Delaware County Waste Paper Assessment Survey

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Executive Summary

In the Fall of 1996, a questionnaire was distributed to 2,577 businesses within Delaware County, Indiana, asking them to assess the amount of waste paper that they generate. Based on the 502 responses received, researchers at Ball State University were able to estimate the annual tonnage of waste paper of all Delaware County businesses. The estimated total, which is subject to sampling error, is 48,434 tons.

While the response rate to the survey (about 20 percent) was a pleasant surprise, the accuracy of this estimate can be no better than the accuracy of the responses received from individual businesses. Indeed, the survey encouraged respondents to make reasonable guesses and approximations when better information was not on hand, in the belief that a returned survey with partial information was better than one not returned at all. Thus, estimates of waste paper tonnage derived by other, more expensive procedures (such as on-site audits) may be quite different than those found in this report.

Given the fact that the businesses who took the time to respond to the survey are likely to be the same ones that generate the most paper waste, we believe that this estimate may be a bit higher than one that would be computed if a 100 percent response rate were realized.

There were a number of other survey findings that should be of interest in formulating strategies to encourage recycling. 46 percent of businesses surveyed separate at least part of their paper from their general waste, while 29 percent either take their own paper to a collection point or have it picked up by a contractor. On a per-site basis, companies in the manufacturing and construction industries generate the most paper, about 188 tons per company per year on average. Within each industry category, however, there was wide variability in waste paper generation between individual companies.

1. Introduction

It is estimated that, on average, every American throws away approximately 10 pounds of solid waste (industrial, construction, commercial, and household) each day. The escalation of public concern over the environmental issues has led government officials, business leaders and conservationists to seek a solution to the problems of solid waste pollution.

One ecologically desirable technique for the disposal of trash is recycling. Simply stated, recycling consists of finding new ways of using previously discarded materials. If recycling is to be a feasible solution to the trash problem, there must be some means to channel the waste materials to the recycling facilities. Before designing a channel of distribution for a given type of waste material, a feasibility study should be conducted to estimate the "market potential" for the waste material under consideration.

This document reports the results of such a study, for businesses operating within Delaware County, Indiana. Using a mail survey of 2,577 area businesses, information on paper waste was collected, tabulated, and analyzed. The results are presented in the following sections.

Section 2 describes the reasoning underlying the survey methodology, as well as the development of the survey instrument itself. Section 3 presents descriptive information about the survey respondents. The fourth section presents the main results of the study, namely, the estimates of paper waste. This is followed by a section examining the relationship, if any, between the amount of waste paper businesses generate and other measurable characteristics, such as facility size,

employment level, and paper separation or recycling behavior. The final section summarizes the conclusions and limitations of the study.

2. Survey Development

The decision was made at a very early stage to utilize a mail questionnaire to gather the desired information from businesses. The primary rationale behind this decision was project costs. Since the goal of the study was to develop a waste paper estimate of all Delaware County businesses, on-site interviews and/or waste audits were simply not practicable. Nor was it thought possible to conduct a large scale telephone survey, owing to both the lack of necessary facilities at Ball State, as well as the considerable labor expenses involved.

The major tasks in this phase of the project were (i) design of the survey procedure, and (ii) the design and pre-testing of the survey instrument. Because Delaware County is only medium-sized, it was feasible to send the survey to all businesses, rather than selecting a sample. A list of all county business organizations was obtained from the Muncie-Delaware Chamber of Commerce, and this list, after minor modifications, comprised the universe for our research. The most important modifications were the dropping of churches and religious organizations, defunct, and duplicate businesses.

More time was needed to design, test, and revise the survey instrument, or questionnaire. It needed to be long enough to provide sufficient data for the study, yet not so long as to discourage participation. Formulating questions related to waste generation was a particular challenge, since many businesses do not routinely record such information.

After conducting informal interviews with facilities managers at several area companies, it was decided to pursue a two-branch approach. The first branch was targeted at businesses who

already made some effort to separate their paper from their other waste. These companies tended to think of their paper in separate categories: cardboard, white paper, newsprint, and other. Even though we did not seek paper waste estimates at this level of detail, it was easier for companies who separated their paper to think of it at this level.

The second branch was aimed at companies who do not separate their paper from their other trash. For these companies we used a "refuse content" approach. This simply asked companies to report their total waste, from all sources, followed by an estimate of waste paper as a percentage of total waste. Respondents were encouraged to use their best judgement in cases where exact information was not available.

The survey instrument was pretested with a small number of businesses, followed by a brief telephone interview. Based on the information obtained from the pre-test group, a number of small changes were made to the questionnaire. A question about annual revenues of the businesses was dropped, as respondents seemed reluctant to reveal such information. Final decisions were also made about question formatting, ordering and layout.

It was estimated that each business should need no longer than 15 minutes to complete each questionnaire.

3. Survey Respondents

The survey was returned by 502 businesses, government agencies and non-profit organizations from within Delaware County. This represented a 19.4 percent response rate, which has to be considered very good for a survey of businesses. Not all of these surveys, however, contained completed information. There were 70 surveys returned that had either omissions, contradictions, or other problems that rendered them unsuitable for the analysis. In the remainder of this report, we will confine ourselves to the discussion of the 432 surveys that contained complete information.

In addition to the questions about waste paper generation, each business was asked a number of questions for classification purposes. The answers to these questions are useful in getting a feel for the kinds of businesses that responded to the survey, as well as in exploring the relationships between paper generation and business characteristics, as we do in Section 5.

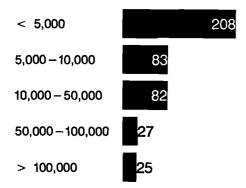
As can be seen from Figure 1, companies in the services industries were the most prevalent among survey respondents, followed by retailing businesses, manufacturing companies, and government agencies. There were 111 respondents that classified themselves in the Other Services category, including many small professional businesses as well as larger companies involved in transportation, maintenance, or other services.

Figure 2 makes it clear that the overwhelming majority of companies who responded to the survey were very small employers. There were 190 responses from companies with fewer than 6 employees, while only six responses were received from companies with more than 500 on their

Waste Paper Assessment Survey Report Characteristics of Respondents

Figure 1 Figure 2 Survey Responses by Company Type Survey Responses by Number of Employees Agricultural 1-5 190 Fin. Services 34 32 Government 142 6 - 2540 Health Services Manufacturing 80 26 - 20044 Merchandise 45 Other Retail 201 - 500Other Services 111 Restaurant over 500 Wholesale/Dist.

Figure 3
Survey Responses by Square Footage of Facility



payrolls. While we do not have data on the size distribution of employers of all types in Delaware County, such data are available on manufacturing employers. They indicate, for example, that there are only 2 manufacturers in the county with more than 500 employees.

The fact that the distribution of survey responses shown in Figure 2 is skewed towards very small firms can mean at least two different things. It may indicate that small firms were more likely to return the survey. This could be a serious problem, since it would mean that the survey responses tabulated and displayed in this report are not representative of Delaware County employers as a whole.

However, since there are so many more small employers than there are large ones, the skewed distribution shown in Figure 2 could easily happen, even if large employers were just as likely to fill out and return the survey as smaller ones. Based on our knowledge of the size distribution of manufacturing employers, we feel this is the most likely explanation, and thus we feel that the survey responses are representative of all Delaware County businesses.

The responses to the employment question provided the means for translating the waste paper tonnage estimates of individual businesses into an estimate of paper waste for the entire county.

This is explained in more detail in the next section.

A final piece of information collected about respondents that was collected was the size of their facilities. The answers are shown in Figure 3. In line with other characteristics, we found that most respondents had modest sized facilities, with more than 40 percent housed in spaces of less

than 5,000 square feet. At the other extreme, 25 companies reported total building space of greater than 100,000 square feet.

4. Estimation of Paper Waste

We now turn to the estimation of the paper waste generated by businesses that is the crux of this report. The estimation process itself consisted of two basic steps: (i) developing and applying rules to convert the responses of individual companies into usable information on waste tonnage, and (ii) using responses and other available information to estimate total paper waste for all businesses in the county.

The survey was designed to make it as easy as possible for respondents to successfully complete.

Thus businesses were given the option, at many stages, to use whatever units of measurement they were most comfortable with to estimate their paper waste. The first problem encountered was to convert these individual estimates into annual tonnage estimates.

Table 1 shows the conversion factors used to transform volume estimates into weight for the four different types of paper waste measured in this report: cardboard, computer or white paper, newsprint, and miscellaneous paper. These factors were based on an expected density of 125 pounds per cubic yard for cardboard, 300 pounds per cubic yard for computer paper and newsprint, and 200 pounds per cubic yard for miscellaneous paper. These figures were obtained from Mr. Tom Pease of Rock-Tenn.

Once all paper waste was measured in the same units, deriving a total estimate for each business was relatively straightforward. For the 200 respondents who indicated they separated all or part of their paper, we multiplied their paper waste tonnage for each paper category by the annual collection frequency, to get an annual tonnage estimate by type.

Table 1

Waste Paper Assessment Survey Volume/Tonnage Conversion Factors

Paper Type	Tons per <u>Cubic Yard</u>	Tons per <u>Gallon</u>
Cardboard	0.0625	0.0058
Computer/White	0.1500	0.0139
Newsprint	0.1500	0.0139
Miscellaneous	0.1000	0.0094

To this we added an estimate of "other" paper waste, based on the company responses to section C of the survey instrument. The process was similar to that employed for specific paper types, namely, converting volume to tonnage, and multiplying by the annual frequency of collection. For the 232 respondents who said that they did not separate any paper, this last step by itself produced the estimate of company paper waste.

In this process, 70 surveys were rejected because there was insufficient information to produce a waste paper estimate. The most frequently encountered problem was companies that gave information on what kinds of paper they threw away, but gave no indication as to the volume, weight, or frequency of disposal. This brought the number of usable responses from 502 down to 432.

The second stage of the estimation process, converting the survey responses to a county-wide estimate, utilized the survey information, as well as estimates of Delaware County employment obtained from the most recent time period available. The latter were obtained from the Indiana Department of Workforce Development and are based on employer reports to the Unemployment Insurance (UI) system.

The process of calculating a county waste estimate is shown in Table 2. For each industry, the total employment of the businesses who returned usable surveys was compared to county employment from the UI records. For example, the 110 retailing companies who responded to the survey represented 4,771 employees, compared to 12,913 reported on retail payrolls countywide.

Rock-Tenn Waste Paper Assessment Survey Estimation of County Paper Waste

	€	(B)	(C)	(D)	= (C) / (D)	= (B) * (D) / (C)
Type	Number of <u>Firms</u>	Annual Waste <u>Paper (tons)</u>	Employment of Respondents	County Employment	Percent of County Employment	Annual County Paper Waste (Tons)
Agricultural	7	32.2	437	1,597	27.4	117.6
Total Services: Financial Services	185 34	2627.3 573.7	7529 1180	21,014	35.8	7,333.0
Other Services Health Services	111 40	902.6 1151.1	3727 2622			
Government or Non-Profit	32	453.6	2168	10,866	20.0	2,273.3
Manufacturing/Construction	71	13338.7	7794	14,800	52.7	25,328.8
Total Retail: Merchandise	110	4496.8 2179.5	4771 1594	12,913	36.9	12,170.8
Other Retail	45	2020.8	1741			
Restaurant	21	296.5	1436			
Wholesaling/Distribution	27	131.9	818	7,507	10.9	1,210.4
COUNTY TOTAL						48,434.0

This relationship was used to "blow up" the survey estimates into estimates for the entire county. For retailing, again, according to the table the survey respondents reported 4,497 tons of annual paper waste. Since the survey respondents represent about 37 percent of total retail employment, we estimate that this paper waste total represents a like fraction of waste generated by retail employers county-wide. Thus we estimate that retailing generates 12,171 tons of paper waste, annually.

The distribution of paper waste by major industry can be seen from the last column of Table 2. Even though the Services industries employ more people than any other industry, at 7,333 annual tons they generate only about 15 percent of all paper waste. On the other hand, more than half of the county's 48,434 annual tons of paper are generated by the manufacturing and construction industries, which employ only about 20 percent of the county total payrolls.

5. Exploring the Relationships Between Waste Paper Generation and Company Characteristics

The last question considered in this study is whether there are any measurable relationships between the amount of waste paper that businesses generate, and basic company characteristics, such as employment, industry, and facility size. We also considered the question of which, if any, businesses are more likely to separate their paper waste from their other refuse.

Since the estimates of paper waste are in many cases quite rough, and we did not gather information on each respondent's activities in a great deal of detail, the results we present in this section cannot be considered to be definitive. They do, however, suggest relationships that may bear further attention.

Paper Waste and Industry

The first question is whether or not there is any relationship between paper waste and the industry a business operates in. The answer here, as one would expect, is yes. Table 3 shows the mean, the minimum, and the maximum values of annual waste paper tonnage per business, by industry. The figures reveal not only wide variations between industries, scanning up and down the columns of the table, but also considerable differences between companies in the same industry. The latter conclusion comes from observing the gap between minimum and maximum for any given row.

For example, the manufacturing/construction group had the highest paper waste generation per company of any category, averaging about 188 tons per year. This was more than 45 times the

Table 3

Paper Waste Per Company By Industry Mean, Minimum, and Maximum

	Paper W	laste (tons	per year)
<u>Industry</u>	<u>Mean</u>	<u>Minimum</u>	<u>Maximum</u>
Agricultural	4.59	0.32	14.13
Financial Services	16.87	0.10	502.76
Health Services	28.78	0.28	787.28
Other Services	8.13	0.01	303.60
Manufacturing/Construction	187.87	0.01	4585.40
Merchandise	49.53	0.05	1632.00
Restaurant	14.11	0.04	180.12
Other Retail	44.91	0.05	1539.20
Wholesaling/Distribution	4.88	0.02	48.20
Government/Non-profit	14.17	0.02	220.32

average of either the Agricultural or the Wholesaling/Distribution categories, which were the smallest generators of waste paper.

Within the manufacturing category, however, there was considerable differences between individual companies. The smallest reported an almost negligible 0.015 ton of paper waste per year, whereas the largest had more than 752 tons of paper waste annually. Statistics such as these reveal the limitations in these survey data. It is likely that an audit of the manufacturer or the construction company that reported that tiny amount of paper waste would find that actual waste paper generated was considerably larger. Without another means of measuring waste, however, we have no choice but to accept the company's self-reported statistic.

The differences between industries shown in Table 3 come about not only because of the type of business companies are in, but also because of their size. Manufacturing businesses tend to be larger than, say, businesses in the Other Services category, which includes many of the self-employed. Thus we would expect businesses in the latter to generate less paper. We now turn to the question of how size itself may affect waste paper.

Waste Paper and Company Size

We examined the question of how company size might affect waste paper generated using two measures of size: number of employees, and physical size of facility. Our basic findings are that paper waste does depend positively on size, as one would expect. However, the relationship is quite a bit weaker than one would expect. This weakness may be due to the roughness of the

categories and measures used in this study, or simply to the need for much more information in addition to size in order to make a good prediction of paper waste.

The data in this case lend themselves to a different kind of analysis, namely, the use of simple regression. In this procedure, we statistically fit a linear relationship between the amount of waste each company generates, and the size of the firm. The coefficient, or slope, of this line determines the direction of the relationship, whereas the proximity of the individual points to the fitted line gives information on the quality of the model.

Table 4 shows the results of two simple regression models: one, using employment as a measure of size, and a second, using facility square feet to capture size. In both cases, as can be seen from the column entitled "Coefficient," the relationship is positive, as one would expect. The size of these coefficients gives an indication of the strength of the relationship. For example, the coefficient of 0.793 in the employment model says that every worker adds approximately 0.79 tons of paper waste, on average. Similarly, the 0.0015 coefficient in the square-footage model says that every 1,000 square feet of facility adds about one and a half tons of waste paper.

The coefficients for both these models are statistically significant from zero, which is evidence of a true relationship in the overall population. The other information for each model, however, suggests that employment and facility size would, by themselves, be very poor predictors of waste paper generation. In particular, the fact that the R squared statistics for each model are .06 and .03 for the employment and square footage models, respectively, means that more than 90 percent of the variability in waste paper between companies is not explained by either variable.

Table 4

Model Estimation Results Waste Paper Generation and Company Size

<u>Model</u>	Size <u>Variable</u>	Observations	Estimated Coefficient	<u>T-value</u>	R-square
1	Employment	421	0.793096	5.186	0.0602
2	Square Footage	421	0.001449	3.348	0.0260

The results are encouraging, as they appear to make sense, and give us a degree of confidence in the survey responses as being at least roughly accurate. Clearly, however, much more work would have to be done to get a real handle on the problem of predicting paper waste for an individual company with any precision.

Paper Waste and Whether Waste Paper is Separated

In the course of asking companies to estimate their own paper waste, we asked each respondent whether or not they separated paper from their other trash. Since waste paper has value, it stands to reason that companies that have more such waste would be more likely to separate it. We tested that proposition by analyzing the difference in waste paper generated by three groups of companies: those who said they separated all of their paper, those who said the separated some of their paper, and those who reported they did not separate any paper from their general waste.

The results of this analysis were similar to others we performed. That is, the direction of the relationship was as expected, but the strength was weak. Using an analysis of variance procedure, we were able to detect statistically significant differences between companies who separated all of their waste, and those who did not attempt any separation. Indeed, the difference between the average paper waste for these two groups was 94 tons per year.

The degree of confidence we can put in this estimated difference, however, is quite low. We can say with 95 percent confidence that the true difference between the groups is between 3 and 185 tons per year, a fairly wide interval that reflects our uncertainty about the actual amount.

Moreover, the differences we measured between both of these "extreme" groups and the middle

group, which said they separated some, but not all, of their paper, were not statistically significant. The differences in means had the expected signs, at least — that is, the middle group had more waste than the non-separators on average.

Thus we conclude that the survey responses again "make sense" with what we would expect companies to do, but lack the precision needed to formulate an adequate forecasting model.

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6. Conclusion

This report details the results of an attempt to estimate the amount of paper waste generated by businesses within Delaware County, using a mail survey. Using the estimates provided by the nearly 20 percent of all county businesses who responded to the survey, we conclude that the total paper waste of all commercial and industrial facilities within the county is 48,434 tons per year.

To put this estimate in perspective, the Indiana Department of Environmental Management estimates that the total waste — residential and commercial — of all types that originated in Delaware County and ended up in landfills was 85,058 tons in 1995. If one assumes that 38 percent of the waste stream, by weight, is paper waste, this puts non-recycled paper waste at about 32,000 tons. Thus a fairly high percentage of our 48,434 ton estimate would have to be recycled in order to be reconciled with the landfill data. For example, if 50 percent were recycled, that would leave only 8,000 tons (= 32,000 - 48,000/2) left as non-recycled residential paper waste.

This rough calculation leads us to believe that our estimate of total paper waste may err slightly on the high side of the actual value. The reason may lie in the way we scaled up the survey results to represent the entire county. Since those who returned surveys (and thus showed an interest in recycling) probably produced more waste paper than those who did not, scaling up the responses may have produced this overestimate.

Despite these possible shortcomings, the survey data have yielded solid, sensible information about the patterns of waste paper generation within Delaware County. This information should prove very useful in making decisions on strategies to induce more businesses to take advantage of the profit opportunities in turning their waste paper into products of value.

Appendix

Survey Instrument

Delaware County Waste Paper Assessment Survey

The purpose of this survey is to assess the amount of waste paper that is generated by businesses, such as yours, in Delaware County. Your answers will be tabulated into a report that will not identify any specific businesses. Please answer each question in the space provided. If your business does not keep records on the information requested, feel free to substitute as good of an estimate as you can provide. We also welcome any additional comments that you think would be helpful.

This survey should take no longer than 15 minutes to complete.

3. What is the size of your building (total of all buildings if more than one)? (Check one)□ under 5,000 square feet	☐ between 5,001 and 10,000 square feet ☐ between 10,001 and 50,000 square feet ☐ between 50,001 and 100,000 square feet ☐ more than 100,000 square feet	B. Your Company's Waste Paper 1. Do you separate any of your waste paper from your other trash or waste material? (Check one)	trash or waste material? (Check one) □ yes, all waste paper is separated □ yes, some kinds of paper are separated, others are not □ no, we don't separate paper from other trash If you answered no, please skip to section C, on page 3.	
I. Describe the kind of business your company is in: (Check one)☐ AgriculturalRetailing:	☐ restauraunt ☐ merchandise ☐ other retail ☐ Wholesaling/Distribution ☐ Manufacturing		☐ Government or Non-Profit ☐ Other – please describe: 2. How many employees do you have? (Check one) ☐ between 1 and 5 ☐ between 6 and 25 ☐ between 26 and 200	☐ between 201 and 500

Cardboard	Computer/high grade white	Newsprint	Miscellaneous
∢	В	O	Ω
 a. Does your business separate card- board or other corrugated paper board? 	 a. Does your business separate computer or other high grade white paper? 	a. Does your business separate news- print?	a. Does your business separate any other type of miscellaneous paper?
☐ no, cardboard is not separated. (skip to column B) ☐ ves. cardboard is separated.	☐ no, white paper is not separated. (skip to column C) ☐ yes, white paper is separated.	☐ no, newsprint is not separated. (skip to column D) ☐ yes, newsprint is separated.	☐ no, miscellaneous paper is not separated. ☐ yes, miscellaneous paper is separated (on to the next nage)
i. How often does your business gather or bundle carboard for disposition? (check one)	 How often does your business gather or bundle white paper for disposition? (check one) 	i. How often does your business gather or bundle newsprint for disposition? (check one)	i. How often does your business gather or bundle miscellaneous paper for disposition? (check one)
☐ daily☐ weekly☐ monthly☐	☐ daily ☐ weekly ☐ monthly ☐ other	☐ daily☐ weekly☐ monthly☐ other —	daily weekly monthly
ii. About how much cardboard is gathered each time? (fill in one	ii. About how much white paper is gathered each time? (fill in one line)	ii. About how much newsprint is gathered each time? (fill in one line)	u otherii. About how much miscellaneous paper is gathered each time? (fill in one line)
lbs. square yards bales, boxes or truck loads weighing lbs. each other volume or weight	lbs. square yards bales, boxes or truck loads weighing lbs. each other volume or weight estimate:	lbs. square yards bales, boxes or truck loads weighing lbs. each other volume or weight estimate:	lbs. square yards bales, boxes or truck loads weighing lbs. each other volume or weight estimate:
estumate:iii. Is your cardboard (check one) baled? shredded?	iii. Is your white paper (check one) baled? shredded?	iii. Is your newsprint (check one) ☐ baled? ☐ shredded?	iii. Is your miscellaneous paper (check one) ☐ baled? ☐ shredded?
iv. How do you dispose of your cardboard? (check one)□ we take it away ourselves to a	 iv. How do you dispose of your white paper? (check one) we take it away ourselves to a collection point 	iv. How do you dispose of your newsprint? (check one)□ we take it away ourselves to a collection point	iv. How do you dispose of your miscellaneous paper? (check one)ue take it away ourselves to a
collection point it is picked up by an outside	 it is picked up by an outside contractor 	 it is picked up by an outside contractor 	collection point it is picked up by an outside
contractor we incinerate it, or otherwise	☐ we incinerate it, or otherwise dispose of it on our premises	☐ we incinerate it, or otherwise dispose of it on our premises	contractor
dispose of it on our premises Go to the next column.	Go to the next column.	Go to the next column.	dispose of it on our premises Go to the next page.

C. Your Company's Total Waste

 What is the approximate size of your business's trash receptacle(s): (Fill in all that apply) 	3. How full, on average, are your waste containers when they are emptied? (check one)
dumpster(s), each being square yards	☐ 100%, totally full
barrels or cans, each being gallons	☐ not totally full, only percent full
other volume estimate:	
	4. Approximately how much paper, by volume, would you say is contained in your general trash? (fill in one line)
2. How often is (are) your waste container(s) emptied?	Our trash is:
(Check one)	\Box more than 40% paper, by volume
□ dailv	□ 30-40% paper
□ week v	□ 20-30% paper
other interval:	□ 10-20% paper
	□ less than 10% paper
	☐ no paper, all is separated
Commente.	

