EPA-R2-73-178
MARCH 1973

Environmental Protection Technology Series

National Meat-Packing Waste Management Research and Development Program

National Environmental Research Center
Office of Research and Monitoring
U.S. Environmental Protection Agency
Corvallis, Oregon 97330

RESEARCH REPORTING SERIES

Research reports of the Office of Research and Monitoring, Environmental Protection Agency, have been grouped into five series. These five broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. The five series are:

1. Environmental Health Effects Research
2. Environmental Protection Technology
3. Ecological Research
4. Environmental Monitoring
5. Socioeconomic Environmental Studies

This report has been assigned to the ENVIRONMENTAL PROTECTION TECHNOLOGY series. This series describes research performed to develop and demonstrate instrumentation, equipment and methodology to repair or prevent environmental degradation from point and non-point sources of pollution. This work provides the new or improved technology required for the control and treatment of pollution sources to meet environmental quality standards.

EPA-R2-73-178
March 1973

NATIONAL MEAT-PACKING WASTE MANAGEMENT RESEARCH AND DEVELOPMENT PROGRAM

Jack L. Witherow, S. C. Yin and David M. Farmer

Robert S. Kerr Environmental Research Laboratory
Ada, Oklahoma 74820

Project 12060 FGF
Program Element 1B2037

National Environmental Research Center
Office of Research and Monitoring
U.S. Environmental Protection Agency
Corvallis, Oregon 97330

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
Price 75 cents domestic postpaid or 50 cents GPO Bookstore

ABSTRACT

The meat-packing process is viewed from the standpoint of its use and discharge of water. The concept of integrated water management through in-plant control, solids recovery and disposal, wastewater treatment, and water reuse is presented. The necessity for in-plant change in unit processes and housekeeping practices to reduce waste loads is shown by the wide variation in wastewaters from packing-houses.

The scope of the meat industry's waste management problem is defined, and the objectives of the National Meat-Packing Waste Management Research Program are categorized. Environmental Research Needs are introduced as a means by which the meat industry can present its waste treatment problems to the program.

The past and current research projects are briefly described according to the objectives and accomplishments with more detailed information referenced. The results of the recent waste survey of the meat industry are given along with interpretation of their meaning. Future research projects will evolve around closed-loop technology. Unit processes which offer great potential in waste reduction are described as the initiation point for a program to reach the goal of "no discharge of pollutants."

Key Words: Meat-Packing Wastes, Pollution Control, Pollution Abatement, Water Quality, Industrial Wastes.

CONTENTS

FIGURES

TABLES

SECTION I

SUMMARY AND CONCLUSIONS

The status of the National Meat-Packing Waste Management Research and Development Program is introduced by a brief review of the production process and resulting waste problems. The meat-packing process is presented from the viewpoint of water uses and discharges. This viewpoint leads to the concepts of an integrated management of water to reduce waste by recovery of solids from separated waste streams and of design of wastewater treatment systems for water reuse. The necessity for in-plant process changes is verified by statistics from four waste surveys of the industry. From the large variation in waste load between discharges from similar plants, it is concluded that a 50 percent or more decrease in pollutants discharged to the treatment system can be accomplished by existing in-plant improvements.

The objective of the research program is to develop and demonstrate the necessary technology to achieve the required degree of pollution control for wastewaters from the red meat processing industry by least or reasonable cost methods. The ultimate goal is to achieve a level of technology capable of no discharge of pollutants through use of a closed-loop water system. Meeting this goal will require an expanded and systematic development program. Such a program must receive support and direction from industry. The Environmental Research Need Statement is a means for industry to add direction to the research projects selected for partial funding under the EPA grant programs. Research projects which offer a new or novel solution to the widespread needs of the meat industry are given high priority. To date, ten research projects have been undertaken in this program at a total project cost of $5 million. Federal participation has averaged 50 percent. These projects, which include in-house and grant and contract efforts, were to develop and demonstrate by-product recovery systems and improved primary, secondary and tertiary treatment processes. The major objectives and accomplishments of the projects are described

to indicate their investigative scope and cooperation between industry, universities, consultants, and the Federal government. Detailed information on these projects can be obtained from the reports referenced.

Recent legislation terminates the issuing of permits for waste discharges under the 1899 Refuse Act and authorizes a discharge permit system within EPA. A recent EPA-sponsored waste survey of the meat products industry developed mean raw waste load values for Biochemical Oxygen Demand exerted in five days (BOD_5), suspended solids, and grease. A base level of discharge was determined by using the efficiencies of the most common treatment system, anaerobic-aerobic lagoons. The best levels of discharge were based on an existing highly efficient treatment plant serving the meat industry. The next decade will see stringent discharge limitations on the meat products industry, which are expected to exceed present treatment process limitations or to eliminate discharge of all pollutants. These two limits are so close that water reuse and perhaps complete closed-loop waste systems will become common in the industry.

The future research program is clearly defined by the goal of "no discharge of pollutants." Because of the economic advantages for reuse of such a high quality effluent, closed-loop technology is the planned strategy. Present knowledge defines the point of initiation for such technology as water and waste reduction through production changes. Separation of waste streams for by-product recovery and reuse of high quality streams should precede treatment processes designed for reuse of the effluents.

EPA is prepared and has the instrument to support financially, through grants and contracts, those research projects that will aid in development of closed-loop technology for the meat-packing industry.

SECTION II

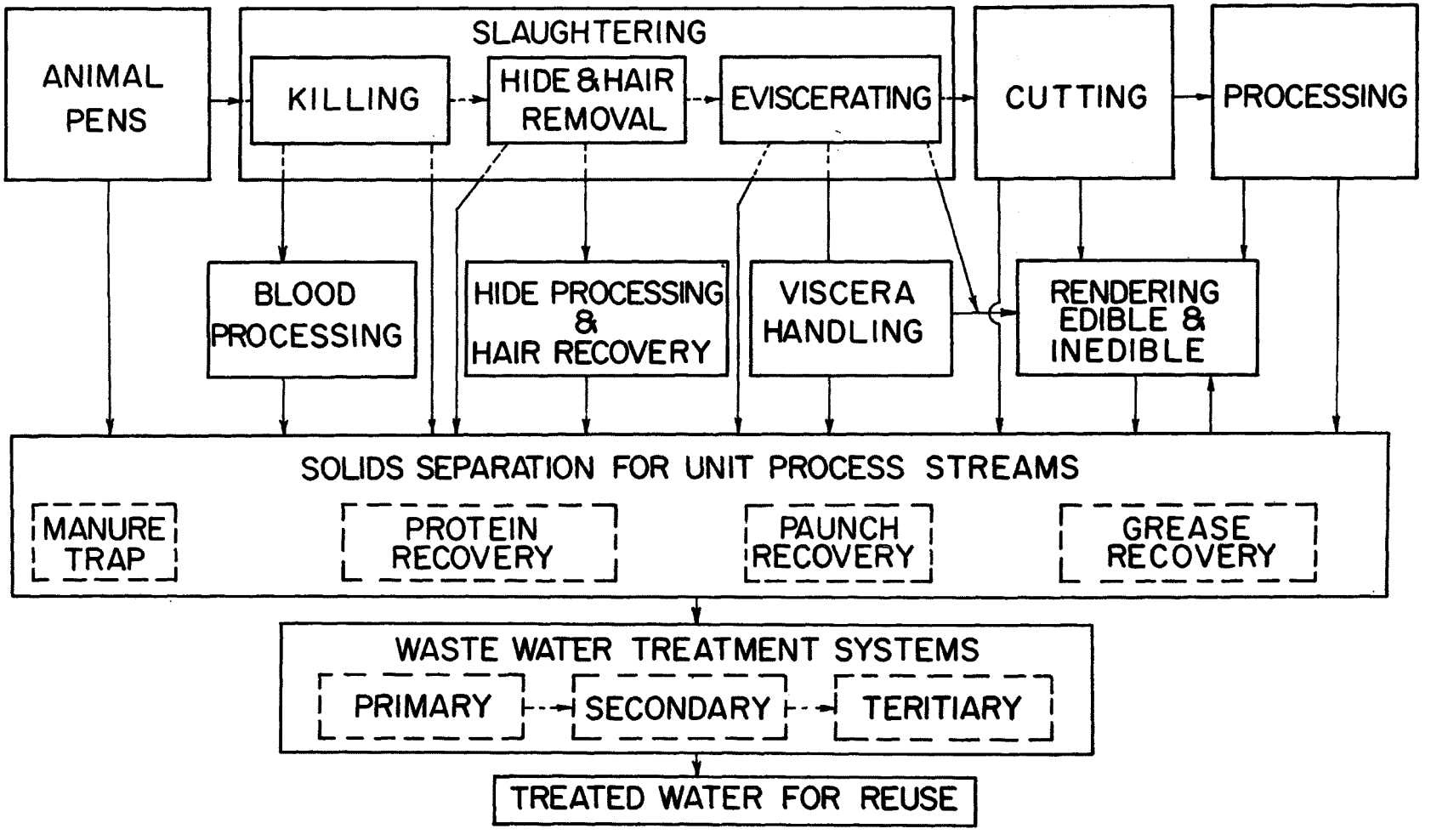
INTRODUCTION

Meat-Packing Process

Compared to operations of other industries, the meat-packing process appears to be a topsy-turvy assembly line--a large product is first stored, then disassembled, and finally repackaged into smaller units. A general flow sheet of a packinghouse is shown in Figure 1. Fresh meat, the most economically important output, is the product of the first three stages of the primary process line: animal holding pens, the slaughtering area, and the cutting area. The fourth stage, processing, includes such operations as grinding, curing, pickling, smoking, cooking, and canning. The secondary, or by-product, process line utilizes materials discarded from the primary line for manufacture of a variety of food, animal feed, and industrial raw materials. Major subsystems of the secondary line include: blood processing, hide processing and hair recovery, viscera handling and recovery, and edible and inedible rendering (fat extraction). Due to specialization and economics of scale within the industry, not all of the aforementioned processes may be found within a given plant, nor will the unit operations in a given process necessarily be identical in each plant. The common element in most subsystems, however, is the use of water during a processing operation and cleanup. Because good quality water historically has been cheap and abundantly available, a copious flow of this versatile solvent and cleansing medium is inherent in the design of common process machinery; thus, even in a well operated plant over a gallon of water per pound of animal live weight is used during the production operation. Despite the ingenuity demonstrated by the industry in recovering marginally profitable by-products, the large volume of wastewater produced still contains vast quantities of organic process residues; this, coupled with the intermittent production schedule, places a severe burden on wastewater treatment systems.

FIGURE - 1

MEAT-PACKING PROCESS



Most of the primary and secondary process waste streams shown should be separately handled to recover valuable material and/or reduce costs in the treatment system. The manure trap and dry paunch recovery are examples of such systems. A majority of treatment systems in the meat-packing industry today consist of primary units for liquid-solids separation, followed by secondary biological treatment systems to reduce the BOD and suspended solids to levels suitable for discharge. Tertiary treatment units, which are needed for further reduction of pollutants, especially nutrients, will become more common as stricter discharge limitations become effective. The necessity for further treatment and the rising cost of water can make the reuse of treated waters from tertiary systems economically practical.

Waste Management Problems

On a national basis the wastewater discharged from meat-packing plants is the number-one potential polluter among the food and kindred products industries; only pulp and paper processing, of all other agricultural processing industries, has a higher potential for water pollution. This statistic is based on the U.S. Department of Agriculture computations of pollutional discharges using a raw waste load of 14.0 lbs. Biochemical Oxygen Demand (BOD) per 1,000 lbs. Live Weight Killed (LWK) with 73 percent eliminated in treatment processes (1). Besides pollutional loads, waste management problems are also measured by number and distribution of plant discharges. There are over 4,000 meat slaughtering and processing plants distributed across every state in the nation. By comparison, there are about 400 pulp and paper mills located in half of the states. Though these statistics indicate the national significance of meat-packing wastes, more specific information is necessary in order to achieve reduction in pollutional discharges. In a study sponsored by EPA, North Star Research and Development Institute, in cooperation with the American Meat Institute, recently completed a survey of the waste load characteristics of representative slaughterhouses, packinghouses, red meat processing plants, poultry processing plants, and rendering plants (2).

Since most of the waste load is generated by packinghouses, the following discussion is limited to this segment of the meat industry. Selected pollutional parameters (BOD, suspended solids, grease, nitrogen) of the North Star study and comparable data from three previous surveys (3, 4) are summarized in Table I. The number of packinghouses surveyed by North Star, Mohlman, Hill and Kerrigan are 52, 16, 10 and 10, respectively. In interpreting the data shown in Table I, a statistical approach is helpful. For a given wastewater parameter, a comparison of the average, or mean (M), values shows remarkable similarity among the four studies; thus, although larger surveys would shift the mean values slightly, the results of the studies are complementary. However, mean values do not indicate the variation in water quality which exists among the plants; this is given by a second statistical measure, the standard deviation (σ). Data from 66 percent of the plants surveyed will be within plus or minus one standard deviation of the mean. These limits exclude extremely high or low values and include the maximum number of plants per unit of waste load. For example, with a M of 13.3 lbs. BOD_5/1,000 lbs. LWK plus or minus σ of 4.7, 66 percent of the plants surveyed would be in the range of 8.6 to 18.0 lbs. BOD_5/1,000 lbs. LWK.

The ratio of the standard deviation to the mean is known as the "coefficient of variation" ($C\nu$); this ratio permits comparison between the four surveys of the variation in a particular waste load parameter. The values are given in Table I. With one exception (North Star-nitrogen), the values are similar for each parameter and averages are shown for each parameter. The average coefficient in percent indicates that the standard deviation is 35.6 percent of the mean BOD_5 or that variation about the mean BOD encompassing 66 percent of the plants is 71 percent. Similar values for suspended solids, grease and nitrogen are 93 percent, 192 percent, and 62 percent, respectively.

In terms of reducing the waste management problem in the meat-packing industry, this extreme variation in waste loads between plants is more

significant than the mean values or even efficiencies of subsequent treatment processes. If the reasons for low level waste loads at certain plants can be determined and their in-plant improvements incorporated into other plants, pollutants discharged to the treatment systems can be decreased by 50 percent or more.

The importance of measuring the waste load variation of common operations between plants was recognized by the American Petroleum Institute (API), a trade association for the oil refinery industry. The API, in cooperation with the Robert S. Kerr Environmental Research Laboratory, has completed an in-depth survey of 24 waste parameters for over 75 percent of the domestic refining capacity. The waste characteristics of common refinery operations were established. Analysis of the variation between plants showed that the waste load per unit of production could be reduced by decreasing water usage. This and other information obtained on waste load reduction establishes the importance of investigating in-plant controls.

Research Objectives

The stated objective of the Meat-Packing Waste Management Research Program is to develop and demonstrate the necessary technology to achieve the degree of pollution control required of the red meat processing industry by least, or reasonable, cost methods. This objective can be subdivided into six areas:

1. In-plant control through characterization and reduction of wastes by unit operations,
2. Solids recovery and disposal from separated waste streams,
3. Odor control from processing, rendering, and waste treatment,
4. Treatment systems demonstrating future discharge limitations,
5. Utilization of wastewaters and by-products in closed-loop systems; and
6. Technology dissemination to implement environmental protection.

TABLE I

MEAT-PACKING WASTE LOAD CHARACTERISTICS

Mean Values (lbs./1,000 lbs. LWK)

Survey by	BOD	Susp. Sol.	Grease	Nitrogen
North Star	12.1	8.7	6.0	1.0
Mohlman	14.6	11.3	1.6	1.7
Hill	15.0	12.4	---	1.7
Kerrigan	11.8	9.0	8.2	0.9
Average	13.3	10.3	5.2	1.3

Coefficient of Variation ($C\nu = \sigma/M$)

Survey by	BOD	Susp. Sol.	Grease	Nitrogen
North Star	.429	.552	.983	1.58*
Mohlman	.315	.362	.877	.217
Hill	.348	.419	----	.355
Kerrigan	.332	.533	1.03	.364
Average	.356	.466	.963	.312

*This extreme value was omitted in calculation of the average coefficient of variation.

Of these six areas, the first and second, both of which will reduce costs of treatment necessary for water recycle, may produce the most discernible advancements with regard to pollution abatement. The meat-packing industries as well as the EPA should give high priority to these areas of technology.

The challenge is to meet the forthcoming goal of no discharge of pollutants at costs commensurate with the industry's ability to attract capital. This is a critical challenge to the meat industry. Obviously, development of the necessary technology will require the best scientific and engineering talent drawn from industry, universities, private research groups, and consulting engineers. The goal is high; the time is short; the technology needs are great. The talent must be mustered and a critical research path must be coordinated and funded. It is in this area of coordination and funding which the Environmental Protection Agency can be most helpful. The technology necessary to obtain no discharge of pollutants will only be obtained by a well-financed, systematic research program.

Research Need Statements

The Office of Research and Monitoring of the Environmental Protection Agency has recently established a new planning system for the purpose of developing a coordinated research, development, and demonstration program. The system begins with the user community; without the participation of industry, the most critical technology may not be funded. In the first stage of the system, Environmental Research Need Statements are solicited from industry, industrial organizations, research groups, and governmental agencies. A copy of this form is shown in Figure 2. In brief, the Need Statement pinpoints a specific problem having general applicability to the industry and specifies the form of solution which would be most useful. Related need statements are grouped by EPA into packages termed Environmental Research Objective Statements (EROS), each of which forms the basis for a

FIGURE - 2

FORM APPROVED
OMB NO. 158-R-0018

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND MONITORING

ENVIRONMENTAL RESEARCH NEED

DESCRIPTIVE TITLE

DEFINE THE SPECIFIC PROBLEM TO BE SOLVED

WHAT IS THE EXTENT AND IMPORTANCE OF THE PROBLEM?

WHAT FORM OF A SOLUTION IS NEEDED? *(e.g., instruction manual, research report, process or facility demonstration).*

HOW WILL THE SOLUTION BE USED AND BY WHOM?

WHEN WILL THE SOLUTION BE NEEDED AND WHAT ARE THE CONSEQUENCES, IF ANY, OF DEFERRING ON THE PROBLEM?

NAME AND ORGANIZATION OF REQUESTOR	DATE

FOR ADMINISTRATIVE USE ONLY

SPONSOR			EQUIVALENT NEEDS	PROGRAM NUMBER	IDENT. NUMBER
SPONSOR PRIORITY RATING	REQ'D BY *(Mo/Yr)*	PROGRAM PRIORITY RATING	REQ'D BY *(Mo/Yr)*	AGENCY PRIORITY RATING	REQ'D BY *(Mo/Yr)*

EPA Form 5300-2 (7-71)

GPO 918-206

coordinated effort in a particular area of research. From each Objective Statement, a corresponding Research Objective Achievement Plan (ROAP) is developed, outlining the path and schedule by which the solution will proceed. These objective and achievement statements are the basis for setting priority and funding levels. Thus the future level of Federal funds to be allotted to meat-packing waste management research can be directly affected by written Need Statements from the public. The one-page form shown in Figure 2 has been designed to simplify the effort of writing the Need Statement and to assist the user in evaluation of his needs. Completed forms can be forwarded to the National Meat-Packing Waste Management Research Program, Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma, or sent to the nearest EPA Regional Office.

Table II lists Environmental Research Needs of the meat-packing industry which have been submitted to date.

Because of the goal of "no discharge of pollutants," water reuse or closed-loop water systems will probably emerge as the most economical alternatives for the meat-packing industry. Need Statements related to development of components for such systems may well be given top priority.

TABLE II

ENVIRONMENTAL RESEARCH NEEDS AS OF FY 1973

Objective	Title
In-Plant Control	"Meat Industry In-Plant Prevention of Pollution Losses"
	"Determine Quality Variability and Possible Reduction of Major Process Wastes that Make Up Meat-Packing Wastewaters"
	"Establish Range and Average of Flow from Various Parts of the Meat-Packing Operation and Characterize the Wastewater"
	"Process Change for Reduction of Wastewaters"
Solids Recovery and Disposal	"Product and By-Product Recovery from Food Processing Wastes"
	"Cattle Paunch Recovery Systems for Small Meat-Packers"
	"Blood Recovery Systems for Small Meat-Packers"
	"Recovery of Proteinaceous Nitrogen from Meat-Packing Wastewater"
	"Meat-Packing Paunch Manure Handling and Disposal System"
	"Meat-Packing Blood Handling and Disposal System"
	"Meat-Packing Grease Handling and Disposal System"
Odor Control	"Meat-Packing Wastewater Lagoon System Odor Control"
	"Reduction of Odors Emanating from Anaerobic Lagoons Treating Meat-Packing Wastewaters"
Treatment for Discharge	"Small Meat-Packers--Waste Treatment Systems"
	"Ammonia Removal from Treated Packinghouse Wastewaters"
	"Prevention of Algal Suspended Solids Discharge from Meat Industry Lagoon System"
	"All Season Meat Industry Effluent Irrigation with Pollutional Side Effects"
Utilization in Closed Loop	"Treatment of Anaerobic Effluents at Meat-Packing Plants"
	"Development of Methods for Increased Utilization of Slaughterhouse Waste By-Products"
Dissemination	"Meat-Packing and Slaughterhouse Waste Control--Updating State of the Art"

SECTION III

CURRENT RESEARCH PROGRAM

Responsibility for the administration and implementation of the meat-packing wastes research program of the Environmental Protection Agency is at the Robert S. Kerr Environmental Research Laboratory in Ada, Oklahoma. The program goals are achieved through three avenues: in-house research, grants, and contracts. Because of the lack of manpower, in-house efforts have been restricted, the major efforts having been expended in the grant and contract areas. To date, ten research projects have been undertaken in this program. The total project estimated cost is $5 million, with Federal participation at about 50 percent of total cost. Five of these projects have been completed. Final reports are being prepared or are at the printers, and all will be available for distribution within the year. Three projects are in the evaluation state; these are scheduled for completion next year. The two remaining projects were terminated prior to construction after completing the feasibility studies.

In-House Projects

There are currently two in-house research projects within the program. One is development of waste treatment systems and the other is development of by-product recovery systems; both are slanted toward the special needs of small meat-packers.

1. Project No. 12060 GPP--"Small Meatpackers Waste Treatment Systems." The waste treatment project is a cooperative effort between industry, education, and government. The parties involved are: W. E. Reeves Packinghouse, East Central State College, and the Robert S. Kerr Environmental Research Laboratory, all located in Ada, Oklahoma. The project incorporates construction and evaluation of three full-scale treatment ponds and three pilot-scale soil treatment plots. Five biological treatment processes are to be evaluated; these

are: anaerobic pond, transitional pond, stabilization pond, aerated pond, and spray-runoff irrigation. Figure 3 shows the completed treatment units drawn to scale. The piping is arranged so that 12 different treatment systems could be operated and evaluated.

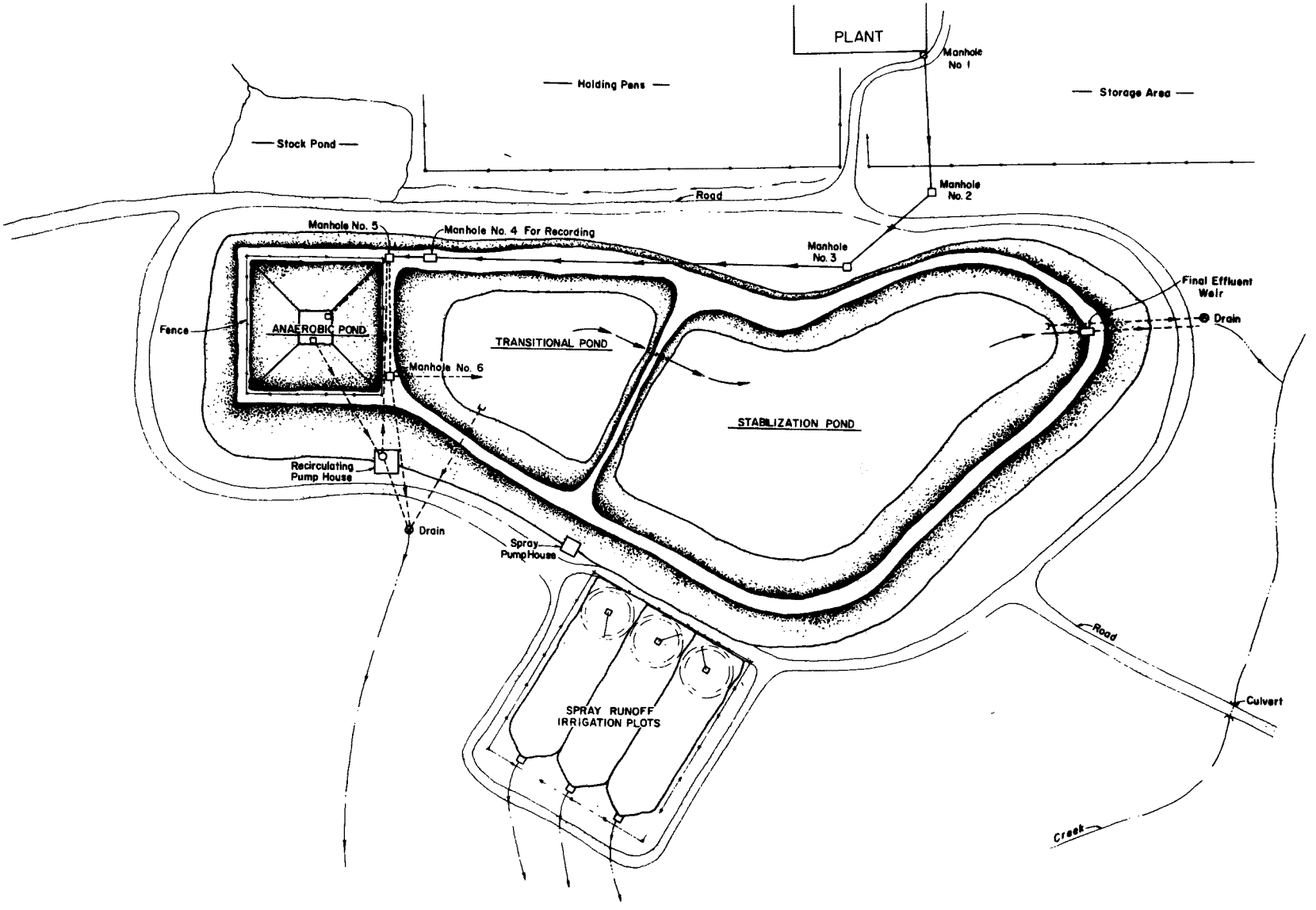
The investigation is divided into two phases. The first phase is almost completed. During this phase, the common system of an anaerobic pond followed by a transitional pond and a stabilization pond was evaluated. The pond system has operated as expected with high removals of BOD and suspended solids, but with a discharge averaging 14 mg/l of ammonia. During the second phase, the anaerobic pond is to be converted to a batch-operated aerated pond. This all-aerobic system is expected to be utilized where hydrogen sulfide odors would create a nuisance or where ammonia discharges are restricted.

The objective of the spray-runoff irrigation units is to meet future nitrogen and phosphorus effluent limitations. The influent for the units can be tapped from any of the three ponds. These units will be evaluated in series with the anaerobic pond, the anaerobic-aerobic pond, and the aerated-aerobic ponds. Evaluation thus far has been on effluent from the anaerobic pond. The units have performed equivalent to the transitional and stabilization ponds, but under present loading rates nitrogen and phosphorus have not been reduced to the desired levels.

2. Project No. 12060 HVQ--"Utilization of Paunch Manure as a By-Product Feed for Channel Catfish and Its Effects on Water Quality." The by-product development investigation is to air-dry and demonstrate the suitability of paunch contents as a food for commercial catfish production. A preliminary report (5) showed the feasibility of air-drying paunch and the potential of dried paunch as a feed supplement in catfish culture. It was demonstrated that paunch can be air-dried successfully and that the dehydrated product can be stored for months without spoilage. The data collected on time required for

FIGURE - 3

WASTE TREATMENT SYSTEMS FOR SMALL MEAT-PACKERS



air-drying were inconclusive, but redesign of the drying facilities has incorporated new techniques, and the desired information will be obtained. These feasibility studies showed that catfish will readily consume dried paunch material and that Salmonellae are not present in fresh paunch. However, dehydrated paunch has an extended BOD_L of over 200,000 mg/1,000 grams. This oxygen demand was exerted at a rate of 2,000 to 4,000 mg/day/1,000 grams of dried paunch.

Oxygen depletion potential of dried paunch incorporated into fish feed and other related factors require further studies. A full-scale cooperative project with Oklahoma State University, Stillwater, Oklahoma, has been initiated to evaluate the use of dried paunch contents (a potential economic by-product) as a feed supplement in commercial channel catfish farming, and to determine the effects of the two methods of commercial catfish cultures--pond and cage--on water quality. This project will be completed by November 1972; the final report is expected to be ready by June 1973.

Grant Projects

The objective of four of the five completed projects was to develop and demonstrate improved treatment systems. That of the other completed project was to evaluate a by-product recovery system for blood and paunch. Brief descriptions of these projects follow; more detailed information is available in the referenced proceedings of technical conferences at which the research data were presented and from the EPA Environmental Protection Technology Series reports.

1. Project No. 12060 EUB--"Construction and Study of a Demonstration Plant Utilizing the Aerobic Channel Method for Treating Packinghouse Wastes." The research project by John Morrell & Company was designed primarily to investigate the effectiveness of using an oxidation channel for the secondary treatment of meat-packing wastes. Figure 4 illustrates the treatment system evaluated in the project. The oxidation channels were operated to test effects of variation in retention time and mixed

liquor solids levels on organic removal and waste sludge quantities. Two final settling tank designs were evaluated at various hydraulic and solid loadings. The removal of grease and grit in the primary tanks was evaluated.

Laboratory evaluation was carried out on means of harvesting the waste activated sludge solids and their suitability as a feed supplement. Bench-scale chlorination of the final effluent was done in the laboratory, using chlorine residual and fecal coliform counts as criteria for the measurement of the effectiveness of this treatment. A preliminary report on this project was presented at the Second National Symposium on Food Processing Wastes (6). The final results were presented at the 27th Industrial Wastes Conference, Purdue University, May 1972.

2. Project No. 11060 DLF--"Tertiary Treatment of Combined Domestic/Industrial Wastes." The project at Tualatin, Oregon, was to develop improved secondary and tertiary treatment. A flow diagram of systems shown in Figure 5 depicts a combination of unit processes which constitute a waste treatment plant followed by a water treatment plant. The project objectives were to demonstrate a high-rate, mixed media filter following an extended aeration process and to determine the economics of the systems in providing "drinking water" quality effluent. Filter runs ranged from 1.5 to 1.0 hours and were dependent upon solids discharged from the tube settler. This settler did not prove to be an effective clarifier for the extended aeration unit, and its effluent averaged 110 mg/l suspended solids, resulting in an average BOD of 70 mg/l. With dosage of 220 mg/l of alum, final effluent averaged >0.1 mg/l orthophosphate and >1.0 mg/l suspended solids. Evaluation is completed and the results were presented at the Third National Symposium on Food Processing Wastes (7).

3. Project No. 11060 EKK--"Efficiency and Economy of Polymeric Sewage Clarification." Figure 6 is the flow diagram of the project at South St. Paul, Minnesota, which added a combination of anionic-cationic chemicals to a 90 percent meat-packing wastewater to improve

FIGURE - 4

AEROBIC CHANNEL for TREATING PACKINGHOUSE WASTE

AWARDED DEC. 1966 — TO JOHN MORRELL & CO.

FED. GRANT $489,000 — PROJECT COST $815,000

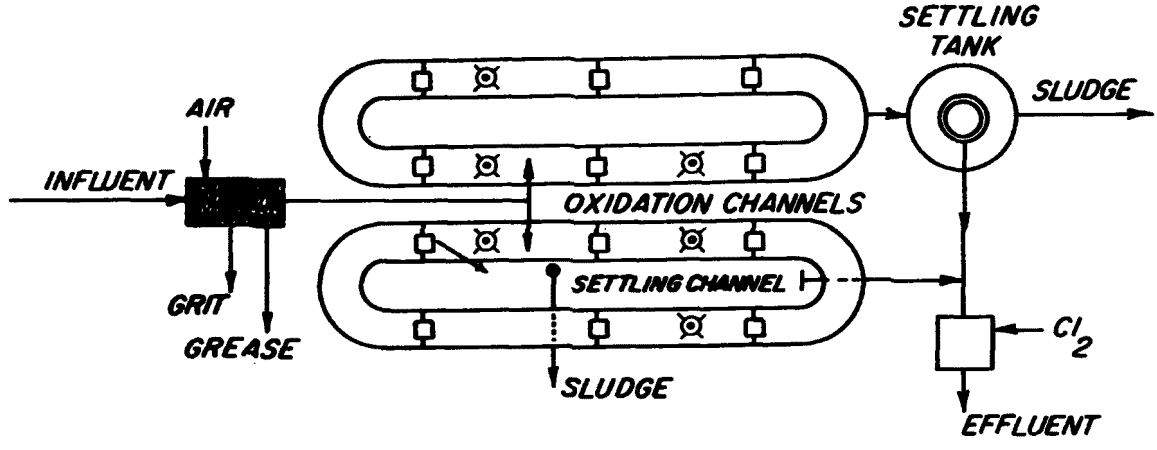
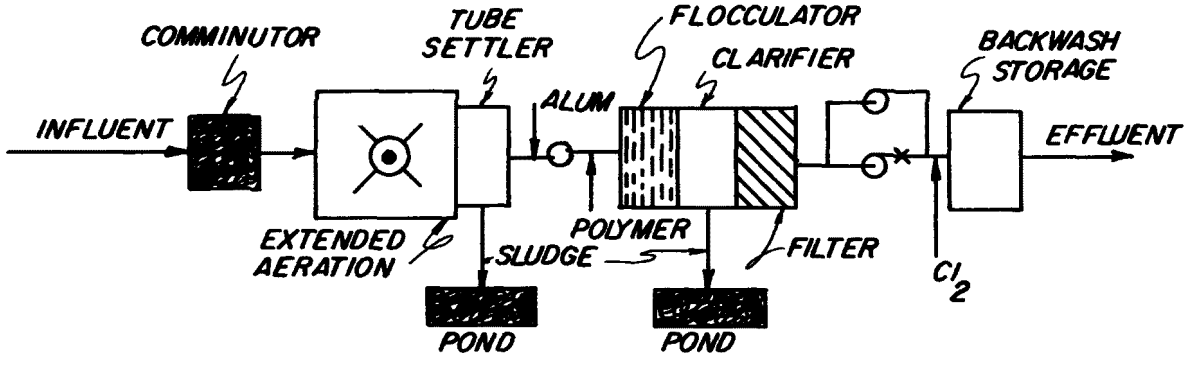


FIGURE - 5

TERTIARY TREATMENT of COMBINED WASTES

AWARDED 3/20/68 — TO TUALATIN, OREGON

FED GRANT $230,800 — PROJECT COST $323,600



primary treatment efficiency. Of the various treatment schemes demonstrated, a dual system of ferric chloride followed by the addition of an anionic organic polyelectrolyte proved to be the most successful. Chemical addition decreased suspended solids by 100 mg/l and BOD by 140 mg/l leaving effluent concentrations of 120 mg/l and 550 mg/l, respectively. The cost of chemical treatment was $0.045/1,000 gal. of waste treated. The costs were 71 percent for chemicals, 15 percent for construction, 12 percent for labor, and 2 percent for utilities. The evaluation at a 10 mgd plant has been completed and the results published (8).

4. Project No. 12060 DFF--"Waste Treatment Facilities, Farmbest Inc., Denison, Iowa." The waste treatment facilities are shown in Figure 7. The facilities were designed to handle waste flow from the plant having a capacity to slaughter and process 5,000 hogs per day. Though the air flotation tank and anaerobic lagoons were evaluated, the major objective was to demonstrate secondary treatment in two 22-foot-deep plastic media trickling filters. These filters were evaluated in both series and parallel operations, but only series operation was successful. The BOD_5 removal in the filters averaged 74 percent during the test year. Odors were noticeable at the anaerobic lagoon weir and in the preaeration tank. The plant effluent was chlorinated; to determine effectiveness, residual chlorine measurements, along with pre- and post-chlorination coliform counts, were made. Evaluation is complete, but the final report is being revised to analyze more thoroughly the data collected. Preliminary results were reported at the Second National Symposium on Food Processing Wastes (9).

5. Project No. 12060 FDS--"Elimination of Water Pollution by Packing House Animals Paunch and Blood." Beefland International, Inc., Council Bluffs, Iowa, evaluated a system to develop and demonstrate a collection and drying process for blood and paunch contents (two major pollutants in abattoirs), converting these wastes into

FIGURE - 6

EFFICIENCY and ECONOMY of POLYMERIC SEWAGE CLARIFICATION

AWARDED 6/15/67
FED. GRANT $450,000

TO SOUTH ST. PAUL, MINN.
PROJECT COST $845,145

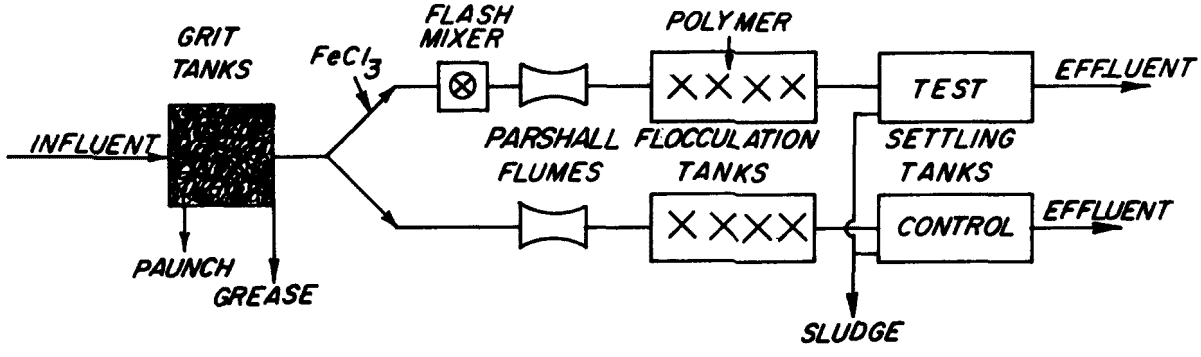
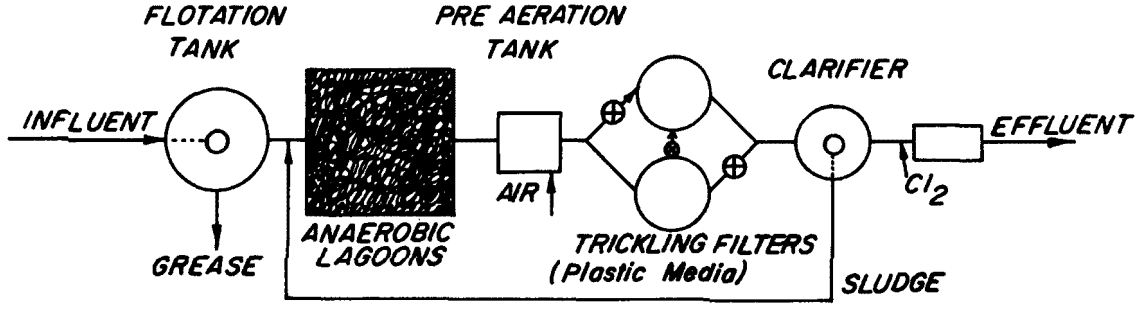


FIGURE - 7

WASTE TREATMENT FACILITY

AWARDED 10/5/68
FED. GRANT $289,790

TO FARMBEST INC.
PROJECT COST $755,587



marketable by-products. This plant has a maximum daily capacity of 2,500 head of cattle. Through this process, the two major pollutants were eliminated from the wastewater of the plant, substantially reducing the waste load required for treatment. Figure 8 is a schematic drawing of the process.

Laboratory studies included five-day BOD of whole blood and fresh paunch, which were established to be 156,500 mg/l and 50,200 mg/l, respectively. The moisture, protein, fat, carbohydrate, and other contents of the dried products were also determined. Capital and operating costs per ton of dehydrated products were $43.75 for blood and $38.46 for paunch. The project has been completed and the final report is available (10).

6. Project No. 12060 FMF--"Evaluation of the Rotating Biological Surface System on Meat Packing Wastes." Iowa Beef Packers, Inc., Dakota City, Iowa, is demonstrating the effectiveness of the rotating biological surface (RBS) process as a secondary treatment system for meat-packing wastes following anaerobic lagoon treatment. A flow diagram of this system is shown in Figure 9. Based on pilot plant data, the full-scale rotating biological surface is designed to have a loading of 6.0 gallons per day per square foot of disc area. The units built for this plant have a total disc area of 500,000 square feet. The rotating speed of the discs will be varied to determine optimum treatment. Operational and economic data will also be collected on the flotation tanks and the two anaerobic lagoons. Construction has been recently completed. The evaluation is scheduled for completion by July 1973.

Contract Project

One contract has been let to survey the meat products industry. The North Star Research and Development Institute completed a survey designed to determine "Standard Raw Waste Load, Base Level of Treatment, and Best Available Treatment." The results of this survey were published (2) and are further described in Section IV, Future Discharge Limitations.

FIGURE - 8

ELIMINATION of PAUNCH & BLOOD AS WASTES

AWARDED 11/25/69
FED GRANT $161,398

TO BEEFLAND INTERNATIONAL
PROJECT COST $367,870

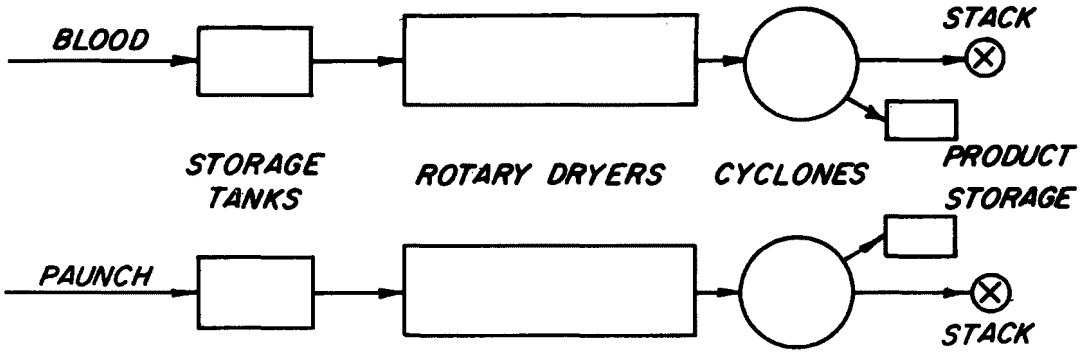
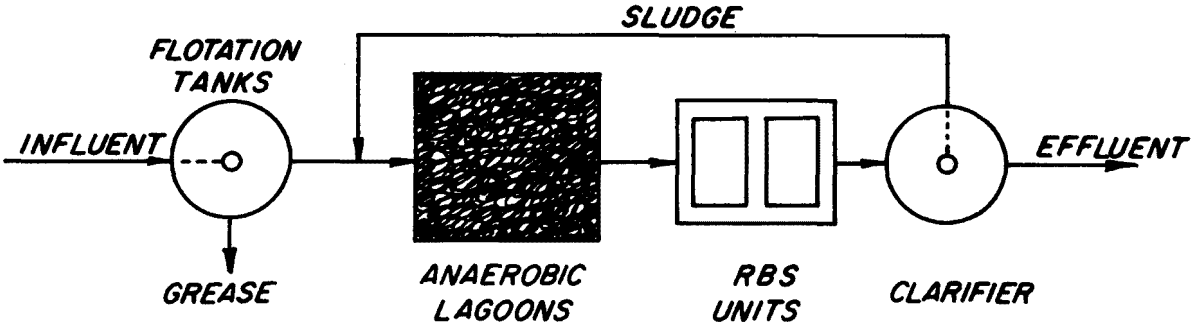


FIGURE - 9

EVALUATION of ROTATING BIOLOGICAL SURFACE on MEAT PACKING WASTE

AWARDED 6/30/70
FED. GRANT $195,750

TO IOWA BEEF PROCESSORS
PROJECT COST $466,630



The projects described have provided some of the information and technology necessary for the abatement and elimination of pollution by the meat products industry, but additional research is needed before the ultimate goal of a closed-loop system envisioned for the industry can be achieved.

SECTION IV

FUTURE DISCHARGE LIMITATIONS

Under the 1899 Refuse Act, EPA found it necessary to develop discharge guidelines for the meat products industry. North Star Research and Development Institute, under an EPA contract, performed a survey of the industry designed to determine "Standard Raw Waste Loads," "Base Level of Treatment," and "Best Available Treatment" for the parameters: BOD_5, suspended solids, and grease (2). These data were expressed in terms of "lbs. of pollutants per 1,000 lbs. LWK" in the case of slaughterhouses and packinghouses and "lbs. of pollutant per 1,000 lbs. of product" for strictly processing operations (Table III).

The "Standard Raw Waste Loads" are mean values developed from 11 slaughterhouses, 52 packing plants and 6 processing plants. The suggested "Base Levels of Treatment" were based on removal efficiencies of the most common treatment system of an anaerobic lagoon followed by aerobic lagoons. A well operated anaerobic-aerobic lagoon system can readily achieve 95 percent reduction of BOD_5, 90 percent reduction in suspended solids, and 97 percent reduction of grease content.

The suggested "Best Available Treatment" figures were based on an existing, highly efficient poultry wastewater treatment plant which consists of 24-hour extended aeration, a settling tank with sludge collection, a polishing pond with a 9-day detention period, and chlorination. The suggested "Best Available Treatment" values for BOD_5 and suspended solids correspond to a 99 percent reduction in the "Standard Raw Waste Load." Grease was not detectable in the effluent from this plant; Kjeldahl nitrogen values are based on 95 percent removal.

Utilizing the information in Table III and other information in the literature, EPA, after conferences with representatives of the meat industry, developed a proposed Effluent Limitation Guidance for the Refuse Act

TABLE III

SUMMARY OF RESULTS

	Slaughterhouse	Packinghouse	Processing Only
Standard Raw Wasteload	(lbs/1,000#LWK)	(lbs/1,000#LWK)	(lbs/1,000#Product)
BOD_5	5.8	12.1	5.7
SS	4.7	8.7	2.7
Grease	2.5	6.0	2.1
Base Level of Treatment			
BOD_5	0.30	0.61	0.30
SS	0.47	0.87	0.27
Grease	0.08	0.18	0.06
Best Available Treatment			
BOD_5	0.06	0.12	0.06
SS	0.05	0.09	0.03
Grease	Trace	Trace	Trace
Kjeld.-N	0.014	0.05	0.04

Permit Program. Two schedules of effluent limitations for BOD_5 and SS were defined on a lbs. per 1,000 lbs. of LWK basis for slaughterhouses and packinghouses. For processing plants the basis was lbs. per 1,000 lbs. of product. Discreet criteria were also given for oil and grease, coliform, and pH; conditions for the application of BOD_5, and SS limitations were defined for grab samples, 24-hour composite samples collected over any 20-consecutive-day operating periods and for a single 24-hour composite sample.

Since completion of the North Star survey, the Federal Water Pollution Control Act Amendments of 1972 established a new wastewater discharge permit system to be administered by EPA and terminated the permit system under the 1899 Refuse Act. The new law requires toxic and pretreatment effluent standards on meat plants which discharge to municipal treatment works and national standards of performance on meat plants which have their own treatment works and discharge to a watercourse. The law also sets dates for compliance with the discharge limitations. The two major deadlines are July 1, 1977 and July 1, 1983.

By July 1, 1977, meat industry treatment works shall apply the best practicable control technology currently available and municipal treatment effluent limitations are to be based upon secondary treatment. Also by this date, compliance with more stringent limitations based on water quality standards or other state or federal laws or regulations are to be met. Pretreatment standards for discharge to municipal systems will be effective prior to this date.

By July 1, 1983, meat industry treatment works shall apply the best available technology economically achievable which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants. Elimination of the discharge of all pollutants shall be required if the EPA Administrator finds that such elimination is technologically and economically achievable by the meat

industry. By this date municipal treatment works will provide for the application of the best practicable waste treatment technology over the life of the works.

National pretreatment standards will limit discharges into municipal treatment works necessitating in-plant controls and pretreatment facilities in the meat plant. Pretreatment standards will prohibit the discharge of toxic materials and establish limits on pollutants not susceptible to treatment or which interfere with operation of the municipal treatment works. For new sources, the pretreatment standards shall prevent the discharge of pollutants which may interfere with, pass through or otherwise be incompatible with the municipal treatment works.

The law is quite inclusive and requires the Administrator of EPA to define the best practical control technology, the best available technology economically sound and pretreatment standards. A contract has recently been let to develop information to assist in defining these terms for the red meat industry. The Administrator must also promulgate minimum requirements for acquisition of information from owners and operators of point sources of discharge.

It would only be speculation to suggest the final definition of "best practical" and "best available" in terms of loading or concentration of standard parameter, but it is obvious that the next 10 years will see much more stringent discharge limitations on the meat products industry. The treatment works in the meat industry achieving the best known results discharged, on an average, 3 mg/l of BOD_5 and SS, 0.5 mg/l phosphate as P and O.3 mg/l Kjeldahl nitrogen and no detectable grease (2). If these concentrations or elimination of the discharge of all pollutants are required in the next decade, water reuse and perhaps complete closed-loop water systems will become common in the meat industry.

SECTION V

FUTURE RESEARCH PROGRAM

Based on the "Federal Water Pollution Control Act Amendment of 1972," the program's future research objective is closed-loop technology. The goal of the National Meat-Packing Waste Management Program is to develop the technology necessary to achieve the required degree of pollution control--ultimately, no discharge of pollutants. The best available technology presently demonstrated is identified in the North Star report (2) as the Gold Kist Poultry treatment works in Florida. The previously listed average concentration of pollutants discharged are very close to no discharge of pollutants and lower than those in some water supply sources. Because reuse of such high quality effluents can be economically desirable, closed-loop technology is considered as the optimum integrated water management strategy for pollution control.

Review of previously published meat-packing literature suggests many areas of potential water and waste reduction. For example, one of the major sources of in-plant pollution is the blood from the kill floor. Whole blood has a BOD_5 of 156,500 to 198,000 mg/l (10, 11) and an ultimate biochemical oxygen demand (BOD_L) of 405,000 mg/l (11); this represents a potential BOD load of 7 to 15 lbs. per 1,000 lbs. LWK. By enlarging the curbed area used for blood collection, by installing separate sewers for blood drainage and for cleanup, and by use of dry cleaning and/or high-pressure, low-volume cleanup hoses, this potential waste load can be substantially reduced. If the blood is coagulated prior to drying, the serum (blood water) has a BOD_5 of 30,000 mg/l and contributes a waste load of 1.3 per 1,000 lbs. LWK. This can be eliminated by evaporation of the blood water or by drying of the whole blood. Drying of whole blood produces a profitable by-product (10).

Contents of the beef paunch, or rumen, also represent a primary pollution hazard. This partially digested material exerts a BOD_5 of 50,200 mg/l and a BOD_L of 104,000 mg/l (10, 11) or 3 to 6 lbs. per 1,000 lbs. of LWK. Sixty to eighty percent of the BOD in paunch is water soluble and is thus not removed by the common solids separation screens used in the industry. However, a simple process change, dry dumping of paunch coupled with a press-open foot pedal valve for separate sack washing, can practically eliminate this waste load.

A BOD_5 value of 70,000 mg/l was measured in effluent from the hasher-washer machine, a visceral comminution-cleaning operation often performed prior to rendering. In one plant, removal of the hasher and washer, i.e., sending the viscera directly to rendering, reduced the BOD_5 to the waste treatment plant by 2,000 lbs. per day, with an attendant increase in rendered animal feed production (12). Waste loads of wet rendering tank water (45,000 mg/l BOD_5) or water centrifuged from low temperature rendering (30,000 mg/l BOD_5) can be eliminated by evaporation processes.

Efficient grease recovery not only improves the yield of valuable by-products, but also has been found to improve aerobic biological treatment efficiencies. Grease coats the media of trickling filters, thus reducing the degree of treatment; its presence is also reported detrimental to the performance of activated sludge systems. Use of an air flotation system has, in one plant, reduced the waste load discharged to 3 lbs. BOD_5 per 1,000 lbs. LWK (12). These units are effective when used in series with a catch basin, but their use must be coordinated with subsequent sludge and skimmings processing operations.

Animal holding pens accumulate large quantities of manure. To minimize fly and odor problems, these are usually washed down on either a daily or a weekly basis. Designs which facilitate dry removal and disposal of solids prior to flushing can effect a major reduction in waste loads.

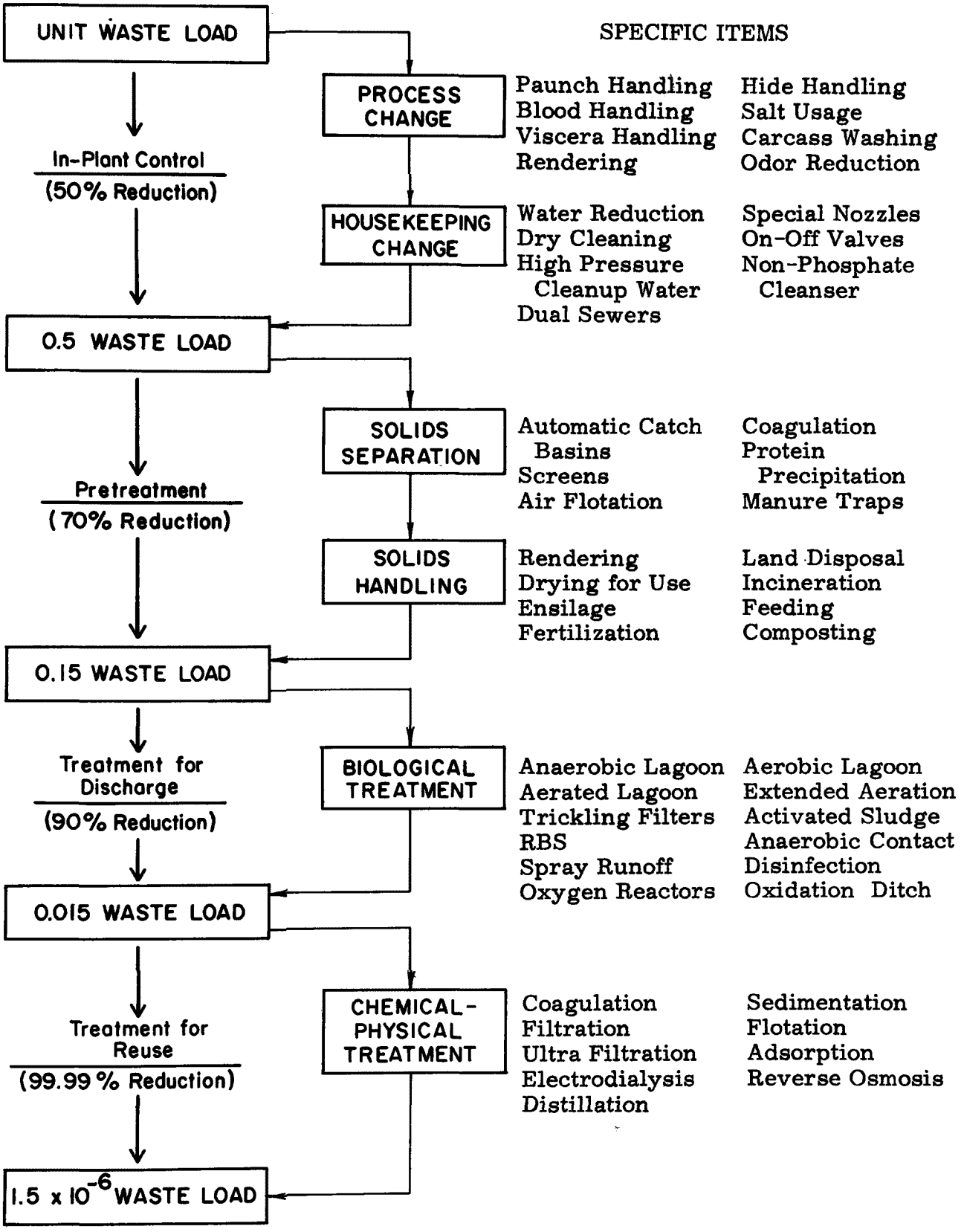
An excellent opportunity for waste load reduction through closed-loop technology lies in recovery and reuse of salt and pickling brines. In the use of present production techniques, only 25 percent of the pickling brine remains in the product; through loss of the remainder and other additions of salt to wastewater streams, a packinghouse typically adds over 1,000 mg/l of chloride to its effluent. In one plant, over 2,000 lbs. of dextrose, another brine constituent, was lost daily (12). The National Canners Association, through its Western Research Laboratory, has recently completed an EPA grant project entitled, "The Reduction of Salt Contents of Food Processing Liquid Waste Effluents" (13). This report describes a method for recycling the brines used in olive processing; presumably, such technology could be transferred to curing operations of the meat industry.

Through grants and contracts, EPA will support research projects that are necessary to develop closed-loop technology for the meat-packing industry. The Agency has means of assisting pilot-scale or full-scale development as well as laboratory research. Such research grants have been awarded to industries, industrial associations, universities, consultants, and research institutions or combinations thereof. Most grants have received about 50 percent Federal funds, but several projects under $50,000 have obtained greater percent of Federal participation. Prospective grantees are encouraged to prepare letter format preproposals describing the scope, significance, and general design and cost of their investigation. The authors will review such preproposals, indicate EPA interest, and suggest desired details to reduce the effort and time in preparing and submitting a formal proposal. Figure 10 lists a number of specific research approaches which should prove effective in the management of meat-packing wastewaters.

Along with the very stringent discharge goals that Congress has enacted, increased funds for industrial waste research are authorized to develop the necessary technology. We have only a decade to achieve this goal, but certainly if other men could land on the moon in a decade we can achieve "no discharge of pollutants."

FIGURE 10

MEAT-PACKING WASTEWATER MANAGEMENT PATH



SECTION VI

REFERENCES

1. Hoover, S. R., and L. B. Jaseqitz, "Agricultural Processing Wastes: Magnitude of the Problem," Agriculture and the Quality of our Environment, Am. Assoc. for the Adv. of Sci., Washington, D.C. (1967).

2. Pilney, J. P., E. E. Erickson, and H. O. Halvorson, "Results of Industrial Waste Study," The National Provisioner, Vol. 166, No. 8, pp. 27-52.

3. Anonymous, "An Industrial Waste Guide to the Meat Industry," U.S. Dept. of Health, Education, and Welfare, Public Health Service, Publication No. 386 Revised (1965).

4. Kerrigan, J. E., C. J. Crandall, and B. A. Rohlich, "The Significance of Wastewater from the Meat Industry as Related to the Problems of Eutrophication," prepared for the American Meat Institute, Chicago (November 1970).

5. Yin, S. C., and J. L. Witherow, "Dried Cattle Paunch Contents as a Feed Supplement for Channel Catfish," presented at the Third National Symposium on Food Processing Wastes, New Orleans, La. (March 28-30, 1972).

6. Paulson, W. L., D. R. Kueck, and W. E. Kramlich, "Oxidation Ditch Treatment of Meat Packing Wastes," Second National Symposium on Food Processing Wastes Proceedings, EPA, Water Pollution Control Research Series, No. 12060--03/71, pp. 617-635 (March 1971).

7. Thompson, H. W., and K. A. Dostal, "Tertiary Treatment of Combined Domestic and Industrial Wastes," presented at the Third National Symposium on Food Processing Wastes, New Orleans, La. (March 28-30, 1972).

8. Larson, K. P., R. E. Crowe, D. A. Maulwurf, and J. L. Witherow, "Use of Polyelectrolytes in Treatment of Combined Meat Packing and Domestic Wastes," Journal of Water Pollution Control Federation, Vol. 43, No. 11, pp. 2218-2228 (November 1971).

9. Baker, D. A., and J. White, "Treatment of Meat Packing Waste Using PVC Trickling Filters," Second National Symposium on Food Processing Wastes Proceedings, EPA, Water Pollution Control Research Series, No. 12060--03/71, pp. 289-312 (March 1971).

10. Baumann, D. J., "Elimination of Water Pollution by Packinghouse Animal Paunch and Blood," EPA, Water Pollution Control Research Series, No. 12060FDS11/71 (November 1971).

11. Witherow, J. L., "Meat Packing Waste Management Research Program," The National Provisioner, Vol. 164, No. 12, pp. 12-18 (March 20, 1971).

12. Miedaner, W., "In-Plant Waste Water Control," presented at the University of Wisconsin, Department of Engineering Extension Course: Waste Water Treatment in the Meat Industry (April 17-18, 1972).

13. Mercer, W. A., and J. W. Ralls, "Reduction of Salt Content of Food Processing Liquid Waste Effluent," EPA, Water Pollution Control Research Series, No. 12060DXL/01/71 (January 1971).

☆ U. S. GOVERNMENT PRINTING OFFICE : 1973—514-153/228

SELECTED WATER RESOURCES ABSTRACTS

INPUT TRANSACTION FORM

1. Report No. | 2. | 3. Accession No. W

4. Title: NATIONAL MEAT-PACKING WASTE MANAGEMENT RESEARCH AND DEVELOPMENT PROGRAM

5. Report Date

6.

8. Performing Organization Report No.

7. Author(s): Witherow, J. L., Yin, S. C., and Farmer, D. M.

10. Project No: 12060 FGF

9. Organization: Agricultural Wastes Section, Treatment & Control Research Program, Robert S. Kerr Environmental Research Laboratory

11. Contract/Grant No.

13. Type of Report and Period Covered

12. Sponsoring Organization

15. Supplementary Notes: Environmental Protection Agency report number, EPA-R2-73-178, March 1973.

16. Abstract

The meat-packing process is viewed from the standpoint of its use and discharge of water. The concept of integrated water management through in-plant control, solids recovery and disposal, wastewater treatment, and water reuse is presented. The necessity for in-plant change in unit processes and housekeeping practices to reduce waste loads is shown by the wide variation in discharges from similar plants.

The scope of the meat industries' waste management problem is defined, and the objectives of the National Meat-Packing Waste Management Research Program are categorized. Environmental Research Need Statements are introduced as a means by which the meat industry can present its waste treatment problems to the program.

The past and current research projects are briefly described according to objectives and accomplishments with more detailed information referenced. The results of the recent waste survey of the meat industry are given along with interpretation of their meaning. Future research projects will evolve around closed-loop technology. Unit processes which offer great potential in waste reduction are described as the initiation point for a program to reach the goal of "no discharge of pollutants."

17a. Descriptors

*Industrial Wastes, *Wastewater Treatment, Water Pollution Sources, Pollution Control, Canneries

17b. Identifiers

Meat-Packing Wastes, Research Program

17c. COWRR Field & Group

18. Availability

19. Security Class. (Report)

20. Security Class. (Page)

21. No. of Pages

22. Price

Send To:

WATER RESOURCES SCIENTIFIC INFORMATION CENTER
U.S. DEPARTMENT OF THE INTERIOR
WASHINGTON, D. C. 20240

Abstractor Jack L. Witherow | Institution Robert S. Kerr Environmental Research Lab.

WRSIC 102 (REV. JUNE 1971)