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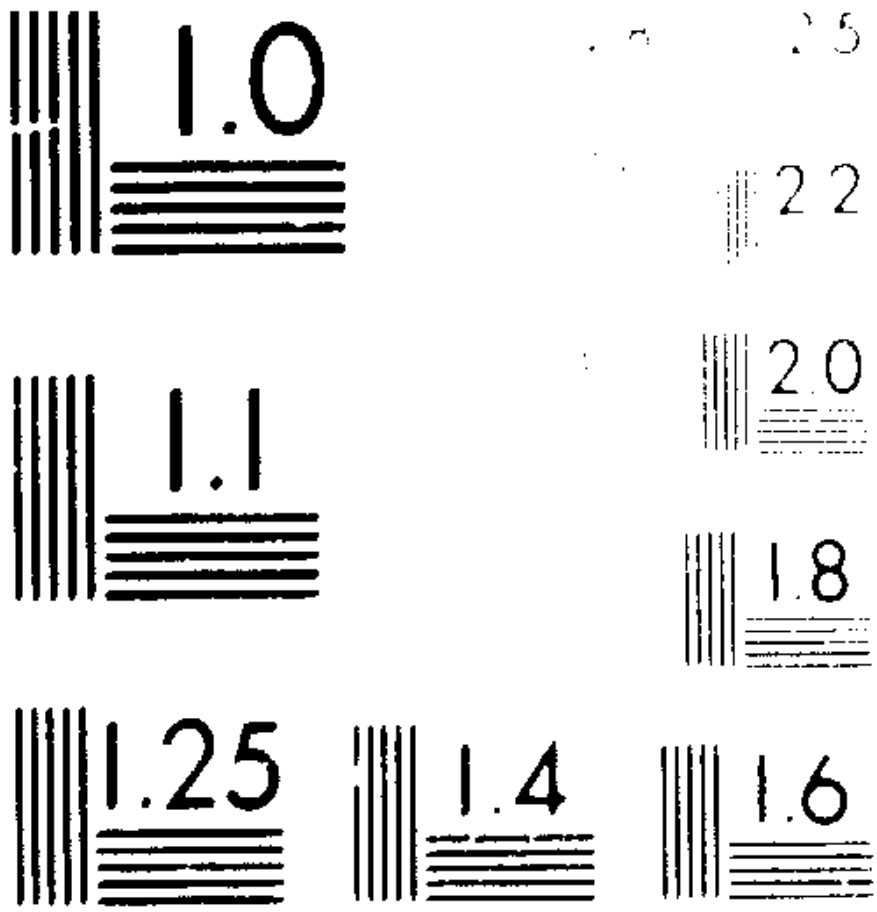
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Draft report on industrial water pollution control in Hong Kong.

DRAFT REPORT TO UNIDO

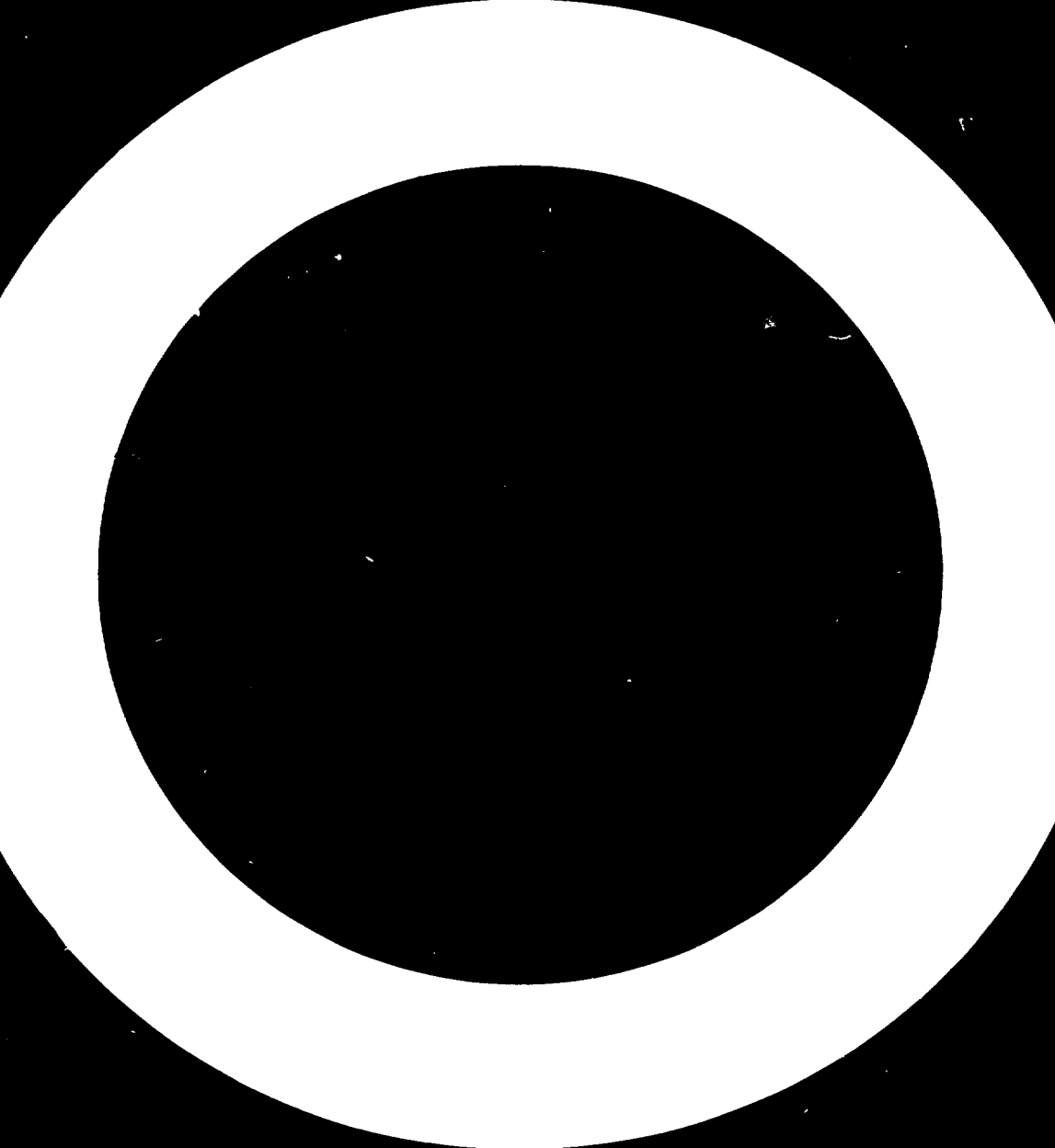
UNIDO, VIENNA, AUSTRIA
A-1400

DP/ HOK/ 80/ 11-51/ 32.1 J for UNIDO VIENNA - AUSTRIA

BY

DR. NELSON LEONARD NEMEROW, WATER POLLUTION CONTROL EXPERT, ADVISOR

JULY 5, 1982



Brief Introduction

The Hong Kong Productivity Centre is divided into seven (7) divisions; Industrial Development, Information Services, Computer Services, Management Consultancy, Technology/Metal, and Electronics. The Environmental Services Unit is attached to the Industrial Development Division and is housed in the Wing On Centre. The Freder Centre houses the Labotatories as well as the Metal and Electronics Division. The Head Office is in the Sincere Building and the Bank Centre contains the Information Services Division. The current roster of personnel of the H.K.P.C. is attached to this Report in Appendix A.

The aims and objects of the Hong Kong Productivity Council - which was established by Government statute in January 1967 - are as follows:

(a) to promote the increase in productivity of industry in Hong Kong and to encourage the more efficient utilization of resources therein;

(b) to consider matters affecting the productivity of industry in Hong Kong;

(c) to advise the Governor concerning the productivity of industry in Hong Kong and measure design to increase it;

(d) to establish and maintain a Productivity Centre.

This UNIDO consultant was enployed to assist the Hong Kong Productivity Centre as an expert in water pollution control. More specially, he was expected to assist the Centre in enhancing its value and services to the industries of Hong Kong in abating water pollution. To accomplish this mission it was necessary for this consultant to review the technical expertise of the Centre in pollution control, read and evaluate Project Reports, visit certain typical industrial plants, advise staff on specifications and areas of concern; and give some seminars on industrial waste treatment.

Details of these activities follow in this Report.

Acknowledgement

The facilities and freedom of activities provided by Dr. Peter D. Bentley, Manager of the Industrial Development Division are acknowledged with thanks by this consultant. The cooperation, individual attention, and daily assistance of Mr. Henry Chiu were invaluable in enhancing every effort made by this consultant and his secretary-wife. Without Mr. Chiu's understanding and helpfulness such an extensive and comprehensive study would not have been possible.

Brief Summary

This consultant expended every effort to assist the Environmental Services Unit of the Division of Industrial Development of the Hong Kong Productivity Centre. This was accomplished primarily by meetings, seminars, conferences, plant visits and informal discussions. The pollutions problems of Hong Kong are unique as a direct result of the type of industry (relatively small and non-integrated product-wise), the lack of land area for expanison or waste treatment, the relatively low unit margin of profit of the polluting industries, and the absence of public understanding or awareness of the environmental impact of the wastes of industry on humans and flora and fauna of our fragile environmental. Because of these unique problems this consultant stressed utilizing innovative, non-conventional, methods of abating industrial contaminants. Many such methods were discussed in some detail during the six week stay in Hong Kong. The use of such non-conventional methods should be reviewed and evaluated after some progress has been made in that direction in Hong Kong.

CONTENTS

1- Assessment current technical expertise of the Environmental Control Services Unit of the Hong Kong Productivity Center, and make recommendations for future improvements which may be required.

2- Read and review larger and representative Project Reports and give assessments and evaluations.

3- Visit typical Hong Kong Industrial Plants and evaluate specific Hong Kong problems and operations.

4- Provide Consultancy to the Center on specific problems.

5- Deliver a series of external public Seminars on the latest technical solutions to Industrial Pollution problems.

6- Appendices

DETAILED CONTENTS

1- (A) Assessment of Technical Expertise

(a) personnel and education background

(b) facilities available to Services Unit

1- Freder Center Laboratories

2- Kowloon Information Retrieval and Library

(B) Recommendations for Future Improvement

(a) personnel and qualifications

(b) facilities needed

(c) activities desirable

2- (A) Review of Center's Reports

(a) Shirley (TEXTILE) Report (Background information only)

(b) Tannery at Kam Tin

(c) Effluents from Bleaching and Dyeing Industry in Hong Kong

(d) Junk Bay Inventory of Industrial Processes Part- III

(e) Relocation of Chiap-Hua Comalco & Chiap-Hua Shinko Companies, at Junk Bay.

3- (A) Visit to New Territories Plants

(a) San Miguel Brewery - Beer Plant

(b) Tung Hing Textile Company

(c) Seng Chen Leather Company, Tannery

4- Consultancy to Productivity Center, Hong Kong

(A) Discussion of Project Reports

(B) Visit to the E.P.A.

(C) Evaluating Government Regulations & Guidelines for Environmental Protection

(D) Tour of Hong Kong Polytechnic Institute, Seminar presented and subsequent meeting with Civil Engineering personnel at the Productivity Center included later; continued discussions.

(E) Meeting with Hong Kong University Personnel at Center

(F) Theory and Design of Laboratory Continuous Flow Pilot Plant for the treatment of Industrial Wastewater -- initially Textile Waste. A detailed written plan in theory and designed drawings for a Pilot Treatment Plant for the Center.

(G) Informal meetings with Centre's Administrative Executives.

5- SEMINARS PRESENTED - two seven (7) hour Individual Lectures and one two (2) hour Lectures.

(A) Polytechnic Institute

"TEXTILE WASTES AND TREATMENT"

(B) Productivity Centre's Seminar I

"INDUSTRIAL WATER POLLUTION CONTROL"

(C) Productivity Centre's Seminar II

"INDUSTRIAL WATER POLLUTION CONTROL AND INDUSTRIAL BALANCED COMPLEXES FOR INDUSTRIES AND POLLUTION CONTROL EBIC"

6- APPENDICES

(A) Roster of Personnel of the Centre

(B) Map of Hong Kong and the New Territories

(C) Government Regulations (2) and Effluent Guidelines (1).

(D) Tolo Water Control Zone - Water Quality Objectives

(E) Water Pollution Control Ordinance (Chapter 358) Tolo Harbour and Channel Water Control Zone Statement of Water Quality Objectives

(F) Laboratory and Laboratory Pilot Research Plant System

1 (A) ASSESSMENT OF TECHNICAL EXPERTISE

(a) Personnel and Educated Background

1. Henry Chiu

B.S. in Microbiology, University of Kansas, U.S.A.

M.S. in Public Health, University of California, Berkeley, U.S.A.

5 years experience in the municipal Government of Toronto, Canada Health Department

2 years at Centre

2. C.M. Lin

B.S. in Science, London University, U.K.

M.S. in Mechanical Engineering, Hong Kong University

9 years as Inspector for Labour Department of Hong Kong in air pollution

1 year at Centre

3. K.L. Tsang

B.S. in Chemistry, Chinese University of Hong Kong

M.S. in Environmental Technology, University of London, U.K.

2 years at Centre

4. Sam Cheng

Diploma in Science from Baptist College, Hong Kong

M.S. in Environmental Tech. in Concordia Univeristy, Canada.

2½ years in Information Services Division of Centre

½ year in Services Unit at Centre

5. C.W. Hui

B.S. in Chemical Engineering from University of Aston, U.K.

3½ years in Technical Division of Centre

½ year in Services Unit of Centre

6. Kenneth Wong

B.S. in Electrical Engineering,
Texas A & M University, U.S.A.

M.S. in Atmospheric Science from N.Y.U.
U.S.A.

1 year Field Engineer, Computer Firm

2 years Smoke Inspector in Air Pollution Control Division with Government

½ year in E.P.A.

½ year in Centre

1 (A) (b) Facilities Available to Environmental Services Unit

1- Freder Centre Laboratories

These Centre facilities were visited by this Consultant on May 27, 1982. Two persons are employed here to carry out laboratory analyses of wastewaters.

Maria Pang and Kozena Ko both of whom possess diplomas from Baptists College (4 years) with majors in Biology and minors in Chemistry. This included a one semester course in pollution control. Maria has worked in the laboratory for two years and Kozena for one year.

The laboratories contain two separate rooms - one for housing the sophisticated equipment such as Atomic Absorption and Gas Chromatograph and other (larger) room for more routine general analyses. Equipment for carrying out the following analyses was available: BOD, COD, Solids (suspended, total, and dissolved), pH, turbidity, colour, acidity, alkalinity, heavy metals, complex organic matter such as insecticides, etc. These was a definite lack of facilities and equipment for necessary biological characteristics of wastewaters and receiving waters.

2- Kowloon Informational Services Division

This Centre was visited by this Consultant on May 24, 1982. We met with Mr. C.T. Leung, Senior Consultant.

The Division contains an excellent library of books and journals pertaining to all aspects of industrial technology. Mr. Leung demonstrated the use of the Computer Retrieval System for deriving all publications up to 1981 dealing with

a particular environmental subject. We used the subject of agricultural wastes as an example and found the system general excellent, but lacking in recent information of the textbook type. Mr. Leung spent a "machine time" of 0.145 hours at a printed out cost of $11.45 U.S. in this search. The retrieval system machine cost about $4,000 U.S.

1 - (3) Recommendations for Future Improvement

(a) Personnel and qualifications

Additional Personnel are needed at all three location as follows:

Wing-On Centre Industrial Development Division-Environmental Services Unit

The six A grade staff employees possess Ba chelors degrees and five own Masters Degrees. Three possess basic degrees in science and three in engineering. The science degrees are divided into one in biology, one in microbiology, and the third in chemistry. The engineering degrees are divided into one each of mechanical, electrical, and chemical. Although the masters degree holders possess graduate level knowledge in environmental technology none of the staff prossess either an undergraduate or a graduate degree in the basic and traditional discipline of civil engineering. At least one person with this background and education is needed in the Unit. This will provide additional strength in the areas of open channel hydraulics, water and sewage treatment plant design, soil and transportation mechanics as well as improved conceptual knowledge of municipal government and services.

Freder Centre

The two laboratory scientists are suitably educated in chemical and basic biological sciences. They should be supplemented by a higher level, preferably masters degree holder, scientist who has specific education and training in environmental engineering. Such a person will enable the Centre to initiate treatment projects, design monitoring analyses and techniques, and evaluate laboratory results.

Kowloon Informational Services Centre

Mr. C. T. Leung has more than ten years experience and holds the rank of Senior Consultant; his background and experience is primarily in mechanical engineering. He should be supplemented at the Centre with a person holding a Masters Degree in Environmental Engineering. Such a person could enhance the search for literature specifically related to some area of the environment. This would improve the effectiveness of the E.S.U. in retrieving valuable data on any subject of immediate interest to one of its clients.

(b) Facilities needed

Wing-On Centre

A computation and design room is urgently needed since the six staff members of the Environmental Services Unit are jammed into an area of about 300 square feet. One small conference room is provided for all the units of the Industrial Development Division. The new computation and design room could house the rather extensive and bully texts and design and equipment catalogues currently stored rather randomly on working desks of the staff members. Since conferences are a vital part of the daily activities of the E.S.U., a separate conference room for its use is vital to its future effectiveness.

Freder Centre

Two additional laboratries are needed in light of expected water quality requirements of the E.P.A. and new activities recommended by this consultant. One laboratory of about 300 $ft.^2$ would be used for bacteriological and biological analyses of wastewaters while the other of about 750 ft^2 would serve as a pilot plant research laboratry for continuous flow industrial waster treatment systems.

Kowloon Informational Services Centre

Additional and separate storage facilities are required for environmental texts, journals, and references. Also office space is needed for the new staff member recommended by this consultant.

(c) Activities Desired

The following new activities for the E.S.U. are recommended:

1. Hydraulic and design computations for pilot plants largely a responsibility of the new Wing-On Centre staff member but in consultation with other unit staff personnel.

2. Design, construction, and operation of a laboratory pilot, continuous-flow, industrial waste treatment system.

3. Bacteriological and biological analysis of waste water.

4. Improved specific Environmental Retrievel Service and Consultancy to the E.S.U. at the Kowloon Information Service Centre.

2 - (A) Review of Centre's Reports

(a) Shirley Report

The Shirley Institure Report was done for the Federation of Hong Kong Industries located in the Eldex Industrial Building, 21, MA TAU WEI Road, Hung Hom, Kowloon, Hong Kong. It consisted of a survey of the Hong Kong Textile bleaching, Dyeing, Printing and Finishing Industry. The Client Report was prepared by L.J. Gibson and B.A. Taylor of the Shirley Consulting Group Reference No.21/13/1314 and dated April, 1982.

While Section 3.6 water and waste water is intended to provide general background information about the water and wastewater treatment needs of this industry. it does relate the impression that proper the handling of these wastes in crowded, small plants (as currently located) represents almost an impossibility. Facts are given by the Institute of the space, workforce, water, and wastewater treatment required should such mills be relocated in industrial estates.

(b) Tannery at KAM TIN

Report of a Study on pollution control of Effluents Discharged From a Tannery at KAM TIN. This report was done for the tannery client which has a long history of leather tanning and dressing operations at Yuen Long. It manufactures dressed leather from fresh hides and crust blue leather. The Centre's objective was to recommend the most appropriate effluent treatment systems in order to reduce the pollution loading to acceptable limits before

ultimate discharge. The Centre concluded that both the trickling filter system and the activated sludge system designed by ECCO Engineering Company are technically suitable for treating tannery wastewater. Despite the higher initial cost, the trickling filter system has the advantages (according to the E.S.U.) of being more reliable in performance and less power consumption than the activated sludge system. The Centre prefers this trickling filter system because of the possible increase in the cost of electricity in the future.

This consultant reviewed about three pages of suggestions with the E.S.U. Most of the suggestions were details relating to the tanning and deliming chemicals, recovery of these, sampling properly for true composite analysis, flow measurement, and real comparisons between trickling filter and activated sludge treatment systems.

(c) Effluents from Bleaching and Dyeing Industry in Hong Kong

The Report entitled Environmental Study of Treatment of Effluents Resulting from Bleaching and Dyeing Industry in Hong Kong was sponsored by the ASIAN PRODUCTIVITY ORGANIZATION with headquarters in Tokyo, Japan. It was dated November 1981. Twenty local bleaching and dyeing factories were surveyed and effluent discharge samples were collected for characterization. After characterizing the various types of mills and processes, appropriate treatment systems together with their costs to treat the effluents were proposed to meet the interim coastal waters and stream discharge guidelines issued by the Hong Kong Government. The annual pollution control costs per unit production and expressed as

percentage of dyed goods processing fees are detailed to give an indication of the cost of pollution control required by the factories to meet the interim discharge quideline. To assist local bleaching and dyeing companies in reducing local bleaching and dyeing companies in reducing their pollution control costs, various alternatives of reduction of volume of effluents discharged and some less land-demanding disposal methods applicable to local context are enamined.

This consultant had two pages of comments to the E.S.U. about this Report. They were largely concerned with methods of sampling, color measurement and importance, COD to BOD ratios, ozone's use in removing COD, and effect of conventional municipal waste treatment on textile wastes. Research efforts on a laboratory scale to ascertain actual treatment efficiencies were discussed in some detail.

(d) Junk Bay Inventory of Industrial Processes

The Report entitled Emission Inventory of Industrial Processes in Junk Bay was sponsored by the Hong Kong's Department of Trade, Industry and Customs. The Report describes the manufacturing processes of shipbreaking, steel rolling, and other non-squatter and non-cottage industries in Junk Bay and gives an emission inventory of these industrial processes. The costs of installing pollution control devices are estimated on both data from technical publications and direct price quotes. The Report contains a series of recommendations made to improve pollution control in Junk Bay.

In general, the Reporting is an excellent survey providing sufficient data for follow up when Government regulations and environmental quality levels are established. The only significent comment made by this consultant concerned the steel rolling plants and related to wastewater, oil-water mixtures used in cooling the metal.

(e) Relocation of Chiap-Hua Comaler and Chiap-Hua Shinko Companies at Junk Bay

The Report entitled "Assessment of the engineering and other implications of Relocating the Chiap-Hua Comalco and Chiap-Hua Shinko Companies, Junk Bay was done for the Hong Kong Public Works Department through W.S. Atkins and Partners, an overseas consulting firm. It is dated April 1982. The Centre's contribution to this Report is limited to only Appendix F, "Cost Implications in Meeting Existing and Proposed Pollution Control Standards for both metal finishing plants. The Study considers and evaluates the various strategies for moving and re-establishing the two companies at a new industrial area which will be developed towards the south of the bay. For each of the companies the following three schemes were considered: (1) a complete new works, (2) a relocation of the existing works and (3) an intermediate proposed.

Appendix F represented a major effort in the Report and consisted of almost 50 pages. It was recommended by the E.S.U. that the effluents be treated at a communal treatment system to save chemicals, equipment, land, and construction costs, major comments made by this consultant referred to the quality definition of the industrial effluents rather than a quantity basis which may be preferable for design considerations.

3 (A) Visit to New Territories Plants

(a) San Miguel Brewery

The San Miguel Brewery was visited on June 2, 1982. It is located in the southwestern part of the New Territories (See Appendix B). Our tour through the bottling plant was guided by W.C. Chan, Engineer. The bottling machines are operating at about 500 cans per minute. All raw materials including the cans, grain, malt, hops are imported. Bottles are reclaimed, washed, examined for defects, sterilized and reused. An abnormal amount of solid waste consisting of broken glass, reject cans, plastics, cartons, etc. was observed. Liquid waste arising from leakage of beer during filling, foamed-lubricant of conveyor belts overflow, bottle cleaning water, and condensate from can sterilization were noticed.

The management is planning to expand this production and is in the process of designing new facilities adjacent to the present plant. Production will be somewhat different from the existing one; therefore, it is more difficult to assess pollution load from sampling the present waste. The major difficulty is that a decision must be made about waste treatment required and yet the Government has not yet given any specific waste treatment requirements. Land is at a premium, and rental costs for land is at a premium, and rental costs for land represent a greater percentage of production cost than most other costs. Therefore new plants will tend to locate further offshore where rental costs are less; but waste treatment costs may be higher since more stringent regulations will be in effect in streams than in the harbour.

The cost of a can of San Miguel beer is about $1.70 HK of which about half of which is the materials. The Government also taxes the plant based upon the gallons of beer brewed.

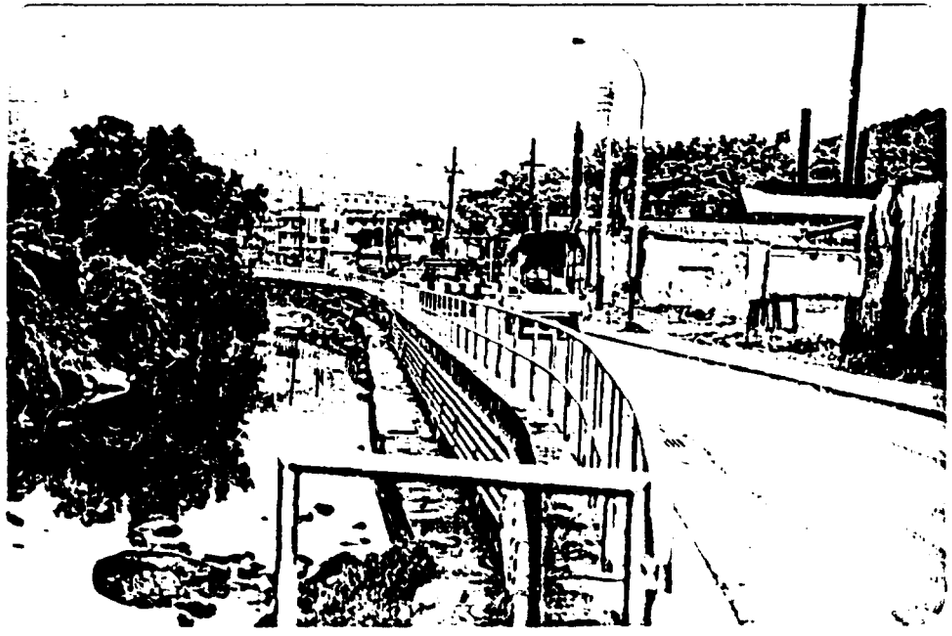
(b) Tung Hing Textile Company

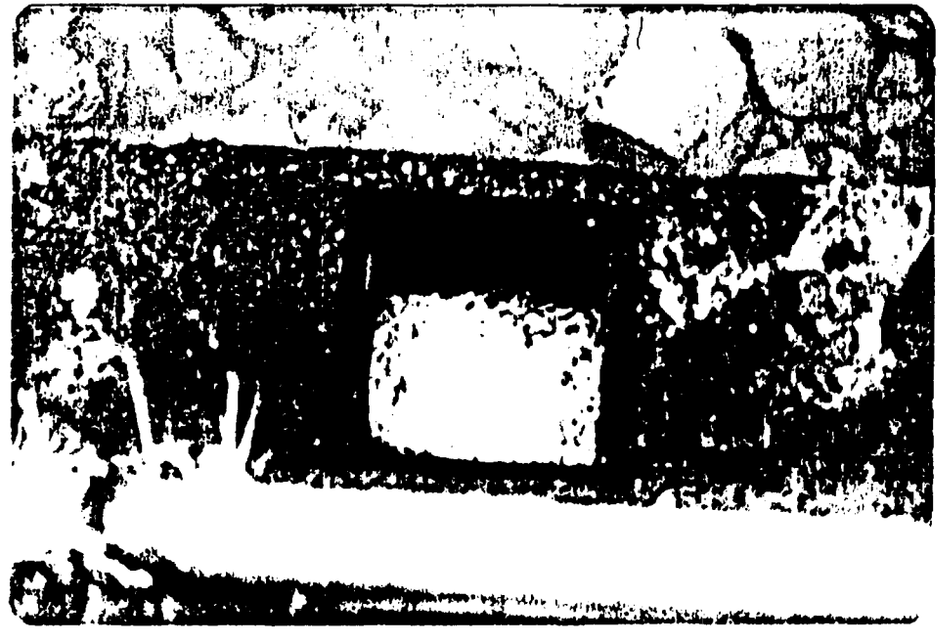
The Tung Hing Textile Company was visited on June 7, 1982. It is located in the SAI KUNG area of southeast New Territories shown as (2) on the map, Appendix B. Mr. Y.O. KAM, the plant owner guided us through his plant. Mr. Kam is very well educated and informed about production problems as well as environmental problems of the textile industries. This mill does all piece dyeing in jigs. Exhausted dyes and wash waters are wasted to the sewer line which leads to HO CHUNG River and carried along to the Bay for further dilution. The Bay water is used for recreation (several hotels and resorts) and fish farming.

Although Mr. Kam may not be typical of the quality of small textile mill owners, his plant represents the type of problem faced by the industry. His profit margin is too small to invest in much capital intensive equipment either for production improvements or waste treatment, even though the potential exists for both as improvements to his operational efficiency. Mr. Kam, for example agrees in principal to the change in boilers and feedwater heating to conserve oil-energy use and to the continuous dyeing machinery or dye bath saving to reduce pollution cost. However, all systems are either too expensive-capitalwise - or untried.

Mr. Kam showed us the adjacent textile dyeing mill which dyes yarns with indigo dyes almost exclusively. This mill saves its exhausted dye bath wasterwater in liquid form in stainless steel drums for reuse in subsequent dyeing operations. This is an indication that, at least in certain situations, dye wastes can be conserved and reused rather than wasted to the river or treated by expensive processes. Mr. Kam agreed that many dyes are stable and will not deteriorate upon storage and can be reused. He also indicated that he would be more receptive to paying the waste treatment costs if all textile mills in Hong Kong were required to do so. Competition

OUTSIDE TUNG HING TEXTILE MILL





Dr. Nemerow - H. Chiu

now is keen from TAIWAN, KOREA and CHINA because of lower labor costs in these developing countries. He pays fair wages in keeping with the standard of living in Hong Kong.

3 (c) SENG CHAN TANNERY

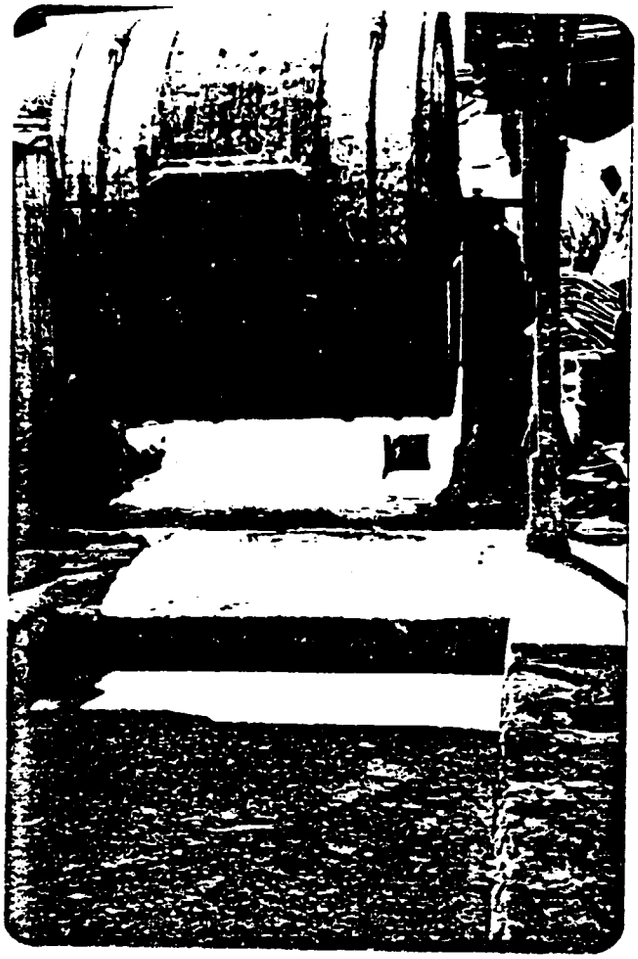
The Seng Chan leather plant was visited on June 16, 1982. It is located in Northwest part of the New Territories in the Yuen Long District and close to KAM TIN. The small stream receiving the wastewater from this plant leads rather quickly into DEEP BAY (See Appendix B, (3)). Our visit through the plant was guided by S.M. FAN.

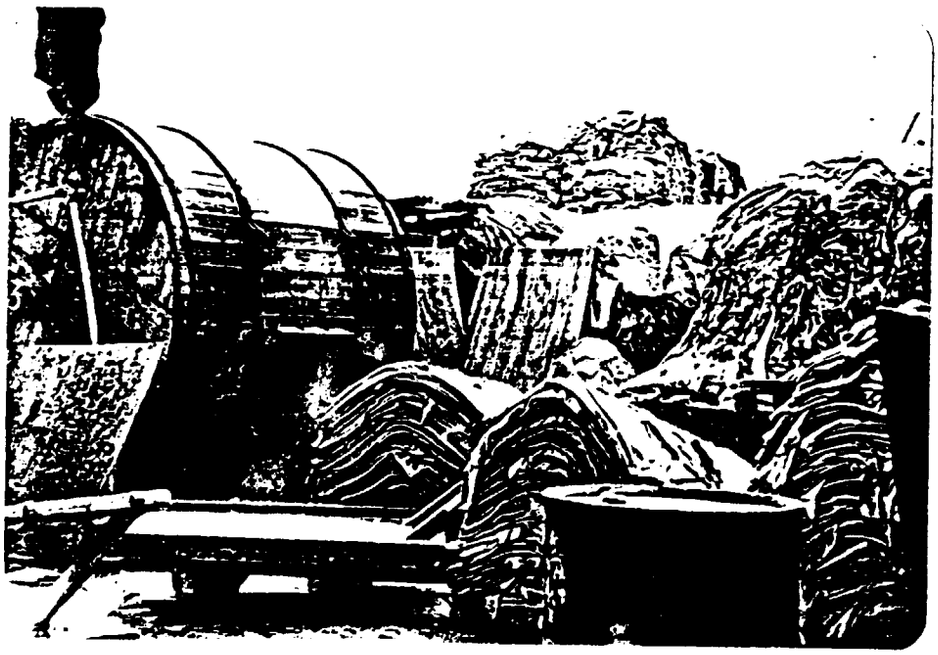
The plant imports 4 to 5,000 salted hides per month, generally from Australia and some from the United States. The are beamed and tanned in drums, but not cut or finished further, but sold directly to Hong Kong glove manufacturers for cutting, sewing, and marketing.

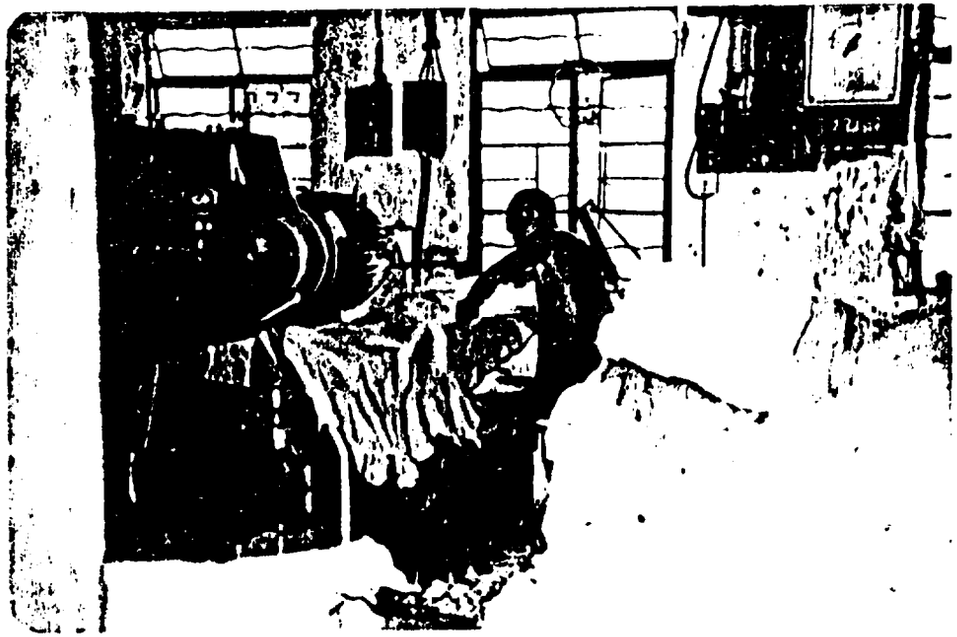
This tannery does not treat any waste or recover any sulfide or chromium, fleshings, or blue hide shavings (See photograph of shavings and this consultant).

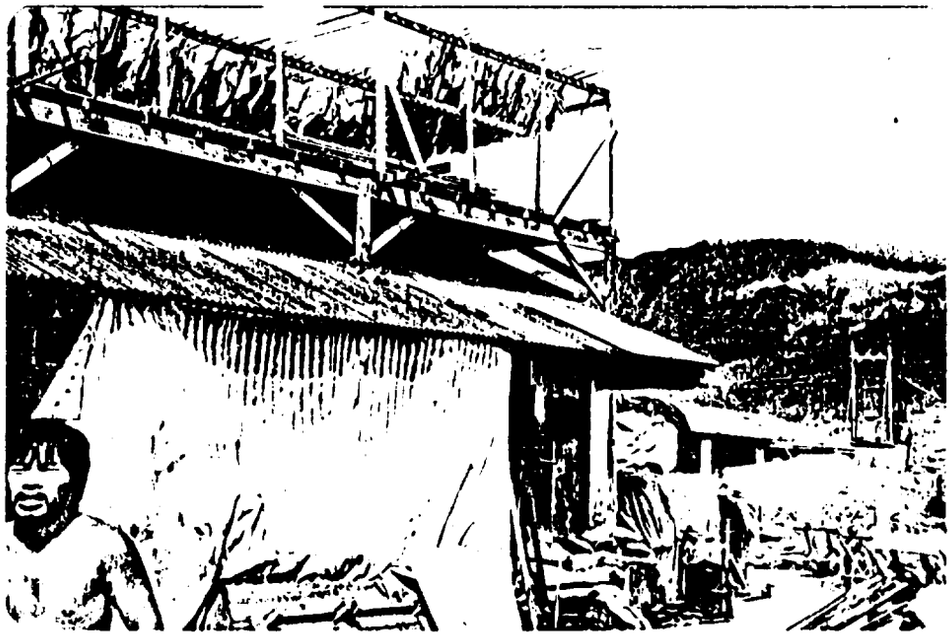
Solid wastes are hauled away; liquid wastes are discharged directly into the samll stream leading through housing areas to Deep Bay. There appears to be little chance for improvements at this plant. However, the whole operation is expected to change and be relocated to another facility.

SENG CHAN LEATHER FACTORY









4- CONSULTANCY TO HONG KONG PRODUCTIVITY CENTRE

(A) Discussion of Project Reports

Separate discussion sessions were held at the Centre with Messrs. Chiu and Tsang on each of the E.S.U.'s Reports listed in Section 2 of this Consultant's Report . Most of the pertinent points of these discussions have been mentioned in Section 2. The object of these discussions was to make suggestions to the E.S.U. for improvement of their Reports in the future. Suggestions can be classed in two types (1) general, pertaining to format and content and (2) specific, pertaining to technical details included within each Report. These discussions were conducted as a "give-and-take" learning affair for the E.S.U. people.

(B) Visit to the E.P.A.

This consultant met with Mr. Paul Holmes who is in charge of the Water Qualtiy Management Group of the Hong Kong Environmental Protection Agency. Mr. Holmes possess a geology background in education and many years experience serving on the Yorkshire Water Authority in England. He appeared to have a good understanding of water quality objectives and criteria and the constraints of establishing proper guidelines in Hong Kong although he has been on this job for only about six months. He plans upon setting a flexible guideline system and has already identified ten (10) zones of which one (1) has already been gazetted (the Tolo Harbour). The E.P.A. - in the official publication of this Tolo Water Quality Zone - included in this Report as Appendix D, has proposed six beneficial uses in the Tolo Harbour Subzone; two uses in the Tolo Buffer Subzone; and one other in the Tolo Channel Subzone. E.P.A is recommending Water Quality Objectives to protect these beneficial uses identified for the 3 subzones (see Appendix D). Tolo Harbour was selected as the first to come under the new control because of its vulnerability to contaminants and because it contains the Tai Po Industrial Estate. E.P.A. includes ten (10) water quality objectives for main

of the subzones of the Harbour. They can be found in detail in Appendix E. Briefly, these objectives include the (1) aesthetic appearance (odors, colours and visible matter) applying equally to all 3 subzones, (2) bacteria also applying equally to all 3 subzones, (3) chlorophyll-A applying in varying concentrations in each of the three subzones from 20 to 6 mgs per cubic metre, (4) dissolved oxygen also varying in allowable concentrations form 2 to 4 mgs/liter depending upon the harbour subzone and the depth of the water, (5) light penetration varying from 20 to 10 percent of the normal level of light transmission depending on the subzone, (6) pH varying in allowable extension of the value from ± 0.5 units to ± 0.1 units caused by the waste discharge, (7) salinity not extended more than ± 3 ppt at any time in any of the 3 subzones, (8) settleable material shall not be allowed in any of the subzones such that it will give rise to bottom deposits which adversely influence bottom-living communities or affect any other beneficial use of the waters, (9) temperature extensions of greater than ± 1.0 degree Celsius caused by waste discharges in any of the subzones and also at rates of temperature change of greater than 0.5 degree Celsius per hour at any location and (10) toxicants which result in significant effects in humans, fish or any other aquatic organisms from wastes are not allowed in any subzones. Due regard is also given to toxicants which possess a biological cummulative effect in food chains and to inter-actions between toxicants.

E.P.A. will declare a first and second appointed day. The first appointed day (expected in late 1982) will delineate existing discharges-volumes and character. The second appointed day (expected one year later) will be the time which all exemptions must be notified by E.P.A. and thereafter licenses for each discharge must be granted. In order for an industrial plant to be exempted from licensure it must submit in writing with adequate proof that the flow and character had been established. Thereafter the plant will be allowed up to a "30 percent increase" in pollution. Those industrial plants not exempted must be licensed by the E.P.A. Decisions made by EPA on the details

of any license will be based largely on a Mathematical Model Study currently being made for EPA to predict the assimilative capacity of the Harbour. EPA expects to be able to control new sources of pollution by licensing better than older sources exempted by the legislation.

It should be noted by the reader that EPA plans on basing water quality objectives upon the receiving water quality and not directly on the concentration of contaminants in the effluents. Therefore, decisions of discharge limits in the license will be made on the water resource. This procedure should be applauded. It is appropriate and equitable even though it may be more difficult to administer.

(C) Evaluating Government Regulations and Guidelines for Environmental Protection

Two Government Regulations were given to this Consultant for review and one guideline as follows:

Regulations

1- Water Pollution Control Bill 1980 enacted July 1980

2- Waste Disposal Bill 1979 e :cted April 1980

and

Guidelines

1- Proposed effluent guidelines for coastal wasters, streams, and into sewers 10 pgs.

These documents are included with this Report in Appendix C. The regulations are quite general and essentially "lay the groundwork" for subsequent legislation setting forth specific guidelines and water quality criteria for the various best uses of the receiving waters. The Water Pollution Control Bill is divided into the following eight parts 1-preliminary 2-water control zones and water quality objectives 3- Prohibited Discharges and Deposits 4-Exemption of Existing Discharges and Deposits 5-Licensing of Discharges and Deposits 6-Appeals 7-Process of Enforcement 8-Miscellaneous.

The Waste Disposal Bill of 1979 is another very general regulatory bill for the collection and disposal of solid wastes. This general legislation is divided into seven parts as follows 1-preliminary 2-waste disposal plan 3- collection of wastes 4-disposal of waste 5-licences 6-appeals and 7-miscellaneous. It, too, is intended to provide basic and underlaying legislation for future more specific legislation.

The proposed effluent guidelines content separate details for each of the following discharges into: 1-coastal waters 2-streams and 3-sewers. The proposed guideline for discharges to streams do not apply to streams within the waterworks catchment areas. They apply only to new discharges. The guidelines cover most of the parameters normallly encountered, but are not exhaustive.

The guidelines for discharge into coastal waters are influenced by (a) discharges of greater than 100 m^3/day (b) these larger volumes and located between 1 and 3 km from any beach and desalter intakes and (c) all volumes when located within 1 km from any beach or desalter intakes. For example, BOD guidelines meeting one of the above criteria will be limited to 20 mg/ℓ or less while those exlcuded from the above would be 500 mg/ℓ. The reader is referred to Appendix C for limits on each contaminant.

For dischargesinto streams the guidelines are influenced by the presence of waterworks catchment areas, downstream for potable water supply with boiling or chlorination either directly or through shallow wells. For example, COD will be less than 80 mg/ℓ when constrained by the above definitions but raised to less than 200 mg/ℓ when not covered by these same criteria.

For discharges into sewers the guideline depends upon flows greater than 100 m^3/day and location in the Tai Po Industrial Estate. For example, in the first case BOD will be lss than 1000 mg/ℓ while 2000 mg/ℓ will be allowed if the flow is less than 100 m^3/d, but only less than 300 mg/ℓ will be permitted in the industrial estate.

4- (D) Tour of Hong Kong Polytechnic Institute, Seminar, and Discussion with Civil Engineering Faculty at the HKPC

On June 3, 1982 this Consultant visited the Hong Kong Polytechnic Institute, delivered a lecture on textile wastes and treatment during the morning, and toured the Education Technology Unit and Institute Industrial Centre. Subsequent to this on June 22, 1982 two members of Polytechnic's Civil Engineering Department visited this Consultant at the Centre for a discussion on academic matters.

On the June 3rd venture we were guided by Fred Mack and Dr. Daniel Lau of the Institute's Centre of Environmental Studies. The Seminar Lecture prepared and delivered by this Consultant was taped and later transcribed and typed by Joan B. Nemerow, secretery and wife of this Consultant. The Lecture is included in this Report as Appendix 5 (A).

Dr. Lau appears highly-qualified academically and is very aggressively seeking to set up a degree-granting program in environmental engineering. Two important activities were observed in some detail (1) Education Technology Unit headed by Barry Hutchison who described his operation and (2) Industrial Centre headed by D.V. Lindsay who also described his Centre's policy and procedures. These two facilities greatly enhance the Centre of Environmental Studies 's ability to do research and educate students. The latter Centre appears to be rather obviously independent of the Civil Engineering Department of the Polytechnic Institute although located on the same campus.

This Consultant was also visited by Mr. Wong See Hoi and Mabel Mac, Assistant Lecturer and Lecturer, respectively, of the Civil Engineering Department of the Polytechnic Institute. Considerable time and discussion ensued concerning the academic program at the Institute in Environmental Engineering. This program - now seven years old-presently gives a High Diploma in Civil Engineering or Structural Engineering. Next year they plan on also offering the same diploma in Geotechnics and Municipal Engineering. In two years they expect to be permitted to give a certified Bachelor of Science Degree in Civil Engineering. In addition to Mr. Wong two other senior lecturers, Stuart Traynor and S.L. Tang are involved in the Environmental Engineering academic area. They declared that their mission at the Institute is essentially an academic one as differentiated from the Coordinating mission of the Centre of the Environmental Studies

Initial cooperation between the Civil Engineering Department of the Institute and the Hong Kong Productivity Centre will take the form of an exchange of speakers for Seminars.

4- (E) Meeting with Hong Kong University Personnel at Centre

Dr. H.W. Lee, Lecturer in Environmental Engineering of the Department if Civil Engineering at the University of Hong Kong conferred with this Consultant at the Productivity Centre on June 24, 1982. He described the curriculum at the University which is at present 3 years old. Dr. Lee, whose entire educational background is in the fluid mechanics area at Massachusetts Institute of Technology of the U.S.A., has been "thrust" into the environmental area along with two or three faculty at the University. He is very engrossed and enthralled with this field, but described a major problem in which they urgently need assistance. That problem involves motivating the Civil Engineering Students towards the discipline of environmental engineering. This Consultant suggested several solutions to this problem; and discussed other possibilies with Dr. Lee. Their curriculum needs improvement especially in the environmental area and especially at the higher (senior) level. His survey-type course in the Junior year also needs modification to make it more meaningful and challenging to the students.

Also discussed briefly were the problems involved in stream modeling with special reference to the Chaugpoo River near Shanghai, China and Tolo Harbour in the New Territories. This Consultant offered advice on pollution indexing of such watercourses and on inputs to river models.

4- (F) Theory and Design of Laboratory Continuous Flow Pilot Plant for the Treatment of Industrial Wastes

During the course of this Consultant's stay in Hong Kong the Hong Kong Productivity Centre's Environmental Services Unit requested assistance in any area of additional service to its clients. This Consultant recommended laboratory pilot plant research - and initially on textile dye and finishing waste.

Several days were spent during these period explaining the theory of design of wastewater treatment units and in actually designing a small scale laboratory continuous flow system for textile waste treatment. The general set up of a new labotatory and bench set ups were also designed. The details of the new laboratory benches, and continuous flow treatment system are given in this Report in Appendix F.

The system is designed to treat a average flow of 2.5 gallons per day of textile finishing waste containing about 630 ppm of BOD. The system is so complete (tertiary type) and so flexible that it may be able to produce a colourless, odorless, effluent with less than 25 ppm BOD and Suspended Solids. The object of the system is to verify treatability or treatment efficiency under a variety of loadings and sequence of treatments. Final construction design and/or field pilot plant design can also be ascertained for definite capital costs.

4(G) Informal Meeting with Centre's Administrative Executives

The Consultant and his Secretary-wife joined Dr. Peter Bentley to visit the Administrative headquarters of the Hong Kong Productivity Centre on June 29, 1982. They met and conferred for some time with S. K. Chan, Executive Director and Donald Taylor, Technical Director.

The future potential of industrial pollution control in Hong Kong was the main topic of discussion. Special emphasis was given to the part the Centre could play in abating industrial pollution. This consultant stressed the importance to the Centre of developing a competent team of Environmental Engineers with incentives and abilities to derive innovative, cost-effective solutions to industries' waste problems.

Advanced education in industrial waste treatment is needed by the Centre's scientists and engineers to cope with the unique problems of Hong Kong. Pilot plant laboratory research should be instigated immediately to assist competent staff in defining optimum design criteria for new treatment systems. Inspired thinking and planning is required to produce innovative treatment solutions. This means that the Centre's technical people must have the incentive to utilize other than conventional treatment solutions.

Ways of creating personnel with incentives to accept the challenges of unusual solutions to industry's waste problems were discussed by all present at this meeting. Rewards such as monetary bonuses and sponsorship of Ph. D. education in this discipline were suggested as possibilities.

It was obvious to this consultant that some of his ideas and opinions about Hong Kong's industrial pollution problems were new and suprising to the Administrators. This consultant was left with the impression that the Centre was eager to begin developing expertise in the field of environmental quality control.

5. SEMINARS PRESENTED - two seven (7) hour Individual Lectures and one two (2) hour Lectures.

(A) Polytechnic Institute

"TEXTILE WASTES AND TREATMENT"

(B) Productivity Centre's Seminar I

"INDUSTRIAL WATER POLLUTION CONTROL"

(C) Productivity Centre's Seminar II

"INDUSTRIAL WATER POLLUTION CONTROL AND INDUSTRIAL BALANCED COMPLEXES FOR INDUSTRIES AND POLLUTION CONTROL EBIC"

5(A) Seminar at the Polytechnical Institute - Hong Kong
FOR THE HONG KONG PRODUCTIVITY CENTER

By Dr. Nelson L. Nemerow, Professor - Advisor, UNIDO EXPERT
University of Miami, Coral Gables, Florida U.S.A.

" SEMINAR ON TREATMENT AND DISPOSAL OF INDUSTRIAL TEXTILE WASTEWATERS."

"Thank you very much for the kind introduction, I appreciate it, and it is my pleasure to be here to talk to you about a subject which is close to my heart,for a longer period probably than you are living. I'm not that old,but I have been interested in this subject for a long time. This is my first official business trip to Hong Kong, and I had hoped to visit a Textile Mill in Hong Kong before I came to talk to you today, but because of the floods I was not able to get to a Textile Mill on time, and so I'll be talking to you today about my experiences in Industrial Waste Treatment, and especially about Textile Waste treatment outside of Hong Kong. I have had a chance to read a few reports about the textile industry in Hong Kong, so I am not entirely unfamiliar with the problems that exist in Hong Kong. A few words before I start about education in this field of Industrial Waste Treatment. It's a long and difficult educational program if you study correctly. It takes a long time to become highly qualified to become what we call in some parts of the Western World, an"Environmental Engineer." It takes a long time because you have to be an Engineer, you have to be a Chemist,and you have to be a Biologist. And to be anyone of the three is enough of an accomplishment.but to be all three, is almost"super-human." It is very difficult for any Environmental Engineer to be equally qualified in all three areas. However, you have to be at least knowledgeable in all three areas. You have to be a knowledgeable Chemist,Biologist, and Engineer. So you have to start thinking now how you are going to accomplish that.We have had many people study Chemistry first, and become a graduate Chemist, and then work into Environmental Engineering and take some Biology at the same time before they finish. We've had other people start in Biology , actually receive a degree in Bacteriology or Microbology and then suddenly decide that they wanted to be Environmental Engineers, so we have to build on the Chemistry and the Engineering. Most common, is the Engineer who takes Civil Engineering or Chemical Engineering and becomes a Graduate Engineer and then decides to follow the environmental engineering course and has to go back and get the Chemistry and the Biology. Most of the program then has to be filled with Chemistry and Biology. It's very difficult and long, but the sooner you plan an educational program, the better qualified you will be when you complete the program and the better able you will be to understand the program. Mr. Low told

you my background started in Chemical Engineering. When I took Chemical Engineering, I had no idea I was going to be and Environmental Engineer. But when I got out and saw the environmental consequences of the Chemical Industry, I decided that I wanted to become an environmental engineer.to help preserve the environment. The environment is very fragile and very limited. Only you know that perhaps better than I do. There's a limited resource of everything in the world available, including educational facilities. You know how difficult it is to enter into the Polytechnical and the same is true of how much water you have to supply the people, how much water pollution carrying capacity exists. It's limited! The challenge is going to you people of how to stretch that limit, how to make more resource available for more production and more people. It is a very difficult challenge,and everybody in the world,be it Hong Kong or Miami, Florida,where I come from, the same challenge exists, and it doesn't matter if the industry in Hong Kong says they don't want to build waste treatment plants, or if the industry in Miami,Florida says they don't want to build treatment plants, they are going to have to. do something, or we, none of us will survive. Everyone will have to something to contribute to preserve our limited water resources, and conserve water. So with that pre-amble, I will tell you I have one copy of a new bulletin describing the University of Miami Ph.D.and Master of [illegible] rogram. If you would like to take a look at it and see how the [illegible] and how the program can possibly be adapted to your interest and [illegible]r studies, the type of graduate programs available, you are welcome to look at it. Also, there are some cards here for those interested in contacting me later, in English and Japanese with my name and address. Unfortunately, I haven't had time to get cards made here yet, we might still-- but I stopped in Toyko on the way here, and they gave me a box of cards in English and Japanese in case you question this. A last item that is up here is my last textbook in Industrial Water Pollution, Industrial Waste Disposal. This was published in 1978, as Low said, and in the last 4 years many changes have taken place. This is the third edition really-- they all have different titles,but the third edition since 1963 when the first edition came out, the subject has changed so much and so fast, it's such a dynamic field, that you have to stay up with the latest improvements and inovations in the field. I don't know if you can all see the beautiful painting on the Cover -- but my wife who is sitting very quietly in the back of the room, and is my secretary, did the Artwork, she did the painting on the cover.She travels with me all over the world, Paints, takes notes, types, and makes sure that I say the right things to you.

You are welcome once again to look through this any time you are interested. I have picked one chapter here before I came to Hong Kong. I didn't know you were going to request me to talk to you about textile waste specifically. I had planned some other lectures, but since you are so interested in textile waste,I prepared this short discussion with you this morning on the treatment of Textile waste, and some of the material I am going to present, is new, it doesn't appear in the book, some of it was created at the Hong Kong Productivity Center during the last week or so when I knew I was going to talk to you, so it ought to be interesting to you, and it was interesting to me as well to prepare it for you. I'd like to define Pollution before we start, and for you to keep this in the back of your minds; everybody thinks they know what pollution is. Many of my students think they know until they get long into the subject material, but I'm going to define it as, "too much", or an excessive amount of contamination such that the water resource or even the air resource, or the land resource is not able to assimilate that contamination for its best use period. Now think back on what I define pollution as, TOO MUCH. In other words, pollution is a state of having too much of a given contaminant. Just because you have BOD or color, or a low pH in the water doesn't mean that it's polluted. All water,air, land can take some pollution. Just like every Boxer can take a few punches, but too many punches and the fighter is "polluted",or he's knocked out. So will the river take all kinds of contamination to a certain degree. Now, not all fighters can take the same amount of punches, right? Not all rivers can take the same amount of contaminants. Why not? Because some rivers are used to grow fish, some are used to provide drinking water. Some rivers are just for bathing, some only for irrigation, some just for power. So it depends not only on the contaminant, but on the usage of the river. So you have some key words in the definition of pollution. What are they? Excessive, Too Much, Contaminants; and contaminants are all types, and the third critical word is the best usage. So when you want to determine whether the Pearl River is polluted, what do you have to do? You have to find out how much contaminants are present, analyze for all the contaminants in there, then you have to find out what best and highest usage is made ofthe river or is potentially going to be made of the river or water resource, highest quality,then you determine what quality that water has to be to maintain that high usage, and then you determine whether the contaminant is too much or suitable.If it is too much, it is then in a state of being Polluted.So

we are going to talk today about an Industry, the textile industry which is known-- it has a great reputation, if you will,for contributing contaminants which could, could be contributing pollution, but we do know that the textile industry contributes contaminants, regardless of what happens whether there's any pollution or not, the textile industry contributes contaminants to the water, that's what we're going to talk about;today's water primarily not air,or solid waste,or land pollution, for they exist as well. Today we're going to talk about"water pollution." The textile industry in U.S. is about the fourth largest user of all the industrial water consumed by industry. Paper industry,oil refineries, steel industry use more water. But the textile industries in U.S.,probably in Hong Kong too,uses a great percentage of the amount of industrial water, and therefore anything they put in that water is what? Contaminant , not Pollutant,-- not pollution, and we're going to study those contaminants today and decide then if they are excessive for the water use, then we're going to have to do something about it, we're going to have to treat it. But the first thing we have to look at are the different processes which could produce those contaminants,and I don't know how much background each of you has in the textile industry. I won't take too long ; they're all available in my textbook starting on Page 310, any of you interested, you can read up on it, I don't know if there's a copy in the library here, however, I am leaving this copy with Mr. Chiu at the Productivity Center, and it's available to anyone wanting to lookup textile or other wastes as you see fit. The first one I'd like to show you is Cotton Industry, not just producing cotton fabrics, but from a standpoint of the wastes which originate from the usage of cotton of the dresses and shirts you're wearing. I'll put that on the projector first. As you can see by looking at the diagram behind me, the first process is to take the raw cotton, and convert it to cloth. This is done by weaving first, or knitting, or making of yarn, and once we convert it into cloth; there isn't any waste involved there. There are many words such as spin sizing etc., and this is what makes a new language for the textile industries, and other industries,so you can imagine how long it takes to become an expert at textile waste, and then go to pulp and paper waste & become an expert in that. Nobody can do it. So my knowlege of these industries is probably superficial.

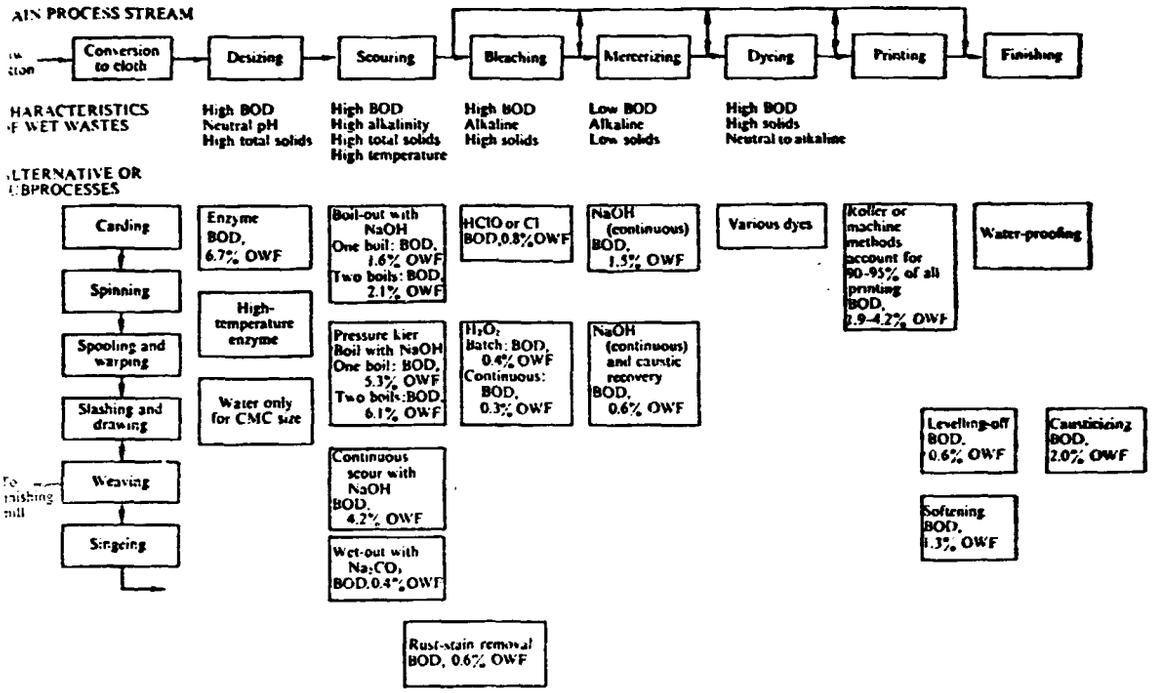


Fig. 22.1 Cotton-textile finishing process flow chart. (Taken from a chart prepared for the F.W.P.C.A.)

Table 22.1 Pollutional loads contributed by various textile processes. (After Masselli and Burford [68].)

Department	Process	lb BOD/1000 lb cloth*	% of total
Desizing		53	35
Scouring	Either pressure kier, first scour	53	16
	Either pressure kier, second scour	8	1
	Or continuous scour	42	15
	Average	47	
	Subtotal (scouring)		32
Dyeing		0.5–32	15–30
Printing	Color-shop wastes	12	7
	Wash after printing, with soap	17–30	17–30
	Wash after printing, with detergent	7	7
	Subtotal (printing)		15–35
Bleaching	Hypochlorite bleach	8	3
	Peroxide bleach	3	1
Mercerizing		6	1
Total		125–250	

*Approximately 800 to 1000 lb of impurities are discharged in the waste per 1000 lb of cotton processed.

But at least I can explain some of the words. A major word here is, "slashing" and drawing, because you have put some starch normally on the fabric or on the yarn with some sizing in order to weave it so it will have strength, to go to the textile dying and finishing plant. That's important consideration, because later on we have to take that off. I won't take too much time on that. Now we get to textile dying and finishing plant. I will speak mostly about cotton processing and will give you a quick diagram of silk, wool and rayon as well. We have to take that sizing off now, to take it over to the dying and finishing plant, and we haven't found a way to weave or knit it unless we take the starch off that was put on to make it stronger. When we remove the starch, we have a waste with a high BOD, thoroughly neutral pH, but we have a lot of solid material there, we do it with either enzymes, or we do it by high temperature enzymes, or sometimes we do that with sulphuric acid which I haven't shown on here; but you can take it off with acid as well as enzymes. If you use a water-soluble size such as CMC, you can take it off just by washing it it water. Then we have to scour it to get rid of the non-cellulose material that is present in the starch, and we have 3 or 4 ways of doing this, but most involve high caustic soda & high temperature and high pressures, cooking in other words, & you end up with a high BOD, with a high alkalinity, & high solids, and high temperature. All of those are what? CONTAMINANTS, & temperature as well, heat is a contaminant, high BOD, solids, even alkalinity are all considered contaminants. The next is bleaching. We bleach, end up with a high BOD & alkaline solution generally, sometimes an acid solution, but generally an alkaline solution. If we bleach with straight chlorine & we washed out the scouring we end up with an acid waste as you'll see later on, and quite high BOD as well. Then we have to strengthen the fibre, and then mercerize it, another stretching with caustic soda as it is called. After a period of time we wash out that caustic soda, and end up with very high pH, doesn't have much BOD left in it, it's very alkaline & low in solids. Then we're ready to dye the fabric, & this is an interesting & challenging process, I'll talk more about that where we end up with a high BOD & all kinds of dyes & high solids; can be neutral to alkaline, sometimes we use some acid dyes. Another contaminant is Color. If you see water coming out red or purple, it would appear to you as polluted, right? You wouldn't want to swim, or drink, or eat fish from that water. It would appear polluted, but it may not be excessively contaminated except with color or with the iron. I'm going to talk more about this later. Then some fabrics

are printed rather than dyed solely, with a presser or machine, and finished and sent out. Each of those gives you contaminants, and the important thing to remember is; that each process produces a waste which contains contaminants. Then we have the wool industry. I don't know how much of wool is produced here, but the Western world, Scot land, England, & U.S. has many wool industries. Using wool; it is scoured to get rid of the grease and the lanolin, and then it's dyed, carted and pulled & washed & carbonized. See, here's some new words just from changing from cotton industy to woolen industry, which are all processes. In washing there are 2 different ways of doing it, in scouring we have 5 ways. It depends on how you carry the processes out, the amount of contaminants you get from the process. So if you want to become an expert in Indutrial Waste, you have to study processes. " "" " " " Textile Waste, you have to study the textile industry pretty carefully.Now we have some dying,bleaching & whitening. The third is the non-cellulose type of synthetic industry. Non-cellulose, are generally polyester types of operation, nylon, acrylic, & polyester. You can see here the processes; & they're not as extensive as wool & cotton. You dont have such a great attrition because the fibres are made by the chemical industry and are made artificially, & so most of the contamination has been done already at the chemical industry & this is an important to you in Hong Kong, in that most of your raw materials are imported, & in importing them, the pollution comes from the industries left here, the major pollution has been done by somebody else at some other site. The chemical industry for example here, has been making the fiber, has produced pollution, a lot of it, but you have your chemical preparation to prepare nylon. You scoured it, washed it, bleached it, dyed it, and finished the fabric as shoron in the line diagram (Fegs 22.3 and 22.4).

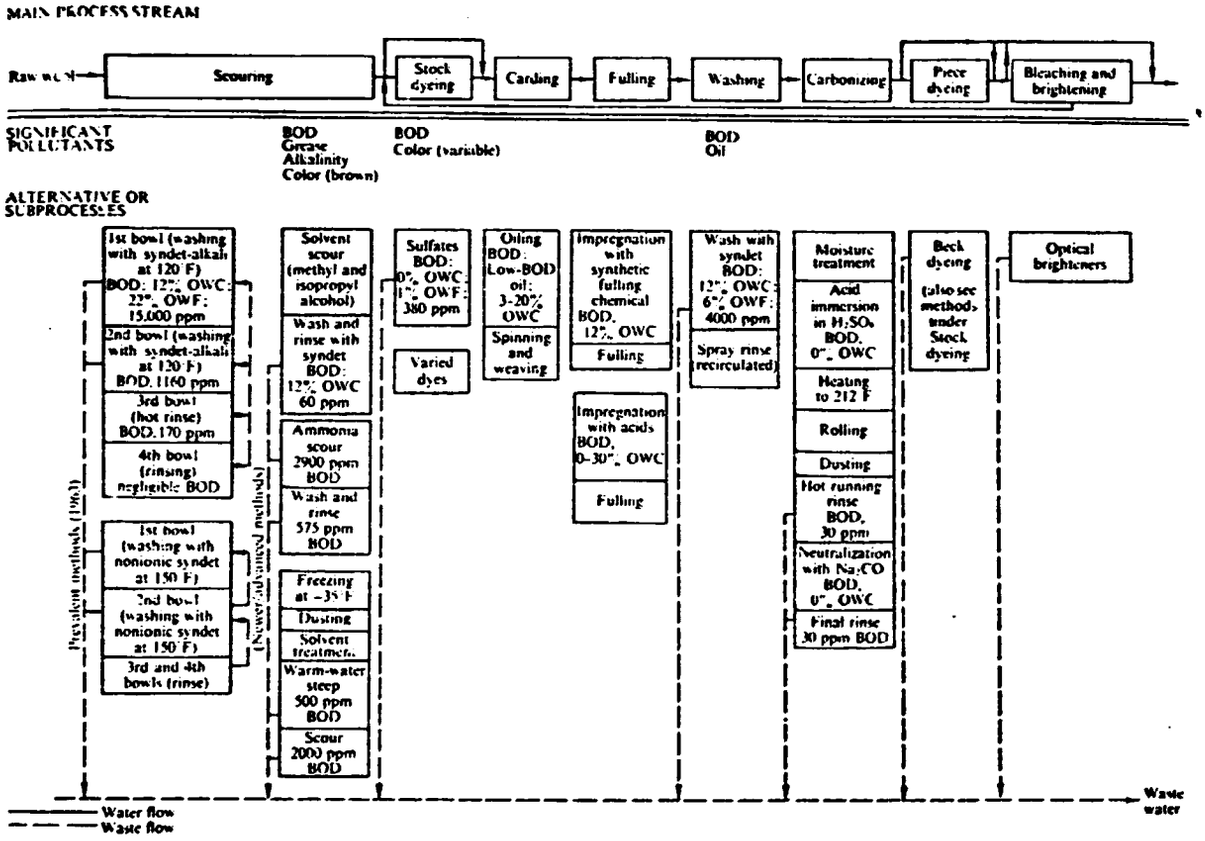


Fig. 22.2 Wool-textile production process flow chart. (Taken from a chart prepared for the F.W.P.C.A.)

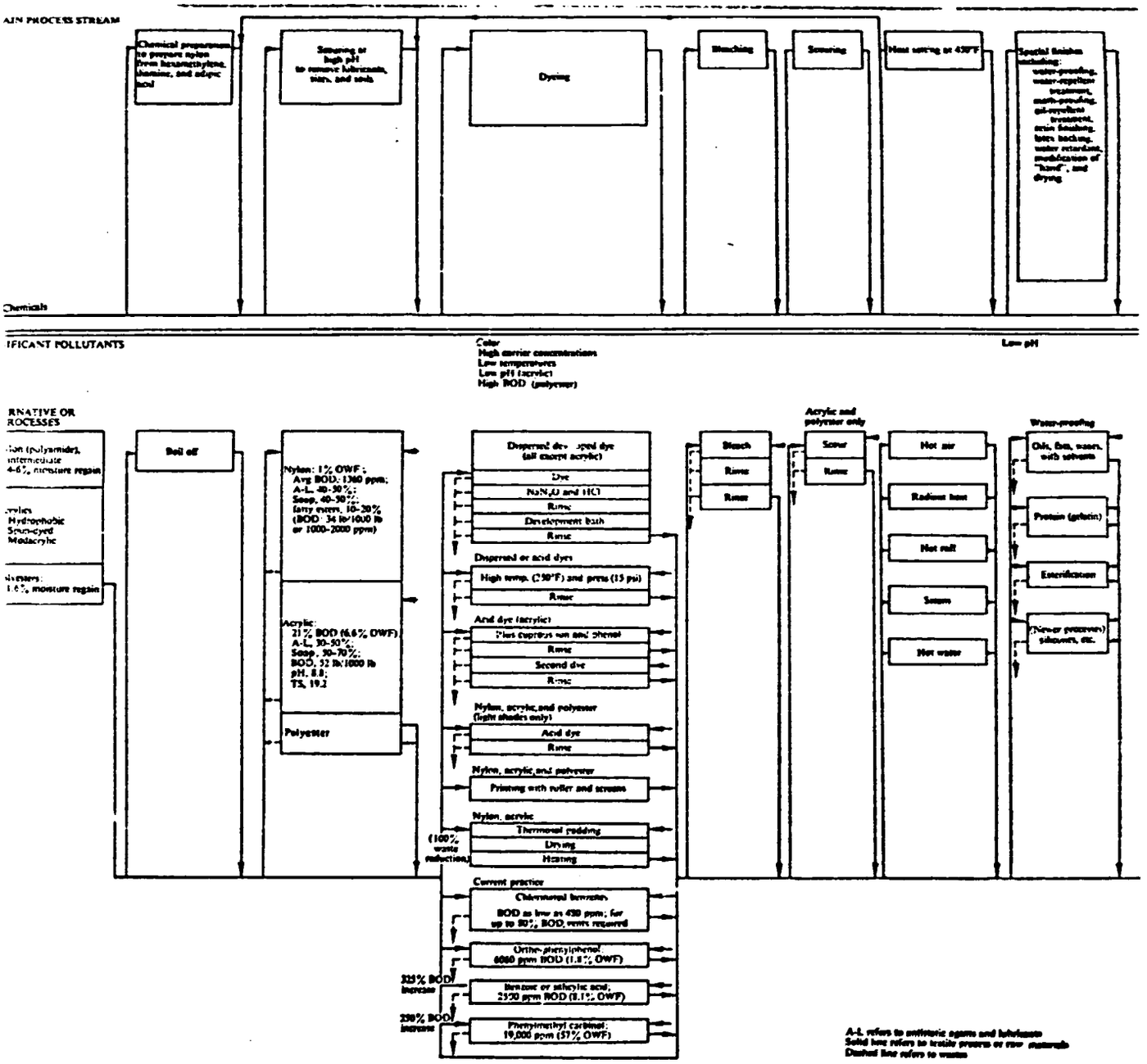


Fig. 22.3 Noncellulose synthetic-textile finishing process flow chart. (Taken from a chart prepared for the F.W.P.C.A.)

The common contaminants are 12 in number, and maybe there are others you can think about and remember, but color, BOD, COD, Chromium, Phenol, pH, foam forming matter, refractories, -- long chain orga nic materials that are very difficult to remove by conventional methods of treatment. An example is an insecticide that you put on the cotton fields in order to prevent the bowl-weavel or some decomposition of cotton before it reaches the market. The refractory insecticide is a very undesirable, is indigestable from a bacterilogical standpoint the bacteria don't want anything to do with a long-chain compound, or benzene ring compounds; the benzene ring is ugly to us because we have to feed the bacteria to decompose the material before it goes into the river. Bacteria just don't like benzene compounds, benzene rings are just undesirable. But the BACTERIA will take care of it, if given the right environment. That's one type of refactory which may be interesting to you. Salts are a contaminant, even though the oceans are full of salts, if you get too much at the wrong place, it interferes with the best usage; it then becomes a contaminant. Odors -- certainly nobody wants to live around abjectionable odors, espectionable, & sulphur. Sulphur, rotten-egg odors from sulphur dyes are objectionable, & therefore if you get too much of it, you have pollution. Sulphide itself, is objectionable not only from a standpoint of odor, but from other standpoints. Heat is the 12th contaminant. So you have 12 contaminants present in textile waste that you have to worry about. You won't have them all in every textile factory, but you will have them. Let's talk about the effect of those 12 wastes. Color appears objectionable & therefore it has to be removed whether it is actually polluting or not, if it appears objectionable. It comes from dye-baths & generally the effect it has on a municipal sewage-treatment plant is generally none, but that doesn't mean that it is harmless just because it has no effect on the textile or municipal waste treatment plant, that it's harmless. It means that it may go right through the municipal treatment plant and end up in the river, or the sea, or bay, & be objectionable there, because people can see it. BOD uses up oxygen, the higher the BOD, the more oxygen is used up, therefore it becomes objectionable. If too much oxygen is used up the fish die, the odors are created, the metals turn black etc. You can't put much into a stream, it will only take 8 mg./ liter generally, even when you get fully saturated, 8 gms/ cu. centimeter is a very small amount -- 8 parts per million parts, so it doesn't take much BOD and all the oxygen is taken out of the river, so you have to figure out some way of removing that BOD. I don't say we have to spend a lot of money on treatment to remove it, I say we have to challenge our

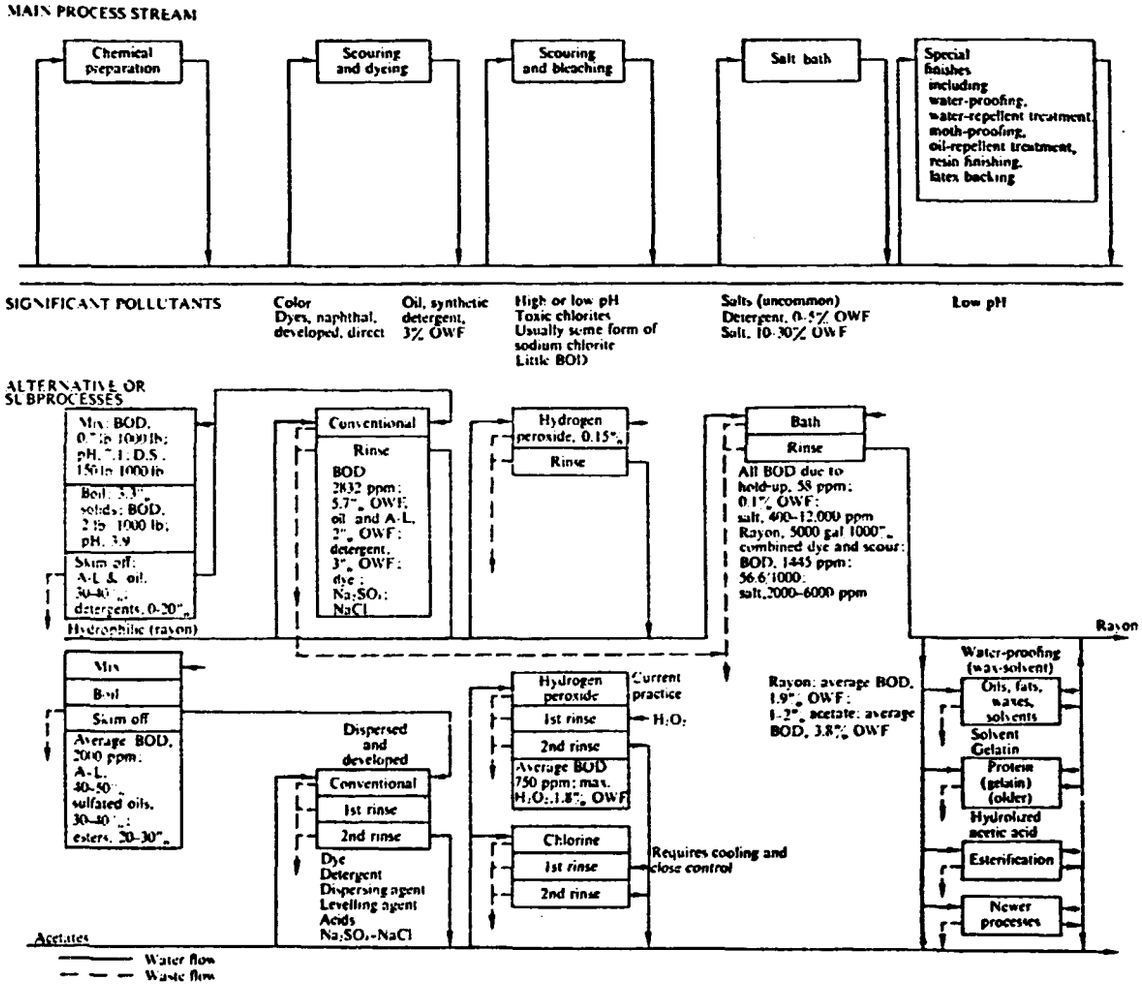
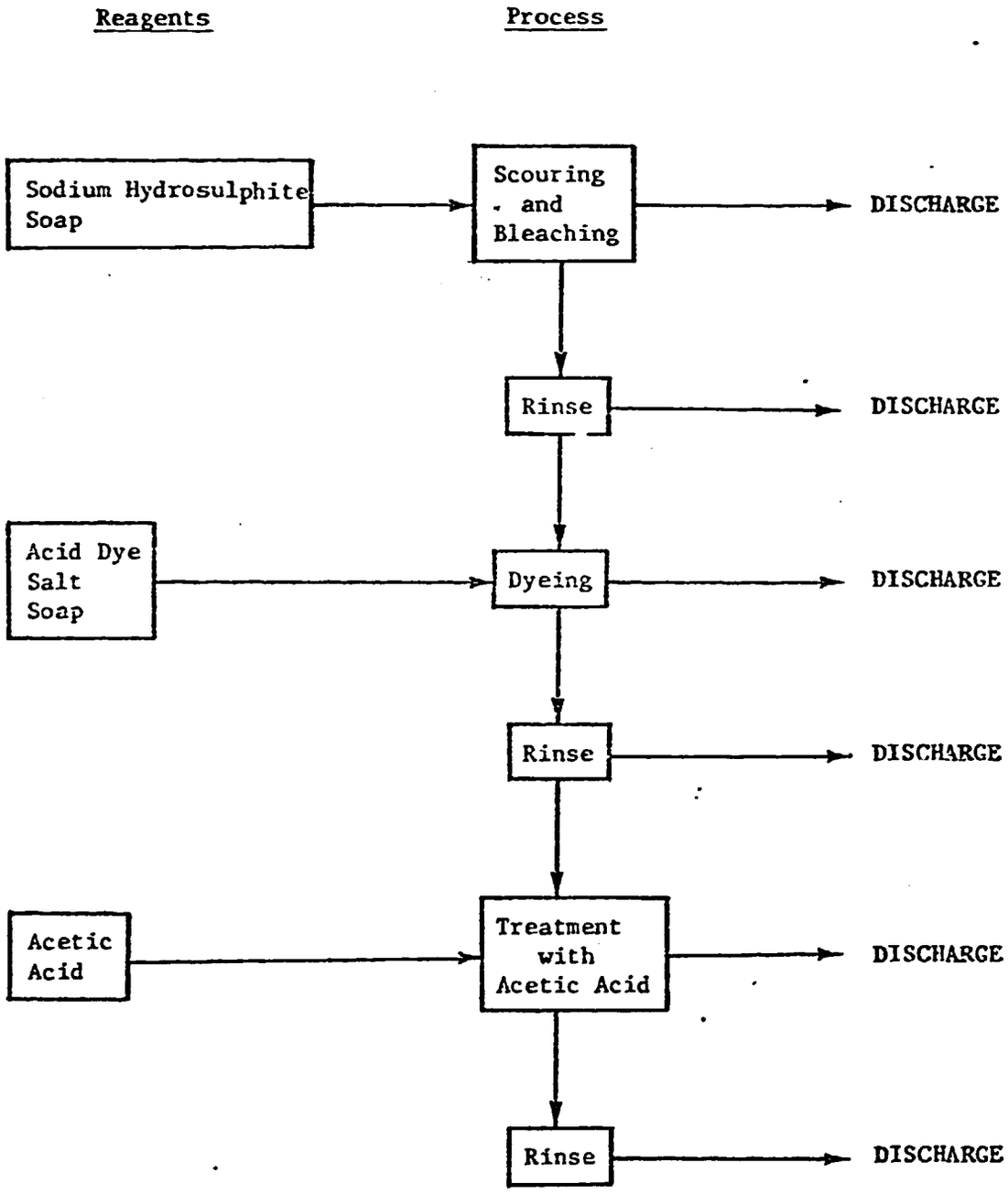


Fig. 22.4 Cellulose synthetic-textile finishing process flow chart. (Taken from a chart prepared for the F.W.P.C.A.)

The Bleaching and Dyeing Processes for Silk Cloth



minds, that's what we are here for today, perhaps to figure out other ways to get rid of BOD. Mostly from kiering and de-size to get rid of BOD, to cook it and take off the size from the fabric, that's where we get the BOD and it increases the secondary capacity required in waste treatment plants. COD is the chemical oxygen demand. I really don't have enough time today to define all these terms. I assume you are familiar, or know something about them. COD contributes a lot of organic material some of which may not be digestible by bacteria. Or the word we use is biodegradable. It might not be biodegradable and the chemicals used for various reasons or which happen to be in the fabrics to start with , and if there is a high amount of COD it will lengthen the amount of treatment needed. It means we will need more time or more capacity or larger plants, and that means more money. So the COD to BOD ratio is extremely important. In domestic sewage,that ratio is largely twice the amount of organic material in the COD as BOD. This means 2 times the amount of food the bacteria have to ingest is digestible. The other part is not disgestable. So it may go out in the river undigested. But in textile waste we might have 6 or 8 times the ratio. Therefore, we might not be able to use biological treatment the way it is. We might have to adapt a separate group of bacteria to do the job. Or we may use another method. Chromium that we use in sulphur dying of textile waste will kill many fauna (fish & biological life in the stream), comes from sulphur dyes and it kills the working bacteria. If we're going to use the bacteria to break down the organic material to digest it, we certainly don't want to add anything to the wastewater which is going to kill the bacteria, which is doing the job. Phenols adds tastes and odors, kills the bacteria and flora and fauna as well. It's primarily in the despersed dyes & adds extra odors to sewages and extra load on bacteria. Phenol is quite an interesting compound. It intensifies the odor of the wastewater especially if you chlorinate the water, besides having those benzene rings that I mentioned before. Then the phenol becomes chlorinated phenol & the odor is preceptible in parts per billion, not per million, but pp b. It's very objectionable from that standpoint. pH,of course, is toxic if it gets too acid or too alkaline to all flora and fauna that we're trying to protect, and that pH high or low pH, can come from the kiering from the desizing, dying, bleaching-- inter feres with bacterial degredation. No respectible bacteria likes a low pH or a high pH. They like a neutral pH -- around 6-8. But sometimes they have to operate that way. Foamy matter appears sudsy. It comes from dyeing and finishing baths & carries contaminants on to the sewage plants where it looks bad.We visited a plant yesterday with a foamy- sudsy appearance, & we immediately thought that

it might be something dangerous. We don't know how dangerous it is with COD or BOD, but it looked bad, because it was all foamy and being discharged--- and unless you can analyze it, you don't really know, but just looking, you know there's pollution there. Refractories add permanent material, and it comes from fibre degredation-- some of the hemi-celluloses comes from the chemicals added, mainly insecticides added to cotton or wool and ABS tart detergents. Many of the textile industries use ABS detergents. ABS (study chemistry & you'll know the meaning of ABS, a long-chained compound) It doesn't digest, and becomes refractory. It has very little effect on the sewage treatment plant. What does that mean? It means it goes right through & if the STP effluent goes into a river & the river is taken up for drinking water either by the fish (off the main subject, a discussion for necessary courses of study and research in Labs, and the need for a good educational background for discovery and how to recognize these things and how to apply it to another discovery or to what you are doing, etc.) We have a few more contaminants to talk about. Salts will increase the conductivity of wastewater, and therefore it interferes with using the water over again, if you get too much salts in there. You can't have more than 10 parts/PPM of chloride in the water because the electrical insulating paper will absorb too much chloride and then will become conductive, carry the current away from the wire, out into the external environment, and become objectionable and have a loss of current. That's just one example. There are many other examples-- precipitation of dyes, salts normally coming from dye baths -- what effect on domestic sewage treatment? Generally nothing. In fact bacteria are happy with high salt concentration. It seems to stimulate their activity, and they go right out with the effluent. So you might say if it doesn't interefere with sewage treatment, discharge the textile waste along with sewage, treat it with domestic sewage and let it go out. But what you have to remember is, what you are doing there is perpetuating a contaminant, which at some point in the chain of water-cycle may become contaminating to the point where it is polluted. Odors, largely coming from sulphur-dyes, they use up oxygen, add odor to sewage, & perform two objectionable characteristics, and heat, sulphide has the same problems as odors in that they use up oxygen very fast. Put sulphide dye waste into a treatment plant they will use up oxygen very fast, therefore no O_2 available for the bacteria. Heat is the last contaminant. It decreases the O_2 capacity because water has a capacity to absorb O_2 only based upon it's temperature. The lower the temp. the more O_2 the water can absorb. The higher the temp, the less the water can absorb. Remember O_2 holding capacity is very limited. So the more you warm up temp. from a scouring or a kiering

and you warm up temp. of waste treatment you can't absorb as much O_2. If you can't absorb as much O_2 -- you'll be out of business sooner. Bacteria won't have enough ability to perform its duties of decomposing the organic material. Also, it may increase the bacterial oxidation rate. If you get the temp. too high, it may cause the bacteria to work so fast which is good in one case, because they work fast they break down the organic material is what you want to do, but bad in another because it uses up the oxygen at a faster rate & you'll have to supply the oxygen at a faster rate, and perhaps you'll have to take that into account in your design, the amt. of oxygen supplied. Well, that's a new Table to appear the next time I publish this textbook, you can look back on it & say if hadn't been for you asking me to talk about textile waste, this Table would never have been prepared to be put into my book. Now we have to talk about waste treatment. Of course we are going to try to do everything we can within the Factory to minimize the amount of contaminants we are going to be discharging. We're going to change production, re-use and re-cycle , we're going use non- polluting chemicals, non- polluting processes, everything we can to minimize pollution. But in the long run we can't be perfect, some contaminants will escape, so we must talk about how we will treat these contaminants which escape. These are the implant methods of reduction, such as dying we can replace the slashing with low pollution compounds, such as CMC, or certain gums to be used for sizing rather than starch which has a very high BOD. But remember whenever you replace things with low BOD compounds and they are organic, they're just going to be refractory , and end up as pollution somewhere. But it might get you by the river stage and into the Harbour. And that might be just satisfactory. This might be a good solution to the Textile Waste Problem. So all of these are processes which can be used in plants to solve the problem--- such as storing the bleaching washes to make up kiering baths which are highly alkaline so you can use that water to begin your kiering and just add fresh caustic soda to it. After finishing with all these in-plant processes, then the first suggested full scale treatment is some equalization and holding-basin, putting all alkaline waste, your low BOD's together with your acid wastes and your high BOD's into one large basin in which they are all mixed, what we call,"equalized." So what comes out of that basin is uniform in character and quality, what goes in is very different from what goes out equalized. "Homoginized." From there you can go either to a municipal treatment plant with sewage by biological treatment, with any of these forms:- aeration, tricking filter, lagoon activated sludge, and then end up with chemical cooagulation. Or you can go to municipal treatment where they use " " " and then a tricking filter with sludge-handling devices. These are the two common forms of municipal treatment that are used. If you don't

No. of Contaminants	Contaminants Found in Textile Mill Dyeing and Finishing Wastewaters	Effects of Contaminants on Receiving Waters	Origin of Textile mill Contaminants	Effects of Contaminants on municipal sewage treatment plants
1	COLOR	APPEARS OBJECTIONABLE	DYE BATHS	GENERALLY NONE
2	BOD	USES UP OXYGEN	MOSTLY KIERING AND DESIZING	INCREASES SECONDARY CAPACITY REQUIRED
3	COD	CONTRIBUTES ORGANICS	CHEMICALS ADDED FIBROUS MATTER REMOVED	LENGTHENS TREATMENT TIME
4	CHROMIUM	KILLS FAUNA	SULFUR DYES	KILLS WORKING BACTERIA
5	PHENOL	ADDS TASTE & ODORS KILLS FAUNA	DISPERSE DYES	ADDS ODOR TO SEWAGE EXTRA LOAD ON BACTERIA
6	pH	TOXIC TO FLORA AND FAUNA CORRODES MATERIALS	KIERING, DESIZING, DYEING, BLEACHING	INTERFERES WITH BACTERIAL DEGRADATION
7	FOAM FORMING MATTER	APPEARS SUDSEY	DYEING & FINISHING BATHS	CARRIES CONTAMINANTS ONTO SEWAGE PLANT AREA - LOOKS BAD
8	REFRACTORIES	ADDS PERMANENT MATTER	FIBER DEGRADATION CHEMICALS ADDED *	GENERALLY NONE
9	SALTS	INCREASES CONDUCTIVITY INTERFERES W/ WATER REUSE	DYE BATHS	GENERALLY NONE
10	ODORS	SMELLS OBJECTIONABLE	SULFUR DYES	USES UP OXYGEN ADDS ODOR TO SEWAGE
11	SULFIDE	USES OXYGEN FAST	SULFUR DYES	SAME
12	HEAT	DECREASE OXYGEN INTERFERES WITH BIOTA	SCOURING - KIERING	MAY LOWER OXYGEN LEVEL AND INCREASE BACTERIAL OXIDATION RATE

* MAINLY INSECTICIDES ADDED TO COTTON OR WOOL AND ABS-TYPE DETERGENTS

TABLE 1

TEXTILE MILL CONTAMINANTS

--- if you use your own treatment at your own textile mill, primarily after equalization, you can settle the waste, lagoon the waste, chemical cooagulate the waste, or you can go to activated sludge or trickling filter or even an oxidation pond before discharging it into a stream. Now, one thing you'll notice here -- that with textile waste you've got a decision to make. Whether you're going to treat it along with after your implant changes, "" " ' " " with domestic sewage or ------ " " " " ' it at your own factory by yourselves and the decision you make is dependent upon a lot of factors. Cost, distance, or acceptability of the municipality and the type of treatment the municipality is expecting to use, it may not be compatible with yours. Fortunately, with textile waste, most municipal treatments are generally compatible. It doesn't mean that you're going to remove all the contaminants of textile waste by putting it to a municipal treatment plant. It does mean that most textile wastes will go into " " " and not interfere with it's operation, and will generally be respondant to some degree of purification or removal by the treatment plant. No, we have never solved the whole problem by doing just that, why not? Because it costs a great amount of money. It has to be added to the cost of the fabric too, the production of textile mill cost, In Hong Kong the dyers and finishers have to be competitive with the people producing in Tiawan, or China, or Thialand, or wherever textile goods are produced in order to stay competitive on a World market. So any slight increase in cost of production will have to show up in the price of the product. Therefore, you won't be able to sell as much, then someone will suffer, worker's will be out of jobs, and manufacturing will cease. This is happening in many cases, in U.S. in the steel industry, because now the cost of pollution abatement has put the U.S. steel production out of competition with Japan & West Germany. So we must make decisions on how to solve the problem. So we can't say that just because treatment costs money, that we should give up or not have any treatment. We shouldn't let any textile mills get away with the idea that they don't have to protect the environment just because it costs money. But we should say to the Textile Industry, " You have to use innovative ideas and treatment which cost less money, and therefore will not put you out of competition." Let's put this in perspective to start with, cost of waste treatment is a very small percentage cost

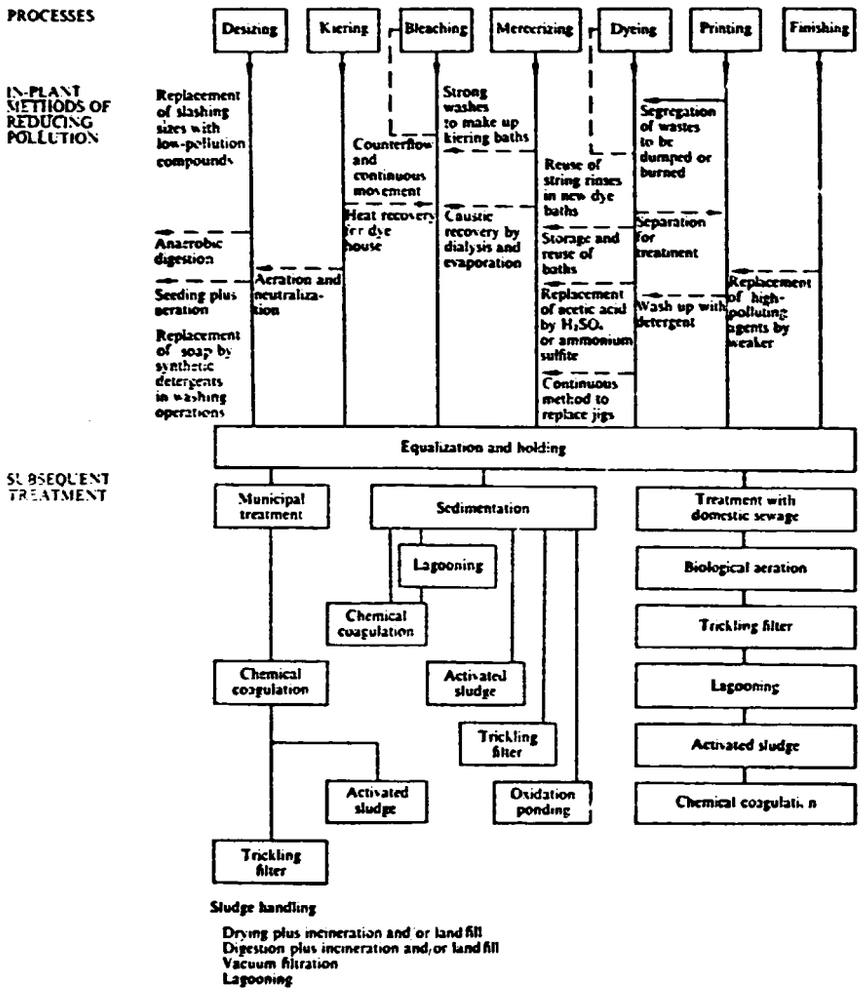


Fig. 22.5 Cotton-textile finishing waste-treatment flow chart. (Taken from a chart prepared for the F.W.P.C.A.)

of production. Generally, in the range of 1 %; one percent is a quantity in mass which can be detrimental to the texitile industry, or any industry, but if handled correctly, and worldwide faced with the same problem, is not going put the textile industry out of business--- anymore than if you have to pay extra 5¢ on Star Ferry, you'll still take the ferry. 1% is a very small percentage of cost of production & somehow it can be "woven" into the cost of production.

I have prepared some challenges (4) today for you to help keep this cost down, that might work effectively for the textile industry, in fact I have found in my experience and research that these processes do in effect result in efficient reduction of contaminants and at the same time lower costs of treatment. The first one is an idea I have of spray-drying or evaporating to concentrate the dyes from the different dyeing equipment which are known as jigs or becks or baths and continuous dyeing. Collecting these dyes, and storing them for reuse. Now, I don't know of any textile mill in the world that's using this process now, concentrating the dye-baths and storing the dyes for re-use at another time to makeup with fresh dyes; but that's no reason for us to say that it can't be done. What we need is to try it out, so the innovation here will eliminate the environmental adverse effects of those dyes that I spoke about, all contaminating effects of color, odors, BOD,COD, as well as re-use valuable dye material which cost much money to textile manufactures to buy these dyes from the chemical companies. They will also re-use BODMATTER if done properly.

Many are done under elevated temperatures. If you can re-use the water for heat value to evaporate, you get steam and it can be used to heat the various scouring baths, so you can recover BTU's, dyes, and eliminate an adverse environmental impact.-Now, these are <u>three good</u> reasons for doing this, but we have problems anyway. I have experienced & know the many problems existing in Industry. It means you have to change your operation, operating managers don't like this naturally, nobody likes this. Textile operators will resist and say that it can't be done. It takes extra work to conserve, a lot more work to recover, and make new designs --basins for evaporation, take the solids evaporated and store in drums; and then you get a certain color out of those dyes. That color may not match until another order next month. So it requires extra work, to match dyes and feed it back into system etc, and the operator is used to less work. Objections come from product being slightly off-color to start with, until system is down pat. Eventually, problems can be overcome, and later all will be happy when they see the cost ledger and the savings in cost & treatment plant involved. Remember elimination of treatment of dye waste, by recovery, elimination of waste treatment, is quite a cost-saving device. So that's one item. Another process is called dispersed- growth biological treatment.

POTENTIAL ADVANCED TREATMENT SOLUTIONS FOR TEXTILE FINISHING WASTES

NO. OF METHOD SUGGESTED	DESCRIPTION OF METHOD	RATIONALE FOR INNOVATION	PROBLEMS
1	RECOVERING AND STORING AND REUSING OR SPRAY-DRYING OR EVAPORATING TO CONCENTRATE DYES FROM JIGS, BECKS, OR BATHS, COLLECTING, AND STORING FOR REUSE OF SOLID DYES	ELIMINATE ENVIRONMENTAL ADVERSE EFFECT RECOVERS VALUABLE DYE REUSE OF BTU HEAT ENERGY	CHANGE IN OPERATION EXTRA WORK TO CONSERVE MAY CAUSE PRODUCTION DETERIORATION
2	DISPERSED GROWTH BIOLOGICAL TREATMENT	LOW COST OPERATION AND EASE OF CONTROL	RELATIVELY LONG DETENTION PERIOD LOWER BOD REDUCTION
3	PRESSURE FILTRATION FOR CONCENTRATION OF DYE WASTES	CONCENTRATES FOR RECOVERY AND REUSE OF VALUABLE DYES	COST OF DYE RECOVERY EXCEEDS (MAY) THAT OF NEW DYE
4	*INDUSTRIAL COMPLEX PRINCIPAL	REDUCES PRODUCTION COST ELIMINATES ADVERSE ENVIRONMENTAL IMPACT	UNTRIED REQUIRES APPROVAL OF PROPER MIX OF SELECTED MILLS

*See Example in FIG. 1

When you biologically treat textile dye waste, you have mostly soluble and coloidal material. You have very little suspended material like you do with sewage, or paper mills or tanneries. Therefore you tend to have a difficulty building up of suspended solids, concentrations like you do with activated sludge and sewage, or paper mills or tanneries. Therefore it isn't very efficient to remove the BOD, not very easy by biologic aeration to remove the BOD, by returning suspended material or sludge from the bottom, you don't get much sludge when you aerate textile mill waste, biologically. So, therefore what I propose, and have done it in laboratory & I have several mills that are using this process, is to recirculate the supernate, not the sludge, because it's difficult to build up a sludge, you don't have a nucleus to do it, and you aren't building up enough cell growth. Maybe this is "over your heads", think about it, write me, or ask your professor, or read about it— but there is a possibility of recirculating the supernate without any controls, which has the dispersed bacteria to be recirculated, but has no surface area for the bacteria to really work on. Dispersed growth bacteria will work on the organic matter, feed on it directly, without being absorbed on any particular matter such as suspended solids. The operation is easier, you don't have to settle it, return sludge, build up suspended solids concentr. It takes a little longer, generally, but is less expensive and efficient. You do have problems such a relatively long detention period, and won't get as much BOD reduction as you do with suspended solids, mix-liquor, high suspended solids. But you have to remember that you can't build up much ss. with bio. aeration of textile mills. You just don't have colloids or suspended materials to start with as in tanneries, sewage, and pulp and paper mill work. The third type of treatment is what I'd like to suggest to you to recover your dye waste which are predominant portion of total waste from textile industry by pressure-filtration, using a chemical engineering technique of pressure-filtering the dye waste on a very finely divided clay material, or earth material or fine sand filter. You will remove the dyes on the sand or on grain or on fabric if you want use a pressure filter with a very fine weave nylon fabric, this is done often You have a plate and frame press. filter, just force the dye waste through on a bench-scale, release the pressure, remove the plates, and then scrape off the dyes and contaminates. It's possible to concentrate the dyes to a very high degree, maybe ... solids, then evaporate the last 10-15% water, at a lower cost than the # 1 system, and you concentrate and

recover those dyes for valuable re-use. The cost of dye-recovery may exceed the cost of fresh dyes, but I doubt it. Some direct inexpensive dyes -- you may have to spend more money wit h this system --- a problem. It may be better to purchase fresh dyes in this instance.Remember in the back of your mind that you are avoiding waste treatment, adverse environmental impact of these dyes if you don't have any waste treatment.That avoidance to the environment is worth something in dollars to society. If you include that savings in adverse effects along with cost, or subtract it from cost of waste treatment, then you have a lower cost than you would have for producing or buying direct dyes on the market.

The last item, after talking all day, and very important, is a new idea for building a proper "Industrial Complex" in which the textile mill doesn't have to put in any waste treatment at all. Nice to put a text. mill at right location with right mixture of industries so that you don't have put in any waste treatment at all, nice?? You could just produce textile fabrics & goods and not have to worry about the environment. That I think is possible! It's not being done anywhere in the world again, not yet, but it will be in your time, I can asssure you of that! There are so many areas of Industrial waste treatment that I predicted 20-30 years ago, that are now very common-place. Advanced "Waste water-treatment", is a concept that I dreamed up about 25 years ago, now is very common-place, used all over the world, except in Hong Kong, I guess, but it may be coming here too. If you have such a Complex, it will reduce the production costs, you don't need waste- treatment. Among other things it will reduce costs of production, eliminate adverse environmental impact-- and that's what we're interested in doing, as environmental engineers. The problems are that it's "untried"-- such a complex is untried, and it requires approval of the proper mix of selected Mills, so that waste treatment is not required, and you put them all in an estate or "Industrial Complex", some call them "Industrial Estates", if you put the right industries in there, it can be done., at lower production costs & no treatment. How? The major problem with that is

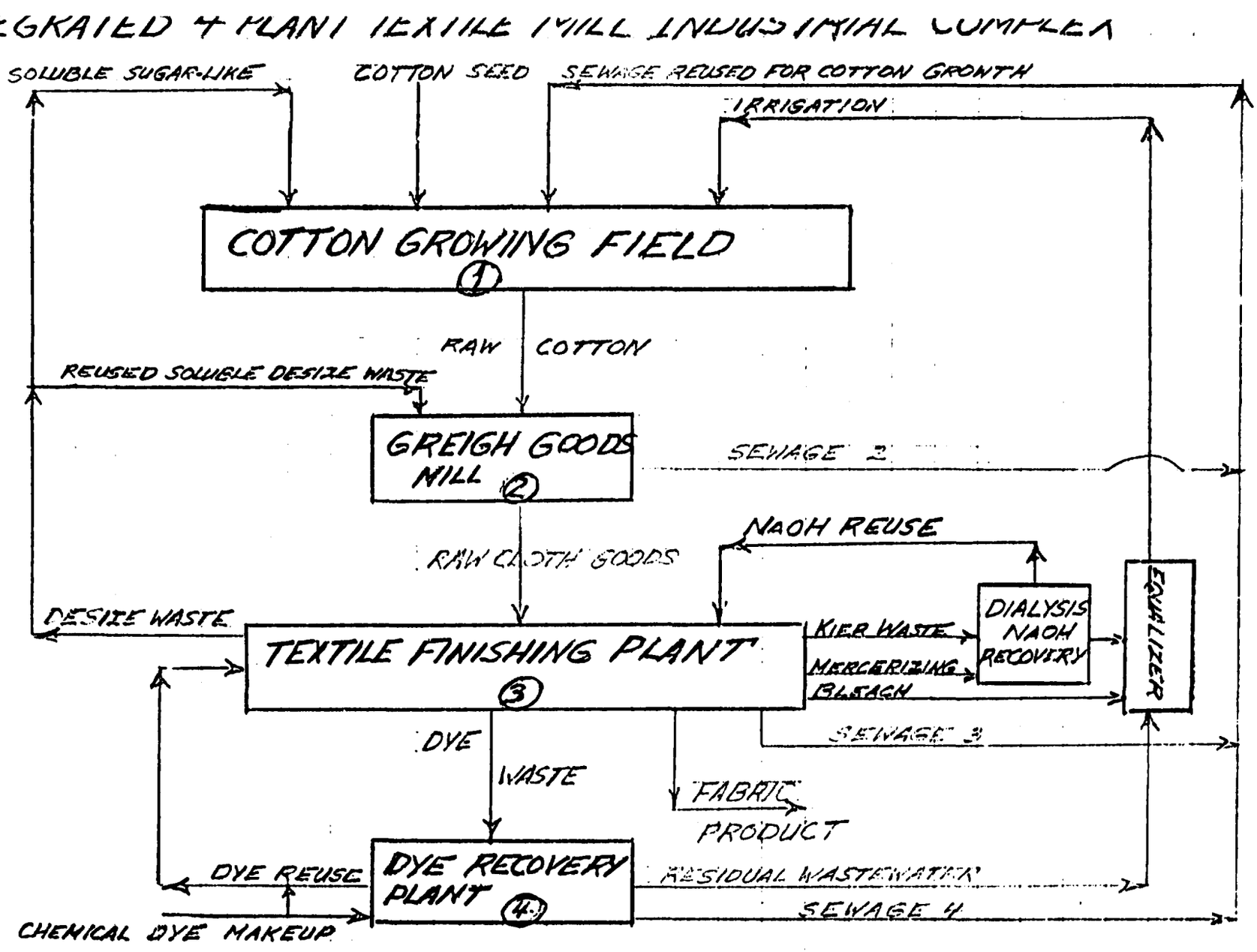

INTEGRATED TEXTILE MILL INDUSTRIAL COMPLEX
SOLUBLE SUGAR-LIKE
COTTON SEED
SEWAGE REUSED FOR COTTON GROWTH
IRRIGATION
COTTON GROWING FIELD
1
RAW COTTON
REUSED SOLUBLE DESIZE WASTE
GREIGH GOODS MILL
2
SEWAGE 2
NAOH REUSE
RAW CLOTH GOODS
DESIZE WASTE
TEXTILE FINISHING PLANT
3
KIER WASTE
MERCERIZING
BLEACH
DIALYSIS NAOH RECOVERY
EQUALIZER
SEWAGE 3
DYE WASTE
FABRIC PRODUCT
DYE REUSE
DYE RECOVERY PLANT
4
RESIDUAL WASTEWATER
SEWAGE 4
CHEMICAL DYE MAKEUP

FIGURE 1

finding the right industries to put together.You not only need the right type of Industries, but right size of Industry. Here I have put together for you a 4 plant (for your special seminar today), 4 plant integrated textile mill "Industrial Complex." You can see here on diagram how difficult it is to get these 4 industries together; in Hong Kong it may be impossible. Because one industry is growing cotton , and you know how difficult it is to find land or area here, and it's much cheaper for you to import it. But, in certain areas of the world, such as the Southern part of USA, we can grow cotton in the same place that we can produce the grey goods, (means woven, starched, sized & knitted to go to dye-finishing plants). So if we put the cotton-growing & grey goods plant, and the textile dyeing and finishing & dye recovery plant which I mentioned, all in one complex, no waste-treatment is required. Now, how is that possible? Well, all we need is the cotton seed to produce cotton, raw cotton is then transported accross the complex to grey goods mill, they make cloth out of it, and raw cloth goods then is sent right to the finishing mill where it's de-sized first, the desized waste which is soluble sugar after using sulphuric acid or enzymes, "" " " can be used again for slashing or making starch solutions for grey goods & they can be used to help fertilize the cotton.So there's no treatment for desized waste. Then its kiered and cooked or mercerized so kiering waste comes off here, and the mercerizing waste comes off here, and we build a little dializer., or the dializer is a membrane-filter technique under pressure or heat, or one that forces the caustic soda through the membrane and rejects the colloidal or impurities. The caustic soda is then regenerated and used back in kiering right back into the mill. The reject goes into an equalizer. The bleach also goes into equalizer. Then only other textile waste is the dye waste. This goes directly to the dye-recovery plant, where we either evaporate or pressure filter & recover our dyes and reuse them back in the finishing mill. Makeup dye will be brought in ; some of it, and reused in textile mill. There'll be some residual reject dye from recovery plant here which will also go into the equalizer. This equalizing produces a homogenius material of organic constituents, neutral pH, we take that back and use that for irrigation, mainly for water for your cotton fields. The only other major waste developing from these 3 industries is sewage from factories, from the people using the toilets in the factories, and generally speaking these go to a

separate sewage line and sewage treatment plant. But this complex is self-sufficient in itself, therefore we're taking the sewage as well from each of these 3 factories, and were putting it back on cotton growing field since the cotton is not used internally for food, we do this now with food processing-- with tomatoes and other foods, and we get away with this by washing the food good,or not fertilizing during the last periods of washing. This helps grow the cotton faster and bigger cotton. Plenty of cotton will grow from plenty of fertilizer and water. No waste, or waste treatment, or No transportation costs! True you have no duty to pay for importing in Hong Kong, but you do have to pay something for the transportation costs. Here it is without transportation, just put it on a conveyer belt and take it right into the next plant. You save labor and all these costs mentioned, and you have no adverse environmental impact.

Ihave worked such complexes out with other industries. I've actually done a Mass Balance for one slaughter house, a tannery, rendering plant, even the feeding and growing of cattle-- then the slaughter house,then the tannery, then the rendering plant all in one plant, with a "Mass Balance".There are some problems naturally, but I want to "plant the seed" with you. Somewhere, sometime I'm going to start convincing people to use these concepts. Once they do, we will reduce production costs, and avoiding pollution control.

(Time to stop and to ask questions about Seminar)
You can write to me, call me at the Productivity Centre, ask Mr.Chiu for help, or see me now. Thank you very much.

5- (B) PRODUCTIVITY CENTRE'S SEMINAR I

"INDUSTRIAL WATER POLLUTION CONTROL"

June 14, 1982

I - Type of Industrial Contaminants (Chapter 1)

II - Effects of Contaminants in Receiving Water Sources (Chapter 1)

A-ON S T P (1.1 and 1.2)

III - Conventional Treatment Methods

Theories Part 2 Text

Volume Reduction
Strength Reduction
Neutralization
Equalization
Removal of Susp. Solids
Removal of Colloidal Solids
Removal of Inorganic Solids
Removal of Diss. Org. Solids
Treatment of Sludge

HONG KONG PRODUCTIVITY CENTRE

SEMINARS ON INDUSTRIAL WATER POLLUTION CONTROL (I)

(14/6/82)

Participant's List

Name	Organisation
1. Dr. Y.S.Fung	Hong Kong University
2. Mr. K.T.Chan	-ditto-
3. Mr. Joseph Lee	-ditto-
4. Dr. S.W.Kueh	Hong Kong Polytechnic
5. Mr.s Shirley Lee	Environmental Protection Agency
6. Mr. Wong Ho Yan	-ditto-
7. Mr. Wu Ming Wo	Agriculture & Fisheries Dept
8. Mr. Wong Pui Tat	Professional Cleaning Services (HK) Ltd
9. Mr. Fung Tai Tung	-ditto-
10. Mr. Alfred Leung	Hydrex Asia Ltd
11. Mr. William Tsang	-ditto-
12. Mr. Eric Cheung	-ditto-
13. Mr. Ko Wing Hon	Polltyion Control Division
14. Mr. Luk Kam Leung	Electronic Devices Ltd
15. Mr. M.J.Arnulphy	J.Mortensen & Co Ltd
16. Mr. J.A.P.Damour	-ditto-
17. Miss Ho Siu Lai	First Dyeing Works Ltd
18. Mr. Ma Iu Ki	New Territories Services Dept
19. Mrs. Karen Pong	H.K.Government Dept of Industry
20. Mr. Cheung Mo Tsing	H.K.Baptist College
21. Mrs. Lam Leung Suei Yee	-ditto-
22. Mr. Lo Wai Kwok	Sonca Ind Ltd
23. Mr. Chung Yiu Fan	New Territories Services Dept
24. Mr. Tsang Kam Lam	Hong Kong Productivity Centre
25. Mr. C.W.Hui	-ditto-
26. Mr. Sam Cheng	-ditto-
27. Miss Ko Ka Mei	-ditto-
28. Mr. Lin Chaan Ming	-ditto-
29. Mr. Wong Kin Wah	-ditto-
30. Miss Pang Suk Fong	-ditto-

香港生產力促進中心訓練課程

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Seminars on "Industrial Water Pollution Control" (English)
Seminar I: 14.6.82 (Monday) $150
9:30 a.m. – 5:00 p.m.
Seminar II: 21.6.82 (Monday) $150
9:30 a.m. – 5:00 p.m.
(including lunch)

保險契約之一般原則（中文） $440
General Principles of the Contract of Insurance
14.6.82 – 7.7.82
逢星期一、三下午七時十五分至九時四十五分

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EFFECT OF WASTES ON STREAMS AND WASTE-WATER TREATMENT PLANTS

1.1 Effects on Streams

All industrial wastes affect, in some way, the normal life of a stream [11].* When the effect is sufficient to render the stream unacceptable for its "best usage," it is said to be polluted. Best usage means just what the words imply: use of water for drinking, bathing, fishing, and so forth. A more detailed description of these uses is given in Chapter 2.

Streams can assimilate a certain quantity of waste before reaching a polluted state. Generally speaking, the larger, swifter, and more remote streams that are not much used are able to tolerate a considerable amount of waste, but too much of any type of polluting material causes a nuisance. To call a stream polluted, therefore, generally means that the stream contains an excessive amount of a specific pollutant or pollutants. The following materials can cause pollution:

Inorganic salts	Heated water
Acids and/or alkalis	Color
Organic matter	Toxic chemicals
Suspended solids	Microorganisms
Floating solids and liquids	Radioactive materials
	Foam-producing matter
	Refractive Matter

Inorganic salts, which are present in most industrial wastes as well as in nature itself, cause water to be "hard" and make a stream undesirable for industrial, municipal, and agricultural usage. We mention here just a few of the hundreds of difficulties arising from the use of hard water.

Salt-laden waters deposit scale on municipal water-distribution pipelines, increasing resistance to flow and lowering the overall capacity of the lines. Hard waters interfere with dyeing in the textile industry, brewing in the beer industry, and quality of the product in the canning industry. Magnesium sulfate, a particularly bothersome constituent in hard waters, has a cathartic effect on people. The chloride ion increases the conductance of electrical insulating paper; iron causes spots and stains on white goods manufactured by textile mills and on high-grade papers produced by paper mills; and carbonates produce a hard scale on peas processed in canneries. Most types of hard water encrust boiler tubes, so that transfer of heat to the water from the fire chamber is impaired. This condition, called "boiler scale," results in lowered boiler efficiency and increased cost of operation.

Another disadvantage is that, under proper environmental conditions, inorganic salts, especially nitrogen and phosphorus, induce the growth of microscopic plant life (algae) in surface waters. Although algae are really a secondary form of pollution, they can be of extreme importance. Their advantage is that of adding dissolved oxygen to the stream; their disadvantage is the organic loading they contribute after dying. Too little attention is given by industrial waste engineers to these inorganic products of waste liquors. The role of phosphorus is diverse and complicated, but it is known that in the absence of phosphorus there is practically total elimination of algae life.

There is another facet of the problem worth noting: a total absence of salts is apt to result in corrosive and/or tasteless water, whereas a certain degree of hardness enhances the development of a protective film on surfaces and renders water more palatable. Producers of baked goods, for instance, feel that some concentration of calcium

sulfate helps to achieve a golden brown crust on bread. It is therefore desirable that *some* inorganic salts be present in the water supply. The amount, rather than the presence, is the important factor.

A rather different form of pollution may exist along the coasts of southern California and Florida, as well as in parts of Texas and Arizona, where excessive withdrawal of ground water has allowed subterranean intrusion of salt water into previously fresh-water aquifers.

Acids and/or alkalis discharged by chemical and other industrial plants make a stream unsuitable not only for recreational uses such as swimming and boating, but also for propagation of fish and other aquatic life. High concentrations of sulfuric acid, sufficient to lower the pH to below 7.0 when free chlorine is not present, have been reported to cause eye irritation to swimmers, rapid corrosion of ships' hulls, and accelerated deterioration of fishermen's nets. The toxicity of sulfuric acid for aquatic life is a function of the resulting pH; i.e., a dose that would be lethal in soft water may be quite harmless in hard or highly buffered water. It is generally agreed that the pH of a stream must be not less than 4.5 and not more than 9.5 if fish are to survive. Yet stream pH values from as low as 2 to as high as 11 may occur near industrial sources of pollution.

Sodium hydroxide—to cite an example of an alkali—is highly soluble in water and affects the alkalinity and pH. It appears in wastes from many industries, including soap manufacturing, textile dyeing, rubber reclaiming and leather tanning. Streams containing as little as 25 parts of sodium hydroxide per million have been reported deadly to fish. Alkali in boiler-feed water can, by its caustic action, cause caustic embrittlement of pipes. Water-treatment plants are also adversely affected by these pollutants; for example, treatment plants using alum as a coagulant often find shock loads of acid or alkali interfering with floc formation.

Some miscellaneous processes affected by using waters of certain pH values are the rate of industrial fermentation, quality of dough in baking, flavor in soft drinks, yeast activity in brewing of beer, taste of canned fruits, especially tomatoes, cleaning of industrial metals, and gelatin and glue manufacture. A low pH may cause corrosion in air-conditioning equipment, and a pH greater than 9.5 enhances laundering.

Organic matter exhausts the oxygen resources of rivers and creates unpleasant tastes, odors, and general septic conditions. Fish and most aquatic life are stifled by lack of oxygen, and the oxygen level, combined with other stream conditions, determines the life or death of fish. It is generally conceded that the critical range for fish survival is 3 to 4 parts per million (ppm) of dissolved oxygen. We know that some species of fish may not survive in water containing 3 ppm of dissolved oxygen, while other species may not be affected even slightly by the same low oxygen level. For example, trout are sensitive fish, requiring oxygen concentrations of at least 5 ppm, whereas carp are scavenger fish, capable of surviving in waters containing as little as 1 ppm of oxygen. This oxygen shortage, caused by organic matter, is often considered to be the most objectionable single factor in a stream's pollution.

Certain organic chemicals, such as phenols, affect the taste of domestic water supplies. If rivers containing phenols permeate nearby wells, they cause objectionable medicinal tastes, and in addition there is the less-obvious organic matter, which may cause discomfort or diseases.

Suspended solids settle to the bottom or wash up on the banks and decompose, causing odors and depleting oxygen in the river water. Fish often die because of a sudden lowering of the oxygen content of a stream, and solids that settle to the bottom will cover their spawning grounds and inhibit propagation. Visible sludge creates unsightly conditions and destroys the use of a river for recreational purposes. These solids also increase the turbidity of the watercourse and enhance flooding by diminishing the stream-bed volume. Although each stream varies in the quantity of suspended solids it can safely carry away, most pollution-control authorities specify that suspended solids may be discharged into a stream only in amounts that will not impair the best usage of the stream.

Floating solids and liquids. These include oils, greases, and other materials which float on the surface; they not only make the river unsightly but also obstruct passage of light through the water, retarding the

growth of vital plant food. Some specific objections to oil in streams are that it: (1) interferes with natural reaeration; (2) is toxic to certain species of fish and aquatic life; (3) creates a fire hazard when present on the water surface in sufficient amounts; (4) destroys vegetation along the shoreline, with consequent erosion; (5) renders boiler-feed and cooling water unusable; (6) causes trouble in conventional water-treatment processes by imparting tastes and odors to water and coating sand filters with a tenacious film; (7) creates an unsightly film on the surface of the water; and (8) lowers recreational, e.g. boating, potential.

Heated water. An increase in water temperature, brought about by discharging wastes such as condenser waters into streams, has various adverse effects. Stream waters which vary in temperature from one hour to the next are difficult to process effectively in municipal and industrial water-treatment plants, and heated stream waters are of decreased value for industrial cooling. Indeed, one industry may so increase the temperature of a stream that a neighboring industry downstream cannot use the water. Furthermore, warm water is lighter than cold, so that stratification develops, and this causes most fish life to retreat to stream bottoms. Since there may be less dissolved oxygen in warm water than in cold, aquatic life suffers, and less oxygen is available for natural biological degradation of any organic pollution discharged into these warm surface waters. Also, bacterial action increases in higher temperatures, resulting in accelerated depletion of the stream's oxygen resources.

Color, contributed by textile and paper mills, tanneries, slaughterhouses and other industries, is an indicator of pollution. Compounds present in waste waters absorb certain wavelengths of light and reflect the remainder, a fact generally conceded to account for color development of streams. Color interferes with the transmission of sunlight into the stream and therefore lessens photosynthetic action. It may also interfere with oxygen absorption from the atmosphere—although no positive proof of this exists.

Visible pollution often causes more trouble for industry than invisible pollution. Unseen pollution which does not create a nuisance will often be tolerated by state agencies, but the red and deep-brown colors of slaughterhouse wastes, the browns of paper-mill wastes, various intense colors of textile-mill wastes, and the yellows of plating-mill wastes will focus public indignation directly on those industries. It is only human to complain about visible pollution: property values decrease along a visibly polluted river, and fewer people will swim, boat, or fish in a stream highly colored by industrial wastes. Furthermore, municipal and industrial water plants have great difficulty, and scant success, in removing color from raw water.

Toxic chemicals. Both inorganic and organic chemicals, even in extremely low concentrations, may be poisonous to fresh-water fish and other, smaller, aquatic microorganisms. Many of these compounds are not removed by municipal treatment plants and have a cumulative effect on biological systems. Such insecticides as toxaphene, dieldrin, and dichlorobenzene have allegedly killed fish in farm ponds and streams. Insecticides used in cotton and tobacco dusting have their maximum effect following heavy rainfalls—i.e. they are more lethal in solution—but insecticides and rodenticides are hard to detect in a stream. However, newer techniques, e.g. electron-capture gas chromatography, can detect chlorinated hydrocarbon pesticides in concentrations of 0.001 micrograms per liter in one-liter samples of water.

New, highly complex, organic compounds produced by the chemical industry for textile and other companies have also proved extremely toxic to fish life. One example is acrylonitrile, a raw material used in the manufacture of certain new synthetic fibers.

Almost all salts, some even in low concentrations, are toxic to certain forms of aquatic life. Thus, chlorides are reportedly toxic to fresh-water fish in 4000 ppm concentration, as are hexavalent chromium compounds in concentrations of 5 ppm. Copper concentrations as low as 0.1 to 0.5 ppm are toxic to bacteria and other microorganisms. Although oyster larvae, for setting, *require* a copper concentration of about 0.05 to 0.06 ppm, concentrations above 0.1 to 0.5 ppm are toxic to some species. All three salts are often found in watercourses.

Accidental or intermittent discharge of certain toxic materials may go unnoticed and yet may com-

Table 1.1 Limits set on contents of chemical elements or compounds in water supplies [1].

Characteristic	Natural mandatory limit, ppm	Recommended limit, ppm
Lead	0.1	0.05
Fluoride	1.5	0.7–1.2
Arsenic	0.05	0.01
Selenium	0.05	
Chromium (hexavalent)	0.05	
Copper		1.0
Iron		0.3
Magnesium		125
Zinc		5
Chloride		250
Sulfate		250
Phenolic compounds, in terms of phenol		0.001
Total solids		
Desirable		500
Permitted		1000
Normal carbonate ($CaCO_3$)		120
Excess alkalinity over hardness ($CaCO_3$)		35
pH (25°C)		10.6
Alkyl benzene sulfonate		0.5
Carbon chloroform extract (CCE)		0.2
Cyanide (Cn)		0.01
Manganese (Mn)		0.05
Nitrate (NO_3)		45
Strontium 90		10 $\mu\mu$c/liter
Radium 226		3 $\mu\mu$c/liter
Gross β radiation concentration		1000 $\mu\mu$c/liter

pletely disrupt stream life. Building-floor and storm-water drains that lead directly to the stream may convey contamination because of an upset in an industrial process or ignorance of the consequences. For example, the flushing of a chemical delivery tank at the unloading dock may carry dissolved toxic material into the stream through a storm drain.

Complex inorganic phosphates, such as P_2O_5, at levels as low as 0.5 ppm, perceptibly interfere with normal coagulation and sedimentation processes in water-purification plants. Increased coagulant dosages and/or increased settling times are required [9] to solve the problem. Phenols in concentrations exceeding one part per billion have been found to be objectionable in a stream. Phenol reacts with chlorine and, even in extremely small quantities, gives the residual drinking water a noticeable medicinal taste. Table 1.1 lists water-quality limits recommended by the U.S. Public Health Service [1].

Microorganisms. A few industries, such as tanneries and slaughterhouses, sometimes discharge wastes containing bacteria. Vegetable and fruit canneries may also add bacterial contamination to streams. These bacteria are of two significant types: (a) Bacteria which assist in the degradation of the organic matter as the waste moves downstream. This process may aid in "seeding" a stream (deliberate inoculation with biological life for the purpose of degrading organic matter) and in accelerating the occurrence of oxygen sag in the water. (b) Bacteria which are pathogenic, not only to other bacteria, but also to humans. An example is the anthrax bacillus, originating in tanneries where hides from anthrax-infected animals have been processed.

Radioactive materials. The manufacture of fissionable materials, the increasing peacetime use of atomic energy, and the projected development of atomic-power facilities have introduced new complications in the field of sanitary engineering. The problem of disposing of radioactive wastes is unique [2], since the effects of radiation can be immediate or delayed, and radiation is an insidious contaminant with cumulative damaging effects on living cells. Certain highly active radioisotopes such as Sr^{90} and Cs^{137} continue to release energy over long periods of time (several generations of the human race). This radiation is not readily detectable by the methods usually employed to determine the presence of contaminants in the environment. Furthermore, the biological and hydrological characteristics of a stream may have a profound influence on the uptake of radioactivity.

At present, the maximum safe concentration of mixed fission products for lifetime consumption, according to the Atomic Energy Commission, is 1×10^{-7} microcuries per milliliter. Therefore, regulatory agencies, as well as the public, are concerned about preventing contamination of surface streams by radioactive wastes [13].

Foam-producing matter, such as is discharged by textile mills, pulp and paper mills, and chemical plants, gives an undesirable appearance to the receiving stream. It is an indicator of contamination and is often more objectionable in a stream than lack of oxygen. More court cases have been fought and won on evidence about the appearance of a stream than about the unseen contents of the water. (This in itself should serve as a warning to industries discharging foam-producing wastes.)

Refracture Matter *

1.2 Effects on Sewage Plants

It is only natural for industry to presume that its wastes can best be disposed of in the domestic sewer system, and municipal officials often feel that it is their responsibility to accept any wastes flowing into their city's disposal system. However, city authorities should not accept any waste discharges into the domestic sewer system without first learning the facts about the characteristics of the wastes, the sewage system's ability to handle them, and the effects of the wastes upon *all* components of the city disposal system. Institution of a sewer ordinance, restricting the types or concentrations of waste admitted in the sewer leading to a treatment plant, is one means of protecting the system.

To remove pollution from industrial wastes, a sewage-treatment plant must have sufficient capacity and of the proper type. Theoretically, a sewage-treatment plant could be designed to handle any type of industrial waste, but present plants fall short of this ideal. Joint treatment of municipal and industrial waste waters which are amenable to treatment may offer greater *removal* efficiencies, but economics will usually be the deciding factor.

The pollutional characteristics of wastes having readily definable effects on sewers and treatment plants can be roughly classed as follows: (1) biochemical oxygen demand (BOD); (2) suspended solids; (3) floating and colored materials; (4) volume; and (5) other harmful constituents. Table 1.2 presents a comparison of domestic-sewage pollutional characteristics and those of some industrial wastes.

Table 1.2 General comparison of pollutional loads in industrial wastes versus domestic sewage [14].

Origin of waste	Population equivalent*	
	Biochemical oxygen demand	Suspended solids
Domestic sewage	1	1
Paper-mill waste	16–1330	6100
Tannery waste	24–48	40–80
Textile-mill waste	0.4–360	130–580
Cannery waste	8–800	3–440

*Persons per unit of daily production.

Biochemical oxygen demand (BOD) is usually exerted by dissolved and colloidal organic matter and imposes a load on the biological units of the treatment plant. Oxygen must be provided so that bacteria can grow and oxidize the organic matter. An added BOD load, caused by an increase in organic waste, requires more bacterial activity, more oxygen, and greater biological-unit capacity for its treatment. This calls for an increase in both capital outlay and daily operating expense.

* such as insecticides, lignin, carleaxy, methyl cellulose, tannin, pesticides, herbicides, etc. do not decompose readily by the natural ecological environment nor treatment plants. Therefore, these contaminants persist in the water resource environment and may be ingested by fish, plants, and humans. These contaminants can build up to such a degree in these "hosts" so as to become hazardous to our health.

Since a major system of industrial waste treatment is by combination with sewage the following effects should be well-understood by pollution control engineers.

However, not all dissolved or colloidal organic matter oxidizes at the same rate, with the same ease, or to the same degree. Sugars, for example, are more readily oxidized than starches, proteins, or fats. The rate of decomposition for industrial organic matter may therefore be faster or slower than that for sewage organic matter, and this difference must be considered in the design and operation of biological units. Before private industry embarks on a joint disposal venture with the city, the oxidizability of industrial wastes should be determined by the use of Warburg or other similar respirometer tests, which instantaneously measure the oxygen utilized and the carbon dioxide evolved by various solutions.

Figure 1.1 illustrates one possible effect of a given industrial waste on a sewage plant. In this instance the industrial waste, with its constant rate of degradation, tends to smooth out the rate of decomposition of the sewage so that the result shows less upsurge due to nitrogenation. Also, the rate of decomposition of the industrial waste tends to slow down the initial rapid rate of domestic sewage.

After much experimentation, Ettinger [3] believes that there is still some doubt whether activated-sludge biological units are able to handle slug waste discharges better than digesters, which have the advantages of inherent storage capacity and assumed complete mixing.

Suspended solids are found in considerable quantity in many industrial wastes, such as cannery and paper-mill effluents. They are screened and/or settled out of the sewage at the disposal plant. Solids removed by settling and separated from the flowing sewage are called *sludge*, which may then undergo an anaerobic decomposition known as digestion and be pumped to drying beds or vacuum filters for extraction of additional water. Certain settleable suspended solids from industrial wastes, e.g. fine grit and insoluble metal precipitates, may hinder sludge digestion.

Suspended solids in industrial waste may settle more rapidly or slowly than sewage suspended matter. If industrial solids settle faster than those of municipal sewage, sludge should be removed at shorter intervals to prevent excessive build-up. Quantities of stale sludge may be "scoured" (dislodged by physical means) off the bottom of the basin, with resultant increase of sludge in the effluent. A faster-

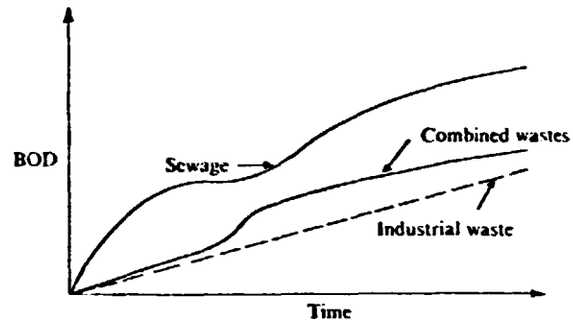

Fig. 1.1 Deoxygenation rates of sewage, a certain industrial waste, and a combination of the two.

settling industrial waste may accelerate the settling of sewage solids; a slower-settling one will require a longer detention period and larger basins and increase the likelihood of sludge decomposition, with accompanying nuisances, during slack sewage-flow periods. However, regardless of the settling rate, the quantity of sludge to be pumped to the sludge-disposal facilities at the treatment plant will be increased by the addition of such industrial waste. Since sludge digesters, drying beds, and filters are designed to handle a certain number of pounds of solids per unit of capacity, any increased demands on the system usually require larger sludge-handling devices and may ultimately necessitate an increase in the plant's capacity, with resulting higher capital and operating expenses.

The settling characteristics of industrial wastes, alone and combined with municipal waste, should be determined before any disposal agreement between industry and city. Sludge consistency, percentage of total suspended solids removed, and weight of suspended solids removed are the criteria for evaluating settling characteristics.

Floating materials and colored matter, such as oil, grease, and dyes from textile-finishing mills, are disagreeable and visible nuisances. Visible pollution retards the development of a community or area, since it discourages camping, boating, swimming, and fishing—recreations indispensable to the vitality of a physically and mentally healthy community—and industry is reluctant to locate on a stream which is visibly polluted. Lack of industry further depresses

the growth of city, county, and state, for less tax money means less progress. It is therefore imperative that nuisances such as color and floating matter be removed by the sewage-treatment plant.

A modern treatment plant will remove normal grease loads in primary settling tanks, but abnormally high loads of predominantly emulsified greases from laundries, slaughterhouses, rendering plants, and so forth, passing through the primary units (screens, grit chambers, and settling basins) into the biological units, will clog flow-distributing devices and air nozzles. A lengthy shutdown of these units may result in stream pollution and sudden loss of fish life.

Color removal by the treatment units of sewage plants is a knotty problem, and too little effort has been made so far to find an effective solution. The author found that trickling-filter plants in North Carolina were removing between 34 and 44 per cent of the dye color in the influent [12]. An overloaded primary plant, on the other hand, *added* 12 per cent to the color as waste passed through the plant. A knowledge of the character and measurement of color is essential. Since most colored matter is in a dissolved state, it is not altered by conventional primary devices, although secondary treatment units, such as activated sludge and trickling filters, remove a certain percentage of some types of colored matter. Sewage-treatment plants are generally not designed to remove color, so any reduction in this constituent is a fortunate coincidence, but, because of the previously mentioned detriment to streams, municipal disposal plants should in the future give increased consideration to removal of color. If an industry defines the type and quantity of colored matter in its waste, engineers can then make some prediction concerning the effectiveness of color removal by the treatment designed for domestic sewage.

Volume. A sewage plant can handle any volume of flow if its units are sufficiently large. Unfortunately, most sewage plants are already in operation when a request comes to accept the flow of waste from some new industrial concern. The hydraulic capacity of all units must then be analyzed; sewer lines must be examined for carrying capacity, bar screens for horizontal flow velocity, settling basins for detention periods and surface and weir overflow rates, trickling filters for excessive hydraulic loadings, and so forth.

An industry with a relatively clean waste such as condenser water can usually discharge it, after cooling, directly into the receiving stream and thus avoid overloading the sewage-treatment plant. This expedient saves capital and operating expenses at the disposal plant. However, before seemingly clean waters are accepted for direct disposal, they must be carefully examined for dissolved solids. Even a small concentration of solids in a large volume of waste water will sometimes result in a significant total-solids load.

Other harmful constituents. Industrial wastes may contain harmful ingredients in addition to the polluting load. These wastes can cause malfunctioning of the sewer system and/or the disposal plant. Some nuisances and their accompanying effects are:

(a) Toxic metal ions (Cu^{++}, Cr^{+6}, Zn^{++}, CN^{-}), which interfere with biological oxidation by tying up enzymes required to oxidize organic matter.
(b) Feathers, which clog nozzles, overload digesters, and impede proper pump operation.
(c) Rags, which clog pumps and valves and interfere with proper operation of bar screens or comminutors.
(d) Acids and alkalis, which may corrode pipes, pumps, and treatment units, interfere with settling, upset the biological purification of sewage, release odors, and intensify color.
(e) Flammables, which cause fires and may lead to explosions.
(f) Pieces of fat, which clog nozzles and pumps and overload digesters.
(g) Noxious gases, which present a direct danger to workers.
(h) Detergents, which cause foaming of aeration units.
(i) Phenols and other toxic organic material.

1.3 Differences Between Industrial and Municipal Wastes

Industry's primary objective is to produce the best possible product of its type at the lowest possible cost. Thus having to install waste treatment devices would contravene industry's primary objective. In order to

compete in the world market, industry must hold production costs to a minimum. The most obvious area for cost-saving is in the area of waste treatment, since the product is least affected by reductions here. While a municipality may also be concerned with reducing its operating costs, it is more likely to be influenced by regulations requiring conformance to generally accepted practice. If this should result in higher costs, they will somehow be met by the larger and more distant "municipal fathers." A municipality is also concerned with providing a service in an orderly manner. It is significant to note that this service may provide additional employment for municipal constituents—a notion not inconsistent with the municipality's objective. The reader can comprehend rather readily that there are distinct and rather significant purposes for an industrial plant and its municipal counterpart.

Industry's operating schedule is one of extreme variability. One day an industrial plant might be closed while on another day it might be operating at two or three times its normal capacity in order to fill an urgent order. On one day a load of wastewater might be "dumped" at noon because of an error in operating schedules and on another day wastewater might not be discharged at that same time either because of a lack of orders or because of a malfunction in a production unit. There may be no wastewater from an industrial plant on weekends; however, the municipal wastewater system must and usually does operate 24 hours a day, 7 days a week. Further, wastewater flows from a municipality in a rather predictable pattern throughout each day. Therefore treatment plants must be designed and operated differently to handle the two systems.

Industry views wastewater treatment as an imposed necessity which it employs when it is compelled to, especially when wastewater's effect on the receiving watercourse is readily visible or when public approval and acclaim will be gained for the expenditure and effort. A municipality views wastewater treatment as a service to the community to be employed whenever the people are willing or can be convinced by higher authorities to pay the extra taxation required to implement it.

The number of contaminants in industrial waste can run the gamut of a scale from zero to about 100,000 parts per million. Industrial waste varies temporally and, in the normal course of operation, is unpredictable. The strengths and volumes of municipal sewage, on the other hand, are well established and occur within the rather narrow limits of 100 to 1000 parts per million for the contaminants that are generally measured in volumes of 50 to 150 gallons per person per day. Once again treatment systems for each type of contaminant must be designed and operated differently.

Industrial waste deoxygenates at rates which vary from negative values to about five times the rates at which normal domestic sewage deoxygenates. Some wastes have no organic matter and thus no deoxygenation rates or oxygen demands. Domestic sewage deoxygenates at a quite constant rate, seldom varies from a range of 0.07 to 0.20, and is usually discharged independently of the time of day or week.

Water-using industrial plants are generally located in specially zoned areas—that is, newer plants are located outside municipal limits and upstream from the sewage effluent discharges, while older plants are located nearer the city and many times within the city limits but still generally upstream from sewage outfalls. Often industrial plants are not conveniently located near municipal sewers or, if they are, these sewers may be of inadequate capacity to accept the industrial wastes. Municipal sewage-treatment plants are generally located in low-lying areas downstream from the municipality but near its boundaries. Usually many miles may separate municipal plants and industrial operations.

Industrial plants are generally managed by personnel who have been centrally trained and brought in from some distant location. These managers frequently change location, thus they are seldom inbued with the area patriotism of a locally born and raised citizen. Industrial plant managers often attempt to overcome this barrier by purposely taking an active interest in community affairs. In some cases they are successful, but in many others their participation is primarily superficial and, in any event, is impeded by their temporary status at this plant location. Municipal officials are mostly "hometown" people who have gained the respect and confidence of their people over a great number of years. And further, they must act on the behalf of their people since they wish to remain respected citizens of the community after their official municipal duties are over.

These examples point out to the reader that one must not approach the solution to industrial-waste problems in a manner similar to those of municipal sewage problems. Now that you have seen the differences between industrial and municipal operations you are in a better position to absorb the remaining chapters of this text.

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VOLUME REDUCTION

In general, the first step in minimizing the effects of industrial wastes on receiving streams and treatment plants is to reduce the volume of such wastes. This may be accomplished by: (1) classification of wastes; (2) conservation of waste water; (3) changing production to decrease wastes; (4) reusing both industrial and municipal effluents as raw water supplies; or (5) elimination of batch or slug discharges of process wastes.

6.1 Classification of Wastes

If wastes are classified, so that manufacturing-process waters are separated from cooling waters, the volume of water requiring intensive treatment may be reduced considerably. Sometimes it is possible to classify and separate the process waters themselves, so that only the most polluted ones are treated and the relatively uncontaminated are discharged without treatment. The three main classes of waste are:

a) Wastes from manufacturing processes. These include waters used in forming paper on traveling wire machines, expended from plating solutions in metal fabrication, discharged from washing of milk cans in dairy plants, and so forth.

b) Waters used as cooling agents in industrial processes. The volume of these wastes varies from one industry to another, depending on the total Btu's to be removed from the process waters. One large refinery discharges a total of 150 million gallons per day (mgd), of which only 5 mgd is process waste; the remainder is only slightly contaminated cooling-water waste. Although cooling water can become contaminated by small leaks, corrosion products, or the effect of heat, these wastes contain little, if any, organic matter and are classed as nonpollutional from that standpoint.

c) Wastes from sanitary uses. These will normally range from 25 to 50 gallons per employee per day. The volume depends on many factors, including size of the plant, amount of waste-product materials washed from floors and the degree of cleanliness required of workers in the process operation.

Unfortunately, in most older plants, process, cooling, and sanitary waste waters are mixed in one pipeline; before 1930, industry paid little attention to segregating wastes to avoid stream pollution.

6.2 Conservation of Wastewater

Water conserved is waste saved. Conservation begins when an industry changes from an "open" to a "closed" system. For example, a paper mill which recycles white water (water passing through a wire screen upon which paper is formed) and thus reduces the volume of wash waters it uses is practicing water conservation. Concentrated recycled waste waters are often treated at the end of their period of usefulness, since usually it is impractical and uneconomical to treat the wastewaters as they complete each cycle. The savings are twofold: both water costs and waste-treatment costs are lower. However, many changes to effect conservation are quite costly and their benefits must be balanced against the costs. If the net result is deemed economical, then new conservation practices can be installed with assurance.

A paperboard mill may discharge 10,000 gallons of waste water per ton of product, although there are many variations from one mill to the next. Paper mills may release as much as 100,000 gallons or as little as 1,000 gallons of waste water per ton of product. The latter figure is usually the result of a scarcity of water and/or an awareness of the stream-pollution problem and demonstrates what can be accomplished by effective waste elimination and conservation of water. One large textile mill reduced its water consumption by 50 per cent during a municipal water shortage, without any drop in production.

STRENGTH REDUCTION

Waste strength reduction is the second major objective for an industrial plant concerned with waste treatment. Any effort to find means of reducing the total pounds of polluting matter in industrial wastes will be well rewarded by the savings due to the reduced requirements for waste treatment. The strength of wastes may be reduced by: (1) process changes; (2) equipment modifications; (3) segregation of wastes; (4) equalization of wastes; (5) by-product recovery; (6) proportioning wastes; and (7) monitoring waste streams.

7.1 Process Changes

In reducing the strength of wastes through process changes, the sanitary engineer is concerned with wastes that are most troublesome from a pollutional standpoint. His problems and therefore his approach differ from those of the plant engineer or superintendent. Sometimes tremendous resistance by a plant superintendent must be overcome in order to effect a change in process. The superintendent possesses considerable security because he can do a familiar job well; why should he jeopardize his position merely to prevent stream pollution? The answer is obvious. Industry dies when its progress stops. No manufacturer can meet present-day market competition without continually, and critically, reviewing and analyzing his production techniques. In addition, pollution abatement can no longer be considered by industry as a "optional" act; on the contrary, it must be regarded as a vital step in preserving water resources for all users. Many industries have resolved waste problems through process changes. Two such examples of progressive management are the textile and metal-fabricating industries. On the other hand, the leather industry still generally uses lime and sulfides (major contaminants of tannery wastes), although it is known that amines and enzymes could be substituted. The lag between research and actual application is often extensive and is caused by many operational difficulties.

Textile-finishing mills were faced with the disposal of highly pollutional wastes from sizing, kiering, desizing, and dyeing processes. Starch had been traditionally used as a sizing agent before weaving and this starch, after hydrolysis and removal from the finished cloth, was the source of 30 to 50 per cent of the mill's total oxygen-demanding matter. The industry began to express an interest in cellulosic sizing agents, which would exhibit little or no BOD or toxic effect in streams. Several highly substituted cellulosic compounds, such as carboxymethyl cellulose, were developed and used in certain mills, with the result that the BOD contributed by desizing wastes was reduced almost in direct relation to the amount of cellulosic sizing compound used.

In the metal-plating industries [1], seven changes of process or materials have been suggested. Thus, to eliminate or reduce cyanide strengths: (1) change from copper–cyanide plating solutions to acid–copper solutions; (2) replace the $CuCN_2$ strike before the copper-plating bath with a nickel strike; (3) substitute a carbo-nitriding furnace, which uses a carburizing atmosphere and ammonia gas, for the usual molten cyanide bath. For other purposes: (4) use "shot blast" or other abrasive treatment on non-intricate parts instead of H_2SO_4, in pickling of steel; (5) substitute H_3PO_4 for H_2SO_4 in pickling; (6) use alkaline derusters instead of acid solutions to remove light rust which occurs during storage (the overall pH will be raised nearer to neutrality by this procedure, which will also alleviate corrosive effects on piping and sewer lines); (7) replace soluble oils, and other short-term rust-preventive oils applied to parts after cleaning, with "cold" cleaners. These cleaners can be used in both the wash solution and the rinse solution. They inhibit rust chemically rather than by a film of oil or grease.

Excessively acid or alkaline wastes should not be discharged without treatment into a receiving stream. A stream even in the lowest classification—that is, one classified for waste disposal and/or navigation—is adversely affected by low or high pH values. This adverse condition is even more critical when *sudden* slugs of acids or alkalis are imposed upon the stream.

There are many acceptable methods for neutralizing overacidity or overalkalinity of waste waters, such as: (1) mixing wastes so that the net effect is a near-neutral pH; (2) passing acid wastes through beds of limestone; (3) mixing acid wastes with lime slurries or dolomitic lime slurries; (4) adding the proper proportions of concentrated solutions of caustic soda (NaOH) or soda ash (Na_2CO_3) to acid wastes; (5) blowing waste boiler-flue gas through alkaline wastes; (6) adding compressed CO_2 to alkaline wastes; (7) producing CO_2 in alkaline wastes; (8) adding sulfuric acid to alkaline wastes.

The material and method used should be selected on the basis of the overall cost, since material costs vary widely and equipment for utilizing various agents will differ with the method selected. The volume, kind, and quantity of acid or alkali to be neutralized are also factors in deciding which neutralizing agent to use.

In any lime neutralization treatment, the waste engineer should establish a minimum acceptable effluent pH and allow adequate reaction time for an acid effluent to reach this minimum pH. This will usually save considerable unnecessary expense [13]. In many cases, a mill can cut down on neutralization costs by providing sufficient detention time and sacrificing some efficiency in subsequent biological treatment (if used). During storage of alkaline wastes in contact with air, CO_2 will slowly dissolve in the waste and lower the pH. However, detention time alone, within feasible limits, will not effect as low a final pH as can be obtained by the use of neutralizing chemicals. Since biological treatment is more efficient at pH values nearer neutrality, prior neutralization by chemicals renders such treatment more effective.

8.1 Mixing Wastes

Mixing of wastes can be accomplished within a single plant operation or between neighboring industrial plants. Acid and alkaline wastes may be produced individually within one plant and proper mixing of these wastes at appropriate times can accomplish neutralization (Fig. 8.1), although this usually requires some storage of each waste to avoid slugs of either acid or alkali.

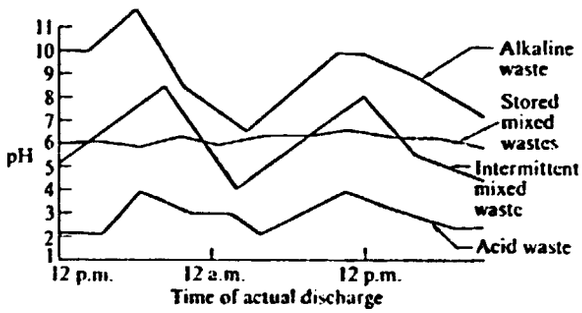

Figure 8.1

If one plant produces an alkaline waste which can be pumped conveniently to an area adjacent to a plant discharging an acid waste, an economical and feasible system of neutralization results for each plant. For example, a building-materials plant producing an alkaline (lime and magnesia) waste pumps the slurry, after some equalization, about one-half mile to mix with the effluent from a chemical plant producing an acid waste. The neutralized waste resulting from this combination is more readily treatable for final disposal and both plants thus solve problems in economics, politics, and engineering.

EQUALIZATION AND PROPORTIONING

9.1 Equalization

Equalization is a method of retaining wastes in a basin so that the effluent discharged is fairly uniform in its sanitary characteristics (pH, color, turbidity, alkalinity, BOD, and so forth). A secondary but significant effect is that of lowering the concentration of effluent contaminants. This is accomplished not only by ironing out the slugs of high concentration of contaminants but also by physical, chemical, and biological reactions which may occur during retention in equalization basins. For example, the recent increases in industrial wastes reported by Fall [1] at Peoria have greatly varied the organic loading at the treatment plant. A retention pond serves to level out the effects of peak loadings on the plant while substantially lowering the BOD and suspended-solids load to the aeration unit. Air is sometimes injected into these basins to provide: (1) better mixing; (2) chemical oxidation of reduced compounds; (3) some degree of biological oxidation; and (4) agitation to prevent suspended solids from settling.

The size and shape of the basins vary with the quantity of waste and the pattern of its discharge from the factory. Most basins are rectangular or square, although Metzger [5] has recently found that triangular tanks produce satisfactory flow distribution. The capacity should be adequate to hold, and render homogeneous, all the wastes from the plant. Almost all industrial plants operate on a cycle basis; thus, if the cycle of operations is repeated every two hours, an equalization tank which can hold a two-hour flow will usually be sufficient. If the cycle is repeated only each 24 hours, the equalization basin must be big enough to hold a 24-hour flow of waste. Herion and Roughhead [3] report the use of 72-hour equalization for a pharmaceutical waste to ensure ample mixing. This period (three times the 24-hour cycle of operations) was selected as the proper detention time in order not to disrupt the biota of the activated-sludge

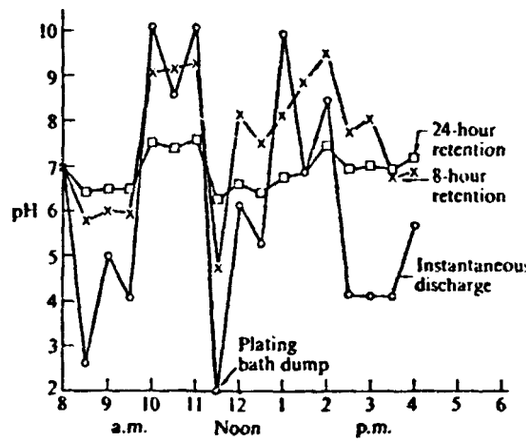

Fig. 9.1 Effect of equalization.

units. In a wool-finishing-mill waste containing dieldrin (a mothproofing insecticide) an equalization period of 44 days was necessary to yield a receiving stream concentration of less than 0.0005 mg/liter. Figure 9.1 compares the effects of 8-hour and 24-hour detention periods on the final pH of metal-plating wastes.

The mere holding of waste, however, is not sufficient to equalize it. Each unit volume of waste discharged must be adequately mixed with other unit volumes of waste discharged many hours previously. This mixing may be brought about in the following ways: (1) proper distribution and baffling; (2) mechanical agitation; (3) aeration; and (4) combinations of all three.

Proper distribution and baffling is the most economical, though usually the least efficient, method of mixing.

9.2 Proportioning

Proportioning means the discharge of industrial wastes in proportion to the flow of municipal sewage in the sewers or to the stream flow in the receiving river. In most cases it is possible to combine equalization and proportioning in the same basin. The effluent from the equalization basin is metered into the sewer or stream according to a predetermined schedule. The objective of proportioning in sewers is to keep constant the percentage of industrial wastes to domestic-sewage flow entering the municipal sewage plant. This procedure has several purposes: (1) to protect municipal sewage treatment using chemicals from being impaired by a sudden overdose of chemicals contained in the industrial waste; (2) to protect biological-treatment devices from shock loads of industrial wastes, which may inactivate the bacteria; (3) to minimize fluctuations of sanitary standards in the treated effluent.

REMOVAL OF SUSPENDED SOLIDS

10.1 Sedimentation

Although sedimentation is a method of treatment utilized in almost all domestic-sewage treatment plants, it should be considered for industrial-waste treatment only when the industrial waste is combined with domestic sewage or contains a high percentage of settleable suspended solids, such as are found in cannery, paper, sand-and-gravel, coal-washery, and certain other wastes. The efficiency of sedimentation tanks depends, in general, on the following factors:

Detention period	Velocity of particles
Waste-water characteristics	Density of particles
Tank depth	Container-wall effect
Floor surface area and overflow rate	Number of basins (baffles)
Operation (cleanliness)	Sludge removal
Temperature	Pretreatment (grit removal)
Particle size	Flow fluctuations
Inlet and outlet design	Wind velocity

Although settling tanks have been used for other purposes, such as grease flotation, equalization, and BOD reduction, they are primarily used for removing settleable suspended matter. Theoretically, a suspended particle in a waste-water solution will continue to settle at a fixed velocity relative to the solution, as long as the particle remains discrete; when it coalesces with other particles, its size, shape, and resulting density will change, as will its settling velocity. Coagulation, or self-flocculation, of particles causes an increase in velocity. In liquid wastes containing high percentages of suspended solids, greater reductions in the suspended solids will occur primarily because of increased flocculation. The fixed settling velocity will also be altered by changes in the temperature and density of the liquid solvent through which the particle is moving. Rising layers of warmer liquid can cause eddying and a disturbance in the settling of particles; an increased density in the lower layers of liquid can deter the particle from settling to the bottom. These factors can interfere with settling to such an extent that particles may be carried out of the tank with the effluent.

Depth of tank is also of great importance. The deeper the tank (all other factors being equal) the better the chance of preventing the deposited solids from being resuspended—e.g., by sudden scouring due to turbulence caused by unequal flow distribution or by exposure to wind or temperature effects—and thus being carried out with the effluent. This is especially important when sludge is stored in sedimentation basins for lengthy periods before pumping. If the solids are continuously removed from the bottom of settling tanks as soon as they land, shallower tanks can be built.

Surface area is another factor affecting tank efficiency, and engineers agree that floor area must be adequate to receive all the particles to be removed from the waste waters. However, many state health departments, when establishing acceptable dimensions for settling basins, do so on the basis of standard detention periods. In certain designs this method may not provide adequate floor area and complete settling is not achieved.

Figure 10.1 illustrates the effect of doubling the floor area and halving the depth of a settling basin, with volume and detention time remaining constant. Theoretically, the basin in Fig. 10.1 (b) will remove twice as many discrete particles as the basin in (a). Therefore, the engineer should strive to design settling basins which are as shallow as possible and contain ample floor area. However, tanks less than six feet deep have been found impractical from an operational standpoint, because they are subject to upsetting by scouring or velocity of currents. The floor area is increased most satisfactorily by extending the length of the basin.

Flotation and screening are also used in special cases to remove suspended solids.

REMOVAL OF COLLOIDAL SOLIDS

11.1 Characteristics of Colloids

A colloid may be defined as a particle held in suspension by its extremely small size (1 to 200 millimicrons), its state of hydration, and its surface electrical charge. There are two types of colloids: *lyophobic* and *lyophilic*. Because of the difference in their characteristics, they react differently to alterations in their environment. Table 11.1 will assist the student in understanding their properties. Colloids are often responsible for a relatively high percentage of the color, turbidity, and BOD of certain industrial wastes. Since it is important to remove colloids from waste waters before they can get into streams, one must understand their physical and chemical characteristics.

Colloids exhibit Brownian movement, a bombardment of the particles of the disperse phase by molecules of the dispersion medium. They are essentially nonsettleable because of their charge, small size, and low particle weight. They are dialyzable; that is, they can be separated from their crystalloid (low molecular weight) counterparts by straining through a semipermeable membrane. The colloids diffuse very slowly compared to soluble ions. Colloidal particles, in general, exhibit very low (if any) osmotic pressure because of their large size relative to the size of soluble ions. They also possess the characteristic of imbibition (the taking in of water by gels). In fact, it is by this very process that bacteria spores (often considered colloidal) take up water and germinate. Colloidal gels are very often used as ultrafilters, having pores sufficiently small to retain the dispersed phase of a colloidal system but large enough to allow the dispersion medium and its crystalloid solutes to pass through. For example, Perona *et al.* [10] in 1967 found that the formed membranes may be used to remove up to 90 per cent of the colored material and somewhat less of the COD and total dissolved solids of pulp-mill sulfite wastes. Colloidal systems show a wide range in viscosity or plasticity. Usually the lyophobic colloidal suspensions exhibit a viscosity only slightly higher than that of the pure dispersing medium (Fig. 11.1) and this concentration increases only very slightly when the concentration of the dispersed material is increased. On the other hand, lyophilic systems may reach very high values of viscosity. With these types of colloids, a parabolic, rather than a linear, relationship exists between viscosity and the concentration of dispersed phase, as shown in Fig. 11.1. Woodard and Etzel [21] have shown that, under certain conditions, one may change a lyophilic colloid in an industrial waste to a lyophobic one. In this case, lignin was altered by the addition of acetone and sodium hydroxide to render the colloid less stable and to enhance color removal.

Many colloidal systems, especially lyophilic (gel) systems, possess the property of elasticity ("springiness" or r[illegible]ance). This property enables the gels to resist defo[illegible]tion and thereby recover their original shape and size once they have been deformed. If a concentrated beam of light is passed through a colloidal solution in which the dispersed phase has a different refractive index from that of the dispersion medium, its path is plainly visible as a milky turbidity when viewed perpendicularly. This is known as the Tyndall effect.

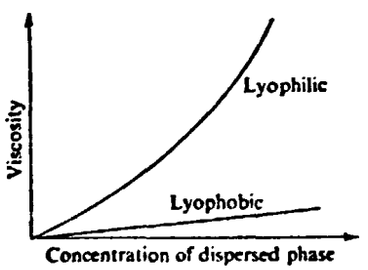

Fig. 11.1 Effect of colloidal type on viscosity.

They are usually removed by chemical coagulation resulting from a neutralization of negative changes with Al^{+++} or Fe^{+++}.

REMOVAL OF ORGANIC DISSOLVED SOLIDS

The removal of dissolved organic matter from waste waters is one of the most important tasks of the waste engineer, and, unfortunately, also one of the most difficult. These solids are usually oxidized rapidly by microorganisms in the receiving stream, resulting in loss of dissolved oxygen and the accompanying ill effects of deoxygenated water. They are difficult to remove because of the extensive detention time required in biological processes and the elaborate and often expensive equipment required for other methods. In general, biological methods have proved most effective for this phase of waste treatment, since bacteria are adept at devouring organic matter in wastes, and the greater the bacterial efficiency the greater the reduction of dissolved organic matter. Microorganisms, however, are quite "temperamental" and sensitive to changes in environmental conditions, such as temperature, pH, oxygen tension (level of oxygen concentration), mixing, toxic elements or compounds, and character and quantity of food (organic matter) in the surrounding medium. It is the responsibility of the engineer to provide optimum environmental conditions for the proliferation of the particular biological species desired.

There are many varieties of biological treatment, each adapted to certain types of waste waters and local environmental conditions such as temperature and soil type. Some specific processes for treating organic matter are: (1) lagooning in oxidation ponds; (2) activated-sludge treatment; (3) modified aeration; (4) dispersed-growth aeration; (5) contact stabilization; (6) high-rate aerobic treatment (total oxidation); (7) trickling filtration; (8) spray irrigation; (9) wet combustion; (10) anaerobic digestion; (11) mechanical aeration system; (12) deep well injection; (13) foam phase separation; (14) brush aeration; (15) subsurface disposal; and (16) the Bio-Disc system.

13.1 Lagooning

Lagooning in oxidation ponds is a common means of both removing and oxidizing organic matter and waste waters as well. More research is needed on this method of treatment, which originally developed as an inexpensive procedure for ridding industry of its waste problem. An area adjacent to a plant was excavated, and waste waters either flowed or were pumped into the excavation at one end and out into a receiving stream at the other end. The depth of the lagoon depended on how much land was available, the storage period desired or required, and the condition of the receiving stream. Little attention was paid originally to the effect of depth on bacterial efficiency. In fact, reduction of dissolved organic matter was usually not anticipated or even desired, since it was presumed, and with good reason, that biological degradation of organic matter would lead to oxygen depletion and accompanying nuisances from odors. Thus, the lagoons served solely to settle sludge and equalize the flow. Now, modern techniques have led to new theories about the stabilization of organic matter in lagoons.

We now know that stabilization or oxidation of waste in ponds is the result of several natural self-purification phenomena. The first phase is sedimentation. Settleable solids are deposited in an area around the inlets to the ponds, the size of the area depending on the manner of feeding in the waste and location of the inlet. Some suspended and colloidal matter is precipitated by the action of soluble salts; decomposition of the resulting sediment by microorganisms changes the sludge into inert residues and soluble organic substances, which in turn are required by other microorganisms and algae for their metabolic processes.

REMOVAL OF INORGANIC DISSOLVED SOLIDS

The removal of dissolved minerals from waste waters has been given relatively little attention by waste-treatment engineers, because minerals have been considered less pollutional than other constituents, such as organic matter and suspended solids. However, as we learn more about the causes and effects of pollution, the importance of reducing the quantity of certain types of inorganic matter which sewage plants permit to enter streams is apparent. Chlorides, phosphates, nitrates, and certain metals are examples of the more common and significant inorganic dissolved solids. Among the methods employed mainly for removing inorganic matter from wastes are: (1) evaporation; (2) dialysis; (3) ion exchange; (4) algae; (5) reverse osmosis; and (6) miscellaneous methods. Other treatment methods which remove minerals incidentally but are aimed primarily at other contaminants are discussed in Chapters 10, 11, and 13. One should not overlook the minerals contributed by natural runoff from overland flow. The amount of dissolved solids which these natural flows contain often exceeds that contributed by waste waters from industry.

12.1 Evaporation

Evaporation is a process of bringing waste water to its boiling point and vaporizing pure water. The vapor is either used for power production, or condensed and used for heating, or simply wasted to the surrounding atmosphere. The mineral solids concentrate in the residue, which may be sufficiently concentrated for the solids either to be reusable in the production cycle or to be disposed of easily. This method of disposal is used for radioactive wastes, and paper mills have for a long time been evaporating their sulfate cooking liquors to a degree where they may be returned to the cookers for reuse.

Major factors in the selection of the evaporation method are: (1) *Economics:* does the value of the reusable residue outweigh the cost of fuel for evaporation? (2) *Initial dissolved solids:* are there enough solids in the waste, of a variable nature, to warrant evaporation? Generally, 10,000 ppm are required. (3) *Foreign matter:* is there foreign matter present which could cause scale formation or corrosion or interfere with heat transfer in evaporation? (4) *Pollution situation:* what effect will the minerals have on the receiving stream? For example, caustic soda kills fish, ammonium salts initiate troublesome algae growths and in some cases stimulate bacterial growth upon organic matter already present [1], salt interferes with water use by industries and municipalities, and so forth.

Today many evaporators are heated by steam condensing on metallic tubes, through which flows the waste to be concentrated or evaporated. The steam is at a low pressure, usually less than 50 pounds per square inch (psi) (absolute). Most evaporators operate with a slight vacuum on the vapor side, to lower the boiling point and to increase the rate of vapor removal from the evaporator. Vacuum systems are especially preferable to atmospheric evaporators when the decomposition of organic matter is involved. Care must be exercised, however, that the vacuum is not great enough to permit priming of the waste water into the vapor.

Evaporating a waste presents many problems, which include concentration changes during evaporation, foaming, temperature sensitivity, scale formation, and the materials used in evaporator construction. In industrial-waste concentration, scale formation usually presents the major obstacle. As crust is deposited on the heating surface, the overall heat-transfer coefficient decreases, causing the efficiency to drop until it is necessary to shut down and clean the tubes—a complicated process when the scale is hard and tenacious.

TREATMENT AND DISPOSAL OF SLUDGE SOLIDS

Of prime importance in the treatment of all liquid wastes is the removal of solids, both suspended and dissolved. Once these solids are removed from the liquids, however, their disposal becomes a major problem. Unfortunately, waste engineers spend more time and money removing the solids than finally treating and disposing of them, so that often a poor solids-disposal program will cause trouble in an otherwise properly designed and operated waste-treatment plant. When the solids-disposal system is poor, the solids tend to build up in the flow-through treatment units and overall removal efficiences then begin to decrease. Therefore, proper sludge handling enhances the overall treatment of all wastes. The following list contains most of the methods commonly used to deal with sludge solids: (1) anaerobic and aerobic digestion; (2) vacuum filtration; (3) elutriation; (4) drying beds; (5) sludge lagooning; (6) wet combustion; (7) atomized suspension; (8) drying and incineration; (9) centrifuging; (10) sludge barging; (11) landfill; (12) sludge pumping; and (13) miscellaneous methods.

14.1 Anaerobic and Aerobic Digestion

Anaerobic digestion is a common method of readying sludge solids for final disposal. All solids settled out in primary, secondary, or other basins are pumped to an enclosed airtight digester, where they decompose in an anaerobic environment. The rate of their decomposition depends primarily on proper seeding, pH, character of the solids, temperature, and degree of mixing of raw solids with actively digesting seed material. Digestion serves the dual purpose of rendering the sludge solids readily drainable and converting a portion of the organic matter to gaseous end-products. It may reduce the volume of sludge by as much as 50 per cent organic matter reduction. After digestion, the sludge is dried and/or burned, or used for fertilizer or landfill.

Two main groups of microorganisms, hydrolytic and methane, carry out digestion. Hydrolytic bacteria exist in great numbers in sewage and waste sludges and are capable of rapid rates of reproduction; they are saprophytic microorganisms that attack complex organic substances and convert them to simple organic compounds. Among these saprophytes are many acid-forming bacteria which produce fatty acids of low molecular weight, such as acetic and butyric, during degradation processes. In some cases, such acids are produced in quantities sufficient to lower the pH to a level where all biological activity is arrested.

Fortunately, methane bacteria, the other group of microorganisms, are capable of utilizing the acid and other end-products formed by the hydrolytic bacteria. Methane producers, however, are sensitive to pH changes and proliferate only within a narrow pH range of 6.5 to 8.0, with an optimum of 7.2 to 7.4; furthermore, they are few in number and reproduce slowly. Consequently, organic acids may form faster than they can be assimilated by the limited population of methane bacteria. As a result, the pH may be lowered and conditions made even more unfavorable for methane bacteria. When this happens, lime is usually added and the digestion process stopped until normal conditions return.

The proper environment for both types of bacteria requires a balance between population of organisms, food supply, temperature, pH, and food accessibility. The following factors are measures of the effectiveness of digestive action: gas production (both quantity and quality), solids balance (total, volatile, and fixed), BOD, acidity and pH, volatile acids, grease, sludge characteristics, and odor.

5 (C) THE HONG KONG PRODUCTIVITY CENTRE PRESENTS

SEMINAR II

BY

DR. NELSON LEONARD NEMEROW, UNIDO EXPERT

JUNE 21, 1982

" ADVANCED WASTE TREATMENT TECHNIQUES." (COST-EFFECTIVE SOLUTIONS)

1- High pH - High Solids BIOLOGICAL AERATION	9:30- 10:45 AM
2- BAFFLED BIOLOGICAL BASINS	11:15 AM- 12:30 PM
3- AQUACULTURE SYSTEMS	2 PM - 3:00 PM
4- ENVIRONMENTALLY - BALANCED INDUSTRIAL COMPLEXES	3:30 - 5:00 PM

SEMINARS ON
INDUSTRIAL WATER POLLUTION CONTROL

Water pollution control for industrial production is rapidly becoming necessary throughout the world in order to protect the quality of our limited water resources. In most developed countries industry has accepted this fact and includes any associated expense as part of the cost of production. The cost can no longer be avoided, but it can be minimized by a combination of early research, planning, and an adequate knowledge of waste treatment techniques.

Water pollution, if unabated, will eventually constrain any and all types of industrial production. Therefore we all have a vital stake in preventing pollution from our factories.

Dr. Nemerow, the author of several textbooks on industrial waste treatment, serves as consultant-expert for UNIDO, WHO and the World Bank.

The first of the two seminars given by Dr. Nemerow is intended to acquaint the participants with a basic understanding of the various types of industrial contaminants and the generally accepted techniques for rendering these contaminants safe for discharge. The second seminar will describe some advanced techniques devised by him to prevent environmental pollution at the lowest cost.

Speaker

Dr. Nelson Leonard Nemerow, a professor, researcher, and consulting engineer, for 30 years is currently Professor Environmental Engineering, University of Miami, Coral Gables, Florida, U.S.A.

Date & Time

SEMINAR I 14.6.1982 (Monday)
9:30 a.m. - 5:00 p.m.

SEMINAR II 21.6.1982 (Monday)
9:30 a.m. - 5:00 p.m.

Venue

The Hong Kong Productivity Centre
20th Floor, Sincere Building,
173 Des Voeux Road Central,
Hong Kong.

Fees

HK$150 per participant per day
(Lunch & tea provided)

Medium of Instruction

English

Contents

Seminar I
- Types of Industrial Contaminants
- Effects of Contaminants on Receiving Water Sources
- Conventional Treatment Methods
- Discussion

Seminar II
- Advanced Waste Treatment Techniques
- Cost-effective Solutions
  1) High pH - High Solids Biological Aeration
  2) Baffled Biological Basins
  3) Aquaculture Systems
  4) Environmentally-Balanced Industrial Complexes
- Discussion

HONG KONG PRODUCTIVITY CENTRE

SEMINAR ON INDUSTRIAL WATER POLLUTION CONTROL (II)

By Dr. Nelson Nemerow - UNIDO Consultant

(21/6/82)

Participant's List

Name	Organisation
1. Mr. Wong Ho Yan	Enviromental Protection Agency
2. Mr. Yeung Chi Hung	Hong Kong Polytechnic
3. Miss Ho Siu Lai	First Dyeing Works Ltd
4. Mr. Luk Kam Leung	Electronic Devices Ltd
5. Mr. Chow Man Tat	Civil Engineering Office
6. Mr. Alfred Leung	Hydrex Asia Ltd
7. Mr. William Tsang	-ditto-
8. Mr. Eric Cheung	-ditto-
9. Mr. Wong Fai Tat	Professional Cleaning Services (HK) Lt
10. Mr. Anthnoy Fung	-ditto-
11. Mr. Wu Ming Wo	Agriculture & Fisheries Dept
12. Mr. M.J.Arnulphy	J.Mortensen & Co Ltd
13. Mr. J.A.P.Damour	-ditto-
14. Mr. A.J.Wood	Whitehead ' Poole (HK) Ltd
15. Mr. Peter Wong	-ditto-
16. Mr. Chan Kai King	Hutchison Boag Eng Ltd
17. Dr. Y.S.Fung	Hong Kong University
18. Mr. WS.Miu	Hong Kong Polytechnic
19. Mr. Lo Wai Kwok	Sonca Ind Ltd
20. Mr. Lin Chan Ming	Hong Kong Productivity Centre
21. Miss Pang Suk Fong	-ditto-
22. Mr. Wong Kin Wah	-ditto-
23. Mr. Tsang Kam Lam	-ditto-
24. Mr. C.W.Hui	-ditto-
25. Mr. San Cheng	-ditto-
26. Miss Ko Ka Mei	-ditto-

SECTION I

1- High pH, High Solids, Bilogical Aeration

Water pollution control for industrial production is rapidly becoming necessary throughout the world in order to protect the quality of our limited water resources. In most developed countries industry has accepted this fact and includes any associated expense as part of the cost of production. The cost can no longer be avoided, but it can be minimized by a combination of early research, planning, and an adequate knowledge of waste treatment techniques.

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  4) Environmentally-Balanced Industrial Complexes
- Discussion

A NEW AND EFFECTIVE SOLUTION FOR TREATMENT OF TANNERY WASTEWATERS

Nelson L. Nemerow, Professor
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INTRODUCTION

A tannery processing 70,000 lbs green cattle hides a day into finished upper shoe leather was a contributor to the polluting of a long stretch of a river. The other contributors, located in close proximity to the tannery, were a small municipality and a large animal glue manufacturing plant. Separate treatment of the tannery waste was selected as a solution to its problem. The uniqueness of the solution can be summarized by the following six statements.

1. It was solved by separate treatment rather than combination with the other area-wide wastes which seemed on the surface to be more feasible.
2. It was solved by combining beamhouse and tanhouse wastes rather than treating them separately and differently.
3. No primary sedimentation was used – instead all wastes were equalized and kept in motion so as to prevent settling.
4. No pH adjustment of the highly alkaline combined wastewater was utilized prior to biological treatment.
5. A mixed liquor suspended solids concentration of from 9,500 to 12,000 mg/l was found to be optimum for maximum BOD reduction and suspended solids removal.
6. Chemical coagulation following biological aeration was found to be effective and necessary to attain sufficient BOD and suspended solids reduction without resorting to additional tertiary treatment.

BACKGROUND INFORMATION

The Moench Tanning Company is located in the Village of Gowanda, New York, and immediately adjacent to and on the banks of the Cattaraugus Creek. It produces chrome-tanned upper shoe leather with saving of hair and flesh grease. The upstream creek water is relatively clean and flowing at a mean annual flow rate of 212 cfs as measured by a USGS a few miles downstream. The company is located about 1 mile upstream from the village center. The village possesses its own primary sewage treatment plant which operates efficiently but is running at about design capacity. The Peter Cooper Animal Glue Manufacturing Plant is located immediately downstream of

the company. It possesses a poorly designed, overloaded, and malfunctioning primary sedimentation treatment system preceded by bar screens and followed by sludge vacuum filtration. The glue plant is wavering on the brink of economic disaster and is uncertain whether it will continue in production. However, it has expressed an interest in trying to improve its waste treatment facilities and efficiencies. The village officials are not overly concerned with their problem. They feel that in time they will be able to solve any treatment problems which may face them. However, they are hopeful and concerned that the two industrial plants will be able to build adequate treatment facilities. They do not express any interest in a cooperative effort in this connection. A leading consulting engineering firm which was hired by the county to appraise the county's overall pollution abatement plan recommended a joint treatment facility for the village, glue plant and tannery.

The creek's best usage is that of fishing and although repeated stream surveys have shown that about 50% removal of BOD would protect the stream for this purpose, New York State Department of Environmental Conservation has required, in general, a minimum of secondary treatment.

Figure 1 shows the relative locations of the contributors on the creek as well as sampling stations.

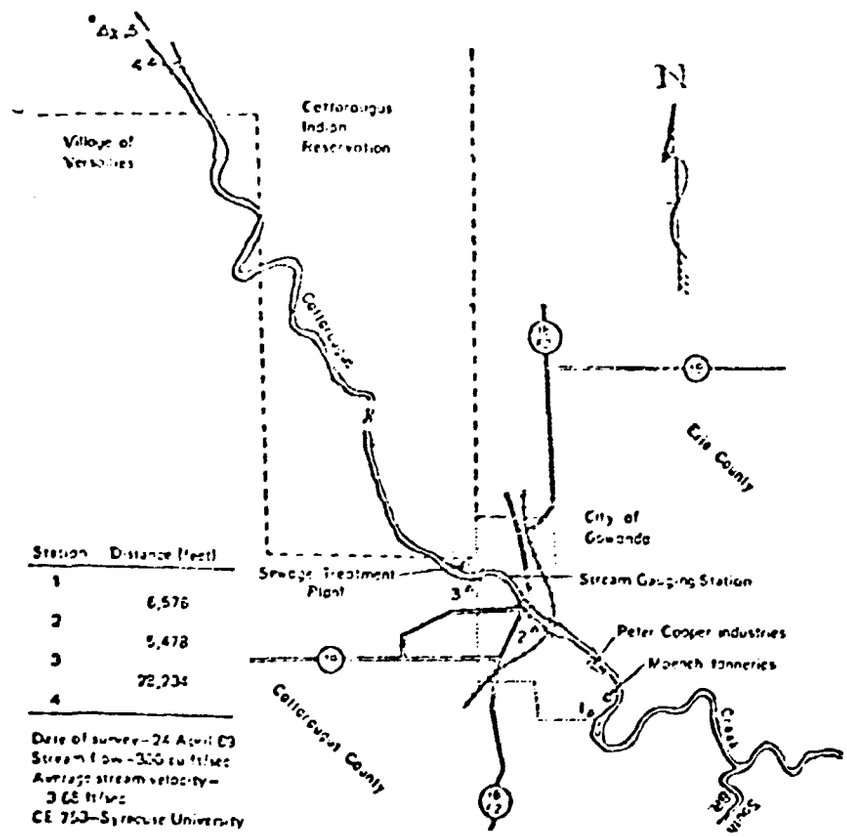

Figure 1. Stream survey area of Cattaraugus Creek in the vicinity of Gowanda, New York.

CHARACTERISTICS OF TANNERY WASTES

The wasteflow and strength characteristics of the tannery have been established by many measurements to average as follows.

Hides processed per day = 74,500 lb
Flow of wastewater = 253,000 gal/day
BOD (5 day, 20 C) = 1,323 mg/l
Total Kjeldahl Nitrogen = 180-445 mg/l
Suspended solids = 1530 mg/l
Chromium = 0.1 mg/l Cr^{+++}
< 0.07 mg/l Cr^{VI}
pH = 10.9
k_1 = 0.076

The typical flow of wastewater pattern during a given 24 hour period is shown in Figure 2. The tannery owns and operates a bar screen and two rectangular settling tanks operating in series. Each of these tanks are simply holding tanks and possess no provision for sludge removal. The effluent from the top of the second basin (as well as the sludge periodically) is discharged continuously into the creek.

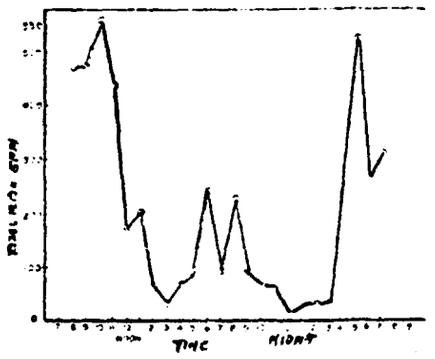

Figure 2. Typical hourly total waste flow of Moench Tanning Company (January 16, 1968).

RECEIVING CREEK WATER QUALITY AND USES

Cattaraugus Creek at one time was known for its fine fishing, but in later years fishing has deteriorated primarily because of the excessive contaminants discharged into it by the three point sources. The creek has now been reclassified as "C" for fishing below the plants as the best usage of the creek. In view of this, Moench Tannery has been directed by the New York State Health Department to treat its waste in an effective manner so as to discharge to Cattaraugus Creek in BOD. Since Moench's current plant operation is such that 3,920 lb of BOD_u are discharged to waste, a 92.3% reduction in BOD_u must be effected in order to comply with the state mandate.

The creek is shallow, turbulent, rocky, and meandering. It generally possesses an amount of water at least two or three times that of the "once-in-ten-year minimum seven-day low flow".

The problem facing the tannery is what overall approach to pollution abatement should be taken and more specifically what type of waste treatment will be required to protect the creek.

ALTERNATIVE SOLUTIONS

Six alternate solutions to this problem have been suggested: the first five by Hazen and Sawyer Engineers of New York City and the sixth by the writer based upon new laboratory and pilot plant findings. These alternatives are identified by number and description below.

Alternative Number	Descriptions
1	A combined treatment plant and system serving Moench Tannery, Peter Cooper Glue Company, and the Village of Gowanda at the site of the present sewage treatment plant.

2	The same system as No. 1 except that the plant would be located at the site of the Indian Reservation downstream of the existing village plant and in a rather desolate, undeveloped and unused creek segment.
3	Plant serving the tannery and glue plants only at the site of the tannery.
4	Plant serving the tannery and village wastes only at the existing sewage treatment plant.
5	Plant serving only the tannery at the tannery plant site using conventional treatment methods with preliminary separation of beamhouse and tanhouse wastes.
6	Plant serving only the tannery at the tannery plant site using combined treatment of equalized beamhouse and tanhouse wastes.

LABORATORY PROTOTYPE RESULTS

A laboratory pilot plant was built and operated on a continuous basis during 1968. The results were published in 1969 [1]. The pilot plant consisted of a high solids biological aeration unit fed a continuously mixed, unsettled, composite of the Moench Tanning Company waste. In general, the findings were that the composite leather plant waste could be treated successfully *without primary settling* and *without segregation* of the beamhouse and tanhouse wastes. And furthermore, the findings showed that 92% BOD reduction could be obtained at elevated loadings over 200 lb of BOD per 1000 ft^3 per day. And, in addition, the suspended solids were separable effectively in the final settling tank. All of this was made possible by feeding a high pH waste and maintaining high suspended solids concentration (12-16,000 mg/l) in the biological aeration basin.

TREATMENT SOLUTION AND METHODS SELECTED

Alternative No. 6 was selected as a solution to the Moench Tanning Company wastewater problem. This decision was based largely on three factors: (a) the waste could be effectively treated separately to remove excessive contaminants; (b) there existed no desire to cooperate on a combined plant on the part of the other two major contributors; and (c) a separate treatment system could be designed at the lowest capital cost to the tannery.

The separate system called for by the results of the laboratory prototype experiments was a relatively new one and untried in actual practice. Waste treatment at tanneries had not been practiced to any extensive degree before this time. And what systems had been constructed utilized separate tan and beamhouse treatment. It was decided, therefore, to construct and operate a field prototype at the site of the tannery. This plant would receive a small percentage of the tannery's actual wastewater (normally no less than 5% or 10 gpm, whichever was the smaller quantity) on a 24-hr daily basis, 7 days each week, and at least representative cold and warm weather seasons.

FIELD PILOT PLANT RESULTS

The field prototype treatment plant was operated over a six month period from the late fall of 1970 to early summer of 1971. The treatment system consisted of a waste collection and overflow chamber into which a centrifugal pump extracted a continuous flow of approximately 5% of the total plant wastewater flow. The pumped flow was directed to an equalizing basin the contents of which was kept in constant motion by a lighting-type mixer for a 24-hour period. The equalized waste flowed continuously to a high-solids, biological aerator which was supplied air by means of a floating, mechanical aerator. Detention time in the biological unit was about 12 hr; MLSS 10-15,000 mg/l, and pH 8.5-9.0. The effluent was settled for two hours in a final sedimentation basin. The sludge was pumped to a compaction tank for final concentration prior to disposal by landfill.

Some difficulties were encountered during the operation of the prototype plant. For example, the floating mechanical aerator froze up due to the cold weather and


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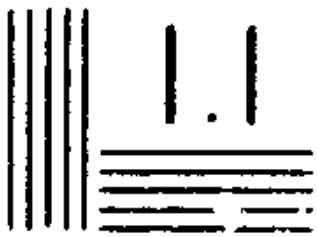
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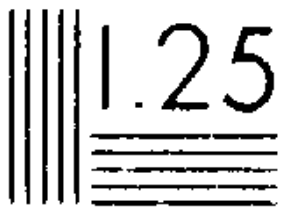
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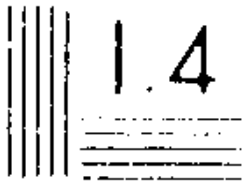
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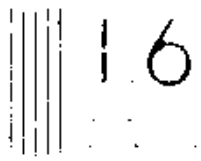
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was replaced with a compressed air system. Some solids clogging of air diffusers also occurred. These were problems which could be rectified in the design of the full-scale treatment facility.

These studies proved the laboratory results that an equalized chrome leather tannery waste could be treated effectively without prior sedimentation at a pH of greater than 10.5 by biological aeration. The BOD and suspended solids reductions, although slightly less than that obtained in the laboratory studies, averaged 80-90%.

It was agreed, then, to design a full-scale treatment plant for the entire plant wastewater.

DESIGN AND PERFORMANCE OF TREATMENT PLANT

The full-scale wastewater treatment facility was designed and constructed in 1971 and began operating in June of 1971. It was designed to contain equalization for one days' flow, followed by biological aeration with no pH adjustment of the pH 11 equalized influent for about 12 hr. The aeration basin effluent is settled and the sludge is withdrawn to a compaction tank from where it was periodically pumped out to a truck for conveyance to the company's sanitary landfill near the plant. Some sludge is recirculated from the compaction tank to the biological aeration in order to keep a MLSS concentration of about 12,000 mg/l.

The results of the first 26 month average operation of the treatment plant is shown in Table I.

Table I. Treatment Plant Performance

	Plant Influent	Plant Effluent	Reduction (%)
pH	10.6	8.1	—
Temperature	68.2 F		
Suspended solids, mg/l	2,763	314	88.7
BOD_5, mg/l	1,587	362	77.3

Some interesting loading parameters were also computed. They are presented in Table II.

Table II. Loading Parameters

	Plant Influent	Plant Effluent
= BOD/1000 # HDLS	50.57	11.59
= BOD/1000 ft^3/day	139.2	—
F/M	0.200	
= Suspended solids/1000 # HDLS	—	9.8

The MLSS averaged 11,825 mg/l of which 45% were organic. The total Kjeldahl nitrogen in the effluent averaged about 150 mg/l.

The reduced efficiency in both BOD and suspended solids reductions, when compared to laboratory and field prototype experiments, was attributed to the following three problems:

1. A change in production processes by: (a) replacing dimethylamine sulfide with lime and sodium sulfide for unhairing; (b) introducing a grease plant effluent wastewater —resulting from processing fleshings—into the wastewater stream; (c) adding leather buffing waste to the effluent; and (d) an increase in hide processing from 70,000 to 100,000 lb/day.
2. A scale-up effect in the final sedimentation basin resulting in velocity currents and subsequent loss in solids over the weir and into the effluent.

3. The inability to pump sludge continuously from the bottom of the sedimentation basin and into the sludge concentration basin. Intermittent pumping at high rates caused disturbance with solids settling.

After all attempts had been made to rectify the effects which the changes in production made, the writer began to combat problems 2 and 3. Field studies made in August and September of 1974 established the relationship between the aeration basin pH and MLSS and the suspended solids in the plant effluent. These relationships are shown in Figure 3. Operational procedures were altered accordingly.

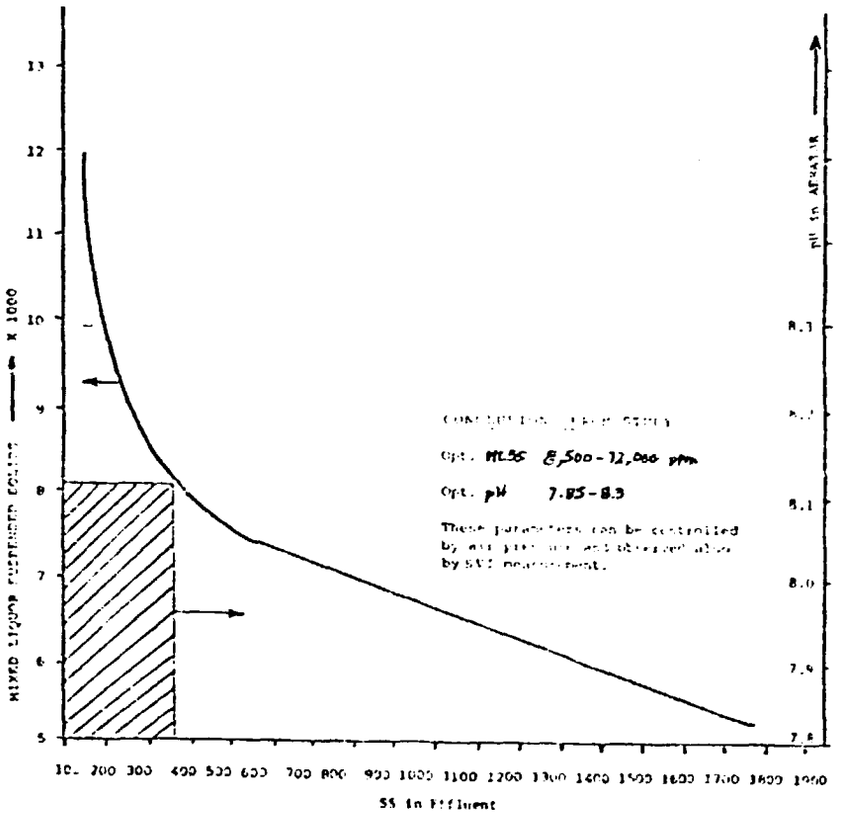

Figure 3. Effect of pH and MLSS on effluent suspended solids.

The final sedimentation basin was changed by adding a shallow baffle plate ahead of the effluent weir and the approach velocity of wastewater influent was reduced by better horizontal distribution.

A second sludge compaction basin was built so that sludge could be pumped on a continuous basis from the settling basin. One could be compacting sludge while the other received sludge.

Laboratory experiments were carried out to determine what coagulents could be used to enhance sedimentation of the MLSS entering the basin. It was found that 100 mg/l of ferric sulfate improved the removal of suspended solids to the point where consistent concentrations of less than 100 mg/l of suspended solids was present in the laboratory effluent. The coagulent had to be added to the aeration basin effluent and

flocculated properly prior to final sedimentation. Two chemical feed tanks and a flocculating basin were constructed to serve this purpose.

All of these full-scale alterations in both the construction and operation of the treatment plants were completed by the fall of 1976. Since that time the plant has given much better efficiency in BOD and suspended solids removal.

CREEK WATER QUALITY AFTER TREATMENT

Cattaraugus Creek water quality has improved dramatically since the advent of the tannery waste treatment plant. A certain and significant part of this improvement is due to the closing of the major contributor of contaminants, the Peter Cooper Glue Manufacturing Plant.

As can be seen from the photographs the creek is clear, oxygen abundant again, and supporting fish life to the extent never before realized. In fact, the tannery is now very careful and very conscious about its wastewater discharge since the recreational value of the creek has increased so greatly. The efficiency of the treatment plant is presented in Table III.

Table III. Treatment Plant Operational Efficiency Since 1976

	Plant Influent	Plant Effluent	Reduction (%)
pH	10.6	8.1	—
Temperature, °F	68.2		—
Suspended Solids, mg/l	2,763	131	95.3
BOD_5, mg/l	1,587	226	85.8

SIGNIFICANT DESIGN AND OPERATION CONSIDERATIONS

Diffused air system was selected finally because it preserved and conserved heat especially important during cold winter temperatures. Surface aerators were found to be not viable on activated tannery sludge in typical Western New York State climate.

Preliminary tannery waste treatment with Hydrasieves was installed with screen sized in two units of 0.04 in. These reduced the BOD loading on the treatment plant by 8-12%. In addition many clogging problems in treatment plant equipment were eliminated.

Positive displacement pumps were selected because they are more accurate and variable and were used as a check on the flow rate.

Several chemicals were tried to lower BOD, provide oxygen, and to enhance sludge dewatering but were not found acceptable; i.e., (a) H_2O_2 could not be justified on a cost basis; (b) activated carbon was too costly and produced little filtration efficiency; and (c) several polymers were also found to be outperformed as sludge conditioners by both ferric chloride and ferrous sulfate.

Aluminum handrails and gratings are recommended to minimize maintenance.

Moench Tannery production operations were improved by the optimization of performance of the waste treatment plant. This was possible as a result of the conservation practices which were forced on the company. Two examples of these are: (a) chromium recovery and reuse; and (b) sulfides recovery and reuse from the Beam House Liquors.

COST OF TREATMENT

Operational costs for 1977 were as follows:

Electricity	$24,600
Direct Labor*	$30,000
Chemicals	$65,000
Maintenance	$25,000
Total	$144,000

*Does not include management nor administrative time; but includes all other labor costs for treatment plant including sludge dewatering and landfilling.

Production for 1977
About 15,000,000 ft of hides (plus splits)
Thus, waste treatment production costs were *
14,400,000 ¢/15,000,000 ft of hide; or about 1 ¢/ft of hide.

EVALUATION OF THIS SOLUTION

We have seen and studied a very unusual waste treatment problem. It has been solved satisfactorily in what may be considered by many as an unconventional manner. The uniqueness of the problem and its solution can be summarized as follows:

- It was solved by separate treatment of the tannery plant waste rather than in combination with the other area-wide wastes which seemed on the surface to be more feasible.
- It was solved by combining the beamhouse and tanhouse wastes rather than treating them separately and differently.
- No primary sedimentation was used; instead all wastes were equalized and kept in motion so as to prevent settling.
- No pH adjustment of the highly alkaline combined wastewater was utilized prior to biological treatment.
- A mixed liquor suspended solids concentration of from 9,500 to 12,000 mg/l was found to be optimum for maximum BOD reduction and suspended solids removal.
- Chemical coagulation following biological aeration was found to be effective and necessary to attain sufficient BOD and suspended solids reduction without resorting to additional tertiary treatment.

REFERENCE

1. Emerson, D. B. and Nemerow, N. L. "High Solids, Biological Aeration of Unneutralized, Unsettled Tannery Wastes," *Proc. 24th Purdue Univ. Industrial Waste Conf.*, May 7, 1969.

*These costs do not include amortization of capital expenses. The total capital cost with improvements and modifications is approximately 1 million as of 1978.

SECTION II

BAFFLED BIOLOGICAL BASINS

2- BAFFLED BIOLOGICAL BASINS

REMOVAL OF ORGANIC DISSOLVED SOLIDS

a seasonal one: algae are less effective in winter.

Ice and snow cover during winter months interferes with the stabilization process in the following manner:

1) It prevents sunlight from penetrating the pond, causing a reduction in the size and number of algae present. Algae are not necessarily killed by the absence of sunlight (those known as facultative chemo-organotrophs can carry on metabolic processes despite darkness), but they release little or no oxygen without sunlight.

2) It prevents mixing and reaeration by wind action.

3) It prevents reaeration by atmosphere–water dynamic equilibrium phenomena.

4) It usually results in anaerobic conditions if it continues over an extended period of time.

These factors tend to result in a lowered pond or lagoon efficiency during the winter.

Hermann and Gloyna [10] (disregarding the part played by minerals) describe the reaction in high-rate ponds in which sewage is oxidizing as:

$$C_{11}H_{29}O_7N + 14O_2 + H^+ \rightarrow 11CO_2 + 13H_2O + NH_4^+$$

The canning industry, one of the first to attempt lagooning, soon found it difficult to maintain aerobic conditions in basins; other industries experienced similar situations. As industries became aware that biological degradation occurs in lagoons, they made attempts to encourage and control the oxidation and began to refer to such lagoons as waste-oxidation basins.

Most modern oxidation basins have a maximum water depth of four feet and operate on a continuous-flow basis. Engineers try to maintain in the basin near-neutral pH, adequate oxygen concentration, and sufficient nutrient minerals for biological oxidation. Chemical neutralizers are used to alter pH values, oxygen concentrations are maintained by reducing detention times and using shallow basins, and mineral-salts nutrients may be added as needed, to accelerate biological activity. BOD removals range from as low as 10 per cent to as high as 60 to 90 per cent. START

In an interesting full-scale study [26], the author treated an air-base oxidation pond, at 43° north latitude with ice cover during the winter, with an elevated loading of 130 pounds of BOD in the waste water per acre of pond area. The BOD reductions at these relatively high loadings ranged from 87.7 per cent in August to 53 per cent in January, with a yearly average of 69.3 per cent. In another pilot-plant study [25], the writer achieved BOD removals in excess of 80 per cent, using close-baffled four-foot-deep, or unbaffled eight-foot-deep, basins, during the critical summer period in central New York State, at elevated loadings of 312 to 467 pounds per acre per day. A photograph of the five parallel pilot-plant basins appears as Fig. 13.2.

Oswald [30] believes that in such heavily loaded ponds, particularly during periods when methane fermentation is either nonexistent or limited by temperature and when algal photosynthesis is not taking place in the surface layers, a buildup of organic acid occurs, with a subsequent lowering of the pH level and emission of hydrogen sulfide from the pond. The writer, however, did not experience these odors, even at the high loadings described above. Oswald offers the explanation that, if methane fermentation becomes established in the bottom deposits, high rates of BOD removal may be attained without

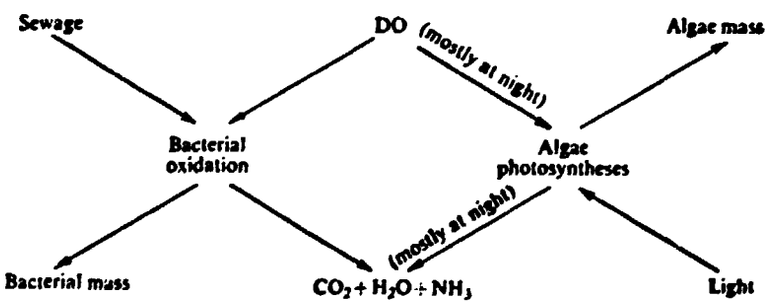

Fig. 13.1 The role of algae in stabilization ponds [37].

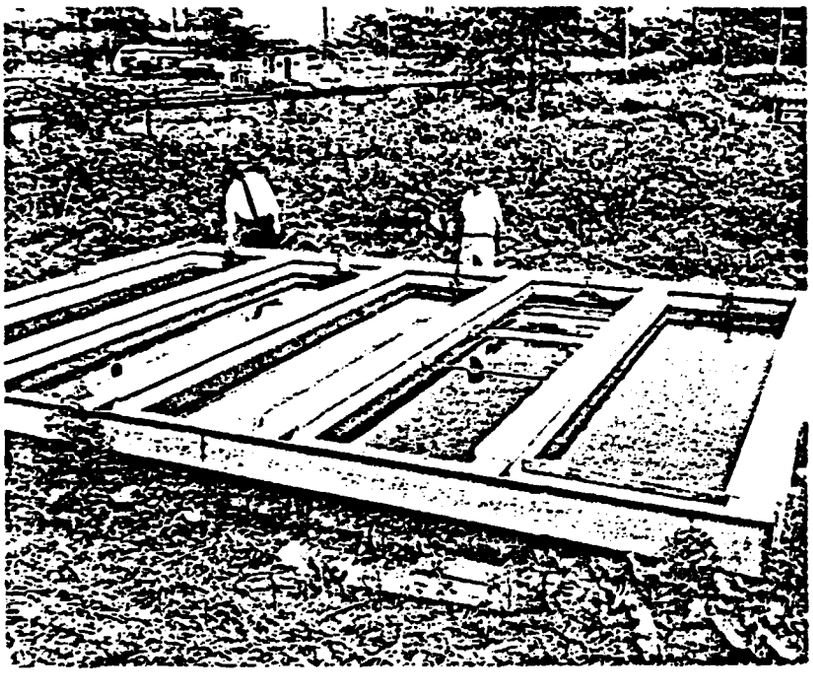

Fig. 13.2 Accelerated-oxidation pilot-plant basins [25].

appreciable odors. He also believes that ponds in which both photosynthetic oxygenation and methane fermentation occur (facultative ponds) must be restricted to about 50 pounds of BOD per acre per day, because conditions are at times unfavorable for either process. The author, at this point, does not necessarily agree with these findings. Furthermore, Oswald's later high-rate oxidation ponds for treating sewage in warmer climates have been loaded to over 600 pounds of BOD per acre per day or over, being aerated for an hour each midnight.

The reader is referred to the discussion in Section 12.4 of the necessity of preventing algae growth in bodies of water that are used for water supplies and recreational activities.

13.2 Activated-Sludge Treatment

The activated-sludge process has proved quite effective in the treatment of domestic sewage, as well as a few industrial wastes from large plants. In this process, biologically active growths are created, which are able to adsorb organic matter from the wastes and convert it by oxidation–enzyme systems to simple end-products like CO_2, H_2O, NO_3, and SO_4. Biological slimes develop naturally in aerated organic wastes which contain a considerable portion of matter in the colloidal and suspended state, but for the efficient removal of organic dissolved solids there must be high floc concentrations, to provide ample contact surface for accelerated biological activities. The flocs (zoogleal masses) are living masses of organisms, food, and slime material and are highly active centers of biological life—hence the term "activated sludge." They require food, oxygen, and living organisms in a delicately controlled environment.

Various degrees of efficiency are obtained by controlling the contact period and/or the concentration of active floc. The contact period can be regulated by careful design of the hydraulic systems of aeration basins, the average time of aeration being 6 hours for domestic sewage and 6 to 24 hours for various industrial wastes. The desired concentration of active floc is maintained by recirculating a specific volume of secondary settled sludge, normally about 20 per cent.

DISCHARGE OF COMPLETELY TREATED WASTES TO STREAMS OR LAND

Complete treatment of wastes prior to direct discharge to a receiving stream is gradually receiving more and more consideration. The amount of dilution water in streams is not increasing and, on the other hand, pollution loads unfortunately *are* increasing. With the population explosion and industrial expansion, we can expect more extensive waste-treatment requirements. At present, complete treatment is required only in special instances and in the case of the large, wet industries—for example, textiles, pulp and paper, steel, and chemicals.

There is some doubt as to what is meant by the expression "complete treatment." It is generally conceded that complete treatment refers to secondary treatment; that is, the removal of about 85 to 90 per cent of the BOD by a combination of physical, biological, and/or chemical means. According to this definition, one is removing only two polluting constituents: suspended solids and dissolved organic matter (including colloidal solids). Does this definition, then, imply that the removal of *any* two forms of pollution—such as color and suspended matter, oils and alkalinity (high pH), or acids and organic matter—also constitutes complete treatment? The author doubts that this is the original meaning of the term; and in these days when "complete treatment" is insufficient and certainly not complete in some cases, a reevaluation of our terminology is in order. For example, an industry may have little or no dissolved organic matter in its waste and yet be required to remove two or more other forms of pollution. In the author's mind, this also constitutes complete treatment, as the term is currently defined. The expression "complete treatment" will hardly be satisfactory, with its present definition, when the public begins to accept and include "tertiary treatment" in its thoughts on the subject. Tertiary treatment presently provides for the removal of three or more forms of contamination: suspended solids, dissolved organic solids, and dissolved inorganic solids. True complete treatment would remove refractory solids as well.

An industry requiring complete treatment for its waste usually discharges a large volume of waste and is located outside, and some distance from, a municipality, on a stream requiring the maintenance of high standards of water quality. This author prefers to consider "complete treatment" as that which renders waste waters reusable for industrial and (in some cases) municipal water supplies. This normally will mean a fairly complete removal of all suspended, dissolved, and colloidal solids, including both inorganic and organic fractions. Since this is, at present, rarely practiced, we are forced to accept as a definition of "complete treatment" the removal merely of a major portion of the suspended solids and dissolved organic matter.

AN EXAMPLE OF COMPLETE WASTE TREATMENT BY A FIRM PRIOR TO DIRECT DISCHARGE INTO THE RECEIVING STREAM

20.1 The Problem

Townsends, Inc., an integrated poultry operation, consists of a hatchery, feedmill, soybean mill, and poultry-processing plant located about two miles east of Millsboro, Delaware. It is owned privately by the Townsend family, and the raising and processing of chickens is their main business. The waste problem is at the poultry-dressing plant. This plant, built in 1957, is located about 50 yards from Swan Creek, a tributary of the tidal Indian River. The relative locations of the plant, town, and receiving waters are shown in Fig. 20.1. Of special significance is the location of the Millsboro extended-aeration sewage-treatment plant which discharges into the Indian River about 3 miles above the confluence with Swan

Creek. The poultry-plant waste from Townsends is discharged after screening and ineffective flotation treatment into Swan Creek about 1 mile upstream of the confluence with the Indian River. The proximity of these waste discharges to the shellfish area only 2½ miles below Swan Creek is a major concern to the regulatory authorities. Although the main portion of the town of Millsboro (Fig. 20.1) is served by the extended-aeration sewage-treatment plant followed by chlorination, many of the homes along Route 24 are individually served with septic tanks and well-water supplies located in relatively sandy soils. The underground disposal in sandy areas of sewage or wastes may represent some danger to these water supplies. During each of the last three years many areas of the Indian River Bay have had to be closed periodically during the summer for cleaning because of bacterial contamination. Coliform standards have been set at 70/100 ml for shellfish and at 1000/100 ml for swimming.

In 1956, the Delaware Water Pollution Commission concluded in their *Indian River Drainage Basin Survey* that:

1. A portion of the fresh-water flow within the Indian River watershed originates from swampy and marshlike areas which have a decided effect upon the chemical and physical composition of the runoff waters. These waters are generally high in iron and color, low in turbidity, suspended solids, and dissolved oxygen, and acid in pH.
2. Average dry-weather flow in this basin area is approximately 0.25 cfs per square mile.
3. Small tributaries predominate in the drainage basin. The only surface supply location with sufficient volume for either domestic or industrial use is at Millsboro dam.
4. Studies made by the Delaware State Water Pollution Commission when the former owner of the plant was in operation clearly indicated that dry cleaning of manure solids, coagulated blood, and feather removal followed by satisfactory removal of settleable solids with heavy disinfection will effectively and satisfactorily protect state waters downstream from this plant.

Millsboro (the closest and most significant municipal co-polluter in this case) is located on the Indian River, 13 miles from the ocean and is one of the prin-

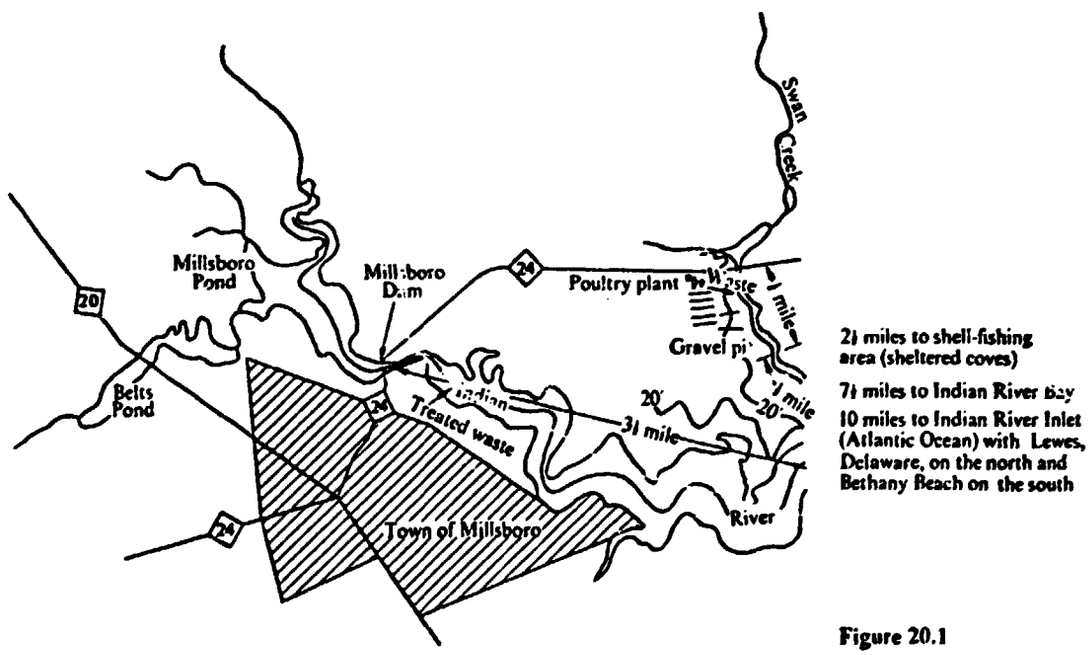

Figure 20.1

cipal towns of the Indian River County of Delaware. It is a distributing point for carloads of poultry feed and coal for the broiler chicken industry. The Commission's historical survey revealed that as late as 1956 the pool at the base of Millsboro Dam was still noted for its herring run in April and May; in good seasons as many as a million have been taken in a few weeks. At times crabbers brought thousands of soft-shell crabs to Millsboro for shipment alive in boxes filled with wet grass. The alternate opening and closing of Indian River Inlet prior to 1938 nearly ruined the industry, though a few soft-shell crabs were still shipped from there during the periods of transformation. The new inlet revived the market for crabs, fish, oysters, and clams taken in Indian River. The main body of the Indian River from Millsboro to the ocean is tidal, with an elevation of less than 10 feet at Millsboro. This, the flattest stretch of the area, yields a slope of only 0.7 foot per mile.

In 1956 about one-third (18,600 acres) of the Rehoboth and Indian River Bays, which receive the poultry waste, was utilized for oyster cultivation at an annual "take" of $800,000. At the same time an additional $237,500 revenue resulted from the growing and harvesting of clams in these bays. Each year as much as $250,000 is spent in the shore-line areas between Lewes and Bethany Beach for fishing tackle, bait, and other small items associated with the sport. Boat rentals have been estimated to bring $96,000 per year. The Indian River is a vital link to the tremendous menhaden fishing industry in the mid-Atlantic states. In 1953 the U.S. Fisheries Statistics Report stated that Lewes, Delaware, was the nation's leading fishing port poundwise with landings of about 363 million pounds, consisting almost entirely of menhaden. This catch had a reported value of $4,117,000. Duck hunting is also estimated to contribute about $25,000 per season and muskrat trapping about $15,000. Despite the value of the shell-fishing, fishing and hunting industries, the 1956 Delaware Report stated that "there is little doubt that bathing and swimming is a primary interest in this drainage basin area." They were referring to the areas of Rehoboth Beach, Lewes, Rehoboth Bay, Dewey Beach, Indian River Bay, and Bethany Beach.

The foregoing information led the Delaware Water Pollution Commission in 1956 to conclude that "this entire basin must, of necessity, be classified as an unusually clean water area which has as its major interests bathing, swimming, boating, sports fishing, commercial fishing, shellfish, wildlife, recreation, and seasonal real estate."

20.2 Stream Studies

The Delaware State Water Pollution Commission conducted many studies of the Indian River and Inlet Bay areas during 1952–55. Figure 20.2 shows the drainage basin and the location of the sampling points (described in Table 20.1).

The State of Delaware Water Pollution Commission investigated the quality of the Indian River (Fig. 20.1), which extends from the Millsboro Dam to the vicinity of Oak Orchard, on July 1 and 28, 1953. The results are shown in Tables 20.2 to 20.3. Fresh-water flow in the Indian River Basin was determined during two periods, May 1, 4, and 5, 1953, and May 5, 1955. These results are shown in Table 20.4. One may note that in Tables 20.2 and 20.3 samplings were taken as near to high tide as possible. Thus the increased volume of dilution water from the bay might tend to minimize the effects of pollution. It may also be noted that the water temperatures were high—a fact which is not considered abnormal since the Indian River Bay is broad and quite shallow. The high dissolved oxygen (although the upper reaches near the Millsboro Dam are relatively low) may indicate that little or no pollution is present.

The reader should recognize the scarcity of meaningful analytical data on the sanitary characteristics of the receiving stream. The evidence for pollution comes from instances of fish deaths rather than direct stream analytical measurements. However, coliform bacteria counts have been run on many samples of the Indian River at the sampling points shown in Fig. 20.3. Typical data on coliforms at some of these points collected as late as 1964 are shown in Table 20.5. These data indicate that considerable attention should be given to the bacteriological quality of the receiving water, since these are primarily recreational and fishing waters.

20.3 State Decision

The stream data illustrate a lack of positive evidence on the effect of organic loading, especially from the poultry plant. They do show bacterial contamination

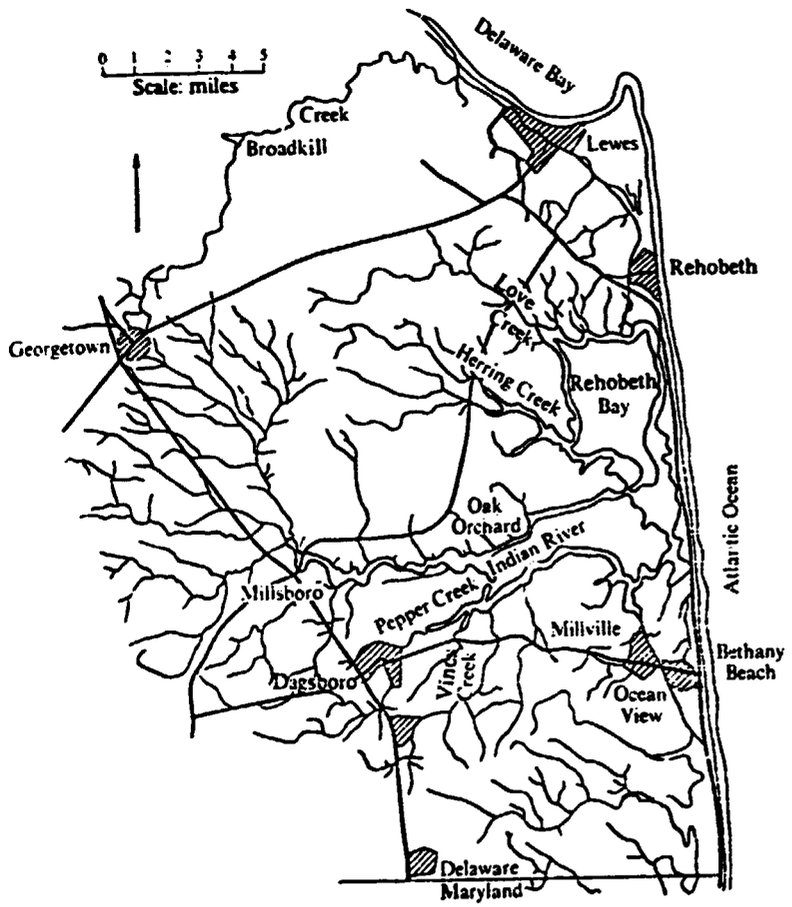

Fig. 20.2 Delaware Water Pollution Commission Survey of the Indian River-drainage basin.

in recreational, fishing, and shellfish-producing waters. The author had to decide whether to recommend a complete stream survey to determine the exact degree of treatment required for the poultry wastes. He decided against this survey for the following important reasons: (1) it would be costly and time-consuming with no apparent financial support available from the poultry processer or the state; (2) the state commission had already decided that a high degree of treatment was required (and only this would be approved) in order to protect the valuable resources of the receiving waters downstream.

20.4 Poultry-Waste Characteristics

During the normal 8- to 11-hour working day at the poultry plant 9000 to 10,000 chickens weighing 3½ pounds each are processed every hour. The processes and their associated wastes are summarized in Fig. 20.4. A separate septic-tank sewage-disposal system serves the 225 plant employees. The chickens are not force-fed (a procedure of fattening before killing to produce more weight) at the plant and dry removal is practiced. Although the killing room is separated from the rest of the processing operation and blood

Table 20.1 Indian River basin sampling stations.

Description	Miles from Indian River inlet	Description	Miles from Indian River inlet
Assawoman Canal, Ocean View	5.50	Indian River	13.31
White Creek tributary, Ocean View	6.20	Pepper Creek	13.45
White Creek, Millville	6.34	Pepper Creek	13.50
Indian River	6.59	Iron Branch at railroad	13.52
Indian River	7.16	Vines Creek, Frankford	13.70
Lewes–Rehoboth Canal jetty	7.60	Indian River at Millsboro	14.10
Indian River	7.73	Iron Branch near Millsboro	14.40
Indian River, mouth of Island Creek	8.30	Vines Creek	14.65
Blackwater Creek	8.46	Vines Creek	14.70
Indian River	9.01	South tributary of Iron Branch	14.80
Stokely Cannery, Rehoboth Beach	9.40	South tributary of Iron Branch	14.82
Vines Creek	9.43	Lewes–Rehoboth Canal Bridge	14.86
Lewes–Rehoboth Bridge, Route 41	9.45	Vines Creek near Frankford	14.90
Love Creek	10.00	Vines Creek	14.95
Unity Branch ir. Fairmont	10.16	Shoals Branch at Betts Pond	15.20
Indian River	10.20	Famys Branch near Millsboro	15.50
Chapel Branch in Angola	10.24	Betts Pond at Route 113	15.70
Indian River	11.00	Vines Creek near Millsboro	15.90
Vines Creek	11.70	Roosevelt Inlet	16.59
Indian River	11.74	Cow Bridge Branch	17.62
Indian River	11.80	Stockley Branch	17.90
Pepper Creek	11.82	Wood Branch near Morris Millpond	18.75
Love Creek	11.95	Deep Branch near Morris Millpond	18.85
Swan Creek near Millsboro	12.10	Cow Bridge near Morris Millpond	19.60
Indian River	12.57	Wood Branch near Georgetown	20.07
Iron Branch near Millsboro	12.58	Wood Branch near Georgetown	21.40
Vines Creek, Frankford	13.30	Wood Branch, Georgetown	22.20

Table 20.2 Indian River water quality, Millsboro to Oak Orchard*

Sampling station, miles from inlet	Time	Temperature, °C	D.O., ppm	D.O. saturation, %	Salinity as NaCl, ppm	Depth, ft
Millsboro Dam (14.10)	1:00 p.m.	27.8	4.65	60.7	3,500	
13.31		27.5	5.5	71.0	3,200	
12.57		30.5	7.8	105.7	2,400	
11.74		29.5	7.3	97.3	2,500	
11.00	1:30 p.m.	30.5	7.35	101.8	4,500	5
10.20		30.0	7.5	105.5	6,800	
9.01		30.0	7.4	105.5	8,050	
8.30	2:00 p.m.	30.0	8.3	131.0	16,300	
8.55		31.0	8.6	137.0	16,450	2
11.80		31.5	8.65	139.5	16,450	1.5
7.73		30.0	8.7	136.6	16,700	

*High tide (from U.S. Geological Survey Table) 2 p.m. at Indian River inlet. Water throughout stretch being studied, quiescent before 1:30 p.m., choppy after.

Table 20.3 Quality of water in the Indian River from Millsboro to Oak Orchard on July 28, 1953 (high tide).

Sampling station, miles from inlet	Time (p.m.)	Temperature, °C	Air temperature, °C	D.O., ppm	D.O. saturation, %	Salinity as NaCl, ppm
Millsboro Dam (14.10)	2:00	17.5	25.0	3.5	17.1	7,100
13.31	2:05	28.0		5.0	68.6	8,200
12.57	2:10	30.0		11.8	170.0	9,000
11.74	2:20	30.0		8.3	123.0	11,800
11.00	2:28	30.0		7.9	118.0	12,200
10.20	2:35	30.0		7.7	118.0	14,300
9.01	2:45	29.5		7.7	120.0	18,200
8.30	2:55	30.0		7.6	124.0	20,000
7.73	3:04	28.5		8.3	134.0	21,400
7.16	3:12	28.0	26.0	8.5	138.0	23,000
6.59	3:22	27.5		8.5	139.0	28,000

is scooped out of the killing-floor area and disposed of with the screenings, the film which collects on the walls is washed into the sewer at the end of each working day. The feathers, which constitute about 14 per cent of the raw chicken weight, are sold for rendering for about $16 per ton; the offal, making up 16 per cent of the weight of the chicken, is sold for about $21 per ton. The processing waste-water is screened through four Sweco vibrating screens which are cleaned daily with alkali (1 pound/day) to keep them clean of feathers.

The Delaware Water Pollution Commission carried out composite analysis of the poultry-plant effluent on July 21 through 24, 1964. The results are shown in Table 20.6. The BOD averaged about 630 ppm with total nitrogen (mostly organic) of about 60 ppm and a slightly alkaline pH (7–8). Suspended solids were about 200 to 600 ppm, mostly organic.

Although quite accurate water-flow records are kept at the poultry plant and indicate a consumption of about 800 gallons per minute (500,000 gallons per day or an average of 5 gallons per bird), for additional information the plant effluent was weired and measured every half-hour during a typical operating day on January 27, 1965 (Table 20.7). Some reduction in process wash water may be achieved by closer control and using higher pressure nozzles. The flow rate, however, must be approved by the Department of Agriculture, which supervises cleanliness within poultry-processing plants.

Table 20.4 Fresh-water volume within Indian River basin.

Station (miles from inlet)	Flow, mgd	
	May 1, 4, and 5, 1953	May 5, 1955
11.95	10.25	4.04
10.24	7.2	2.80
10.16	13.0	4.03
12.10	6.20	3.58
14.10	111.1	39.40
14.40	3.54	1.55
14.80	3.02	1.60
11.82	1.59	1.63
13.45*		3.60
11.70	3.68	
13.70	0.36	
Total	159.37	60.60

*Upstream from 11.82 and not added into total.

20.5 The Solution

Since the Indian River and its receiving bays were already contaminated in the 1950s before the poultry plant began operations in 1957 and since the poultry-plant waste was also found to be highly pollutional

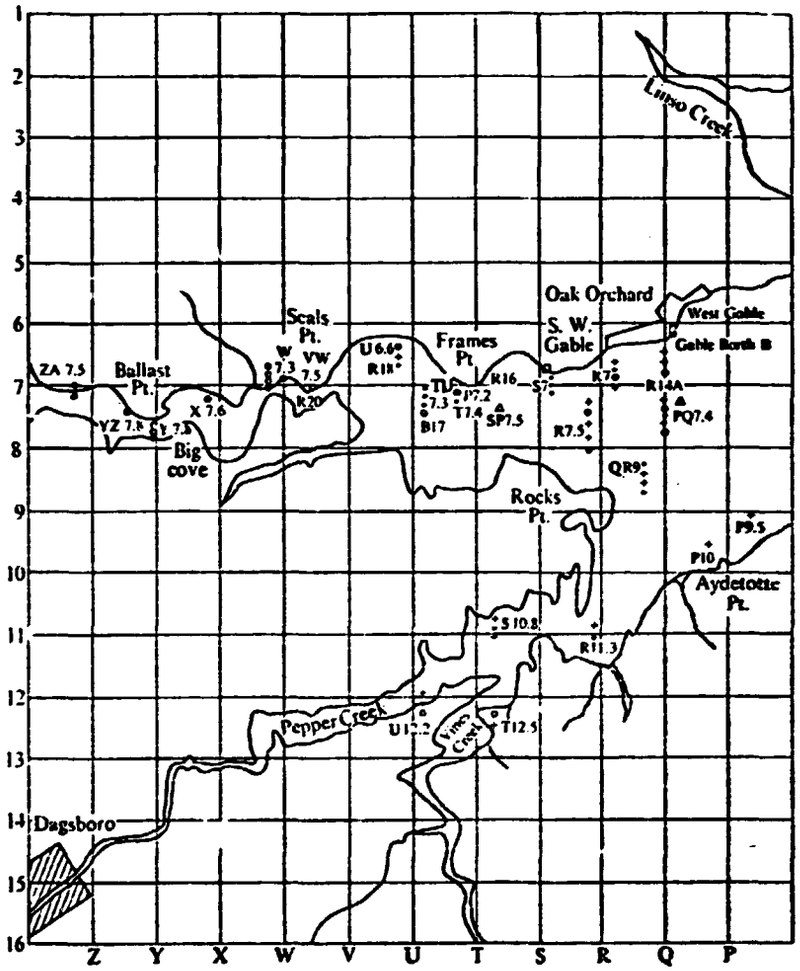

Figure 20.3

(both from analysis and stream observations), adequate treatment of the waste was necessary. From Tables 20.6 and 20.7 the total BOD load was computed to be 2550 pounds—equivalent to a population of 12,750 persons. The major question was what type of treatment should be used to protect the best uses of the stream. Obviously, the major concern is bacterial contamination, so that chlorination of the poultry-plant waste would be a minimum requirement. Chlorination in the presence of 2550 pounds of BOD and the other suspended and floating matter normally found in poultry-plant effluents would be difficult and costly. Organic matter reacts rapidly with chlorine and the chlorine necessary would be expected to cost well over $250 per day. Therefore, more economical means for removing a major portion of the organic matter prior to chlorination were demanded.

A two-stage, oxidation-pond treatment system was chosen to perform the task because of the low construction and operation costs compared with other biological treatment systems. The first stage consists of a baffled, high-rate, deep pond to allow sedimentation of heavy solids, flotation of grease or feathers which escape preliminary treatment by the screens, and bacterial degradation of the organic matter. This pond is 595 feet long, 109 feet wide, and 8 feet deep;

Table 20.5 Selected data on coliforms at stations in Indian River.

Date	Sampling point*	Coliform count, MPN/100 ml	Salinity, ppm
8/14/61	U6.6	790	14,500
7/25/62	QR9	430	23,600
7/29/63	VW7.3	430	
7/25/62	W7.3	4,600	17,700
8/8/62	W7.3	2,400	
8/21/62	W7.3	11,000	18,600
8/8/62	W7.3	2,400	
7/15/64	T7.2	430	
10/13/64	ST7.5	430	
	ST7.5		
7/24/62	R7	430	21,600
6/21/61	S7	1,600	
7/24/62	R7	930	22,500
7/15/64	R7.5	430	

*See Fig. 20.3.

30 over-and-under baffles on 15-foot centers cover the middle 435 feet. The second stage is a shallow photosynthetic pond designed to remove more organic matter and convert inorganic phosphates and ammonia nitrogen to an algal mass. It is 635 feet long, of nonuniform width, and about 2 feet deep, covering an area of about 212,000 square feet. The effluent from this two-stage treatment is chlorinated before discharge into Swan Creek. Detailed drawings of this plant are shown in Fig. 20.5. The area chosen for this two-stage treatment plant was predominantly sandy. Four tests in the area confirmed that the soil was about 99.5 per cent inorganic matter (stable at 900°C) and only about 5 to 6 per cent moisture.

A rough cost estimate of $83,738 was given to Townsends by the author on May 25, 1965 (Table 20.8) and some minor revisions were made in the original plans on July 22, 1965. On August 25, 1965, George and Lynch Construction Company signed a contract with Townsends, Inc., for construction of the treatment plant at a cost of $90,000 and a construction period of about 45 days. Some photographs of the treatment plant during construction are shown in Fig. 20.6. The plant was officially inaugurated on March 14, 1966, although operation actually began about January 1, 1966.

20.6 Results

Some details of the design and operation of the facility were presented in *Poultry Meat* (August 1966). In a letter dated January 30, 1967, Mr. Donald J. Snyder, manager of the Dressed Poultry Division of Townsends, stated, "The system has been working very well and has never given us any trouble... and we are happy to have anyone inspect the system if they should care to."

Samples were collected and analyzed by the Delaware Water Pollution Commission on April 7, June 29, and December 6, 1966, and March 23, 1967. These results are shown in Table 20.9.

From these four samples it was apparent that the treatment facilities were operating satisfactorily at a BOD loading of about 1390 lb/day. The loading on

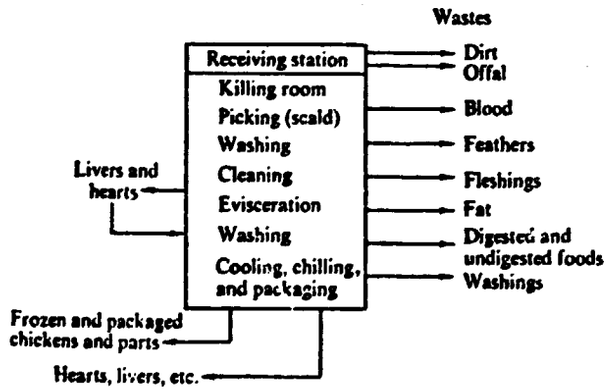

Fig. 20.4 Flow sheet of poultry-processing plant.

Table 20.6 Sanitary characteristics of the poultry-plant effluent as reported by the Delaware State Water Pollution Commission.

Characteristic*	Date (July 1964)					
	21	21†	22	22	23	24
Sample no.	638	640	642	672	674	676
5-day BOD††	425	1200	395	800	500	457
Chloride, ppm	64	74	37	55	45	24
COD††	1710	3690	3250	1590	2700	2780
Total N	62.4	91.8	57.4	60.2	57.7	59.3
Organic N	56.3	80.2	54.3	54.3	53.2	55.7
NH_3N	6.1	11.6	3.1	5.9	4.5	3.6
NO_2-N	0.076	0.018	0.09			
Acidity				28	5	20
Total alkaline (as $CACO_3$)				48	73	39
pH			7.6	6.9	8.1	7.4
Total suspended solids			360	606	254	204
Suspended volatile solids			360	584	244	180
Suspended ash			0	22	10	24
Total solids			801			
Total volatile solids			482			
Total ash			319			

*All results are given in milligrams/liter unless otherwise indicated.
†Plant washdown during sample collection on this day led to unusual results.
††An additional plant effluent sample was composited and analyzed on 3/17/65 and found to contain 418 ppm of BOD and 880 ppm of COD.

the first basin is

$$\frac{1390}{(595 \times 109)/43{,}560} = 1390/1.49 = 935 \text{ lb BOD/acre.}$$

At a daily waste-flow rate of about 530,000 gallons the detention time in this first basin is 7.35 days:

$$\frac{595 \text{ ft} \times 109 \text{ ft} \times 8 \text{ ft} \times 7.5}{11 \text{ hrs/day} \times 800 \text{ gal/min} \times 60 \text{ min/hr}}$$

This unusually high loading resulted in a BOD reduction of about

$$\frac{313 - 87}{313} \times 100 = 72.5 \text{ per cent.}$$

The second basin handled a BOD loading of 385 lb/day or

$$\frac{385}{212{,}000/43{,}560} = 385/4.87 = 79 \text{ lb/acre}$$

and effected an addditional BOD

$$\frac{87 - 79}{87} \times 100 = 9.2$$

when the algae are not removed from the effluent and

$$\frac{87 - 26}{87} \times 100 = 70 \text{ per cent}$$

when the algae are filtered out of the final effluent. Detention time in the second basin averages about 6 days. No attempt is made to remove algae from the final effluent but the effluent is withdrawn slightly below the surface.

The overall BOD reduction obtained during the first year of operation (based upon only four samples) was about

$$\frac{313 - 26}{313} \times 100 = 92 \text{ per cent}$$

Table 20.7 Poultry-plant effluent flow on January 27, 1965.*

Time	Flow, gpm	Time	Flow, gpm
6:00 a.m.	645	12:30 p.m.	645
6:30	1190	1:00	645
7:00	800	1:30	645
7:30	1020	2:00	645
8:00	800	2:30	645
8:30	645	3:00	525
9:00	1190	3:30	380
9:30	800	4:00	352
10:00	1020	4:30	380
10:30	1020	5:00	408
11:00	645	5:30	380
12 noon	645	6:00	408
		6:30	380

*Average rate was 674 gpm or 40,400 gal and chickens were processed on this day at the rate of 8570 per hour, so that $\frac{40,400}{8,570} = 4.7$ gal/chicken were used.

when the algae were filtered from the final effluent and

$$\frac{313 - 79}{313} \times 100 = 75 \text{ per cent}$$

when the algae cells were left in the final effluent. Although scum removal in the first basin was frequently required in 1966, no operating difficulties or nuisance resulted from an overall plant BOD loading of

$$1390/(1.49 + 4.87) = 1390/6.36$$
$$= 219 \text{ lb BOD/acre/day.}$$

The preliminary results point out some other interesting phenomena, for example, that the expected rise in pH in the second pond was coupled with a corresponding reduction in phosphates and coliform bacteria. Total coliform counts in the chlorinated effluent approximate 10/100 ml and apparently meet current shellfish standards. Although it is too early to formulate any firm and final conclusions, one can observe that elevated BOD loadings were handled in a properly designed two-stage, oxidation-pond treatment plant system and produced satisfactory operating results.

Table 20.8 Rough cost estimate of waste-treatment system for poultry-processing plant.

Item*	Cost per item, $
Pumps (2)	3,708
Installation and delivery of pipeline	500
Pipeline at $7.50/ft for 955.5 ft	7,180
Chlorinator (duplicate of existing one)	1,500
Excavation for two basins at $0.50/yd³	30,000
Cement of soil cement at $4.50/barrel	15,800
Wood at $200/mbf	10,000
Poured concrete at $25/yd³	2,500
Steel at $0.20/lb	10,000
Concrete block at $0.50/unit	1,100
C.I. pipe and fittings	750
Chlorination shack	200
Flagstone	500
Total	83,738

*These figures do not include some additional items which should be considered by the company such as

Fencing, especially for the no. 1 basin;
Ditching around basins to prevent groundwater intrusion;
Seeding of the birms to prevent erosion;
Landscaping to improve the aesthetic appearance of the system.

Continued sampling of the treatment plant facilities on March 29, June 14, and July 26, 1967, yielded the results shown in Table 20.10. Excellent BOD reduction continues, in the range of 85 to 90 per cent. In addition, coliform bacteria counts are less than 10/100 ml, which is acceptable for discharge into water used primarily for shellfish cultivation.

This example shows how a large poultry plant discharging about half a million gallons of waste per

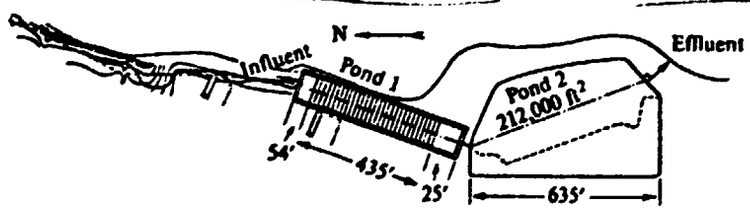

Fig. 20.5 Diagram of the two-stage, oxidation-pond treatment system designed for the poultry-processing plant.

Table 20.9

Characteristic	Influent pond no. 1			Effluent pond no. 1			Effluent pond no. 2			
	4/7/66	6/29/66	3/23/67	4/7/66	6/29/66	3/23/67	4/7/66	8/29/66	12/6/66	3/23/67
Physical										
Color, units			380			175				220
Turbidity, units			110			60				55
Dissolved oxygen, mg/liter		3.84			0			5.18	2.5	
Temperature, °C		21.5			24			25	7.0	
Minerals										
pH	6.4	6.4	6.9	6.8	6.7	6.8	7.4	8.7	7.0	7.1
Acidity ($CaCO_3$), ppm	31	26	42	41	55	50	27	0	52	36
Alkalinity ($CaCO_3$), ppm	38	32	16.4	135	143	155	138	8	144	153
Hardness ($CaCO_3$), ppm			65			69				68
Chloride (Cl), ppm		80	82		69	84		73		83
Nitrogen balance (mg/liter as N)										
Total Kjeldahl N	98.3	54.3	42.5	15	31.7	33.3	17	22.9	30	28.0
Organic N	89.9	45.4	28	4.2	8.7	5.3	9.0	17.4	4.5	8.0
NH_3–N	8.4	8.9	14.5	10.8	23	28.0	8.0	5.5	25.5	20.0
NO_2–N	0.47	2.44	0.013	<0.02	0	0	<0.02	0	0	0
NO_3–N	4.3	2.98	0.4	<2	0.1	0.24	0.38	0.4	0.5	0
Waste analyses										
BOD, mg/liter	300	380	260	70	86	105	97(u)* 24(f)	83(u) 27(f)	65	70
COD, mg/liter	600	560	370	185	150	150	196	270(u) 190(f)	130	120
Total PO_4, mg/liter		0.74	10		2.8	9.9		1.6	9.7	9.2
Ortho PO_4, mg/liter	8.6			11.4			7.4			
Methylene blue alkyl benzene sulfonate		16			1.9			1.5		
Solids balance										
Settleable solids, mg/liter	1.2	2.0	0.6	<0.1	<0.1	<0.1	0.2			<0.1
Total suspended solids, mg/liter		338	148		70	50		218	52	52
Volatile suspended solids, mg/liter		326	140		64	50		208	52	52
Total solids, mg/liter		592	470		318	332		56.9	29.7	323
Total volatile solids, mg/liter		362	238		125	118		33.5	207	110
Bacteriological analysis										
Total coliform/100 ml	2.5×10^6	6×10^6		0.2×10^6	9×10^4		5.4×10^4	3×10^3		
Fecal coliform/100 ml	6×10^4	1.2×10^6		5×10^3	1×10^4		6×10^3	1×10^3		
Fecal streptococci/100 ml	1.3×10^6	2.0×10^6		3.2×10^3	4.5×10^4		6.3×10^4	$<1 \times 10^3$		

*Unfiltered = u; filtered = f.

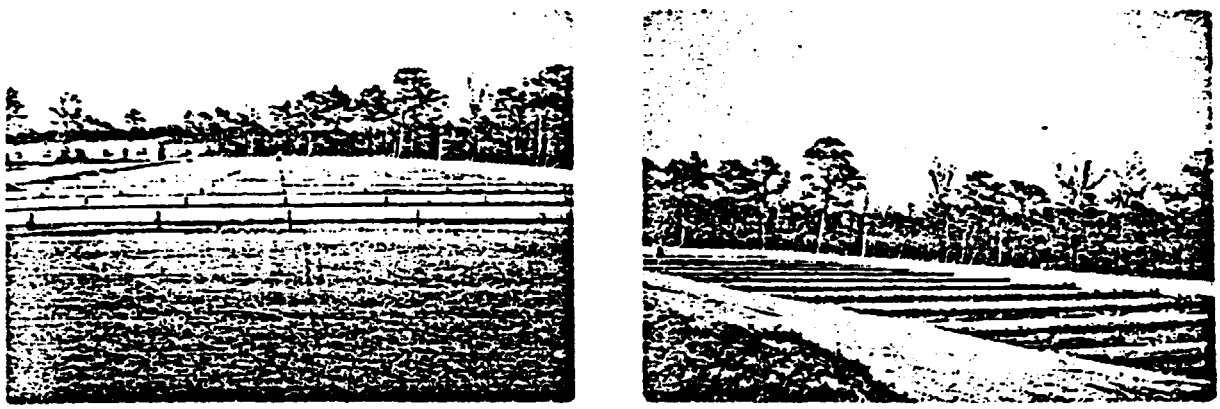

Fig. 20.6 Two views of oxidation basin no. 1: (a) down length, showing scum collection area in foreground and baffles in background; (b) on diagonal across basin in baffled area.

Table 20.10 Continued analyses of treatment plant.

Characteristic	3/29/67			6/14/67		10/31/67		7/26/67	
	Influent	Effluent basin no. 1	Effluent basin no. 2	Influent	Final chlorinated effluent	Influent	Final chlorinated effluent	Effluent	Final chlorinated effluent
pH	6.4	6.7	7.1	6.4	8.3	6.0	6.9	7.2	7.1
Acidity ($CaCO_3$), ppm	29	66	35	30	5	36	34	32	35
Alkalinity ($CaCO_3$), ppm	35	152	134	40	121	29	110	135	135
Hardness ($CaCO_3$), ppm	49	72	73	130	180	93	86		
Chloride (Cl), mg/liter	98	84	84	149	124	160	135		
Total Kjeldahl N	49.8	32	30.5			87.2	30.8	30.5	
Organic nitrogen	49.8	5.0	10			74.0	7.3	106	
NH_3–N	0	27	20.5	23.6	21.2	13.2	23.5	19.9	
NO_2–N	0.042	0	0	1.1	0.41	0.39	0.10	0.120	
NO_3–N	6.8	0.43	0.14	50.0	6.40	4.3	1.3	0.05	
BOD, ppm	340	100	55	365	39	470		38	30
COD, ppm	420	125	90	280	160	560	110		
Total PO_4	10	17	14	13.5	12.2	25	13	1.3	
Settleable solids, ml/liter				2.5		1.0	<0.1	0.3	<0.1
Total suspended solids, ppm	292	68	72	220	110	274	80	54	68
Total solids, ppm	727	443	350	776	479	820	459	523	514
Color	395	180	195	115	115	86	79	40	95
Turbidity	162	62	54	21	36	115	40	16	40
Temperature, °C								27	27
Coliform bacteria, 100 ml							<10		<10

day solved its pollution problem in a satisfactory manner. It was forced by circumstances to provide the equivalent of secondary treatment but did so at a cost of less than $100,000 capital expense. Adequate screening, followed by two-stage oxidation utilizing over-and-under contact baffles, and final chlorination gave 85 to 95 per cent BOD reduction. The cooperative spirit exhibited by both the plant and the regulatory authority, combined with some engineering innovations in design, resulted in success.

20.7 An Example

The Growers and Packers Cooperative (Gro-Pac), formed in 1936, was originally located in North Collins, New York. Its wastes were discharged to the North Collins Municipal Sewage Treatment Plant. In February 1965 the municipal treatment plant experienced operating difficulties due to an overload from the plant of high flows and odors from the cannery. At that time, the cannery's waste was classified as a readily oxidizable organic waste which could be biologically treated. Because of waste-related problems with the municipal treatment plant, Gro-Pac decided in 1966 to construct a new plant in Eden, New York, a few miles north of North Collins. The new facility was completed in 1967 and its owners contracted with a local engineer to design an industrial waste treatment facility at their new location.

As a rule, wastes were treated in the plant's three-pond lagoon system. The treated wastes were then discharged into a drainage ditch, which finally discharged into Rythus Creek. During the 1967 packing season (a 10-week period), the following problems occurred:

1. There were offensive odors coming from the ponds.
2. There was the possibility that Rythus Creek's was being polluted.
3. There was over-production and excessive hydraulic loading.
4. Discharge into the drainage ditch was visible.
5. Maintenance of treatment facility was inadequate.

Because of these problems, the state health department issued a letter to Gro-Pac requesting that the problems be corrected before the 1968 packing

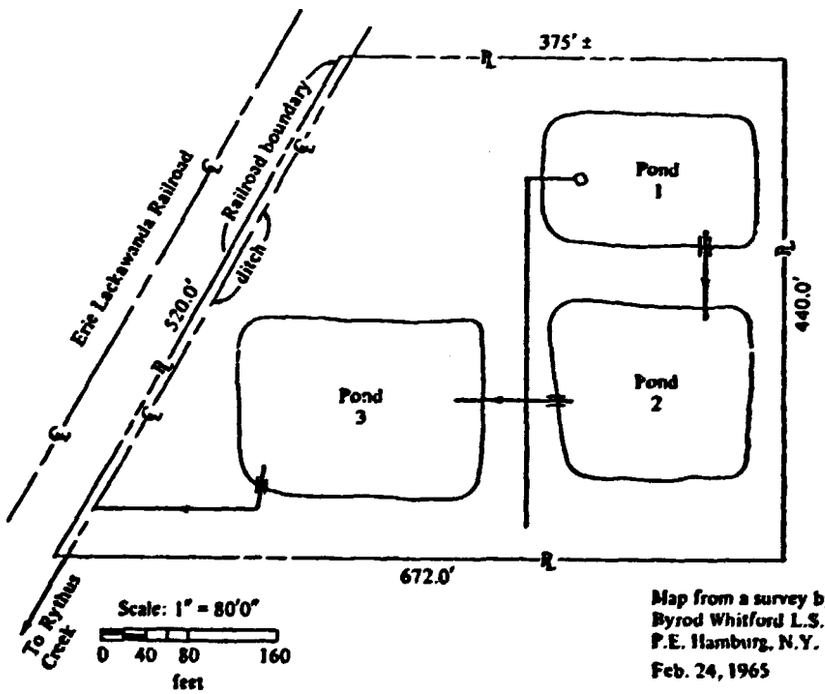

Fig. 20.7

AN EXAMPLE

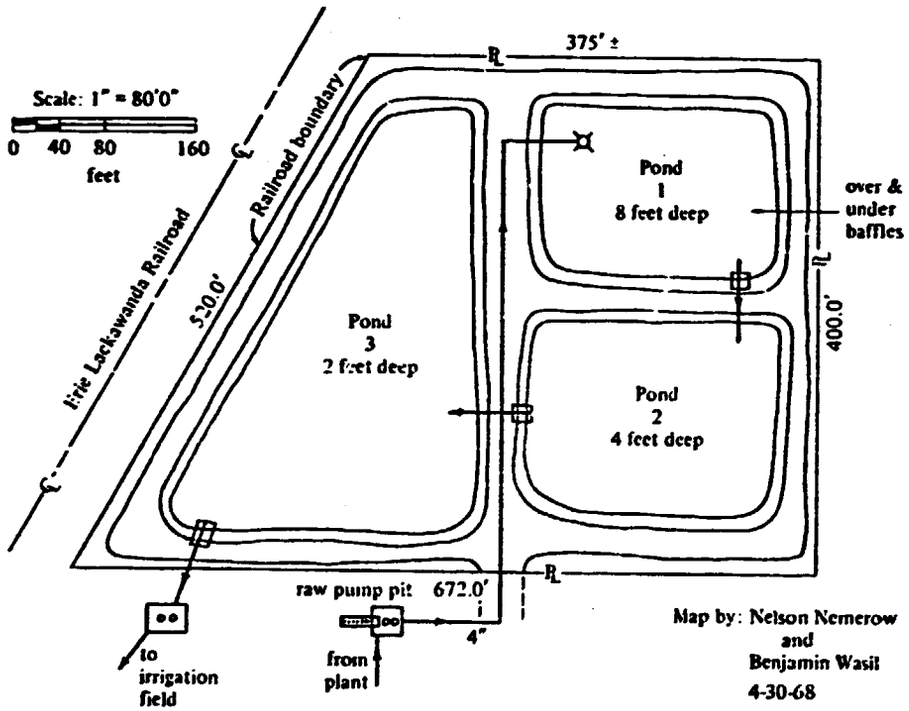

Fig. 20.8

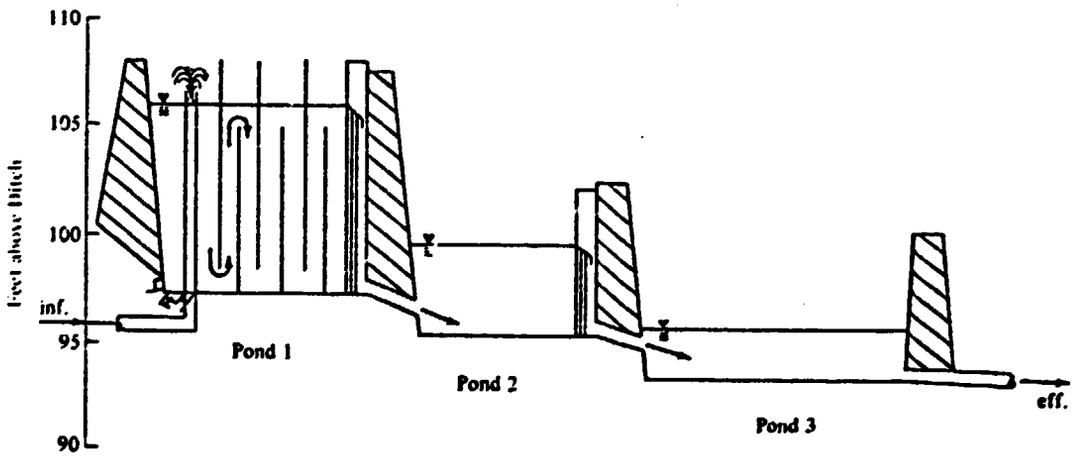

Fig. 20.9

season began or an operating permit would not be issued.

The composite wastes from this plant contained BOD in the range of 200–1000 ppm, COD in the range of 500–2200 ppm, suspended solids in the range of 48–1200 ppm, and pH in the range of 4.2 and 6.6.

Basis of Design

The decision for the design of the new treatment facility was based on the following constraints:

1. The waste produced was a readily-oxidizable organic waste.
2. Adequate (but not abundant) land was available.
3. No sewers or municipal treatment facilities were located in the immediate area.
4. Rythus Creek, the receiving stream, was used mainly as irrigation water.
5. The plant operated each year during the packing season (10 weeks) only.

It was decided after reviewing three previous studies by Nemerow [1, 2, 3,] to use a three-pond system of lagoon treatment, with over-and-under baffles in the deepest of the three ponds. After lagoon treatment this waste was sprayed to irrigate a rye-grass field. Under ideal conditions the sprayed effluent reached the creek only after percolating through the soil substrata. In case of surface runoff only the three-pond-lagooned effluent would reach the creek.

The three studies [1, 2, 3] had shown that over-and-under baffles increased the BOD removal efficiencies of normally operated lagoons. This waste-treatment facility as designed and built is shown in Figs. 20.7, 20.8, and 20.9.

Essentially these three ponds acted as high-rate oxidation basins. The ponds were designed to operate at 8, 4, and 2 foot depths, respectively. Pond 1 was expected to operate as anaerobic in its lower levels and aerobic near the surface. The products of anaerobic decomposition from the settled solids were expected to diffuse from the bottom to the higher levels, where more oxygen would be available. The over-and-under baffle system (33,000 feet² of surface area) was used to enhance bacterial, protozoal, and slime growth. The baffles served both to effect complete mixing and to increase the contact between bacterial growth and organic matter. The detention time was short enough (8 days) to prevent complete anaerobiosis.

Pond 2 was shallower and since its effluent would be of higher quality and clarity more oxygen could be supplied to the oxygen deficient waste by algal growth and surface reaeration. However, the detention time in this pond was also short (4 days) to ensure an adequate oxygen balance. Some residual solids were expected to settle out in this pond also.

In Pond 3 no settled solids were expected. The major emphasis was placed upon algal production in order to supply sufficient oxygen for final oxidation of the remaining decomposible products. The detention time in this pond was designed to provide 6 days under which aerobic conditions should have been sufficient for rather complete (80–90 per cent) BOD reduction. This highly treated waste would then be sprayed on a rye-grass field and tile-underdrain system, which would finally reach Rythus Creek. This additional phase of treatment (spray irrigation) would produce a highly polished and clarified effluent which would minimize its impact on Rythus Creek.

A total detention time in the system of 18 days was estimated if the bottoms and sides of the ponds were sealed with bitumastic or clay and if the ponds were constructed and operated as designed.

The first packing season for the new treatment facility was in 1968 lasting for a period of 10.5 weeks. Prior to this, the following modifications were made:

1. An over-and-under baffle system covering 33,000 ft² of surface area was used.
2. Pond 3 was enlarged to double its original size.
3. The spray-irrigation area was regarded and replanted with rye grass.
4. Several banks of distribution pipes were added to the spray-irrigation system.
5. A collection weir and effluent sump were constructed for Pond 3.

The total cost of the treatment facility including the above modifications was $55,000.

Sampling

Samples of the raw waste and three-pond effluents were collected as soon as they became available, as were upstream and downstream samples of Rythus Creek—a potential receiving stream for drainage

Table 20.11 1968 packing-season average analytical results of waste-treatment system

Sample location	BOD (ppm)	BOD (per cent reduction)	COD (ppm)	COD (per cent reduction)	Normal pH range	Suspended solids (ppm)	Suspended solids (per cent reduction)
Raw waste	429	0	1004	0	4.2–6.6	304	0
Pond 1 effluent	276	35.7	191	81	4.5–6.3	48	84.3
Pond 2 effluent	201	53.2	343	65.8	5.2–6.9	47	85
Pond 3 effluent	135	68.7	127	87.2	5.4–7.0	69	77.3
Rythus Creek: When flowing upstream	3.4	—	7.6	—	5.6–7.9	7	—
When flowing downstream	3.8	—	14.1	—	5.8–8.4	13	—

from the spray-irrigation land. Samples were analyzed for BOD, COD, pH, and suspended solids.

Analytical Results

Although the results varied during each packing season as well as from year to year, the overall average results are shown in Tables 20.11–20.15.

Operational Problems and Corrective Measures

During the first year of operation (1968 packing season) a few of the over-and-under baffles in Pond 1 did not remain in position; they floated to the surface and tilted on their sides, which resulted in an inefficient flow distribution throughout Pond 1. In addition, the stilling basin approach to the effluent weir of Pond 1 leaked on the sides all the way to the bottom, allowing bottom anaerobic sludge to escape through the weir stops into the remaining two ponds. In addition, apparently the last baffle was placed too close to the effluent weir and, under existing circumstances, did not provide sufficient settling prior to weir discharge.

Since some of the oxygen-deficient matter was scoured from the bottom of Pond 1 at times, faint odors of hydrogen sulfide existed near the pond's banks. The following steps were immediately taken to correct the situation:

1. The effluent weir stilling basin was filled and sealed with clay so that all the effluent from Pond 1 was discharged only over the surface of the weir.
2. An attempt was made to "right" those baffles which had erupted from their soil anchor.

While the first remedial measure was successful, the floating-baffle problem was not corrected until the 1969 packing season. Although some baffles were placed back in their original vertical position and weighted with concrete filled cans, this task was not completed until the ponds could be emptied and the baffles placed in concrete supports during the summer of 1969.

Because of an unanticipated scouring of the bottom of Pond 1, other remedial measures were taken to prevent odors from reaching the objectionable or nuisance level. These measures included the following:

1. Feeding compressed air into the screened influent pumped to Pond 1.
2. Adding $NaNO_3$ (100 #/day) to the raw screened waste prior to pumping it to Pond 1.
3. Recirculating (by means of a small pump) some of the contents of Pond 3 back into Pond 1.

Even though the ponds were all black and extremely low in dissolved oxygen, odors and hence nuisance conditions were averted during the first packing season (1968) by applying the above-mentioned measures.

As corrections were made in Pond 1, the compressed air being fed to the raw-waste-screen chamber and the recirculation of Pond 3 contents to Pond 1 were discontinued in 1969 with no apparent deleterious effects on the efficiency of the treatment system. However the feeding of sodium nitrate was continued

Table 20.12 1969 packing-season average analytical results of waste-treatment system

Sample location	BOD (ppm)	BOD (per cent reduction)	Normal pH range	SS (ppm)	SS (per cent reduction)
Raw waste	312	0	4.4–5.6	310	0
Pond 1 effluent	197	37.5	6.1–6.3	362	—
Pond 2 effluent	130	63.5	6.2–6.5	200	35.5
Pond 3 effluent	84	74	6.5–6.6	120	61
Rythus Creek: When flowing upstream	—	—	—	—	—
When flowing downstream	—	—	—	—	—

Table 20.13 1970 packing-season average analytical results of waste-treatment system

Sample location	BOD (ppm)	BOD (per cent reduction)	Normal pH range
Raw waste	470	0	4.8–7.2
Pond 1 effluent	176	63	6.5–7.2
Pond 2 effluent	121	75	6.9–7.3
Pond 3 effluent	70	85	6.9–7.9
Rythus Creek: When flowing upstream	—	—	—
When flowing downstream	—	—	—

since analyses indicated a possible deficiency of nitrogen in the raw waste.

Residents in the area were canvassed periodically during the canning season to discover whether they had encountered objectionable odors. None were noted in 1969; however, no data on the odors were available in 1970–71. Slight odors could be detected periodically if one stood on the dike between Pond 1 and Pond 2. These odors were later found to be caused by sulfur in the water supply and the sulfur bacteria converting the sulfur to hydrogen sulfide. Those odors were present only under ideal wind and waste-loading conditions and almost vanished as one moved away from the treatment area. There were no odors present

Table 20.14 1971 packing-season average analytical results of waste-treatment system

Sample location	BOD (ppm)	BOD (per cent reduction)	SS (ppm)	SS (per cent reduction)	Normal pH range
Raw waste	615	0	454	0	5.1–6.8
Pond 1 effluent	274	555	126	50	6.0–7.2
Pond 2 effluent	209	66	66	86	6.8–7.4
Pond 3 effluent	160	75	70	85	6.8–7.5
Rythus Creek: When flowing upstream	—	—	—	—	—
When flowing downstream	—	—	—	—	—

Table 20.15 BOD and efficiency over the period 1968–71

	Packing season							
	1968		1969		1970		1971	
	BOD		BOD		BOD		BOD	
Sample location	(ppm)	(per cent reduction)	(ppm)	(per cent reduction)	(ppm)	(per cent reduction)	(ppm)	(per cent reduction)
Raw waste	429	0	312	0	470	0	615	0
Pond 1 effluent	276	35.7	197	37.5	176	63	274	55.5
Pond 2 effluent	201	53.2	130	63.5	121	75	209	66
Pond 3 effluent	135	68.7	84	74	70	85	160	75

at any time in the spray irrigation field area. Some odors, however, did exist near a truck used to load and haul away the leaves and bean snips screened out of the waste. After bringing this to the attention of the cannery owners, the situation was promptly corrected by emptying the truck more often and washing it thoroughly between loadings.

Gro-Pac personnel were extremely cooperative during the entire period of operation. They assisted in sample collection, made the necessary structural corrections to Pond 1, and cooperated fully in operating the ponds at their proper levels, and in changing waste-treatment operating procedures immediately as instructed.

Results of Treatment

The waste-treatment system, a three-stage lagoon system of three varying depth basins, effected removals of 68–85 per cent BOD and 60–85 per cent suspended solids over a four-year operational period (1968–1971). This reduction was ample to (1) prevent nuisances and (2) to allow for final disposal of the effluent by spray irrigation with no soil clogging, ponding, odors, or contamination of receiving waters. The first pond accomplished the most of the reduction of contaminants as expected. The last pond contained dissolved oxygen, an elevated pH, some algal growth, and low suspended solids. Raw-waste BOD, COD, and suspended solids were about 450, 1000, and 300 ppm, respectively, and were reduced by the series pond treatment to values of approximately 110, 127, and 70 ppm, respectively.

Flow Measurement

Because of the erratic pattern of discharge of raw waste from the cannery and because of the resulting discontinuous discharges from each pond, accurate flow measurements during the average 10-week packing season were not available.

However, the raw-waste pump rated at 400 gpm was operated approximately 50 per cent of the time for 18 h of the day. This amounted to a daily hydraulic loading of 216,000 gallons per day.

At four times during the 1968 packing season, the flow leaving Pond 1 was measured during the 18 hours of operation; this measurement averaged about 175 gpm. This was in good agreement with the estimated raw-waste flow if one assumes a 12 per cent loss in Pond 1 due to evaporation and exfiltration.

The total waste load was therefore computed on this flow basis (0.216 mgd). This load would be 450 ppm BOD × 8.34 × 0.216 mgd or 810 pounds of BOD per day on the three pond system. Since the three-pond area contains 3.1 acres, the unit loading on this entire lagoon system is 260 pounds of BOD per acre per day.

In comparison with loadings applied to domestic-sewage-lagoon systems of 20–50 pounds of BOD per

acre per day, these were roughly 10 times as high. Three reasons for the relatively acceptable efficiency at the elevated loadings are proposed: (1) a readily oxidizable wastewater; (2) a properly designed three-stage-lagoon system and (3) the use of baffles to obtain additional biological growth surface area.

Conclusions

The following conclusions were reached from this case treatment:

1. A three-stage biological-oxidation-pond system was used to successfully treat bean-cannery waste during short packing seasons.
2. No permanent nuisances were created in the area surrounding the plant. Temporary odorous conditions were corrected by $NaNO_3$ feeding and aeration of the lagoon influent in the raw-pump wet-well chamber.
3. Efficient operation of this plant was greatly hampered in the earlier stages by construction and structural failures.
4. After all the structural problems were corrected, the plant operated at a considerably higher efficiency—an increase from 68 per cent to 85 per cent BOD reduction.
5. The three-pond system with over-and-under baffles in the first pond effected seasonal average BOD, COD, and suspended solids removals of 78, 87.3, and 77 per cent, respectively. The estimated BOD loading was 260 pounds per acre per day.
6. The pond-system-treated effluent was successfully spray irrigated on a rye-grass field without nuisances such as odors, ponding, or contamination of the potential receiving streams. The irrigation-field loadings were 72,000 gallons per acre per day over the 3 acre field and a BOD load of 67 pounds per acre per day was applied. These values are well within acceptable hydraulic loads and BOD loading did not seem to be the critical design factor.

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Questions for Problem 1

1. When is it necessary from a technical standpoint to completely treat an industrial waste prior to discharge into a stream?
2. What does this particular problem in waste treatment entail?
3. Why was this wastewater so difficult to treat?
4. Why was it important to remove such a high percentage of the organic matter?
5. Why wasn't a river study carried out?
6. Describe the unique treatment system used to obtain our objectives in this case.
7. What was the major limiting constraint placed by the industry on waste treatment in this case?
8. What combination of factors allowed the author to comply with this constraint and still obtain the treatment required?

Questions for Problem 2

1. What is the major difference in background factors in this problem from the first one in this chapter?
2. What is the major difference in technical character of this waste from the first waste?
3. What is the purpose of the baffling in the oxidation ponds in both problems?
4. What combination of conditions led to the solution selected by the author to this problem?
5. What are the purposes of the relatively deep first basin and shallow third basin?
6. What is necessary for final disposal of treated industrial wastewater onto the land?

SECTION III

AQUACULTURE SYSTEMS

3- AQUACULTURE SYSTEMS

The effluent from baffled biological basins may not be suitable for discharge into a water supply requiring high quality characteristics. Primary treated sewage effluents also may not be satisfactory for final discharge, however conventional secondary treatment may be too costly for certain situations. In addition, protein matter is becoming increasingly costly and scarce, especially in Developing Nations experiencing too rapid population growths.

To counteract these problems, I have devised a potentially cost-effective, environmentally protective, food conserving treatment process. It consists of following primary settling or intermediate-type biological treatment with an aquaculture basin system. The system will be in two stages, the first to promote the growth of algae and small crustaceans, and the second to support the propogation of fast-growing food-fish (probably Tilapia). The fish will be harvested periodically and either steam-stripped of their protein to serve as animal food or sold directly to fish markets for eventual human consumption. The systme will be most suited for tropical and semi-tropical climates preferably with average or subaverage rainfall. The effluent now devoid or mineral nutrients, such as nitrogen and phosphorous, and reasonably low in BOD, suspended solids, and other potential contaminants, can be reused for secondary industrial and municipal purposes - such as watering parks and golf courses, cleaning public streets,

fighting fires, industrial and municipal cooling waters, power cooling waters, toilet flushing, and many other uses except public drinking water.

An illustrative diagram of one potential use of the system is shown in Figure 1. This treatment depends only upon natural gravity flow of wastewater and natural sunlight for energy. Oxygen for fish life will be supplied by natural surface aeration and that released by the algae coming directly from the algae pond. Therefore, power costs for pumping wastewater, supplying oxygen, and for mixing wastewater have been eliminated or minimized.

Detention times, and hence size of the treatment units are expected to be considerably longer and larger than those of conventional secondary treatment systems. However, for relatively smaller municipalities and industrial plants, the land area required should not be excessive. Further, since there is no effluent from this system (or only a portion of the the effluent wasted), the environmental impact is far less (and almost nihil) than even a conventional tertiary treatment system.

The success of this system depends upon establishing the proper combination of environmental factors to support bacteria algae, crustracean, and fish food growth. Similar, but not exact, systems are already in experimental use in India and even in the United States. The precise design criteria for our system will be evolved after more complete pilot plant research is concluded.

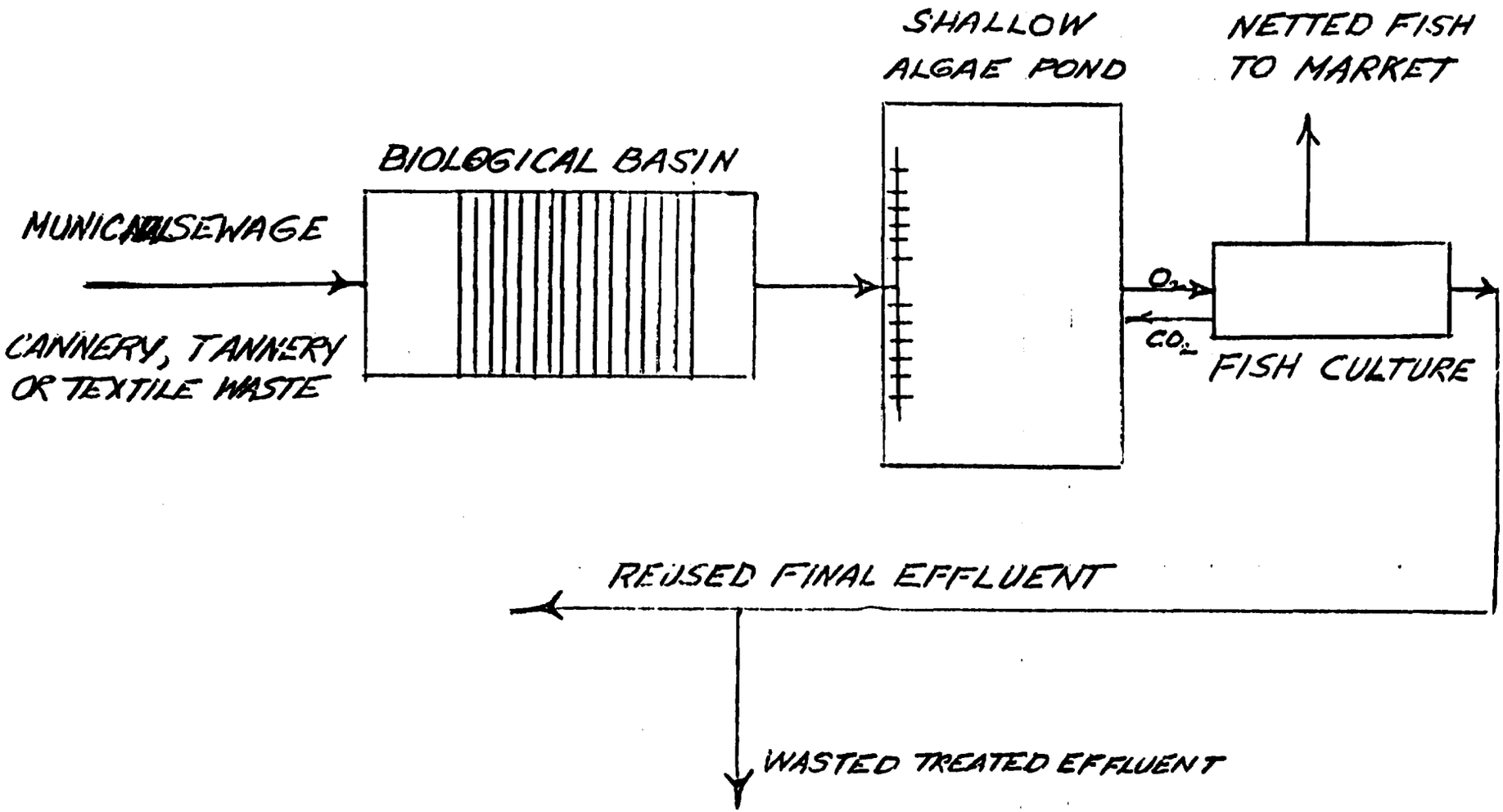

FIG. 1
AQUACULTURE SYSTEM

NLN 6-82

SECTION IV

ENVIRONMENTALLY BALANCED - INDUSTRIAL COMPLEXES

ENVIRONMENTALLY BALANCED INDUSTRIAL COMPLEXES

By

[1] Nelson Leonard Nemerow

[2] Avijit Dasgupta

INTRODUCTION

Although the real measurable cost of industrial environmental pollution control remains relatively small when compared to total production or value added costs, it can be considered a significant amount when considered by itself. In fact, it may be enough to influence management of an industry to produce or discontinue the manufacture of specific consumer goods. While we as environmental engineers are usually not involved in that decision, our goal should be to reduce treatment costs to a minimum while protecting the environment to a maximum.

Environmentally Balanced Industrial Complexes (EBIC) are simply a selective collection of compatable industrial plants located together in a complex so as to minimize environmental impact as well as industrial production costs. These objectives are accomplished by utilizing the waste materials of one plant as the raw material for another with

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a minimum of transportation, storage, and raw material preparation costs. When the same industry neither treats its wastes, imports, stores, or pre-treats its raw materials, its overall production costs must be reduced significantly.

In conventional industrial solutions to waste problems, industry uses separate treatment plant units such as physical, chemical, and biological systems. These add production costs onto already highly competetive manufacturing problems. These costs are also easily identified and, even if relatively small when compared to other production costs, strenuosly opposed or objected to by industry. On the other hand, reuse costs, if any, in an environmentally balanced industrial complex, will be difficult to identify and more easily absorbed into reasonable production costs.

Large, water-consuming, and waste-producing industrial plants are ideally suited for location in such industrial complexes. Not only are their wastes hazardous to our fragile environment, but they are also amenable to reuse by close association with satellite industrial plants using wastes and producing raw materials for others within the complex. Examples of such major industries are steel mills, fertilizer plants, pulp and paper mills, and tanneries.

These complexes are not without their own problems, or at least some unknowns which may determine their acceptability. For example, will it be politically and socially

feasible, and practical to encourage several specific industries of specific production capacity to locate in one complex at a specific site ? Will contaminants build up in recirculated and reused wastewaters to a degree which will interfere with production ? Or will these contaminants be removed in the manufactured products and cause product quality rejections ? How will fluctuations in product demand in the external market affect production in the complex ? Will special temporary storage facilities be necessary ? Will malfunctioning of equipment in the production of one product affect the other components within the complex ? These and other answers need verification before continuing promotion of the complexes.

At this time we will propose and describe preliminary concepts of four typical complexes centered about the following four major industries : 1) fertilizer, 2) steel mill, 3) pulp and paper, 4) tannery. Some of the same auxiliary industrial plants will be located in several complexes. We deem this necessary because many major industrial plant wastes are somewhat similar in nature.

1. FERTILIZER PLANT COMPLEX

As the world population increases rapidly from its already high level the demand for more food and hence greater production of agricultural products is also spiralling. Increased fertilizer use is inevitable as the major means

of providing the extra food. Phosphatic rocks, largely found in United States and predominantly in Florida, provide the basic starting material for phosphoric acid, P_2O_5 , and Ammonium phosphate fertilizer for commercial use. In the usual sulfuric acid process for dissolving the rock, a gypsum-like sludge is wasted as a by-product and some sulfur dioxide and fluorine are driven off in the gases evoloved at the high reaction temperatures. Both gypsum sludges and sulfur dioxide-fluorine effluents are troublesome wastes to dispose of in our environment. Massive quantities of gypsum, relatively impure, result from the production of P_2O_5 fertilizer (in ratios of 5:1). These defy usual waste treatment processes. Fluorine in the gas as hydrofluoric acid is present in concentrations varying from 1 to 10 percent which is too low for commercial use without further treatment. This may be both costly and extensive. Location of such a fertilizer plant in an industrial complex with other plants able to utilize these wastes as raw materials in the manufacture of new products is a feasible solution to the environmental problem. One such complex is presented in Figure-1.

2. STEEL MILL COMPLEX

Steel mills are actually five separate industrial plants in one consisting of 1) Coke Plant 2) Iron Ore Reduction Plant 3) Steel Production 4) Hot Rolling Mill and 5) Cold Rolling Mill. Predominant wastes originate from the

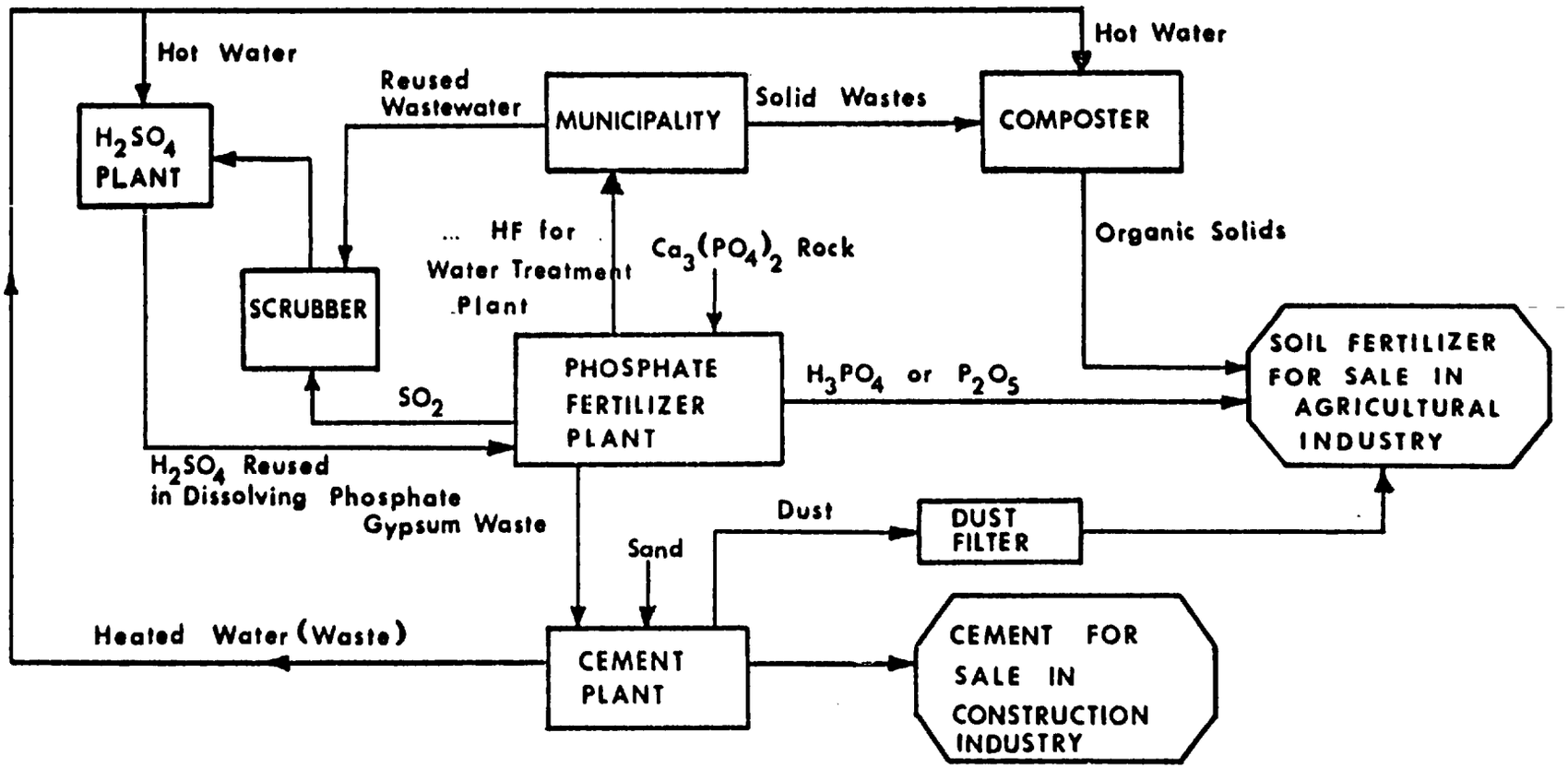


Fig. 1 Fertilizer Plant Complex

coke and steel plants, although certain dusts, slag, and iron also come from the other plants. Troublesome waste products include ammonia, cyanide, phenol, heat, and acidic ferrous sulphate or chloride pickle liquor. Steel mills also use huge volumes of water - mostly for cooling and quenching and produce like volumes of air, water and solid contaminants. They have developed a world-wide reputation as one of the most polluting industries existing in modern times. They require so much land area and employ so many people that their location in a separate industrial complex would be a natural development. Fertilizer and building material plants are likely candidates for auxiliary industries for a steel mill complex. Such a complex is proposed and presented in Figure 2.

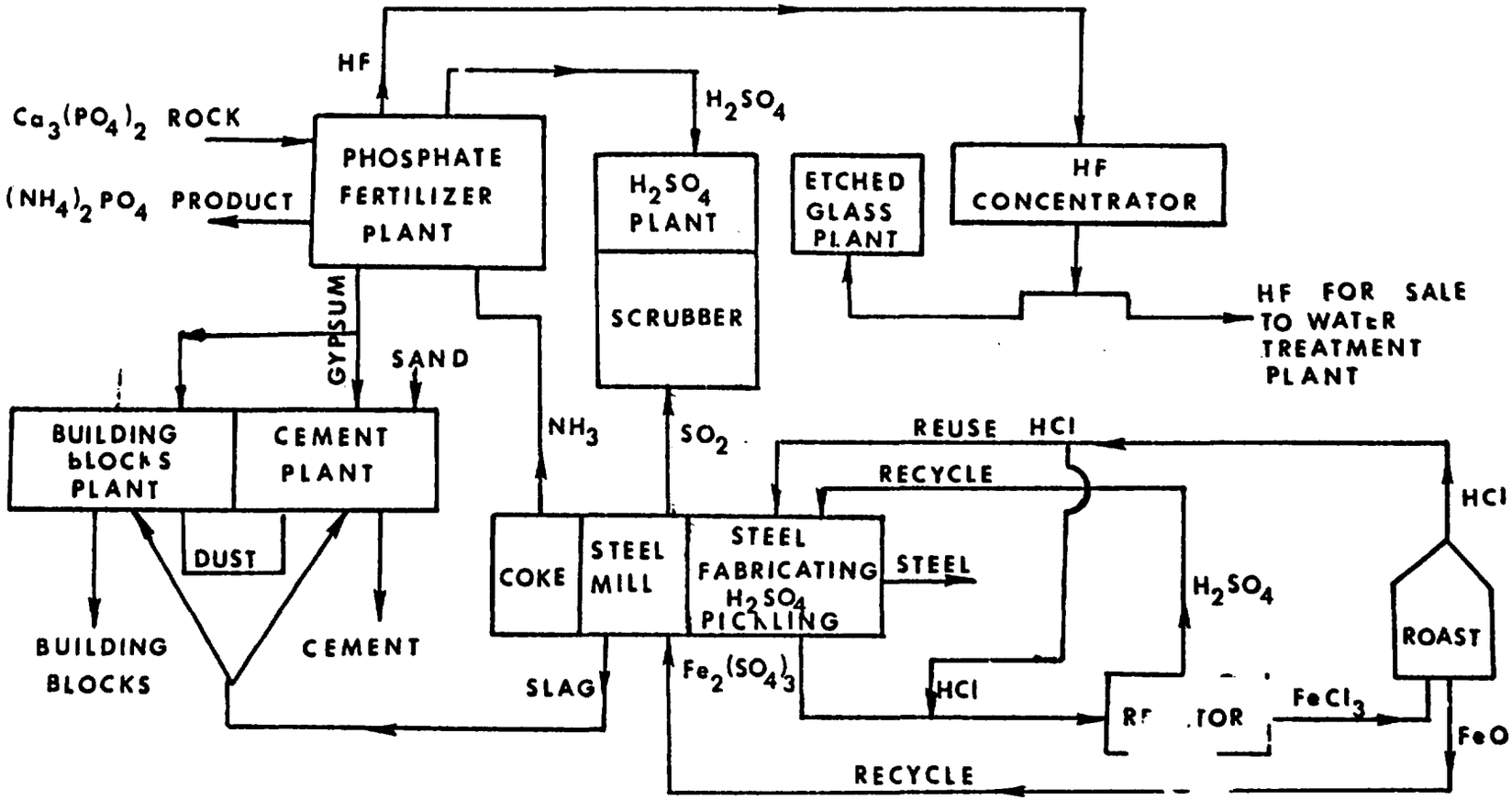


Fig. 2 Steel Mill - Fertilizer Complex

3. PULP AND PAPER MILL COMPLEX

The products of pulp and paper mills, the fifth largest in the U.S. economy are consumed at the annual rate of about 400 pounds per person. The pulping of the wood and the formation of the paperproduct produce wastes containing considerable quantities of sulfates, fine pulp solids, bleaching chemicals, mercaptans, sodium sulfides, carbonates and hydroxides, sizing casein, clay, ink, dyes, waxes, grease, oils, and other small fibers. The overall wastes can be high or low in pH, and certain high color, suspended, colloidal, as well as dissolved solids and inorganic filters. Because of its high water consumption and wastewater discharge of 20,000 to 60,000 gallons per ton of product, the wastes contain large total quantities of organic, oxygen-demanding matter. The high water use and wastewater production usually preclude the possibility of joint treatment with municipal sewage. These wastes also create considerable environmental impacts because of their concentrated loads of air, water, and land pollutants. The siting of new pulp and paper mills today has become a major endeavor. They must be located near vast quantities of relatively clean water as well as receiving water resources, downwind and at a distance from residential habitation (because of common air pollutants such as SO_2 and mercaptans), usually on a rail line and near major highways for shipping, and near adequate land area for waste treatment and sludge disposal. Such sites are also difficult

to find. For these and other reasons previously given we recommend consideration of a pulp and paper mill complex with little or no adverse environmental effect. The following Figure 3 describes one possible complex centered about an averaged-sized paper mill producing 1000 tons of paper product per day.

In the first publication (1, 1977) a balanced industrial complex centered about a pulp and paper mill was presented. The preliminary mass balance was given in this paper and is ~~also~~ produced here as Fig.3 for additional clarification. Eight separate industrial plants were included as part of this complex; five of which would produce products to be used within the complex.

Timber is brought into the complex to the pulp mill (1) where it is converted into pulp for use by the paper mill (2). Major wastes from (1) are bark which is burned subsequently in the steam plant and sulfate waste liquor which is used in three internal complex plants; road binder (3), vanillan (4), and sulfate concentrating (8). Products from (3), (4) can be sold locally or internationally while those from (8) are reused in the complex by (1) or by the hardboard manufacturing plant (7). Fine paper product from (2) can be sold in the world market. Wastes from (2) include heat, fillers, and fines which can be used internally in the groundwood pulp mill (5) which also uses a percentage of used newspaper stock.

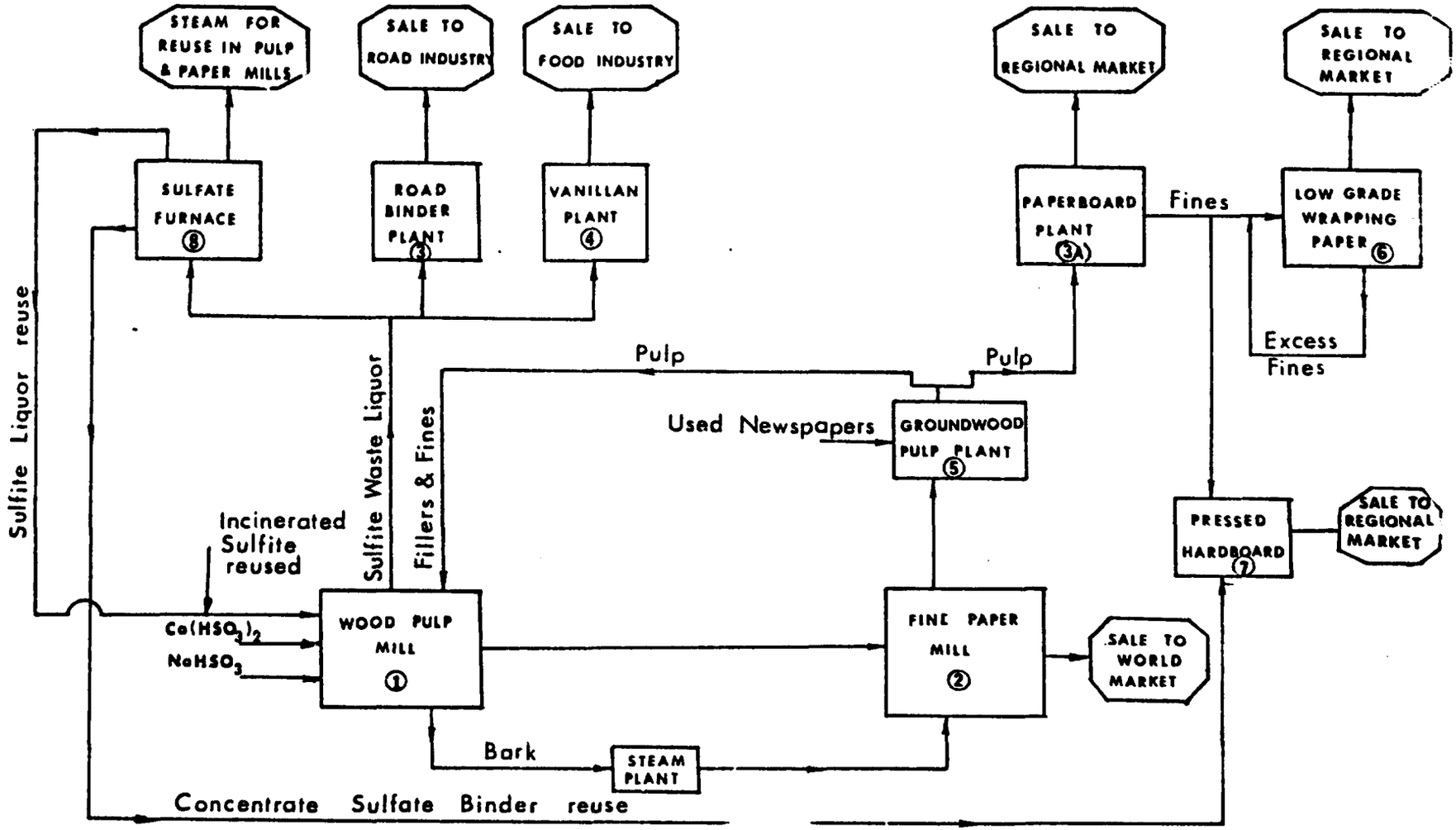


Fig. 3 Pulp and Paper Mill Complex

The pulp product from (5) will be used partially in the complex by (1) and sold externally as paperboard. The plant (5) produces waste suspended solids which are used internally by the wrapping paper plant (6) and (7). The product of (6) and (7) can be sold regionally. Thus, this industrial complex produces six products for external sale and for internal use while minimizing or eliminating entirely wastes to the environment.

4. TANNERY COMPLEX

Tannery wastes from upper sole, chrome tanning mills contribute to a significant pollution problem in the United States. The wastes are hot, highly alkaline, odourous, highly colored, and contain elevated quantities of dissolved organic matter, B.O.D., total suspended solids, lime, sulfides and chromium. The treatment of such wastes has been difficult because of the conflicting pollutional parameters of pH, organic matter, and potential toxic compounds. Most successful treatment plants utilize some form of biological treatment to reduce the oxygen demand on receiving wastes. This necessitates the use of well-designed and operated preliminary treatments to ensure safe and efficient biodegradation. High sludge quantities result from these treatments. Therefore, properly designed and operated tannery waste treatment systems may be costly to build and operate; while the lack of these facilities will cause excessive stream

pollution. Placing the tannery in an environmentally optimized industrial complex eliminates both of these negatives. A detailed study of this type of complex is given in Section 5 which follows.

5. THE SLAUGHTERHOUSE-TANNERY-RENDERING COMPLEX

The author has presented two formal papers at technical meetings on the subject (1, 1977 and 3, 1980) and a Report (4, 1980) representing a first attempt at providing a complete mass balance of reference-validated inputs and outputs of plants within an industrial complex. The fulcrum industrial plant of this complex is a tannery. Supporting industries include slaughterhouse and rendering plants. The three-industry complex is also expanded to consist of an animal grazing and feedlot facility as well as a residential area for homes of all personnel working in the complex. As the complex is expanded to include the feedlot and residences and biogas and power plant services the complex becomes more self sustaining. Outside service requirements are minimized by the expansion. All power is generated within the complex - in the expanded third stage version. Excess products of leather, meat, meal, soap, and even electricity are sold to consumers outside the complex. Chemicals, water, cattle, and animal feed are imported to the complex. Wastewater, blood and bone meal, hide and leather trimmings, cattledung, residential solid wastes are recovered and reused within

RAW MATERIAL REQUIRED FROM OUTSIDE THE COMPLEX		MANUFACTURED PRODUCTS FOR OUTSIDE SALE	
Material	**Amount**	**Material**	**Amount**
1. Fresh Makeup water	97,599 gal/d	1. Meat products	513,341 #/d
2. Elect. Power	45,432 KWH/d	2. Tanned leather	36,000 sq.ft./d
3. Cattle	900/d 854,100 #LWK/d	3. Blood meal	4092 #/d
4. Chemicals	495 #/d Na_2S 3960 #/d $Ca(OH)_2$ 1500 #/d H_2SO_4 2475 gal/d kerosene 1980 #/d oil or wax 2475 #/d $Cr_2(SO_4)_3$ 4208 #/d NaCl	4. Tallow	79,740 #/d
		5. Bone meal	70,776 #/d
		6. Tanned hide trimmings, shavings etc.	1802 #/d

TABLE - 1 External Raw Materials and Manufactured Products in Three Industry Complex (STAGE - 1)

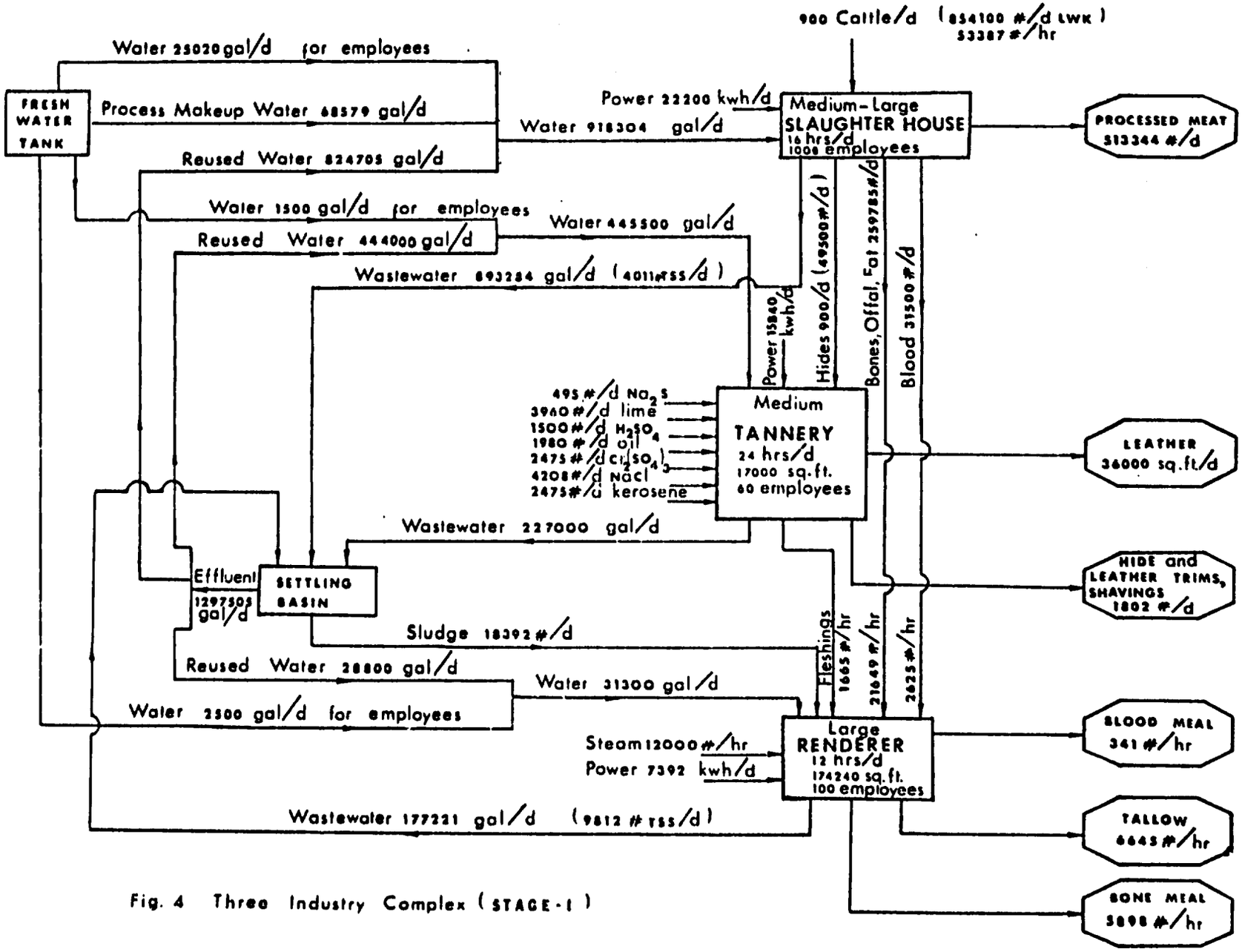


Fig. 4 Three Industry Complex (STAGE-I)

(internally) the expanded complex. The complex can be constructed as shown in the first stage, second stage, or fully expanded to the third stage. Criteria for decision will be based upon area requirements and individual, local objectives.

STAGE 1

This is the first of the three stage Industrial Complex which is balanced internally so that little or no adverse environmental impact results from any of the industrial plant's productive activities. Each stage represents a totally balanced and individual industrial complex.

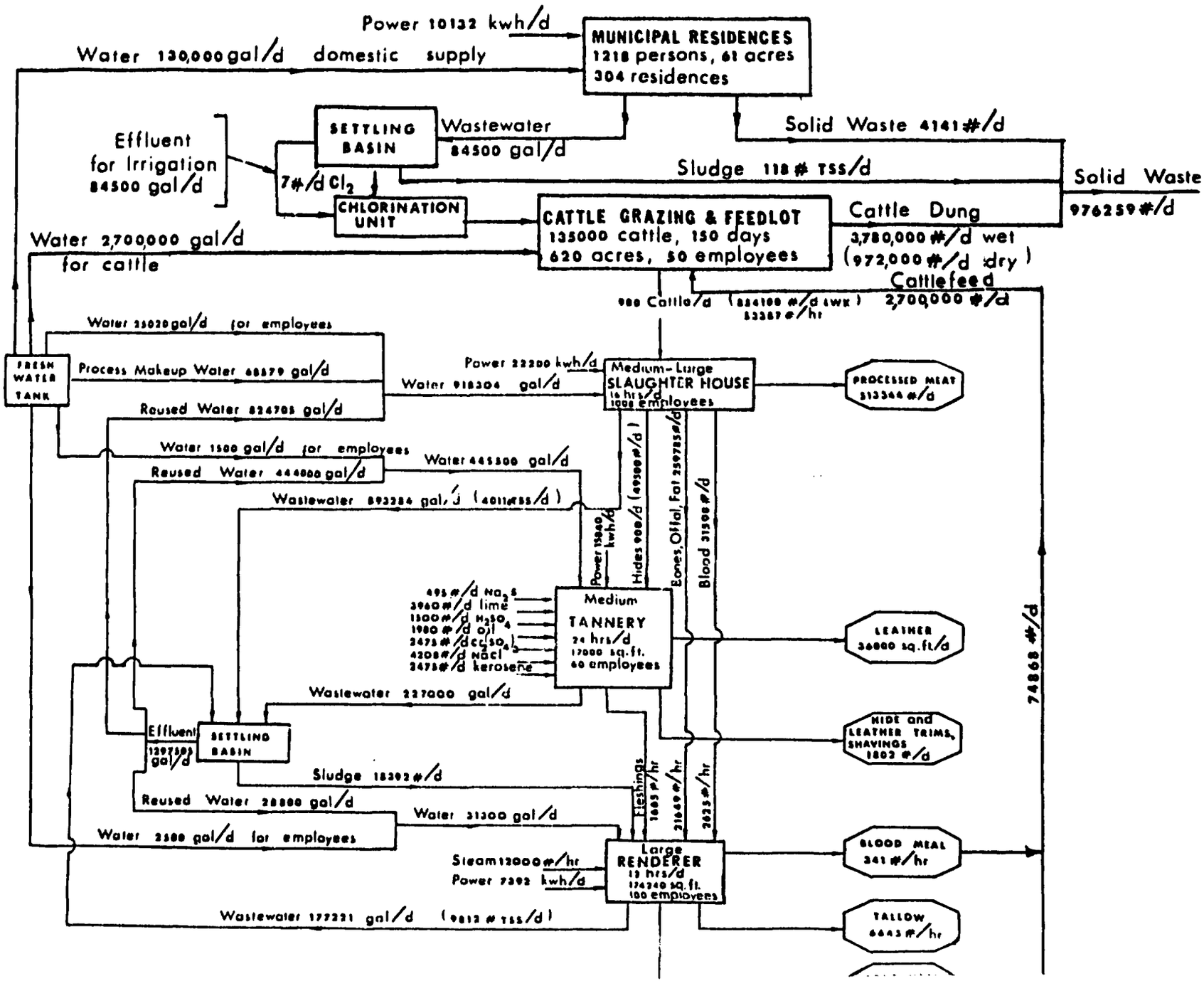
The first stage consists of a three industry plant complex comprising 1) a slaughterhouse 2) a tannery and 3) a rendering plant. A schematical drawing of the complex is given in the following Figure 4, which includes inputs and outputs from each industrial plant. External raw materials and manufactured products for external sale are given in Table 1.

STAGE 2

The second of the three stage industrial complex is also balanced internally so that little or no adverse environmental impact results from any of the industrial plants' ~~plants~~ productive activities. It differs from the first stage in that it provides a more complete and self

RAW MATERIAL REQUIRED FROM OUTSIDE THE COMPLEX		MANUFACTURED PRODUCTS FOR OUTSIDE SALE	
Material	Amount	Material	Amount
1. Fresh Makeup water	2,927,599 gal/d	1. Meat products	513,341 #/d
2. Elect. Power	55,564 KWH/d	2. Tanned leather	36,000 sq.ft./d
3. Calves	900/d (150 days prior to production) 540,000 #/d	3. Tanned hide trimmings, shavings etc.	1802 #/d
4. Chemicals	495 #/d Na_2S 3960 #/d $Ca(OH)_2$ 1500 #/d H_2SO_4 2475 gal/d kerosene 1980 #/d oil or wax 2475 #/d $Cr_2(SO_4)_3$ 4208 #/d NaCl 7 #/d Cl_2	4. Tallow	79,740 #/d
		5. Solid Waste (Municipal refuse and sludge)	4,259 #/d dry wt.
		6. Animal Dung	3,760,000 #/d (wet) or 972,000 #/d (dry)
5. Cattlefeed	2,625,000 #/d		

TABLE - 2 External Raw Materials and Manufactured Products in Three Industry


Power 10132 kwh/d
MUNICIPAL RESIDENCES
1218 persons, 61 acres
304 residences
Water 130,000 gal/d domestic supply
SETTLING BASIN
Wastewater 84500 gal/d
Solid Waste 4141 #/d
Effluent for Irrigation 84500 gal/d
7 #/d Cl2
Sludge 118 # TSS/d
Solid Waste 976259 #/d
CHLORINATION UNIT
CATTLE GRAZING & FEEDLOT
135000 cattle, 150 days
620 acres, 50 employees
Cattle Dung
3,780,000 #/d wet
(972,000 #/d dry)
Water 2,700,000 gal/d for cattle
Cattlefeed
900 Cattle/d (884100 #/d twice) 2,700,000 #/d
83387 #/hr
Water 25020 gal/d for employees
FRESH WATER TANK
Process Makeup Water 68579 gal/d
Power 22200 kwh/d
Medium-Large SLAUGHTER HOUSE
16 hrs/d
1008 employees
Water 918304 gal/d
PROCESSED MEAT 513344 #/d
Reused Water 824785 gal/d
Water 1500 gal/d for employees
Reused Water 444800 gal/d
Water 445300 gal/d
Wastewater 893284 gal/d (40114 #SS/d)
Power 13640 kwh/d
Hides 900/d (49500 #/d)
Bones, Offal, Fat 259785 #/d
Blood 31500 #/d
495 #/d Na2S
3960 #/d lime
1500 #/d H2SO4
1980 #/d oil
2475 #/d Cr2(SO4)3
4208 #/d NaCl
2475 #/d kerosene
Medium TANNERY
24 hrs/d
17000 sq.ft.
60 employees
LEATHER 36000 sq.ft/d
Wastewater 227000 gal/d
Effluent 1297593 gal/d
SETTLING BASIN
HIDE and LEATHER TRIMS, SHAVINGS 1802 #/d
Sludge 18392 #/d
Fleshings 1665 #/hr
21649 #/hr
2625 #/hr
Reused Water 28800 gal/d
Water 31300 gal/d
Water 2500 gal/d for employees
Large RENDERER
19 hrs/d
174240 sq.ft.
100 employees
Steam 12000 #/hr
Power 7392 kwh/d
BLOOD MEAL 341 #/hr
Wastewater 177221 gal/d (9813 # TSS/d)
TALLOW 6643 #/hr
74868 #/d

RAW MATERIAL REQUIRED FROM OUTSIDE THE COMPLEX		MANUFACTURED PRODUCTS FOR OUTSIDE SALE	
Material	**Amount**	**Material**	**Amount**
1. Fresh Makeup water	2,927,599 gal/d	1. Meat products	513,341 #/d
1A. Well water (one time only)	12 MGD	2. Tanned leather	36,000 sq.ft./d
2, Calves	900/d (150 days) 540,000 #/d	3. Tallow	79,740 #/d
3. Chemicals	495 #/d Na_2S	4. Energy	694,710 KWH/d
	3960 #/d $Ca(OH)_2$		
	1500 #/d H_2SO_4		
	2475 gal/d kerosene		
	1980 #/d oil or wax		
	2475 #/d $Cr_2(SO_4)_3$		
	4208 #/d NaCl		
	7 #/d Cl_2		
4. Cattlefeed	2.625,000 #/d		

TABLE - 3 External Raw Materials and Manufactured Products in Three Industry Complex (STAGE - 3)

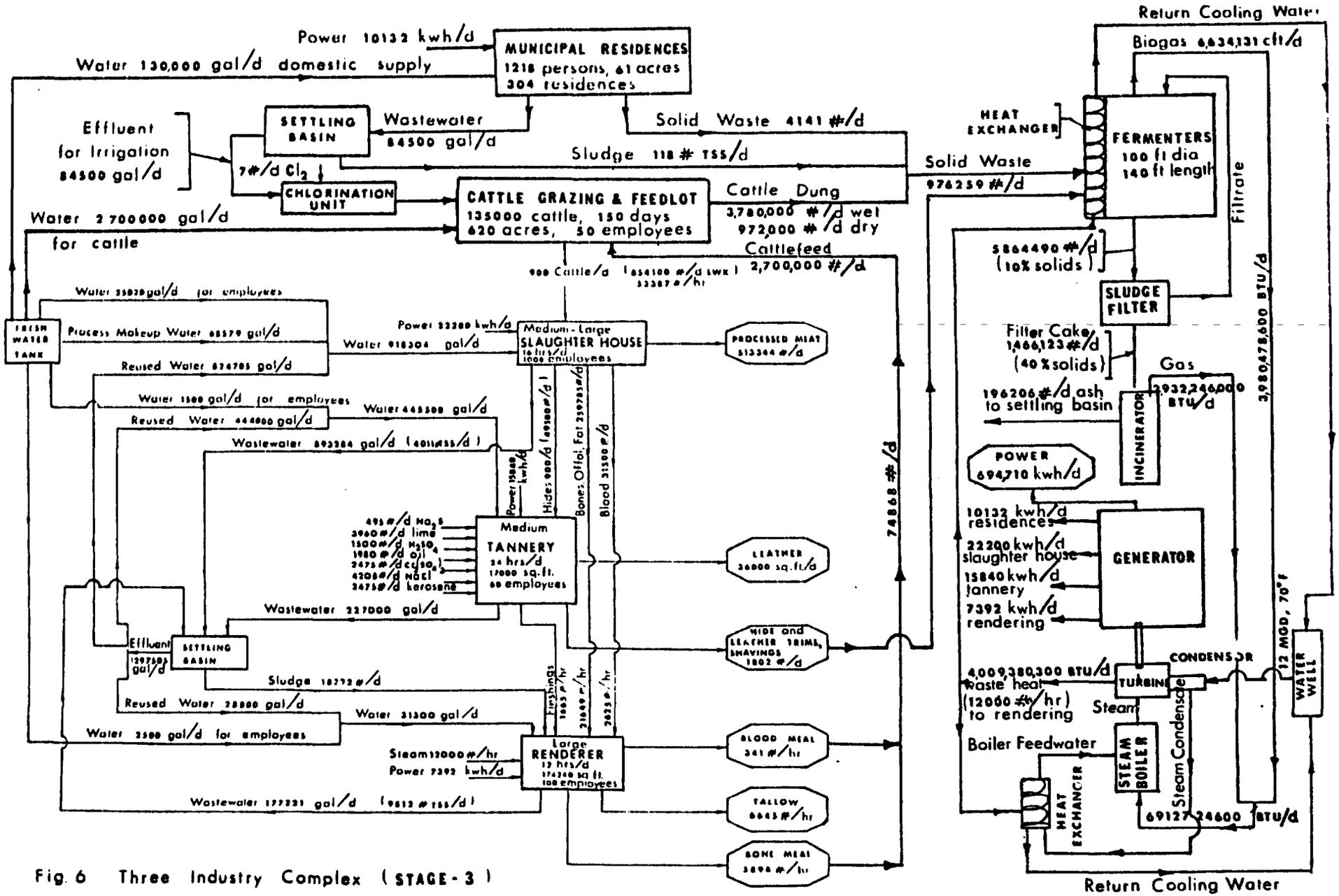


Fig. 6 Three Industry Complex (STAGE - 3)

sufficient complex. It also provides more reuse potential for the three industrial effluents than the first stage. In addition, it provides living space in the complex for employees of the industrial plants and feedlot and grazing area for raising the animals to the required weight. Whenever feasible the second stage complex is recommended in preference to the first stage. Mass balance of the second complex are given in Figure 5. External raw materials and manufactured products for external sale are given in Table-2.

STAGE 3

This is the third of three stage industrial complex. It enlarges the smaller complex and is more balanced internally so that little or no adverse environmental impact results from any of the industrial plants' productive activities. Agriculture and municipal residence services are provided in this complex. Residential solid wastes from both industrial and municipal facilities are fermented to methane gas which is used subsequently to produce electrical energy for use in the complex. Waste sludge from the fermenter is incinerated to produce additional electrical energy for use in the complex. The schematic arrangement of the third phase of the complex is shown along with the mass balances of each unit in Figure-6. External raw materials and manufactured products for external sale are given in Table 3.

GENERAL DISCUSSION

As we proceed with the Three Industry Complex (Figs. 4, 5, 6) ~~complex~~ by adding stages, some apparent potential problems arise. For example, when we add stage 2 to the complex, we compute that a cattle grazing and feedlot area of 620 acres is required for the 135,000 cattle. This vast acreage may be difficult to obtain. In addition, 1350 tons per day of feed must be supplied from internal and external sources.

In the third stage of the complex we are proposing to produce methane gas from solid waste residues. This gas will subsequently be used for power production. An excess of power within the complex results from this sequence of operations. An alternative to exporting power for sale outside the complex would be the production of other valuable intermediate products such as alcohol from the fermenters. This can be determined from market conditions at the time of establishment of the complex.

This three stage complex analysis is the deepest study of the new concept. As shown in Table 3, the managers of the three stage complex still must import four basic materials : water, calves, chemicals, and cattlefeed . About 3 million gallons of water, 2.6 million pounds of feed, 900 cattle, and about 6 tons of chemicals are needed each and every production day. This complex also will produce for external sale about 250 tons of meat, 36,000 square feet

of leather, 40 tons of tallow, and almost 700,000Kilowats of energy each production day. Although we haven't made a complete economic analysis of such a system, it appears at least self-sustaining and probably will show a considerable net profit. The implications of such complexes are obvious. However, if we are able to produce a profit and protect the environment from any degradation, our major goals will have been achieved.

CONCLUSION

A three stage environmentally balanced complex has been designed. Mass balances of all plant inputs and outputs have been computed based upon the most recent published industrial data. From an analytical standpoint an industrial complex consisting of a slaughterhouse, tannery, and rendering plants is technically feasible. This complex is also technically feasible when expanded to include animal grazing and feedlots as well as municipal residences (second stage). The expanded version (third stage) of the complex is more self-sustaining as far as reused products and electrical energy generation is concerned.

RESEARCH AND DEVELOPMENT REQUIRED

This study representing the first analytical analysis of a potential environmentally-balanced industrial complex,

indicates continued research is warranted. The research can be divided into two classes, one specific for the complex proposed in this paper and the other, general, which applies to this and other potential complexes.

The following recommendations apply to the first class :

1. A cost-benefit analysis comparing the complex industrial plants with similar plants producing the same products in separated locations.
2. A product quality evaluation for considering increased amount of contaminants absorbed from recirculated and reused solids and wastes.
3. A product market use survey for ascertaining the feasibility of sales and uses for each material manufactured in the complex for external consumption.
4. Verification of solid and liquid reuse within the complex.
5. Planning, designing, constructing, operating, and evaluating of a demonstration scale complex of this type.

The following recommendations which occur at this stage apply to the second class :

1. Development of other potential industrial complexes.
2. Development of an optimum management program for industrial complexes.

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2. Nemerow, N.L., S.Farooq and S.Sengupta. Industrial Complexes and their Relevance for Pulp and Paper Mills. Jour. of Environment International. Vol.3, No.1, Page 133, 1980. Pergamon Press, Oxford, England.

3. Nemerow, N.L. Environmentally Optimized Industrial Complex. National Env. Engg. Research Inst., Nagpur, India. Lecture delivered on Jan. 15, 1980. Published in bound proceedings of Institute.

4. Nemerow, N.L. Preliminary Assessment of Environmentally Balanced Industrial Complex - Three Stage Evolution. Report to EPA. Contract No. 68-02-3170, RTP, N.Carolina June, 1980.

6- APPENDICES

(A) Roster of Personnel of the Centre

(B) Map of Hong Kong and the New Territories

(C) Government Regulations (2) and Effluent Guidelines (1).

(D) Tolo Water Control Zone - Water Quality Objectives

(E) Water Pollution Control Ordinance (Chapter 358) Tolo Harbour and Channel Water Control Zone Statement of Water Qaulity Objectives

(F) Laboratory and Laboratory Pilot Research Plant System

Appendix A

Roster of Personnel

HONG KONG PRODUCTIVITY CENTRE

Head Office : 5-443181
Wing On Centre: 5-441396
Bank Centre : 3-308251
Freder Centre : 3-624351

EXTENSION NO.

	Name	Designation	Ext. No.
EXECUTIVE DIRECTOR	Mr. S.K. Chan	E.D.	11
TECHNICAL DIRECTOR	Dr. Donald F. Taylor	T.D.	14
	Mrs. Lee Lam Mee Yu, Sylvia	A.A.	12
	Miss Leung Siu Mei, Mimi	A.A.	13
ADMINISTRATION DIVISION	Mr. So Chai Sang, James	S.A.	18
	Miss Lee Yee Man, Brenda	Sec.	52
	Mr. Andy Ng	S.P.R.C.	17
	Mr. Wong Chiu Yuen		BC26
	Mr. Wong Kin Shi, Alex	A.O.	19
	Mrs. Melisia Lee	A.S.	53
	Mr. Yeung Jo Ling		BC29
	Miss Amelia Chan	P.R.A.	15
	Mrs. Sheila Dennis		24
	Miss Eleanor Pang	A.A.	BC28
	Miss Angela Chan		15
	Miss Sandie Chow		16
	Miss Wong Po Fan		BC29
	Accounting Office		20,21,51
	Filing Office		23
	Purchasing Office		22
	General Office		36
	Telephone Operator		0

INDUSTRIAL DEVELOPMENT DIVISION

(Wing On Centre) 5-441396
5-243181 Exts. 40 & 41

Dr. P.D. Bentley	D.M.I.D.	20
Miss Mary Cho	Sec.	22
Mr. Henry S.S. Chiu		33
Mr. Johnny K.Y. Chung		24
Dr. Ho Chung Fai		31
Mr. Law Cheung Kwok		25
Mr. Lin Chaan Ming		32
Mr. Peter Y.F. Mok		23
Mr. Samuel K.H. Cheng		37
Miss Eliza Fung		23
Mr. Hui Chun Wai		34
Mr. Stanley W.C. So		30
Mr. Tsang Kam Lam		36
Mr. Raymond S.L. Wan		27
Mr. Lawrence W.C. Wong		30
Miss Maggie Y.L. Yung		28
Miss Stella C.P. Wong		26
Mrs. Cissy C.F.L. Wu	A.A.	21

INFORMATION SERVICES DIVISION

(Bank Centre) 3-308251

	D.M.I.S.	11
Miss Helen Yuen	Sec.	12
Mr. Leung Chi Ting	S.C.	21
Mrs. Jane B. Hanney		30
Mr. Anthony Chong		13
Mrs. Lip Teo Goon Chin		30
Mr. H.C. Yuen		36
Mr. Ho Tin Wing		14
Mrs. Catherine Cheung		36
Miss Maria Lo	A.A.	12
Library		27

COMPUTER SERVICES DIVISION

(Head Office) 5-443181

Miss Maria Santos	D.M.E.	33
Mrs. Lo Wu Yuet Kuen, Agnes	Sec.	33
Mr. Tse Pak Cheong, Nelson	S.C.	28
Mr. Kong Pe Hin, Ninny		49
Mrs. Luk Chia, Hannah		50
Mrs. Chong Kwok Kam Wah, Margaret		50
Mr. Choi Sei Kuen, Leslie		34
Mrs. Chan Li Siu Po, Vivian		35
Miss Tsang Po Ching, Clara		49
Mr. Leung Ming Tak, Freddy		35
Mr. Luk Kai Hang, Kenneth		34
Mr. Ho Shun Man, Simon		34
Computer Room		32

MANAGEMENT CONSULTANCY DIVISION

(Head Office) 5-443181

	D.M.C.	31
Miss Sandy W.Y. Lau	Sec.	31
Mr. Louis C.L. Tsang	S.C.	27
Mr. M.K. Cheung	S.C.	37
Mr. Peter Y.F. Mok		39
Mr. Harry C.C. Chan		47
Mr. S.H. Wong		29
Mr. Wilfred C. Leung		46
Mr. Jason Y.P. Hung		30
Mr. K.S. Ho		38
Mr. Alfred F.P. Chau		45
Mr. Albert S.F. Ng		25
Mrs. Chung Ng Yuk King		42
Mr. Danny C.C. Wai		43
Mr. S.K. Tse		44
Mr. Francis Y.K. Ko		43
Mr. Edmund S.L. Sung		42
Miss Ophelia L.L. Ho		26

TECHNOLOGY/METAL DIVISION (Freder Centre) 3-624351

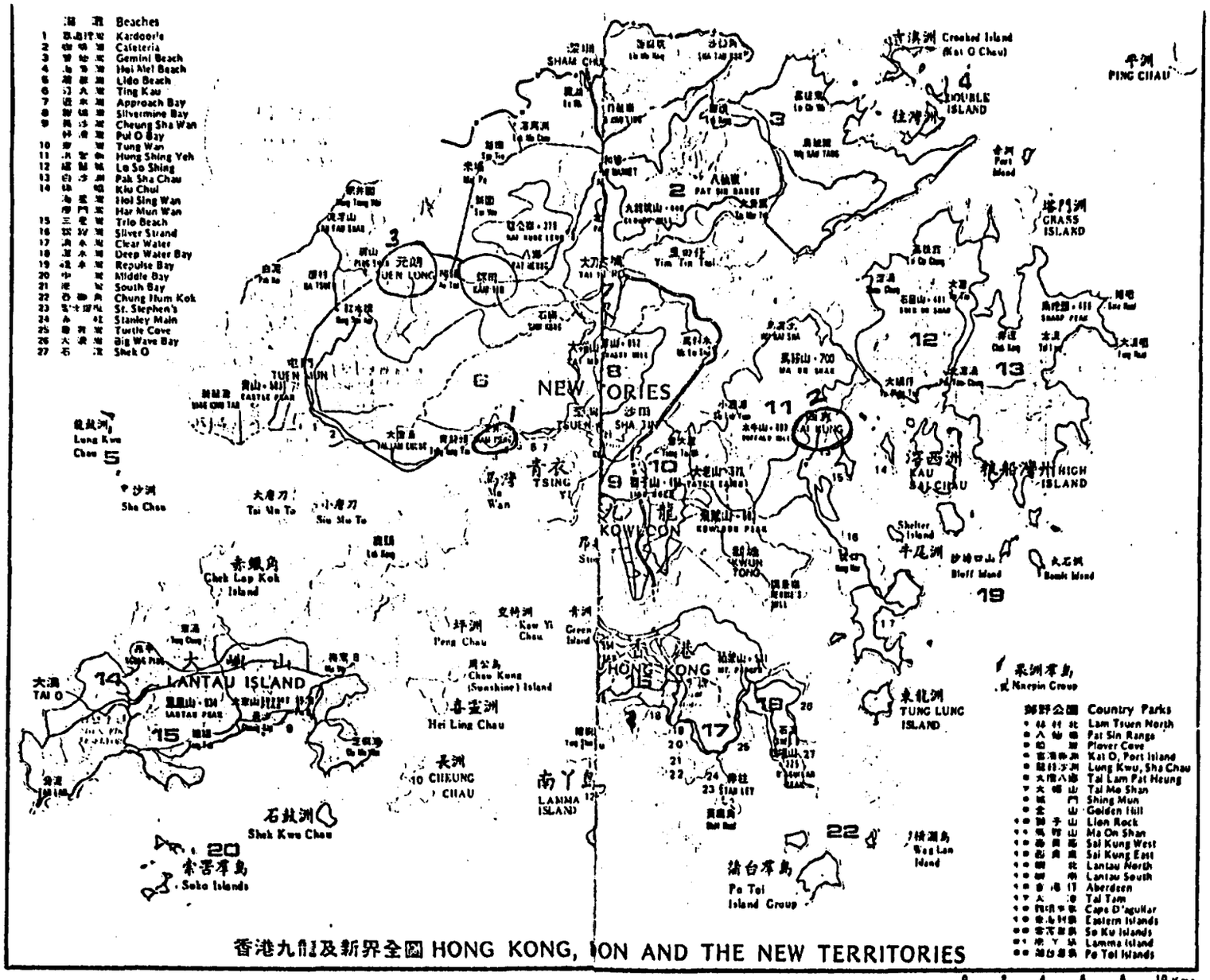
Dr. L.T. Chan	D.M.T.	11
Miss Josephine Hui	Sec.	11
Dr. F.T. Wong	S.C.	16
Mr. H.K. Man	S.C.	18
Mr. C.S. Chan		19
Dr. W.C. Keung		20
Mr. B.W. Lee		21
Mr. S.H. Sy		20
Mr. Wilson Yu		21
Mr. H.F. Chien		25
Mrs. Janet Keung		24
Mrs. Frances Lo		24
Dr. S.W. Lui		23
Mr. K.S. Siu		19
Mr. Peter Yau		28
	A.A.	22
Die Casting Staff		26
Workshop (L.C.A.)		33
Metal Finishing Laboratory		34
Heat Treatment Laboratory		35
Chemistry Laboratory		36,37

ELECTRONICS DIVISION (Freder Centre) 3-624351

Dr. Edmond Chan	P.C.	12
Mr. Norman Cheung		17
Mr. Kevin Tong		29
Mr. K.H. Yeung		27
Mr. W.K. Yip		29
Mr. C.C. Ho		30
Mr. T.C. Leung		30
Mrs. Ophelia Ha	A.A.	31
Electronics Laboratory		32

Appendix B

Map of Hong Kong and the New Territories



Appendix C

Regulations 1

Legal Supplement No. 3

To the

Hong Kong

Government Gazette

Friday 13/06, 1980

Sup. to Gazette No. 24 /81 on

pp C231 – C264

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A BILL

To

Control the pollution of the waters of Hong Kong.

Enacted by the Governor of Hong Kong, with the advice and consent of the Legislative Council thereof.

PART I

PRELIMINARY

Short title and commencement.

1. This Ordinance may be cited as the Water Pollution Control Ordinance 1980 and, subject to section 7, shall come into operation on a day to be appointed by the Governor by notice in the *Gazette*.

Interpretation.

2. (1) In this Ordinance, unless the context otherwise requires—

"Appeal Board" means an Appeal Board constituted under Part VI;

"Authority" means—

(a) in relation to a water control zone, a public officer appointed by the Governor under section 4(1)(b) for that zone;

(b) in relation to the powers, functions and duties mentioned in section 4(3), the Director of Public Works;

"existing deposit", in relation to a water control zone, means a deposit of matter which—

(a) was made, whether or not regularly or continuously, in any place and which is, or of which a component is, likely to enter the waters of Hong Kong or into inland waters or a public sewer or public drain in that zone; and

(b) was so made during the period of 12 months ending with the day appointed by the Governor by order under section 7(2) which applies to that zone and that deposit;

"existing discharge", in relation to a water control zone, means a discharge of matter which was made, whether or not regularly or continuously—

(a) into the waters of Hong Kong or into inland waters; or

(b) into a public sewer or public drain,

in that zone during the period of 12 months ending with the day appointed by the Governor by order under section 7(2) which applies to that zone and that discharge;

"inland waters" means any river, stream, watercourse, lake, pool or pond, whether natural or artificial or above or below ground, and the bed or channel of any such river, stream, watercourse, lake, pool or pond which is for the time being dry, but excluding—

(a) a lake, pool or pond the waters of which do not enter (whether directly or by way of another lake, pool or pond) any river, stream or watercourse or the territorial waters or tidal waters of Hong Kong unless the lake, pool or pond is brought within this definition by regulations made under section 46(1)(l);

(b) waters in any waterworks within the definition of waterworks in section 2 of the Waterworks Ordinance; (Cap. 102.)

(c) any drain or sewer;

"licence" means a licence granted under section 20;

"public drain" means a drain which is vested in and maintained by the Government as a public utility;

"public sewer" means a sewer which is vested in and maintained by the Government as a public utility;

"register" means a register required to be kept under section 42;

"Secretary" means the Secretary for the Environment;

"water control zone" means any part of Hong Kong declared to be a water control zone under section 4;

"water quality objective" means a water quality objective established by the Secretary under section 5;

"waters of Hong Kong" means all inland waters, territorial waters and tidal waters of Hong Kong and in sections 5(1), 6(5)(*a*), 13(1), 17, 24 and 29(4)(*a*) includes the flora and fauna thereof.

(2) References in this Ordinance to discharging or making a discharge of matter into the waters of Hong Kong or into inland waters or into a public sewer or public drain are references to causing or permitting that matter to enter those waters or the public sewer or public drain (whether by emitting, throwing, placing or by any other means) at the place where the matter first enters the same.

(3) References in this Ordinance to discharging or making a discharge of matter into the waters of Hong Kong or into inland waters or into a public sewer or public drain in the water control zone include causing or permitting matter to be deposited in any place (whether in that zone or elsewhere) in circumstances where the matter, or any component of it, is likely to enter the waters of Hong Kong or inland waters in that zone or to enter the public sewer or public drain within a reasonably foreseeable time by falling, descending, percolating or being carried by wind or water.

overnor may give rections.

3. (1) The Governor may give such directions as he thinks fit, either generally or in any particular case, with respect to the exercise or performance by the Secretary or an Authority of any powers, functions or duties under this Ordinance.

(2) The Secretary and an Authority shall, in the exercise or performance of their respective powers, functions and duties under this Ordinance comply with any directions given by the Governor under subsection (1).

PART II

WATER CONTROL ZONES AND WATER QUALITY OBJECTIVES

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4. (1) The Governor in Council may by order published in the *Gazette*—

(*a*) after consultation with the Environmental Protection Advisory Committee, declare any part of Hong Kong to be a water control zone for the purposes of this Ordinance;

(*b*) designate a public officer by name or office to be the Authority for any water control zone and as such, subject to subsection (3), to exercise and perform in respect of that zone the functions, powers and duties conferred on the Authority by this Ordinance.

(2) An order under subsection (1)(*b*) may, subject to subsection (3), designate different public officers to be Authorities for a water control zone in relation to the discharge or deposit of any specified classes or descriptions of matter or matter resulting from the operation of specified classes or descriptions of trade or industry.

(3) Notwithstanding any designation under subsection (1)(*b*), the Director of Public Works shall be the Authority for the purposes of enforcing the prohibition in section 9 and exercising and performing any

power, function or duty under this Ordinance in relation to discharges into public sewers and public drains.

(3) An order under subsection (1) shall, for each water control zone constituted thereby—

(*a*) make reference to a plan or map of that zone deposited in the Land Office at Victoria; or

(*b*) sufficiently describe the zone by other means.

Secretary to establish quality objectives.

5. (1) The Secretary shall, after consultation with the Environmental Protection Advisory Committee, establish for the waters of Hong Kong in each water control zone a water quality objective or different objectives for different parts of a zone.

(2) The water quality objective for any particular waters shall be the quality which, in the opinion of the Secretary, should be achieved and maintained in order to promote the conservation and best use of those waters in the public interest.

(3) Any water quality objective may be amended from time to time by the Secretary, after consultation with the Environmental Protection Advisory Committee.

(4) A statement of every water quality objective established under subsection (1) and all amendments thereto, signed by the Secretary, shall be published in the *Gazette* and shall be kept with the register and made available for inspection by the public free of charge at the same times as the register is so available.

(5) Where under subsection (1) the Secretary establishes different water quality objectives for different parts of a water control zone he shall ensure that the statement thereof kept with the register pursuant to subsection (4) sufficiently delineates each part of the water control zone.

Authority to seek to achieve quality objectives.

6. (1) The Secretary shall in writing notify an Authority of the objective or objectives of quality established for a water control zone for which that Authority is responsible and of any amendment thereof under section 5(3).

(2) The Secretary shall notify the Director of Public Works of all water quality objectives and of any amendment thereof under section 5(3).

(3) Each Authority shall exercise and perform his powers, functions and duties under this Ordinance with the aim of achieving the relevant water quality objectives as soon as is reasonably practicable and thereafter maintaining the quality so achieved.

(4) If in the opinion of the Secretary the achievement or maintenance of any water quality objective would be better served by the exercise by the Authority of any of his powers under section 17, 20(4) or 24, the Secretary may, subject to subsection (5), give directions in writing to the Authority as to the manner in which he shall exercise those powers; and, in the case of a direction which relates to section 20(4), any such direction may be of a general nature or relate to a particular case or particular cases.

(5) The Secretary shall not give any direction under subsection (4) as to the manner in which an Authority shall exercise the powers in section 17 or 24 in relation to a discharge or deposit unless he considers that—

(*a*) any part of the waters of Hong Kong are in such a condition as to constitute a danger to the health of the public, or a section of the public, and the exercise of the powers in relation to that discharge or deposit would tend to lessen the danger; or

(*b*) in the case of an exemption from section 9 or a licence for the purposes of that section, the discharge or deposit may be harmful to the operation of any sewage treatment plant.

(6) The Authority shall comply with any direction given to him under subsection (4) and the discretion conferred on the Authority by section 17(1), 20(4) or 24(1) shall not apply to any discharge or deposit in respect of which such a direction is in force.

PART III

Prohibited Discharges and Deposits

Application and commencement of sections 8 and 9.

7. (1) Notwithstanding that this Ordinance has come into operation by virtue of a notice under section 1, neither section 8(1)(*a*), nor section 8(1)(*b*) nor section 9(1) shall apply—

(*a*) to any discharge or deposit, not being an existing discharge or existing deposit, which would otherwise be prohibited by those sections until the day appointed by the Governor under subsection (2) which applies to that discharge or deposit;

(*b*) to an existing discharge or existing deposit which would otherwise be prohibited by those sections until the day appointed by the Governor under subsection (3) which applies to that discharge or deposit.

(2) The Governor may from time to time by order published in the *Gazette* appoint a day by reference to which the following shall be classified as an existing discharge or existing deposit for the purposes of this Ordinance which is declared to be applicable to any water control zone—

(*a*) the discharge of any matter, or any specified category of discharge, into the waters of Hong Kong or inland waters in that zone, being a discharge within the prohibitions in section 8(1);

(*b*) the deposit of any matter, or any specified category of deposit, which, or a component of which, is likely to enter the waters of Hong Kong or inland waters in that zone, being a deposit within the prohibitions in section 8(1);

(*c*) the discharge of any matter, or any specified category of discharge, into a public sewer or public drain in that zone, being a discharge within the prohibition in section 9(1);

(*d*) the deposit of any matter, or any specified category of deposit, which, or a component of which, is likely to enter a public sewer or public drain.

(3) The Governor may from time to time by order published in the *Gazette* appoint a day on and after which which is declared to be applicable to any water control zone—

(*a*) section 8(1)(*a*) shall apply to all existing discharges into the waters of Hong Kong in that zone or to all existing deposits which, or a component of which, is likely to enter the waters in that zone or to any specified category of such discharges or deposits;

(*b*) section 8(1)(*b*) shall apply to all existing discharges into inland waters in that zone or to all existing deposits which, or a component of which, is likely to enter the inland waters in that zone or to any specified category of such discharges or deposits;

(*c*) section 9(1) shall apply to all existing discharges into a public sewer or public drain in that zone or to all existing deposits which, or a component of which, is likely to enter a public sewer

or public drain in that zone, or to any specified category of such discharges or deposits.

(4) For the purposes of an order under this section, a category of discharge or deposit may be determined by reference to—

(*a*) the discharge or deposit of a particular class or description of matter or of matter resulting from the operation of a particular class or description of trade or industry;

(*b*) the discharge or deposit of matter at a particular rate or in a particular quantity during a specified period;

(*c*) where section 9 applies, in addition to paragraphs (*a*) and (*b*), the fact that the discharge or deposit is of domestic sewage or surface water and is made into a public sewer or public drain provided for the carriage of foul water or of surface drainage water,

or a combination of all or any such factors.

(5) An order under this section may, in respect of the same water control zone, appoint different days for discharges, or any category thereof, and for deposits, or any category thereof.

Prohibited discharges into waters of Hong Kong and inland waters

8. (1) Subject to section 12, a person commits an offence who discharges—

(*a*) any poisonous, noxious or polluting matter into the waters of Hong Kong in a water control zone;

(*b*) any matter into any inland waters in a water control zone which tends (either directly or in combination with other matter which has entered those waters) to impede the proper flow of the water in a manner leading or likely to lead to a substantial aggravation of pollution.

(2) Where any matter referred to in subsection (1)(*a*) or (*b*) is discharged from any premises or vessel, then, subject to section 12, the occupier of the premises or the person having command or charge of the vessel commits an offence, in addition to any other person who may be guilty of an offence under subsection (1).

(3) This section does not apply to any of the following discharges or deposits—

(*a*) a discharge which is made by way of a public sewer or public drain;

(*b*) a discharge of oil or a mixture containing oil into the waters of Hong Kong (within the meaning of each of these terms in sections 45 and 46 of the Shipping and Port Control Ordinance); (Cap. 313.)

(*c*) a discharge incidental to, or derived from, the normal operation of a vessel (including a dynamically supported craft) or of its equipment;

(*d*) a discharge which requires to be licensed under paragraph 1 of Schedule 1 to the Dumping at Sea Act 1974 (Overseas Territories) Order 1975; (SI 1975/181)

(*e*) a discharge or deposit made—

(i) by, or with the consent of, the Director of Marine for the purpose of carrying out harbour works or providing moorings or aids to navigation;

(ii) as part of an undertaking authorized by the Governor in Council under subsection (2) of section 3 of the Public Reclamations and Works Ordinance or by the Governor under subsection (3) of that section; (Cap. 127.)

851

(iii) under, and in accordance with, a Crown lease granted under the *Foreshores and Sea Bed Ordinance*;

p. 295.) (f) a discharge or deposit which is forbidden by the Dangerous Goods Ordinance or any regulations made thereunder.

hibited charges public ers and blic drains.

9. (1) Subject to section 12, a person commits an offence who discharges any matter into a public sewer or public drain in a water control zone other than—

(a) a discharge of domestic sewage into—

(i) a public sewer, or

(ii) a public drain,

for the carriage of foul water;

(b) a discharge of unpolluted water into—

(i) a public sewer, or

(ii) a public drain,

for the carriage of surface drainage water.

(2) Where any matter is discharged into a public sewer or public drain in a water control zone from any premises, then, subject to section 12, the occupier of the premises commits an offence, in addition to any other person who may be guilty of an offence under subsection (1).

(3) In subsection (1)—

"domestic sewage" means any waste of a kind and quantity which is ordinarily disposed of in a household by the normal use of a toilet, watercloset, bath, shower, sink, basin or other sanitary fitment by persons residing therein;

"unpolluted water" means—

(a) rain water from any part of a building, including any area appurtenant to a building;

(b) water which does not contain any poisonous, noxious or polluting matter.

(4) This section does not apply to—

p. 295.) (a) a discharge or deposit which is forbidden by the Dangerous Goods Ordinance or any regulations made thereunder; or

(b) water used—

(i) for firefighting purposes;

(ii) in connexion with an occurrence in which life or property is endangered;

(iii) for the cleansing of streets, thoroughfares, and other areas.

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10. In any proceedings for an offence under section 8(1), 8(2), 9(1) or 9(2) in which it is alleged that the defendant caused matter to enter the waters of Hong Kong or inland waters or a public sewer or public drain or caused matter to be deposited as provided in section 2(3) it shall not be necessary for the prosecution to prove that the acts or omissions in question were accompanied by any intention, knowledge or negligence on the part of the defendant as to any element of the offence.

alties.

11. A person who commits an offence under section 8(1), 8(2), 9(1) or 9(2) is liable to—

(a) for a first offence, a fine of $50,000;

(b) for a second or subsequent offence, a fine of $100,000,

and in addition, if the offence is a continuing offence, to a fine of $500 for each day during which it is proved to the satisfaction of the court that the offence has continued.

Defences.

12. (1) A person does not commit an offence under section 8(1), 8(2), 9(1) or 9(2) if he proves that—

(a) the discharge or deposit in question is an existing discharge or deposit which is exempt under section 15; or

(b) the discharge or deposit in question is made under, and in accordance with, a licence granted under section 20; or

(c) where section 2(3) applies, the matter was deposited pursuant to an approval under subsection (2) and in accordance with the terms and conditions thereof; or

(d) he exercised all such care and took all such steps as the court considers reasonable in the circumstances to avoid the occurrence of the prohibited discharge or deposit; or

(e) the discharge or deposit was made in an emergency in order to avoid danger to life or property and as soon as was reasonably practicable he informed the Authority thereof in writing; or

(f) he acted under instructions given to him by his employer and complied with paragraph (d) to the extent which the court considers reasonable having regard to his position as an employee.

(2) The Director of Agriculture and Fisheries may by order published in the *Gazette* approve the making of any particular kind of deposit as a farming practice to which the provisions of subsections (1)(*a*) and (1)(*b*) of section 8, or either of those provisions, do not apply so far as it is made in such areas by such persons and in such manner as may be specified in the order.

(3) The power of the Director of Agriculture and Fisheries under subsection (2) extends to practices employed in all kinds of farming, including agriculture, animal husbandry and fish farming.

Restoration of waters by convicted person.

13. (1) Where any person has been convicted of an offence under section 8(1), 8(2), 9(1) or 9(2) the Authority may if he is of the opinion that—

(a) any part of the waters of Hong Kong suffered continuing damage as a direct result of the commission of the offence; and

(b) it is reasonably practicable to restore, or partially restore, that part to the condition it was in before the commission of the offence,

by notice in writing require the person so convicted to carry out such work as is specified in the notice to effect such restoration or partial restoration.

(2) A notice under subsection (1)—

(a) may specify the manner in which the work is to be carried out;

(b) shall stipulate the time before which the work shall be commenced and the time by which it shall be completed;

(c) shall be addressed to and served personally or by registered post on the person who committed the offence.

(3) If a person fails to comply with a notice under subsection (1) served on him, the Authority may, without further notice but subject to subsection (4), carry out or cause to be carried out the work, or the remaining work, specified in the notice and recover from that person the cost of so doing as a civil debt due to the Crown.

(4) The Authority shall not exercise the power in subsection (3)—

(a) until after the expiry of the time allowed under section 29(3) for appeal against a requirement under subsection (1); and

(b) where an appeal is brought, until it is determined, withdrawn or abandoned.

(5) A copy of a document which purports to be a notice signed by the Authority for the purposes of subsection (1) shall be admitted in evidence in proceedings under subsection (3) on its production without further proof and—

(a) until the contrary is proved, the court before the document is produced shall presume that the signature to the document is genuine and the person signing it was the Authority at the time when he signed it; and

(b) such document shall be sufficient evidence of the opinion of the Authority and of all other matters contained therein.

PART IV.

Exemption of Existing Discharges and Deposits

Notices of existing discharges and deposits.

14. (1) After a day appointed by order under subsection (2) of section 7 and before a day appointed by order under subsection (3) of that section a person may give notice to the Authority of an existing discharge or deposit to which those orders apply.

(2) A notice under subsection (1) shall be given in such manner and form and contain such information and estimates as may be prescribed.

(3) Any person who in any notice under subsection (1) makes any statement or gives any estimate which he knows to be incorrect in a material particular or who recklessly makes any statement or gives any estimate which is incorrect in a material particular or knowingly omits any material particular therefrom commits an offence and is liable to a fine of $5,000.

Exemption existing discharges and deposits.

15. (1) Subject to sections 16 and 17—

(a) an existing discharge or deposit to which subsection (1)(a) of section 8 would otherwise apply is exempt from the operation of that subsection if notice of the existing discharge or deposit has been duly given under section 14;

(b) an existing discharge or deposit to which subsection (1)(b) of section 8 would otherwise apply is exempt from the operation of that subsection if notice of the existing discharge or deposit has been duly given under section 14;

(c) an existing discharge or deposit to which section 9(1) would otherwise apply is exempt from the operation of that section if notice of the existing discharge or deposit has been duly given under section 14.

(2) An exemption under subsection (1) is not limited to the making of the discharge or deposit by the person who gave the notice under section 14 but extends to the discharge or deposit in question when made by any person.

(3) No exemption shall arise under this section if, at the time when notice is given under section 14, the existing discharge or deposit is being or has been made—

(a) from premises that have been unlawfully erected on unleased land in contravention of section 4 of the Crown Land Ordinance; or

(b) from premises on land held under a Crown lease or on land occupied under a licence issued under section 5 of the Crown Land Ordinance and such discharge or deposit is in breach of that Crown lease or licence.

(4) A person may apply for a licence for any discharge or deposit notwithstanding that the discharge or deposit is already exempt under subsection (1) and the Authority may, subject to Part V, grant a licence therefor.

(5) The exemption conferred by this section shall apply to the discharge or deposit as from time to time varied under section 17 or 18.

Cessation and cancellation of exemption.

16. (1) Subject to section 29(9) and without prejudice to the powers in section 17, an exemption conferred by section 15(1) ceases to be operative during any time when—

(a) either of the following ceases to be the same as that described in the notice given under section 14 or the same as that required or approved by the Authority under section 17 or 18—

(i) the place at which the discharge or deposit is made;

(ii) the period within which the discharge or deposit is made;

(b) any one of the following exceeds by more than 30 *per cent*, calculated in such manner as may be prescribed, the information or estimate relating thereto in the notice given under section 14—

(i) the quantity of the discharge or deposit or any component of it;

(ii) the rate at which a discharge or deposit or any component of it is made;

(iii) the temperature of the discharge or deposit;

(c) a new component is added thereto without the approval of the Authority under section 18.

(2) If it appears to the Authority that a statement in any notice given under section 14 is incorrect in a material particular, but that no contravention of subsection (3) of that section arises therefrom, he may—

(a) by notice in writing call upon the person who is making the existing discharge or deposit, within such time as the Authority may allow, to give reasons why the notice under section 14 should not be declared inoperative; and

(b) after considering such reasons (if any), by notice in writing addressed to the said person declare the notice under section 14 to be inoperative for the purpose of conferring the exemption provided for in section 15(1) as from such date as the Authority may fix.

(3) If, in any proceedings for an offence against section 8(1) or 9(1), it appears to the court that an incorrect statement in a notice under section 14 has been made in contravention of subsection (3) of that section (whether or not the person who gave the notice is convicted under that subsection) the court shall declare the notice to be inoperative for the purpose of section 15(1) and it shall be treated as never having been operative for that purpose.

Further powers in relation to an existing discharge or deposit.

17. (1) Subject to section 6(6), the Authority may, by notice in writing to a person who is making a discharge or deposit which is exempt under section 15(1), exercise any of the powers set out in subsection (3) if he considers that—

(a) any part of the waters of Hong Kong are in such a condition as to constitute a danger to the health of the public, or a section

of the public, and the exercise of the power in relation to the exempt discharge or deposit would tend to lessen that danger; or

(*b*) in the case of an exemption from section 9, the discharge or deposit may be harmful to the drainage or sewerage system, or any part thereof, or to the health or safety of any person engaged in the operation thereof.

(2) Where neither paragraph (*a*) nor paragraph (*b*) of subsection (1) applies to a discharge or deposit, the Authority may (by notice in writing as provided in that subsection) exercise any power set out in subsection (3), in relation to that discharge or deposit, only with the prior approval of the Governor in Council, as to both the exercise and the manner of the exercise of the power, or with the agreement of the person who is making the discharge or deposit.

(3) The powers referred to in subsections (1) and (2) are—

(*a*) (i) to impose terms and conditions subject to the observance of which, as from a specified date, the exemption shall continue in force;

(ii) to declare the exemption liable to cancellation if at any time the person fails to observe any such term or condition;

(iii) to cancel the exemption as from a specified date if the person fails to observe any such term or condition;

(*b*) to cancel the exemption as from a specified date;

(*c*) to amend or add to any notice previously given under this section, or any part of such notice, or to substitute a new notice for it.

(4) The Authority may revoke a notice previously given under this section, subject to the further approval of the Governor in Council in the case of a revocation which affects anything previously done under this section with the approval of the Governor in Council.

(5) The date specified in a notice for the imposition, amendment or addition of any term or condition under paragraph (*a*)(i) or (*c*) of subsection (3) or for the cancellation of an exemption under paragraph (*a*)(iii) or (*b*) thereof shall be not less than 90 days after the day on which the notice is given to the person who is making the discharge or deposit.

(6) Subject to subsection (2), the Authority may impose such terms and conditions under subsection (3) as he thinks fit including any term or condition—

(*a*) requiring the person to restrict or from time to time to suspend the discharge or deposit;

(*b*) relating to the matters set out in the First Schedule. First Schedule.

Application for approval of changes in discharges or deposits.

18. (1) A person who is making a discharge or deposit which is exempt under section 15(1) may apply to the Authority in the prescribed form for—

(*a*) a variation or cancellation of any term or condition imposed by the Authority under section 17;

(*b*) approval of a change in the period within which the discharge or deposit may be made;

(*c*) approval of the addition to the discharge or deposit of a new component, being a substance normally resulting from the carrying on of the trade or business carried on by the applicant at the date appointed by the Governor by order under section 7(2) which applies to the discharge or deposit.

(2) An application under subsection (1) shall be accompanied by the prescribed fee.

(3) Section 19(3) and (4) shall apply for the purpose of publicly notifying an application under this section which relates to an exemption from section 8(1)(*a*) or 8(1)(*b*) as if it were an application for a licence.

(4) The Authority may either grant the application in whole or in part or refuse to grant it but in the case of an application which relates to an exemption from section 8(1)(*a*) or 8(1)(*b*) shall not do so earlier than 30 days after the last notice is published in a newspaper pursuant to subsection (3).

(5) If the Authority refuses to grant an application or any part thereof he shall notify the applicant and shall inform him of the reasons for his refusal.

(6) Section 20(3) shall apply to the exercise by the Authority of his discretion under this section as it applies to the exercise of his discretion to grant or refuse a licence.

(7) The Authority may grant an application in such terms and on such conditions as he thinks fit (including terms and conditions relating to the matters set out in the First Schedule) except that, without prejudice to section 17, he shall not impose any new obligation on the applicant in relation to that part of the discharge or deposit which is already exempt unless, in his opinion, such part would have a significantly different effect on the relevant waters as a result of the granting of the application. First Sch.

PART V

LICENSING OF DISCHARGES AND DEPOSITS

Applicatio for licenc

19. (1) A person who wishes to obtain a licence for the purposes of section 8(1)(*a*), 8(1)(*b*) or 9(1) shall apply to the Authority in the prescribed form.

(2) An application under subsection (1) shall be accompanied by the prescribed fee.

(3) The Authority shall publicly notify all applications for licences for the purposes of section 8(1)(*a*) or section 8(1)(*b*)—

(*a*) by entering in the register such particulars thereof as may be prescribed;

(*b*) by causing a notice to be published at the expense of the applicant in an English language and a Chinese language newspaper determined by the Authority containing such particulars of the application and other information as may be prescribed and a statement of the place or places where a copy of the application may be inspected.

(4) During the period of 30 days after the last notice is published pursuant to subsection (3)—

(*a*) a copy of the application shall be kept at each place notified under subsection (3)(*b*) and shall be available for inspection by the public during normal office hours;

(*b*) any person may, in such manner as may be prescribed, object to the granting of the application on the ground that it would tend to inhibit the attainment or maintenance of the relevant water quality objective.

Grant of licences.

20. (1) Subject to section 21, the Authority may, not earlier than 40 days after the last notice is published in a newspaper pursuant to section 19(3), either grant or refuse to grant a licence.

(2) If he refuses to grant a licence the Authority shall notify the applicant in writing of his refusal and shall inform him of his reasons therefor.

(3) In the exercise of his discretion to grant or refuse to grant a licence the Authority shall—

(*a*) have as his purpose the attainment and maintenance of the relevant water quality objective;

(*b*) grant a licence unless he considers that to do so would tend to inhibit the achievement of that purpose,

and for the purposes of this subsection it shall be relevant for the Authority to have regard to the need to protect and ensure the efficient operation of the drainage and sewerage systems and the health and safety of persons engaged in the operation of those systems.

(4) Subject to section 21, the Authority may grant the licence in such terms and on such conditions as he thinks fit including terms and conditions relating to the matters set out in the First Schedule.

First Schedule.

(5) A licence shall specify a period of time during which any cancellation or variation thereof which imposes additional obligations on the person making the discharge or deposit shall, unless that person agrees otherwise, give rise to the liability to pay compensation provided for in section 25.

Special provisions where discharge licensed after cessation of exemption.

21. Where a licence is applied for in respect of a discharge or deposit which, having been exempt under section 15(1), has ceased to be exempt by reason of section 16(1)(*b*), the following provisions shall apply—

(*a*) the applicant shall be entitled to a licence for so much of the discharge or deposit as was previously exempt;

(*b*) the Authority shall not under section 20(4), but without prejudice to section 24, impose any new obligation on the applicant in relation to that part of the discharge or deposit which was previously exempt unless, in the opinion of the Authority, such part would have a significantly different effect on the relevant waters as a result of the change whereby the discharge or deposit ceased to be exempt under section 16(1)(*b*).

Effect of a licence.

22. (1) A licence for the purposes of section 8(1)(*a*) shall, subject to the terms and conditions of the licence and during the period specified therein, authorize—

(*a*) the discharge of matter or any specified class or description of matter into the waters of Hong Kong;

(*b*) the deposit of matter or any specified class or description of matter (as provided in section 2(3)),

which, but for such authorization, would be a contravention of section 8(1)(*a*).

(2) A licence for the purposes of section 8(1)(*b*) shall, subject to the terms and conditions of the licence and during the period specified therein, authorize—

(*a*) the discharge of matter or any specified class or description of matter into inland waters;

(*b*) the deposit of matter or any specified class or description of matter (as provided in section 2(3)),

which, but for such authorization, would be a contravention of section 8(1)(*b*).

(3) A licence for the purposes of section 9(1) shall, subject to the terms and conditions of the licence and during the period specified therein, authorize—

(*a*) the discharge of matter, or any specified class or description of matter, into a public sewer or public drain;

(*b*) the deposit of matter, or any specified class or description of matter (as provided in section 2(3)),

which, but for such authorization, would be a contravention of section 9(1).

(4) A licence shall not be limited to a discharge or deposit by a particular person but shall extend to the discharge or deposit in question when made by any person.

Renewal of licences.

23. (1) During such period before the expiry of a licence as may be prescribed, the person who is making the discharge or deposit may apply in the prescribed form for a renewal of the licence.

(2) An application for renewal of a licence shall be accompanied by the prescribed fee.

(3) Section 19(3) and (4) shall apply for the purpose of publicly notifying an application for the renewal of a licence for the purposes of section 8(1)(*a*) or 8(1)(*b*) as if it were an application for a licence.

(4) The Authority may renew or refuse to renew the licence but in the case of an application for renewal of a licence for the purposes of section 8(1)(*a*) or 8(1)(*b*) shall not do so earlier than 30 days after the last notice is published in a newspaper pursuant to subsection (3).

(5) Subsections (2), (3), (4) and (5) of section 20 shall apply to the renewal of a licence as they apply to the grant or refusal of a licence under that section, but section 21 shall not apply on the renewal of a licence.

Cancellation or variation of a licence.

24. (1) Subject to section 6(6), the Authority may, by notice in writing to a person who is making a discharge or deposit for which a licence is in force, exercise any of the powers set out in subsection (3) if he considers that—

(*a*) any part of the waters of Hong Kong are in such a condition as to constitute a danger to the health of the public, or a section of the public, and the exercise of the power in relation to the discharge or deposit would tend to lessen that danger; or

(*b*) in the case of a licence for the purposes of section 9(1), the discharge or deposit may be harmful to the drainage or sewerage system, or any part thereof, or to the health or safety of any person engaged in the operation thereof.

(2) Where neither paragraph (*a*) nor paragraph (*b*) of subsection (1) apply to a discharge or deposit, the Authority may (by notice in writing as provided in that subsection) exercise any power set out in subsection (3), in relation to that discharge or deposit only with the prior approval of the Governor in Council, as to both the exercise and the manner of the exercise of the power, or with the agreement of the person who is making the discharge or deposit.

(3) The powers referred to in subsections (1) and (2) are—

(a) (i) to impose new or amended terms and conditions subject to the observance of which, as from a specified date, the licence shall continue in force;

(ii) to declare the licence liable to cancellation at any time the person fails to observe any such term or condition;

(iii) to cancel the licence as from a specified date if the person fails to observe any such term or condition;

(b) to cancel the licence as from a specified date;

(c) to amend or add to any notice previously given under this section, or any part of such notice, or to substitute a new notice for it.

(4) The Authority may revoke a notice previously given under this section, subject to the further approval of the Governor in Council in the case of a revocation which affects anything previously done under this section with the approval of the Governor in Council.

(5) The date specified in a notice for the amendment or addition of any term or condition under paragraph (a)(i) or (c) of subsection (3) or the cancellation of a licence under paragraph (a)(iii) or (b) thereof shall be not less than 90 days after the day on which the notice is given to the person who is making the discharge or deposit.

(6) Subject to subsection (2), the Authority may impose such terms and conditions under subsection (3) as he thinks fit including any term or condition—

(a) requiring the person to restrict or from time to time to suspend the discharge or deposit;

First Schedule. (b) relating to the matters set out in the First Schedule.

Compensation on cancellation or variation of certain licences.

25. (1) Where a licence is, pursuant to section 24(1)—

(a) cancelled as provided in section 24(3)(b); or

(b) varied as provided in section 24(3)(a)(i) or (c) so as to impose additional obligations on the person making the discharge or deposit,

within the period specified pursuant to section 20(3), the Authority shall be liable to pay compensation if the circumstances set out in subsection (2) are present.

(2) The circumstances mentioned in subsection (1) are—

(a) that the possibility of danger to health or harm to the drainage or sewerage system or to the health or safety of any person engaged in the operation thereof (as provided in section 24(1)(a) and (b)) was known or could with reasonable foresight have been known, to the Authority at the time the licence was granted or renewed; or

(b) that the danger or harm mentioned in paragraph (a) is a consequence of licences granted or renewed after the grant, or, where a licence has been renewed, the last renewal of the licence which is cancelled or varied.

Compensation on cancellation of licences and exemptions with the approval of the Governor in Council.

26. (1) Where an exemption under section 15(1) is, pursuant to section 17(2)—

(a) cancelled as provided in section 17(3)(b); or

(b) varied as provided in section 17(3)(a)(i) or (c) so as to impose additional obligations on the person making the discharge or deposit,

the Authority shall be liable to pay compensation.

(2) Where a licence is, pursuant to section 24(2)—

(a) cancelled as provided in section 24(3)(b); or

(b) varied as provided in section 24(3)(a)(i) or (c) so as to impose additional obligations on the person making the discharge or deposit,

within the period specified pursuant to section 20(5) the Authority shall be liable to pay compensation.

Assessment of compensation.

27. (1) Subject to subsection (2), the manner of determining the amount of compensation payable under sections 25 and 26, the factors to be taken into account or disregarded and the principle to be applied in determining that amount shall be such as may be prescribed in regulations made under section 46.

Second Schedule.

(2) The provisions of the Second Schedule shall have effect for the purposes of determining the amount of compensation payable under sections 25 and 26 and for the purposes of the incidental matters for which they provide.

Applications for variation of licences.

28. (1) A person who is making a discharge or deposit for which a licence is in force may apply to the Authority in the prescribed form for a variation of the licence.

(2) The application shall be accompanied by the prescribed fee.

(3) Section 19(3) and (4) shall apply for the purpose of publicly notifying an application under this section for the variation of a licence for the purposes of section 8(1)(a) or section 8(1)(b) as if it were an application for a licence.

(4) The Authority may either grant the application, with or without modifications, or refuse to grant it but in the case of a variation of a licence for the purposes of section 8(1)(a) or 8(1)(b) shall not do so earlier than 30 days after the last notice is published in a newspaper pursuant to subsection (3).

(5) If the Authority refuses to grant an application or any part thereof he shall notify the applicant and shall inform him of the reasons for his refusal.

(6) Section 20(3) shall apply to the exercise by the Authority of his discretion under this section as it applies to the exercise of his discretion to grant or refuse a licence.

First Schedule.

(7) The Authority may grant an application on such terms and conditions as he thinks fit (including terms and conditions relating to the matters set out in the First Schedule) except that, without prejudice to section 24, he shall not impose any new obligation on the applicant in relation to that part of the discharge or deposit which is already licensed unless—

(a) the place at which the discharge or deposit may be made is being varied; or

(b) in his opinion such part would have a significantly different effect on the relevant waters as a result of the granting of the application.

PART VI

APPEALS

When appeal may be brought.

29. (1) Subject to subsection (2), a person who is aggrieved by a requirement or decision of the Authority or the Secretary under any of the following provisions may appeal to an Appeal Board constituted under this Part—

(a) section 13(1) (requiring a convicted person to restore waters);

(b) section 15(2)(b) (declaring an exemption to be inoperative);

(c) section 17(3)(a)(i) (imposing terms and conditions subject to which an exemption may continue in force);

(d) section 17(3)(a)(iii) or 17(3)(b) (cancelling an exemption);

(e) section 17(3)(c) (amending or adding to a notice or substituting a new notice);

(f) section 18(4) (refusing to vary an exemption);

(g) section 20(1) (refusing to grant a licence);

(h) section 20(4) (fixing terms and conditions of a licence);

(i) section 20(5) (fixing the period for non-cancellation of a licence without compensation);

(j) section 23(4) (refusing to renew a licence);

(k) section 24(3)(a)(i) (imposing new or amended terms or conditions for continuance of a licence);

(l) sections 24(3)(a)(iii) and 24(3)(b) (cancelling a licence);

(m) section 24(3)(c) (amending or adding to a notice or substituting a new notice);

(n) section 23(4) (refusing to vary a licence);

(o) section 35 (requiring information to be furnished);

(p) section 45 (refusing to withhold information from the register).

(2) No appeal shall lie under this section where the requirement of the Authority is made with the prior approval of the Governor in Council under section 17(2) or 24(2).

(3) An appeal under subsection (1) shall be made by lodging a notice of appeal in the prescribed manner and form within 21 days after the person aggrieved has received notice of the decision or requirement.

(4) Where the decision or requirement appealed from was made under a provision mentioned in paragraphs (a) to (e), (j) to (n) or (o) of subsection (1) the notice thereof shall be suspended and cease to have effect as from the day on which notice of appeal is duly given to the Authority and until the appeal is disposed of, withdrawn or abandoned, unless—

(a) the decision or requirement is considered by the Authority to be necessary because—

(i) in any case, the quality of the part of the waters of Hong Kong to which the decision or requirement relates may constitute a danger to the health of the public or a section of the public; or

(ii) in the case of a licence for the purposes of section 9, the discharge or deposit to which the decision or requirement relates may be harmful to the drainage or sewerage system, or any part thereof, or to the health or safety of any person engaged in the operation thereof; and

(b) the notice contains a statement to that effect.

(5) Where the appeal is from a decision of the Secretary under section 43, he shall not enter in the register the information to which the appeal relates until the appeal is disposed of, withdrawn or abandoned.

Constitution of Appeal Board.

30. (1) Every appeal under section 29 shall be determined by an Appeal Board constituted under this Part.

(2) The Governor shall appoint as Chairman of Appeal Boards a person who is qualified in law.

(3) Subject to section 32(3), the Chairman shall be appointed for a term of 2 years but may be reappointed.

(4) The Governor shall also appoint a panel of persons whom he considers to be suitable for appointment as members of an Appeal Board pursuant to section 31(1).

(5) An appointment under subsection (2) and every appointment to the panel under subsection (4) shall be notified in the *Gazette*.

(6) In subsection (2) and in section 32(1) "qualified in law" means qualified for appointment as a District Judge under section 5 of the District Courts Ordinance. (Cap. 336.)

Exercise of Appeal Board's jurisdiction.

31. (1) The jurisdiction of an Appeal Board on any appeal or group of appeals shall be exercised by the Chairman and such number of persons from the panel referred to in section 30(4) as the Chairman may appoint for that appeal or group of appeals.

(2) On any appeal an Appeal Board may confirm, reverse or vary the decision or requirement of the Authority or the Secretary.

(3) Every question before an Appeal Board shall be determined by the opinion of the majority of the Chairman and the members hearing the appeal except a question of law which shall be determined by the Chairman; in the event of an equality of votes the Chairman shall have a casting vote.

(4) An Appeal Board shall not at any time consist of a majority of persons who are public officers.

(5) An Appeal Board may—

(*a*) receive evidence on oath;

(*b*) admit or take into account any statement, document, information or matter whether or not it would be admissible as evidence in a court of law; and

(*c*) by notice in writing summon any person to appear before it to produce any document or to give evidence.

(6) The Chairman may determine any form or matter of practice or procedure in so far as no provision is made therefor in this Ordinance.

Supplementary provisions as to Appeal Board.

32. (1) If the Chairman of Appeal Boards is precluded by illness, absence from Hong Kong or any other cause from exercising his functions the Governor may appoint any other person qualified in law to act as Chairman and as such to exercise and perform all of the powers, functions and duties of the Chairman during the period of his appointment.

(2) If a person appointed by the Chairman under section 31(1) to hear an appeal or group of appeals is precluded by illness, absence from Hong Kong, or any other cause from exercising his functions, the Chairman may appoint any other person from the panel provided for in section 30(4) to act in his place.

(3) The Chairman of Appeal Boards may at any time resign his office by notice in writing to the Governor.

(4) If the parties to an appeal consent, the hearing of the appeal may be continued notwithstanding any change in the membership of an Appeal Board as if the change had not occurred.

33. (1) This section applies where—

(a) an Appeal Board has reversed or varied a decision or requirement of the Authority or the Secretary; and

(b) the Authority or Secretary considers that exceptional circumstances require the review of the Board's decision in the public interest.

(2) The Authority or Secretary may, where this section applies, within 14 days of being notified of a decision of an Appeal Board refer the case for review by the Governor in Council.

(3) Where the Authority or the Secretary has referred a case for review under subsection (2), he shall forthwith notify the other party in writing of the reference, giving his reasons for seeking the review and inviting him to submit written representations concerning the review, within 14 days of receiving the notice, for consideration by the Governor in Council.

(4) Upon a reference under subsection (2) and upon the expiry of the period of 14 days referred to in subsection (3) the Governor in Council may review the case, considering any representations submitted under subsection (3), and may confirm, reverse or vary the decision of the Appeal Board.

34. (1) The Chairman of Appeal Boards may of his own motion, before an appeal is determined, refer any question of law to the Court of Appeal by way of case stated.

(2) On the hearing of the case the Court of Appeal may amend the case or order it to be sent back to the Appeal Board for amendment.

PART VII

Powers of Enforcement

35. (1) The Authority may by notice in writing to any person require him to furnish to the Authority, within a period and in a form stipulated in the notice, any information specified in the notice being information which he is authorized to obtain by regulations made under section 48(1)(j) or which the Authority may reasonably require for the purpose of exercising and performing his powers, functions and duties under this Ordinance.

(2) A person who—

(a) fails without reasonable excuse to comply with the requirements of a notice served on him under subsection (1); or

(b) in compliance or purported compliance with such a notice, makes any statement which he knows to be false in a material particular or recklessly makes any statement which is false in a material particular or knowingly omits any material particular,

commits an offence and is liable to a fine of $5,000.

36. (1) Subject to subsection (2), the Authority may in writing authorize public officers to exercise the powers conferred on an authorized officer by sections 37 and 38, or such of those powers as the Authority may specify.

(2) The Authority shall under subsection (1), authorize only a public officer of or above the rank specified to exercise the following powers—

(a) the powers in section 38(b) and (c), an officer of or above the rank of Pollution Control Officer;

(b) any other power conferred by section 37 or 38 on an authorized officer, an officer of or above the rank of Assistant Pollution Control Inspector.

(3) An authorized officer exercising any power in section 37 or 38 may take with him such persons as he reasonably requires to assist him in the discharge of his duties.

Powers of authorized officers to enter premises etc.

37. (1) Subject to subsection (2), an authorized officer may, for the purposes of this Ordinance, without a warrant enter any place or premises or stop and board any vessel—

(a) from or on which he has reason to suspect that, in contravention of section 8(1), matter has been or is being discharged or deposited into the waters of Hong Kong or inland waters, or, in contravention of section 9(1), matter has been or is being discharged or deposited into any public sewer or public drain;

(b) from or on which matter is being discharged or deposited as mentioned in paragraph (a) pursuant to a licence or an exemption conferred by section 13(1), whether or not there is a suspected contravention of section 8 or 9;

(c) on which he has reason to believe there is any thing likely to be, or to contain, evidence of an offence against this Ordinance.

(2) An authorized officer shall not under subsection (1) enter domestic premises (other than that part of such premises on which there is a private sewage treatment plant) or board any vessel used wholly or principally for dwelling purposes without a warrant issued by a magistrate under subsection (3).

(3) A magistrate may issue a warrant empowering any authorized officer to enter domestic premises or to board any vessel used wholly or principally for dwelling purposes if the magistrate is satisfied by information on oath that there is reasonable ground for suspecting that—

(a) contrary to section 8(1), any matter is being or has been discharged or deposited into the waters of Hong Kong or inland waters from those premises or that vessel; or

(b) contrary to section 9(1), any matter is being or has been discharged or deposited from those premises, or that vessel into any public sewer or public drain;

(c) there is on those premises or on that vessel any thing likely to be, or to contain, evidence of an offence against this Ordinance.

(4) An authorized officer who enters any place or premises or boards any vessel—

(a) shall, if so required, produce evidence of his identity and of his authorization by the Authority under section 36; and

(b) shall, if a warrant is under subsection (3) required for entry, produce that warrant.

Further powers of authorized officers.

38. An authorized officer who has pursuant to section 37 or any warrant issued thereunder, entered any place or premises or boarded any vessel, or who has been admitted to any place, premises or vessel in the course of his duties, may—

(a) inspect any plant or equipment or observe any process or procedure which he has reason to suspect is being, or has been, or is intended to be, used, in connexion with—

(i) a discharge or deposit which is being, or has been, made contrary to section 8(1) or 9(1), or is made pursuant to a licence or an exemption conferred by section 15(1);

(ii) the treatment of any matter which is being, or is intended to be, discharged or deposited into the waters of Hong Kong or inland waters or into any public sewer or public drain,

and may require any person in charge of the place, premises or vessel to do anything which the officer reasonably considers to be necessary for facilitating the inspection or observation;

(b) require the person in charge of the place, premises or vessel to produce for examination any drawing, record or document which is in the possession of such person, or which he can reasonably obtain, relating to any plant or equipment referred to in paragraph (a) or to any discharge or deposit to which section 8(1) or 9(1) applies or the officer has reason to suspect may apply;

(c) seize, remove and detain any drawing, record or document referred to in paragraph (b) or any other article or thing if he has reason to suspect that it is, or contains, evidence of an offence under this Ordinance;

(d) examine and make copies of records kept pursuant to a condition of the kind mentioned in paragraph 9 of the First Schedule; First Schedule.

(e) take samples of any matter which is within the description in paragraph (a)(ii) or which he has reason to believe may come within that description.

Analysis of samples. 39. (1) A certificate of analysis of a sample of any matter may be tendered in evidence in any proceedings under this Ordinance and shall, until the contrary is proved, be sufficient evidence of the facts stated therein if the procedure set out in this section has been complied with, or substantially complied with so far as is reasonably practicable, in relation to that sample.

(2) An authorized officer who takes a sample of any matter for the purposes of subsection (1) shall—

(a) divide it into 3 approximately equal parts;

(b) place each part in a separate container and suitably mark or label each container;

(c) ensure that the person appearing to be in occupation of the premises on which the sample was taken or his servant or agent—

(i) is handed such one of the parts as that person or his servant or agent may select or, if that is not reasonably practicable, is handed or sent by registered post such one of the parts as the officer shall select; and

(ii) is informed that one of the other 2 parts is intended to be submitted to the analyst for analysis;

(d) except where an analysis proves to be unnecessary, personally submit one of the remaining 2 parts to the analyst for analysis and retain the other for the purposes of comparison.

(3) As soon as the analyst has completed the analysis he shall furnish to the relevant Authority and to the person referred to in subsection (2)(c), or his servant or agent, a certificate of the results of the analysis.

(4) A certificate under subsection (3) shall be signed by the analyst, but the analysis may be made by a person acting under his directions;

and any certificate purporting to have been signed by the analyst shall be presumed, until the contrary is proved, to have been signed by him.

(5) In this section "analyst" means the Government Chemist or any person appointed by the Governor as an analyst for the purposes of this section.

(6) An appointment by the Governor under subsection (5) shall be notified in the *Gazette*.

Offences in relation to sections 37 and 38.

40. A person who—

(a) wilfully obstructs an authorized officer in the exercise of any power conferred on such officer by or under section 37 or 38; or

(b) fails without reasonable excuse to comply with any requirement duly made by an officer under those sections; or

(c) in compliance or purported compliance with any such requirement produces any drawing, document or record which he knows to be incorrect or inaccurate in a material particular or does not believe to be correct and accurate,

commits an offence and is liable to a fine of $5,000.

PART VIII

MISCELLANEOUS

Authority may hold a hearing.

41. (1) Where on an application under section 18, 19, 23 or 28, any objection to the grant of the application is duly made to the Authority, he may hear the applicant and any objector if he considers it expedient for the purpose of obtaining information relevant to any question to be decided.

(2) The procedure to be followed at, or for the purpose of convening, any hearing under subsection (1) shall be determined by the Authority.

Authority to keep register.

42. (1) The Authority shall cause to be kept, in such form as the Secretary may determine, a register containing the prescribed particulars in relation to such of the following as fall under his jurisdiction—

(a) all discharges and deposits which are exempt pursuant to section 15 and applications and notices under this Ordinance in respect thereof;

(b) all discharges and deposits for which a licence is in force, applications for such licences and other applications and notices under this Ordinance in respect thereof;

(c) such other matters as may be required by regulations made under section 46 to be recorded in the register.

(2) The register shall be open for inspection by the public during normal office hours at such places as the Secretary thinks fit.

(3) A person shall be entitled, upon payment of the prescribed fee, to a copy of any entry in the register certified by or on behalf of the Authority.

Protection of private information from publicity.

43. (1) Any person may apply to the Secretary to withhold from public notification or other public access under this Ordinance any specified information concerning a discharge or deposit, whether appearing in a licence or an application therefor or in any notice, return or other document.

(2) An application under subsection (1) shall be granted by the Secretary to the extent that he is satisfied that public notification or other public access to the information would—

(a) be contrary to the applicant's private interest to an unreasonable degree; or

(b) be contrary to the public interest.

(3) Where an application under this section is refused by the Secretary, whether in whole or in part—

(a) notice of the refusal and of the reasons therefor shall be given in writing by the Secretary to the applicant;

(b) the information shall not be publicly notified or otherwise made accessible to the public until the time for appeal under section 29(3) has expired.

44. (1) A person commits an offence who, except in the circumstances provided for in subsection (2), discloses or gives to another person any information or document concerning a trade or business secret which has come to his knowledge or into his possession in the course of the exercise or performance of his powers, functions or duties under this Ordinance.

(2) A person does not commit an offence under subsection (1) if he discloses or gives any information or document to another person—

(a) for the purpose of the exercise or performance of his powers, functions or duties under this Ordinance and proceedings connected therewith;

(b) pursuant to an order of a court under subsection (3);

(c) with the consent in writing of all such persons as appear to him, after reasonable inquiry, to be interested in the confidentiality of the information or document.

(3) Where in any proceedings a court considers that the justice of the case so requires, the court may order the disclosure of any information or the giving of any document referred to in subsection (1).

(4) A person who commits an offence under subsection (1) is liable to a fine of $10,000 and to imprisonment for 6 months.

45. (1) No liability shall rest on the Crown or upon any public officer by reason of the fact that any licence or exemption is granted or continued under this Ordinance for the discharge or deposit of any matter into the waters of Hong Kong or into inland waters or into a public sewer or public drain.

(2) A public officer shall not be personally liable in respect of any act or omission of his if it was done or made by him in the honest belief that it was required or authorized in the exercise of any power, function or duty of his under this Ordinance.

(3) The protection conferred on public officers by subsection (2) in respect of any act or omission shall not in any way affect any liability of the Crown in tort for that act or omission.

46. (1) The Governor in Council may, after consultation with the Environmental Protection Advisory Committee, by regulation provide for—

(a) the manner in which quantities and rates of discharges and deposits are to be calculated for the purposes of section 16(1)(b);

(b) the form and contents of—

(i) a notice under section 14;

(ii) an application for approval under section 18;
(iii) an application for a licence under section 19;
(iv) an application for a renewal of a licence under section 23;
(v) an application for a variation of a licence under section 28;

(c) the period within which a licensee shall make an application for a renewal of the licence, and the circumstances in which a licence may continue in force pending the determination of any such application;

(d) the particulars to be entered in the register;

(e) the particulars to be contained in a notice referred to in section 19(3)(b);

(f) the manner in which objections shall be made under section 19(4)(b);

(g) the manner of determining the amount of compensation payable under sections 25 and 26, the factors to be taken into account or disregarded and the principles to be applied in determining that amount;

(h) the forms to be used and the procedure to be followed for the purpose of appeals under Part VI;

(i) fees and charges which may be imposed by an Authority or the Secretary—

(i) on persons who are making discharges or deposits which are exempt under section 15 or for which a licence is in force, or on any class or description of such persons or in respect of such discharges or deposits or any class or description thereof, including charges for the reception, treatment and disposal of matter discharged pursuant to a licence for the purposes of section 9;

(ii) persons making any application referred to in paragraph (b);

(j) matters "about" which information may be obtained under section 35(1);

(k) the manner in which notices required or authorized by this Ordinance may be given or sent to the person to whom they are addressed;

(l) the inclusion of a lake, pool or pond or any description of lake, pool or pond within the definition of "inland waters" in section 2 as provided for in paragraph (a) of that definition;

(m) prescribing anything (including any fee) which is to be or may be prescribed by regulations;

(n) generally for the better carrying out of the provisions and purposes of this Ordinance.

(2) Regulations made under subsection (1)(a) may delegate to the Authority the power to determine in any particular case the method of making any calculation for the purposes of section 16(1)(b).

(3) Regulations made under this section may provide that a contravention of specified provisions thereof or of specified conditions of an exemption conferred by section 15 or of specified conditions of a licence shall be an offence and may provide penalties therefor not exceeding a fine of $5,000 and imprisonment for 6 months.

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47. (1) Subject to this section, this Ordinance shall bind the Crown.

(2) Sections 8 and 9 shall not have effect to permit proceedings to be taken against, or to impose any criminal liability on, the Crown or on any person who makes any discharge or deposit which he is required to make in the course of carrying out his duties in the service of the Crown.

(3) If it appears to an Authority that any discharge or deposit is being, or has been, made in contravention of section 8(1) or 9(1) by any person in the course of carrying out his duties in the service of the Crown, he shall, if the contravention is not forthwith terminated to the satisfaction of the Authority, report the matter to the Chief Secretary.

(4) On receipt of a report under subsection (3) the Chief Secretary shall inquire into the circumstances and, if his inquiry shows that a contravention of section 8(1) or 9(1) is continuing or likely to recur, he shall ensure that the best practicable steps are taken to terminate the contravention or avoid the recurrence.

(5) Any notice or application under this Ordinance concerning a discharge or deposit which is to be, or may be, given or made by or on behalf of the Crown may be given or made by any public officer on behalf of the Crown.

(6) Any notice under this Ordinance concerning a discharge or deposit which is to be, or may be, given by the Authority to the Crown shall be given to the principal officer of the Government Department which appears to the Authority to be responsible for the discharge or deposit or, in the event of any question arising as to which Department is responsible, to such public officer as the Chief Secretary shall determine.

(7) No compensation shall be payable under section 25 in respect of any discharge or deposit made by or on behalf of the Crown.

(8) No fee or charge prescribed for the purposes of this Ordinance shall be payable by the Crown.

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48. If any question arises as to who are the body of persons for the time being constituting the Environmental Protection Advisory Committee mentioned in sections 3, 5 and 46, the matter shall be referred to the Chief Secretary who shall determine the question by certificate under his hand.

ot affect affected or ces.

49. (1) No exemption which arises for the purposes of this Ordinance by operation of section 15 and no licence shall be construed as a dispensation from the requirements of any other Ordinance except where that other Ordinance so provides.

(2) Without limiting section 8(3), the giving, granting or making of any direction, licence, permit, consent, approval or other requirement or authority under any other Ordinance shall not be taken to authorize any act or omission which contravenes section 8(1) or 9(1).

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50. The enactments specified in the Third Schedule are amended in the manner specified therein.

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51. Upon section 8(1)(*a*) or 9(1) becoming applicable to a discharge or deposit pursuant to section 7 the enactments mentioned in the first column of the Fourth Schedule shall have effect in relation to that discharge or deposit as if they were amended in the manner specified in the second column of that Schedule.

FIRST SCHEDULE [ss. 17(6), 18(7), 20(4), 24(6), 28(7) & 35.]

TERMS AND CONDITIONS SUBJECT TO WHICH A LICENCE MAY BE GRANTED OR AN EXEMPTION CONTINUED

1. The place and times or periods at or during which the discharge or deposit may be made.

2. The design and construction of any plant or equipment used in making the discharge or deposit.

3. The rate of discharge or deposit or the total amount thereof in relation to the matter discharged or deposited or any constituent thereof.

4. The nature, composition, colour and temperature of the matter discharged or deposited or of any constituent thereof.

5. The treatment of matter before it is discharged or deposited and the plant and equipment to be provided, maintained and used therefor.

6. The equipment and facilities to be provided for inspecting, sampling or measuring the discharge or deposit or any constituent thereof.

7. The maintenance and security of any equipment and facilities referred to in paragraph 6.

8. The provision to the Authority of samples, and of the results of the analysis of samples, of discharges and deposits.

9. The keeping of records in relation to the matters mentioned in paragraphs 3 and 4.

10. The access of authorized officers to the equipment, facilities and records referred to in paragraphs 6 and 9.

11. Precautions to be taken against matter discharged or deposited entering any specified part of the waters of Hong Kong or any public drain or public sewer.

SECOND SCHEDULE [s. 27(2).]

DETERMINATION OF COMPENSATION

1. A person who claims compensation under section 25 or 26 shall submit to the Authority particulars in writing of his claim.

2. (1) A claim under paragraph 1 shall be submitted—

(*a*) where a licence or exemption is cancelled, within 1 year after the cancellation;

(*b*) where a licence or exemption is varied so as to impose additional obligations on the person making the discharge or deposit, within 1 year after the completion of the works attributable solely to the requirement of the Authority.

(2) The period referred to in sub-paragraph (1) may, upon application made to the Governor either before or after the expiry of that period be extended in accordance with this paragraph.

(3) Notice of an application under sub-paragraph (2) shall be given to the Authority by the applicant.

(4) The Governor may extend the period within which particulars of a claim must be submitted to the Authority if he considers that the delay in submitting such particulars was occasioned by mistake of fact or mistake of any matter of law (other than the matters contained in sub-paragraph (1)) or by any other reasonable cause or that the Crown is not materially prejudiced by the delay.

(5) An extension may be granted by the Governor under sub-paragraph (4) with or without conditions for such period as he thinks fit but not in any case exceeding 6 years from the time when the right to compensation first arose.

3. If the Authority and the claimant do not agree on the settlement or compromise of the claim within 3 months of the submission of particulars under paragraph 1, the claimant may notify the Authority that he desires a reference to a tribunal; and the Authority shall thereupon refer the claim with the particulars thereof to a tribunal, consisting of a District Judge nominated by the Chief Justice for the purpose.

4. The tribunal shall hear any evidence which the Authority or the claimant may wish to tender and, if so desired, hear counsel on behalf of the Authority and the claimant, and shall determine the amount of compensation, if any, to be paid to the claimant.

5. For the purposes of paragraph 4, the tribunal shall have powers similar to those vested in the Supreme Court for hearing evidence, determining claims for damages and awarding costs.

6. The practice and procedure in connexion with any proceedings before a tribunal under this section shall be such as the tribunal may determine.

7. Any award or decision of a tribunal under this Schedule shall be final but if a party is dissatisfied with the decision as being erroneous in point of law, he may, within 1 month after the decision, require the tribunal to state and sign a case for the decision of the Court of Appeal.

8. The tribunal may direct that interest be paid on compensation (but not on costs) from such date and for such period as the tribunal thinks fit, at the lowest rate paid from time to time by members of the Exchange Banks Association on time deposits or at such other rate as may be determined by resolution of the Legislative Council.

9. All compensation, including interest thereon and costs, shall be paid from such money as may be provided from time to time by the Legislative Council.

THIRD SCHEDULE [s. 50.]

Enactment	*Amendment*
Cap. 111, 1967 Ed. Public Cleansing and Prevention of Nuisances By-laws.	By-law 4 is amended by inserting after paragraph (3) the following— "(4) No offence under paragraph (1)(c) is committed by a person who

Enactment	*Amendment*	
	makes a discharge or deposit under and in accordance with—	
(of 1980.)	(*a*) a licence granted under section 20 of the Water Pollution Control Ordinance 1980; or	
	(*b*) an exemption which arises under section 15 of that Ordinance.".	
Public Cleansing and Prevention of Nuisances (New Territories) Regulations	Regulation 4(1) is amended by inserting after paragraph (3) the following paragraph—	(Cap. 132, sub. leg.)
	"(4) No offence under paragraph (1)(*c*) is committed by a person who makes a discharge or deposit under and in accordance with—	
(of 1980.)	(*a*) a licence granted under section 20 of the Water Pollution Control Ordinance 1980; or	
	(*b*) an exemption which arises under section 15 of that Ordinance.".	
Marine Hawkers Regulations	Regulation 19 is revoked.	(Cap. 160, sub. leg.)
Country Parks and Special Areas Regulations	Regulation 12 is amended—	(Cap. 208, sub. leg.)
	(*a*) by being renumbered as paragraph (1);	
	(*b*) by inserting after paragraph (1) the following—	
	"(2) No offence under paragraph (1)(*b*) is committed by a person who makes a discharge or deposit under and in accordance with—	
(of 1980.)	(*a*) a licence granted under section 20 of the Water Pollution Control Ordinance 1980; or	
	(*b*) an exemption which arises under section 15 of that Ordinance.".	
Mining Ordinance	The Ordinance is amended by adding after section 28 the following—	(Cap. 285.)
"Discharges and deposits under Water Pollution Control Ordinance.	28A. No offence under section 27 or 28 is committed by a person who makes a discharge or deposit under and in accordance with—	
(of 1980.)	(*a*) a licence granted under section 20 of the Water Pollution Control Ordinance 1980; or	
	(*b*) an exemption which arises under section 15 of that Ordinance.".	

	Enactment	*Amendment*
112.	Pearl Culture Control Ordinance	Section 9 is amended—
		(*a*) by being renumbered as subsection (1);
		(*b*) by inserting after subsection (1) the following—
		"(2) No offence under subsection (1) is committed by a person who makes a discharge or deposit under and in accordance with—
		(*a*) a licence granted under section 20 of the Water Pollution Control Ordinance (Cap. of 1980) 1980; or
		(*b*) an exemption which arises under section 15 of that Ordinance.".
113.	Shipping and Port Control Ordinance	The Ordinance is amended by adding after section 48 the following—
	"Discharges under the Water Pollution Control Ordinance. (Cap. of 1980)	48A. No offence under section 46 is committed by, and no obligation arises under section 48 on the part of, any person who makes a discharge or deposit of oil or a mixture containing oil under and in accordance with a licence for the purposes of section 9 of the Water Pollution Control Ordinance 1980 granted under section 20 of that Ordinance.".

FOURTH SCHEDULE [s. 51.]

Enactment	*Amendment deemed to have been made for the purposes of section 51*
1. Public Health and Urban Services Ordinance	The Ordinance shall have effect as if section 5(1) were amended as follows—
	(*a*) by deleting paragraphs (*a*), (*c*) and (*d*);
	(*b*) by deleting paragraph (*b*) and substituting the following—
	"(*b*) causes or permits any solid matter, mud or waste to be placed or thrown, or to fall, or to be carried over any grate communicating with any public sewer or drain;".
2. Public Cleansing and Prevention of Nuisances By-laws	The By-laws shall have effect as if they were amended as follows—
	(*a*) in by-law 10, by deleting sub-paragraph (*c*);

Enactment	Amendment deemed to have been made for the purposes of section 51	
	(b) in by-law 14, by deleting paragraph (2) and substituting the following— "(2) No person shall discharge, deposit, or place any pigwash in or into a public place.".	
Public Cleansing and Prevention of Nuisances (New Territories) Regulations	The Regulations shall have effect as if they were amended as follows—	(Cap. 132, sub. leg.)
	(a) in regulation 10, by deleting sub-paragraph (e);	
	(b) in regulation 14, by deleting paragraph (2) and substituting the following— "(2) No person shall discharge, deposit, or place any pigwash in or into a public place.".	
Summary Offences Ordinance	The Ordinance shall have effect as if it were amended as follows—	(Cap. 228.)
	(a) in section 4(1), by deleting the words ", or into the waters of the Colony", the words ", stream, watercourse, ford or reservoir, or into any drain or sewer" and the words ", stream or watercourse";	
	(b) in section 5(1), by deleting paragraph (c).	
Pearl Culture (Control) Ordinance	The Ordinance shall have effect as if section 5(b) were amended by deleting "or to pollute or to be likely to pollute the waters in any such area".	(Cap. 207.)

Explanatory Memorandum

The purpose of this Bill is to control pollution of the waters of Hong Kong i.e. rivers, streams and other inland waters and the territorial sea of Hong Kong.

Pollution Offences

2. There are two key offence provisions. First it will be an offence to cause or permit any poisonous, noxious or polluting matter to enter the waters of Hong Kong in a water control zone or to cause or permit any matter to enter inland waters and thereby create pollution by impeding the flow of the waters (clause 8(1) when read with clause 2(2)). Secondly it is made an offence to cause or permit anything other than domestic sewage to enter a foul water drain or sewer or other than unpolluted water to enter a surface water drain or sewer (clause 9(1) when read with clause 2(2)).

3. A deposit of such matter in any place from which it is likely to enter the waters of Hong Kong or inland waters, as indicated above or a drain or sewer is also prohibited (clause 2(3)).

4. There are a number of exemptions and defences to these offences (clauses 8(4), 9(4) and 12). The most important defences are that the discharge or deposit is exempt or is licensed. These provisions are explained below.

5. It will not be necessary for the prosecution to prove that a person who causes any of these occurrences knew or could reasonably have known that he was so doing (clause 10) and the occupier of premises and the master of a vessel will be vicariously liable for offences which emanate from the premises or vessel. However in any case a person will escape liability if he proves that he took all reasonable precautions (clause 12(1)(d)).

6. The penalty on first conviction is a fine of $50,000 plus a daily penalty of $500 and on a second or subsequent conviction a fine of $100,000 plus the daily penalty (clause 11). An offender may also be required by the relevant Authority to carry out remedial work (clause 13).

Commencement of penal provisions

7. For the purpose of gradually introducing the controls which these offences will afford, Hong Kong will be divided into water control zones each with an enforcement Authority (clause 4). The Secretary for the Environment is required, after consultation with the Environmental Protection Advisory Committee, to establish water quality objectives for those zones (clause 5) which the enforcement Authority must then aim to achieve and maintain and if necessary the Secretary may give the Authority directions for that purpose (clause 6).

8. The pollution offences in clauses 8 and 9 will only apply in a water control zone as follows—

(*a*) the Governor will by order appoint a day for that zone after which all discharges or deposits, or all discharges or deposits of a specified kind or description, will be classified as new discharges or deposits and will be forbidden unless licensed under Part V of the Bill (clauses 7(1)(*a*) and (2));

(*b*) any discharge or deposit or any discharge or deposit of the specified kind or description which was being made in that zone during the 12 months preceding that appointed day will be an existing discharge or deposit (clause 7(2)) and will be allowed to continue until a day to be appointed by order by the Governor under clause 7(3);

(*c*) if after the day appointed under clause 7(3) an existing discharge or deposit has not been notified to the Authority under Part IV it will also be forbidden;

(*d*) a discharge or deposit will not come within the offences in clause 8 or 9 in accordance with the procedure described unless that kind of discharge or deposit is covered by the order made by the Governor.

Exemption of existing discharges and deposits

9. After the Governor has appointed a day for a particular water control zone under clause 7(2), and if the order covers the discharge or deposit in question, the person making an existing discharge or deposit (as defined in clause 2) may give notice thereof to the Authority before the day appointed under clause 7(3) (clause 14(1)). If such notice is duly given the discharge or deposit will be exempt from the offence provisions in clauses 8 and 9.

10. However an exemption will cease if the discharge or deposit is changed in any of the ways described in clause 16(1) or if the particulars given in a notice under clause 14 are incorrect and the notice is declared inoperative under clause 16(2) or (3).

11. An exemption for a discharge or deposit may also be cancelled or varied by the Authority on the grounds of danger to the public health, or to the sewerage system or persons engaged in its operation (clause 17(1)). The Governor in Council may however authorize the Authority to do so even though such grounds are not present (clause 17(2)). In the latter case compensation is payable under clause 26(1).

12. A person who is making an exempt discharge or deposit may apply to the Authority for approval of changes thereto (clause 18(1)) in which case public notice must be given of the application (clause 18(3) and (3)). In granting any such application the Authority may not impose any new obligation on the applicant so far as the existing discharge or deposit is concerned unless the change would make it a significantly different discharge or deposit (clause 18(7)).

Licensing of discharges and deposits

13. If after the day appointed by the Governor under clause 7(2) for a water control zone a person wishes to make a new discharge or deposit in that zone of a kind covered by the Governor's order, the person must, to avoid committing an offence under clause 8 or 9, obtain a licence under Part V of the Bill.

14. All applications for licences must be publicly notified (clause 19(3)) and any person may lodge an objection (clause 19(4)).

15. If a licence is granted the Authority may impose conditions including conditions relating to the matters set out in the First Schedule. In the case of a licence for a discharge or deposit which, having been previously exempt, has lost the exemption by reason of any of the changes mentioned in clause 16(1)(*b*) the Authority shall not impose any obligation on the applicant so far as the existing discharge or deposit is concerned unless the change would make it a significantly different discharge or deposit (clause 21).

16. A licence may be cancelled or varied by the Authority on the same basis as is described above for an exemption (clause 24(1) and (2)). If the licence is cancelled or varied within a period specified in the licence (as provided in clause 20(5)) compensation will be payable (clauses 25 and 26).

17. A person who is making a licensed discharge or deposit may apply to the Authority for approval of changes thereto (clause 28). These provisions are similar to those described above for such applications in respect of an exempt discharge or deposit.

Appeals, enforcement etc.

18. The Bill contains provisions for—

(*a*) appeals against requirements or decisions of the Authority (Part VI) with provision in clause 33 for a review of an Appeal Board's decision if the Authority considers that exceptional circumstances require such a review in the public interest;

(*b*) the exercise of powers in aid of enforcement, namely powers to require the furnishing of information, and in defined circumstances, to enter premises, to inspect premises and equipment, to require the production of documents, to examine records and to take samples (Part VII);

(*c*) the Authority to hold a hearing where objections have been received to an advertised application (clause 41);

(*d*) the keeping of a public register of exempt and licensed deposits and discharges (clause 42);

(c) the protection of private information from publicity (clauses 43 and 44);

(f) the protection of the Crown and public officers in carrying out their duties (clause 45);

(g) the application of the legislation to the activities of the Crown (clause 47);

(h) the making of regulations (clause 46);

(i) consequential amendments to and the effect of the Bill on other legislation (clauses 49, 50 and 51 and the Third and Fourth Schedules).

19. To administer the Bill a new Liquid Effluent Pollution Investigation and Control Division is to be established within the Public Works Department. The annual staff costs for this division are estimated to be approximately $1.4 million in year 1 rising to approximately $2.4 million after 4 years. Capital expenditure is estimated to be $0.2 million. There will also be a need to recruit additional staff for the Agriculture and Fisheries Department during the second year of operation, but it is not possible to estimate the cost of this recruitment. Expenditure may also be required should compensation under the Bill be paid. A certain amount of revenue will be produced in the form of licence fees and cost recovery charges.

一九八〇年水污染管制法案

摘要說明

本法案旨在管制本港河流、溪涌、其他內陸水域及個別之污染。

污染罪

二、 有關污染罪之主要規定有二：一、凡導致或容許任何有毒、有害或污染物質進入本港水污管制區之水中，及導致或容許任何物質進入內陸水域，因而損壞水質及造成污染者，均屬違法（法案第八條第(1)款及參閱法案第二條第(2)款）。二、凡導致或容許任何物質（家庭污水除外）進入污水渠或溝渠，及任何物質（未經污染之水除外）進入地面排水渠或溝渠者，均屬違法（法案第九條第(1)款及參閱法案第二條第(2)款）。

三、 凡在任何地方儲藏上述物質，以致其可能經上文所述進入本港之污域或內陸水域，或進入排水渠或溝渠者，均在禁止之列（法案第二條第(3)款）。

四、 至於上述罪名之豁免情形及辯護理由，本法案亦有規定（法案第八條第(3)款、第九條第(3)款及第十二條）。最重要之辯護理由，即所排出或儲藏之物質已獲豁免或發有許可證。有關規定詳於下文解釋。

五、 在法院程序中，證方如欲證明導致上述違法情事發生之人士明知或理應知道其行此等違法有罪（法案第十條），而使手之作為及個人之知識，則須證明該人士或負責控制要發生之違例事項之代理人員責任。推定該如何，凡能證明屬已採取一切合理預防措施者，皆可免負責任（法案第十二條第(1)款(b)段）。

六、 違例者首次定罪之罰款定為五萬元，另加每日罰款五百元；第二次及其後定罪之罰款為十萬元，另加每日罰款一千元（法案第十一條）。有關當局並可着令違犯者進行補救工作（法案第十三條）。

排出廢物之責任

七、 任何人士在污染地區內排出廢物，即屬犯罪，一經循簡易程序定罪，可處第五級罰款及監禁六個月。

八、 任何人士在污染地區內排出廢物，即屬犯罪，一經循簡易程序定罪，可處第五級罰款及監禁六個月。

九、 任何人士在污染地區內排出廢物，即屬犯罪，一經循簡易程序定罪，可處第五級罰款及監禁六個月。

十、 任何人士在污染地區內排出廢物，即屬犯罪，一經循簡易程序定罪，可處第五級罰款及監禁六個月。

十一、 任何人士在污染地區內排出廢物，即屬犯罪，一經循簡易程序定罪，可處第五級罰款及監禁六個月。

十二、 任何人士在污染地區內排出廢物，即屬犯罪，一經循簡易程序定罪，可處第五級罰款及監禁六個月。

十三、 任何人士在污染地區內排出廢物，即屬犯罪，一經循簡易程序定罪，可處第五級罰款及監禁六個月。

十四、 任何人士在污染地區內排出廢物，即屬犯罪，一經循簡易程序定罪，可處第五級罰款及監禁六個月。

Regulations 2

Legal Supplement No. 3

To the

HONG KONG

GOVERNMENT GAZETTE

Friday, 6 July, 1979

Solid waste

Enacted 4/80

WASTE DISPOSAL BILL 1979

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A BILL

To

Provide for the collection and disposal of waste and to make consequential amendments to the *Public Health and Urban Services Ordinance*.

Enacted by the Governor of Hong Kong, with the advice and consent of the Legislative Council thereof.

PART I

PRELIMINARY

Short title and commencement

1. (1) This Ordinance may be cited as the Waste Disposal Ordinance 1979.

(2) This Ordinance shall come into operation on a day to be appointed by the Governor by notice in the *Gazette*, and notices under this section may appoint different dates for different provisions of this Ordinance.

Interpretation

2. (1) In this Ordinance, unless the context otherwise requires—

"animal waste" means the manure of any animal and also means any part of any dead animal not fit for, or not intended for, human consumption;

"collection authority" means—

(a) in respect of the urban areas, the Urban Council;

(b) in respect of the New Territories (excluding New Kowloon), the Director of Urban Services and the Director of Agriculture and Fisheries;

"household waste" means waste produced by a household, and of a kind that is ordinarily produced by a dwelling when occupied as such;

"street waste" means dust, dirt, rubbish, mud, road scrapings or filth, but does not include human excretal matter;

"trade waste" means waste from any trade, manufacture or business, or any waste building or civil engineering materials, but does not include animal waste;

"waste" means any substance or article which is abandoned;

"waste collection licence" means a licence under section 11;

"waste disposal authority" means—

(a) in respect of animal waste, the Director of Agriculture and Fisheries; and

(b) in respect of all other classes of waste, the Director of Public Works;

"waste disposal licence" means a licence under section 17.

(2) For the purposes of this Ordinance any substance or article which is discarded or otherwise dealt with as waste shall be presumed to be waste until the contrary is proved.

PART II

WASTE DISPOSAL PLAN

Establishment of Waste Management Advisory Committee.

3. (1) There is hereby established the Waste Management Advisory Committee.

(2) The Committee shall consist of—

(a) the Environmental Protection Adviser or his representative, who shall be Chairman;

(b) the Director of Public Works or his representative;

(c) the Director of Urban Services or his representative;

(d) the Director of Agriculture and Fisheries or his representative;

(e) the Director of Marine or his representative;

(f) the Secretary for the New Territories or his representative; and

(g) not more than 6 other persons appointed by the Governor.

(3) The Committee shall advise the Secretary for the Environment on the preparation of waste disposal plans, any revision thereof and all matters relating to waste disposal plans, on the preparation and revision of Codes of Practice and on the control of waste generally.

(4) The Committee shall from time to time consult the Urban Council on all matters in respect of which the Urban Council has, under this Ordinance, a duty to discharge or a function to fulfill.

(5) The Committee may appoint sub-committees for the better discharge of its functions under this Ordinance and any such sub-committee may include persons who are not public officers.

(6) The procedure to be followed at any meeting of the Committee or any sub-committee thereof and to be followed in the discharge of the functions of the Committee or sub-committee shall be such as the Committee may determine.

paration of te waste posal plans.

4. (1) The Secretary for the Environment shall, after consultation with the Waste Management Advisory Committee and the Urban Council and having regard to their views, prepare draft plans showing—

(a) the arrangements made or proposed to be made for the collection and disposal of—

(i) all solid and semi-solid wastes other than those which may be discharged into the atmosphere as particulates or discharged into water as solids suspended in effluents; and

(ii) such other wastes, or classes of waste, as may be prescribed; and

(b) all existing and proposed waste disposal sites and the methods of waste disposal used or to be used at each site.

(2) Where the Secretary for the Environment has prepared a draft waste disposal plan under subsection (1) he shall publish in the *Gazette* a notice in English and in Chinese—

(a) giving particulars of the places and times at which a copy of the draft plan may be inspected by the public; and

(b) specifying the time within and the manner in which representations concerning the draft plan may be made.

(3) Where the Secretary for the Environment publishes a notice under subsection (1) he shall not later than 7 days thereafter publish a copy of the notice in 3 issues of one English language and of two Chinese language newspapers.

(4) A copy of the draft plan shall be available for inspection by the public free of charge at such offices of the Government as the Secretary for the Environment thinks fit for a period of 45 days from the date of publication of a notice under subsection (1) and during the hours when those offices are normally open to the public.

(5) The Secretary for the Environment shall supply a copy of the draft plan upon payment of such fee as may be prescribed.

Representations concerning draft waste disposal plans.

5. (1) Any person wishing to make representations concerning a draft waste disposal plan may, within a period of 45 days from the date of publication of a notice under section 4(2), submit to the Secretary for the Environment his written representations.

(2) The Secretary for the Environment shall consider such representations and may make any change to the draft plan which he considers appropriate in consequence of the representations.

Submission of draft waste disposal plan to Governor in Council.

6. The Secretary for the Environment shall, within 12 months from the last day of the period during which representations may be made, submit the draft waste disposal plan to the Governor in Council for approval and shall at the same time submit—

(a) a schedule of representations made under section 5; and

(b) a schedule of the changes made by him to the draft waste disposal plan in consequence of the representations.

Power of Governor in Council upon submission of draft waste disposal plan.

7. (1) Upon submission of a draft waste disposal plan under section 6, the Governor in Council shall—

(a) approve the draft plan;

(b) refuse to approve it; or

(c) refer it back to the Secretary for the Environment for further consideration and amendment.

(2) Where the Governor in Council has either approved or refused to approve a draft waste disposal plan, the Secretary for the Environment shall as soon as possible after such approval or refusal give notice thereof in the *Gazette* of such approval or refusal; and where the draft plan has been approved he shall also publish in the *Gazette* a notice declaring the plan to be a waste disposal plan.

(3) A copy of any waste disposal plan shall be available for inspection by the public free of charge at such offices of the Government as the Secretary for the Environment thinks fit during the hours when the offices are normally open to the public.

(4) The Secretary for the Environment shall supply a copy of any waste disposal plan upon payment of such fee as may be prescribed.

Revision of waste disposal plans.

8. The Secretary for the Environment may from time to time revise any waste disposal plan and sections 4, 5, 6 and 7 shall apply to any revision in like manner as they apply to a waste disposal plan.

Collection authorities and waste disposal authorities to have regard to waste disposal plans.

9. In discharging their duties and functions under this Ordinance, the collection authorities and the waste disposal authorities shall have regard to the waste disposal plans.

PART III

COLLECTION OF WASTE

Provision of collection and scavenging services.

10. Subject to this Part, the collection authority may provide services for—

(*a*) the removal and disposal of household waste, street waste, trade waste and animal waste;

(*b*) the cleansing and emptying of pail latrines;

(*c*) the desludging of aqua privies and ieptic tanks; and

(*d*) the removal and disposal of excretal matter from such latrines, privies and tanks.

Licensing of collection and scavenging services.

11. (1) Notwithstanding section 10, the collection authority may, by licence, permit any person to provide services for all or any of the matters referred to in that section.

(2) A licence under subsection (1) may specify the place and method of disposal or may require that any waste or matter for disposal be delivered to facilities provided by the collection authority or the waste disposal authority.

(3) Where a licence under subsection (1) is granted by the Urban Council as a collection authority, the fee for such licence shall be such as the Urban Council may from time to time determine.

Prohibition of unauthorized collection of waste.

12. Subject to section 13, where in any area, the collection authority has provided any services under section 10 or has, by licence under section 11, permitted any other person to provide any of the services specified in section 10, any person who, not being the holder of a licence under section 11, provides any such services, that is to say any service provided by the collection authority under section 10 or by any other person under a licence under section 11, commits an offence and is liable to a fine of $2 000.

Occupier of building may move household waste to waste collection contractor.

13. (1) Notwithstanding section 12, it shall not be an offence under that section for an occupier of any building, or any person responsible for the management of any building, to remove household waste from any building if—

(*a*) the collection authority or any person holding a waste collection licence neglects or fails for a period of 48 hours to remove household waste for any building in respect of which the authority or person provides that service under section 10 or 11; or

(*b*) no such service for the removal of household waste is provided by a collection authority or a person holding a waste collection licence.

(2) Any waste removed under subsection (1) may be disposed of in any way permitted by law.

(3) Nothing in this section shall derogate from any regulations made under section 15 of the Public Health and Urban Services Ordinance.

p. 132.)

Collection of trade waste, animal waste and removal of excretal matter.

14. (1) If the collection authority is requested by the owner or occupier or person responsible for the management of any building or land to remove any trade waste or animal waste, the collection authority may remove it, and may recover from the person requesting the removal a fee not exceeding the cost of removal and disposal.

(2) The collection authority may by notice served on the owner or occupier or person responsible for the management of any stable, cowhouse, piggty, kennel, poultry farm or similar establishment require the removal from the premises of animal waste, bedding, straw or other waste.

(3) If, where a notice has been served under subsection (2), any person, who is required by the notice to remove any animal waste, bedding, straw or other waste from any premises specified in the notice, fails to comply with that requirement, he commits an offence and is liable to a fine of $2,000 and, in addition, if the offence is a continuing offence to a fine of $200 for each day during which it is proved to the satisfaction of the court that the offence has continued.

Property in collected waste, etc.

15. All household waste, street waste, trade waste, animal waste and any matter obtained from the cleansing and emptying of pail latrines and the desludging of aqua privies and septic tanks, collected by the collection authority in the operation of any service provided under section 10 or section 14 or collected by a person licensed by a collection authority under section 11 shall—

(a) where the collection authority is the Urban Council, be the property of the Urban Council; and

(b) where the collection authority is the Director of Urban Services or the Director of Agriculture and Fisheries, be the property of the Crown,

and may be sold or disposed of by the Urban Council or the Director of Urban Services or the Director of Agriculture and Fisheries in such manner as the Council or the Director thinks fit.

Storage of animal waste.

16. The Governor may, by order published in the *Gazette*, designate any area of Hong Kong as an area in which—

(a) animal waste or any class of animal waste is to be stored in such containers or enclosures as may be prescribed;

(b) such precautions as are prescribed are to be taken to guard against dangers to public health or risks of pollution arising from animal waste.

PART IV

DISPOSAL OF WASTE

Prohibition of unauthorized disposal of waste.

17. (1) Subject to subsection (2), a person shall not use, or permit to be used, any land for the disposal of waste unless he has a licence from the Director of Public Works to use the land for that purpose.

(2) Subsection (1) shall not apply to the use of land for—

(a) the disposal of household waste from a private dwelling if the disposal takes place within the curtilage of that dwelling;

(b) the disposal of waste if the land is used for tipping by the Public Works Department or such use is authorized by that Department;

(c) the deposit of any inert matter used as landfill (other than any matter to which the Dangerous Goods Ordinance applies or that is toxic); (Cap. 295.)

(d) the deposit of any substance which is being used in the course of agricultural or horticultural operations;

(e) the disposal of such other wastes, or classes of waste, or in such circumstances as may be prescribed.

(3) Any person who contravenes subsection (1) commits an offence.

(4) Where waste is disposed of on unlicensed land, as defined in the Crown Land Ordinance, pursuant to a licence issued under section 5 of that Ordinance, no licence under subsection (1) shall be required. (Cap. 28)

Notice to be given before disposal of certain wastes.

18. (1) Any person having in his possession waste of such a class or of such a quantity as may be prescribed shall, before disposing of that waste, give written notice to the Director of Public Works of the class and quantity of the waste, and shall not dispose of it except in accordance with written directions given by the Director.

(2) Any person who—

(a) disposes of waste of such a class or of such a quantity as may be prescribed without giving notice to the Director of Public Works; or

(b) having given notice to the Director, disposes of that waste otherwise than in accordance with directions given to him by the Director,

commits an offence.

Penalties for offences under sections 17 and 18 and defences.

19. (1) Any person who commits an offence under section 17 or 18 is liable—

(a) for the first offence, to a fine of $50 000;

(b) for a second or subsequent offence, to a fine of $100 000; and

(c) in addition, if the offence is a continuing offence to a fine of $500 for each day during which it is proved to the satisfaction of the court that the offence has continued.

(2) A person does not commit an offence under section 17 or 18 if he proves that the waste was disposed of in an emergency to avoid danger to the public and as soon as was reasonably practicable he informed the Director of Public Works thereof in writing.

Information as to waste delivered for disposal.

20. (1) The Director of Public Works may require any person who delivers to him for disposal any waste (other than household waste) to state the nature of the waste and to given such other information relating to the waste as the Director may require.

(2) Any person who, in complying with a requirement under subsection (1) makes any statement or gives any information which he knows to be incorrect in a material particular or who recklessly makes a statement or gives information which is incorrect in a material particular or knowingly omits any material particular therefrom commits an offence and is liable to a fine of $5 000.

Prohibition on import of waste into Hong Kong.

21. (1) Any person who, without the permission of the Director of Public Works, imports into Hong Kong any waste for the purpose of disposing of it in Hong Kong commits an offence and is liable to a fine of $50 000.

(2) Where a person is convicted of an offence under subsection (1)—

(a) the Director of Public Works may seize and dispose of the waste; or

(b) the court may order the convicted person, within a specified time, to remove the waste from Hong Kong.

(3) A person who fails to comply with an order made under subsection (2)(b) commits an offence and is liable to a fine of $50 000; and,

in the event of such failure to comply, the Director of Public Works may seize and dispose of the waste.

(4) Where the Director of Public Works seizes and disposes of waste under this section, he may recover, as a civil debt, the costs of seizure and disposal from the importer of the waste or the owner of the waste.

(5) This section shall not apply to—

(a) any waste imported into Hong Kong for the purposes of any manufacturing process;

(b) any waste imported into Hong Kong by a vessel, aircraft or train for disposal in Hong Kong if such waste is incidental to or derived from the normal operation of the vessel, aircraft or train or its equipment.

PART V

LICENCES

Applications for and grant of licences.

22. (1) A person who wishes to obtain a waste collection licence or a waste disposal licence shall apply to the appropriate licensing authority, in the prescribed form.

(2) An application under subsection (1) shall be accompanied by the prescribed fee or the fee determined by the Urban Council under section 11(3), as the case may be.

(3) The appropriate licensing authority may either grant or refuse to grant a licence.

(4) If he refuses to grant a licence, the licensing authority shall within 30 days of such refusal notify the applicant in writing of his refusal and shall inform him of his reasons therefor.

Effect of licences.

23. (1) A waste collection licence shall, subject to the terms and conditions thereof and during the period specified therein, authorize and require, in relation to any area specified therein all or any of the following—

(a) the removal and disposal of household waste, street waste, trade waste or animal waste;

(b) the cleansing and emptying of pail latrines;

(c) the desludging of aqua privies and septic tanks; and

(d) the removal and disposal of excretal matter from such latrines, privies and tanks,

which, but for such authorization, would be a contravention of section 12.

(2) A waste disposal licence shall, subject to the terms and conditions thereof and during the period specified therein, authorize the use of land for the disposal of waste, which, but for such authorization, would be a contravention of section 17.

General provisions as to licences.

24. (1) A licence issued under this Ordinance shall be for such period and may be subject to such terms and conditions as the authority issuing the same thinks fit.

(2) Any licence issued under this Ordinance may, upon its expiry, be renewed upon application and upon payment of the prescribed fee.

(3) Where a licence issued under this Ordinance is in force and the authority by whom it was issued considers it necessary in the public interest, the authority may, by notice in writing, to the holder of the licence—

(*a*) (i) impose new or amended terms or conditions subject to the observance of which, as from a specified date, the licence shall continue in force;

(ii) cancel the licence as from a specified date if the holder fails to observe any such term or condition;

(*b*) cancel the licence as from a specified date;

(*c*) revoke or amend or add to any notice previously given under this subsection, or any part of such notice.

(4) Subject to subsection (5), the date specified in a notice for the addition or amendment of any term or condition under paragraph (*a*)(i) or (*c*) of subsection (3) or the cancellation of a licence under paragraph (*b*) thereof shall be not less than 90 days after the day on which the notice is given to the holder of the licence.

(5) Where in the opinion of the authority by whom a licence is issued it is necessary to amend or add a term or condition under paragraph (*a*)(i) or (ii) or (*c*) of subsection (3) or cancel a licence or consent under paragraph (*b*) thereof because the continuation of the activities to which the licence relates would cause a danger to public health or would be so seriously detrimental to the amenities of the area affected by the activities that the continuation of them ought not to be permitted, he may exercise any of the said powers with effect from such date as the circumstances may require and shall not be bound to comply with subsection (4).

(6) Where a notice is given under subsection (4), the person to whom the notice is given may, within the period of 30 days after such notice is given, make written submissions to the authority by whom the notice was issued as to why any new or amended terms and conditions should not be imposed or as to why the licence should not be cancelled.

(7) The authority by whom a notice under subsection (4) is issued and to whom written submissions are made by any person under subsection (6) may, after considering such submissions, by further notice to the said person withdraw the notice at any time before it comes into effect.

PART VI

APPEALS

Appeal may be brought.

25. (1) A person who is aggrieved by a decision or direction of a public officer or a collection authority or waste disposal authority under any of the following provisions may appeal to the Appeal Board established under section 26—

(*a*) section 13(1) (directions as to disposal of waste);

(*b*) section 21(1) (refusing to give permission to import waste into Hong Kong);

(*c*) section 22(3) (refusing to grant a licence);

(*d*) section 24(1) (fixing terms and conditions of licence);

(*e*) section 24(3)(*a*)(i) (imposing new or amended terms or conditions for continuance of licence);

(*f*) sections 24(3)(*a*)(ii) and 24(3)(*b*) (cancelling a licence);

(g) section 24(3)(c) (revoking, amending or adding to a notice).

(2) An appeal under subsection (1) shall be made within 21 days after the person aggrieved has received notice of the decision or direction.

(3) Where the decision appealed from was made under a provision mentioned in paragraphs (e), (f) or (g) of subsection (1) the notice thereof shall be suspended from the day on which notice of appeal is given and until the appeal is disposed of, withdrawn or abandoned, unless—

(a) the decision is considered by the authority whose decision it is to be necessary because in relation to a licence to which the notice relates the continuation of the activities to which the notice relates would cause a danger to public health or be seriously detrimental to the amenities of the area affected by the activities; and

(b) the notice contains a statement to that effect.

Constitution of Appeal Board.

26. (1) Every appeal under section 25 shall be determined by an Appeal Board constituted under this Part.

(2) The Governor shall appoint as Chairman of Appeal Boards a person who is qualified in law.

(3) Subject to section 28(3), the Chairman shall be appointed for a term of 2 years but may be reappointed.

(4) The Governor shall also appoint a panel of persons whom he considers to be suitable for appointment as members of an Appeal Board pursuant to section 27(1).

(5) An appointment under subsection (2) and every appointment to the panel under subsection (4) shall be notified in the *Gazette*.

(6) In subsection (2) and in section 23(1) "qualified in law" means qualified for appointment as a District Judge under section 5 of the District Court Ordinance. (Cap. 336)

Exercise of Appeal Board's jurisdiction.

27. (1) The jurisdiction of an Appeal Board on any appeal or group of appeals shall be exercised by the Chairman and such number of persons from the panel referred to in section 26(4) as the Chairman may appoint for that appeal or group of appeals.

(2) On any appeal an Appeal Board may confirm, reverse or vary the decision or direction appealed from.

(3) Every question before an Appeal Board shall be determined by the opinion of the majority of the Chairman and the members hearing the appeal except a question of law which shall be determined by the Chairman; in the event of an equality of votes the Chairman shall have a casting vote.

(4) An Appeal Board shall not at any time consist of a majority of persons who are public officers.

(5) An Appeal Board may—

(a) receive evidence on oath;

(b) admit or take into account any statement, document, information or matter whether or not it would be admissible as evidence in a court of law; and

(c) by notice in writing summon any person to appear before it to produce any document or to give evidence.

(6) The Chairman may determine any form or matter of practice or procedure in so far as no provision is made therefor in this Ordinance.

Supplementary provisions as to Appeal Board.

28. (1) . . . Chairman is precluded by illness, absence from Hong Kong or any other cause from exercising his functions the Governor may appoint any other person qualified in law to act as Chairman and as such to exercise and perform all of the powers, functions and duties of the Chairman during the period of his appointment.

(2) If a person appointed by the Chairman under section 27(1) to hear an appeal or group of appeals is precluded by illness, absence from Hong Kong, or any other cause from exercising his functions, the Chairman may appoint any other person from the panel provided for in section 26(4) to act in his place.

(3) The Chairman may at any time resign his office by notice in writing to the Governor.

(4) The hearing of an appeal may be continued notwithstanding any change in the membership of an Appeal Board as if the change had not occurred:

Provided that no person shall be appointed as a member of an Appeal Board before which the hearing of an appeal has been commenced without the consent of the parties.

Review of Appeal Board's decision by Governor in Council.

29. (1) This section applies where—

(a) an Appeal Board has reversed or varied a decision or direction of a public officer or a collection authority or waste disposal authority; and

(b) that officer or authority considers that exceptional circumstances require the review of the Board's decision in the public interest.

(2) The public officer or authority may, where this section applies, within 14 days of being notified of a decision refer the case for review by the Governor in Council.

(3) Where a public officer or authority has referred a case for review under subsection (2), he shall forthwith notify the parties in writing of the reference, giving his reasons for seeking the review and inviting the parties, within 14 days of receiving the notice, to submit written representations concerning the review for consideration by the Governor in Council.

(4) Upon a reference under subsection (2) and upon the expiry of the period of 14 days referred to in subsection (3) the Governor in Council may review the case, considering any representations submitted under subsection (3) and may confirm, reverse or vary the decision of the Appeal Board.

...se may be ...ted.

30. (1) The Chairman may of his own motion, before an appeal is determined, refer any question of law to the Court of Appeal by way of case stated.

(2) On the hearing of the case the Court of Appeal may amend the case or order it to be sent back to the Appeal Board for amendment.

PART VII

MISCELLANEOUS

...overnor may ...e directions.

31. (1) The Governor may give such directions as he thinks fit, either generally or in any particular case, with respect to the exercise

or performance by any public officer of any powers, functions or duties under this Ordinance.

(2) A public officer shall, in the discharge of his powers, functions and duties under this Ordinance, comply with any directions given by the Governor under subsection (1).

Mental intention of offences under sections 13, 17 and 18.

32. In any proceedings for an offence under section 12, 17 or 18 it shall not be necessary for the prosecution to prove that the acts or omissions in question were accompanied by any intention, knowledge or negligence on the part of the defendant as to any element of the offence.

Protection of Crown, Urban Council, etc.

33. (1) No liability shall rest on the Crown, the Urban Council or upon any public officer by reason of the fact that any waste collection or waste disposal licence is issued under this Ordinance.

(2) A public officer shall not be personally liable in respect of any act or omission of his if it was done or made by him in the honest belief that it was required or authorized in the exercise of any power, function or duty of his under this Ordinance.

(3) The protection conferred on public officers by subsection (2) in respect of any act or omission shall not in any way affect any liability of the Crown or the Urban Council for that act or omission.

Regulations.

34. (1) The Governor in Council may after consultation with the Environmental Protection Advisory Committee and with the Urban Council in respect of matters which the Urban Council has under this Ordinance a duty to discharge or a function to fulfil by regulation provide for—

(a) the additional wastes or classes of waste to which a draft waste disposal plan under section 4 shall apply;

(b) the design and construction of containers or enclosures for the storage of animal waste;

(c) the precautions to be taken to guard against dangers to public health or risks of pollution arising from waste;

(d) the waste or classes of waste that may be disposed of under section 17 without a licence;

(e) the class or quantity of waste in respect of which notice must be given under section 18 before the waste can be disposed and any exceptions or exemptions from the requirement to give such notice;

(f) the capacity, design, construction and materials to be used in the construction of containers holding beverages or fluids;

(g) prohibiting the distribution of containers or any class of container which do or does not comply with such requirements as may be prescribed under paragraph (f), and without prejudice to the generality of the foregoing, such prohibition may be by reference to—

(i) the type of container;

(ii) the date of distribution;

(iii) place of distribution by retail sale;

(iv) the type of beverage or fluid;

(v) the source of the container;

(h) the treatment or reprocessing of such classes of waste as may be prescribed;

(i) any fees and charges payable under this Ordinance (other than any fee determined by the Urban Council under section 11(3));

(j) the charges payable to the Director of Public Works for the disposal of any waste or class of waste;

(k) prescribing anything which is to be or may be prescribed by regulations.

(2) Regulations made under this section may provide that a contravention of specified provisions thereof shall be an offence and may provide penalties therefor not exceeding a fine of $5 000 and imprisonment for 6 months.

Environmental Protection Advisory Committee.

35. If any question arises as to who are the body of persons for the time being constituting the Environmental Protection Advisory Committee mentioned in section 34 the matter shall be referred to the Chief Secretary who shall determine the question by certificate under his hand.

Codes of Practice.

36. (1) The Secretary for the Environment may, after consultation with the Waste Management Advisory Committee prepare and revise Codes of Practice giving guidance and directions as to the disposal of waste.

(2) A failure on the part of any person to observe any Code of Practice issued under subsection (1) shall not of itself render that person liable to criminal proceedings of any kind but any such failure may, in any proceedings whether civil or criminal and including proceedings for an offence under this Ordinance, be relied upon as tending to establish or to negative any liability which is in question in those proceedings.

Application of Ordinance to Crown.

37. (1) Subject to this section, this Ordinance shall bind the Crown.

(2) Sections 17, 18, 20 and 21 shall not have effect to permit proceedings to be taken against, or to impose any criminal liability on, the Crown or any person who does any act which he is required to do in the course of carrying out his duties in the service of the Crown.

(3) If it appears to the Director of Public Works that there has been a contravention of section 17, 18, 20 or 21 by any person in the course of carrying out his duties in the service of the Crown, he shall, if the contravention is not forthwith terminated to his satisfaction, report the matter to the Chief Secretary.

(4) On receipt of a report under subsection (3) the Chief Secretary shall enquire into the circumstances and, if his enquiry shows that a contravention of section 17, 18, 20 or 21 is continuing or likely to recur, he shall ensure that the best practicable steps are taken to terminate the contravention or avoid the recurrence.

(5) Any notice or application under this Ordinance concerning a deposit or disposal of waste which is to be, or may be, given or made by or on behalf of the Crown may be given or made by any public officer on behalf of the Crown.

(6) Any notice or application under this Ordinance concerning a deposit or discharge of waste which is to be, or may be, given to the Crown shall be given to the principal officer of the appropriate waste disposal authority which appears to be responsible for the deposit or disposal or, in the event of any question arising as to which waste disposal authority is responsible, to such public officer as the Chief Secretary shall determine.

(7) No fee or charge prescribed for the purposes of this Ordinance shall be payable by the Crown.

38. The enactments specified in the first column of the Schedule are amended in the manner and to the extent specified in the second column of the Schedule. Consequential amendments. Schedule.

39. Any licence or contract issued under section 16 of the Public Health and Urban Services Ordinance and in force at the commencement of this Ordinance shall continue in force and have effect as if it were a waste collection licence issued under this Ordinance. Transitional provisions. (Cap. 132.)

SCHEDULE [s. 38.]

CONSEQUENTIAL AMENDMENTS

Public Health and Urban Services Ordinance. (Cap. 132.)

1. Section 2 is amended—

(a) by being re-numbered subsection (1) thereof;

(b) in subsection (1)—

(i) by deleting the definition of "house refuse" and substituting the following—

"household waste" means waste produced by a household and of a kind ordinarily produced by a dwelling when occupied as such;";

(ii) in the definition of "street refuse" by deleting "refuse" and substituting the following—

"waste";

(iii) by deleting the definition of "trade refuse" and substituting the following—

"trade waste" means waste from any trade, manufacture or business, or any waste building or civil engineering materials;";

(iv) by inserting after the definition of "washhouse" the following—

"waste" means any substance or article which is abandoned;"; and

(c) by inserting after subsection (1) the following—

"(2) For the purposes of this Ordinance any substance or article which is discarded or otherwise dealt with as waste shall be presumed to be waste until the contrary is proved.".

2. Section 6(1) is amended—

(a) in paragraphs (a), (b) and (c) by deleting "refuse" wherever it occurs and substituting in each place the following—

"waste"; and

(b) in paragraph (d) by deleting "manufacturing, trade or other refuse" and substituting the following—

"trade waste".

3. Section 7(1) is amended by deleting "refuse" and substituting the following—

"waste".

4. Section 15 is amended—

(a) In subsection (1)—

(i) in paragraphs (a), (d) and (j) by deleting "refuse" and substituting the following—

"waste";

(ii) in paragraph (f)—

(A) by deleting "street refuse" and substituting the following—

"street waste"; and

(B) by deleting "house refuse" in both places where it occurs and substituting in each place the following—

"household waste";

(iii) by deleting paragraph (g) and substituting the following—

"(g) the provision, design and construction of containers for the collection and storage of household waste;"; and

(b) by deleting subsection (2).

5. Sections 16, 17, 18, 19 and 21 are repealed.

6. Sections 20, 22A, 23 and 56(2)(b) and (c) are amended by deleting "refuse" wherever it occurs and substituting in each place the following—

"waste".

7. Section 77(1)(i) is amended by deleting "waste matters, refuse" and substituting the following—

"waste".

8. The Third Schedule is amended by deleting the following—

"16	Urban Council	Director of Urban Services
17	Urban Council	Director of Urban Services
18	Urban Council	Director of Urban Services
19(1) and (2)	Urban Council	Director of Urban Services
21(2)	Urban Council	Director of Urban Services".

9. The Sixth Schedule is amended by deleting the following—

"17	Urban Council	Director of Urban Services
21(2)	Urban Council	Director of Urban Services".

10. The Ninth Schedule is amended by deleting the following—

"17	$1 000 fine	—
21(2)	$1 000 fine	$20 fine".

Public Cleansing and Prevention of Nuisances By-laws.

1. By-law 3 is amended— (Cap. 132, sub. leg.)

(a) by deleting the definition of "dangerous refuse" and substituting the following—

"dangerous waste" means any waste of a kind specified in the Second Schedule;";

(b) by deleting the definition of "refuse collecting point";

(c) by deleting the full stop at the end of the definition of "street" and substituting a semicolon; and

(d) by inserting after the definition of "street" the following—

"waste collection point" means any place at which the Council, or any licencee of the Council, provides services for the removal of waste for disposal.".

2. By-law 11 is amended by deleting "refuse" in both places where it occurs and substituting in each place the following—

"waste".

3. By-law 15 is amended—

(a) by deleting "refuse" in the first place where it occurs and substituting the following—

"waste"; and

(b) by deleting "house refuse" and substituting the following—

"household waste".

4. The heading to Part III is amended by deleting "HOUSE REFUSE" and substituting the following—

"HOUSEHOLD WASTE".

5. By-laws 16, 17, 18, 19 and 20 are amended—

(a) by deleting "refuse" wherever it occurs and substituting in each place the following—

"waste"; and

(b) by deleting "house refuse" wherever it occurs and substituting in each place the following—

"household waste".

6. Part IV is amended by deleting the heading and substituting the following—

"DANGEROUS WASTE AND TRADE WASTE".

7. By-law 21 is amended—

(a) by deleting "refuse" wherever it occurs and substituting in each place the following—

"waste";

(b) by deleting "house refuse" and substituting the following—

"household waste".

8. By-law 22 is amended by deleting "refuse" wherever it occurs and substituting in each place the following—

"waste".

9. By-law 24 is amended—

(a) by deleting "refuse" in the first place where it occurs and substituting the following—

"waste"; and

(b) by deleting "refuse collecting point" and substituting the following—

"waste collection point".

10. By-law 26(1) is amended by deleting "refuse" and substituting the following—

"waste".

11. The heading to the Second Schedule is amended by deleting "REFUSE" and substituting the following—

"WASTE".

Cap 132, sub. leg.) Public Cleansing and Prevention of Nuisances (New Territories) Regulations.

1. Regulation 3 is amended—

(a) by deleting the definition of "dangerous refuse" and substituting the following—

"'dangerous waste' means any waste of a kind specified in the Second Schedule;";

(b) by deleting the definition of "refuse collecting point";

(c) by deleting the full stop at the end of the definition of "street" and substituting a semicolon; and

(d) by inserting after the definition of "street" the following—

"'waste collection point' means any place at which the Director, or any licensee of the Director, provides services for the removal of waste for disposal.";

2. Regulation 11 is amended by deleting "refuse" in both places where it occurs and substituting in each place the following—

"waste".

3. Regulation 15 is amended—

(a) by deleting "refuse" in the first place where it occurs and substituting the following—

"waste"; and

(b) by deleting "house refuse" and substituting the following—

"household waste".

4. The heading to Part III is amended by deleting "House Refuse" and substituting the following—

"Household Waste".

5. Regulations 16, 17, 18, 19 and 20 are amended—

(a) by deleting "refuse" wherever it occurs and substituting in each place the following—

"waste"; and

(b) by deleting "house refuse" wherever it occurs and substituting in each place the following—

"household waste".

6. Part IV is amended by deleting the heading and substituting the following—

"DANGEROUS WASTE AND TRADE WASTE".

7. Regulation 21 is amended—

(a) by deleting "refuse" wherever it occurs and substituting in each place the following—

"waste";

(b) by deleting "house refuse" and substituting the following—

"household waste".

8. Regulation 22 is amended by deleting "refuse" wherever it occurs and substituting in each place the following—

"waste".

9. Regulation 24 is amended—

(a) by deleting "refuse" and substituting the following—

"waste"; and

(b) by deleting "refuse collecting point" and substituting the following—

"waste collection point".

10. Regulation 26(1) is amended by deleting "refuse" and substituting the following—

"waste".

11. The heading to the Second Schedule is amended by deleting "REFUSE" and substituting the following—

"WASTE".

Explanatory Memorandum

The Bill makes improved provision for the collection of waste and introduces new provisions relating to the disposal of waste. It will also require the formulation of comprehensive plans for the whole of Hong Kong for the disposal of waste.

2. Part I of the Bill contains interpretation provisions. "Waste" is defined to mean any substance or article which is abandoned. If any substance or article is discarded or is dealt with as waste then it is presumed to be waste until the contrary is proved.

3. Part II of the Bill deals with the preparation of a waste disposal plan. Clause 3 establishes a Waste Management Advisory Committee,

which will advise the Secretary for the Environment on the preparation of the plan, any revision thereof and generally on the control of waste. Clauses 4 to 8 are concerned with the preparation of draft waste disposal plans, representations concerning draft plans, the submission of a draft plan to the Governor in Council for approval, the powers of the Governor in Council on the submission of a draft plan and the revision of any waste disposal plan. Clause 9 requires the collection authorities and the waste disposal authorities to have regard to the waste disposal plan in discharging their statutory duties and functions.

4. Part III of the Bill contains provisions relating to the collection of waste. Clauses 10 to 15 deal with the provision by the collection authorities of collection and scavenging services, the licensing of persons to perform such services, the removal of household waste, the prohibition of unauthorized collection of waste, the collection of trade waste and the ownership of collected waste. These clauses replace sections 16 to 19 of the Public Health and Urban Services Ordinance. Clause 16 empowers the Governor to require provision to be made for the storage of animal waste and precautions to be taken to guard against dangers to public health or risks of pollution arising from animal waste.

5. Part IV of the Bill makes new provision for the disposal of waste. Clause 17 prohibits the use of land for the disposal of waste without the licence of the Director of Public Works. Certain land uses are excluded from the prohibition including the disposal of waste on a controlled tip or for landfill or where the disposal is in the course of agricultural or horticultural operations. Clause 13 requires that the permission of the Director of Public Works be obtained before the disposal of certain prescribed classes of waste. Clause 19 contains penalties for offences under clauses 17 and 18. A first offence will be liable to a fine of $50 000, while a fine of $100 000 can be imposed for a second or subsequent offence. Where the offence continues, a daily penalty of $500 may be imposed. Clause 20 empowers the Director of Public Works to obtain information as to the nature of any waste (other than household waste) delivered to him for disposal. Clause 21 prohibits the import of waste into Hong Kong without the permission of the Director of Public Works.

6. Part V of the Bill provides the licensing systems by which the relevant authorities will regulate licensed waste collection services and the disposal of waste. Provision is made for the application for waste collection and waste disposal licences, the effect of such licences and their issue, variation and cancellation. Provision is also made for the duration of licences and the attaching of conditions to them.

7. Part VI of the Bill establishes machinery for appeals against decisions made under certain provisions of the Bill. An appeal will be heard by an Appeal Board, which will consist of a legally qualified chairman and members selected from a panel of suitable persons appointed by the Governor. A decision of the Appeal Board may, in exceptional circumstances, be reviewed by the Governor in Council. The chairman may also refer a point of law to the Court of Appeal for determination.

8. Part VII of the Bill contains miscellaneous provisions. Clause 32 makes clear that offences under clauses 12, 17 and 18 are absolute offences. Clause 34 empowers the Governor in Council to make regulations, after consultation with the Environmental Protection Advisory Committee and the Urban Council. Clause 36 empowers the Secretary for the Environment to prepare and revise Codes of Practice giving guidance and directions as to the disposal of waste. Clause 39 contains transitional provisions in respect of any licence or contract issued under section 16 of the Public Health and Urban Services Ordinance and in force at the commencement of the Ordinance. The Schedule contains a

number of consequential amendments to the Public Health and Urban Services Ordinance, the Public Cleansing and Prevention of Nuisances By-laws and the Public Cleansing and Prevention of Nuisances (New Territories) Regulations.

9. It is estimated that the enforcement of this Bill, if enacted, will require additional staff costing approximately $0.31 million in the first year of operation and rising to $1.5 million in 5 years time.

一九七九年廢物處理法案

摘要說明

本法案旨在[illegible]現行有關廢物收集之規定，並在廢物處理方面[illegible]規定。此外，本法案又規定[illegible]之全盤計劃。

二、法案第一部載有釋義條款。「廢物」一詞之定義指[illegible]之物質或物件。凡[illegible]作廢物處理之物質或物件，除能證明其並非廢物外，[illegible]。

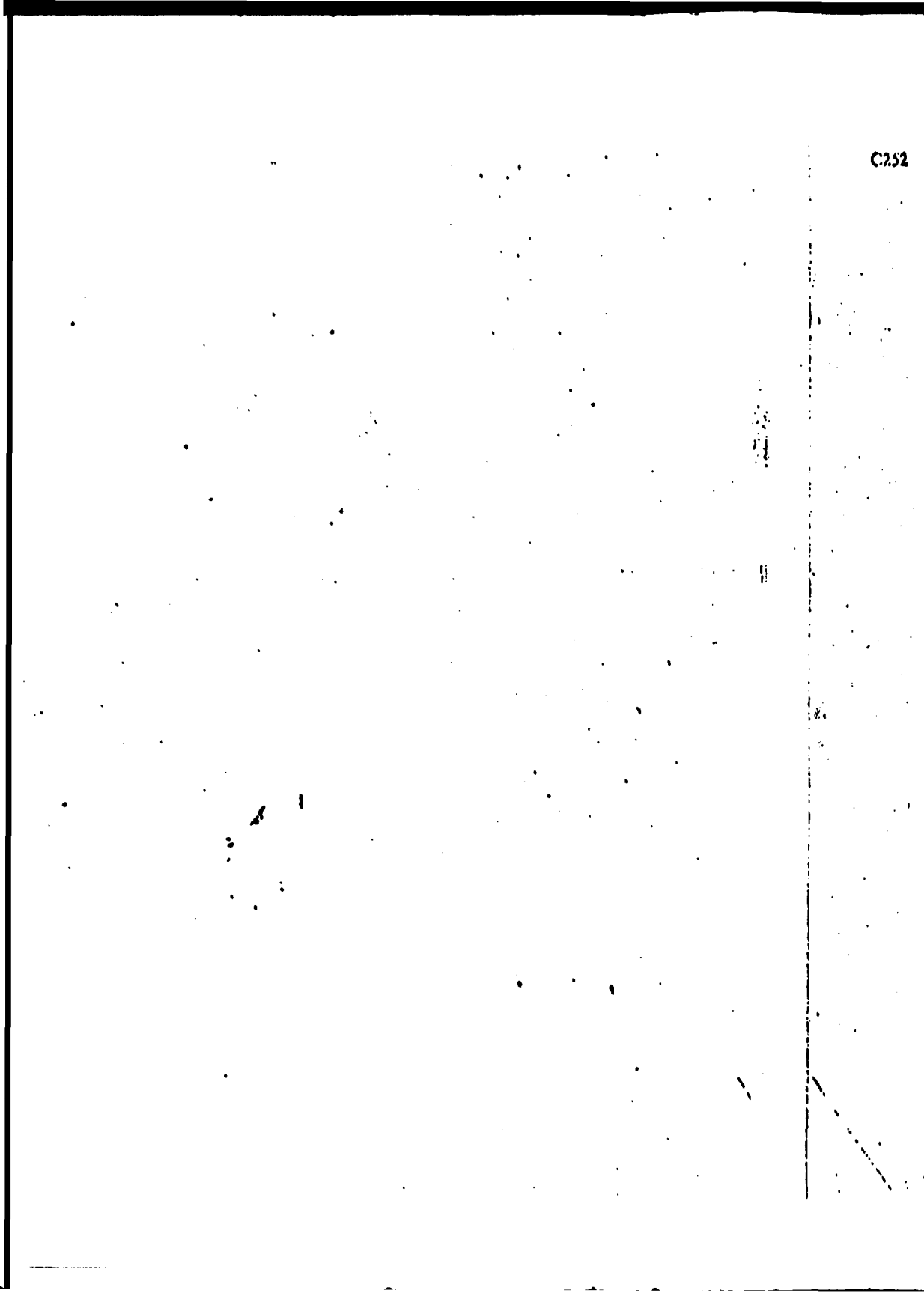
三、法案第二部[illegible]廢物處理計劃之[illegible]。[illegible]

四、法案第三部[illegible]有關廢物收集之規定。[illegible]

五、[illegible]

六、[illegible]

七、[illegible]



八、 該草案第七條之目的是規定。法案第三十二條到第規定法案第十二、第十七及第十八條所規定罰名乃不管是罰之罰者。該案第三十四條授權管理會同行政局可在其認為需要時委任委員及市政局之意見後制訂規例。法案第三十六條授權規定規則及指導工作守則，對其他處理工作者予指引及指示。該草案第三十九條為有關改性條文，以使目的是公眾衛生及市政事務執行第十六條最成效計而作出其他適當規例生效時仍然有效之情況成為可，加以規定。該草案之目的是有對公眾衛生及市政事務條例、公眾衛生及防止滋擾而作附例，及公眾衛生及防止滋擾（新界）規例所作之若干相應修訂。

九、 本法案通過後，預料在執行上須增聘額外人手，首年之經費約需八十一萬元，五年後將增至一百五十萬元。

Appendix C

Guidelines 2

Relevant points to be noted

1. Proposed guidelines for discharges to streams do not apply to streams within the Waterworks catchment areas.

2. The proposed effluent guidelines apply to <u>new discharges</u> only.

3. Guidelines for temporary discharges of duration not expected to exceed one year may be suitably relaxed if considered justified. It is suggested that, as these cases are likely to be rare, such guidelines are to be determined by P.W.D., in consultation with A.F.D. and other concerned departments if necessary.

4. The guidelines cover most of the parameters normally encountered but are not exhaustive. Should limits of other parameters be required in future, it is proposed that they are to be fixed by P.W.D., in consultation with A.F.D. and other concerned departments if necessary.

Proposed effluent guidelines for coastal waters

Parameters	C.A. guidelines (See notes (1))	C. B. guidelines (See notes (1))	Remark
pH	6 - 10	6 - 10	
Temperature	⩾45°C & ⩾2°C in excess of ambient temperature outside 50 m from point of discharge.	as for C.A.	
Colour	Not objectionable	Not objectionable	
Suspended solids	⩾30 mg/l	⩾500 mg/l & ⩾30 mg/l in excess of receiving water when the effluent comes to the sea surface.(see notes 2(ii))	
B.O.D. 5	⩾20 mg/l (See Notes 2(i) & Notes 3)	⩾500 mg/l & ⩾20 mg/l in excess of receiving water when the effluent comes to the sea surface. (see notes 2(ii))	
C.O.D. Cr.	⩾80 mg/l	⩾1000 mg/l	
Grease & oil (Hexane extractables)	⩾20 mg/l	⩾50 mg/l	
Toxic metals (Non-ferrous)			
Cadmium	⩾0.1 mg/l	⩾0.1 mg/l	
Mercury	⩾0.1 mg/l	⩾0.1 mg/l	
Any other metal individually	⩾2 mg/l	⩾5 mg/l	
Total	⩾5 mg/l	⩾10 mg/l	
Iron	⩾10 mg/l	⩾20 mg/l	
Cyanide (include compounds producing HCN on acidification)	⩾0.1 mg/l	⩾1 mg/l	
Sulphide (S)	⩾10 mg/l	⩾10 mg/l	
Phenol	⩾0.5 mg/l	⩾0.5 mg/l	
Detergents	⩾15 mg/l	⩾30 mg/l	
Chlorine (Total residual chlorine)	⩾1 mg/l	⩾1 mg/l	
Total nitrogen (N)	⩾100 mg/l	⩾100 mg/l	
Total phosphate (P)	⩾10 mg/l	⩾10 mg/l	

(Con't)

Proposed effluent guidelines for coastal waters

Parameters	C.A. guidelines (See notes (1))	C. B. guidelines (See notes (1))	Remarks
Bacteria count Total coliform Faecal coliform	$\geq 10^4$/100 ml) see $\geq$ 5000/100 ml) notes 2(i)	No requirement	Guidelines only applies to discharge within 3 km of beaches desalter intakes where the discharge will return in less than 3 hours.

Prohibited Substances : Floatable substances, solids > 10 mm Biocides, pesticides, radio-active substances, sludge, refuse, calcium carbide, petroleum oil or tar, organic solvents, wastes liable to cause scums, deposits or discolouration.

Notes :

(1) (i) C.A. guidelines shall apply to the followings:-

(a) Discharges of average daily volume $\geq 100\ m^3$ discharged into any of the areas of the sea marked CWA on Drawing No. ED 873 B (Hereinafter referred to as the Drawing).

(b) Discharges of average daily volume $\geq 100\ m^3$ discharged at a point between 1 and 3 km from any beach or any existing or proposed desalter intakes as shown on the Drawing.

(c) All discharges within 1 km from any beach or any existing or proposed desalter intakes shown on the Drawing.

(ii) C.B. guidelines shall apply to all discharges other than (a), (b) & (c) above.

Notwithstanding the above, no discharge of sewage or trade effluent will be allowed within 100 m from any beach and 500 m from any desalter intake shown on the Drawing.

For easy reference, see Table 1 below :

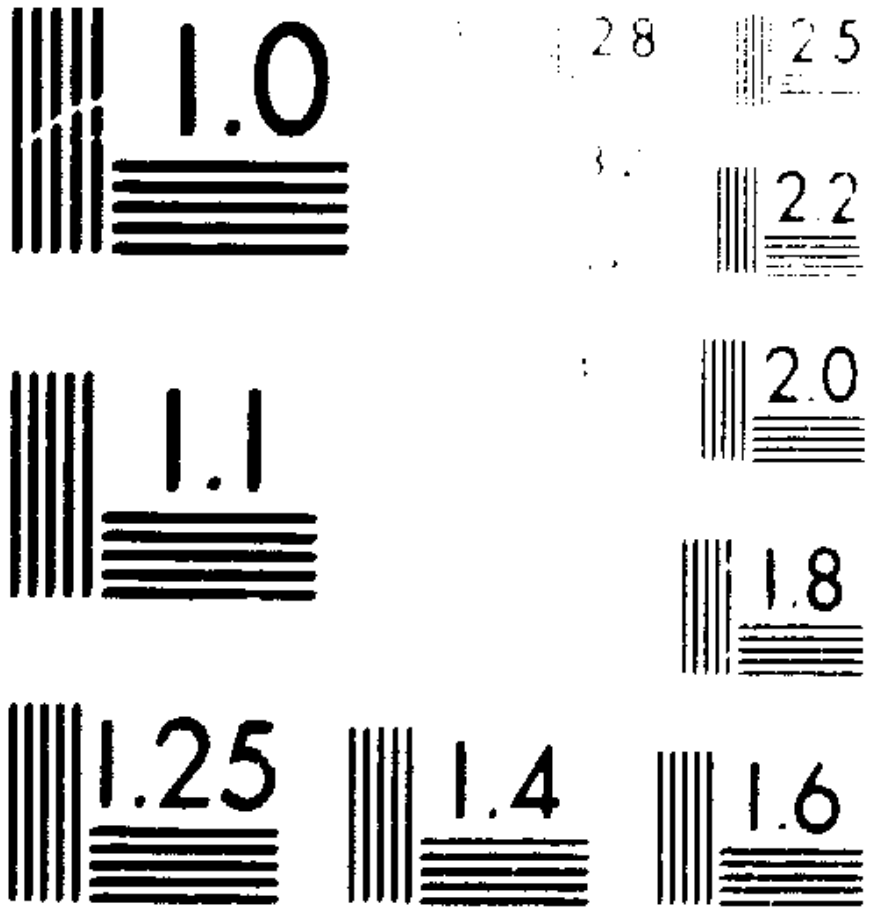
/Table 1.....

Table 1

	(1)	(2)	(3)	(4)	(5)	(6)
Type of receiving waters	CWA waters			CWB waters		
Distance of discharge point from beach/Desalter Intake	>3km	Between 1 & 3 km	<1km	>3 km	Between 1 & 3 km	<1 km
(a) Av. Daily discharge ⩾ 100 m^3	CA	CA	CA	CB	CA	CA
(b) Av. Daily discharge < 100 m^3	CB	CB	CA	CB	CB	CA

2 (i) For municipal/domestic sewage discharged into CWB waters under conditions where CA guidelines apply, i.e. cases 5(a), 6(a) & 6(b) in Table 1, the B.O.D./S.S./bacteria count limits will be waived if any one of the following treatment and disposal arrangements is provided:-

	Treatment provided	Disposal facilities provided
(a)	screening to remove all solids > 10 mm	With submarine outfall giving an initial dilution ⩽ 85 times at a location that will give ⩽ 3 hours delay and ⩾ 500 times dilution before the sewage field reaches any beach or desalter intake. If a 3 hours delay cannot be provided, the bacteria count limits shall apply to the treated effluent.
(b)	Primary sedimentation with a retention time ⩽ one hour at peak flow	With submarine outfall giving an initial dilution ⩽ 50 times at a location that will give ⩽ 3 hours delay and ⩽ 350 times dilution before the sewage field reaches any beach or desalter intake. If the 3 hours delay cannot be provided the bacteria count limits shall apply to the treated effluent.
(c)	Secondary treatment, treating sewage to an effluent standard of 30/20 mg/l (S.S./B.O.D.)	Discharged at a location giving at least 3 hours delay before the sewage field reaches any beach or desalter intake. If the 3 hrs delay cannot be provided, the bacteria count limits shall apply to the treated effluent.


1.0
2.8
2.5
2.2
1.1
2.0
1.8
1.25
1.4
1.6

(ii) For municipal/domestic sewage discharged into C#A and C#B waters under conditions where C3 guidelines apply, i.e. cases 1(b), 2(b), 4(a), 4(b) and 5(b) in Table 1, notwithstanding the B.O.D./S.S. limits given, one of the following treatment and disposal arrangements or equivalent is to be provided:-

	Treatment provided	Disposal facilities provided
(a)	screening to remove all solids > 10 mm	With submarine outfall giving an initial dilution $\geq$ 85.
(b)	primary sedimentation with a retention time $\geq$ 1 hour at peak flow	With submarine outfall giving an initial dilution $\geq$ 50.
(c)	secondary treatment treating sewage to an effluent standard of 30/20 mg/l (S.S./ B.O.D.)	

(3) For trade effluents discharged within 5 km of any beach or any existing or proposed desalter intake but outside C#A waters as shown on the Drawing, the B.O.D./S.S./C.O.D. limits can be relaxed up to 500/500/1000 mg/l if the effluent is discharged in such a way as not to raise the background B.O.D./S.S. level by more than 3 mg/l when it comes up to the sea surface.

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Proposed effluent guidelines for streams

Parameters	SA guidelines (See notes)	SB guidelines (See notes)	Remarks
pH	6.5 - 9	6 - 10	
Temperature	≯ 2°C rise over ambient	≯ 2°C rise over ambient	
Colour	≯ 100 Hazen units	Not objectionable	
Suspended solids	≯ 30 mg/l	≯ 50 mg/l	
B.O.D. 5	≯ 20 mg/l	≯ 50 mg/l	
C.O.D. Cr	≯ 80 mg/l	≯ 200 mg/l	
Grease & oil (Hexane extractables)	≯ 2 mg/l	≯ 5 mg/l	
Heavy metals			
Cr	≯ 0.1 mg/l	)	
Cu	≯ 0.5 mg/l	)	
Pb	≯ 0.1 mg/l	)	
Ni	≯ 0.5 mg/l	) ≯ 0.5 mg/l	
Ag	≯ 0.1 mg/l	)	
Zn	≯ 0.5 mg/l	)	
Mn	≯ 0.5 mg/l	)	
As	≯ 0.1 mg/l	)	
Cd	≯ 0.02 mg/l	) ≯ 0.1 mg/l	
Hg	≯ 0.002 mg/l	)	
Total of above metals	-	≯ 1 mg/l	
Fe	≯ 2 mg/l	≯ 5 mg/l	
Ba	≯ 2 mg/l	-	
Mg	≯ 300 mg/l	-	
Cyanide (include compounds producing HCN on acidification)	≯ 0.1 mg/l	≯ 0.1 mg/l	
Sulphide (S)	≯ 0.1 mg/l	≯ 1 mg/l	
Sulphate (SO_4)	≯ 800 mg/l	- (200 mg/l)	
Phenols	≯ 0.004 mg/l	≯ 0.5 mg/l	
Total dissolved solids	≯ 3000 mg/l	- (700 mg/l)	
Hardness (as $CaCO_3$)	≯ 1000 mg/l	-	
Detergents	≯ 2 mg/l	≯ 15 mg/l	
Chlorine (Total residual Chlorine	≯ 1 mg/l	≯ 1 mg/l	

/Chloride.....

-- (Con't)

Parameters	SA guidelines (See notes)	SB guidelines (See notes)	Remarks
Chloride	1200 mg/l	-	
Flouride (F)	3 mg/l	-	
Ammonia (N)	0.1 mg/l	10 mg/l	
Oxidised nitrogen (N)	20 mg/l	-	
Bacteria count Total Coliform	100/100 ml	-	
Prohibited substances	PAH, PCB, biocides, radio-active substances, refuse, sludge, calcium carbide, Petroleum oil or tar, organic solvents, wastes liable to form scum, deposits or discolouration	Biocides, radio-active substances, refuse, sludge, calcium carbide, petroleum oil or tar, organic solvents, wastes liable to cause scum, deposits or discolouration	

Notes :-

(1) The above guidelines do not apply to streams within Waterworks Catchment Areas.

(2) SA guidelines shall apply to all discharges into streams where, downstream of the discharge, the stream water is extracted for potable purposes after boiling/chlorination, either directly or through nearby shallow wells.

SB guideline shall apply to all discharges into streams other than those to which SA guidelines apply except that, for discharges into streams where the water is used for irrigation, the pH value should lie between 6 and 8, and the total dissolved solids and sulphate contents should not exceed 700 mg/l and 200 mg/l respectively.

Proposed effluent guidelines for discharges into sewers

Parameters	Discharges ≥100 m^3/d (av.)	Discharges < 100 m^3/d (av.)	Exception: Tai Po Industrial Estate Stage I	Remarks
pH	6 - 10	6 - 10	6 - 9	
Temperature	≯ 43°C	≯ 43°C	≯ 43°C	
Colour	Not excessive	Not excessive	Not excessive	
Suspended solids	≯1000 mg/l	≯ 2000 mg/l	≯300 mg/l	
B.O.D. 5.	≯ 1000 mg/l	≯ 2000 mg/l	≯ 300 mg/l	
C.O.D.	≯ 2000 mg/l	≯ 4000 mg/l	≯ 1200 mg/l	
Grease and Oil	≯ 50 mg/l	≯ 100 mg/l	≯50 mg/l	
Toxic metals (non-ferrous)				
Cadmium	≯ 1 mg/l	≯ 1 mg/l	≯0.2 mg/l	
Mercury	≯ 1 mg/l	≯ 1 mg/l	≯0.2 mg/l	
Total	≯ 10 mg/l	≯ 20 mg/l	≯2 mg/l	
Any one	≯ 5 mg/l	≯ 10 mg/l	≯1 mg/l	
Iron	≯ 50 mg/l	≯ 50 mg/l	≯5 mg/l	
Cyanide	≯10 mg/l	≯10 mg/l	≯3 mg/l	
Sulphide (S)	≯ 10 mg/l	≯10 mg/l	≯5 mg/l	
Sulphate (SO_4)	≯ 1000 mg/l	≯1000 mg/l	≯1000 mg/l	
Phenol	≯10 mg/l	≯20 mg/l	≯10 mg/l	
Detergents	≯50 mg/l	≯50 mg/l	≯30 mg/l	

Prohibited Substances: biocides, radio-active substances, uncontaminated water, chlorinated hydrocarbon, organic solvents, petroleum oil or tar, calcium carbide, sludge, wastes liable to form scum, deposits in any part of the public sewer, any substance of a nature and quantity likely to injure the sewer or to interfere with the free flow of its content or to injure any sewage treatment works or any worker or equipment or to interfere with any of the treatment processes.

Tolo Water Control Zone

Water Quality Objectives

1. Introduction

The implementation of a Water Control Zone under the Water Pollution Control Ordinance 1980 requires under Section 5 the setting of Water Quality Objectives which form the basis for water quality management within the control zone. This paper proposes the beneficial uses of the waters of the Tolo Water Control Zone (defined in Appendix 1) that should be protected and the Water Quality Objectives which need to be attained to safeguard these beneficial uses. Also discussed are the implications for dischargers.

Notes appended to the paper compare the present and expected water quality in relation to the proposed objective parameters.

2. Beneficial Uses

It is proposed that the following beneficial uses shall be protected for the three subzones of the Tolo Water Control Zone as follows:-

(a) Tolo Harbour Subzone

(i) Maintenance and preservation of natural aquatic ecosystems and wildlife.

(ii) Maintenance and preservation of foreshores, littoral zones and their vegetation.

(iii) Aesthetic enjoyment.

(iv) Boating, fishing and other secondary contact recreation.

(v) Navigation and shipping.

(vi) Industrial and domestic (flushing) water supply.

(b) Tolo Buffer Subzone

As for Tolo Harbour Subzone and in addition:-

(vii) Production of fish, crustaceans and shellfish for human consumption.

(viii) Bathing, diving and other primary contact recreation.

(c) Tolo Channel Subzone

As for Tolo Buffer Subzone and in addition:-

(ix) Maintenance of supply of flushing dilution water for inner subzones.

3. Water Quality Objectives

In order to protect the above beneficial uses it is necessary that the water in the area concerned meets certain minimum quality requirements. These are expressed as Water Quality Objectives (WQOs). The aspects of water quality that are most important in relation to safeguarding particular beneficial uses are set out in Table 1.

The Water Quality Objectives needed to safeguard the beneficial uses identified for the three subzones of the Tolo Water Control Zone are set out in an accompanying paper entitled "Water Pollution Control Ordinance (Chapter 358): Tolo Harbour and Channel Water Control Zone: Statement of Water Quality Objectives".

4. Comparison of Proposed Water Quality Objectives and Present Water Quality

A comparison of present water quality and the proposed Objectives is set out in Table 2. Also, the third column of Table 1 shows the present status of water quality in the Tolo WCZ in relation to the beneficial uses that it is proposed should be protected. From Table 2 it may be noted that chlorophyll-a and dissolved oxygen are the main water quality parameters whose present values fail to meet the proposed WQOs in parts of the Tolo WCZ. The significance of the present non-compliance with these objectives is discussed further in Section 6.

Appendix E

will be gazetted June 15'

WATER POLLUTION CONTROL ORDINANCE

(Chapter 358)

TOLO HARBOUR AND CHANNEL WATER CONTROL ZONE
STATEMENT OF WATER QUALITY OBJECTIVES

Made under section 5 after consultation
with the Environmental Protection Advisory Committee

The water quality objectives set out in the first column of the First Schedule have been established for the subzones defined in the Second Schedule set opposite such water quality objectives in the second column of the First Schedule.

FIRST SCHEDULE

WATER QUALITY OBJECTIVE	SUBZONE
A. AESTHETIC APPEARANCE	
(i) Odours, taints and colours	
Waste discharges shall cause no noxious or offensive odour or offensive taint or colour in either waters or edible aquatic organisms in the subzone to be present in concentrations detectable by bioassay or organoleptic tests.	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.
(ii) Visible matter	
Waste discharges shall cause no visible foam, oil, grease, scum, litter or other objectionable matter in waters of the subzone.	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.

WATER QUALITY OBJECTIVE	SUBZONE
B. BACTERIA	
Waste discharges shall not cause the level of Escherichia coli to exceed 1000 per 100 ml in waters of the subzone, levels to be calculated as a running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.
C. CHLOROPHYLL-A	
Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 20 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Harbour subzone.
Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 10 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Buffer subzone.
Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 6 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Channel subzone.
D. DISSOLVED OXYGEN	
Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 2 milligrams per litre within two metres of the bottom, or to be less than 4 milligrams per litre in the remainder of the water column.	Harbour subzone.

WATER QUALITY OBJECTIVE	SUBZONE
Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 3 milligrams per litre within two metres of the bottom, or to be less than 4 milligrams per litre in the remainder of the water column.	Buffer subzone.
Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 4 milligrams per litre at any point in the water column.	Channel subzone.

E. LIGHT PENETRATION

No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 20 per cent of the normal level in the subzone at any location or any time.	Harbour subzone.
No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 15 per cent of the normal level in the subzone at any location or any time.	Buffer subzone.
No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 10 per cent of the normal level in the subzone at any location or any time.	Channel subzone.

F. pH

Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than $\pm$ 0.5 pH units at any time.	Harbour subzone.

WATER QUALITY OBJECTIVE	SUBZONE
Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than ± 0.3 pH units at any time.	Buffer subzone.
Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than ± 0.1 pH units at any time.	Channel subzone.

G. SALINITY

Waste discharges shall not cause the normal salinity range of any waters of the subzone to be extended by greater than ± 3 parts per thousand at any time.	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.

H. SETTLEABLE MATERIAL

Waste discharges shall give rise to no bottom deposits or submerged objects which adversely influence bottom-living communities, alter the basic Harbour geometry or shipping channels, present any hazard to shipping or diving activities, or affect any other ~~declared~~ beneficial use of the waters of the subzone.	(i) Harbour subzone (ii) Buffer subzone. (iii) Channel subzone.

I. TEMPERATURE

Waste discharges shall not cause the natural daily temperature range in waters of the subzone to be extended by greater than ± 1.0 degree Celsius at any location or time. The rate of temperature change shall not exceed 0.5 degrees Celsius per hour at any location, unless due to natural phenomena.	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.

WATER QUALITY OBJECTIVE	SUBZONE
J. TOXICANTS	
Waste discharges shall not cause the toxicants in waters of the subzone to attain such a level as to produce significant toxic effects in humans, fish or any other aquatic organism, with due regard to biologically cumulative effects in food chains and to toxicant inter-actions with each other.	(i) Harbour subzone. (ii) Buffer subzone. (iii) Channel subzone.

SECOND SCHEDULE

In this statement -

"Harbour subzone" means all that water bound by the spring high-water mark of the contiguous south-western land mass and by lines between the southern tip of Yim Tin Tsai (22°26'55"N, 114°12'49"E) and the northern tip of Centre Island (22°26'34"N, 114°13'11"E) and between the northern tip of Centre Island and the western tip of Wu Kai Sha Tsui (22°26'20"N, 114°14'02"E) and more particularly referred to and recorded in the Register;

"Buffer subzone" means all that water bounded by the limits of the Tolo Harbour Zone to the south-west, by the spring

high-water marks on the northern and southern coasts, and by a line between the northwest tip of Three Fathoms Cove (22°26'09"N, 114°15'56"E) and the opposite (northern) coast, passing directly through the northern tip of Bush Reef (22°26'56"N, 114°15'18"E) and joining the northern coast at Pak Sha Tau Chau (Harbour Island) at 22°27'19"N, 114°15'01"E, and more particularly referred to and recorded in the Register;

"Channel subzone" means all that water bounded by the limits of the Tolo Buffer Zone to the southwest, by the spring high-water marks on the northern and southern coasts, and by a line joining the eastern tip of Bluff Head (22°30'34"N, 114°20'02"E) and the northern tip of Ocean Point (22°28'50"N, 114°20'20"E) and more particularly referred to and recorded in the Register.

Made the day of 1982.

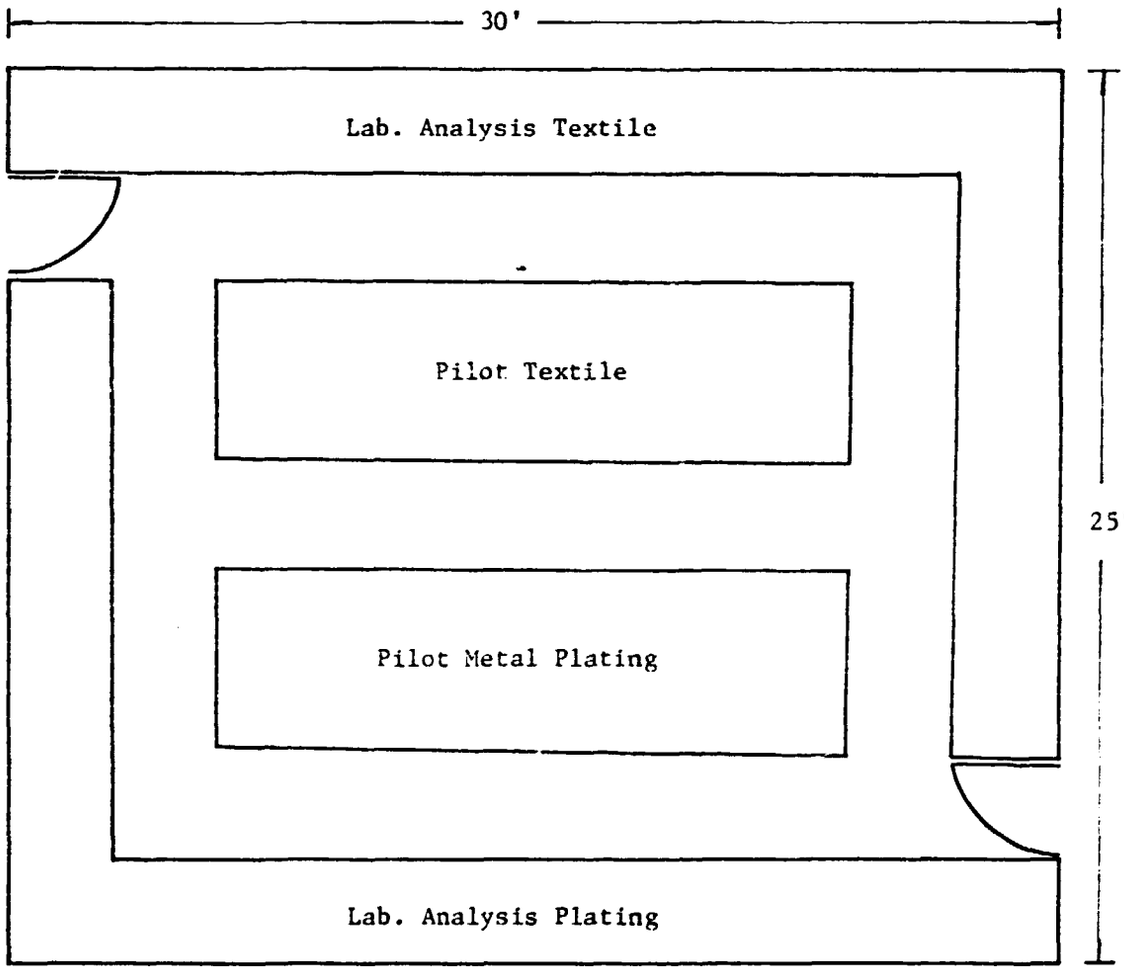
Secretary for Home Affairs.

Explanatory Note

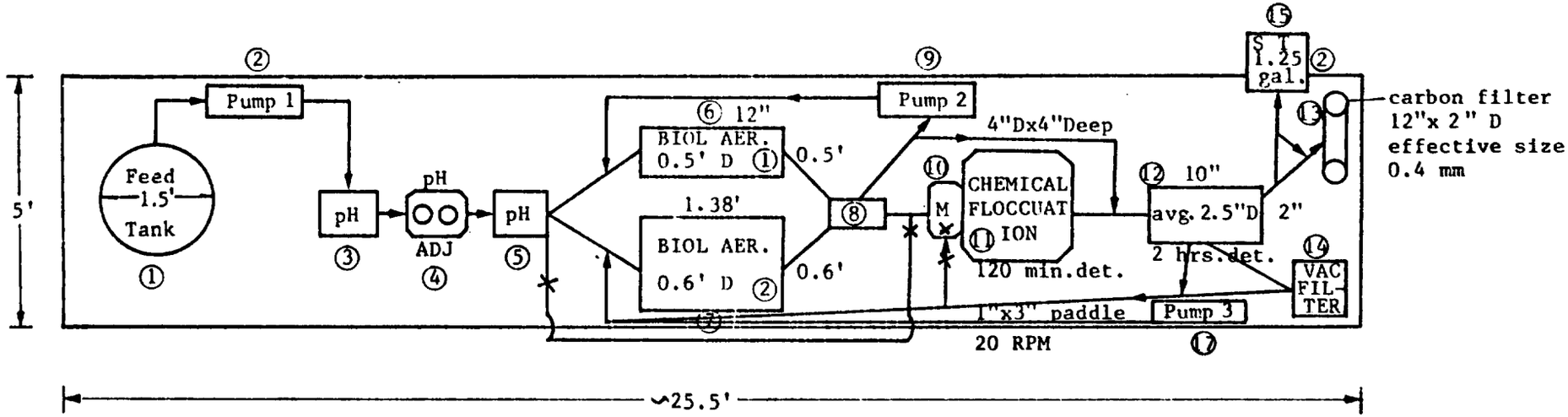
The statement sets out the established water quality objectives for the subzones of Tolo Harbour and Channel Water Control Zone.

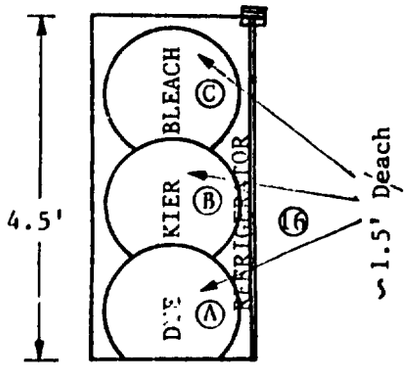
Appendix F

Laboratory Design



$\sim$ 750 ft^2

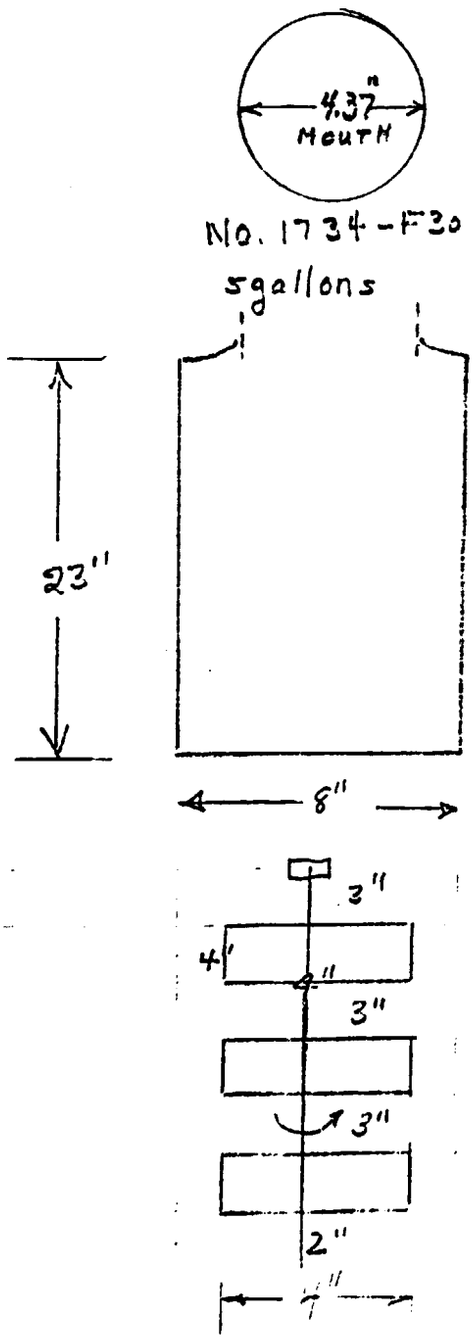

Pump 1
Feed
1.5'
Tank
pH
ADJ
pH
pH
BIOL AER.
0.5' D
0.5'
1.38'
BIOL AER.
0.6' D
0.6'
Pump 2
4"Dx4"Deep
CHEMICAL
FLOCCUAT
ION
120 min.det.
M
10"
avg. 2.5"D
2 hrs.det.
2"
S T
1.25
gal.
carbon filter
12"x 2" D
effective size
0.4 mm
VAC
FIL-
TER
1"x3" paddle
20 RPM
Pump 3
5'
~25.5'


BLEACH
KIER
DYE
RERIGERATOR
4.5'
~1.5' Déach

1" = 3'

More detailed design of each unit in Pilot Plant

#1 – Feed Tank – For feeding to treatment
For equalization



NO. 1734-F30 WIDE MOUTH BOTTLE
5 gallons FLINT GLASS
PRICE #17.30 U.S.

each paddle 120° to each other
1/4 HP motor with variable
speed adjustment

Feed Pump

Unit (2)

$$\frac{2.5\ \frac{gal}{day} \times 3760\ \frac{ml}{gal}}{1440} = 6.56\ cc/min$$

Pump should be capable of delivering from 3 - 20 ml/min

CUNO AMF CAT. Pg 12 1981
Chemical metering Pumps

SPECS. MAX. 3.5 cc/min
0.6 cc/stroke
8# weight

Diam. 4 1/2" 10
7" L
9" H

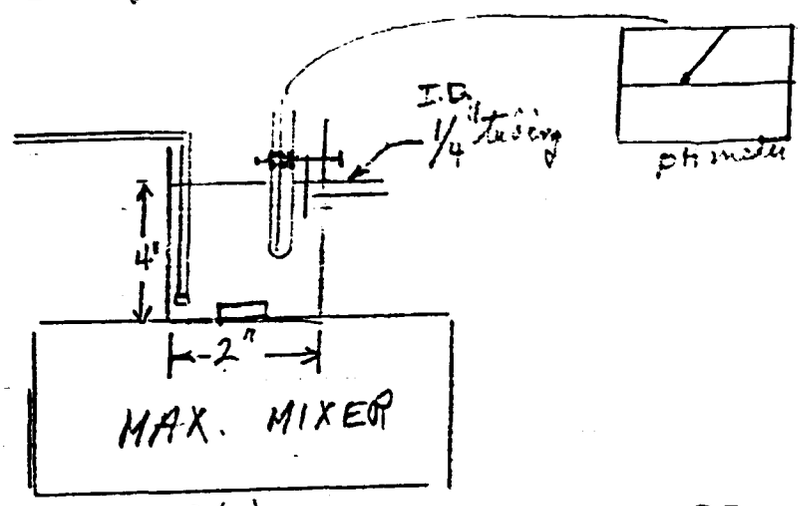
MAX psi = 75 (5.3 kg/cm²)

Alternate

Finder pumps
Rotating tube pressure pumps
preferred because waste does not come in
contact with inside causing clogging & change
in composition of waste

③ pH measuring tank — pH meter

Basis of design



$V = \frac{\pi d^2}{4}(h) = .7854 \times .027 \times .33 = .00717\ FT^3$

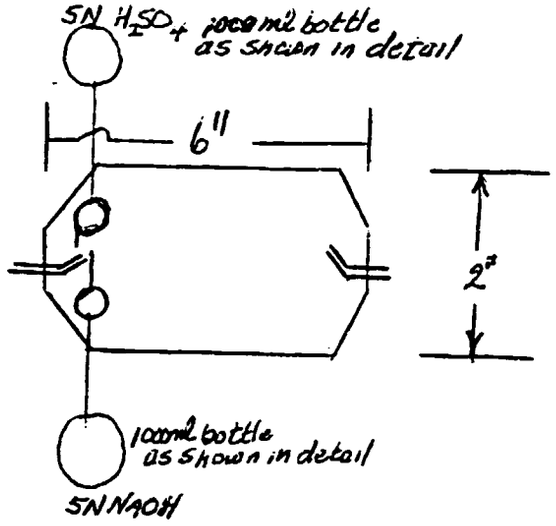
$X \xleftarrow{\frac{.00717\ FT^3}{7.48\ gal/FT^3}} .0536\ gal \times 3780\ \frac{ml}{gal} = 202\ ml$

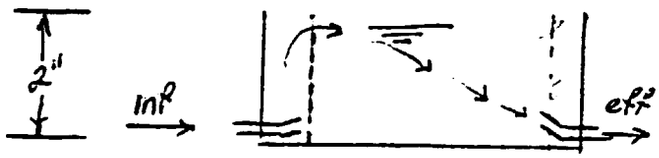
$202 / 6.5\ ml/min = 31\ min$ detention

$6.5\ \frac{ml}{min} \times 20\ drop/ml = 130\ drops/min$

(4)

pH ADJUSTMENT BASIN

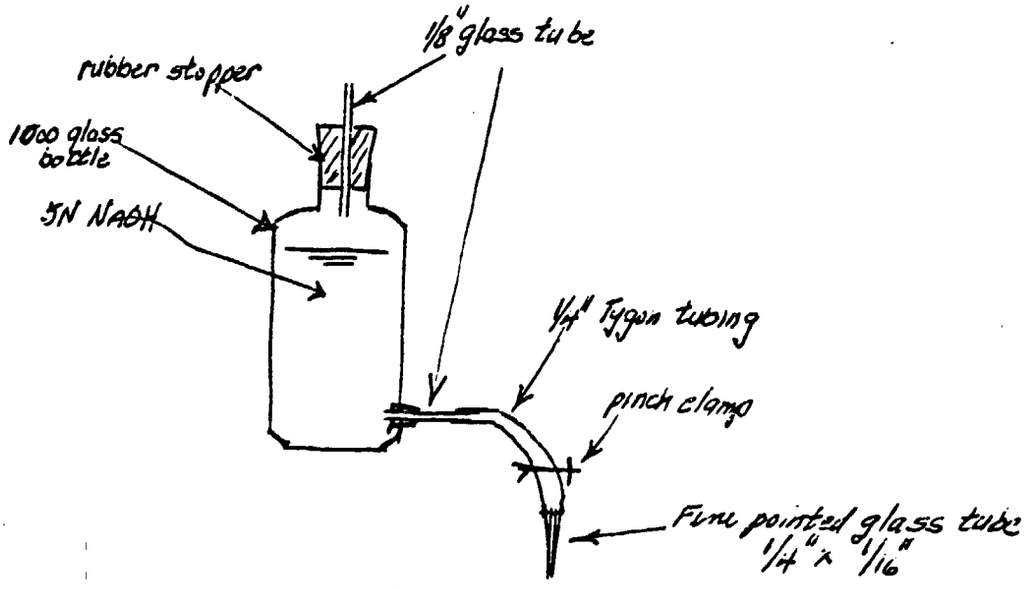




Basin capacity = $2"d \times 6"long \times 2"w = .0127 ft^3 = .1589 gal = 359 ml$

detention time = $359/6.5$ = max. 55 min (discounting beveled ends)

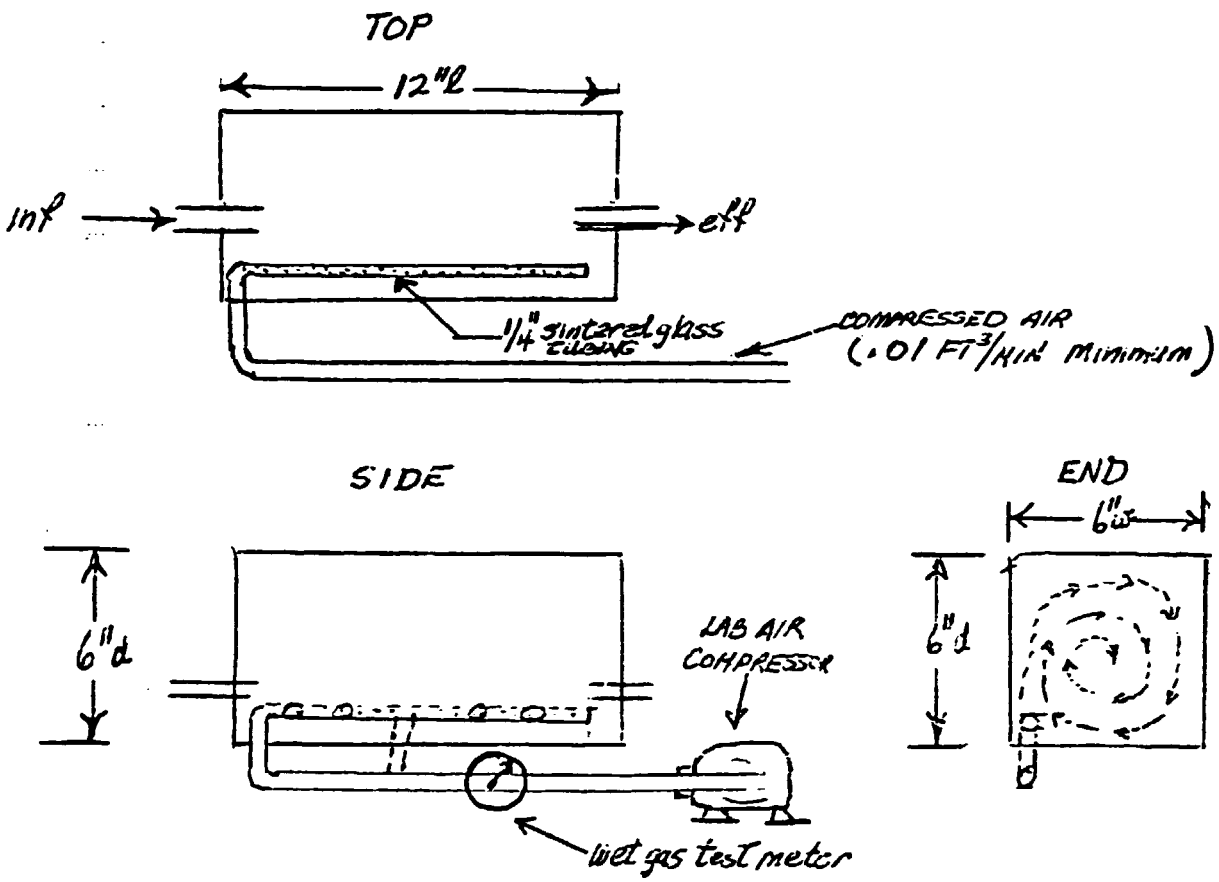
" at 2x rate of 13cc/min = max 27.5 min.



(5) pH verifying tank – pH meter

same units as shown in (3)

(6) Smaller Biological Aeration Basin



volume = $1' \times 0.5' \times 0.5' = .25\ FT^3 = 1.87\ gal = 7068\ ml = 1087\ min$ detention

detention time = 18 hrs at normal loading 2.5 gpd

or 9 hrs at 2X " 5 gpd

$$BOD\ loading = \frac{630\ ppm \times 8.34 \times 2.5}{1{,}000{,}000} = .0131\ \#BOD/day$$

$$= \frac{.0131}{.00025\ (1000's\ ft^3)} = 52.5\ \#BOD/1000\ FT^3$$

$= 105\ \#BOD/1000\ FT^3$ at 2X flow of 5 gal/day

⑦ Larger Biological Aeration Basin
(For more "difficult to degrade" wastewaters)

Same design as ⑥ only the dimensions are

$$1.38'\ell \times 0.6'd \times 0.6'w = .4968 FT^3 = .004968$$

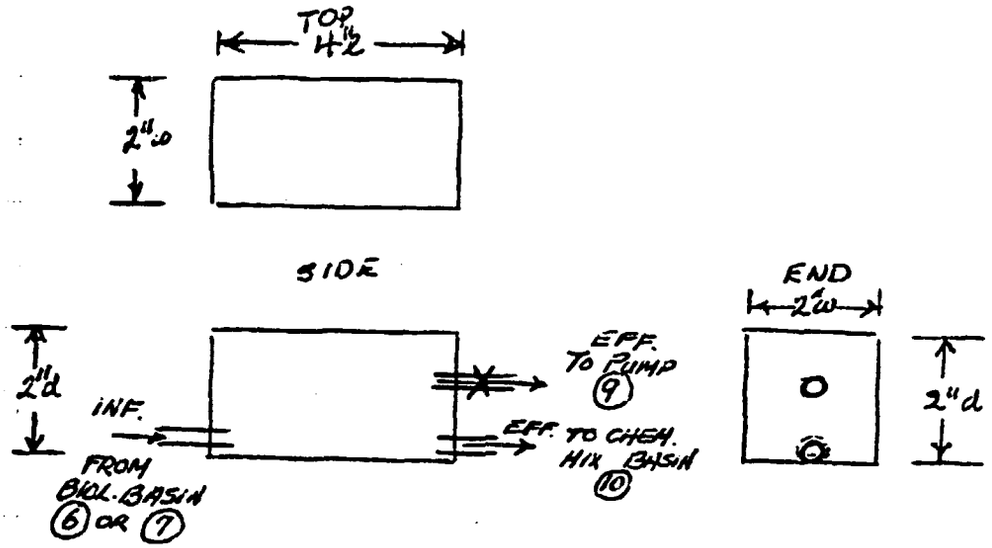
$$= 3.716 gal = 14{,}046 ml$$

at $6.5 \frac{ml}{min}$ = 2161 min or (36 hours)

at 0.0131 #BOD/day

or $\frac{.0131}{.004968} =$ (2.64 #BOD/1000 FT^3)

(8) Biological Effluent Collection Box



Volume = 0.16 x 0.16 x .33 = .0085 FT^3 = 239 ml

detention time = 36.7 min @ 6.5 ml/min (2½ gal/day)

= 18 min @ 13 ml/min (5 gal/day)

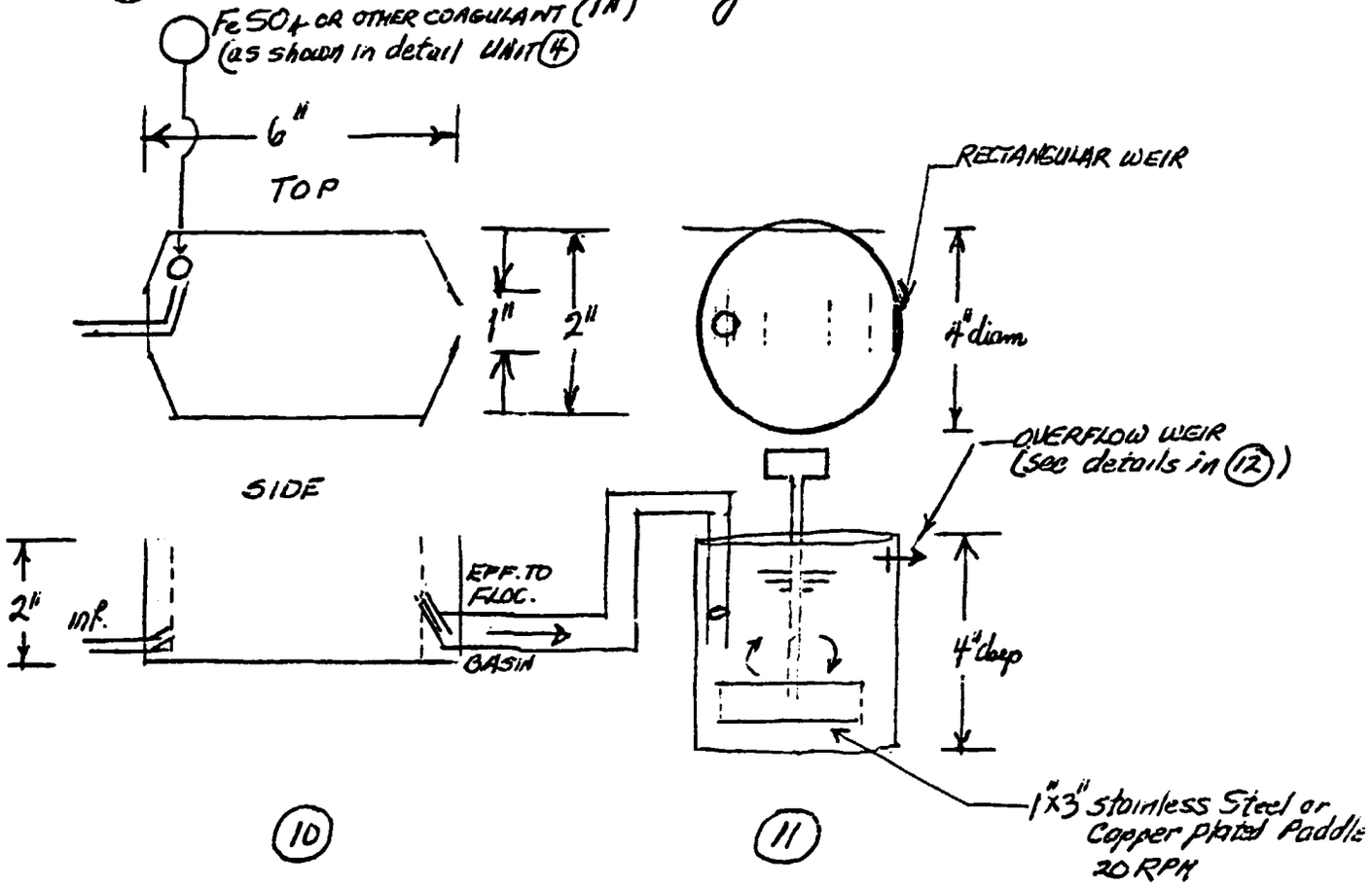
Good mixing because influent and effluent are at same elevation (near bottom) and recirculation to biological basin near upper part to use dispersed growth system if small sludge develops or mixed liquor if ample sludge develops.

⑨ Recirculation Pump

Use same pump as Unit ② with understanding that the pump will be required to deliver – on an average – of 20-30% of raw wastewater flow or $6.5 \frac{ml}{min} \times 0.25 = 1.625 \frac{ml}{min}$

IF THIS pump will not operate at this low flow rate by adjustment of the stroke, then it should pump a greater volume and divert the excess back to the Biological Effluent Collection Box ⑧.

(10) and (11) Combined Chemical Mixing and Flocculation Basins



$Vol. = .16 \times .5 \times .16 = .0127 FT^3$

$= .0127 \times 7.48 \times 3760 = \underline{359}$ ml

detention $= \frac{359}{6.5} = \underline{55}$ min. at 2½ gpd

$= \underline{27.5}$ min at 5 gpd

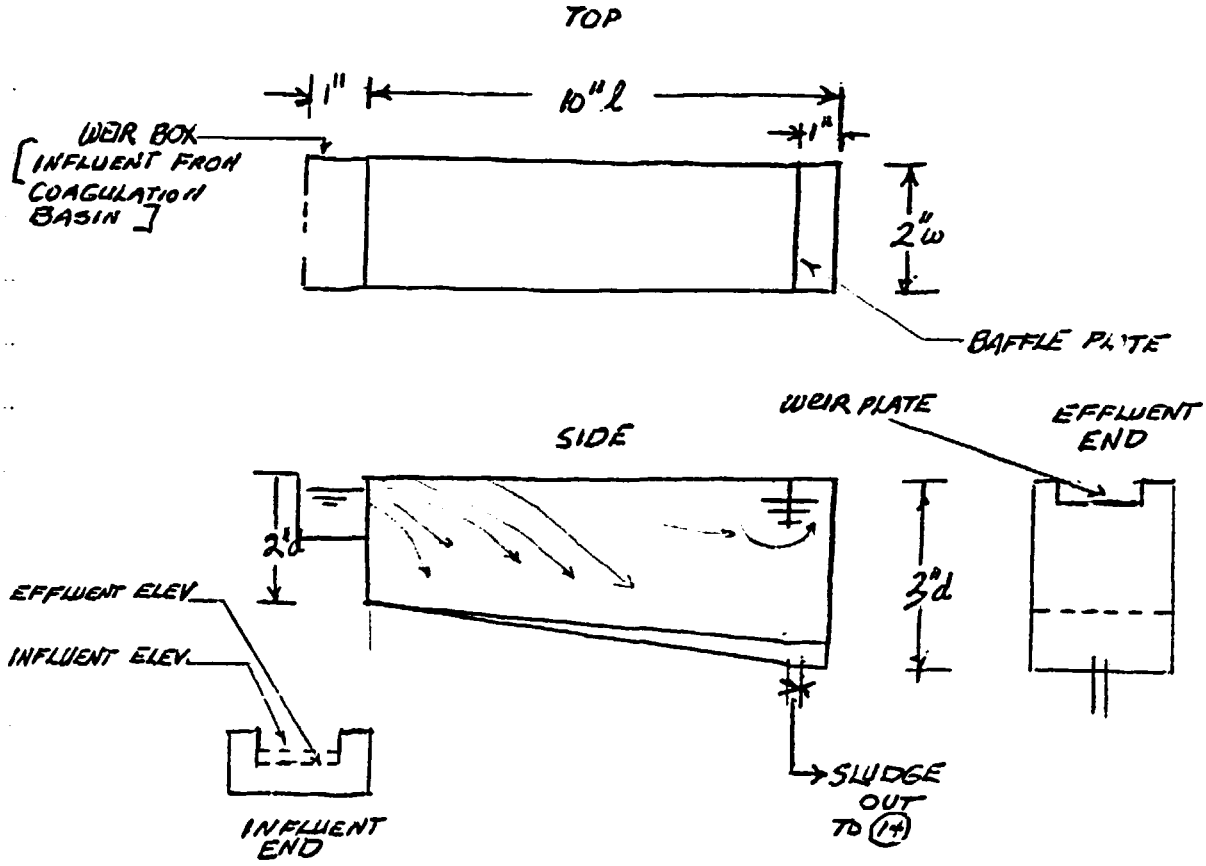
$Vol = .7854 \times .109 \times .33 = .028 FT^3$

$= .028 \times 7.48 \times 3760 = \underline{792}$ ml

detention $= \frac{792}{6.5} = \underline{\sim 120}$ min. at 2½ gpd

$= \underline{\sim 60}$ min. at 5 gpd

(12) FINAL SEDIMENTATION TANK



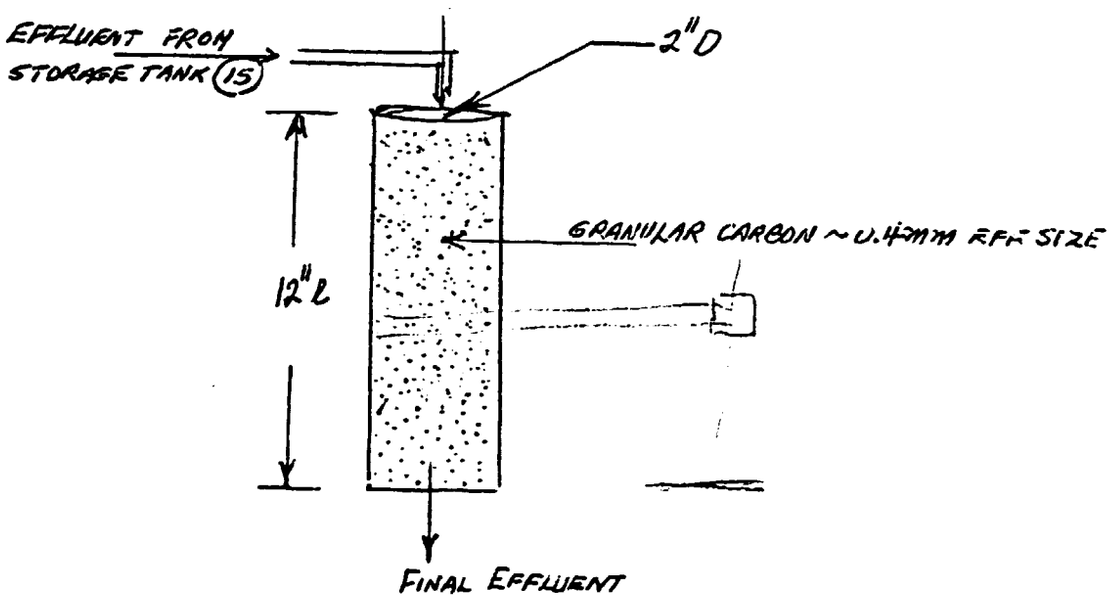
Volume = 10" x 2" x 2.5" = .83 x .16 x .2083 = .0276 FT^3

= .0276 x 7.48 = .207 gal = 782 ml

= $\frac{782}{6.5}$ = 120 min. at 2.5 gpd

= 60 min at 5.0 gpd

(13) TERTIARY CARBON FILTER



Volume of filter $= \frac{\pi d^2}{4} h = .7854 (1.0)(1.0) = .0256\ FT^3$

Area $= \frac{\pi d^2}{4} = .0256\ FT^2$

2 STORAGE TANKS OF 1.25 gals each deliver the effluent over a 60 minute period

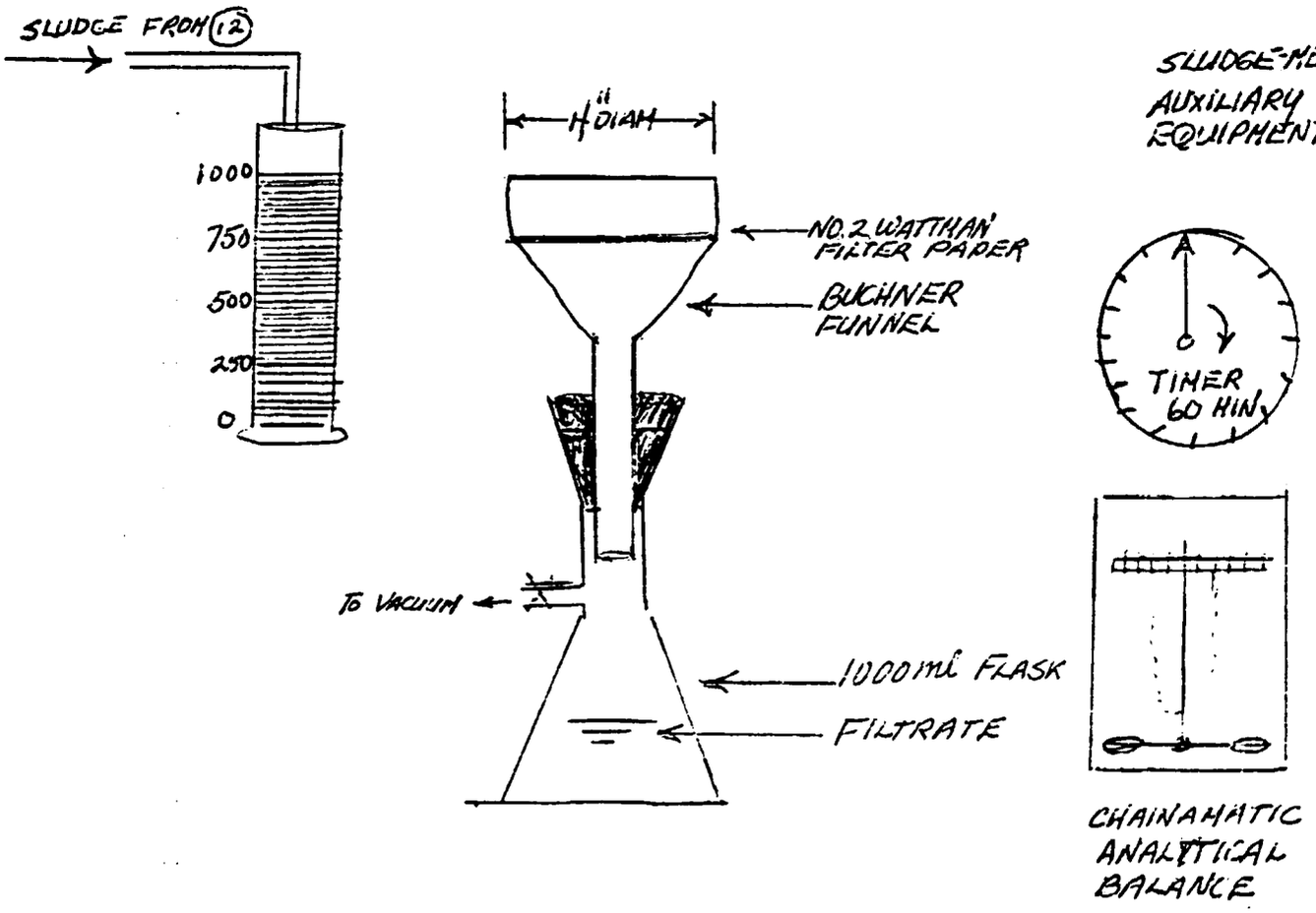
$= \frac{1.25\ gal}{60} = .02\ gal/min.$

Loading $= \frac{.02}{.0256} = \sim 1\ gal/FT^2/MIN$

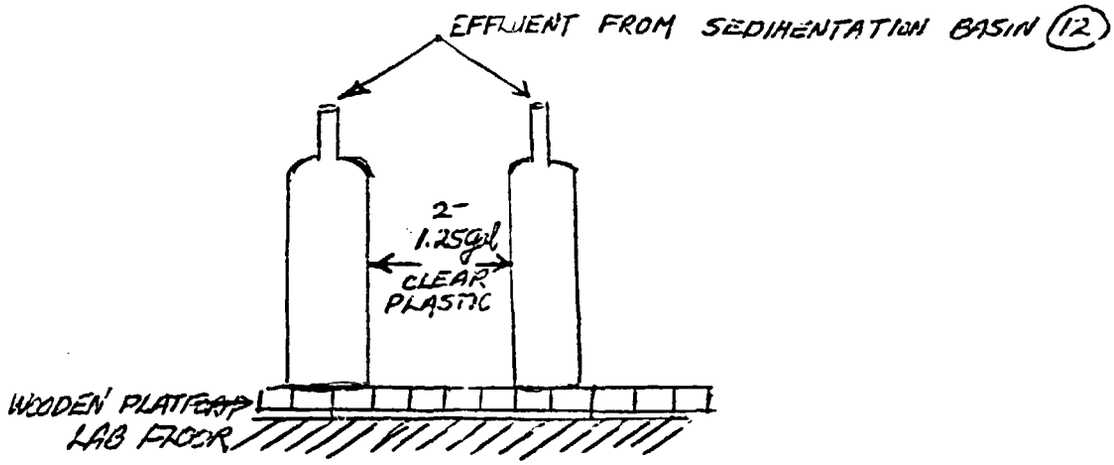
IF entire 1.25 gal were delivered in 10 min, the loading = .125 gal

Loading $= \frac{.125}{.0256} = \sim 5\ gal/ft^2/min.$

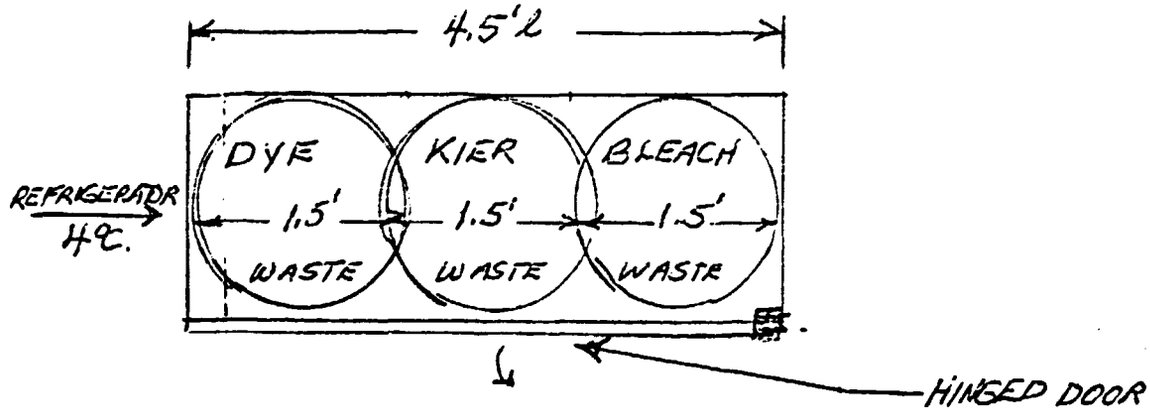
(14) SLUDGE FILTRATION SYSTEM



(15) EFFLUENT STORAGE TANKS



(16) RAW WASTE STORAGE BASINS



(17) SLUDGE RECIRCULATION PUMP

Same as (9) and (2)