COST OF REQUIRED WATER POLLUTION ABATEMENT ON POULTRY PROCESSING PLANTS

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INTRODUCTION

Efforts currently are being made to arrive at pollution abatement standards for the poultry processing industry. Once a set of effluent limits are established, individual firms have several alternatives to meet the best available control requirements by altering in-plant techniques and modifying waste water treatment systems. This study provides information on current cost and expenditure levels for waste water treatment in the poultry processing industry in Georgia. The primary objective was to provide an assessment of the probable industry cost of achieving higher levels of treatment which are required under new pollution control guidelines [10]. Changes needed for individual plants will vary depending on the nature of the waste, the degree and kind of treatment, and the size and location of the firm.

PROCEDURE

A total of 26 poultry processing plants in Georgia were contacted for a personal interview in the summer of 1972. Usable information on practices, costs, and waste treatment systems was obtained from 19 plants which were engaged in some combination of slaughtering, eviscerating, and further processing of poultry.[1] These 19 plants processed 330 million birds per year or approximately 76 percent of all chickens processed in Georgia.

The number of birds slaughtered is one of the most important factors determining waste water volume and pollution loads in poultry processing. Number of birds is also a primary indicator of plant size. The 19 plants in this study processed an average of 17.4 million birds annually per plant with the smallest plant processing only 1.8 million birds and the largest plant processing 37.5 million (Table 1). These 19 processing plants handled an average of 70,000 birds per plant per day.

COST OF POLLUTION ABATEMENT ACTIVITIES

Most poultry processing plants have made significant expenditures on waste reduction and screening equipment in an effort to reduce water use and decrease final treatment costs. There are three types of expenditures: (1) in-plant equipment and processes, (2) screening equipment, and (3) waste treatment systems outside the plant. Total equipment expenditures varied widely from plant to plant. Costs for each of the three types of equipment were obtained for the 1961-1971 period. These expenditures were then adjusted for inflation by using the *Engineering News Record* construction price index (1967=100). The net effect of this adjustment is to value all capital expenditures on the basis of 1967 dollars regardless of the year the investment was made. Although some technological improvements have been made in equipment design over the years, they were not considered great enough to significantly alter the results of this study.

In-plant reduction of waste requires new equipment and processes, equipment modification, or reuse of water and isolation of waste by-products. Substantial in-plant waste reduction expenditures were made by 16 of the 19 plants during the years 1961-1971. These expenditures totaled $85,834 with

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[1] Five of the other seven plants were engaged only in further processing, and information was not available from the other two plants.

Table 1. ANNUAL CAPITAL EXPENDITURES AND AVERAGE TREATMENT COSTS FOR WATER POLLUTION ABATEMENT IN POULTRY PROCESSING PLANTS, GEORGIA, 1972

Processing Plant Volume		Annual Treatment Operational and Maintenance Expenditures	Annual Public Service Payments	Adjusted Annual Equivalent Equipment Expenditures[a]	Average Treatment Cost Per 1,000 Birds Processed[b]
Million Birds Per Year	1,000 Birds Per Day				
-------number-------		----------dollars----------			
1.8	12	8,500	0	32,530	7.79
5.8	25	12,500	0	321,192	11.67
10.0	40	4,600	0	95,159	2.08
12.0	48	2,200	15,000	10,715	1.59
12.3	60	1,500	0	156,000	2.28
12.5	48	300	62,240	2,686	5.05
12.5	50	8,100	0	146,023	2.63
14.9	55	1,300	1,000	2,000	0.18
17.3	72	6,500	0	41,158	0.78
18.0	72	17,500	0	186,767	2.74
18.2	70	6,100	120	7,980	0.42
18.8	75	450	52,911	4,299	2.89
20.8	80	4,400	30,140	44,699	2.03
21.3	85	400	60,000	1,544	2.85
21.6	85	7,600	0	263,993	2.43
23.5	96	9,800	0	377,500	3.15
24.3	96	2,000	0	302,656	2.20
27.6	115	5,000	20,000	10,318	0.97
37.5	150	10,600	25,000	29,611	1.08
Average					
17.4	70	5,755	29,601	107,201	2.88

[a]Capital expenditures adjusted for time period of purchase based on *Engineering News Record,* "Construction Price Index," (1967=100), March 23, 1972.

[b]Average treatment cost per 1,000 birds processed annually. Includes fixed and operating costs. Equal to ACB in text.

an average expenditure of $5,365 per plant. The same plants also reported a total of $19,250 for annual operational and maintenance expenses for in-plant processes, or an average of $1,203 per plant.

Additional expenditures were made on screening equipment for the purpose of removing waste materials from water prior to discharge. This procedure reduces the waste load in the discharged water and is designed to reduce treatment cost. Fourteen firms reported total expenditures of $222,617 on screening equipment during the period from 1961 to 1971, with average expenditures of $15,900 per plant. One plant spent as much as $68,177, while several others spent less than $10,000. These same firms had total annual operational and maintenance expenditures of $50,800 on screening equipment, or $3,629 per plant.

Once the water leaves the plant there are two types of water treatment systems used: public municipal systems, or private lagoon-type systems. Ten processing plants used private systems for treating waste water which consisted of one of several types of lagoon systems. These plants spent a total of $1.7 million for outside facilities, an average of $172,841 per plant. The private systems also required annual operational and maintenance expenses of $146,100, or $14,610 per plant.

Nine firms reported the use of public sewerage systems. Total annual waste treatment charges paid to municipalities were $266,411 for these plants with an

average of $29,601 per plant (Table 1). The cost for public sewerage charges ranged from $.007 to $4.99 per 1,000 birds processed.

FACTORS AFFECTING ANNUAL TREATMENT COST

Individual plant capital expenditures for in-plant, screening, and treatment processes adjusted for year of purchase were combined to get total equipment expenditures which ranged from $1,544 to $377,500 per plant (Table 1). Overhead costs for equipment were subsequently combined with annual operating expenses for the various treatment processes (including municipal treatment payments) by the following formula:

$$(1) \qquad ACB = \frac{.17\,CE + OMC}{B}$$

where

ACB = annual average treatment cost per 1,000 birds processed (dollars),

CE = total plant water treatment capital equipment expenditures (dollars),

Table 2. ESTIMATED CAPITAL EXPENDITURES AND COSTS FOR UPGRADING WASTE WATER TREATMENT LEVELS IN POULTRY PROCESSING PLANTS IN GEORGIA[a]

Item	Current Costs 1967-1972		Future Costs 1972-1985		Increase in Costs	
	Industry Total	Cost Per 1,000 Birds	Industry Total	Cost Per 1,000 Birds	Industry Total	Cost Per 1,000 Birds
	(000 dollars)	(dollars)	(000 dollars)	(dollars)	(000 dollars)	(dollars)
Capital Investment Required[b]						
Lagoon Facilities	1,900	10.2	6,300	33.8	4,400	23.6
Total System	2,700	14.5	6,300	33.8	3,600	19.3
Annual Fixed Costs[c]						
Lagoon Facilities	323	1.73	1,071	5.75	748	4.02
Total System	459	2.46	1,071	5.75	612	3.29
Annual Operating Expenses						
Lagoon Facilities	164	0.88	952	5.11	788	4.23
Total System	203	1.09	952	5.11	749	4.02
Annual Public Sewerage Charges	310	1.26	930	3.77	620	2.51
Total Annual Industry Costs						
Lagoon Facilities	797	1.84	2,953	6.82	2,156	4.98
Total System	972	2.24	2,953	6.82	1,981	4.58

[a]Based on 1972 volume of birds processed with average live weight of 3.73 pounds per bird. Total volume processed was 433 million birds with 57 percent using public treatment facilities and 43 percent private facilities. Current cost levels based on 1972 survey of processing plants. Future cost levels based on engineering values developed by Vertrees [5]. Where not otherwise stated, median values are used.

[b]Current industry costs include both capital expenditures for outside treatment facilities and a total system cost including in-plant treatment, but estimates of future capital expenditures were made with the assumption that investment in any in-plant processes will be essentially a substitute for outside treatment facilities, primarily of the aerobic-anaerobic lagoon type.

[c]Based on 10-year, straight-line depreciation, an interest rate of 8 percent or 4 percent of initial investment, 2 percent of initial value for taxes, and 1 percent for insurance.

OMC = annual operating and maintenance abatement cost (dollars), and

B = birds processed per year (thousand).

The formula assumes an economic life of 10 years for pollution abatement equipment and prorates fixed costs for interest, insurance, and taxes as a percentage of initial costs.[2]

The average annual treatment cost per 1,000 birds processed per year ranged from $11.67 for a plant which processed only 5.8 million birds per year to $0.18 for a plant processing 14.9 million birds per year (Table 1). The average cost for plants which had a private treatment system was $3.78, compared to only $1.90 for those which used a public treatment system.

The following stepwise multiple regression equation was used to determine the effect of selected variables in explaining average treatment cost:

$$(2) \quad Y = a + b_1 \text{Log}X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$$

where

Y = average annual treatment cost per 1,000 birds processed (dollars),

X_1 = 1,000 birds processed per day (indicative of plant size),

X_2 = water treatment operating cost (excluding municipal treatment charges) in thousands of dollars,

X_3 = Dummy variable - 1 if private treatment, 0 if public treatment, and

X_4 = municipal treatment charges in thousands of dollars.

Results of the analysis were:

$$(3) \quad Y=13.13-7.55X_1+0.22X_2+1.84X_3+0.07X_4$$

Standard error	(1.68)	(.10)	(1.12)	(.03)
Increase in R^2	.48	.07	.05	.11

$R^2 = .72$

While all four variables were statistically significant at the 5 percent level, the log of 1,000 birds per day (X_1) which reflects size of plant was the most important variable, and it explained 48 percent of the total variation in average annual treatment cost per bird. Average costs decreased by $7.55 with a one-unit change in log of 1,000 birds processed per day. Significant economies of size in treatment costs are possible with larger operations.

The dummy variable (X_3) for private or public treatment was a significant factor in explaining variation in treatment cost. Because a private treatment system requires large capital expenditures on outside facilities, the dummy variable for private treatment was highly correlated with total capital expenditures. Firms which used private treatment systems incurred an average additional cost of $1.84 per thousand birds processed when all other factors being considered were held constant.

Municipal treatment charges (X_4) exerted a positive influence on overall average treatment costs, although this was a minor factor in explaining variation in these costs. However, in future years these charges could become more important as municipal systems increase sewerage charges to industrial and commercial users. For plants with private systems, operating expenses associated with treatment processes (X_2) also exerted a positive effect on average annual costs which helped explain a small amount of the variation in average costs.

POLLUTION ABATEMENT COSTS FOR THE INDUSTRY

The 19 firms in the study reported total pollution abatement equipment expenditures of slightly over $2 million during 1961-1971 or an average of $107,201 per plant. These expenditures amounted to an average of 15 percent of the book value of total capital for processing plant facilities. These plants processed 330 million birds or 76 percent of the total production in Georgia in 1972. If plants processing the remaining birds had incurred similar pollution abatement costs, total industry costs for pollution abatement equipment expenditures would be $2.7 million. Using an economic life of 10 years for abatement equipment, the equivalent equipment replacement value for the poultry processing industry in Georgia would be $269,450 annually.

Annual pollution abatement operational and maintenance expenses for plants utilizing public service treatment were $25,143 per plant (including public service payments), compared to an average of $8,000 for plants using private treatment only. Total costs for the 19 plants in the study were $301,721 for those using public treatment and $88,000 for

[2] Annual fixed costs for capital expenditures were based on 10-year straight-line depreciation which is 10 percent of initial value, 8 percent interest on the average investment or 4 percent on initial investment, 2 percent of initial value for taxes, and 1 percent for insurance.

those using private systems, or a total of $389,721. If the remaining processors incurred similar costs, then the total amount spent on operational and maintenance expenses for pollution abatement would be about $512,791 annually.

Based on this study, waste from 57 percent of the 433 million slaughtered birds in Georgia in 1972 received public treatment, and the remaining 43 percent received private treatment. Eleven firms with private treatment systems processed 167.8 million birds, or 89 percent of the volume, with private treatment systems. Estimated capital expenditures for all birds processed in Georgia during 1961-1971 utilizing private treatment were $1.9 million or $10 per 1,000 birds processed annually for treatment facility expenditures (plus $200,000 for in-plant equipment). Estimated annual operational and maintenance expenditures for this segment of the industry were $164,150 or $0.88 per 1,000 birds processed annually.

Treatment charges of $266,411 were paid to municipalities by nine other plants, representing approximately 202 million birds, or 87 percent of the total number of birds for which waste is primarily treated by public facilities. If treatment charges for the remaining 13 percent of the volume were similar, total public service costs for the industry would be about $310,000, or $1.26 per 1,000 birds processed annually.

ESTIMATED INDUSTRY COST OF UPGRADING TREATMENT

Most of the effluent discharged into streams by Georgia poultry processing plants meets a gross standard of secondary treatment. Secondary treatment is defined as the removal of approximately 85 percent of the biological oxygen demand (B.O.D.) and suspended solids. However, the Environmental Protection Agency proposes that the discharge of pollutants be completely eliminated by 1985 [10, p. H8859]. Plants are required to adopt the best available control technology resulting in the removal of approximately 90-95 percent of B.O.D. and suspended solids. For plants without access to a public system, it appears that the anaerobic-aerobic lagoon system[3] is the best practical control technology [5].

Estimates of the costs of upgrading to the best available control technology were made for the current number of birds processed in Georgia. In-plant processes were not included since improvements in these operations reduce waste loads going to treatment facilities and are, therefore, a substitute for treatment facilities. Vertrees [5, pp. 36-42] provided estimates of private treatment costs at three different levels for best control technology. Investment or replacement costs per 100 pounds of live-weight slaughter[4] were $0.52 for the low estimate, $0.90 for the medium estimate, and $1.49 for the upper estimate. Operational and maintenance costs were $0.08 for the low estimate, $0.14 for the medium estimate, and $0.23 for the upper estimate.

The number of birds processed in Georgia in 1972 was multiplied by 3.73[5] to obtain total live-weight slaughter volume [9]. Private treatment facilities treated waste from approximately 700 million pounds live weight. Capital costs for meeting the best available technology would range from $3.7 million to $10.5 million based on current replacement value.[6] Operational and maintenance cost would range from $0.6 million to $1.6 million. In comparing the medium investment cost of $6.3 million with the current $1.9 million pollution abatement expenditures for private treatment, the impact on the industry of meeting the best available control technology would require an increase of $4.4 million in capital expenditures, which is three times greater than current levels (Table 2).

The medium estimate of operational and maintenance expenses for meeting the best available technology would be $952,200 annually compared to current expenses of $164,150. Annual expenses would, therefore, be increased by $788,050, which is nearly six times greater than current expenses. These increases reflect the use of additional chemicals and other materials and labor required in operating an enlarged system.

Public sewerage charges are increasing over time, and additional surcharges are being adopted for excessive waste loads. The surcharge method

[3] A primary treatment system removes only 35 percent of the B.O.D. and suspended solids, whereas the secondary treatment system should remove approximately 85 percent of the waste load [7, p. 107].

[4] Vertrees used existing cost equations and other data to estimate the range of cost estimates for daily Biological Oxygen Demand loads based on population equivalents.

[5] Statistical Reporting Service calculated an average weight of 3.68 pounds per young chickens, 4.50 pounds for mature chickens, and 3.73 pounds as a weighted average for total chickens.

[6] Investment credit tax advantages exist on the purchase of pollution control equipment. Due to the large number of possible credit advantages and depreciation methods, the advantages have a great variability. Possible investment credits have not been included in these estimates but could reduce the total cost values.

motivates processors to reduce waste loads and water volume prior to final treatment [1]. Additional costs to processors as a result of upgrading public systems to the best available control technology were based on a percentage increase similar to the additional cost of upgrading municipal systems from secondary to advanced treatment. The Federal Water Pollution Control Administration estimated that the cost of treating industrial waste to a final treatment level would be approximately three times higher than achieving a secondary level treatment [7, p. 107]. Based on present annual municipal charges of $310,000 incurred by the industry, the annual charges to reach the best available treatment level could be as high as $930,000.

As shown in Table 2, meeting the best available treatment requirements could increase total capital expenditures by $24 per 1,000 birds processed annually for treatment facilities in future years. Annual operational and maintenance costs could increase by $4 per 1,000 birds using these facilities. Projected estimates of increased public services charges could be $2.50 per 1,000 birds higher than current levels.

SUMMARY

The poultry processing industry has been making substantial capital expenditures in an attempt to control pollution. Estimates of total industry capital expenditures for pollution abatement from 1961-1971 were $2.7 million, or an annual equivalent replacement value of $269,450. Total operational and maintenance expenses for pollution abatement were about $512,800 annually.

To meet the best available control technology, the poultry processing industry would have to increase capital expenditures by $4.4 million which is three times greater than the previous investment level. Estimates of annual operational and maintenance expenses for meeting the best available technology are $952,200 compared to current expenses of $164,150. Annual charges by municipal public service systems could go as high as $930,000 under the best available technology standards, which is three times higher than current charges paid by the processing industry.

In order to meet the best available technology, total capital expenditures for equipment would increase from current levels of $10 to as much as $34 per 1,000 birds processed annually. Operational and maintenance costs would increase from $0.90 per 1,000 birds processed annually at present to $5 per 1,000 in future years. Public service charges could increase by $2.50 annually per 1,000 birds processed annually.

Poultry processing firms are high volume operations with low profit margins, and any increased costs must be either added to the price of the product or deducted from plant profits. Profits will decline for some firms in the industry because they will not be able to pass on the full cost of pollution abatement to consumers in the form of higher prices due to substitute products being available, or because price increases for some firms, which may have higher unit abatement costs, will be constrained by other firms with lower unit abatement costs. Small plants with high treatment costs may have to use municipal systems or find other low cost abatement techniques that will enable them to stay in business.

REFERENCES

[1] Hudson, B. L.; A. L. Cole, and R. C. Smith. *An Economic Analysis of Poultry Processing Waste Water in Delaware.* University of Delaware Agricultural Experiment Station Bulletin No. 383, Dec. 1970.

[2] U.S. Dept. of Interior. "Industrial Waste Profile No. 8, Meat Products." *Cost of Clean Water,* Vol. III, Federal Water Pollution Control Administration, Sept. 1967.

[3] Crosswhite, William M. "Economics of Water and Waste Management in Poultry Processing" Paper presented at the annual meeting of the American Agricultural Economics Association at Southern Illinois University, Aug. 15-18, 1971.

[4] Seagraves, J. A. "Effects of Surcharges and the Prospects for Pollution Management Through River Charges." Paper presented at the Southern Land Economics Research Committee in New Orleans, Nov. 1972.

[5] Vertrees, James G. *The Poultry Processing Industry: A Study of the Impact of Water Pollution Control Costs.* Marketing Research Report No. 965, Economic Research Service, USDA, June 1972.

[6] U.S. Dept. of Commerce. *1967 Census of Manufacturers.* Bureau of the Census, Vol. III, Area Statistics, Jan. 1971.

[7] U.S. Dept. of Interior. *Cost of Clean Water.* Detailed Analysis, Vol. II, Federal Water Pollution Control Administration, Jan. 1968.

[8] U.S. Dept. of Agriculture. *Processing of Poultry By-Products and Their Utilization in Feeds.* Agricultural Research Service, Utilization Research Report No. 3, Nov. 1961.

[9] U.S. Dept. of Agriculture. *Poultry-Slaughter Under Federal Inspection and Poultry Used in Further Processing.* Statistical Reporting Service, Washington, D.C., Jan.-Dec. 1971.

[10] Congressional Record – House, Conference Report on S. 2770. *Amending Federal Water Pollution Control Act.* Sept. 28, 1972.

[11] Elliot, R. D., and James A. Seagraves. *The Effects of Sewer Surcharges on the Level of Industrial Wastes and the Use of Water by Industry.* Water Resources Research Institute, Report No. 70, University of North Carolina, Aug. 1972.

[12] Kerns, W. R., and F. J. Holemo. "Cost of Waste Water Pollution Abatement in Poultry Processing and Rendering Plants in Georgia." ERC-0673, Georgia Institute of Technology, Atlanta, 1973.