IMPLEMENTATION OF EFFECTIVE POLLUTION CONTROL BY FOOD PROCESSORS

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Over the past two years, a national commitment to reduce pollution has emerged. Firms and governmental units will be required to internalize most, if not all, costs associated with pollution control. This will move us in the direction of reducing the social costs associated with environmental quality deterioration. The subject of social costs or "externalities" has been widely discussed by economists [5].

The heavy reliance by industry on water and air resources for the assimilation of wastes, upon reflection, should not have come as a surprise. It is not a new problem, but a problem that has spread and become large as a result of both a growing population and rising per capita consumption. We would expect that waste dischargers be permitted to use the assimilative capacity of water, air and land resources as long as these uses are not costly to society.

The means selected for internalizing pollution control costs for industrial firms which appear to be favored at this time are direct restrictions and effluent charges (surcharges). On December 23, 1970, the President ordered into effect new regulations establishing a mandatory permit system for all industries discharging wastes into navigable waters under the authority of the 1899 Refuse Act. The Executive Order will affect some 40,000 industrial plants, which must submit their application by July 1, 1971, and an estimated 1,000 new plants each year. Permit holders must submit periodic reports pertaining to the nature and amount of waste discharged. Stream standards and an enforcement program by state agencies regulate the discharge of waste into streams and lakes. Similar regulations have been or will be adopted for control of air pollution.

Adoption of surcharges by cities is encouraged by a requirement of the Water Quality Office, Environmental Protection Agency, that governmental units receiving federal funds for water and waste systems implement a system of equitable charges for all users. A new City of Chicago ordinance places a special tax on industries which discharge more than 3.65 million gallons of waste water annually and is expected to produce about $10 million of new revenue each year. The tax was proposed after a study disclosed that industry contributed 10 percent of the district's annual revenue while contributing 39 percent of the waste load.

New data will be generated by reports from permit holders and municipal surcharges. The availability of better data will enable agencies to develop more effective standards and more equitable charges.

Economists appear to have been successful in making the point that effluent charges give more desirable results than direct regulations, at least in the case of surcharges. When applied among cities along a stream or among industrial firms of a municipal system, effluent charges promote the efficient use of resources and provide for greater equity [6]. Seagraves maintains that the contribution of surcharges to productive efficiency or resource allocation is more important than the question of equity [7]. Equity is a good selling point.

Water pollution is relatively more important in food processing than other types of pollution. For that reason, attention will be focused on the control of water pollution in food processing.

ECONOMIC FRAMEWORK

Water has many uses in food processing for conveying raw products, transporting partially processed products, product preparation, transporting wastes, cleanup and cooling. Waste, added to water in these processes, generates high-strength waste waters when

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compared to normal municipal waste waters. Water pollution problems in food processing are relatively more important than other types of pollution because waste water and waste water treatment are used for disposing of many solid wastes. Guidelines under development by the National Canners Association outline ways to minimize contact between the product and water [1].

There is a wide range in the types and quantities of food processing wastes. Most wastes are highly degradable by biological and chemical waste treatment processes.

Food processing plants create pollution problems by concentrating waste at the plant site. The large waste loadings create serious problems for treatment systems, especially in small towns. Even small food processing plants often produce waste quantities equivalent to domestic wastes from large cities. This problem may become worse as processing plants increase in size, with the seasonal nature of production creating further complications.

The discussion which follows will focus on the problems of water and waste control in food processing. Firms can choose from a wide array of alternatives for reducing water use and waste abatement. Waste abatement can start in the field with prewashing and sorting processes for vegetables and fruits. Other processes include in-plant changes, pretreatment and waste treatment as the final step in preparing waste waters for release.

Water and Sewer Rates

Water rates are typically a function of the quantity of water purchased, with lower rates to large volume users, primarily industrial and commercial users. Sewer charges, levied as a fixed percentage of the water charge, are also a function of the quantity of water used, Figure 1. Water and sewer rates differ widely among cities, reflecting both differences in the cost of providing these services and the level of subsidy to users. The effective price of water is the combined water and sewer rate. Further, the sewer rate is not related to either the strength of the waste waters or total wastes discharged. Under these conditions, waste discharge to the municipal system is not discouraged and the rate structure does not provide economic incentives for in-plant management and control of wastes.

The incremental cost of water reduction, MC in Figure 1A, is the firm's demand curve for water represented by D in Figure 1B. The curve MC is the average total cost of implementing water reduction alternatives, such as field washing, process and equipment modifications, and continued use of process waters. Incremental costs will rise in a stepwise fashion as more costly methods are employed. A firm using q_2 amount of water could reduce water and sewer costs by employing additional water reduction methods until water use is reduced to q_1. At this level of use, employing additional water reduction methods would increase total water and waste treatment costs.

Sewer Surcharges

An increasing number of cities are establishing sewer surcharges for industrial and commercial effluents. Their reasons for enacting surcharges are to encourage a reduction in the volume of wastes, distribute sewage treatment costs more equitably among users, and finance the expansion, construction and operation of new systems [4].

Research on the response of industrial firms to sewer surcharges has been limited. Discussions with managers of municipal sewage treatment systems indicate considerable reduction in waste loadings following the adoption of sewer surcharges. Changes over time have been difficult to assess because of changing levels of production and changing technology. Ethridge estimated the elasticity of pounds of B.O.D. discharged per 1,000 birds with respect to the surcharge of B.O.D. for the poultry processing industry to be −.2 at the mean surcharge of 2.19 cents per pound of B.O.D. [2].

Municipalities enacting sewer surcharges retain the rate structure mentioned earlier. The sewer charge, based on water costs, pays for that portion of the total waste load which is comparable to domestic wastes. Surcharges are then levied on those amounts of Biochemical Oxygen Demand (B.O.D.) and/or suspended solids (S.S.) which exceed the average level of B.O.D. and suspended solids in domestic waste. The sewer surcharge rate is shown in Figure 2 as a horizontal line.

Typically, municipalities establish sewer surcharges which are equal to the average total cost of waste treatment. These rates are generally lower than the average total cost of waste treatment by individual systems because of the economies of plant size. Further, combined water and sewer rates need to be higher than sewer surcharges to discourage dilution of waste waters.

Surcharges are expected to increase sharply in the future as cities are required to comply with stream standards. The higher cost of municipal waste treatment will reflect rising construction and operating costs and increasing requirements for waste treatment. The removal of nitrates and phosphates calls for capital-intensive methods which will shift costs upward [3].

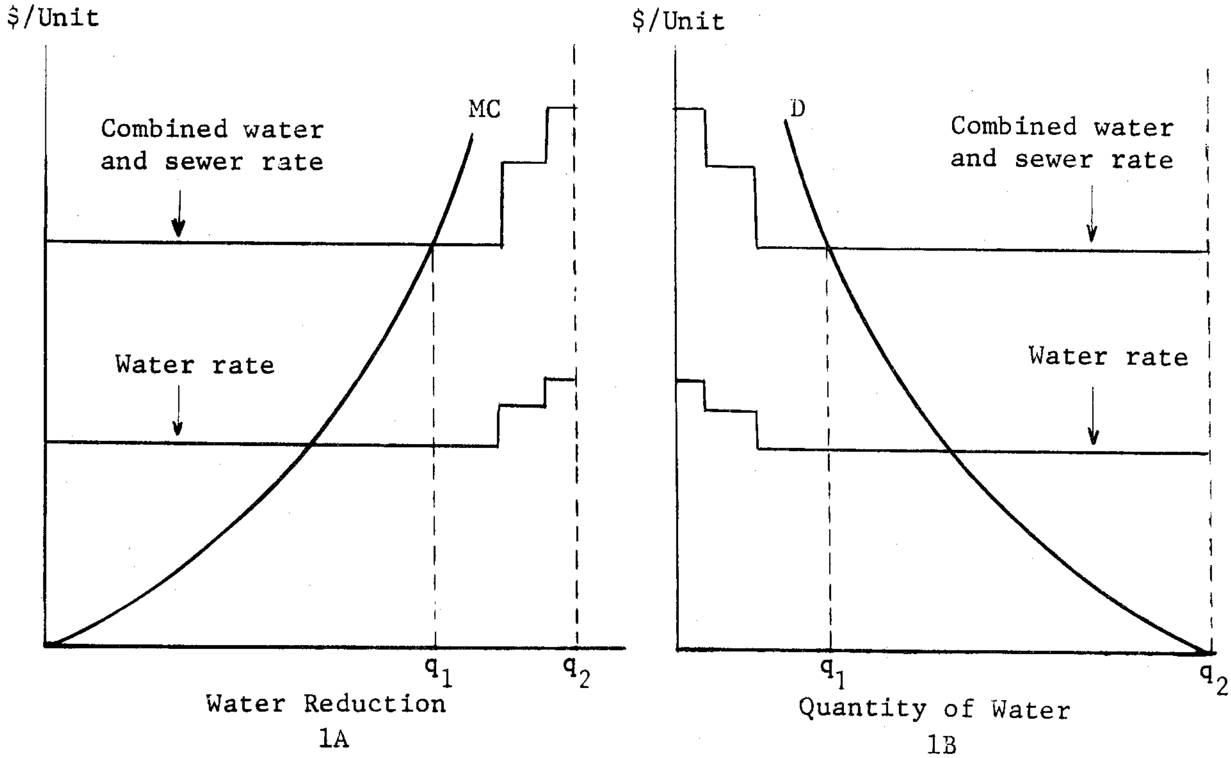

FIGURE 1. MARGINAL COST OF WATER REDUCTION, DEMAND FOR WATER AND TYPICAL PATTERN OF MUNICIPAL WATER AND SEWER RATES

Waste treatment costs could be reduced by employing waste reduction methods when a surcharge is imposed. Firms are expected to implement those waste reduction methods which minimize combined waste reduction and waste treatment costs. The combination of methods will differ among plants because of differences in types of products and raw materials, age of processing plant, and level of technology.

A demand curve for municipal waste treatment, represented by D in Figure 2, can be derived from a marginal cost curve for waste reduction for methods such as in-plant changes, pretreatment and waste treatment. The incremental cost of waste abatement rises at an increasing rate as more costly methods are employed. Costs can be determined for the several methods and are expected to produce a stepwise function. Development of measures which provide revenue (by-product recovery) or lower costs (process and equipment modifications which reduce labor and other input requirements) may result in waste reduction costs which are negative (provide positive net returns).

Assuming a total quantity of waste, q_3 in Figure 2, regular sewer charges pay for treating the amount q_1. A surcharge of p_1 would be levied on each unit $q_3 - q_1$ for a total surcharge of $p_1(q_3 - q_1)$ in the absence of waste reduction methods.

However, surcharges are expected to encourage the use of waste reduction methods. Given a sewer surcharge p_1 and a level of waste abatement technology represented by D, the quantity of waste $q_3 - q_2$ would be removed by waste reduction measures. The quantity q_2 would be discharged to the municipal system for treatment with the amount q_1 treated by the city for the fixed amount of the sewer charge. The firm would pay surcharges p_1 on the quantity $q_2 - q_1$ for a total surcharge of $p_1(q_2 - q_1)$.

Combined Water and Waste Reduction

Firms will find it profitable to employ a combination of water and waste reduction methods. Water and waste reduction are complementary and are interrelated through both technical linkages and institutional arrangements of the rate structure. Reducing the amount of water and controlling the regularity of flow increase the efficiency of pretreatment processes such as screening and settling basins.

A graphic presentation of combining water and waste reduction methods is given in Figure 3. The water and sewer rate structure, Figure 1, is superimposed on the surcharge rate structure, Figure 2. The demand for water D_A is moved up to coincide with the surcharge rate since a reduction in water use would add to the quantity of waste on which sur-

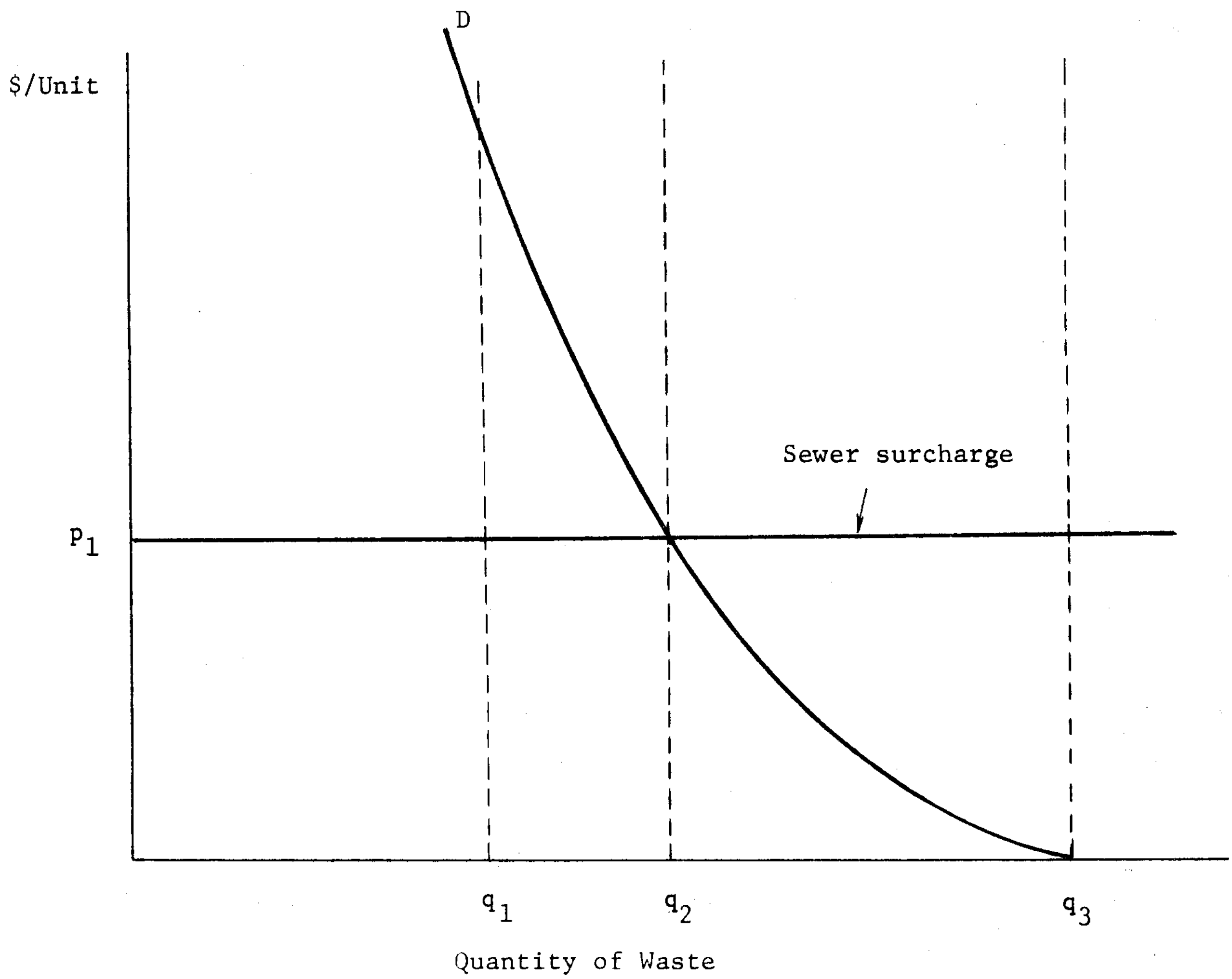

FIGURE 2. DEMAND FOR MUNICIPAL WASTE TREATMENT

charges are levied. Units on the horizontal axis indicate both the quantity of waste and the quantity of water. The two quantities are linearly related since the amount of waste which is included in the sewer cost for each unit of water purchased is specified in the surcharge ordinance.

An examination of the combined effects of implementing both water and waste reduction methods is made in Figure 3. Let us examine separately water and waste reductions when a sewer surcharge is imposed and then their combined effects.

Case 1. A reduction in waste only. Waste reduction methods would be employed to reduce waste from q_5 to q_4, with a net savings represented by the shaded area above D_B.

Case 2. A reduction in water only. Water use would not be reduced as much as it would in the absence of a surcharge because the demand for water in Figure 1 is shifted upward by the amount of the surcharge. Water would be reduced from q_3 to q_1. Surcharges would be levied on the amount of waste $q_5 - q_1$, with a net savings represented by the shaded area above D_A.

Case 3. Both water and waste reduction. By combining water and waste reduction, D_B is shifted to the left, D_C, due to the complementarity between water and waste reduction. Water use would be reduced to q_1 and waste discharged to the waste treatment plant to q_2. Net savings from improved water and waste management by in-plant methods is represented by the total shaded area.

Many firms do not discharge waste to city systems but provide their own waste treatment in order to comply with restrictions imposed by adoption and enforcement of stream standards. A program of in-plant water and waste management can reduce significantly the capital requirements and operating costs of individual waste treatment systems.

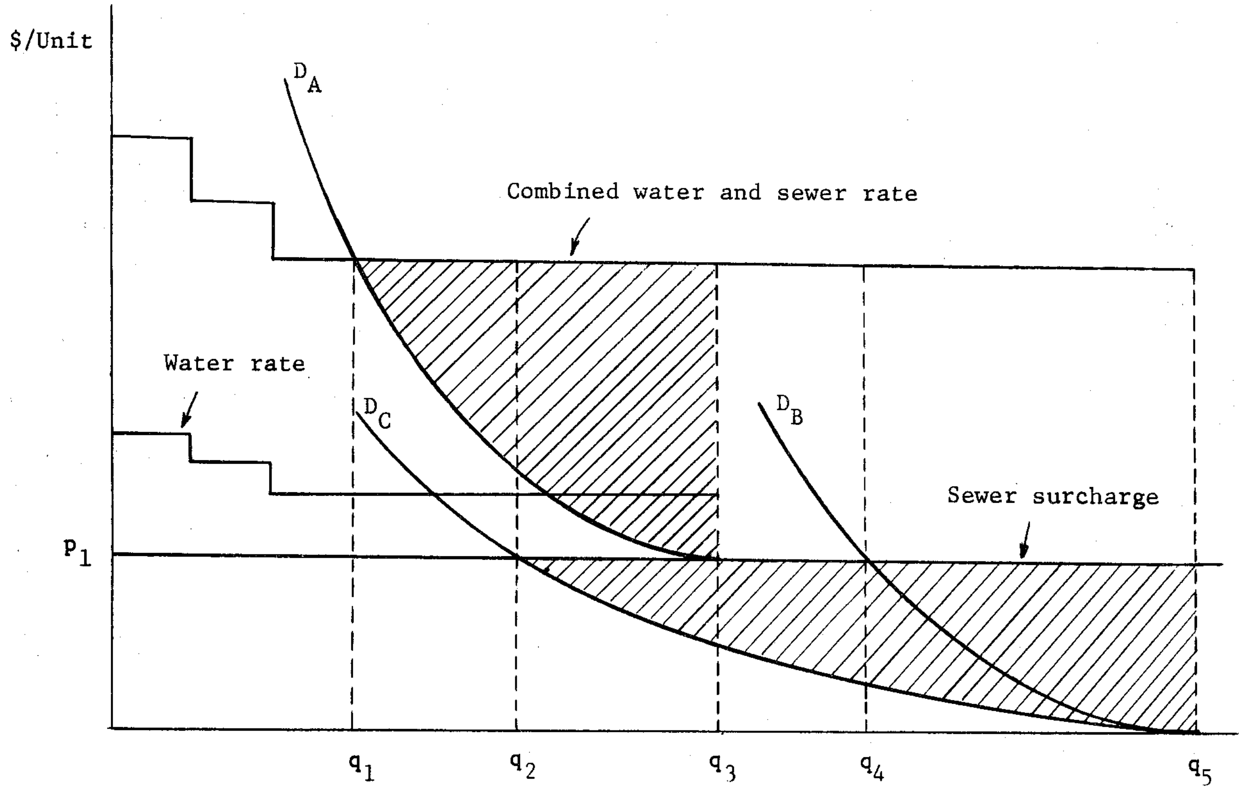

FIGURE 3. DEMAND FOR WATER AND MUNICIPAL WASTE TREATMENT WHEN BOTH WATER AND WASTE REDUCTION METHODS ARE EMPLOYED

Advances in methods from present and future research will enable firms to further reduce the cost of water and waste reduction. Many firms may find it feasible to adequately reduce waste through in-plant management and control and avoid paying surcharges.

WATER AND WASTE REDUCTION ALTERNATIVES

Advances in technology are expected to increase the range and variety of feasible water and waste reduction methods in food processing. Alternative

Alternative	Example	
	Water	Waste
Field preparation	Washing	Screening Sorting
In-plant changes		
Process modification	Dry vs water transport	Infrared potato peeling
Equipment modification	High pressure nozzles	Improved screening
Reuse of water	Counter-current flow	Recirculation
Isolation of waste		Blood recovery
Pretreatment		
By-product recovery		Screening
Reconditioning of water	Clorination	Grease recovery
Solids recovery		Settling basin
Waste water treatment		
Individual systems	Re-cycling	Different levels
Municipal systems	Re-cycling	of treatment

methods can be broadly classified into four groups: field preparation, in-plant changes, pretreatment and waste water treatment.

MANAGEMENT PROBLEMS

A number of people are discouraged by industry's slow pace in implementing pollution control measures. However, food processors face a number of important management problems in implementing pollution control measures.

A general lack of information on pollution control measures is a major problem at this time. The absence of restrictions and charges on waste discharges and low water and sewer rates have resulted in a low priority on research and development of information. A relatively high cost is imposed on food processing firms if they are required to develop their own information for crash programs.

Universities, governmental agencies, machinery and equipment manufacturers and food processing firms, themselves, have developed only limited amounts of information on in-plant changes. Major emphasis has been placed on waste treatment up to now. There is a major language barrier in working on pollution abatement. Effective procedures and programs should be developed for the transfer of research and development findings to industry. The production of useful information must be integrated with educational programs for extending information to user groups.

The product orientation of producers also affects the priority placed on pollution abatement. A product orientation is held also by federal inspectors, most research and extension personnel working closely with these firms and machinery and equipment manufacturers.

Acceptance of methods for improving waste abatement by plant personnel poses a special problem in food processing. Many of the ideas regarding production and plant operations were developed prior to the recent emphasis on environmental quality. Many of the notions of traditional production techniques and housekeeping policies are often incompatible with economic water and waste management solutions [1, p.5].

SYSTEMS APPROACH

The listing earlier of the several waste abatement methods highlights the broad range of alternative courses of action. A need to systematically view water and waste reduction methods for complementary and competitive interrelationships is evident [8].

A systems approach requires a complete understanding of the sources of water and waste, the waste water characteristics, quantities and types of waste, methods for abatement and technical relationships. Variations in water and waste flows are frequently the cause of processing stoppages. These stoppages or line slowdowns related to water and waste management occur much more frequently than has been recognized by management.

A systems approach is an effective means of identifying problems, the most serious of which do not show up readily. As a general rule, a few sources within the plant produce the bulk of the waste and most of the water. However, much depends on identifying the many minor sources and problem areas throughout the plant.

More importantly, a systems approach requires examination of the external and internal economic conditions (water charges, sewer charges, input costs) which influence decisions on production methods. As a general statement, waste recovery techniques cannot be justified in the absence of a surcharge unless there is a saleable by-product. The implementation of regulations and surcharges provides an incentive for adopting in-plant water and waste reduction methods.

A systems approach has one other helpful aspect; it requires a team effort of people from several disciplines which can improve on the problem solving processes in most food processing plants. The economists can influence results significantly by emphasizing the need to examine the many alternatives available to the food processor for solving pollution problems.

AGENCY RELATIONS

The food processing firm, in implementing a monitoring system, will be in close contact with either the state enforcement agency or the manager of the municipal waste treatment facility. There will be checks on both normal and abnormal operations. More attention will have to be given to the impact of a firm's operation on the municipal treatment system. Variations in water flows and waste loadings will have to be controlled and nuisance items eliminated. Adjustments in plant operations in making process changes will have to be coordinated with the municipal system staff. All of these factors increase the importance of process and facility maintenance and control.

Close inspection is not new for food processors since federal and state quality control programs have existed for quite some time. A major concern is that most monitoring systems leave much to be desired. The plant manager should be well informed on monitoring and sewer surcharges so that mistakes are minimized.

Food processing plants provide the major source of income for a number of rural areas and small towns. In the past, industrial firms have had considerable influence on local affairs. Water and sewer rates have often been very favorable. This is expected to change as enforcement shifts to state and federal levels.

INDUSTRY INVOLVEMENT

The individual food processing firm can meet restrictions on wastes and reduce surcharges by employing the presently available technology. Large firms will tend to employ more waste abatement measures and, thus, pay fewer surcharges. Small firms will rely more heavily on waste treatment or municipal treatment.

Industry-wide action will be necessary in making a number of changes which have a significant influence on waste abatement. In the shortrun, a single firm often finds it difficult to act alone in changing marketing practices and developing new methods. Marketing practices often determine the types of products produced by firms within an industry. This standardization of products has developed over time, and if changes are to be made, they will have to occur through industry-wide action.

Giblet processing illustrates the need for changing marketing practices when their influence on water and waste management is significant. Giblets, including liver, heart, gizzard and neck, make up approximately 10 percent of the total weight of the broiler carcass. Tentative analysis indicates that 45 percent of the fresh water, 15 percent of the waste load and 20 percent of the labor force are required by giblet processing. Several alternatives are available for changing the handling of giblets. Discarding the gizzard would have the most favorable impact on water use and waste. Any system for discarding gizzards, however, would need to be accepted by a major segment of the industry.

Regional growth and concentration of food processing may be required to make by-product recovery feasible. This appears to be a prerequisite in the vegetable and seafood industries in North Carolina, for example.

Food processing organizations may need to assume more leadership in promoting research, informational and training programs. These organizations could study the waste disposal problems of their industry, consult with federal and state agencies on enforcement of water quality programs and encourage research and development of effective pollution measures. There is a growing need to increase the availability of training programs for in-plant water and waste managers and treatment plant operators. Industry groups should encourage and support operator training through manpower programs and in-service training.

SUMMARY

Food processors, along with other industrial firms, will be required to internalize a large portion of the costs associated with pollution control in response to restrictions on discharging waste and municipal sewer surcharges. The absence of restrictions and charges has resulted in limited use of pollution control measures. Food processors will find it profitable to employ a combination of water and waste methods in implementing pollution control programs.

Important management problems of food processors in implementing pollution control measures include limited information on effective methods and the incompatibility of traditional production techniques and economic water and waste management solutions.

A systems approach to pollution control provides a way to both identify alternate ways of doing the job and determine the more effective alternatives. A systems approach would require an examination of the external, as well as internal, technical and economic conditions which influence decisions on production methods.

Process and facility maintenance and control have increased in importance. Industry groups will become more involved in research, informational and training programs. Industry-wide action will be necessary to make a number of changes which have a significant influence on water and waste management.

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