitation collection. Such trucks mechanically pick up large containers and are typically operated by a one-person crew as opposed to the two- or three-person crew on manually loaded trucks. A complete change of equipment was not a feasible short-term solution for the city due to the high initial capital expense, but the concept was of interest as a long-term goal.



The risk manager for the city was interested in the injury risk implications of the alternative policies for sanitation collection because the department was a major source of workers' compensation cost. A study was performed of the injury risk of the three alternative policies:

- manual garbage collection with no restriction on containers (old policy);
- manual garbage collection with bags only (new policy); and
- automated garbage collection.

There are two basic areas of concern when

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Photo by Ken Weinstein

evaluating the injury risk of the alternative policies. One concern relates to the risk of contact injuries, such as laceration and puncture wounds. Obviously, there is a greater risk of needles, razor blades and other sharp objects coming through a bag as opposed to a can. Also, bags are more likely to break due to overloading, thus exposing the worker to substances that might cause chemical burns and dermatitis. The second area of concern relates to the risk of sprain/strain and other overexertion injuries due to the heavy physical demand of manually collecting garbage.

Risk of Contact Injury

The risk of contact injury was evaluated by reviewing sanitation collection injury reports associated with handling containers. Over a two-year period a total of 16 incidents could be identified that were contact injuries (i.e., laceration, chemical burn, etc.) associated with handling bags or cans. Eight of the incidents involved bags, and eight involved cans. A survey by the sanitation department revealed that 35 percent of the containers are bags, and 65 percent are cans/other (e.g., cardboard boxes). If there were no difference in risk for bags and

cans, it would be expected that there would have been six injuries associated with bags (35 percent bags multiplied by 16 injuries) and 10 injuries associated with cans. Hence, there are 33 percent more contact injuries associated with bags than expected (eight observed and six expected), but the difference is not statistically significant with this small sample. This suggests that if the number of bags handled is increased because of the elimination of cans, it would be anticipated that the number of contact injuries would also increase due to the greater level of exposure to the higher risk of contact injury.

Risk of Sprain/Strain Injuries

A similar analysis can be performed on sprain/strain injuries to look at whether there appears to be an increased risk of sprain/strain injury associated with handling a bag as opposed to a can. Review of the same injury data revealed that there were 14 sprain/strains associated with bags and 27 associated with cans. The numbers almost exactly match those expected based on the breakdown of 35 percent bags and 65 percent cans put on the streets by residents. Hence, bags and cans appear to be equally likely to cause a sprain/strain injury.

The greater concern is the overall amount of weight handled in a day rather than whether it's in bags or cans. Since there is a maximum weight limit of 50 pounds per container, the concern is not the risk associated with lifting one container. In fact, the average weights of bags and cans are estimated by the city's sanitation department to be 20 pounds and 30 pounds, respectively. Rather, the concern is the endurance required by the garbage collector to handle the typical load of about 1,000 containers per day.

The critical issue is the worker's ability to repeatedly handle moderate weights without sustaining decrements in strength. The worker may have to use only a small part of his or her full capacity to lift containers at the beginning of the day. As fatigue sets in, though, the muscles gradually lose their ability to create force. By the end of the day, it is very possible that some workers will be taxing their muscles to the maximum when lifting even a 20 or 30 pound container. If this occurs, it is not surprising to have overexertion injuries.

Second, the worker loses coordination as he or she fatigues and, thus, is less able to respond safely to an unexpectedly heavy load, shifting containers contents or unforseen trip hazards. The reduced coordination can thereby lead to an increased risk of an overexertion injury.

We can estimate the endurance requirement of the garbage collection job under the three policies through utilization of a set of metabolic demand prediction equations (Garg, 1978). The end product of applying the equations is a metabolic cost for the job in terms of kilocalories per minute (KCal/min). A kilocalorie is equivalent to the calorie associated with food. It is a measure of the energy required per minute to do the particular activity. For example, we expect that there is a higher energy or metabolic requirement when using a manually-loaded truck as opposed to a mechanically-loaded truck. The body has much more movement and exertion per unit of time when throwing garbage bags in the hopper than when manipulating levers to have the truck automatically lift the container and dump it in the bin.

"The 'bags-only' policy, it was felt, would create significant savings"

We can evaluate the energy requirement of the job relative to the capabilities of the U.S. workforce. Our index is the percent of U.S. male and female workers who would have the capability to do the job without significant fatigue, from which they would not be able to recover by the next day. The percent capable can be used as a mechanism to compare the alternative policies.

Metabolic Analysis

The garbage collection job was simulated via the metabolic prediction equations by making some assumptions about the job. First, it was assumed that when manually collecting garbage, there is a two-person crew on a rear-loading truck. While on the route, one person would drive, and the other person would ride standing on the back. It was assumed that the driving task and collection task were split equally between the two members of the crew. The person on the back would step down at each stop, collect the garbage, step back up and ride standing to the next stop. Typically, the collector would walk to the location of the containers and

Table 1.
Route Statistics

	Minimum	Average	Maximum
Number of Stops	270	519	874
Number of Containers	972	2,334	3,957
Route Time (minutes)	142	324	543

then lift and throw them directly into the hopper of the truck. Occasionally, the collector would have to carry the containers to the truck and set them in the hopper.

On the basis of this information, the garbage collection job was broken into the elements of driving/sitting, standing, walking to containers, carrying containers, loading containers and stepping back onto the truck. These elements correspond to the metabolic prediction equations that are available. The amount of time spent walking to containers and carrying them was estimated on the basis of an in-depth study of garbage collection performed for another city (Anderson, 1977). The Anderson study also had equations for the metabolic cost of handling a bag and a can.

The Anderson equations require the number of stops, number of containers, percent of containers that are bags, average bag weight, average can weight, route time and non-route time. Route time is defined as the amount of time spent driving between stops and collecting garbage. Non-route time is all of the other time on the shift. It is assumed that containers are either bags or cans. Hence, the percent of containers is 100 percent minus the percent of bags.

"The greater concern is the overall amount of weight handled in a day"

The metabolic cost of the job is also dependent on sex and body weight, so these variables are also included in the prediction equations. Predictions were made for average-weight males (165 pounds) and average-weight females (137 pounds).

The current routes could be simulated on the basis of route data collected by the sanitation department. The equivalent bags-only route was constructed by assuming that there would be the same weight of garbage on a route regardless of whether it was contained in bags and cans or in bags only. The total weight for a route was estimated by adding the predicted total weight in bags and total weight in cans and other containers. The predicted total weight in bags was obtained by multiplying the average weight per bag by the number of bags. The same process was used for cans and other containers. It was assumed that other containers had the same average weight as cans. The equivalent number of bags on the simulated bags-only route was calculated by dividing the total weight for the route by the average weight per bag.

A second aspect of the proposed bags-only policy was to decrease the workforce by 10 percent. This implies that the number of stops per route would be increased by 10 percent in order to still service the entire city. It was assumed that a 10 percent increase in the number of stops would imply a 10 percent increase in the number of containers per route. Metabolic costs were calculated for reductions in workforce ranging from zero to 20 percent. A reduction would mean the same route length as the current routes.

The automatic-loading truck was modeled under the assumption that there would be no manual loading activity required. It was also assumed that there would still be the same amount of walking as on current routes, but the carry component would be replaced by an equally demanding component for maneuvering the containers into place for automatic loading. Since there is only one person, he or she would have to stand twice as long, do all of the walking to the container piles and step up to the truck twice as often as if there were a two-person crew. It was also assumed that there would be the same number of stops as on the current route.

The Customer Bag Usage Survey conducted

by the city's sanitation department in October 1983 was used for estimating the percent of bags. As mentioned earlier, the average percent was 35 percent bags. The minimum was 22 percent and the maximum was 52 percent.

The Route Management Report was used to obtain estimates of the number of stops, number of containers and on-route time per route. The reports used for the estimates cover 58 eleven-hour routes in March and June, which tend to be heavier times of the year. The average, minimum and maximum values are shown in Table 1.

"Switching to automated equipment would decrease the endurance demand"

Non-route time was estimated by assuming that the remainder of an 11-hour shift on an average day would be spent in non-route activities such as breaks, trips from the terminal to the head of the route, trips to the landfill and trips from the end of the route back to the terminal. Given an average route time of 324 minutes on an average 660 minute shift, the estimated non-route time is 336 minutes. The non-route time was assumed to be constant across all lengths of route (represented by ranges in route times). The total shift length was taken as the sum of route time and non-route time.

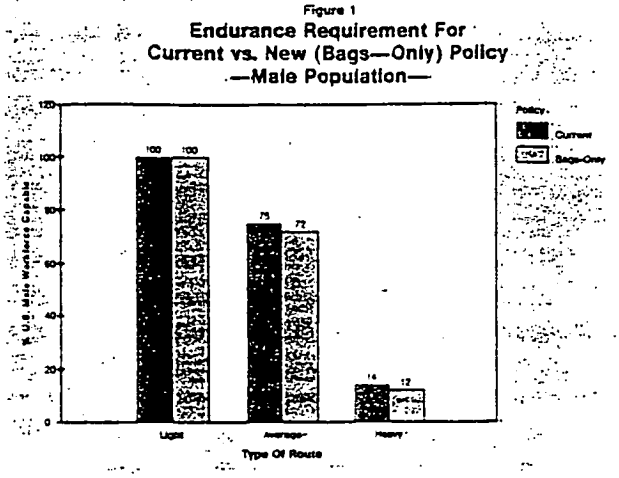
Results

Bags Only Versus No Restriction

The immediate question to be considered by the risk manager was the relative endurance demand of current routes (old policy) compared to routes with bags only and 10-percent reduction in workforce (new policy). The estimated percent of the U.S. male workforce is displayed in Figure 1 for "light," "average" and "heavy" routes under the old policy (no restriction on containers) and the new policy (bags only—10 percent reduction in workforce). The respective minimum, average and maximum number of stops and containers and route times were used to characterize "light," "average" and "heavy" routes. For instance, the heavy route had 874 stops, 3,957 containers, 22 percent bags and 543 minutes of route time.

The first observation is that the bags-only policy leads to only a slight reduction in the per-

Figure 1
Endurance Requirement For Current vs. New (Bags—Only) Policy
—Male Population—



cent of the male workforce capable. This means that the bags-only routes with 10 percent more stops are slightly more demanding metabolically than the current routes. The relative difference is greatest for the heavy route, though the actual drop is only 2 percent (from 14 percent of male workforce capable to 12 percent of the male workforce).

The percent of bags appears to have minimal impact on the endurance requirement for the range of values evaluated relative to the impact of the route type (light, average and heavy). The greatest difference in percent capable for any route type under the assumption of 22 percent versus 52 percent bags is 11 percent. In contrast, the male percent capable ranges from 12 percent to 100 percent, an 88 percent difference, for light versus heavy routes.

Hence, the greatest impact on the endurance requirement is the number of containers on the route. The male percent capable drops from an average 100 percent for light routes, to an average of 74 percent for average routes, to 13 percent for heavy routes. It is clearly a concern that there are routes so demanding that only 18 percent of the male population would be capable without developing excessive fatigue. This strongly suggests that:

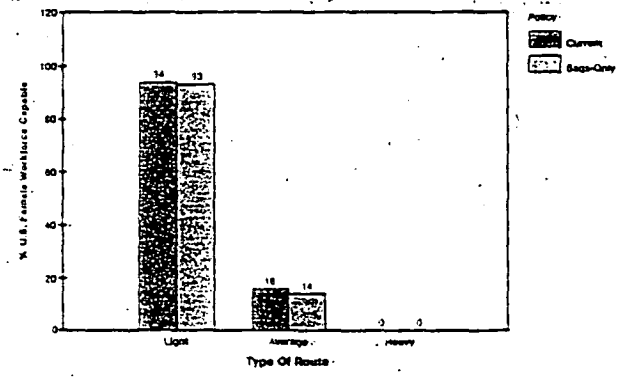
- the heavier routes should be redesigned to have fewer containers/stops;
- other equipment such as semi-automatic or fully-automatic loaders should be considered; and/or
- pre-placement physical ability screening should be implemented.

The fact that one out of four males in the U.S. workforce would not be able to do the average route without developing excessive

fatigue suggests that a screening program would be appropriate in general.

Figure 2 shows the same analysis for the U.S. female population. As with the men, the current policy is slightly less taxing than the bags-only policy. The major influence on difficulty is the number of containers. The light routes would not pose a problem, but the moderate routes would be over-demanding for five out of six women. The heavy routes would be impossible for virtually all women.

Figure 2
Endurance Requirement For
Current vs. New (Bags—Only) Policy
—Female Population—



Impact of Workforce Reduction

It will be recalled that one of the major reasons put forth for proposing a bags-only policy was the opportunity to reduce the workforce. A reduced workforce means larger routes for the remaining personnel in order to cover the same area. The sensitivity of the endurance demand to the percent decrease in workforce under the bags-only policy was studied for the range of zero to 20 percent workforce reduction. Figure 3 shows the percent of the U.S. male workforce capable under the range of decreases in workforce and range of route types (light, average and heavy). For any one route type, it can be seen that there is a moderate effect due to percent decrease in workforce—the greater the percent reduction (the larger the route), the fewer the percent capable of meeting the associated endurance demand. For an average route, the percent of the male workforce capable ranges from 80 percent for bags-only under current staffing to 63 percent for bags-only and 20 percent reduction in workforce, compared to 75 percent capable under the current policy of no restriction on containers. Decreases in workforce of less than 10 percent with bags-only gives greater percent capable (lower metabolic demand) than the current no-restriction policy. Decreases in workforce from 10 percent up put the percent capable below the current level (metabolic demand above).

Figure 3
Endurance Requirement For
Current vs. Bags Only With
A Range Of Workforce Reduction Levels

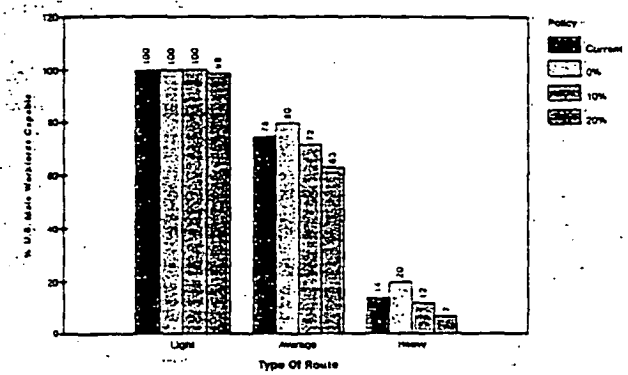
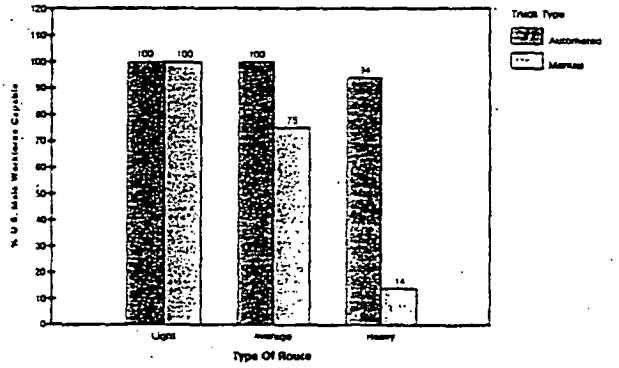


Figure 4
Endurance Requirement For
Automated vs. Manual Garbage Collection
—Male Population—



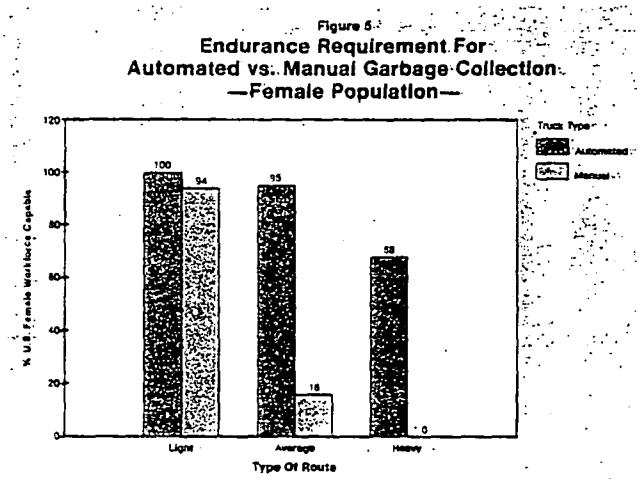
Once again, it can be seen that the much larger impact on endurance requirement is the type of route. The fact that the number of containers on the route can range so dramatically (the difference between light and heavy routes) overshadows the impact of workforce reduction as an independent consideration.

Automatic-Loading Trucks

The alternative of using automated equipment was simulated according to the assumptions delineated above. Figure 4 shows a comparison of the relative endurance demand if the current routes were performed by a one-person crew and an automatic-loading truck under light, average and heavy route conditions for the male population.

The automated equipment has the potential to greatly reduce the endurance requirement. For the heavy route, the percent of the male workforce capable climbs from 14 percent for the current policy to 94 percent. The differences are less dramatic for the average route (from 75 percent capable up to 100 percent capable with automation). There is no difference for the males for the lightest route scenario (both are 100 percent).

Figure 5 shows the same comparison on the basis of female percent capable. As with the males, the difference is most dramatic on the heavy route scenario (from none capable under current policy to 68 percent capable if automated equipment is used). An equally dramatic difference exists under the average route scenario (from 16 percent capable up to 95 percent capable). There is a minimal difference for the light route scenario (from 94 percent capable up to 100 percent).



Conclusions

There appears to be an increased risk of laceration and puncture wounds with bags as opposed to cans. A small sample of data suggests that there are 33 percent more contact injuries with bags. A bags-only policy could exacerbate the contact injury problem by exposing workers to more bags.

From a metabolic standpoint, there will be a very small increase in the endurance demand by shifting from the current policy to the proposed policy (bags-only and a 10 percent decrease in workforce). The purported success of the policy change in other cities in terms of reducing the number of sprains/strains cannot be explained by reductions in the endurance demand of the job.

The number of containers on the route appears to be the strongest determinant of the endurance demand. The endurance demand is substantial for typical routes and extreme for the heaviest routes under either the current policy or the bags-only policy. Hence, redesign is highly recommended. Redesign could take the form of rescheduling the routes or using different types of trucks, to mention a few alternatives.

Rescheduling the route sizes on heavy days would allow an immediate impact on the endurance problem. Switching to automated equipment would greatly decrease the endurance demand and substantially increase the percent of the U.S. workforce capable, particularly females, but it is realized that this is a longer-term solution due to the high initial capital expense.

In the absence of automated equipment or a drastic restructuring of routes, a physical ability screening program is highly recommended. Even for a typical route, roughly 25 percent of the U.S. male workforce would be inappropriate for employment on the job due to increased risk of injury. Roughly 85 percent of the U.S. female workforce would be inappropriate for employment.

In summary, there is minimal difference in injury risk between the old policy and a new policy of bags-only and a 10 percent decrease in workforce. The much larger issue is the overall heavy physical demand which makes the garbage collection job difficult for a substantial portion of both males and females. It is clear that eliminating the heavy routes or switching to automated equipment has much more utility in increasing the percent capable (and thus reducing the risk of injury) than does any policy regarding the type of containers required. This is particularly important to consider if there is an emphasis on safely employing more women on a garbage collection crew. **RM**

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APPENDIX F

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CONTACT LIST

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Waste Management (Sacramento) -- Tim McGill -- 373-3720

Norcal (Sacramento) -- Sold to Sac Val -- David Vacarezza -- 387-1400

BFI (Sacramento) -- John Guest -- 448-9992

APPENDIX G

DETACHABLE CONTAINER BODY TRANSFER SYSTEMS

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DETACHABLE CONTAINER BODY TRANSFER SYSTEMS

If the City of Sacramento decides to direct haul its waste to Kiefer Landfill rather than utilize a transfer station, it may wish to consider a detachable container body transfer system to reduce haul costs and increase route productivity. A number of systems have been developed that involve detachable compactor bodies (using a roll-off type system). Route trucks drop off full compactor bodies at a designated transfer point, pick up an empty body and return to the route to continue collections. Several full bodies are then loaded on a trailer and transferred to the landfill. In cases where more traditional transfer stations are not available, such a system may offer savings as compared to direct haul.

Lodal had manufactured a detachable 8-cubic-yard side-loader body that could be emptied into a front-loader and transferred to the landfill; however, it has discontinued this option due to limited markets. Waste Management Inc., (WMI) in conjunction with Edelhoff GmbH of West Germany, has developed its version of this system, the Multiple Service/Transport System. The MS/TS uses 22-cubic-yard front-loading truck bodies, which can be transported three at a time on a specially designed "transporter" to the landfill. Heil is under contract to manufacture the equipment. WMI has the exclusive rights for this system, however, and it is only available to WMI affiliates. Heil is also in the process of developing a detachable container body for its "Rapid Rail" residential collection vehicles, and Sacramento should evaluate this option for its residential collection system. This system, however, is not expected to be available until mid-1995.

RESOLUTION NO. 94-359

ADOPTED BY THE SACRAMENTO CITY COUNCIL

ON DATE OF _____

RESOLUTION AUTHORIZING DEVELOPMENT OF
COMMERCIAL COLLECTION STUDY IMPLEMENTATION PLAN

BE IT RESOLVED BY THE COUNCIL OF THE CITY OF SACRAMENTO that staff be authorized to develop an implementation plan for the Commercial Collection Study completed in April, 1994.

_____
MAYOR

ATTEST:

APPROVED
BY THE CITY COUNCIL
JUN 8 1994
OFFICE OF THE
CITY CLERK

_____
CITY CLERK

FOR CITY CLERK USE ONLY

RESOLUTION NO.: _____

DATE ADOPTED: _____