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PN-ACE-729
101028

The Hashemite Kingdom of Jordan

Ministry of Water and Irrigation

Water Quality Improvement and Conservation Project

Industrial Audit Background Paper:

Slaughterhouse Industry

Science Applications International Corp.

Development Alternatives Inc

USAID

The Technical Assistance Team Includes
Development Alternatives, Inc
Science Applications International Corp
Harza Environmental Services, Inc
Development Associates, Inc

United States Agency for International Development
Contract No 278-0288-00-C-4026-00

November 1994

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Review of Pollution Prevention and Waste Minimization Techniques Used by the Meat and Poultry Processing Industry

FINAL REPORT

September 15, 1994

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United States Agency for International Development

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SAIC Project No 01-0833-03-8167-100

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PREFACE/ACKNOWLEDGMENTS

This report presents the background materials for Slaughterhouse Industry prepared with emphasis on the pollution prevention/waste minimization (PP/WM) and water conservation practices for this industry The report was prepared by Mr David Hair, of Science Applications International Inc (SAIC), Falls Church, Virginia, under subcontract with Development Alternatives, Inc (DAI), Washington, D C

Efforts for preparation of this report was directed by Dr Shawn R Niaki, P E , Pollution Prevention Program Director, of Harza Consultanting Engineers and Scientists (Harza), Chicago, USA, coordination with Dr Usama Mudallal, Environmental Director, of the Amman Chamber of Industry (Chamber), and the member of the PP/WM Committee from the Ministry of Water and Irrigation (MWI) staff, Eng Rania Khaleq and the Water Autority of Jordan (WAJ) staff including Eng Abdul Wahab Matar, Eng Marwan Al-Tal, Eng Nabeel Hejazeen, and Eng Mohamad Lafi

Special appreciation is given to Dr Mohammed Bani Hani, Secretary General of MWI, Eng Qusai Qushad, Seretary General of WAJ, Mr Khaldun Abuhassan, Chairman of the Chamber, Mr Walid Al-Khatib, Director Genaral of the Chamber, Dr Muwaffaq Saqqar, Project Coordinator, and to DAI, as represented by Edwin D Stains, Chief of Party, for their cooperation and confidence

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1.0 INTRODUCTION

1 1 Background

Under a contract with the United States Agency for International Development (USAID), Development Alternatives Incorporated (DAI) is performing an Industrial Wastewater Discharge Prevention (IWDP) Program in Amman, Jordan The IWDP Program is one of the four components of the Water Quality Improvement and Conservation (WQIC) project funded by USAID The Program is being performed by DAI with full coordination between the Jordanian Ministry of Water and Irrigation (MWI) and the Amman Chamber of Industry (Chamber)

The IWDP will be performed in three phases The first phase requires completion of eight pollution prevention/waste minimization (PP/WM) opportunity audits by DAI and its sub-contractors The second phase requires completion of Feasibility Studies (FS) for four of the audited facilities Finally, demonstration projects will be completed for selected FS facilities

Due to the high cost of waste treatment, as well as the need to minimize waste of raw materials and resources, it is in the best interest of businesses and industries to minimize their waste generating practices Companies with effective PP/WM programs may well be the lowest-cost producers of goods due to their efficient practices Waste management practices can include

1 Reduce waste generation

- Substitution of less hazardous raw materials in product manufacture
- Alteration of products manufactured to eliminate need for hazardous materials use
- Replacement or upgrading of outdated or inefficient process equipment
- Development of employee training programs to ensure employees efficiently manage raw materials and resources

2 Reuse waste materials prior to disposal

- Reuse of uncontaminated raw materials and resources (including water)
- Reprocessing of previously discarded materials (e g , off-spec materials, used materials)
- On site recovery of reusable materials (e g , used solvents, waste heat, scrap)

3 Recycle waste materials

4 Treat wastes and dispose of residues

The audits performed during this project will evaluate all available waste management alternatives and will provide site specific recommendations to assist the study industry in developing a comprehensive waste management strategy

1 2 Objectives

The facility PP/WM audits are designed to assess the potential for pollution prevention and waste minimization at the study facilities The goal of each audit is to evaluate and identify all possible PP/WM, wastewater clean-up, and water conservation techniques that are appropriate for the study facility Audit documentation will consist of a background PP/WM assessment paper and an audit evaluation report This document is intended to serve as the PP/WM background paper for the meat and poultry processing industrial sector

The specific objectives of this audit are as follow

1 Review general industry background data and identify "state-of-the-art" processing and waste management practices

2 Work on-site with industry representatives, ministry officials, and other interested groups to review current processing procedures and identify possible PP/WM options

3 Develop a report that evaluates all possible PP/WM alternatives and provides recommendations to the industry

In order to complete the first objective, a comprehensive literature review was performed This review included searches of the U S EPA Pollution Prevention Information Clearinghouse (PPIC) repository (and its corresponding database PIES), on-line library catalog databases, pollution PP/WM bibliographical references, and personal contacts with pollution prevention specialists The review resulted in the identification of numerous references with a range of very general to very specific PP/WM techniques Source documents were assessed to determine their applicability to this project and categorized appropriately Documents pertinent to this project are included as Appendix A (Fact Sheets), Appendix B (Case Studies) and Appendix C (Bibliography)

Following completion of the literature review, the audit team will perform the on-site audit of the industrial facility The audit will be performed with close consultation of industry representatives to ensure that they are aware of and support proposed actions Audit activities will included the careful gathering of baseline water use and waste generation data, identification and assessment of potential PP/WM options, and solicitation of ideas and proposals from management and production line staff

Finally, the audit findings will be summarized and option evaluated in the audit report The audit will recommend the development of a site-specific program that meets the specific needs and goals of the audited facility Audit recommendations will include both technical PP/WM recommendations (e g , housekeeping practices, treatment options, etc) and suggestions for PP/WM training for facility staff and follow-up studies to assess program successes

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2.0 INDUSTRIAL HISTORY

2 1 Red Meat and Poultry Slaughtering Industry in Jordan

The Ain Ghazel Slaughterhouse is the only facility in the City of Amman, Jordan that provides red meat and poultry slaughtering services The facility is partly owned by the Greater Amman Municipality A recent study [COWS/RSS July 1993] evaluated process and operational characteristics of the Ain Ghazel facility and provided recommendations regarding the control of wastewater discharges The information in this section of the report is summarized from this previous evaluation

The Ain Ghazel facility was built in 1967 and has been expanded in several phases since that time The buildings, equipment and facilities are relatively old and outdated A replacement facility is under development in Marka, but will not be completed for several years The Ain Ghazel facility, therefore, will likely continue its operation for at least 5 years

The operations at the Ain Ghazel facility include two primary production lines One line is for the slaughter and processing of cattle and sheep and the other is for the slaughter and processing of poultry (chickens) The production capacity reported for this facility is provided in Exhibit 2-1

Exhibit 2-1 Production Capacity at the Ain Ghazel Slaughterhouse
(From COWS/RSS 1993)

Type of Animal	Number Killed (per day)	Live Weight Killed (tons/day)
Sheep	3000	90
Cattle	200	100
Chicken	30000	45

Due to import of meat from other foreign markets, the facility was not operating at capacity during the 1993 study The actual production rates for the Ain Ghazel facility, recorded during the 1993 study, are provided in Exhibit 2-2

Exhibit 2-2 Actual Production Rates During 1993 Facility Study
(From COWS/RSS 1993)

Type of Animal	Number Killed (per day)	Live Weight Killed (tons/day)
Sheep	1000	30
Cattle	30	15
Chicken	25000	38

The slaughtering and processing operations at this facility are consistent with those of the industry however, due to the age of the facility and processing equipment, the level of automation is minimal, with many operations performed by hand An overview of these processes is provided in Section 3 of this paper

The water used at the Ain Ghazel facility is provided by the municipal supply system The water consumption rates are reported as

1 Sheep and Cattle Processing - 150 m^3/day
2 Poultry Processing - 480 m^3/day

This level of water consumption is low compared to industry averages reported for the United States however, the previous study indicated that opportunities for water use minimization were apparent

Wastewater generated by this facility is discharged to the sewer system for subsequent treatment at the municipal wastewater treatment facility The discharge reportedly contains high levels of Biochemical Oxygen Demand (BOD) and suspended solids and is not in compliance with applicable discharge requirements Wastewater flows are not routinely measured, but are assumed to be equivalent to the water consumption rate of 630 m^3/day The facility also generates approximately 3 m^3/day of sanitary wastewater

Previous studies indicate that the primary pollutants of concern for the facility are BOD, total suspended solids (TSS), fats, oils and grease (FOG), pH, and fecal coliform bacteria This is consistent with typical slaughterhouse operations (see Section 4) The slaughtering operation is the source of the highest pollutant loadings, with blood contributing a high BOD load Blood and paunch manure are reported as the primary sources of BOD and solids loadings The arithmetic means for several parameters were developed from 30 samples collected during the previous study The results of these analyses are provided in Exhibit 2-3

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Exhibit 2-3 Mean Pollutant Loadings from the Ain Ghazel Facility
(From COWS/RSS 1993)

Animal	Flow (m^3/day)	pH	BOD (mg/l)	COD (mg/l)	TSS (mg/l)
Sheep/ Cattle	150	7 0	5600	8400	2135
Poultry	480	6 1	2350	5940	1620
Total	630	6 8	3120	5550	1750

The 1993 study of the facility recommended several PP/WM practices including development of better handling procedures for blood and paunch manure and proposed several end-of-pipe treatment technologies for control of discharges to the sewer system

3.0 PROCESS OVERVIEW

3.1 Red Meat Slaughtering and Processing

The slaughter and processing of meat for human consumption is an integral segment of the food processing industry in most countries Depending on the size of the population and the area served by the slaughterhouse, a facility may handle anywhere from several animals to several thousand animals per day In addition depending on local demand, a slaughterhouse may handle one or several types of animal The functions of a modern slaughterhouse are described by Veall (1992) as follows

- Reception and lairage
- Slaughtering and bleeding
- Dressing of animals
- Edible by-products recovery and processing
- Inedible by-products processing
- Storage of meat and by-products

Regardless of the type of animal handled at a slaughterhouse, the general processes and functions remain the same A diagram of the process flow in a typical slaughterhouse is shown in Exhibit 3-1

3 2 Poultry Slaughtering and Processing

The operation of a poultry slaughtering and processing facility differs from facilities designed for larger animals in several ways First, the number of animals handled at a poultry slaughterhouse is usually much higher than for large animals, often exceeding 10,000 animals per day Because of this, the live animal reception and lairage facilities must be designed to accommodate the large number of animals that will be processed Second, the slaughtering process is generally more highly automated in order to process the larger number animals Additionally, the equipment used to process the large number of carcasses requires a higher degree of automation

Processes commonly practiced at poultry slaughtering plant are described by Allwood and Coleman (1974) as follows

- Receiving (reception and lairage)
- Slaughtering and bleeding
- Defeathering
- Eviscerating
- Chilling, packing and shipping

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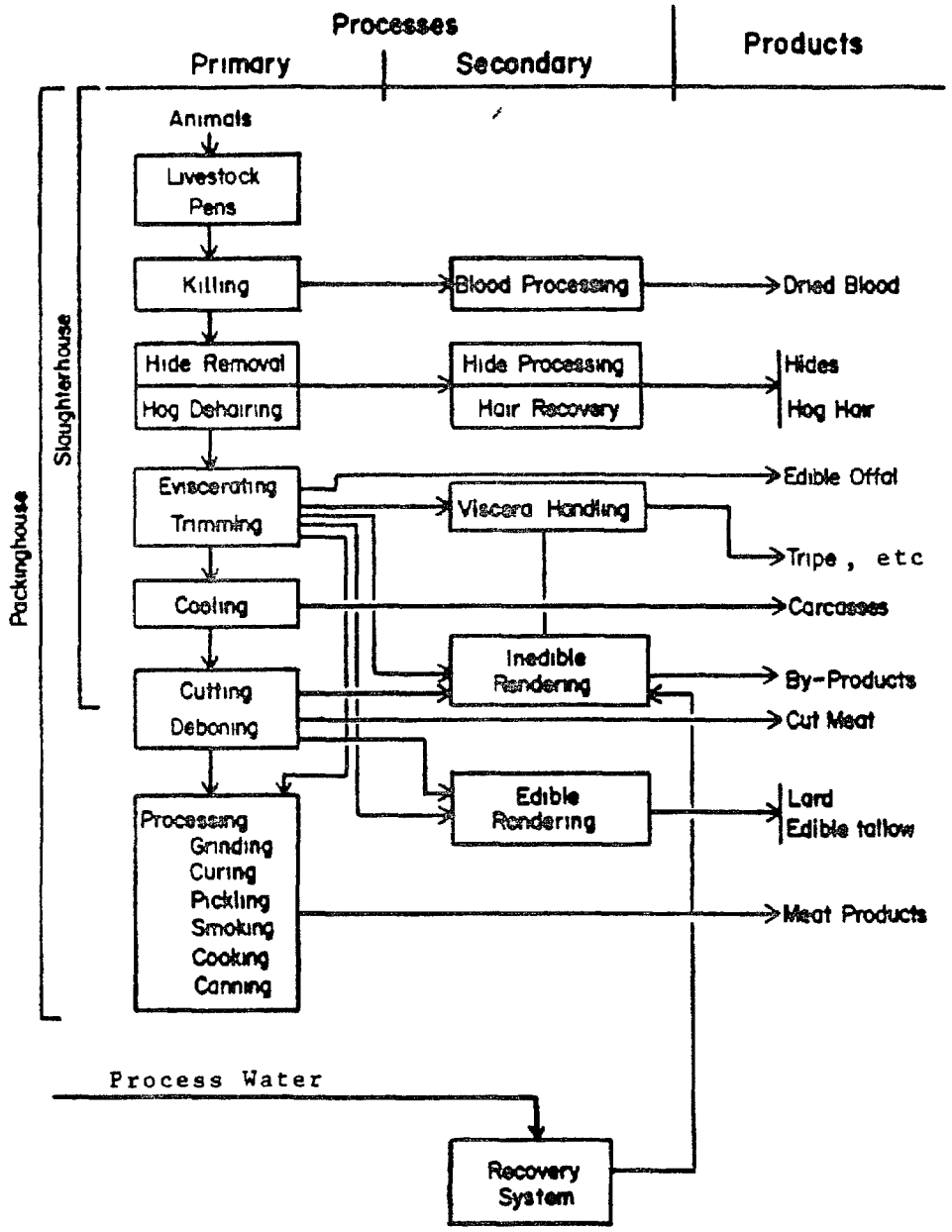

Exhibit 3-1 - Process Flow in a Typical Red Meat Slaughterhouse
(From *Development Document for Red Meat Processing*, USEPA 1974a)

Generally, the birds are slaughtered by severance of the jugular vein either mechanically or by hand The feathers are then removed by a "scalding" process where high temperature water or steam is sprayed on the carcass, or the carcass is immersed in a tank of hot water Feathers are then removed by a combination of mechanical and hand picking Following feather removal, the carcass is eviscerated and edible by-products are removed for further handling The head and lungs are also removed at this stage of processing, and the carcass is washed and prepared for chilling, packing and shipping A flow diagram for a typical poultry processing facility is provided in Exhibit 3-2

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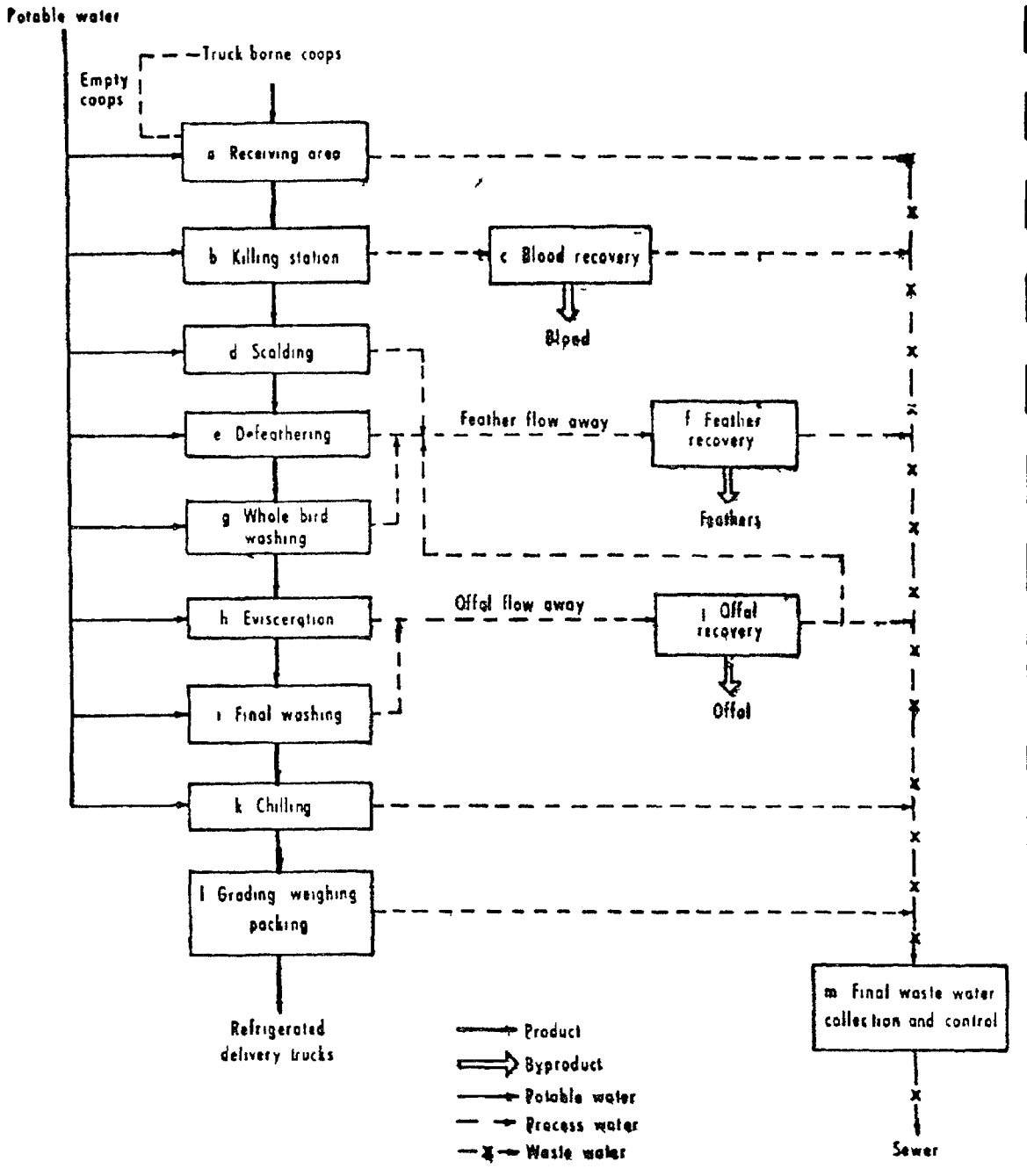

Exhibit 3-2 - Process Flow in a Typical Poultry Slaughterhouse
(From *Economic Analysis for the Poultry Meat Processing Industry*, Allwood and Coleman 1974)

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4.0 WATER USE AND WASTE GENERATION

4 1 Water Use in Meat and Poultry Slaughtering and Processing

Water is used extensively for cleaning and processing at facilities engaged in the slaughter and processing of both red meat and poultry Several literature sources provided estimates of water flow requirements for typical meat and poultry processing facilities The reported values are summarized in Exhibit 4-1

Wastewater is generated in a slaughtering operation from the cleaning of products, and the removal of unwanted materials Nearly all of the operations within a slaughterhouse generate some wastewater, however, the primary sources are the slaughtering floor (including bleeding processes), scalding and evisceration operations (poultry only), and paunch removal Additionally, carcass washing, viscera and offal processing, and floor and equipment washing also require large volumes of water (USEPA 1974a , Veall 1992)

Exhibit 4-1 Water Use in the Meat and Poultry Slaughtering and Processing Industry

Reported Flow (liters/animal)	Industry Segment	Data Source
1000-1200	Cattle - Slaughter only	Veall 1992
2000-2400	Cattle - Slaughter and by product processing	
2650 (1) 3690 (1)	Red Meat - Simple slaughterhouse Red Meat - Complex slaughterhouse	USEPA 1974a
19-38	Poultry - Boiler production	McVaugh 1979
32 40	Poultry - Slaughter and Evisceration Poultry - With further processing	Kerns and Holemo 1973

(1) Liters per 500 kg live weight killed

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4 2 Waste Generation in the Meat and Poultry Slaughtering Industry

The primary pollutants of concern in the meat and poultry slaughtering industry, as reported in the literature (USEPA 1974a , Hrudey 1984 , Cooper, et al 1979), include the following

- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Suspended Solids (TSS)
- Dissolved Solids (TDS)
- Fats, oils and greases (FOG)
- Nitrogen (ammonia, total Kjeldahl nitrogen)
- Phosphorus
- Chlorides
- pH
- Pathogenic organisms

Depending on the types of processes utilized by a given facility, the concentrations and loadings of these pollutants may vary widely

The pollutants are introduced to the wastestream in the form of blood, paunch or rumen contents, fecal matter, washings and meat residues, fats and greases, feathers (poultry), and soil The pollutants enter the wastestream through nearly all processes, however, the highest loads are reportedly introduced in the following areas

- Slaughtering and bleeding - Blood, washings, fecal material
- Paunch or Rumen contents - Partially digested feed, manure, washings
- Floor and equipment washing - Blood, fecal material, meat residues, fats, feathers
- Carcass cleaning and preparation - blood, meat residues, fats, feathers
- Rendering - Fats, meat residues
- Edible and inedible by-products - Meat residues, fats, blood

Water conservation and PP/WM activities should, therefore, focus on these production processes

4.3 United States Effluent Guidelines

The United States Environmental Protection Agency (USEPA) has established numerical "effluent limitations" for several categories of the red meat slaughtering and processing industry These limits, however, apply only to facilities that discharge treated effluent directly to a receiving water Facilities that discharge wastewater to a municipal treatment plant are regulated directly by the local municipal government There are no national effluent guidelines for the poultry slaughtering and processing industry

The limitations established by USEPA are based on an evaluation of the "best available treatment (BAT)" for the types of wastes generated by the meat slaughtering and processing industry USEPA gathered data on the performance of well operated treatment systems, statistically evaluated these data, and developed effluent limitations reflective of treatment system performance Limitations are published in "production-based" format, thus, each facility will receive unique concentration-based limits depending on the production rate at the facility Unique limitations are also developed for both a "daily maximum" (average over a calendar day), and a "monthly average" (average over a calendar month) A summary of limitations for selected meat processing industry categories is provided in Exhibit 4-2

Exhibit 4-2 Selected USEPA Effluent Limitations

(All units are "kilograms per 1000 kilograms LWK"
(Live Weight Killed) unless otherwise noted)

Pollutant	Simple Slaughterhouse		Complex Slaughterhouse		High-Processing Packinghouse	
	Daily Max	Monthly Avg	Daily Max	Monthly Avg	Daily Max	Monthly Avg
BOD5	0 24	0 12	0 42	0 21	0 48	0 24
TSS	0 40	0 20	0 50	0 25	0 62	0 31
FOG	0 12	0 06	0 16	0 08	0 26	0 13
Fecal Coliform	400/100 ml max	400/100 ml max	400/100 ml max	400/100 ml max	400/100 ml max	400/100 ml max
pH	6 0 - 9 0	6 0 - 9 0	6 0 - 9 0	6 0 - 9 0	6 0 - 9 0	6 0 - 9 0

[**Source** *United States Code of Federal Regulations* (40 CFR Part 432)]

In addition to the numerical effluent guidelines for direct dischargers, USEPA has also established "general and specific prohibitions" that apply to all industrial facilities (including meat and poultry slaughterhouses) discharging to municipal wastewater treatment facilities These prohibitions state that no industrial user of a municipal wastewater treatment plan can discharge any pollutant, or combination of pollutants that cause "Pass Through" or 'Interference" at the treatment plant In the context of the regulations, "Pass Through" and "Interference" are specifically defined, and refer to pollutants released at a flow rate or concentration that may upset biological treatment processes or that may pass through the treatment plant without sufficient treatment

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To implement the USEPA regulations, most municipal governments establish site-specific numerical limitations applicable to industries that are served by the sewer system These limitations may be based on the treatment capacity of the municipal treatment plant, or on the technology available to industrial user to control its discharge Facility specific limits are imposed and enforced by the municipality through discharge permits In the United States permits issued to direct and indirect dischargers are enforceable by the Federal, State and local governments and private citizens

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5.0 POLLUTION PREVENTION AND WASTE MINIMIZATION

The types of pollutants introduced and wastewater flows generated by the meat and poultry processing industry are ideal candidates for PP/WM activities In general, the wastes generated by this industry group are organic and non-hazardous, thus, they are more easily handled and reprocessed Slaughterhouse wastes are often amenable to reuse or recycling in order to recover the nutrients, oils, or other by-products that remain in the organic material

The high volumes of water used for cleaning and processing meat/poultry and their by-products can also be reused or recycled in many facilities Water conservation has been practiced by many slaughterhouses, as well as other food processing facilities, and documented in successful case studies Several of these are included in Appendix B of this report

5 1 Water Conservation Techniques Used by the Meat and Poultry Slaughtering Industry

Studies have shown that as water use increases at a meat processing facility, its overall waste load increases (EPA 1974a , Hrudey, 1984) Where water is used indiscriminately, valuable recoverable product materials (e g , meat by-products, blood, fats and greases) will be lost to the sewer Efficient utilization of water at meat and poultry processing facilities should, therefore, result in lower costs for water consumption and waste disposal as well as increased revenue from reclaimed wastes Water use minimization techniques have been successfully demonstrated in a number of facilities and have resulted in substantial cost savings Several case studies which document these successes are provided in Appendix B of this report In addition, Appendix A provides a variety of PP/WM fact sheets and guidance materials that may be useful in establishing a PP/WM program at food processing facilities

To begin a successful water conservation program, plant management should establish specific goals for specific processes The first step in the program requires an inventory of all water uses throughout the facility This inventory should result in an overall plant water balance with all uses and routes of disposal accounted for Management should them establish a plan to reduce water use by specific amounts in each segment of production Hrudey (1984) proposes the establishment of in-plant controls based on the following premises

- Downstream removal of pollutants is not as efficient as their initial exclusion from the sewer
- All drains should be equipped with threaded covers to discourage their removal This will reduce the possibility of large solids being flushed with high volumes of water

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- Use of potable water should be justified, and quantities should be monitored and optimized
- Non-potable water should be utilized wherever possible
- Dry clean-up should be practiced where appropriate followed by controlled wet clean-up

Literature sources describe water conservation methods applicable to slaughtering operations The USEPA (1974a) suggests several methods for water use conservation Several example of these practices are provided below

- Replace drilled spray pipes with more efficient spray nozzles
- Replace washwater valves with hand, foot or knee operated squeeze valves
- Install foot pedal operated handwashing and drinking water sources
- Install spray washers or rinsers that operate on timers (set to reduce wash time)
- Replace water-based chillers with cryogenic (e g , nitrogen) type coolers
- Use low volume, high pressure sprayers for cleaning operations
- Utilize low contamination wastestreams for lower quality needs

Several types of PP/WM techniques which demonstrate these water conservation are described in the literature Specific case study examples and references are provided in Appendices B and C

5 2 Waste Minimization Used by the Meat and Poultry Slaughtering Industry

Due to the nature of wastes generated by the m and poultry slaughtering and processing industry (i e , blood, meat residue, fats and greases, etc), recovery and reuse techniques are widely practiced A review of the literature identified many examples of recovery methods for both liquid and solid wastes generated by these types of operations

The USEPA (1974a) suggests numerous PP/WM opportunities A few examples of these techniques, applied to the processes and pollutant sources described in Section 3, are provided below In addition, Exhibit 5-1 provides an overview of a waste reduction program suggested by USEPA for the red meat slaughtering and processing industry

- Reception and Lairage Pens should be covered and dry cleaned to minimize water use and contamination Manure can be collected and used as fertilizer

- Slaughtering and Bleeding Blood should always be collected and used and should not be sewered Water or steam are not necessary in the blood collection process Blood should be cleaned from slaughter area using dry techniques Blood water can be evaporated to concentrate proteins Dried blood should be mix with feed or manure and reused

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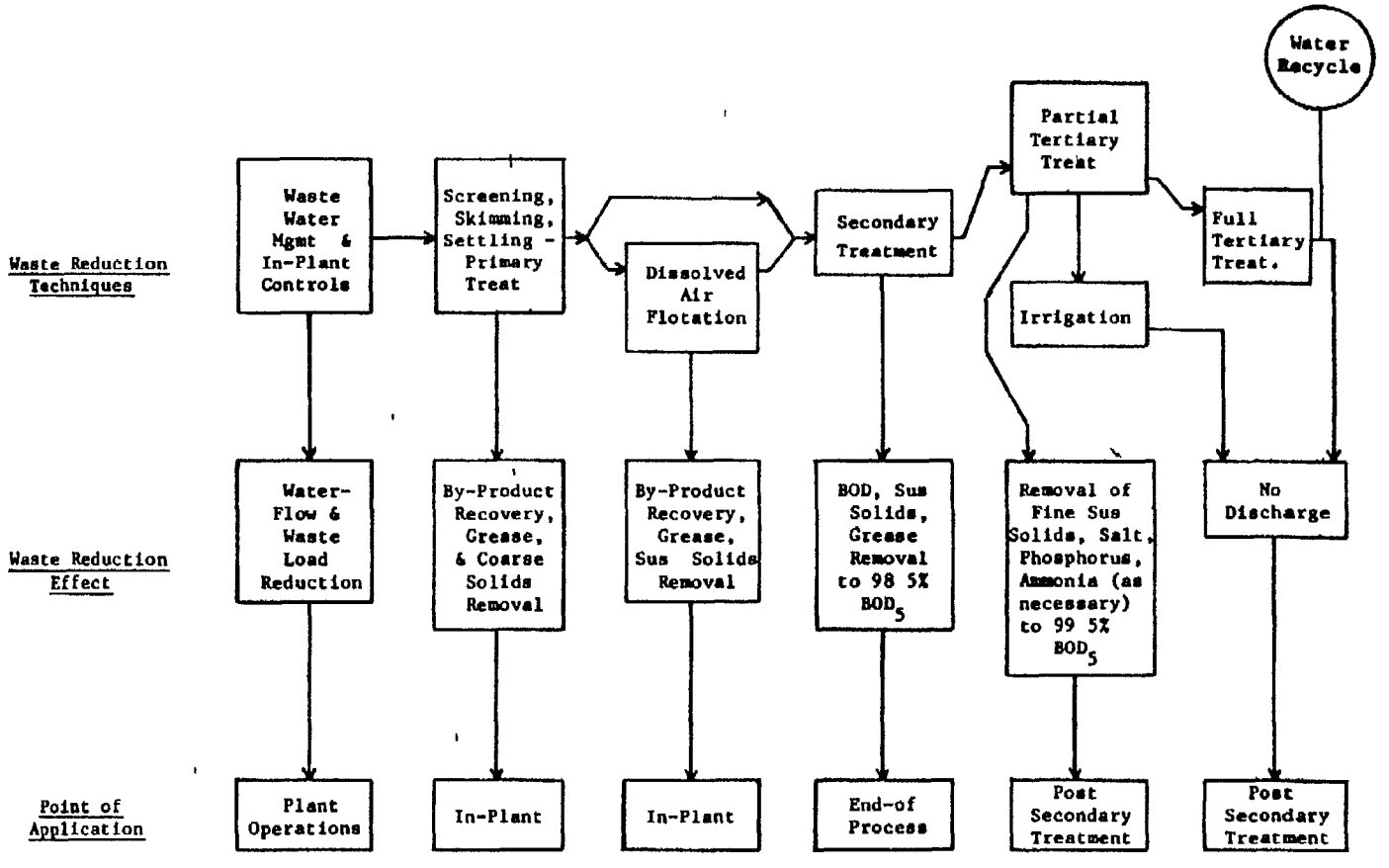

Exhibit 5-1 Suggested Meat Packing Industry Waste Reduction Program
(From *Development Document for Red Meat Processing*, USEPA 1974a)

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- Paunch/Rumen Removal Water should not be used for initial dumping of paunch material Dumped paunch should be collected and removed by dry methods followed by high pressure cleaning with minimal water use Liquids screened from paunch should be evaporated or rendered, but not sewered

- Scalding tanks (poultry) Collection screening settling and reuse of this water should be considered Slow drainage of the tank should be practiced to minimize shock loads the treatment system

In addition to these PP/WP techniques, the literature is replete with examples potential uses for animal by-products The Food and Agriculture Organization of the United Nations (FAO) has published guidance and bibliographical information on animal by-products utilization (FAO 1989 and FAO 1982) These documents describe many successful techniques currently being practiced by facilities throughout the world Additional case studies and examples are provided in the selected case studies and references in Appendices B and C of this paper

5 3 Treatment Technologies Used by the Meat and Poultry Slaughtering Industry

Slaughterhouse wastes are generally in the form of concentrated liquid wastewaters or solid organic wastes The liquid wastes are typically discharged to a municipal sewer system or are treated on-site and discharged to a receiving water Solid wastes may be use directly as fertilizers, mixed with feed as a protein supplement, rendered for recovery of fats and greases, or landfilled as solid, non-hazardous wastes

The liquid wastes generated by a slaughterhouse are characterized by high BOD, suspended solids, and dissolved solids While the organic constituents of these wastewaters are readily biodegradable, and may be compatible with the treatment processes provided by municipal wastewater treatment plants, the wastestream may be of sufficiently high strength to cause upsets or "slug" loads to the treatment plant

To prevent the discharge of an effluent that could cause shock loadings or slugs that can overload or upset the municipal wastewater treatment plant, several in-plant treatment options are available These treatment processes can be categorized as either physical or biological systems Chemical treatment of slaughterhouse wastes is not generally practiced, unless the facility wishes to remove dissolved solids, nutrients (nitrogen and phosphorus), or extract selected proteins for further processing A schematic diagram of a wastewater treatment system at a red meat slaughterhouse, prior to sewering, is provided in Exhibit 5-2

5 3 1 Physical Treatment Systems

Physical treatment processes at slaughterhouse facilities can include flow and loading equalization basins, screens and filters, and, fat, oil and grease separation units These processes and their applications are described below

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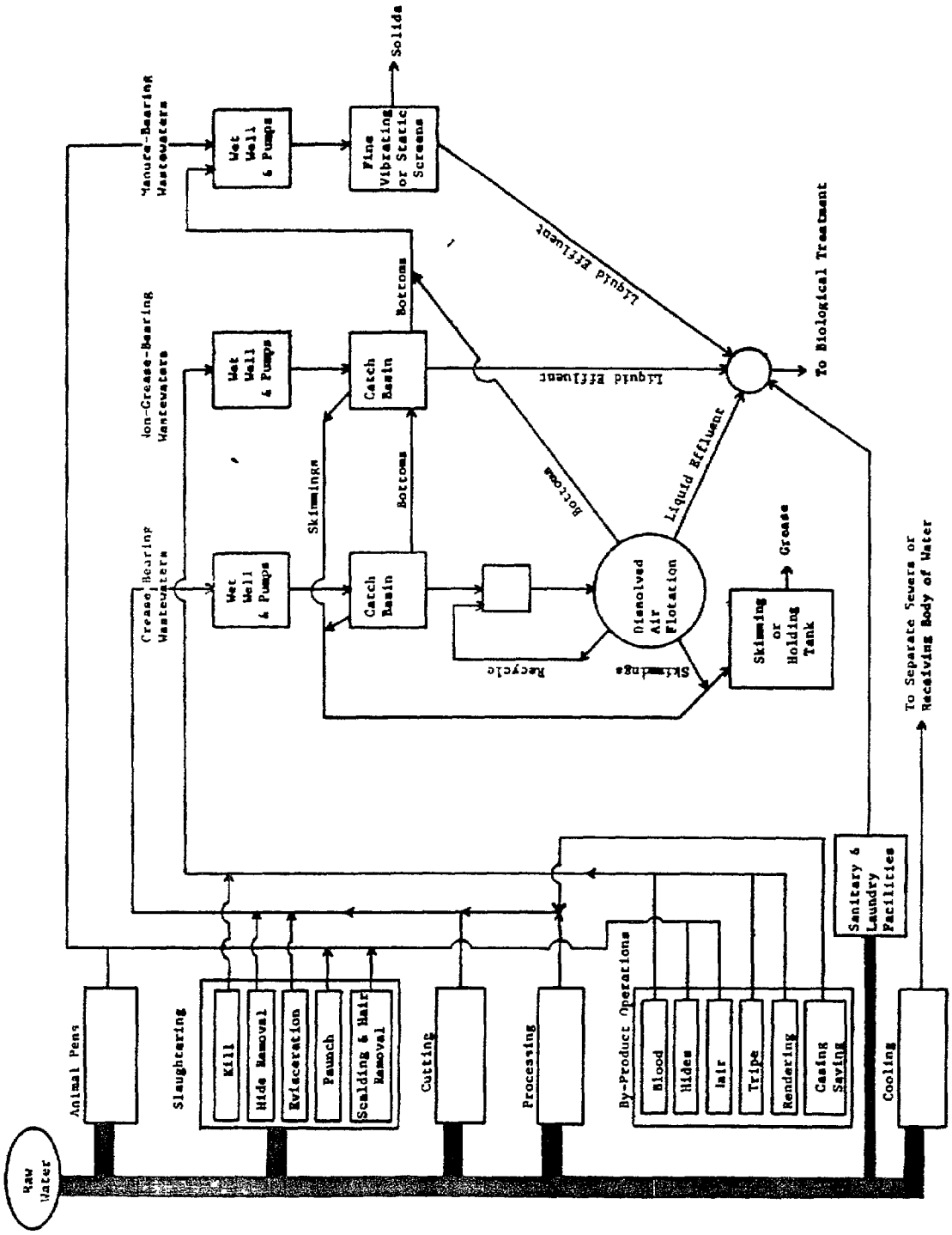

Exhibit 5-2 Integrated Treatment System at a Red Meat Slaughterhouse
(From *Development Document for Red Meat Processing*, USEPA 1974a)

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Flow Equalization

Flow equalization is a relatively simple process that can yield substantial benefits with respect to mitigating shock loads to a municipal treatment plant Equalization facilities consist of tanks and basins that hold flows from various processes, mix these wastestreams, and release a wastestream to the sewer at a relatively constant rate

Equalization basins allow slaughterhouse facilities to combine high and low strength wastes and control the rate of discharge to their own treatment system, or a municipal sewer This process reduces the potential for sporadic discharges of high strength wastewaters and allows the facility to release its wastestream under controlled conditions and during periods (such as late night) when the municipal treatment plant may more readily accommodate the additional loading These systems are also attractive due to their low capital cost and minimal operation and maintenance requirements

Screens and Filters

A large percentage of the wastes generated at a slaughterhouse enter the wastestream in the form of solids These wastes include meat cuttings, manure, feathers, and coalesced fats and greases As these wastes are transferred through the sewer system, they tend to break down and release soluble organic matter to the wastestream The soluble organic matter exerts a high BOD load and introduces nutrients to the wastestream that will have to be removed by the municipal treatment plant The overall loading from these solids can be reduced therefore, by removing them from the wastestream through screening and filtration prior to discharge the sewer

Screens and filters can be installed in a slaughterhouse facility on individual process wastestreams or on the combined wastestream prior to sewering In addition screens can utilize a static, vibrating, or rotary design, depending on the characteristics of the solids to be removed Screens can be used both as preliminary treatment to minimize loadings to subsequent biological systems, and to protect pumps and plumbing from damage caused by solids As with equalization units, screens are simple to install and operate, and require low capital expenditures

Fat, Oil and Grease Removal

Fats, oils and greases (FOG) can be removed from the wastestream by a variety of methods including, catch basins, skimmers, and dissolved air floatation systems

Catch basins are relatively simple units that trap large solids and floatable materials, but allow unrestricted flow to the wastestream Trapped solids and floatables must be routinely removed from these systems to ensure their proper operation Removal can be performed manually, or mechanically using a combination of skimmers, rakes and vacuum equipment

Skimmers can be used to remove FOG where they are suspended in the wastestream These systems allow and encourage the suspended FOG to coalesce on the surface of the separation unit where they can be removed by manually operated or mechanical skimmers

Dissolved air floatation (DAF) units are highly effective in removing dispersed FOG from the wastestream These units utilize fine air bubbles, which are produced by diffusers in the bottom of the separation tank, that promote the coalescing of the FOG as they ascend through the wastewater The coalesced FOG is then removed by manually operated or mechanical skimmers

The FOG removal systems described above each require a moderate capital expenditure and must be properly operated and maintained to ensure efficient pollutant removal The advantages to these systems, however, can include significant reductions in difficult to remove contaminants, and the capture of animal FOG that can be rendered and recovered as a useful product

5 3 2 Biological Treatment Systems

Because of the organic, biodegradable nature of the pollutants generated by slaughterhouses, a wide variety of biological treatment systems can be applied to these wastestreams A brief description of anaerobic and aerobic treatment systems and their application to slaughterhouse wastestreams is provided below

Anaerobic Treatment Systems

Anaerobic lagoons are widely used by slaughterhouses to reduce organic loading prior to secondary treatment on-site or to discharge to the municipal sewer system These systems can reportedly remove up to 95 percent of BOD and TSS and routinely achieve over 80 percent removal Anaerobic lagoons are relatively simple to construct and operate and are less costly than other biological treatment systems Problems associated with these systems include the potential for significant odor generation and high ammonia concentrations in the effluent

Anaerobic contact systems are equally applicable to slaughterhouse facilities, however they require significant expenditures for equipment and operation, and are not widely used Their advantages include a high BOD removal rate in a short timeframe Disadvantages include high cost and operational difficulties

Aerobic Treatment Systems

Aerobic treatment processes are generally used by the slaughterhouse industry as secondary treatment prior to direct discharge to a receiving water The relatively high capital and operation and maintenance costs for these units generally preclude their use to pre-treat wastes prior to disposal to municipal sewers Because the wastewater at the Ain Ghazel facility is discharged to the sewer system, a detailed description of these processes is not provided in this section A list of the different types of aerobic processes that have been used by direct discharging slaughterhouse facilities, however, includes aerated lagoons, aerobic lagoons activated sludge, trickling filters, and rotating biological contactors (RBC) A summary of the performance characteristics of each of these secondary treatment processes is provided in Exhibit 5-3, below

Secondary Treatment System (number of systems used to determine averages)	Water Wasteload Reduction					
	Average Values			Exemplary Values		
	BOD_5	SS	Grease	BOD_5	SS	Grease
Anaerobic + Aerobic lagoon (22)	95.4	93.5	95.3	98.9	96 6	98 9
Anaerobic + aerated + Aerobic lagoon (3)	98 3	93.3	98 5	99.5	97.5	99 2
Anaerobic Contact Process + Aerobic lagoon (1)	98.5	96.0	99.0			
Extended Aeration + Aerobic lagoon (1)	96 0	86.0	98.0	96 0	86 0	98 0
Anaerobic lagoon + Rotating Biological contactor	98.5e	--				
Anaerobic lagoon + Extended Aeration + Aerobic lagoon	98e	93e	98e			
Anaerobic lagoon + Trickling filter (1)	97.5	94.0	96.0			
2-Stage Trickling filter (1)	95.5	95.0	98.0			
Aerated + Aerobic lagoon (1)	99.4	94.5	--	99.4	94.5	--
Anaerobic Contact (1)	96.9	97.1	95.8	96 9	97.1	95.8

e - estimated

Exhibit 5-3 Performance of Various Secondary Treatment Systems
(From *Development Document for Red Meat Processing*, USEPA 1974a)

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6.0 REFERENCES

Appendix A Selected Pollution Prevention/Waste Minimization Fact Sheets and Information Sources for Food and Kindred Products Categories

Appendix B Selected Pollution Prevention/Waste Minimization Case Studies for Food Processing and Meat and Poultry Processing Industries

Appendix C Bibliography

Appendix A

Selected Pollution Prevention/Waste Minimization Fact Sheets and Information Sources for Food and Kindred Products Categories

A Checklist of Water Conservation Ideas
For

Food Processing Industries

This checklist provides water conservation tips successfully implemented by industrial and commercial users This list has been revised from the original copy first published and distributed by the Los Angeles Department of Water and Power

General suggestions

Appoint a water conservation coordinator with the responsibility and authority for a water conservation program

Make the plant manager and other employees aware of the water conservation coordinator s function

Increase employee awareness of water conservation

- ☐ Explain the importance of individual actions to the success of the program
- ☐ Seek employee ideas for water conservation using contests rewards and suggestion boxes

Read water meter daily to monitor and report the success of water conservation efforts

Survey the plant

A plant survey helps to establish facility water savings potential by identifying areas where water is wasted or where water could be re-used

Identify the major water lines Determine the quality quantity and temperature of water carried by each

Identify all points where water is used including hose connections determine the quantity of water used at each point

Determine the capacity of each water-containing unit (washers flumes) and frequency of emptying

Determine the quality of each continuous discharge not yet being re-used

Determine flow rates in floor gutters and whether the flows are adequate to prevent solids accumulation

Evaluate survey

Review the information developed during the survey to identify the major water-using operations and review the water re-use practices currently employed

Develop plans to improve re-use

- ☐ Evaluate the feasibility of installing cooling towers
- ☐ Study the potential for screening and disinfecting reclaimed water to increase the number of times it can be re-used

Maximum water-use efficiency

Install high-pressure low-volume nozzles on spray washers

Use fogging nozzles to cool product

Install in-line strainers on all spray headers inspect nozzles regularly for clogging

Adjust pump cooling and flushing water to the minimum required

Use conveying systems that use water efficiently

- ☐ Handle waste materials in a dry state when possible
- ☐ Use conveyor belts for product transport preference should be given to rabbit-ear or 'V'-shaped roller supports because these are much easier to clean
- ☐ Use pneumatic conveying systems wherever possible
- ☐ Use flumes with parabolic cross sections rather than flat-bottom troughs

Establish optimum depth of product on conveyors to maximize wash water efficiency

Replace water-intensive units with alternatives

- ☐ Rubber-disk units for raw product cleaning and peeling
- ☐ Steam for water blanchers or
- ☐ Evaporative coolers for hydrocooling systems

Determine whether discharges from any operation can be substituted for fresh water being supplied to an earlier operation

- ☐ Divide the spray wash units into two or more sections and establish a counter flow re-use system
- ☐ Use reclaimed water for flushing floor gutters

Replace high-volume hoses with high-pressure low volume cleaning systems

As equipment wears out replace with water saving models

Avoid waste

Equip all hoses with spring loaded shutoff nozzles Be sure these nozzles are not removed

Instruct employees to use hoses sparingly and only when necessary

Adjust flows from recirculation systems (washers, flumes) by controlling the rate of makeup water

- ☐ Install float-controlled valve on the makeup line
- ☐ Close filling line during operation
- ☐ Provide surge tanks for each system to avoid overflow

Turn off all flows during shutdowns (unless flows are essential for clean-up) Use solenoid valves stop the flow of water when production stops The valves could be activated by tying them to drive motor controls

Adjust flows in sprays and other lines to meet the minimum requirements

Evaluate clean-up procedures

Sweep and shovel solid materials from the floor do not use hoses for this purpose

- ☐ Provide an adequate number of receptacles for collecting solids and
- ☐ Empty the receptacles frequently to prevent odor and insect problems

Inventory all cleaning equipment (such as hoses, provided in the plant

- ☐ Determine the number and types of units provided
- ☐ Evaluate their frequency of operation and

- [ ] Use more water efficient equipment where possible

Inventory all cleaning chemicals used in the facility to determine

- [ ] If they are being used correctly and
- [ ] Their water-use efficiency

Control belt sprays with a timer to allow for the intermittent application of chlorinated water

Exterior areas

Discontinue using water to clean sidewalks driveways loading docks and parking lots Consider using mobile sweepers

Wash autos buses and trucks less often

Avoid plant fertilizing and pruning that would stimulate excessive growth

Remove weeds and unhealthy plants so remaining plants can benefit from the water saved

In many cases older established plants require only infrequent irrigation Look for indications of water need such as wilt change of color or dry soils

Limit landscaping additions and alterations In the future design landscapes requiring less water

Install soil moisture overrides or timers on sprinkler systems

Time watering when possible to occur in the early morning or evening when evaporation is lowest

Make sure irrigation equipment applies water uniformly

Mulch around plants to reduce evaporation and discourage weeds

Remove thatch and aerate turf to encourage the movement of water to the root zone

Begin a flexible watering schedule watering only when needed and not on windy or rainy days

Avoid runoff and make sure sprinklers cover just the lawn or garden not sidewalks driveways or gutters

Do not water on windy days

Water in winter only during prolonged hot and dry periods (during spring and fall most plants need approximately half the amount of water that they need during the summer)

For more information contact

California Department of Water Resources
Water Conservation Office
1416 Ninth Street
P O Box 942836
Sacramento California 94236-0001
Telephone (916) 323-5580

The ideas presented are not intended as an endorsement by the California Department of Water Resources of any method process or specific product but are merely suggestions

FUNT3

MINNESOTA TECHNICAL ASSISTANCE PROGRAM

Source reduction and disposal alternatives for commercial food producers

FACT SHEET

- Are your disposal costs draining your profits?
- Are you looking for alternatives?

❑ Source Reduction

The most effective method to reduce your disposal costs is to decrease the volume of waste material generated in the production process Less waste generated means less material needs to be disposed of Source reduction should be the most logical starting point to reduce disposal costs since your company is in business to produce a salable product, not waste materials or by-products

Examples of source reduction include

- Use of high pressure spray washes during clean-up to conserve water
- Dedicating mixing lines to certain products to reduce change over clean ups
- Minimization of spills and leaks on the production line to prevent raw materials from becoming wastes

❑ Disposal Alternatives

If source reduction is not a viable solution, disposal alternatives do exist These alternatives include

- Use of the food waste as an animal feedstock
- Composting or landspreading the food waste so that it will add beneficial plant nutrients back to the soil

❑ Animal Feedstock

Even when the above factors have been considered, feeding by-products to livestock offers several advantages over either composting or plowing the products into the soil These advantages include

- Both liquid and solid products can be fed to livestock.
- Feeding can be continued all year; it is not limited by weather conditions
- Additional labor requirements for feeding the animals are minimal
- The results of feeding food products are predictable, the animals convert the food products to meat

(continued on back)

1313 5th Street SE Suite 207
Minneapolis, Minnesota 55414-4504

(612) 627-4646
(800) 247-0015 (Minnesota only)
FAX (612) 627-4769

The Minnesota Office of Waste Management's Mn TAP program is supported with a grant to the Sch of Public Health, Division of Environmental and Occupational Health, at the University of Minnesota.
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As a result, your "waste material" becomes a useful by-product and the quantity of your liquid and solid waste is reduced if your company can use your food by-products as an animal feedstock

❑ **Composting and Landspreading**

If on the other hand, arranging to feed your products to livestock proves to be impractical, both composting and landspreading the food waste are also viable alternatives Both methods degrade your food products into a useful soil additive called "humus " Composting degrades your products above ground in a concentrated area. Landspreading degrades your by-products beneath the soil in a cultivated field

Composting has the following benefits.

- Transportation costs are reduced since the by-products can be composted on-site The humus produced can have a volume and weight reduction of up to 30-40%
- Composting is a batch process that does not have to be capital intensive It may be a simple windrow system where all the by products are piled and managed so they biologically breakdown.
- For a company (such as a cannery) that only processes food for several months a year, composting may be an excellent alternative Farmers may be unwilling to switch to a feedstock that is only available for a short period.
- Humus can be stored without spoiling – raw food waste cannot

With proper management, the food can be kept out of the landfill, composted and then added to the soil as needed

Landspreading has the following advantages

- A separate compost facility is not necessary
- The finished product does not have to be stored.
- The finished product does not have to be transported. It is left in the soil as a plant nutrient.

With sufficient land, it is possible to incorporate the by-products into the soil on site or a farmer can be paid to take the product to a suitable field Again, with proper management, food is kept out of the landfill and used to enhance the soil.

Because landfill and wastewater treatment costs are increasing and will only continue to do so in the future, it will benefit your company to look at waste reduction opportunities and alternative disposal methods for your by-products MnTAP can help you get started by providing information and referrals. Fact sheets on feeding food by-products to livestock and composting/landspreading food by-products are available from MnTAP MnTAP can be reached at (612) 627-4646 or (800) 247-0015.

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MINNESOTA TECHNICAL ASSISTANCE PROGRAM

Composting and landspreading commercial food wastes

FACT SHEET

☐ What do the terms composting and landspreading mean?

Landspreading and composting are decomposition processes that make use of naturally occurring microorganisms (bacteria, fungi) to break down organic matter into a useful soil additive

When an organic material such as food waste is landspread, the food waste is plowed into the ground where it is biologically broken down and remains in the soil as plant nutrients. On the other hand, composting biologically breaks down the organic material at an above ground site After the material has been completely composted, the finished product, humus, can then be incorporated into the soil

☐ What food products can or cannot be composted or landspread?

Food by products such as fruit and vegetable waste can be either composted or landspread. For a product to be composted, its initial moisture content must be between 40-60% by weight. For by products with a higher moisture content, drier materials such as straw, hay, or wood chips may be added to lower the moisture content to within the 40-60% range Liquids, for example, would have to be mixed with a much drier material before they could be composted, or they could be directly applied to a field through a landspreading process

However, meat products, grease, fat, oils and dairy products are unsuitable for composting or landspreading Meat and dairy products attract rodents, produce odors, and break down too slowly for composting or landspreading to be effective recycling methods For information on recycling meat and dairy products, please contact MnTAP

Composting

☐ What do I need to consider when constructing a compost facility?

Because food by-products are considered an industrial waste, a permit for composting is required by the Minnesota Pollution Control Agency (MPCA). To obtain a permit application form contact the MPCA's Groundwater and Solid Waste Division at 612-297-1785 or 612 296-7830.

The following points regarding design plans, site selection, site construction, and daily management of the compost facility must be included on the permit application.

- The compost facility should be located on ground high enough to prevent run-on of water after a heavy rain.
- The site should also be located away from residential areas to prevent complaints concerning normally occurring odors.

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- The design must include a gently sloped liner This liner will help prevent leachate from the compost site from contaminating ground water Sloping the liner will assist in diverting the water from the compost site to where it can be collected and properly treated.

- A turning device (i.e front end loader) will also be necessary so that the compost material can be rotated at regular intervals. Rotation of the material ensures proper oxygen levels for optimum microorganism activity

Once the site is operational, proper management practices have to be followed. These practices include

- Daily temperature readings of the compost and rotation of the compost material at regular intervals—usually every other day

- The addition of liquid and bulking agents may have to be added during the composting cycle to maintain the proper moisture and oxygen levels of the compost pile

- Turning of the pile also ensures that proper oxygen levels are maintained throughout the compost material

Landspreading

❑ **What do I need to consider when landspreading food by-products?**

A permit is also required for landspreading food by-products. To obtain a permit application form contact the MPCA's Water Quality Division at (612) 296-7355 Information on nutrient content of the food by-products and proposed application rates needs to be included on the permit application.

If sufficient land is available at your production facility the by products can be landspread "on- site " If land is not available for landspreading the material on site, contact your county agricultural extension agent for help locating a farmer who can landspread your by products. You may also want to run an ad in your local paper to contact interested farmers.

❑ **At what rates can I landspread food by-products or compost to the soil?**

Because you will be adding nutrients to the soil, you need to add your materials at acceptable rates, just like any other fertilizer

For information on application rates of compost please contact Tom Halbach at the University of Minnesota Extension Service by calling (612) 625-3135 For information on application rates for landspreading please contact either Dr Jim Anderson or Dr George Rehm at the University of Minnesota Soil Science Department. Dr Anderson can be reached at (612) 625-8209 Dr Rehm can be reached at (612) 625-6210

Dr Anderson and Dr Rehm may need analytical information on the soil at the landspreading site and on the food by products. If this analysis cannot be done at your facility, MnTAP has a list of commercial laboratories that perform the required analysis MnTAP can be contacted at (612) 627-4646 or (800) 247-0015

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MINNESOTA TECHNICAL ASSISTANCE PROGRAM

Feeding food by-products to livestock

FACT SHEET

By-products from the processing and manufacturing of human food are suitable as livestock feed. However, any material that contains meat or has been in contact with meat must be boiled for 30 minutes before it can be used as livestock feed Non-meat materials, such as fruits, vegetables, bakery goods and dairy products can be fed without being cooked provided permitting guidelines are followed

NOTE: Before any material is used as a livestock feed, a permit is required from the Board of Animal Health. Part of the permitting process requires a monthly veterinarian inspection of your plant and the farm where your by-products are being fed. Your local veterinarian can provide this service. For a permit application, contact the Board of Animal Health at 612-296-2942

Following permit approval, the first question a producer needs to answer is, can a farmer be located that can use our by-products? Contact your county agricultural extension agent for assistance in locating a farmer You may also want to run an advertisement in your local paper

Once a farmer has been located, the following questions will need to be answered before the material can be fed to the animals

- What is the chemical analysis of the food product and will it remain consistent? (i e percent protein, moisture, fat, fiber, calcium, phosphorous, etc)
- Are there any pesticide, herbicide or pathogen residues in the food that will be harmful to animals?
- Are there any chemicals that have been added during the processing of the food product such as, preservatives or seasonings that would be harmful to the animals?
- Are rejected raw materials kept separate from animal feedstock materials?

If these questions cannot be answered by your company, a laboratory that does feed analysis can help provide the answers A list of commercial laboratories that perform this type of work is available from MnTAP

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Questions the farmer will be asking the producer include

- Are the quantities and the frequency they are generated consistent enough to become a long term, viable livestock feed?
- How frequently are the by products available? (Daily, weekly, etc)
- Can the material be kept fresh until it can be delivered to a farmer?
- Is there adequate storage space to hold the material until it can be delivered?

After these questions have been answered, the farmer will want to know how to incorporate the by-products into his animal rations The following people can help answer these questions

Dr Jerry Hawton, Swine Extension	(612) 624-3237
Dr Jim Linn, Dairy Extension	(612) 624-4995
Dr Jay Meiske, Beef Cattle Extension	(612) 624-7789

MnTAP can be contacted for other questions that either the farmer or the food producer may have MnTAP can be reached at (612) 627-4646 or (800) 247-0015

NOTICE Although current Minnesota law requires the boiling of all food material for 30 minutes before it can be used as an animal feed, this fact sheet presents the trend for the future to direct attention to alternatives which counteract all kinds of waste increase

In Minnesota, this will require changing the current state law on feeding food by-products MnTAP will be involved in efforts to change the current state law

(4/91-77)

A Checklist of Water Conservation Ideas For

Beverage Industries

This checklist provides water conservation tips successfully implemented by industrial and commercial users This list has been revised from the original copy first published and distributed by the Los Angeles Department of Water and Power

General suggestions

Appoint a water conservation coordinator with the responsibility and anthority for the water conservation program

Make the plant manager and other employees aware of the water conservation coordinator s function

Increase employee awareness of water conservation

- ☐ Explain the importance of individual actions to the success of the program
- ☐ Seek employee ideas for water conservation using contests rewards and suggestion boxes

Read water meter daily to monitor and report the success of water conservation efforts

Survey the plant

A plant survey helps to establish facility water savings potential by identifying areas where water is wasted or where water could be re-used

Identify the major water lines Determine the quality quantity and temperature of water carried by each

Identify all points where water is used including hose connections Determine the quantity of water used at each point

Determine the capacity of each water containing unit and frequency of emptying

Determine the quality of each continuous discharge not yet being re-used

Determine flow rates in floor gutters and whether the flows are adequate to prevent solids accumulation

Evaluate survey

Review the information developed during the survey

- ☐ Identify the major water-using operations
- ☐ Review the water re-use practices currently employed

Develop plans to improve re-use

- ☐ Evaluate the feasibility of installing cooling towers
- ☐ Study the potential for screening and disinfecting reclaimed water to increase the number of times it can be re-used

Maximum water-use efficiency

Install high-pressure low-volume nozzles on spray washers

Use fogging nozzles to cool product

Install in-line strainers on all spray headers inspect nozzles regularly for clogging

Adjust pump cooling and flushing water to the minimum required

Determine whether discharges from any operation can be substituted for fresh water supplied to another operation

Discharges that can potentially be re-used are

- ☐ Final rinses from tank cleaning keg washers fermenters
- ☐ Bottle and can soak and rinse water
- ☐ Cooler flushwater filter backwash and
- ☐ Pasteurizer and sterilizer water

Areas of possible re-use are

- ☐ First rinses in wash cycles
- ☐ Can shredder bottle crusher
- ☐ Filter backflush
- ☐ Caustic dilution
- ☐ Boiler makeup
- ☐ Refrigeration equipment defrost, and
- ☐ Equipment cleaning floor and gutter wash

Use conveying systems that use water efficiently

Handle waste materials in a dry mode if possible

Replace high-volume hoses with high-pressure low-volume cleaning systems

As equipment wears out replace with water-saving models

Avoid waste

Equip all hoses with spring loaded shutoff nozzles Be sure these nozzles are not removed

Instruct employees to use hoses sparingly and only when necessary

Adjust overflows from recirculation systems by controlling the rate at which make-up water is added

- ☐ Install float-controlled valve on the makeup line
- ☐ Close filling line during operation
- ☐ Provide surge tanks for each system to avoid overflow

Turn off all flows during shutdowns (unless flows are essential for cleanup) Use solenoid valves to stop the flow of water when production stops The valves could be activated by tying them to drive motor controls

Adjust flows in sprays and other lines to meet minimum requirements

Evaluate clean-up procedures

Sweep and shovel solid materials from the floor do not use hoses for this purpose

- ☐ Provide an adequate number of receptacles for collecting solids
- ☐ Empty the receptacles frequently to prevent odor and insect problems

Inventory all cleaning equipment (such as hoses) provided in the plant

- ☐ Determine the number and types of units provided
- ☐ Evaluate their frequency of operation
- ☐ Use more water-efficient equipment where possible

Inventory all cleaning chemicals used in the facility to determine

- [ ] If they are being used correctly
- [ ] Their water use efficiency

Exterior areas

Wash autos buses and trucks less often

Discontinue using water to clean sidewalks driveways loading docks and parking lots Consider using mobile sweepers and vacuums

Avoid landscape fertilizing and pruning stimulating excessive growth

Remove weeds and unhealthy plants so remaining plants can benefit from the water saved

In many cases older established plants require only infrequent irrigation Look for indications of water need such as wilt change of color or dry soils

Limit landscaping additions and alterations

In the future design landscapes requiring less water

Install soil moisture overrides or timers on sprinkler systems

Time watering when possible to occur in the early morning or evening when evaporation is lowest

Make sure irrigation equipment applies water uniformly

Investigate the advantages of installing drip irrigation systems

Mulch around plants to reduce evaporation and discourage weeds

Remove thatch and aerate turf to encourage the movement of water to the root zone

Avoid runoff and make sure sprinklers cov[illegible] ju the lawn or garden not sidewalks drivewa[illegible]s gutters

Do not water on windy days

Water in winter only during prolonged hot and dry periods (During spring and fall most p[illegible]an need approximately half the amount that t[illegible]y need during the summer)

For more information contact

California Department of Water Resour[illegible]s
Water Conservation Office
1416 Ninth Street
P O Box 942836
Sacramento California 94236 0001
Telephone (916) 323-5580

The ideas presented are not intended as an endorsement by the California Department of Water Resource[illegible] [illegible]f a method process or specific product but are merely suggestions.

FNCA-2-4

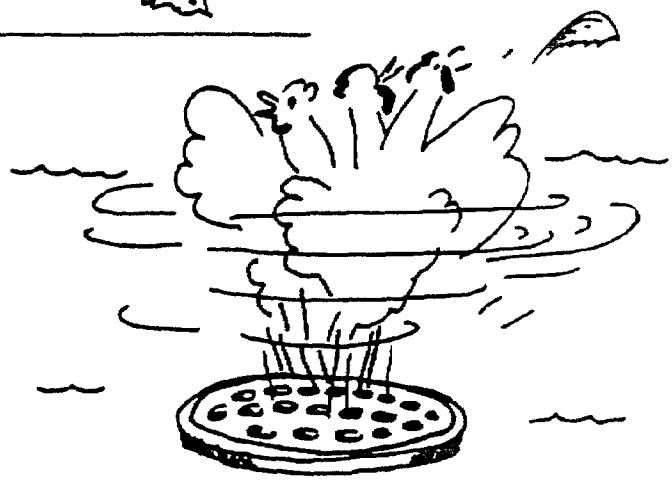
BANK ON DRAIN

Pollution Prevention Pays in Food Processing

Liquid Assets for Your Poultry Plant

Did you realize that your broiler processing plant may use more than 400 million gallons of water every year — enough to supply a town of 7,500 people?

Water Use and Conservation



Water is used for many purposes in poultry processing — scalding washing waste fluming chilling, and cleanup Until recently conserving water was not a concern for most poultry processors because water and sewer costs were usually low

Now uncontrolled water use combined with rapidly rising water and sewer charges has begun to cut into profits Some municipalities providing water and sewer service to poultry processors have increased their charges ninefold over the past 25 years By comparison, broiler prices have about doubled during that period

Less than 10 years ago, poultry processors were using as much as 12 gallons of water to process one broiler Since that time, many plant managers have come to realize that water costs real money As a result, their plants are now using less than 4 gallons per broiler

Multiple Benefits

Cutting costs is not the only reason to take water conservation seriously

Processing plants are often located in rural communities where the water system is designed to serve a small population Because it takes large amounts of water to process poultry a plant can have a major effect on the local water supply even under the best of circumstances During a drought the impact can be disastrous

In 1986, the southeastern states were stricken by the worst drought in nearly a century Had the situation worsened, poultry processors would have faced water limitations, production cutbacks and even temporary plant closings By reducing water consumption now processors can increase their chances of getting through the next drought without having to curtail operations

In almost all food processing plants reducing water use is also accompanied by a reduction in the wastewater treatment load Using less water results in less leaching of solubles better screen recovery rates and more efficient operation of dissolved air flotation cells In designing new plants planning for water conservation can help cut construction costs because the size and cost of the wastewater treatment system can be reduced substantia

FNCA-2-4

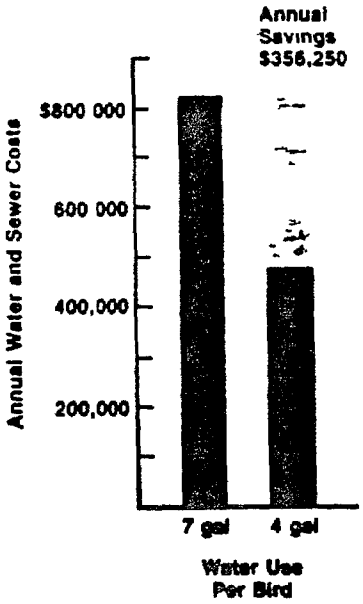
Saving by Conserving. An Example

To see how much money can be saved by reducing water use consider the case of two plants that each processes 250 000 broilers a day and pays $1 90 per thousand gallons for water and sewer services The table shows the savings that can be realized by using only 4 gallons of water rather than 7 gallons per broiler

Plant A uses 3 gallons less water per bird than plant B — and its managers can put $1 425 more in the bank *each day* a savings of over $350 000 per year In effect processor B is pouring that amount of money down the drain

Water and Sewer Costs and Savings for Two Poultry Plants Processing 250,000 Broilers Per Day

	Plant A	Plant B	Savings
Water use per bird (gallons)	4	7	3
Daily water and sewer costs	$1 900	$3 325	$1 425
Annual water and sewer costs	$475 000	$831,250	$356 250
Cost per thousand broilers	$7 60	$13.30	$5 70



Processor A saves $5 70 per 1 000 broilers processed To estimate the potential savings for your plant determine your current water usage cost and the amount you think water usage could be reduced Then enter the current and target values in the following worksheet

Water and Sewer Charges for Your Poultry Plant

	Current	Target
Enter current and target water usage per bird (gallons)	_____	_____
Enter number of broilers processed per day _____		
Multiply current and target water use values by daily production to determine daily water use	_____	_____
Divide daily water use by 1,000 to determine daily water use in thousands of gallons	_____	_____
Enter your combined water and sewer cost per thousand gallons: $_____		
Multiply your daily water use (in thousands of gallons) by your water and sewer cost to determine your daily cost	$_____	$_____
Enter the number of days your plant operates each year _____		
Multiply the daily water and sewer cost by the number of days your plant operates each year to determine your annual water and sewer cost	$_____	$_____
Subtract the annual cost for your target use from the annual cost for your current use to determine your potential annual savings	$_____	

Where Do You Start?

Begin your water conservation program with a positive attitude In talking with your staff emphasize the importance of conserving water as a way of reducing water and sewer costs The effects of your positive attitude and actions will soon spread to workers at all levels Some proven ways to conserve water are listed in the box

Saving Dollars Makes "Cents"

A study at a poultry processing plant in the early 1970s demonstrated that making process changes to conserve water would cost about 8 6 cents per thousand gallons of water saved These same changes today would probably cost about 20 cents per thousand gallons saved When compared with water and sewer service costs of $1 90 per thousand gallons spending 20 cents to save $1 90 really does make sense

Managers set the pace for water conservation and waste reduction Your interest and involvement will let everyone in the plant know that reducing water use is important There s no better time than now to take a close look at your plant and encourage your employees to work with you in conserving water and cutting waste

Be considerate. . and be prepared. Start conserving water now

Water Conservation Hints

- Always consider water as a raw material with a real cost
- Set water conservation goals for your plant
- Install water meters and monitor water use
- Train employees how to use water efficiently
- Use a high-pressure, low-volume cleaning system
- Use nozzles on all water sprays.
- Don't let people use water hoses as brooms
- Don't let water run continuously unless necessary — for example, cycle the side-pan wash
- Reuse water where permitted
- If large amounts of water are being use to flush feathers, parts, or debris away, consider redesigning the work area to prevent these materials from collecting

FDCA-2-4

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Other publications of interest to poultry processors include

Poultry Processors You Can Cut Waste Load and Sewer Surcharges (CD-22)
Survey Shows That Poultry Processors Can Save Money by Conserving Water (CD-23)
Poultry CEOs You May Have a $60 Million Opportunity (CD-24)
Systems for Recycling Water in Poultry Processing (CD-27)

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BANK OR DRAIN

Pollution Prevention Pays in Food Processing

Poultry CEO'S: You May Have a $60 Million Opportunity!

As a chief executive officer, you are no doubt aware that water and sewer costs for some poultry processing plants have risen almost tenfold during the last two decades But did you know that the upward trend is projected to continue at the same rate or higher?

Poultry processors in the United States slaughtered more than 4 6 billion broilers in 1986 Assuming that the average plant used 7 gallons of water to process each bird 1986 water usage by the broiler industry totalled more than 32 billion gallons

Some plants have cut water consumption and now use less than 4 gallons per bird If all broiler plants reduced water usage to that level, the industry would save about 14 billion gallons annually, enough for a city of 100,000 people

The wastewater from broiler plants contains many potential pollutants In terms of biochemical oxygen demand (BOD_5), the waste load of many plants is 65 pounds or more per thousand broilers If the average plant discharges that much BOD_5, the annual load from the broiler processing industry totals almost 300 million pounds — about as much as is produced by a city of 5½ million people

Some plants discharge as little as 30 pounds of BOD_5 per thousand broilers If plants reduced their discharge to that level, about 160 million pounds of BOD_5 per year could be eliminated

Opportunities To Save Money

Poultry processors are finding that water and sewer charges have increased more rapidly than most other expenses Some poultry plants have seen water and sewer costs increase by a factor of five or ten during the past 25 years If the entire poultry industry could successfully conserve water and reduce waste load, more than $58 million could be saved annually

At typical water prices cutting water use from 7 gallons to 4 gallons per bird would save about $5 70 per thousand broilers processed Reducing the waste load from 65 pounds of BOD_5 to 30 pounds would save another $7 00 per thousand broilers Considering the 4 6 billion birds processed each year here s how those savings add up for the industry as a whole

Annual water cost savings at $5 70 per thousand broilers	$26 220 000
Annual surcharge savings at $7 00 per thousand broilers	$32,200 000
Total annual savings	$58 420 000*

*Based on water charges of 90 cents per thousand gallons sewer charges of $1 00 per thousand gallons and a BOD_5 surcharge of 20 cents per pound

Why Is Reducing Water Use and Waste Load Especially Important Now?

Regional water shortages new pollution regulations, and new policies on water pricing make water conservation more important now than ever before Our southern states where the majority of the nation s poultry is processed struggled under a severe drought in 1986 Many plants were faced with conserving water or curtailing production

As the U S Environmental Protection Agency (EPA) tightens restrictions on the quality of water consumed and wastewater released into the environment water costs will probably rise even more rapidly than in the past

Water conservation and waste reduction are becoming much more important because

- Water costs and sewer charges are on the rise
- Water quality and availability are threatened by increased consumption and pollution in many areas,
- Pollution is being aggressively attacked by public agencies and the public at large,
- Future regulations will require water conservation and elimination of pollutant discharges,
- A corporation's image can be tarnished and its sales hurt if its plants are perceived as harming the environment.
- Enforcement actions are becoming more severe and may involve not only lawsuits and fines but even prison terms

Questions for Your Management Team

Here are some things for your management team to consider as you think about your company s water use and waste discharges

- Have your plants experienced a rapid rise in water and sewer charges?
- How much could you save by reducing water use from its present level to 4 gallons per broiler? How much could be saved by cutting BOD_5 discharges to 30 pounds per thousand broilers?
- Do you supply your own water at some plants? How much does this water cost? Is the supply dependable? How is the quality? How will these factors affect future expansion?
- If you treat your plants wastewater or pretreat it have you computed what this treatment costs including proper sludge disposal?

What Can You Do?

If you re the chief executive officer of a firm with 10 percent of the U S broiler production, you may have a $6 million opportunity Reducing water use and waste load now could save you that much money next year If water and sewer costs increase tenfold over the next decade you may be able to save $60 million annually by 1998 Here are some suggestions to help you conserve

- Ensure that plant managers measure water use daily or at each shift change
- Emphasize to personnel at all levels that conserving water and reducing waste load are sound business practices
- Appoint someone in each plant to be responsible for water conservation and waste reduction practices and for monitoring their effectiveness
- Provide a training program for your managers and employees
- Show by your interest and example that you take water conservation and waste reduction seriously Helping your personnel develop the proper attitude is 90 percent of the battle It starts at the top

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For further information, see Extension publication CD-20, *Liquid Assets for Your Poultry Plant,* **and CD-22,** *Poultry Processors You Can Cut Waste Load and Sewer Surcharges*

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Pollution Prevention Pays in Food Processing

Poultry Processors: You Can Reduce Waste Load and Cut Sewer Surcharges

Did you know that many broiler processing plants produce thousands of pounds of potential wastewater pollutants every day — equivalent to the waste load from a city of 90,000 people?

Wastewater from many poultry processing plants is discharged to publicly owned treatment works (POTWs) These treatment plants must remove most of the pollutants (waste load) before the water is discharged to a public waterway Treating the wastewater costs money and most treatment works charge according to the volume of water treated In addition they commonly charge extra (apply a *surcharge*) if the waste load exceeds certain preset levels because it costs more to treat water that contains more pollutants In other words they charge more to clean up dirtier water

Waste load can be determined by a number of different measurements, including BOD_5, the biochemical oxygen demand COD the chemical oxygen demand TSS, the total suspended solids concentration, TKN the total Kjeldahl nitrogen content and FOG, the concentration of fats oils and grease

Poultry plant wastewater is most often tested for BOD_5, a measure of the amount of oxygen needed to degrade the organic matter (feathers, fat and blood) in the wastewater The BOD_5 concentration is measured in milligrams per liter (mg/l) When the level exceeds 250 to 300 mg/l, many treatment plants apply a surcharge

Poultry plants may discharge as much as 65 pounds of BOD_5 per thousand broilers processed [1] This waste load comes mainly from broiler components that find their way into the sewers Blood alone can account for as much as 17 4 pounds of BOD_5 per thousand birds processed, almost 30 percent of the plant s total waste load

Waste Load Affects Profits

In the past, most poultry plant managers did not concern themselves with reducing their plant s waste load because treatment costs were minimal and restrictions few Over the past 25 years however some cities have increased their surcharges ninefold BOD_5 surcharges now exceed 30 cents per pound in some cities Pretreatment ordinances in some localities may limit the level of wastes that can be discharged into the sewers In that case the waste load must be reduced before the wastewater leaves the broiler plant

Sewer costs once a minor operating expense have become something that every cost-conscious manager must consider At today s rates a plant s waste load can have a real effect on profitability Realizing this some plant managers have been able to cut waste discharges to as little as 30 pounds of BOD_5 per thousand broilers processed

[1] Waste load in pounds is found by multiplying the concentration in mg/l by 8 34 times the wastewater flow in millions of gallons

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Saving Money by Cutting Waste Load An Example

How much money could a poultry plant save by reducing its BOD_5 load? To find out consider two broiler plants that each process 250 000 birds per day Both pay a BOD_5 surcharge of 20 cents per pound Processor A however discharges 30 pounds of BOD_5 per thousand broilers, whereas Processor B discharges 65 pounds

The table shows the daily and annual surcharge costs for the two plants The operators of Plant A save $7 00 per thousand broilers That means they can bank an extra $1 750 per day or close to half a million dollars a year In effect Processor B is pouring that amount of money down the drain

To estimate the potential savings for your plant determine your current waste load per thousand birds processed and the sewer surcharges in your community Then estimate the amount you think the waste load could be decreased by improved operating practices Enter the values in the table and compute your savings

Sewer Surcharge Comparison for Two Broiler Plants Processing 250,000 Broilers per Day

	Plant A	Plant B	Savings
Waste load (pounds of BOD_5 per thousand broilers)	30	65	35
Daily surcharge*	$666	$2 418	$1 750
Annual surcharge*	$166 500	$604 000	$437 500
Cost per thousand broilers	$2 66	$9 66	$7 00

A surcharge of 20 cents per pound for BOD_5 loads in excess of 300 mg/l was used in calculating these costs

Sewer Surcharges for Your Plant

	Current Waste Load	Target Waste Load
Enter current and target waste load per thousand birds processed	_____	_____
Enter daily production in thousands of birds _____		
Multiply current and target waste loads by daily production to find daily waste load	_____	_____
Enter your BOD_5 surcharge cost per pound $ _____		
Multiply the daily waste load by the surcharge cost to find your daily surcharge cost	$ _____	$ _____
Enter the number of days your plant operates each year _____		
Multiply the daily surcharge cost by the number of days your plant operates annually to find the annual surcharge cost	$ _____	$ _____
Subtract the annual surcharge cost for the target waste load from the annual cost for the current waste load to find your annual savings		$ _____

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Some poultry plants have cut their BOD_5 waste load by using dissolved air flotation (DAF) cells If your plant has a DAF cell you may not feel a need to institute waste reduction practices To gain a true understanding of total operating costs however it s necessary to take into account the cost of owning and operating a DAF cell and disposing of the sludge it produces

Although a DAF cell may reduce waste concentrations below the sur charge level the organics removed as sludge must be disposed of properly Its high water content (often 97 percent) makes the DAF sludge expensive to haul and render Some renderers will not even accept DAF sludge in offal for reduction into by-products meal because of processing cost and because the chemicals involved often limit the usefulness of the final product

One processor estimates that operating a DAF cell costs 10 cents per gallon of sludge Land applica tion of the sludge may cost an addi tional 3 to 6 cents per gallon Capital costs are not included in these estimates nor are the costs of required testing regulatory permits and forms and monitoring

Therefore it pays to cut waste loads even if your plant has a DAF cell Materials that never find their way into the plant's wastewater will not have to be removed and disposed of as sludge The hints in the box should be helpful in minimizing waste

Waste Reduction Hints

- Reduce water use most water used in processing becomes *wastewater*
- Use screens and efficient systems for recovering solids
- Improve blood collection by ensuring that all birds are properly stunned and by installing a blood collection system Remove any coagulated blood from the floor and walls before they are washed down
- Install dry systems for offal collection
- Collect solids from the floor and equipment by sweeping and shoveling the material into containers before actual cleanup begins *Do not use water hoses as brooms*
- Adopt the attitude that waste load reduction is one of the best business decisions a manager can make
- Train employees in the concepts of pollution prevention, and show them how to perform their jobs in a way that will cut waste loads in your plant.

The Time to Act Is Now

Many changes are taking place in waste regulations Water and waste costs are creeping steadily upward and the increases promise to continue It s im portant for poultry processors to take action now to be prepared for limita tions on water use and waste loads that are likely to occur in the not so-distant future

Reduce your plant's waste load before it has a chance to become a costly burden and a point of contention with your local treatment plant

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BANK OR DRAIN

Pollution Prevention Pays in Food Processing

Survey Shows That Poultry Processors Can Save Money by Conserving Water

Many poultry processors can save 5 cents per broiler and 2 cents per turkey — just by practicing water conservation! That's the conclusion drawn from a survey of poultry processing plants across the nation.

To find out how much water poultry processors are using and how much they spend on water and sewer charges, 15 chicken and turkey processing plants nationwide were surveyed in 1984. If you're responsible for managing a poultry plant, you'll find the results interesting. Comparing your plant's water and sewer costs to those of other processors may suggest ways you can cut water use and save money.

Water Use and Cost

Chicken plants surveyed used from 5.5 to 10 gallons of water per bird and averaged 7 to 8 gallons. Turkey plants used 11 to 23 gallons per bird. The plants surveyed processed 300,000 to 1,000,000 pounds of birds per day (live weight). They used 160,000 to 2,000,000 gallons of water per day, averaging 700,000 gallons.

Water costs ranged from 20 cents to $1.00 per thousand gallons. The average cost was estimated to be 55 cents per thousand gallons (Table 1). Water obtained from public systems cost more than water from private sources.

Sewer Costs

The cost for sewer services ranged from 20 cents to $5.22 per thousand gallons, with an average of about $1.80 (Table 1). For public sewer systems the cost was about $1.00 per thousand gallons *less* than for private systems. Costs were affected by the age of system and the level of treatment. Screening and pretreatment costs for the plants may not be included in these costs.

Table 1. Cost of Water and Sewer Service for Poultry Plants

	Cost Range Per Thousand Gallons	Average Cost Per Thousand Gallons
Water	$ .20 - 1.00	$ .55
Sewer service	.20 - 5.22	1.80

Costs Per Pound and Per Year

Cost Per Pound. The total cost of water and sewer service for chicken processors averaged 0.6 cents per pound (eviscerated weight), ranging from a low of 0.1 cent to a high of 1.56 cents per pound of chicken. In turkey plants the cost ranged from 0.12 to 0.24 cent per pound (eviscerated weight).

Cost Per Year Annual water and sewer service costs ranged from $40 000 to $700,000 per year Costs for most of the plants surveyed ranged from $200,000 to $400,000 per year

Energy Costs

A factor often overlooked in poultry plants is the price tag of energy As use of cooled water and hot water increases, so does the energy bill To illustrate, the costs of water, chilled water and hot water were calculated (Table 2)

Water-Saving Tips

- Set a goal of using 5 gallons or less per broiler and 10 gallons or less per turkey.
- Measure and monitor water use at all points in your plant.
- Appoint a worker in each plant to be solely responsible for water conservation.
- Control water pressure to reduce flow
- Reuse water wherever permitted by the USDA.

Table 2. Cost of Water at Three Different Temperatures

Water Temperature	Cost Per Thousand Gallons	Annual Cost of 100,000 Gallons Per Day
As supplied at 60°F	$2.35	$ 58,750
Heated from 60° to 130°F	6 50	162,500
Chilled from 60° to 35°F	3.35	83,750

Start Conserving Now to Protect Future Profits

Average costs for water and sewer service have increased steadily since 198[illegible] and probably will continue to move upward These costs can have a real effect on profitability How much would your annual operating costs go up if your water and sewer bill reached $6 22 per thousand gallons?

Managers of some broiler processing plants have reduced water use to less than 4 gallons per bird. Compared to the national average of 7 5 gallons per bird, that reduction means a cut in water and sewer service costs of almost 5[illegible] percent.

Saving water could cut your water, sewer, and energy costs and help keep production costs down It's easier than you think. Some helpful hints are given in the box.

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This publication was supported in part by the North Carolina Board of Science and Technology in cooperation with the North Carolina Pollution Prevention Pays Program.

The national survey data summarized in this publication were presented by Donald F Simon in *Poultry Science* 64:485-486.

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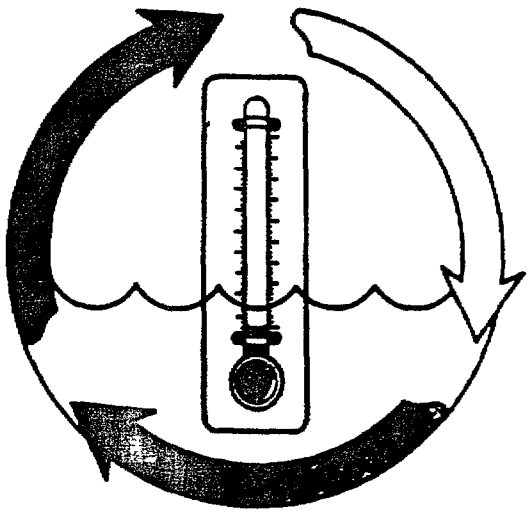
BANK OR DRAIN

Pollution Prevention Pays in Food Processing

Systems for Recycling Water in Poultry Processing

Cut water and sewer costs $85,000 per year by recycling chiller water



Each operation on the process line in a poultry plant uses water and produces wastewater The wastewaters typically contain high levels of organic and inorganic wastes that can impose a very large load on local wastewater treatment plants

The chemical oxygen demand (COD) and total solids (TS) in wastewater streams from poultry plants usually average 2 000 milligrams per liter (mg/l) each Waste concentrations vary with the source of the wastewater They can range from a high of 4 000 mg/l for chemical oxygen demand and 3,000 mg/l for total solids in the giblet chiller effluent to a low of 250 mg/l for each of these parameters in the wastewater from the whole bird washer

Treating and recycling some of the water used in poultry processing can save plant managers a great deal of money by cutting both water and sewer costs, as demonstrated by a recent study

Study Tests Chiller Water Recycling

The study was conducted to identify effective and economical water treatments, including disinfection, to meet the U S Department of Agriculture's standards for the recycling of poultry chiller water Reconditioned chiller water meeting these criteria was used to chill hot broiler carcasses, and the quality of the chilled carcasses was then evaluated

USDA recycling regulations require that the treatment processes reduce microorganism concentrations by at least 60 percent including coliforms, *Escherichia coli* Salmonella, and the total microorganism count The regulations also call for the treated water to have a light transmission (T) of at least 60 percent at 500 nanometers (nm) As the quality of reconditioned water improves, less of the reconditioned water is required to replace a gallon of fresh water in the chiller At the maximum recycle ratio 1 75 gallons of recycled chiller water is required to replace 1 gallon of fresh water As the quality of the reconditioned water improves, this ratio decreases making it possible to use as little as 1 1 gallons of reconditioned water to replace a gallon of fresh water

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Methods and Results

Three methods for treating poultry prechiller water were tested as shown in Figure 1

1 Ozonation in a countercurrent-flow contact column,
2 Screening, ozonation, sand filtration, and ozonation
3 Screening, diatomaceous earth (DE) filtration and ozonation

The results of the three treatment methods are shown in Figures 2 through 5 Ozonation alone (treatment 1) significantly improved the quality of the water, which met all requirements for recycling within 10 to 20 minutes of treatment Twenty minutes of ozonation reduced the chemical oxygen demand by 38 percent and the total solids load by 28 percent

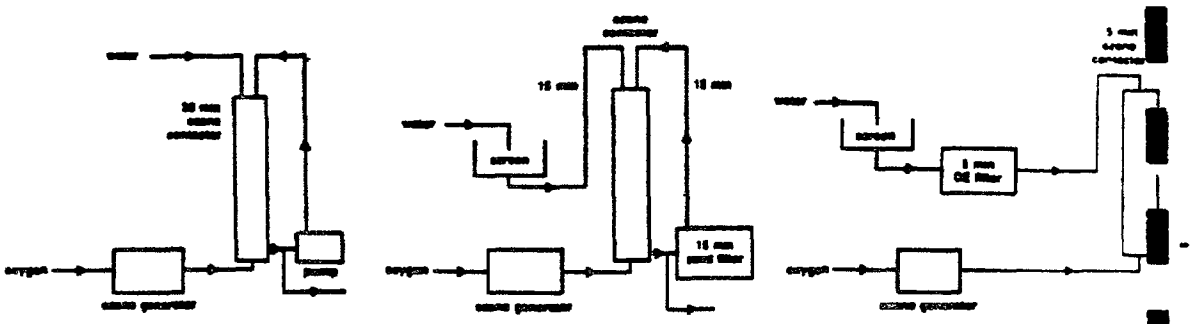
Both the sand and diatomaceous earth filtration treatments (treatments 2 and 3 respectively) yielded water quality that exceeded the federal recycling requirements The DE treatment yielded the highest quality water in the shortest treatment time, although the sand and DE processes are not directly comparable because of variations in process time

Five minutes of filtration through diatomaceous earth followed by 15 minutes of ozonation (treatment 3) resulted in an average light transmission of 97 per cent This method also reduced chemical oxygen demand by 87 percent and total solids by 65 percent

Total microbial loads were reduced by more than 99 9 percent and no coliforms or salmonella were detectable after disinfection No significant carcass quality differences (color, taste or shelf life) could be observed between carcasses chilled in tap water and those chilled in recycled chiller water (at a 1 1-to-1 0 recycle ratio)

Results of this study show that water *can* be effectively treated to reduce effluent waste loads at their sources and to reduce fresh water demands for poultry chillers

Figure 1 Three methods tested for treating prechiller water



Treatment Method 1
Ozonation for 20 minutes (20 ppm) flow rate 4 4 liters per minute

Treatment Method 2
Screening, preozonation for 15 minutes (33 ppm), rapid sand filtration for 15 minutes and postozonation for 15 minutes (33 ppm)

Treatment Method 3
Screening, diatomaceous earth filtration for 5 minutes and postozonation for 15 minutes (33 ppm)

Potential Economic Impact

Current USDA regulations require that ½ gallon of water be used to chill every broiler If a plant processes 240 000 broilers per day it uses at least 120 000 gallons of water daily to chill carcasses If 80 percent of that water could be reconditioned, 96 000 gallons of water could be saved each day At a cost of $1 90 per thousand gallons for water and sewer charges this plant could save 24 000,000 gallons of water valued at more than $45 000 per year

Chemical oxygen demand and total solids loads in the effluent could also be reduced by approximately 200,000 pounds per year (assuming an initial average of 1 000 milligrams per liter of COD and TS respectively in the untreated chiller water) If the surcharge on excess chemical oxygen demand is 20 cents per pound, the surcharge savings could be almost $40 000 per year Thus the potential savings for water, sewer, and surcharges could total $85 000 per year Other savings might be realized through by product recovery and reductions in energy costs The cost of purchasing and operating this type of system is currently being determined

Other treatment processes that have been identified for further study include filtration chlorination, ultraviolet disinfection hydrogen peroxide disinfection chemical treatments screening and clarification The results of the study described here demonstrate however, that the recycling of chiller water may offer a way to prevent environmental pollution while helping to conserve valuable water resources

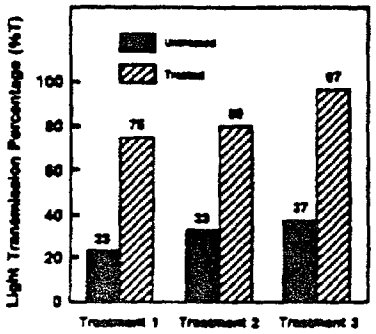


Figure 2 Effect of three treatment methods on light transmission of poultry chiller water

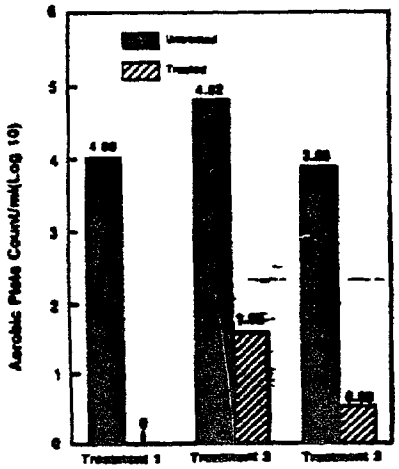


Figure 3 Effect of three treatment methods on aerobic plate count of poultry chiller water

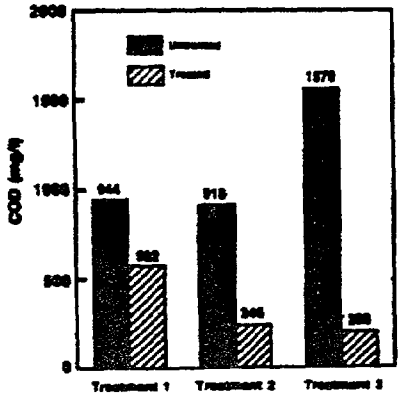


Figure 4 Effect of three treatment methods on chemical oxygen demand (COD) of poultry chiller water

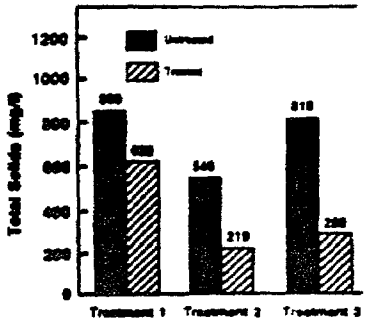


Figure 5 Effect of three treatment methods on total solids in poultry chiller water

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The research reported here and the publication of this fact sheet were supported in part by the North Carolina Board of Science and Technology in cooperation with the North Carolina Pollution Prevention Program and the Southeastern Poultry and Egg Association.

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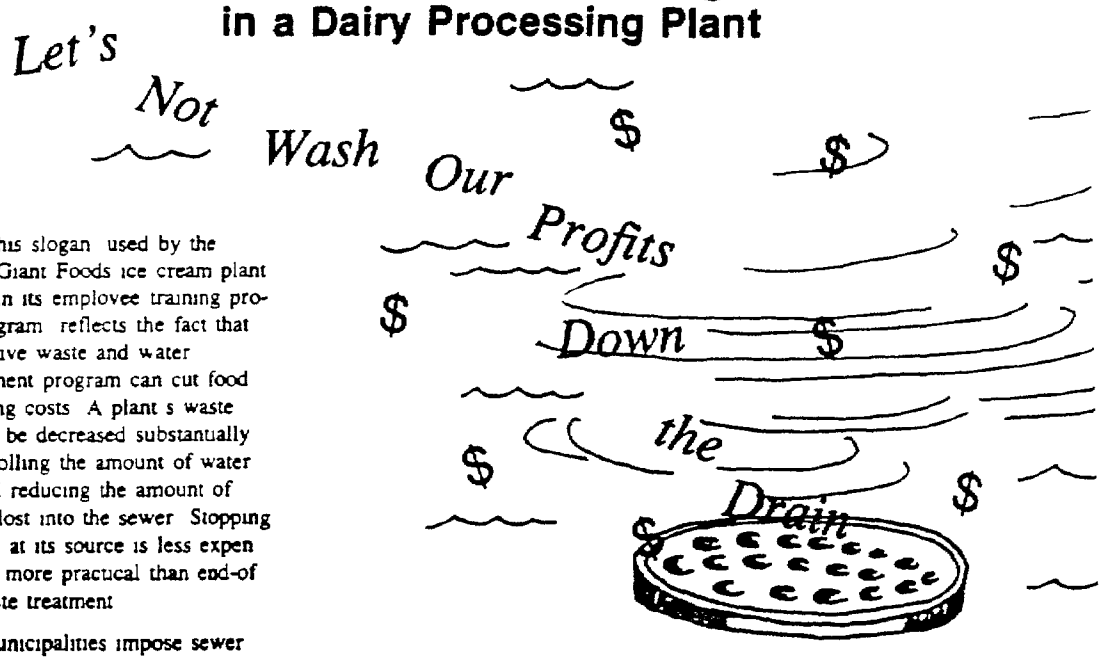
BANK OR DRAIN

Pollution Prevention Pays in Food Processing

Water and Wastewater Management in a Dairy Processing Plant



This slogan used by the Giant Foods ice cream plant in its employee training program reflects the fact that an effective waste and water management program can cut food processing costs A plant s waste load can be decreased substantially by controlling the amount of water used and reducing the amount of product lost into the sewer Stopping pollution at its source is less expensive and more practical than end-of pipe waste treatment

Some municipalities impose sewer surcharges when the level of contaminants in a plant s wastewater is excessive The possibility of saving money on surcharges makes a water and wastewater management program even more attractive Because Giant Foods was faced with limits on biochemical oxygen demand (BOD_5) and suspended solids (SS) for its pretreatment facility implementing a water and wastewater management program became a necessity We can learn much about waste control from the program used by Giant Foods

Conserve Water and Curtail Waste

Did you know that 1 pound of pollutants, in the form of BOD_5, is directly equivalent to a gallon of milk lost down the drain? If you know the BOD_5 level in your plant s wastewater you can use this information to get a reasonably accurate idea of how much product (and money) you are pouring down the drain A plant's water use and the volume and strength of its waste stream are strong indicators of how efficiently the plant is operating

To initiate a water and wastewater management program in your plant first make sure that members of your top management team are committed to reducing the volume and strength of the plant s wastewater Then appoint a water-waste supervisor" to help find ways to reduce product losses and monitor wastewater concentration If your dairy is not large enough for someone to be devoted full time to this task, assign the responsibility to a supervisor who has an interest in this field

To help in finding ways to cut water use and product loss conduct a survey of the plant s water uses Install water meters throughout the plant and read them daily List all water uses and the amount used each day If boiler and condenser water are not metered consult the literature for guidance in estimating usage Balance the amount of water used with the incoming water supply

After completing the water use survey conduct a product waste study Have the water waste supervisor and each production supervisor observe operations closely and list all the waste that occurs Take pictures of leaks spills and other situations in which waste occurs to make slides for use in employee training

When you have collected enough information plan a dinner meeting with the plant manager and all the supervisors Discuss each supervisor s waste find ings and plan ways to reduce waste This type of meeting will convey the importance of waste control and help in obtaining the management team s full commitment to waste reduction

1 Pound of BOD_5
Equals
1 Gallon of Milk

Giant Foods Program Stresses Employee Involvement

Employee training was an important part of Giant Food s water and wastewater program Without the commitment of all employees the program could not have been successful The training phase can be completed in one or two employee meetings

Employees were asked to think about waste prevention and to bring their sug gestions to the first meeting The meetings were conducted on company time and limited to 90 minutes The plant manager opened the first session by explaining that reducing waste and water use is necessary both economically and legally if the plant is to continue to operate and expand He also reviewed the county s pretreatment ordinance

A set of slides introduced employees to the concept of waste treatment and the plant s pretreatment facilities were discussed The session centered on the company s abatement program entitled Washing Our Profits Down the Drain It demonstrated that the plant s waste was made up entirely of ice cream water and cleaning compounds

An Effective Program
BOD Cut 33%
Water Use Reduced 25%

Employees were told the objective of waste treatment to decompose the organic matter with bacteria and oxygen before it reaches public waterways so that it will not steal the stream s oxygen and kill the fish Each bacterium in the trickling filter and activated sludge system was portrayed as a Pac Man' eating his way along the trail The two ghosts ' that can 'knock him out are the ghost of big pH and the ghost of excess food The new pH monitoring system at Giant Foods, it was explained helps eliminate the ghost of high pH but employees must help eliminate the ghost of excess food

After another slide presentation showing plant waste being generated employees were encouraged to contribute ideas on waste reduction in their own work areas -Their suggestions were posted and acted upon

The employees developed a slogan for their efforts to cut waste and reduce water use Let s eat it instead of treating it This slogan reminds them of the advantages of recovering product rather than allowing it to reach the drains where it becomes a pollutant

Reduced Pollution and Water Consumption

The Giant Foods program was very effective BOD_5 loading was cut by one third and water consumption by one-fourth when water and waste reduction efforts were implemented Collecting any unusable material in barrels for use as animal feed was found to be one of the best methods for preventing pollution

The treatment plant is monitored once a week by testing the BOD_5 and suspended solids levels of the raw waste and the final effluent Results are reviewed by the plant manager who notifies supervisors if excessive pollutant levels are found in the raw waste so that they can take corrective action

Controlling waste in the Giant Foods plant has directly involved all personnel Each person recognizes that waste treatment is a vital part of plant operations and that his or her efforts have a direct bearing on the efficiency of the treatment facility

The water waste program in this plant has resulted in daily savings and a minimum amount of waste The full cooperation of the company s employees in reducing waste and water use has resulted in more efficient operation — and money going into the bank rather than down the drain

☞ Bank or drain Which is your choice?

Elements of a Successful Water and Wastewater Management Program

- Obtain full management commitment and understanding,
- Appoint a water-waste supervisor,
- Survey waste production in the plant,
- Survey water use in the plant,
- Conduct a management meeting,
- Train employees,
- Solicit ideas from employees
- Implement the best ideas immediately if suggestions will not be implemented right away or are rejected, let the employees know the reason
- Monitor performance and maintain records

Pollution = Lost Product

75th Anniversary

Prepared by
Roy E Carawan
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5-89—3M—TWK CD-28

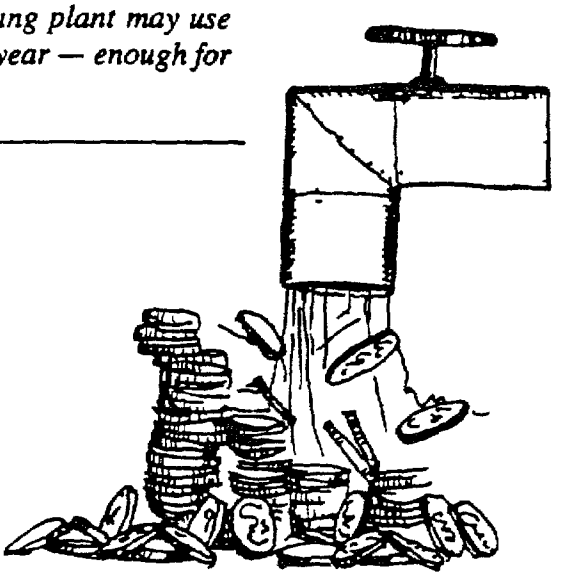
FNCA-2-3

BANK OR DRAIN

Pollution Prevention Pays in Food Processing

Liquid Assets for Your Dairy Plant

Did you realize that your dairy processing plant may use more than 50 million gallons of water a year — enough for a town of 1,000 people?



Saving Water Can Save You Money

Water has many uses in dairy processing — cooling washing heating and cleanup Many plants use more than 4 gallons of water to process each gallon of milk

Water and sewer service costs have been rising rapidly and these increases can cut into profits Using water more efficiently however can help to counter these increases Realizing the potential for savings, some plant managers have cut their plant s water use to as little as 1 gallon of water per gallon of milk processed

Cutting water use has a double benefit it not only lowers the plant s water bill, it can also help to cut sewer charges because most municipalities compute those charges as a percentage of the metered water usage In addition reducing water use will reduce sewer surcharges if the waste concentration does not increase proportionately

Protecting Your Water Supply

Cutting costs is not the only reason to take water conservation seriously Some dairy plants are located in communities without an abundant water supply Because it takes large amounts of water to process dairy products, a plant can have a major effect on the local water supply even under the best of circumstances During a drought the impact can be disastrous

In 1986, the southeastern states were stricken by the worst drought in nearly a century Had the situation worsened, dairy processors would have faced water limitations production cutbacks, and even temporary plant closings By reducing water consumption now processors can increase their chances of getting through the next drought without having to curtail operations

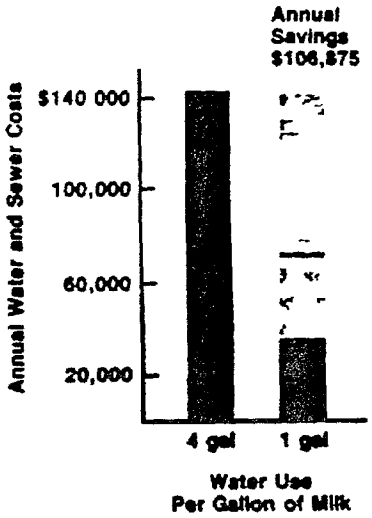
Saving Money by Saving Water: An Example

How much could a dairy plant save by reducing its water use to 1 gallon of water per gallon of milk processed? To find out let s consider two plants that each process 75 000 gallons of milk per day Each pays a total of $1 90 per thousand gallons for water and sewer services However plant A uses 1 gallon of water per gallon of milk processed while plant B uses 4 gallons

Water and sewer costs for the two plants are shown in the table Because plant A uses 3 gallons of water per gallon of milk *less* than plant B — a savings of 225 000 gallons per day — its operators can put $427 50 more in the bank *each day* a total savings of $106 875 per year In effect processor B is pouring that amount of money down the drain

Water and Sewer Costs and Savings for Two Dairy Plants Processing 75,000 Gallons of Milk Per Day

	Plant A	Plant B	Savings
Water use per gallon of milk (gallons)	1	4	3
Daily water and sewer costs	$142.50	$570 00	$427 50
Annual water and sewer costs	$35 625	$142,500	$106 875
Cost per thousand gallons of milk	$1 90	$7 60	$5 70



If you know your local water and sewer charges, the amount of water used in your plant to process a gallon of milk and your plant's daily production you can use the following worksheet to estimate the amount you would save by reducing water usage to a target value you select

Water and Sewer Costs and Savings for Your Dairy Plant

	Current	Target
Enter current and target water usage per gallon of milk (gallons)	_____	_____
Enter daily production in gallons _____		
Multiply current and target water use values by daily production to determine daily water use	_____	_____
Divide daily water use by 1,000 to determine daily water use in thousands of gallons	_____	_____
Enter your combined water and sewer cost per thousand gallons $_____		
Multiply your daily water use (in thousands of gallons) by your water and sewer cost to determine your daily cost	$_____	$_____
Enter the number of days your plant operates each year _____		
Multiply the daily water and sewer cost by the number of days your plant operates each year to determine your annual water and sewer cost	$_____	$_____
Subtract the annual cost for your target use from the annual cost for your current use to determine your potential annual savings	$_____	

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You CAN Save Water and Money

A study of the U S dairy industry showed that it is possible to reduce water use to less than 1 gallon per gallon of milk processed Challenge and encourage your employees to reach that goal in your plant Consider establishing a reward and personal recognition program for employees who contribute significantly to water conservation Some helpful ideas are given in the box

Managers set the pace for water conservation and waste reduction Your interest and involvement will let everyone in the plant know that reducing water use is important There's no better time than now to take a close look at your plant and encourage your employees to work with you in conserving water and cutting waste

Be considerate. . . and be prepared. Start conserving water now

Water Conservation Tips

- Always treat water as a raw material with a real cost
- Set water conservation goals for your plant
- Make water conservation a management priority
- Install water meters and monitor water use
- Train employees how to use water efficiently
- Use automatic shut-off nozzles on all water hoses
- Use high-pressure, low-volume cleaning systems
- Don't let people use water hoses as brooms
- Reuse water where possible
- Minimize spills of ingredients and of raw and finished product on the floor; always clean up the spills before washing

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5-88-1M-TWK CD-21

BANK OR DRAIN

Pollution Prevention Pays in Food Processing

Cut Waste to Reduce Surcharges for Your Dairy Plant

Did you know that your dairy plant may be producing a waste load of 800,000 pounds of BOD_5 per year — equivalent to the load from a city of 13,000 people?

Wastewater from most dairy plants is discharged to publicly owned treatment works (POTWs) where the majority of the pollutants are removed before the water is discharged to the environment Treating the water costs money and most treatment works charge according to the volume of sewage treated In addition they commonly charge extra (apply a *surcharge*) if the waste load exceeds certain specified levels because it costs more to treat water that contains more pollutants

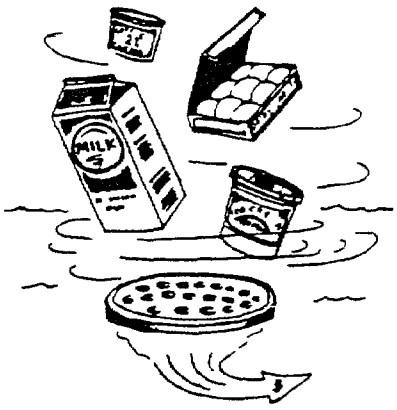
Waste load can be determined by a number of different measurements including BOD_5 the biochemical oxygen demand COD the chemical oxygen demand TSS the total suspended solids concentration TKN the total Kjeldahl nitrogen content and FOG the concentration of fats oils and grease

Wastewater from dairy plants is most often tested for BOD_5 a measure of the amount of oxygen needed to degrade the organic matter carried by the water The BOD_5 concentration is measured in milligrams per liter (mg/l) When the level exceeds 250 to 300 mg/l many treatment plants apply a surcharge

Some dairy plants discharge as much as 12 pounds of BOD_5 per 1 000 pounds of milk received More than 90 percent of a plant s total waste load comes from milk components that are lost and flow into floor drains during processing Lactose proteins and butterfat are the major components The wastewater may also contain cleaning agents lubricants and solids removed from equipment and floors

Waste Load Can Affect Profits

In the past most dairy plant managers did not concern themselves with reducing their plant s waste load because treatment costs were minimal and restrictions few Over the past 25 years however some cities have increased their surcharges ninefold BOD_5 surcharges now exceed 30 cents per pound in some cities Pretreatment ordinances in



some localities may limit the level of wastes that can be discharged into the sewers In that case the waste load must be reduced before the wastewater leaves the dairy plant

Sewer costs once a minor operating expense have become something that every cost-conscious manager must consider At today s rates a plant s waste load can have a real effect on profitability Realizing this some plant managers have been able to cut waste discharges to as little as 1 pound of BOD_5 per thousand pounds of milk received

Calculating Your Surcharge

The total amount of BOD_5 in a plant s wastewater can be calculated by multiplying the BOD_5 concentration in milligrams per liter by the amount of effluent in millions of gallons

Amount of BOD_5 = 8 34 × BOD_5 concentration × effluent volume

For example if a plant discharges 3 7 million gallons of wastewater per month with a BOD_5 concentration of 2 300 mg l the total amount of BOD_5 discharged during the month is calculated as follows

Amount of BOD_5 = 8 34 × 2 300 × 3 7
= 70 973 pounds

The monthly surcharge is normally based on the amount that the BOD_5 concentration exceeds a specified limit To find the monthly surcharge cost multiply the *excess* amount of BOD_5 by the surcharge rate

Surcharge cost = Excess amount of BOD_5 × surcharge rate

If the plant with a BOD_5 concentration is 2 300 mg/l is subject to surcharge on BOD_5 in excess of 250 mg/l the excess concentration subject to surcharge is 2 050 mg l

Amount of BOD_5 subject to surcharge = 8 34 × (2 300 250) × 3 7
= 8 34 × (2 050) × 3 7
= 63 259 lb

If the surcharge rate is 20 cents per pound of excess BOD_5 the monthly cost is

Surcharge cost = 63 259 lb × 20 cents/lb
= $12 652

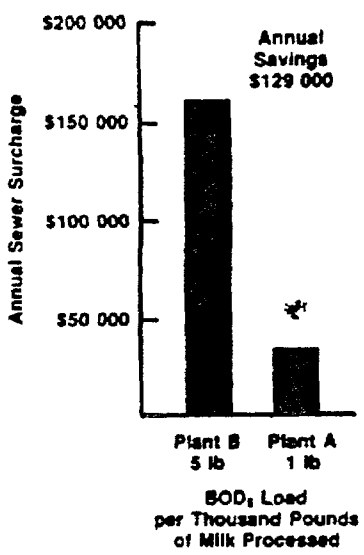
In addition to the charge for excess BOD_5 surcharges may also be made for excessively high levels of COD TSS FOG and TKN

Saving Money by Cutting Waste Load An Example

How much money could a dairy plant save by reducing its BOD_5 load to only 1 pound per thousand pounds of milk? To find out consider two dairy plants that each process 645 000 pounds of milk per day Both pay a BOD_5 surcharge of 20 cents per pound Processor A discharges 1 pound of BOD_5 per thousand pounds of milk processed (1 pound for every 116 gallons) while Processor B discharges 5 pounds in processing the same amount of milk

The table shows the daily and annual surcharge costs for the two plants The operators of Plant A save 80 cents per thousand pounds of milk processed That means they can bank an extra $516 per day or almost $130 000 annually if the plant operates 250 days each year In effect Processor B is pouring that amount of money down the drain

It is also important to remember that the excess waste load reflects milk lost during processing and the cost of this lost product must be added to the surcharge to find the true cost



Sewer Surcharge Comparison for Two Dairy Plants Processing 645,000 Pounds (75,000 Gallons) of Milk Per Day

	Plant A	Plant B	Savings
Waste load (lb of BOD_5 per thousand lb of milk)	1	5	4
Daily BOD_5 surcharge	$129	$645	$516
Annual surcharge	$32 250	$161,250	$129 000
Cost per thousand pounds of milk processed	$.20	$1 00	$ 80
Cost per thousand gallons of milk processed	$1 72	$8 60	$6 88

To estimate the potential savings for your plant, determine the sewer surcharges in your community and the current waste load produced by your plant per thousand pounds of milk processed Then calculate the amount you think the waste load could be decreased by improved operating practices Enter the values in the following work sheet to compute your savings

You Can Reduce Waste Load and Save Money in Your Plant

You can take positive steps to reduce the waste load produced by your plant Some suggestions are given in the box To keep tabs on your progress use the work sheet to calculate your plant s waste load You ll not only help protect the environment you ll also show the people in your community that your firm is a responsible corporate citizen

AND *you will send more money to the bank instead of down the drain*

Sewer Surcharge Savings for Your Plant

	Current	Target
Enter current and target waste load in pounds of BOD_5 per thousand pounds of milk processed	_____	_____
Enter daily production in thousands of pounds of milk _____		
Multiply current and target waste loads by daily production to find daily waste load in pounds	_____	_____
Enter your BOD_5 surcharge cost per pound $_____		
Multiply the daily waste load by the surcharge cost to find your daily surcharge cost	$_____	$_____
Enter the number of days your plant operates each year _____		
Multiply the daily surcharge cost by the number of days your plant operates annually to find the annual surcharge cost	$_____	$_____
Subtract the annual surcharge cost for the target waste load from the annual cost for the current waste load to find your annual savings	$_____	

Waste Reduction Hints

- Make waste reduction a management priority
- Establish waste load reduction goals for your plant
- Establish waste load reduction goals for all important processes and areas of the plant where waste can be monitored and controlled
- Improve maintenance to prevent product leaks from valves, piping, and equipment.
- Reduce water use, remember that water used in processing becomes wastewater that must be treated
- Thoroughly drain product from tanks and vats before cleaning
- Collect solids from floors and equipment by sweeping Shovel the wastes into containers before actual cleanup begins Do not use hoses as brooms.
- Adopt the attitude that waste load reduction is one of the best managerial decisions you can make
- Orient employees toward preventing pollution, and train them how to do their jobs in a way that will reduce the discharge of wastes from your plant.

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10-88—1M—TWK CD-30

FNCA 2-2

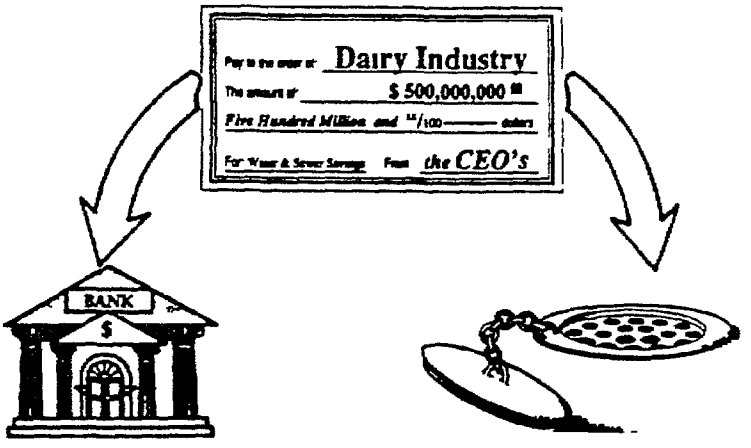
BANK OR DRAIN

Pollution Prevention Pays in Food Processing

Dairy CEO's: Do You Have a $500 Million Opportunity?

Did you know that water and sewer costs for some dairy plants have risen almost tenfold during the last two decades?

This means that water and sewer charges have probably become a significant part of your operating budget



Opportunities to Save

Water Use

In 1986, Grade A dairies in the United States processed over 60 billion pounds of products (milk, cream, cottage cheese, and ice cream) They used about 9 3 billion gallons (80 billion pounds) of milk to make these products If the average plant used 4 gallons of water to process each gallon of milk (a typical amount), total water use for that year by the Grade A dairy industry exceeded 37 2 billion gallons

Some plants now use less than 1 gallon of water per gallon of milk processed If all dairy plants could save 3 gallons of water per gallon of milk processed, savings would amount to approximately 28 billion gallons of water — enough to supply a city of 200,000 people for a year

Waste Load

The average Grade A dairy plant produces 5 pounds of biochemical oxygen demand (BOD_5) per thousand pounds of milk processed The resulting annual BOD_5 load from dairy processing is almost 400 million pounds

The resulting annual BOD_5 load from dairy processing is almost 400 million pounds

Some plants discharge as little as 1 pound of BOD_5 per thousand pounds of milk processed If all plants reduced their discharge to this level about 320 million pounds of BOD_5 could be eliminated — the same amount discharged annually from a city of 5 2 million people

Cost Savings

Water and sewer costs have increased rapidly for many dairy processors Some dairy plants have experienced an increase of 5 to 10 times in water and sewer costs over the past 25 years As much as $117 million could be saved annually if the U S dairy industry could successfully conserve water and reduce waste load as shown in the table

Surcharges for excess waste load are not the only costs associated with waste from dairy processing plants More than 90 percent of the waste load from a dairy plant consists of product that has been lost to the sewer and therefore can never be sold A wastewater analysis can thus indicate a plant s efficiency

One pound of BOD_5 in the sewage means that at least 9 pounds of milk have been lost in processing The 320 million pounds of BOD_5 that could be eliminated represent a milk loss of 2 88 billion pounds With milk valued at $13 50 per hundred pounds the potential savings could be as much as $389 million per year

Combine this $389 million with a possible $117 million reduction in water and sewer charges and you can see that the U S Grade A dairy industry has the potential for saving $506 million annually

Why Is Reducing Water Use and Waste Load Especially Important Now?

Regional water shortages new pollution regulations and new policies on water pricing make water conservation more important now than ever before Widespread areas of our nation have struggled under severe droughts in recent years Many plants were faced with conserving water or curtailing production

As the U S Environmental Protection Agency (EPA) tightens restrictions on the quality of water consumed and wastewater released into the environment water costs will probably rise even more rapidly than in the past To face these changes and be ready for possible future shortages leaders in the dairy processing industry must look ahead and start water conservation efforts now

Water conservation and waste reduction are important because

- Water costs and sewer charges are on the rise
- Water quality and availability are threatened by increased consumption and pollution in many areas of the country,
- Pollution is being attacked aggressively by public agencies and the public at large
- Future regulations may require water conservation and elimination of pollutant discharges
- A corporation s image can be tarnished and its sales hurt if its plants are perceived as harming the environment
- Enforcement actions are becoming more severe Lawsuits fines and even prison terms may face those who are not fully in compliance with environmental laws

Potential Savings from Water Conservation and Waste Reduction

Volume of milk processed	9 3 billion gallons
Savings from reduced water use ($5 70 per thousand gallons)	$53 010 000
Savings from reduced waste load ($6 88 per thousand gallons)	$63 984 000
Total savings	$116 994 000

Note Assumes a water cost of 90 cents per thousand gallons sewer charge of $1 00 per thousand gallons and a BOD_5 surcharge of 20 cents per pound

Questions for Your Management Team

Here are some questions for your management team to ask as you think about each plant s water use and waste discharges

- Has your dairy processing operation experienced a rapid rise in water and sewer charges?
- Do you supply your own water? How much does this water cost? Is the supply dependable? Is the quality high? How will these factors affect future expansion? Is your water source threatened by pollution?
- How much money could you save by reducing water use from its present level to 1 gallon per gallon of milk processed? How much could be saved by cutting BOD_5 discharges from their present level to 1 pound per thousand pounds of milk processed? Would these savings be important to your organization? Should even more stringent goals be adopted for your plants?

What Can You Do?

Compute your share of the $500 million opportunity For example if your company accounts for 5 percent of all U S Grade A milk production you may be able to save $25 million per year by reducing water use and waste load If water and sewer costs increase tenfold over the next decade you may be able to save $250 million annually by 1997

Here are some suggestions to help you start a conservation program

- Ensure that plant managers measure water use daily or at each shift change
- Emphasize to personnel at all levels that conserving water and reducing waste load are sound business practices
- Appoint someone in each plant to be responsible for water conservation and waste reduction practices and for monitoring their effectiveness
- Provide a training program for your managers and employees
- Show by your interest and example that you take water conservation and waste reduction seriously Helping your personnel develop the proper attitude is 90 percent of the battle **IT STARTS AT THE TOP!**

75th Anniversary

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Appendix B

Selected Pollution Prevention/Waste Minimization Case Studies for Food Processing and Meat and Poultry Processing Industries

Selected Case Studies

1 "Waste Minimization for a Dairy" (by G Looby and W Kirch, U S EPA Environmental Research Brief EPA/600/S-92/005 June 1992)

2 'Waste Minimization Demonstration for a Food and Fermentation Industry" (Compendium on Low and Non-Waste Technology, United Nations Economic and Social Counsel 'The Ahmet Process for Wastewater Purification " Monograph ENV/WP 2/5/Add43)

3 'Recovery and Use of Methane from Sugar Beet Processing Effluent" (Clean Technology, Environmental Protection Technology Scheme, Dept of the Environment, 2 Marshall Street, London-SWIP-3EB, 1989, p21)

4 Recovery of Salts from Beet Wastes" (Compendium on Low and Non-Waste Technology, United Nations Economic and Social Counsel, "Demineralization of Beet Juice with Re-Use of Evaluates " Monograph ENV/WP 2/5/Add41)

5 "Treatment and Recovery of Brine from Sauerkraut Manufacturing" (Compendium on Low and Non-Waste Technology, United Nations Economic and Social Counsel, 'Treatment of Juice from Sauerkraut Fermentation and Production of Yeast in this Effluent " Monograph ENV/WP 2/5/Add49)

6 ' Extraction of Potato Starch from Potato Cleaning Wastewater" (Compendium on Low and Non-Waste Technology, United Nations Economic and Social Counsel, "Dry Extraction of Potato Starch Substitute " Monograph ENV/WP 2/5/Add84)

7 "Extraction of Potato Starch from Potato Wastewater" (Compendium on Low and Non-Waste Technology, United Nations Economic and Social Counsel, "Extraction of Potato Starch with Recovery and Use of Proteins in Internal Liquid " Monograph ENV/WP 2/5/Add39)

8 "Recovery of Fats and Proteins from Wastewater" (Compendium on Low and Non-Waste Technology, United Nations Economic and Social Counsel, "Manufacture of Fats by Continuous Melting With Recovery of Fats and Proteins from the Wastewater ' Monograph ENV/WP 2/5/Add78)

9 'Disposal of Wastewaters and Decreased Water Requirements are Achieved Through Conservation, Recycling, and Process Modifications in Dairy Operations" ("Water and Raw Materials for Non-Waste Technology Processes " by Erik Rud Madsen, Technical Research Center of Finland, Espoo Finland, June 20-23, 1988 pp51-62)

10 "Poultry Slaughterhouse Decreases Effluent by Using Dry Suction System for Clean-up" (Secteur Agro-Alimentaire, Technologies Propres, Abattage de Volailles, Gouvernement de Quebec, Ministre de l'Environment, Gestion et Assainissement des Eaux, May 1989 Source document in French)

11 Reduction in Waste Load from a Meat Processing Plant, Carawan and Pilkington, Pollution Prevention Program, North Carolina Department of Natural Resources and Community Development

12 Maola Milk and Ice Cream Company, New Bern, North Carolina Reduction of Dairy Waste (by J W Tillman Achievements in Source Reduction and Recycling for Ten Industries in the United States SAIC Report prepared for Risk Reduction Engineering Laboratory United States Environmental Protection Agency 1991)

13 Mount Dora Growers Cooperative, Mount Dora, Florida Reuse of Wash Water for a Fresh Citrus Packinghouse (by J W Tillman Achievements in Source Reduction and Recycling for Ten Industries in the United States SAIC Report prepared for Risk Reduction Engineering Laboratory, United States Environmental Protection Agency 1991)

EP 1.96.600/S-92/005

Environmental Research Brief, EPA/6

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EPA/600/S-92/005 June 1992

EPA

ENVIRONMENTAL RESEARCH BRIEF

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Waste Minimization Assessment for a Dairy

AUG 26 1992

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Abstract

The U S Environmental Protection Agency (EPA) has funded a pilot project to assist small- and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so In an effort to assist these manufacturers, Waste Minimization Assessment Centers (WMACs) were established at selected universities, and procedures were adapted from the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7 88/003, July 1988) The WMAC team at the University of Tennessee performed an assessment at a plant manufacturing pasteurized milk, cream, buttermilk chocolate milk ice cream mix, fruit drinks, and plastic jugs—approximately 23,300,000 gal/yr of liquid product and 4 160 000 half gallon and 15 600 000 gallon plastic jugs/yr Raw milk is delivered to the plant, filtered, then centrifuged to separate the cream from the skim milk which is then processed through a high temperature short time (HTST) press After the press, the milk is bottled and shipped Buttermilk is skim milk which has been inoculated with cultures in a special processing tank Chocolate milk is made by adding chocolate powder and fructose to blended milk prior to processing in the HTST press The team's report, detailing findings and recommendations, indicated that the majority of waste is wastewater generated from all processes in the plant and that the greatest savings could be obtained by instituting a wastewater management plan to reduce uncontained milk waste (38%) and wastewater (90%)

This Research Brief was developed by the principal investigators and EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from the authors This brief provides only summary information and is not intended for use as a thorough analysis

University City Science Center Philadelphia PA 19104

Introduction

The amount of waste generated by industrial plants has become an increasingly costly problem for manufacturers and an additional stress on the environment One solution to the problem of waste is to reduce or eliminate the waste at its source

University City Science Center (Philadelphia PA) has begun a pilot project to assist small and medium-size manufacturers who want to minimize their formation of waste but who lack the in-house expertise to do so Under agreement with EPA's Risk Reduction Engineering Laboratory, the Science Center has established three WMACs This assessment was done by engineering faculty and students at the University of Tennessee's (Knoxville) WMAC The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize waste generation

The waste minimization assessments are done for small- and medium-size manufacturers at no out-of-pocket cost to the client To qualify for the assessment, each client must fall within Standard Industrial Classification Code 20-39, have gross annual sales not exceeding $50 million, employ no more than 500 persons, and lack in house expertise in waste minimization

The potential benefits of the pilot project include minimization of the amount of waste generated by manufacturers, and reduced waste treatment and disposal costs for participating plants In addition, the project provides valuable experience for graduate and undergraduate students who participate in the program and a cleaner environment without more regulations and higher costs for manufacturers

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Methodology of Assessments

The waste minimization assessments require several site visits to each client served In general the WMACs follow the procedures outlined in the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988) The WMAC staff locates the sources of waste in the plant and identifies the current disposal or treatment methods and their associated costs They then identify and analyze a variety of ways to reduce or eliminate the waste Specific measures to achieve that goal are recommended and the essential supporting technological and economic information is developed Finally, a confidential report that details the WMAC's findings and recommendations (including cost savings, implementation costs, and payback times) is prepared for each client

Plant Background

This dairy produces pasteurized milk (2% fat, 1% fat, 1/2% fat, whole, and skim), cream buttermilk, chocolate milk, ice cream mix and fruit juice drinks The plant also manufactures milk jugs from HDPE (high density polyethylene) pellets The plant operates 4,420 hr/yr to produce approximately 23 4 million gal of milk annually

Manufacturing Process

Raw Milk Processing

The dairy receives fresh raw milk via 19 to 20 daily truck deliveries Raw milk is pumped from the trucks through a centrifuge clarifier where undesirable solids in the milk are removed Waste from the clarifier is collected in a holding tank and is trucked offsite daily to be used as fertilizer After each delivery the truck tanks are cleaned with a Clean-In-Place (CIP) cleaning system which utilizes a spray system built into each tank. Initially a four second burst of water at 60-80 psi is supplied to the tanks, the water/milk solution is pumped through the clarifier and processed with the milk initially pumped from the truck That rinse is followed by an alkaline rinse, an acid rinse, and a rinse containing a sanitizing agent. The rinse solutions drain to the municipal sewer During one CIP cycle each day the clarifier is also washed

It is estimated that approximately 2% of the total amount of milk purchased annually is lost during processing Solids removed from the milk in the clarifier account for part of the volume loss The remainder results from milk spills and leaks from processing equipment, contamination of milk with the CIP sanitizer solution during HTST press washing, and spills of packaged product in the storage cooler Spills and leaks of milk during processing are partially contained in equipment drip-pans drip-pan waste is collected by a local farmer and is subsequently used as hog feed The remaining milk lost annually is drained to the municipal sewer It is not possible to quantify the amounts of waste milk associated with each piece of equipment

Milk exiting the clarifier is cooled to 36°F in a cooling press At this point a second CIP system is used to clean the raw milk lines Drip-pan waste is generated and uncontained spills and leaks occur at the cooling press Five percent of the milk from the cooling press is shipped to other dairies for further processing The remaining 95% is transferred to one of three storage silos

Milk in the storage silos contains on average 3 75% butterfat Approximately 40% of the milk from the storage silos is directed through a centrifuge where cream is separated from the milk The cream contains about 40% butterfat and the remaining skim milk has a butterfat content of approximately 0.25% Each fraction is stored in its own tank Cream from the cream storage tank is transferred to either the ice cream mix process or the filling machines where cream is packaged and transported to the storage cooler (33°F) Drip-pan waste is generated at the filling machines and uncontained spills and leaks occur at both the filling machines and in the storage cooler

A fraction of the skim milk in the storage tank is transferred to the buttermilk process Another fraction is transferred to the pasteurized milk process to be pasteurized and homogenized and sold The remainder of the skim milk is blended with whole milk from the storage silos in a processing blender to obtain milk with different fat contents Milk from the processing blender is then sent to the pasteurized milk process chocolate milk process, and the ice cream mix process

Pasteurized Milk

Skim, 1/2% fat, 1% fat, 2% fat, and whole milk are received from the skim milk storage tank and blend tank and are pasteurized and homogenized in two HTST presses The first stage of the HTST press is a regenerator (heat exchanger) section in which heat is transferred from milk already in the press to milk coming into the press After passing through the regenerator, milk is steam-heated further to 172°F in a vacuumizer where bacteria in the milk are killed Then it is subjected to a pressure of 1 900 psi in a homogenizer Following the homogenizer, milk flows back through the regenerator transferring its heat to incoming milk. The milk is then cooled to 36°F in a chilled water heat exchanger and finally to 32°F in a glycol cooling unit The dairy operates 150 and 180 HP boilers which are used to produce the needed steam Steam condensate is disposed of to the municipal sewer as is the cooling water because of the risk of contamination The HTST presses used in all of the dairy processes are washed a total of five times per day with a water rinse and three times per day with an acid wash Wastewater is disposed of to the municipal sewer During the washing process milk remaining in the presses may be contaminated with the acid or it may be diluted with water Diluted milk is reprocessed and contaminated milk is disposed of in the municipal sewer Some waste milk is also collected in drip-pans under the presses

The pasteurized and homogenized milk is then transferred to a 10,000-gal storage tank where it is stored at 33°F Next cardboard cartons and plastic jugs are filled with milk from the storage tank and transported to the storage cooler A third CIP system is used to clean the pasteurized milk lines This system generates waste cleaning solution which is disposed of in the municipal sewer Drip-pan waste is generated at the filling machines and spill waste and leaks occur at both the filling machines and in the storage cooler (33°F)

Buttermilk

Skim milk is received from the skim milk storage tank and pumped to a processing tank. In the processing tank the milk is steam heated to 186°F for 30 min (Steam condensate is disposed of in the municipal sewer) The milk is then cooled to 75°F in the tank with chilled water (Cooling water is disposed of in the municipal sewer) At 75°F the milk is inoculated with "ready set" culture to promote bacterial growth which thickens and flavors the milk Finally the processing tank is fed with chilled water to cool the milk to a temperature between 40 and

45°F As the buttermilk tank is emptied drip pan waste is generated and spills and leaks occur

The buttermilk is then pumped to filling machines for packaging and is transported to the storage cooler Drip-pan waste is generated at the filling machines and leaks and spills occur at both the filling machines and in the storage cooler (33°F) The pasteurized milk line CIP system is used to clean the processing tank and the filling machines

Chocolate Milk

Milk from the blend tank is pumped to a mixing tank where chocolate powder and fructose are added to the milk. The raw milk line CIP system is used to wash the mixing tank as needed After the ingredients are mixed chocolate milk is pasteurized and homogenized in an HTST press, as described in the pasteurized milk process Following pasteurization and homogenization chocolate milk is stored in a tank until it is transferred to filling machines for packaging Finally packaged milk is transferred to the storage cooler The pasteurized milk line CIP system is used to wash the storage tank and the filling machines Drip-pan waste is generated at the filling machines and spills and leaks occur at both the filling machines and in the storage cooler (33°F)

Ice Cream Mix

Milk is received from the blend tank and is mixed in a blender with cream from the cream storage tank milk powder fructose stabilizers and vanilla The mixture is then transferred to one of three holding tanks The raw milk line CIP system is used to clean the blender and the holding tanks

From the holding tanks the mixture is pumped to an HTST press as described in the pasteurized milk process Following processing in the press ice cream mix is stored in a storage tank at 33°F The mix is then pumped from the storage tank to filling machines where it is packaged and is then transferred to the storage cooler Drip-pan waste is generated at the filling machines and spills and leaks occur at both the filling machines and in the storage cooler The pasteurized milk line CIP system is used to clean the storage tanks and the filling machines

Fruit Drinks

In addition to milk based products this dairy also produces several different flavors of fruit drinks City water is first pumped through a charcoal filter which removes debris and chlorine from the water Periodic backwashing of the filter results in wastewater which is drained to the municipal sewer Next, the de-chlorinated water is mixed in a steam heated mixing tank (168°F) with preservative, liquid juice concentrate, and either sucrose or fructose Spills of approximately 2 080 gal are drained to the municipal sewer each year

The drink mixture then enters the small HTST press Spills, leaks and contaminated product from the presses are drained to the municipal sewer There is no drip-pan waste associated with this process

Drink mixture from the HTST press is then transferred to a surge tank Finally the drink mixture is pumped to filling machines where it is packaged in cartons or jugs and transferred to a storage cooler Spills from the filling machines and the storage cooler are drained to the municipal sewer

Waste Water

Wastewater streams from the entire dairy are collected in a wastewater collection pit before discharge to the municipal sewer Most of the waste streams were described previously Wastewater is also generated in floor washing operations partially from cleaning up milk spills as they occur throughout the day but mainly from the practice of turning water hoses on during the entire cleanup shift The cooling water for the chiller system is also treated as is the daily sanitizing waste from the cleaning of all tanks in the plant during the cleanup shift

Blow Molding

This dairy produces 1-gal and 1/2-gal jugs used in packaging product High density polyethylene (HDPE) pellets from a storage silo enter a blend hopper where they are mixed with regrind pellets Following the blend hopper, the pellets are gravity fed into the extruder barrel, melted at 325°F and then extruded into molds for blow molding with compressed air Jugs are automatically ejected from the mold and trimmed of excess plastic Next, the jugs are leak tested Defective jugs and trimming are reground for reuse which results in the generation of dust Finally, the jugs are labeled and transferred to the filling line

Existing Waste Management Practices

- Milk solids from the clarifier are trucked offsite by a local farmer for use as fertilizer
- Drip-pans have been installed to contain milk spills and leaks The collected waste milk is then transported offsite by a local farmer for use as hog feed
- Wastewater streams and milk-contaminated waste streams are combined to achieve dilution before discharge to the municipal sewer

Waste Minimization Opportunities

The type of waste currently generated by the plant the source of the waste, the quantity of the waste, and the annual management costs are given in Table 1

Table 2 shows the opportunities for waste minimization that the WMAC team recommended for the plant The type of waste the minimization opportunity, the possible waste reduction and associated savings, and the implementation cost along with the payback time are given in the table The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant All values should be considered in that context

It should be noted that, in most cases, the economic savings of the minimization opportunities result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health It should also be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that would result when the opportunities are implemented in a package

This research brief summarizes a part of the work done under Cooperative Agreement No CR-814903 by the University City Science Center under the sponsorship of the U S Environmental Protection Agency The EPA Project Officer was Emma Lou George

*U S Government Printing Office 1992 — 648-080/60015

Table 1 *Summary of Current Generation*

Waste Generated	Source of Waste	Annual Quantity Generated (gal)	Annual Waste Management Cost ($)
Milk solids	Clarifier in the raw milk processing line Milk solids are shipped offsite for use as fertilizer	65 000	8 800
Drip-pan milk waste	Milk spills and leaks from various processes The milk is collected in drip-pans a local farmer transports the waste offsite for use as hog feed	65 000	790
Uncontained milk waste	Milk spills and leaks from various processes Uncontained and contaminated milk is sent to the plant s waste collection pit and is discharged into the municipal sewer	394 000	(see wastewater)
Wastewater	Truck and clarifier washing milk line washing HTST press washing steam condenser water Wastewater is collected in the plant s waste collection pit and is discharged into the municipal sewer	37 299 660	194 190 [1]
Spilled fruit juice	Fruit juice spills from process line Waste fruit juice is collected in the plant's waste collection pit and is discharged into the municipal sewer	6 340	(see wastewater)
High density polyethylene dust	Blow molding of jugs Dust is generated during regrind of defective jugs	1 300	0 [2]

[1] Includes costs for monitoring plant effluent plant labor costs for sampling testing handling and record keeping surcharges imposed by the POTW and sewer charges
[2] The plant reports no cost associated with the disposal of this waste

Table 2 *Summary of Recommended Waste Minimization Opportunities*

Waste Generated	Minimization Opportunity	Annual Waste Reduction Quantity (gal)	Annual Waste Reduction Percent	Net Annual Savings	Implementation Cost	Payba Year
Uncontained milk waste	Institute a wastewater management plan	147 810	38	$320 810	$661 200	2 1
Wastewater	Begin an ongoing employee training and awareness program to minimize milk spills due to human error and to minimize water usage due to lazy maintenance practices	14 601 600	39			
	• Minimize the use of water for clean-up through the use of high pressure nozzles and automatic shut off nozzles on hoses					
	• Install an activated sludge treatment system to treat the wastewater collected in the waste pit before discharge to the POTW Currently the effluent does not meet the POTW's standards and surcharges are being assessed					

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***** DOCNO· 400-043-A-232 *****

INDUSTRY/SIC CODE.	Food and Fermentation Industries/ISIC 3111, 3112, 3113, 3114, 3118, 3131, 3132, and 3133
NAME/CONTACT	AB Sorgona Box 139, S-24500 Staffenstorp, Sweden
TECHNOLOGY DESCRIPTION	Wastewaters from the industry are treated with anaerobic microorganisms for recovery of methane. The water treated in this way is then treated with aerobic microorganisms for achieving a very good effluent quality The aerobically-produced excess biosludge is recycled back to the anaerobic step The recovery of methane is about 300 l/kg COD treated.
FEEDSTOCKS:	Industrial effluents containing large amounts of biodegradable organic material (e.g., wastewaters from food and fermentation industries)
WASTES	Crude digestion gas, small amounts of excess sludge.
MEDIUM·	Aqueous
COST	
CAPITAL COST·	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER.	Not reported
SAVINGS	
DIRECT COST	Not reported
FEEDSTOCK REDUCTION	Not reported
WASTE PRODUCTION	Not reported
IMPACT	
CITATION/PAGE.	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "The Ahamet Process for Wastewater Purification", Monograph ENV/WP.2/5/Add.43
KEYWORDS	Activated Sludge, Methane, Ahamet Process, ISIC 3111

***** DOCNO 453-001-A-000 *****

1 0 Headline Recovery and use of methane from sugar beet processing effluent

2.0 SIC Code SIC 2063, Beet Sugar

3 0 Name and Location of Company

British Sugar plc
Oundle Road
Peterborough PE2 9QU, England

4 0 Clean Technology Category

This technology uses an anaerobic stage to recover methane from sugar beet effluent for use as a process fuel.

5 0 Case Study Summary

5 1 Process and Waste Information. The facility processes sugar beets generating a wastewater effluent with a high chemical oxygen demand. Traditionally, this effluent was dealt with aerobically by a water treatment plant and its organic content wasted. The clean technology was to add an anaerobic stage to the water treatment section to convert the organic content of the effluent to usable methane. The fermentation takes place in the digestion vessel, the off-gas consists largely of methane with some carbon dioxide. Key features of the process are the pre-heating of the incoming stream using low-grade heat, careful control of the pH and the recirculation of sludge. The methane provides process heat to dry the pulp for use as an animal feed.

5.2 Scale of Operation. British Sugar operates 12 beet factories and employs 3,000 people. The Peterborough facility produces 100,000 tons of sugar per year

5.3 Stage of Development. The technology is fully implemented.

5 4 Level of Commercialization. No information provided.

5.5 Material/Energy Balances and Substitutions. No information provided.

6 0 Economics.* It is assumed that the economics cited in the source document are on a per plant basis and not the total of all 12 British Sugar plants.

6 1 Investment Costs. The capital cost of the technology is 750,000 English Pounds.

6.2 Operational and Maintenance Costs. Annual savings in lower sewage charges are 26,000 English Pounds and 8,000 English Pounds in electricity cost savings. The value of recovered gas is 25,000 English Pounds.

6.3 Payback Time. Payback time is 12 years.

7.0 Cleaner Production Benefits

The technology resulted in reduced chemical oxygen demand in the wastewater effluent. Recovery and use of methane from organic matter in the wastewater effluent were achieved. Lower operating costs and energy conservation were added benefits of the technology

8.0 Obstacles, Problems and/or Known Constraints

None were identified.

9.0 Date Case Study Was Performed

Unknown

10.0 Contacts and Citation

10.1 Type of Source Material: Government Publication.

10.2 Citation. Clean Technology, Environmental Protection Technology Scheme, Department of the Environment, 2 Marsham Street, London SW1P 3EB, 1989, p. 21.

10.3 Level of Detail of the Source Material: No additional detail is provided.

10 4 Industry/Program Contact and Address: Mr J.N Smith, Chief Safety and Environment Officer, British Sugar plc, Oundle Road, Peterborough PE2 9QU, England, Telephone (0733) 63171.

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type. Chemical oxygen demand, wastewater effluent, sugar beet processing effluent

11.2 Process type/waste source: Sugar products, agricultural processing

11.3 Waste reduction technique. Anaerobic digestion

11.4 Other keywords: Methane, United Kingdom, SIC 2063

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords. Chemical Oxygen Demand, Wastewater Effluent, Sugar Beet Processing Effluent, Sugar Products, Agricultural Processing, Anaerobic Digestion, Methane, United Kingdom, SIC 2063

***** DOCNO 400-041-A-230 *****

INDUSTRY/SIC CODE.	Food Industry/ISIC 3118
NAME/CONTACT	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14 Boulevard du General Leclerc 92521 Neuilly-sur-Séine Cedex, France
TECHNOLOGY DESCRIPTION	The company demineralizes beet juice with valorization eluates. The demineralization eluates are separated from the other effluents. After having been homogenized, these eluates are concentrated by evaporation and then crystallized. Centrifugation permits the separation of salts that are marketed as fertilizer and the mother liquor, rich in proteins, that is marketed for animal feed.
FEEDSTOCKS	Beet juice, salt
WASTES	Not reported
MEDIUM	Not reported
COST	(1973 Francs)
CAPITAL COST	F 3.0 million
OPERATION/MAINTENANCE.	12 Francs/ton demineralized beets
MONTHS TO RECOVER.	Not reported
SAVINGS	
DIRECT COST	Not reported
FEEDSTOCK REDUCTION	Not reported
WASTE PRODUCTION	Not reported
IMPACT	This process is more reliable than a standard purification process.
CITATION/PAGE.	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Demineralization of Beet Juice with Re-Use of Eluates", Monograph ENV/WP.2/5/Add.41.
KEYWORDS	Foodstuff, Beets, Demineralization, ISIC 3118

***** DOCNO· 400-049-A-238 *****

INDUSTRY/SIC CODE.	Manufacture of Food, Beverages and Tobacco/ISIC 31
NAME/CONTACT	Ministere de l'Environnement Direction de la Prevention des Pollutions 14 Boulevard du General Leclerc 92522 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION	The company treats sauerkraut juice resulting from fermentation a production of yeast on this effluent. Both techniques use the sa method for the production of sauerkraut: after paring, the cabbage shredded, salted, and stored in seven ton fermentation vats for thr weeks. The sauerkraut is then ready for canning. After fermentation, there is an overflow from each vat of about 500 lite of brine, rich in lactic acid and oxidizable matter In the standa technique, the brine is first lime-neutralized and then rejected. In t low-waste technology, the brine is fermented, centrifuged and rejecte At the time of centrifugation, yeast cream is recovered for drying.
FEEDSTOCKS	Sauerkraut juice (brine)
WASTES.	Waste brine containing oxidizable matter.
MEDIUM.	Aqueous
COST	
CAPITAL COST	Not reported
OPERATION/MAINTENANCE.	Not reported
MONTHS TO RECOVER.	Not reported
SAVINGS:	
DIRECT COST·	Not reported
FEEDSTOCK REDUCTION·	Not reported
WASTE PRODUCTION	The quantity of waste is almost the same with either technology· 74 lite per ton of sauerkraut with the low-waste technology versus 75 liters wi the standard technique. The biochemical oxygen demand is 0.25 kg vers 2.6 kg; chemical oxygen demand: 1 kg versus 4 1 kg; lactic acid. 0.03 k phosphorous: 1.5 g versus 21.8 g.
IMPACT	In the standard technology the lactic acid is neutralized by lime. In t low-waste technology, wastes are deacidified with yeast and no long require lime-neutralization.
CITATION/PAGE.	Compendium on Low and Non-waste Technology, United Natio Economic and Social Counsel, "Treatment of Juice from Sauerkra Fermentation and Production of Yeast in this Effluent", Monogra ENV/WP.2/5/Add.49
KEYWORDS	Foodstuff, Fermentation, Brine, ISIC 31

***** DOCNO 400-084-A-255*****

INDUSTRY/SIC CODE.	Food Manufacturing/ISIC 311
TECHNOLOGY DESCRIPTION	Extraction of potato starch without water washing of the finely divided potatoes. The potatoes are separated into solid and liquid phases, which are then processed independently
FEEDSTOCKS	Five tons of potatoes, 0.2 GJ of electric power and 0 1 GJ in the form of steam, per ton of potato powder
WASTES	Wastewater
MEDIUM.	Aqueous
COST	
CAPITAL COST	0.2 million rubles for new process.
OPERATION/MAINTENANCE.	380 rubles per ton of potato powder
MONTHS TO RECOVER.	Not reported
SAVINGS	
DISPOSAL & FEEDSTOCK.	0 4 million rubles in initial investment, due to need for water-treatment station in conventional process. 150 rubles savings per ton of starch produced due to reduced operating costs.
FEEDSTOCK REDUCTION	None
WASTE PRODUCTION	In the low-pollution technique, the water required is 3.5 m^3 per ton of end-product compared to 14.5 m^3 in the conventional process.
IMPACT	Elimination of wastewater generated from wash water and internal vegetation water in the standard starch process. In the low-pollution process of potato powder production, one obtains undiluted potato cell fluid which undergoes direct processing.
CITATION/PAGE.	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Dry Extraction of Potato Starch Substitute", Monograph ENV/WP.2/5/Add84
KEYWORDS	Wastewater Treatment, Food Processing, Potato, Starch, ISIC 311

***** DOCNO 400-039-A-228 *****

INDUSTRY/SIC CODE.	Food Industry/ISIC 3121
NAME/CONTACT	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Néuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION	The company performs extraction of potato starch with recovery and valorization of proteins in internal vegetation water Coagulation followed by centrifugation of the proteins contained in the internal vegetation water permits them to be separated from the water whereas with the standard technique the vegetation water, still full of proteins, was discharged into the river after having been stored for a month.
FEEDSTOCKS	Internal vegetation water
WASTES	Wash water and manufacturing water
MEDIUM	Aqueous
COST	
CAPITAL COST	FF 8.6 million
OPERATION/MAINTENANCE.	Not reported
MONTHS TO RECOVER.	Not reported
SAVINGS	
DIRECT COST	Not reported
FEEDSTOCK REDUCTION	Not reported
WASTE PRODUCTION	The discharge flow, 17.5 m^3/ton of potato starch, remains the same, but the pollution is reduced by about 40 per cent. The biochemical oxygen demand is 70 kg/ton and the chemical oxygen demand is 145 kg/ton compared to 120 kg/ton and 205 kg/ton, respectively, in the standard process.
IMPACT	Although this technique is already operational it may still undergo improvements that will permit an increase in the efficiency of the recovery and valorization of the products recovered.
CITATION/PAGE.	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Extraction of Potato Starch with Recovery and Use of Proteins in Internal Liquid", Monograph ENV/WP.2/5/Add.39
KEYWORDS	Foodstuff, ISIC 3121

***** DOCNO 400-078-A-311*****

HEADLINE.	Recovery of animal fats reduces wastewater generation by 90% and reduces energy costs.
INDUSTRY/SIC CODE.	Manufacture of Food, Beverages and Tobacco/ISIC 31
POLLUTION PREVENTION OPTIONS SUMMARY	Manufacture of fats by continuous melting process with recovery of fats and protein from wastewater Tallow is ground and melted in a steam-fed melting pot. Extracted fats are refined. Process water is treated in a concentrator to further recover fats and proteins. Concentrates are dehydrated and together with the grease can be sold as animal feed. The evaporated process water is condensed before being reused. In the standard technology, the process wastewater is degreased, processed through a florentine flask, and discharged.
FEEDSTOCKS	Water, steam, tallow
WASTES	Wastewater
MEDIUM.	Aqueous
COST	
CAPITAL COST	FF 795,000 (1979 figures)
OPERATION/MAINTENANCE.	FF 14 per ton of tallow (1979 figures)
MONTHS TO RECOVER.	Not reported
SAVINGS	
DISPOSAL & FEEDSTOCK.	Not reported
FEEDSTOCK REDUCTION	200 liters of water per ton of tallow
WASTE PRODUCTION	For each ton of tallow processed, the wastewater generation is reduced from 500 l for the standard technology to 50 l for the modified technology The energy required for processing wastewater with the modified process is 670 MJ versus 21 MJ with the standard process. Also, with the low-waste technology, it is possible to recover 5 7 kg of proteins per ton and 3 kg of animal fats per ton of tallow
IMPACTS.	The volume and the quality of wastewaters in terms of BOD and COD concentrations are improved significantly by the modified process.
CITATION/PAGE.	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Manufacture of Fats by Continuous Melting with Recovery of Fats and Proteins from the Wastewater", Monograph ENV/WP.2/5/Add.78.
KEYWORDS	Food Processing, Fat Recovery, Condensates, Wastewater, ISIC 31

***** DOCNO 452-002 A-000 *****

1 0 Headline Disposal of Wastewaters and Decreased Water Requirements are Achieved Throug- Conservation, Recycling and Process Modification in Dairy Operations

2.0 SIC Code 2202 Cheese Manufacturing

3 0 Name & Location of Company General information presented with no mention of specific companies or facilities.

4 0 Clean Technology Category

Technology Principle This technology involves minimizing water consumption and subsequent wastewater production through onsite conservation and recycling while also increasing productivity

5.0 Case Study Summary

5 1 Process and Waste Information. This new waste technology is concerned with water, which is a universal solvent in many processes and subsequently becomes an environmental problem. This technology focuses on eliminating the need for new water in a process by recycling water into the process and minimizing consumption. Cheese manufacturing was the example presented. Cheese manufacture produces two wastewater streams. the whey and the water from cleaning the plant. Whey can go to an ultrafiltration plant to produce protein and permeate powder and wastewater can be recycled. Total recycle begins with good preparation including initial treatment of water to remove any contaminants such as hardness, inorganic or organic substances through hyperfiltration, and a complete clean out of the plant to eliminate on-site contaminants (i.e., left-over bacteria)

The process water is conserved by installing better-built pumps, i.e., better glands and bearings independent of the motor, preventing release onto the floors. Discontinuous operation is replaced with continuous operation which serves to increase water economy with minimum storage capacity required. In addition, production increases with less investment. Plants must be set up or run to ensure that total shut-down is not required for clean-up, and a phased clean-up can be effectually conducted with all flush water being reused or directed to ultrafiltration plants which recover almost all internal protein as product.

The final step is to acknowledge that no stream is a waste stream and must be handled in sanitary way Stream segregation is important as it permits less complicated treatment or regeneration processes. In a dairy plant wastewater streams contain thermophilic and spore-forming microorganisms and recirculation of this water can only be achieved if organism build-up prevention is practiced. Necessary precautions require that water be stored with cleaning agents to prevent the growth of such organisms or be stored with a very low content of BOD and nutrients. BOD and nutrients can be removed through the use of hyperfiltration. Cleaning agents are also necessary Nitric and phosphoric acids and sodium hydroxide, and some complexing agents can all be recovered (except what has been neutralized), and ultrafiltration of these agents is a good way to remove proteins for animal feeds.

It was mentioned that these strategies have been introduced successfully into a pulp and paper factory in Kai Shan Tun in the Jilin Province in China. This plant recovers lignosulphonate from sulfite liquor using ultrafiltration. The lignosulphonate is used for paper gluing.

5.2 Scale of Operation Specific plants or facilities were not mentioned however, the example given represented a commercial cheese manufacturing process line.

5.3 State of Development. This technology is fully developed.

5.4 Level of Commercialization. The example given represented a commercial cheese manufacturing run.

5.5 Balances and Substitutions. Water is treated before use and is conserved and regenerated throughout the cheese manufacturing process to effectively reduce the amount of new water required and eliminate wastewaters requiring disposal.

Specific amounts were not given.

6.0 Economics. The investment costs in a dairy operation where wastewaters are not produced are higher than those of a conventional process (due to hyperfiltration plants etc.) however, advantages include almost all product ends up as valuable product; most cleaning chemicals are recovered, the amount can be reduced to 20-30% of the normal consumption, water consumption is minimized, no money is spent for wastewater treatment.

6.1 Investment Costs. Specific investment costs were not reported, although it was mentioned that investment costs for nonwastewater dairy plants were higher than conventional dairy plants.

6.2 Operational and Maintenance Costs. Specific costs were not mentioned, however, it can be assumed that savings can be realized with the reduction of cleaning agents and required water due to conservation and recycling, as well as, a reduction in wastewater treatment costs. Profit is also realized in the production of permeate powder and proteins from the hyperfiltration plants.

6.3 Payback Time. Payback time was not discussed although the benefits of recycling can be seen immediately

7.0 Cleaner Production Benefits

Economic benefits are seen in a reduction of cleaning agents and water purchased, the production of proteins and permeate powder, a reduction in wastewater disposal costs, and an increase in productivity due to increased operating hours.

Regulatory compliance is easier with significantly reduced volumes of waste requiring hazardous waste disposal.

8.0 Obstacles, Problems, and/or Known Constraints

The buildup of thermophilic and spore forming microorganisms in plant waters is a problem and must be controlled through additives and controlled storage. Water must be treated prior to use to eliminate the introduction of contaminants into plant waters.

9.0 Date of paper preparation was not provided.

10.0 Contacts and Citation

10.1 Type of Source Material. Paper presented at a Non-waste technology symposium held in Finland.

10.2 Citation. Madsen, Erik Rud, "Water and Raw Materials for Non-Waste Technology Processes" Technical Research Center of Finland, Espoo Finland, June 20-23, 1988, (51-62)

10.3 Level of Detail of Source Material. Source material was designed to present general strategies rather than specific technical information.

10.4 Industry/Program Contact and Address. Rud Erik Madsen, A/S De Danske Sukkerfabrikker, Nakskov, Denmark.

10.5 Abstractor and Address. Susan Wojnarowski, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043

11.0 Keywords.

11.1 Waste Type. Wastewater, Rinsewater, Whey

11.2 Process Type/Waste Source. Cheese manufacturing, SIC 2202

11.3 Waste Reduction Technique: Reclamation, Recovery, Rinsewater Reuse, Spill Control, Conservation, Filtration, Process Control.

11.4 Other Keywords. Hyperfiltration Plant, Denmark

Keywords. Cheese Manufacturing, SIC 2202, Reclamation, Recovery, Rinsewater Reuse, Denmark

***** DOCNO 450-013-A-001 *****

1 0 Headline Poultry Slaughterhouse Decreases Effluent by Using Dry Suction System for Clean-Up

2.0 SIC Code 2015

3 0 Name and Location of Company

La Cooperative Federee de Quebec,
Saint-Felix-de-Valois, Quebec.

4 0 Clean Technology Category

This technology involves wastewater reduction by installing a vacuum system to clean-up poultry organs from cutting tables.

5 0 Case Study Summary

5 1 Process and Waste Information. Water is an essential element for poultry slaughterhouses. It is used to clean poultry cages, to scald the poultry so that feathers may be removed, to wash feathers from poultry, to remove organs from cutting tables, to refrigerate poultry, and to wash equipment. The authorities at the municipal water treatment system of Quebec found that the efficiency of their purification machinery was being greatly compromised by the volume and high pollution levels of water from the poultry slaughterhouses. As a result, the water treatment company and La Cooperative Federee decided to treat the slaughterhouses's waters on site. The company elected to decrease the amount of water it was using and, therefore, avoid the $1,500,000 cost of a treatment system The most obvious way to decrease the volume of water at the facility was to install a vacuum system that sucked organs and other inedible body parts from the visceration tables and collected them in a vat of other non-edible parts. The old system used a lot of water to hose the tables down with disinfectant. As a result of the new suctioning system, the company was able to reduce the pollutants in its effluent by 75% The company also used the following source reduction techniques to decrease its wastewaters.

*Recovered blood instead of washing it away,

*Segregated process waters from rain waters so that only the volume of process waters needing treatment would be discharged to a pit,

*Installed automatic spray nozzles to concentrate water more directly when washing equipment,

*Installed high pressure cleaning systems to clean more efficiently

5.2 Scale of Operation. La Cooperative Federee slaughters approximately 23,000 poultry per day It used 500,000 liters/water/day and discharged 400 kg BOD(5)/day (demande biochimique en oxygen)

5.3 Stage of Development: This technology was fully implemented at the time of this case study

5 4 Level of Commercialization. This technology was fully available at the time of this case study although the suction system needed to be specifically designed for this application.

5.5 Material/Energy Balances and Substitutions

Transportation of Visceral Organs

Parameters (kg/ton)	Traditional Transportation	Transportation at La Cooperative			
	Transportation by Water	Transport by Water		Suction System	
	without hens*	w/o hens*	with hens*	w/o hens*	with hens*
BOD(5)	15.5	17.1	39.5	8.2	11.0
Suspended Solids	10.9	9.7	25.8	7.8	9.4
Oils and Fats	5.1	3.7	7.0	2.1	2.5

* It is noted in the text that hens pollute more than other poultry due to the eggs located in the viscera.

6.0 Economics*

6.1 Investment Costs. In order to install the equipment for the suction system, the company invested $180,000 compared to the $1,500,000 the company would have had to spend to install a chemical and biological treatment system.

6.2 Operation and Maintenance Costs: With the dry suction system, the company must only spend $4,000/year for disinfection chemicals as opposed to spending $10,000/year on chemical and energy costs for the chemical/biological treatment system.

6.3 Payback time: The payback time of this operation was 7 months.

It is assumed that costs are reported in Canadian dollars.

7.0 Cleaner Production Benefits:

This process reduced the wastewaters of the slaughterhouse by 75% The use of disinfection chemicals decreased by 75% and oils and fats in the effluent were reduced by 65%.

8.0 Obstacles, Problems and/or Known Constraints

One of the obstacles the company had to overcome was how to implement a suction system using existing pipes and equipment. The company was able to attach the system to existing conduits to transport the organs to an existing storage area for medible parts.

9.0 Date Case Study Was Performed. This case study was performed in 1986.

10.0 Contacts and Citation

10.1 Type of Source Material. Report

10.2 Citation. Secteur Agro-Alimentaire, Technologies Propres, Abattage de Volailles, Gouvernement de Quebec, Ministre de l'Environnement, Gestion et Assainissement des Eaux, May 1989 Source document is in French.

10.3 Level of Detail of Source Material. More detail is provided about the slaughter industry in general in Quebec. More detail is also provided about the system before the changes and the system after the implementation of the suction system

10 4 Industry/Program Contact and Address. Regional offices, addresses and phone numbers are given on the back of the report.

10.5 Abstractor Name and Address. Blair M Raber, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA, 22043

11 0 Keywords

11 1 Waste Type Wastewater, Food Wastes, Animal and Marine Fats, Fats and Oils.

11.2 Process Type/Waste Source Food Processing.

11.3 Waste Reduction Technique Equipment Modification, Process Modification, Source Reduction, Wastewater Reduction, Jet Sprayers, Vacuum System

11 4 Other Keywords. Agriculture, Annual Cost Savings, Canada, Environmental Impact Reduction, Food Products.

(*) Disclaimer - Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords. Wastewater, Food Wastes, Animal and Marine Fats, Fats and Oils, Food Processing, Equipment Modification, Process Modification, Source Reduction, Wastewater Reduction, Jet Sprayers, Vacuum System, Agriculture, Annual Cost Savings, Canada, Environmental Impact Reduction, Food Products

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Document CS153

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***** DOCNO 034-016-A-152 *****

INDUSTRY/SIC CODE

Meat Processing/2011

NAME/CONTACT:

Pollution Prevention Program, North Carolina Department of Natural Resources and Community Development, P.O. Box 27687, Raleigh, North Carolina 27611-7687

TECHNOLOGY DESCRIPTION·

Several efficiency and process modifications were recommended Modifications for water use include better control of water usage, product losses, and waste load by supervisors, utilizing an education program for management and employees, installing and using valves on all hoses, recording water use and waste characteristics, and recommending waste load mass limitations to the city. Process changes to reduce waste load include using a dry clean-up of the animal holding pens prior to washdown, improving the paunch handling operation; and installing a blood drain system with piping and a heavy duty pump connected to a collection tank

FEEDSTOCKS

Beef cattle

WASTES

Blood, flesh particles, soluble protein losses and waste materials, wastes
are high in 5-day BOD5, TSS, and floatable oil and grease.

MEDIUM:

COST

CAPITAL COST·	<$10,000
OPERATION/MAINTENANCE:	
MONTHS TO RECOVER.	

SAVINGS.

DIRECT COST.	$1,500/year
FEEDSTOCK REDUCTION	none
WASTE PRODUCTION:	reduced 80% (60,000 lbs of BOD5/year) water use reduction of 25% (1,000,000 gallons/year)

IMPACT·

Water use and wastes are reduced.

CITATION/PAGE

Reduction in Waste Load from a Meat Processing Plant, Carawan and Pilkington, Pollution Prevention Program, North Carolina Department of Natural Resources and Community Development, P O Box 27687, Raleigh, North
Carolina 27611-7687

KEYWORDS NORTH CAROLINA, FOOD PROCESSING, WASTEWATER, WASTE SEGREGATION, SIC=2011

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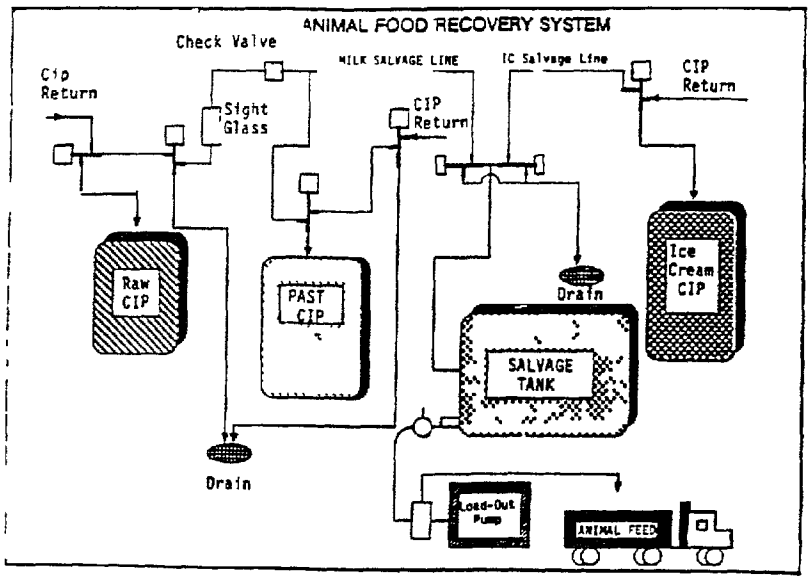
MAOLA MILK AND ICE CREAM COMPANY
NEW BERN, NORTH CAROLINA

Reduction of Dairy Waste Via Minimization of Product Loss and Process Changes to Reduce BOD_5 Load

Maola Milk and Ice Cream Company (Maola) is a multiproduct dairy producing several milk products (i e , buttermilk, chocolate imitation milk drink, etc), frozen desserts, juices, and fruit drinks By the end of 1987, Maola had fully implemented a milk loss program and had completed several process changes that allowed for the recovery and reuse of ice cream, milk and water

The initial source reduction measures prevented the loss of an estimated 170,000 lbs of milk and decreased the biochemical oxygen demand (BOD_5) by 17,000 lbs over an approximate 4 month period (Sept - Dec , 1986) The resulting savings in dollars were estimated at approximately $24,000 per month When the recovery process changes were included with the milk loss program, the company estimated that it had saved in excess of $350,000 during 1988 As a gauge of how much waste was being reduced at its source, the municipal treatment works which receives Maola's waste discharge, reported "profound results" soon after Maola's efforts were implemented Influent data to the City of New Bern Treatment Plant showed a 14 7% reduction in BOD_5 per day and a 22 8% decrease in suspended solids over a one-month period, much of which was attributable to the Maola program This aided the New Bern Plant in complying with the National Pollutant Discharge Elimination System (NPDES) requirements Although difficult to quantify, Maola s reduced BOD_5 load also translated into reduced chemical usage, less sludge accumulation, and reduced power requirements for the New Bern Treatment Plant



Source Carawan et al 1987

Maola s interest in a planned operation for reducing waste began in 1986 with the formation of a research team, consisting of the company management and North Carolina State University (NCSU) food scientists from the North Carolina Agricultural Extension Service This project team conducted a feasibility study for reduction of waste load by the recovery/reuse of process waste The scope of the study included (1) a plant survey to identify sources of milk solids losses from the production processes, (2) identification of methods which could be used to reduce or recover and reuse the milk solids lost from the system, (3) development of a conceptual

design for a recovery/reuse system, and (4) evaluation of the costs and payback period for the identified pollution prevention system

Most of the waste load from dairy processing plants consist of milk products that are either intentionally or inadvertently lost to the sewer system The survey team thus examined each activity that contributed to product loss and waste load Estimated waste loads were calculated from the amount of product lost and the BOD_5 of the product Each loss activity was examined for reuse potential, as summarized in the table below The research team determined from their survey results (Carawan, et al , 1987) that 2,290 gallons per day (GPD) of high solids product/waste material were recoverable (a potential value of $400,000 annually if used as ice cream ingredient), and approximately 120 GPD of ice cream could be recovered (valued at $80,000 annually)

Thus, the research team judged Maola to have the optimum potential for recovering as much as 2,410 GPD of ice cream ingredient valued at $480,000 annually Product recovered and not used as an ice cream ingredient could be beneficially used for animal food One of the conceptual designs generated for animal food recovery, from the research study, is shown diagrammatically on the preceeding page

REUSE POTENTIAL OF MATERIAL

Safe for Incorporation Into Ice Cream Production	Marginally Useful for Incorporation Into Ice Cream Production	Suitable Only for Animal Food
Receiving Bay R/W	Pasteurized Surge Tank R/W	Raw Processing Tank R/W
Heavy Foam from Cream Tanks	Jug Fillers F/R/W	Buttermilk Processing Tank R/W
Raw Blend R/W	Ice Cream Pasteurizer Vats R/W	Juice Processing Tank R/W
Pasteurizer Surge Tank R/W	Ice Cream Blender F/R/W	Clarifier Wash
Bag Fillers F/R/W		Separator Wash
Cream Tanks R/W		
Holding Tanks F/R/W		
Freezers		
Flavor Tank F/R/W		

R/W = Rinse/Wash F/R/W = Flush/Rinse/Wash

Source Carawan et al 1987

From this initial recommendation, Maola has installed a system to recover product-water mixtures from the High-Temperature-Short Time (HTST) Pasteurizing System (the major contributer to product loss and waste load) and a raw rinse recovery for the Raw Cleaning-In-Place (CIP) System The HTST System, basically a plate heat exchanger, is the main component of the pasteurizing process When switching from the pasteurization of one product to another, to prevent mixing of products, the HTST System must be rinsed to clean out the remaining product in the system Maola had in the past used water rinses to clean out the system for discharge to the sewer By diverting rinses between products to a recovery tank instead of discharging the rinses directly to the sewer as was done before, most of the product is now recovered for animal food As the table on the next page indicates, about 90% of the rinse water is reused and approximately 75,000 pounds of dairy solids and butterfat are recovered annually A recovery tank was also installed for the Raw CIP System, to hold recovered product from product lines that carry unpasteurized milk after it arrives from the dairy farm This recovered product is also used for animal food The table on the next page details the material diverted from the wastestream annually at Maola, as reported by Bullard, et al (1988)

MATERIAL DIVERTED FROM THE WASTE STREAM ANNUALLY

		Recovered Material (lb)	Butterfat	Dairy Solids
HTST Rinse	(%)		1 4	8
(Reused)	(lb)	939,120	13,148	61,981
	($)		18,802	23,555
Other Reusable Material	(%)		3 5	12 5
(Presently Diverted to	(lb)	245,960	8,644	22,136
Animal Feed, Value Shown	($)		12,361	8,412
for Reuse)				
Ice Cream Plant	(%)		8	32
(Recovered and Reused	(lb)	117,000	9,360	28,080
Material)	($)		13,385	10,670
Unreusable Waste	(%)		0 5	4
(Animal Feed)	(lb)	804,960	4,025	28,174
	($)		0	0

Source Bullard, et al, 1988

NOTES

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Raleigh NC 27695
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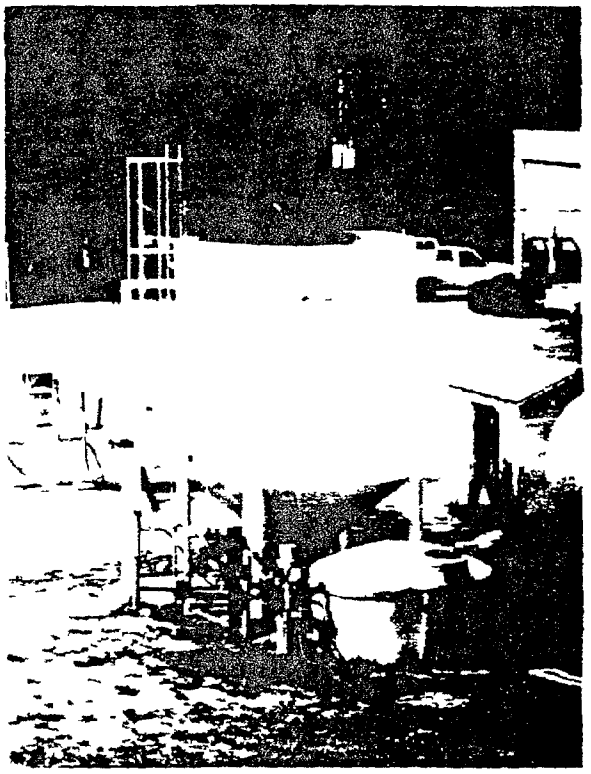
- "Detailed Plans for the Reduction In Waste Load from a Dairy and Ice Cream Plant", by R Carawan, J Rushing and R. Bullard Feb 1987

MOUNT DORA GROWERS COOPERATIVE
MOUNT DORA, FLORIDA

Reuse of Washwater for a Fresh Citrus Packinghouse

The Mount Dora Growers Cooperative represents 46 citrus growers in central Florida The Cooperative s packinghouse which has been a landmark in the city of Mount Dora for almost 75 years, is where oranges grapefruits and tangerines are cleaned and prepared for shipment to out-of-state retail outlets



In 1988, the Cooperative became concerned with the amount of wastewater it generated On a typical day, the Cooperative generated 10 000 to 20,000 gallons of wastewater With the assistance of Boyle Engineering Corporation, the Cooperative has installed (December 1990) a water pretreatment and reuse system that enables the packinghouse to reclaim and reuse their water 20 to 40 times over The resulting daily water savings can exceed as much as 19 000 gallons

Waste washwater is generated from a number of operations conducted at the packinghouse including detergent washing, disinfection waxing, and coloring The chemicals used in these citrus prep operations are listed on the next page

The fruit is first disinfected with a chlorinated water spray and then washed with detergents and wetting agents to remove pesticides residuals sooty mold and dirt A soluble red color additive is then applied to accentuate an orange color appearance to the actual yellow, yellow-green color of the fruit The fruit skin is coated with an FDA food grade wax emulsion primarily to seal the porous skin and lessen any dehydration and help prevent spoilage during shipment A fungicide is also added to retard spoilage

The characteristics of the waste water depend on the type of citrus being processed The water generally contains residuals of cleaning chemicals, wax and oil, sand, sooty mold, and fruit debris (navels and leaves) The strength (i e amount of chemical additives used) of the washwater is dependent on the fruit type time of season and the condition of the fruit upon arrival from the groves

The Cooperative had discharged its washwater to the local city waste water treatment plant (WWTP) but switched to alternative means over concerns about the relative strength of the washwater Parameters of primary concern to the city are total Kjeldahl nitrogen (TKN) chemical oxygen demand (COD), total suspended solids (TSS), oil and grease, and copper

TYPICAL CHEMICALS USED AT FRESH CITRUS PACKINGHOUSES

Function	Compounds
Disinfection	Chlorine
pH Buffer	Potassium Hydroxide Sodium Hydroxide
Mold Stripper	Glycol Ether Naphthalene Sulfanate Phenol
Detergent/Wetting Agents	Non Ionic Surfactant Polyphosphate Orthophenyl phenol
Wax	Ammoniated Wood Resin Shellac
Fungicide	Thiabendazole
Color (Early Fruit)	FDA Red Dye #2 Surfactants Pine Oil
Canker Control	Ammonium Chloride Quaternary Ammonia EDTA
Other	Traces of Grove-Applied Pesticide/Herbicide/Fungicide

Source Melear and Bouch 1990

Source Melear & Bouch 1990

The Cooperative contracted Boyle Engineering Corporation of Orlando, to evaluate pretreatment options for the Coop s combined washwater flow, which ranged from 10,000 - 20 000 gpd

The pretreatment option chosen was a coagulation, flocculation, and primary sedimentation system The pretreatment system, which was started in October of 1988, consisted of three primary components a 10,000 gallon clarifier (see photo, on preceeding page), a septic tank, and a drain field The performance, based on the average of five monthly composite samples collected between December 1988 and April 1989, is shown below

The modified septic tank system, which serves as an aerobic digester and sludge thickener receives sludge 2-4 times a day Supernatant overflows to a drain field, stabilized solids are removed periodically and are applied to a local citrus grove owned by the Cooperative

The reuse system was developed in conjunction with the pretreatment system and created a clean technology that allows reclaimed water to be reused approximately 20 40 times before being replaced The system includes a 1,100 gallon polypropylene reservoir (see photo, preceeding page), a two HP recirculation pump, a canister filter with a removable micro-mesh cartridge element, and a chlorinator A flow diagram of the Cooperative s washwater reuse facilities is shown on next page

The effluent drains by gravity into the reservoir, which provides adequate contact time for chlorination (in accordance with State regulations - Chapter 17-610, F A C) Chlorination also minimizes algae growth in the reuse system If necessary make-up water is added to the reservoir from the potable water system A surfactant is used periodically to reduce foaming that is caused by the color-add process for early season oranges

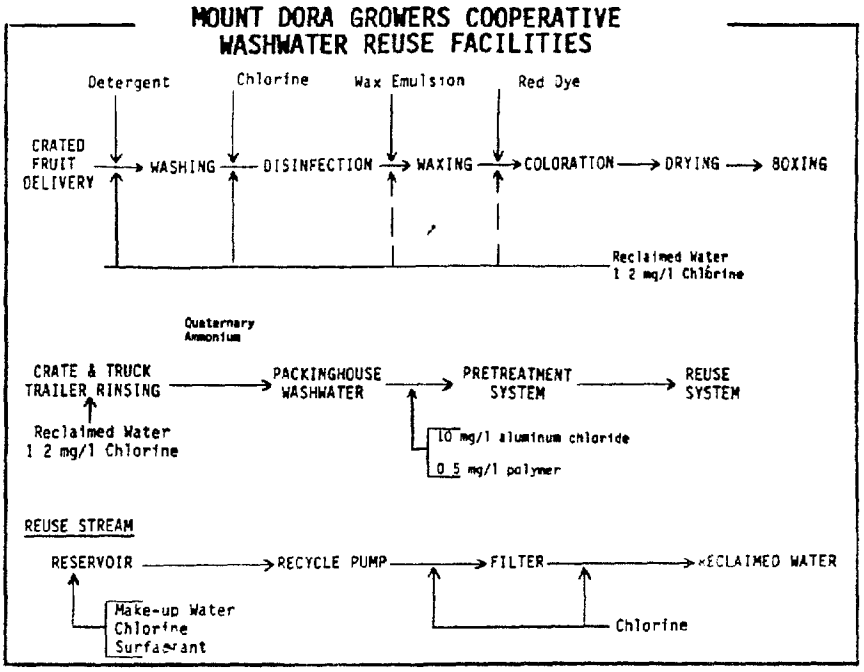
Four reported benefits of the new pretreatment and reuse system are 1) water conservation, 2) compliance with water restrictions, 3) use of a viable disposal method and, 4) lower operating costs

PRETREATMENT PERFORMANCE

Parameter	Removal (%)
TSS	78
COD	60
BOD	50
TKN	49
TP	63
Copper	61
Oil & Grease	60

The capital cost of the pretreatment system was approximately $15 000, and $5,000 for the reuse system Annual operating cost are approximately $8 000 The plant Cooperative spends less than 1 1/2 hours each day on facility operation

In the citrus growing areas of Florida water and sewer charges are currently $2 00 - $5 00 per thousand gallons and are expected to significantly increase in the future Based on figures accumulated since



Note Dashed ( ) lines indicate processes (i e coloration) which are not conducted on late season fruit.
Source Melear and Bouch 1990

system start up, the Cooperative has estimated a reduction of total water usage and sewer disposal costs from $750/month to $25/month Although there are added chemical purchase costs of approximately $150/month, the Cooperative estimates that it will recover initial capital costs within 2-3 growing seasons

NOTES

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