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Cannery Waste Treatment by Anaerobic Lagoons and Oxidation Ditch

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CANNERY WASTE TREATMENT BY

ANAEROBIC LAGOONS AND OXIDATION DITCH

By

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Grant No. WPD 211-02-68
Project 12060 EHS

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ABSTRACT

A mixture of fruit and vegetable cannery wastes and domestic sewage has been treated by a combination anaerobic lagoon-oxidation ditch process for two years.

This study has shown that the anaerobic lagoon has consistently achieved a reduction of BOD of 75-85% at loadings up to 400 lbs BOD/acre/day provided an adequate BOD/nutrient ratio is available. Where the BOD/nutrient ratio exceeds a value which appears to be of the order of 50:1, performance is adversely affected. At a value of the order of 50:1 to 100:1, loadings of 600 lbs/acre/day would appear feasible. At these loadings algae are consistently present in the lagoon contents.

The oxidation ditch has been able to treat the effluent from the anaerobic lagoon and maintain adequate solids in the mixed liquor. This process has been shown to be very stable against overload and the power requirement has been shown to be less than 0.50 Kwh/lb BOD removed. The oxygenation capacity of the rotor has been shown to be of the order of 30 lbs BOD/foot of length.

Based on Australian construction costs it should be possible to treat a mixed waste load of 70,000 lbs BOD for a capital cost of $213,000. Operation cost would be $2600 per month of operation.

This report was submitted in fulfillment of Project Number 12060 EHS, Grant WPD 211-02-68, under the partial sponsorship of the Environmental Protection Agency.

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CONCLUSION

Overall, the process of treating cannery wastes by anaerobic lagoon and oxidation ditch has demonstrated its reliability and freedom from upset over a two year period of operation. Only one hour per day of maintenance has been necessary.

Cost projections indicate that under Australian conditions an overall BOD load of 70,000 lbs BOD/day could be purified for a capital cost of $213,000 with an annual operating cost of $17,600.

SECTION II

RECOMMENDATIONS

Over a period of two years, wastes from a variety of canning processes; i.e., fruit and vegetable and soup making, have been satisfactorily purified when mixed with town sewage by the combination of anaerobic lagoon and aerobic oxidation ditch treatment.

This combination lends itself to the situation where a seasonal peak load of high BOD is superimposed on a moderate year round base BOD load. Under the moderate base load, complete purification of the waste can be achieved in the lagoon system alone. When the seasonal peak load does occur, the anaerobic lagoons can efficiently remove the major portion (75-85%) of the applied BOD load. The reserve treatment capacity of the oxidation ditch is rapidly available to complete the purification of the waste to a low residual BOD level. Land requirements are thus held to a minimum and power and maintenance costs on the ditch are also restricted to the particular period of the year when maximum BOD load occurs.

SECTION III

INTRODUCTION

In the past, many difficulties have arisen from treatment of wastes from food processing plants. These difficulties arise in the main from the often seasonal nature of the wastes with the need for a plant to operate for only a few months of the year. A common problem has been that the plant is not adequate to treat peak loads, with consequent development of operational difficulties, odors, and the discharge of only partly purified waste to nearby streams. Provided the waste is neutralized effectively, and a balanced content of carbon, nitrogen, and phosphorus is achieved in the waste, it can be treated by established biological methods such as activated sludge or trickling filters. The costs are high and there are operational difficulties. Often wastes have been disposed of by flood or spray irrigation, or by aerobic lagoons heavily dosed with sodium nitrate for odor control. Gilde (1) has described a method of disposal by spray irrigation with continuous surface runoff.

Work described previously (2) has shown that these wastes can also be treated by anaerobic lagoons and oxidation ditches with marked advantages over conventional methods in terms of costs of capital equipment and ease of maintenance and supervision.

The objective of this project was to demonstrate by continuous operation over two years the practicability of the methods of treatment of fruit and vegetable cannery wastes by anaerobic lagoons and oxidation ditch indicated by the results of experimental operation previously described (2).

Specifically, these objectives were carried out by:

1. The operation for two years of two anaerobic lagoons of 10 acres each and two oxidation ditches (each 120 ft x 24 ft) treating 50-100,000 gallons per day of peach, pear, citrus, tomato, and general soup making wastes.

2. The practical feasibility of the processes and the design parameters required were determined with regard to:

   (a) short and long term changes in performance of anaerobic lagoon with changes in nature of waste treated and seasonal conditions

   (b) optimum conditions for oxidation ditch treatment of raw waste and anaerobic lagoon effluent with regard to solids content in mixed liquor, detention time, design, and operation of rotor for aeration.

SECTION IV

BACKGROUND

The field work for this project has been carried out at Shepparton in the State of Victoria, Australia, located 113 miles from Melbourne, with a population of 19,000. Shepparton is the regional urban center of the highly productive 1 million acre Central Goulburn irrigation system. The area produces fat sheep, dairy products, stone fruit, and vegetables.

The town is sewered and the domestic sewage together with wastes from a bacon factory, two milk processing plants, a butter factory, abattoirs (slaughter house), textile mill, and laundry is treated by primary sedimentation, separate heated sludge digestion, and a 120 ft diameter 12 ft deep trickling filter. The filter effluent, prior to the development of the facilities described in this paper, was irrigated over 76 acres of pasture and 75 acres of unprepared land, on which sheep were grazed. The disposal area consisted of 183 acres of which 76 acres could be commanded by irrigation.

The Shepparton Preserving Company has been located in Shepparton since 1920. Over the years it has increased the magnitude of its operations and is now the largest cannery in the Southern Hemisphere. It processes apricots, peaches, and pears. From 1938 the cannery waste was pumped through its own 15 inch pipeline, 11,000 ft to the sewage disposal area where the flow during the canning season (January-April) was conveyed by separate channel and flood irrigated over part of the 76 acres of unprepared land. With ever increasing flow, odor problems developed and the extension of housing areas near the disposal site made it essential for the Shepparton Sewerage Authority to provide improved methods of treatment and disposal. The senior author was retained by the Authority in 1962 to carry out investigations which have continued until the present and have led to the construction of the facilities described.

In 1960 Campbells Soup (Aust.) Pty. Ltd. erected a large cannery at Lemnos, a small township 8 miles from Shepparton, and requested the Shepparton Sewerage Authority to construct a pipeline to, and treatment facilities at the disposal area.

This factory was originally intended to manufacture soup and regular products but before the building was complete, facilities were also provided to process citrus and tomatoes. Wastes from all these operations are pumped through a 15 inch concrete pipeline 30,000 ft to the disposal area.

The problem faced by the Sewerage Authority has been how to efficiently purify without nuisance the large seasonal flows of highly polluted food wastes from the two canneries, on areas closely adjacent to a prosperous and rapidly developing urban center.

CHARACTERISTICS OF WASTES

Sewage:

The city sewage containing a variety of industrial wastes, including a large butter factory waste, is high in BOD. The composition of the raw sewage, settled sewage and filter effluent are as shown in Table 1, and the plant performance in Table 2.

Table 1. Sewage Composition

	BOD ppm	SS ppm	Am-N ppm	pH
Raw sewage	556	486	37	6.1
Settled sewage	375	174	36	6.0
Filter effluent	110	110	32	6.5

Table 2. Sewage Plant Loadings

Sedimentation Tanks	
Capacity	112,000 gals. (U.S.)
Flow 24 hours	1.5 mgd
Maximum 6 hours	95,000 gals./hour
Detention	1.2 hours
BOD reduction	33%
SS reduction	64%
Filter	
Flow	1.5 mgd
Load gpd/cu.. yd.	250
Load lbs BOD/cu. yd./day	1.10
Sewage/media ratio	1.3

The filter is loaded at a high rate and the filter effluent is consequently only partially purified. It is high in ammonia and phosphate. The two digesters are adequate in capacity and the sludge is well digested.

Campbells Soup (Aust.) Pty. Ltd.:

The wastes from Campbells Soup (Aust.) Pty. Ltd. come from processing and canning of tomato products over the period January-April, citrus from June-November, and soup and regular products continuously. The cannery operates throughout the year except for about two weeks at Christmas. The composition and flow at peak processing period for 1965 are as shown in Table 3.

Table 3. Campbells Soup Wastes*

Products	Peak Period	Flow gpd	Composition			
			BOD ppm	BOD lbs/day	SS ppm	Am-N ppm
Tomato & regular products	Feb. 25-Mar. 29	1,075,000	728	6,280	438	0.5
Meat & regular products	May-Sept.	800,000	464	2,920	350	2.0
Citrus & regular products	Nov.	1,075,000	400	3,360	315	0.8

* After screening.

The wastes from tomato and citrus processing are acidic and rapidly develop further acidity in the pipeline. To correct this acidity for the protection of the concrete pipes and to facilitate biological treatment, these wastes are dosed with lime continuously before reaching the pipeline. The dosage is adjusted to ensure that the waste reaching the disposal area has a pH not less than 7.0.

The soup making and regular products' waste is pumped through a rotary basket screen, flows to the main grease trap, and thence to the main pump well.

The tomato and citrus are processed in adjacent parts of the factory away from regular products and the flows go to a separate well where they are pumped over a Link Belt vibratory screen and the finely screened (1 mm) waste gravitates to the main pump well.

The combined waste is pumped continuously by a constant speed variable discharge pump 30,000 ft to the treatment area.

Shepparton Preserving Company:

The canning season runs from the beginning of January to the middle of April but may be shorter or longer by a few weeks depending on seasonal conditions. For the first three weeks the pack is almost entirely apricots, the remainder of the season both peaches and pears are processed, one or the other predominating as the various varieties ripen.

The apricots are a dry pack and the waste flow and strength in BOD is relatively small. Peaches are lye peeled yielding a strong highly colored alkaline waste. Pears are mechanically peeled and give rise to a high BOD acidic waste. The solid waste from pear preparation was originally taken by conveyor to a hopper and transported for land disposal. Recently, alterations to the drainage system were made and all solids are flumed with the liquid waste to a common well where they are first dosed with lime to neutralize acidity, pumped over Link Belt vibratory screens and then pumped through a 15 inch concrete pipeline 11,000 ft to the treatment area. It is found that there is a very considerable drop in pH through the line and to deliver the waste to the treatment area at a pH of 7.0 it is necessary to dose with lime to a pH of 10-11. This requires for each long ton of fruit processed, 10 lbs of hydrated lime for apricots, 15 lbs for peaches, and 45 lbs for pears.

Overall Waste Load for Treatment:

The average BOD arising from the sewage treatment plant effluent, from S.P.C., Campbells Soup, and other trade wastes, requiring treatment, is shown in Table 4.

Table 4. Overall Peak Pollutional Load

Source	Peak Load	Flow mgd	BOD ppm	BOD lbs/day
Domestic sewage	Continuous	1.5	250	3,000
S.P.C. Ltd.	Feb.-April	2.0	3,000	55,000
Campbells Soup Co.	Feb.-March	1.07	728	6,280
Butter factory	Oct.-Dec.	0.20	6,000	9,000 (4500 off peak)
Abattoirs	Continuous	0.4	1,600	5,000
Total	(Feb.-Mar.)			74,000

It will be seen that for peak conditions in March it is necessary to treat a daily load of 70 to 80,000 lbs BOD/day or population equivalent of 500 to 600,000 persons whereas the City population of Shepparton is 19,000.

PREVIOUS STUDIES

As reported previously (2) the investigation of methods of purification of cannery waste by lagoons and ditches for the Shepparton Sewerage Authority has been in progress for several years.

Bench-scale experiments had shown that while fruit cannery waste alone or in a mixture with sewage plant effluent could not be purified satisfactorily in small tanks simulating anaerobic type lagoons, this could be achieved if the tanks were seeded daily with a charge of digested sludge or digester supernatant. Similar scale experiments using a model activated sludge process with mechanical aeration demonstrated that the waste, if mixed with sewage plant effluent, could readily be purified from an original BOD of 1500 ppm to produce a final effluent with a BOD of 20 ppm.

By the use of experimental scale field units it was shown that anaerobic lagoon treatment of the waste could be achieved with lagoon loading of 700 to 1000 lbs BOD/acre/day to produce a 75% reduction in BOD and with negligible odor development. With other experimental units it was shown that the waste mixed with sewage plant effluent could also be purified by step feed and recirculation in an aerobic type lagoon. The permissible load was found to be 50 lbs BOD/acre/day. An experimental oxidation ditch 40 ft x 12 ft with a 6 ft rotor also demonstrated that the waste mixed with sewage plant effluent could be completly purified by this process and power requirements and BOD load were determined. Spray irrigation was also evaluated.

Consideration of the results obtained from these experimental facilities pointed to the conclusion that provided the anaerobic lagoon could be operated without odor; this process followed either by an aerobic lagoon or oxidation ditch would be more economic than the adoption of either aerobic process alone.

Consideration of performance and cost data in relation to the short season for fruit canning, suggested an advantage for the ditch in conjunction with the anaerobic lagoon.

The next step was the construction of a three acre anaerobic lagoon which would conclusively demonstrate whether the process was acceptable with regard to BOD removal and odor level, and a pilot plant oxidation ditch to determine whether this process could treat the effluent from the anaerobic lagoon. This conjuction of processes proved successful. It reduced BOD by 75-80% through the lagoon and the ditch was capable of further reducing BOD to 15-20 ppm and maintained adequate solids in the mixed liquor. The BOD of the raw cannery waste during this period was 2500 ppm. There was no odor from the lagoon and power consumption data obtained from the ditch indicated a value of 0.40 kwh/lb BOD destroyed. This information provided the basis for the design of full size units.

A pilot plant installation of two 10 acre anaerobic lagoons and two large oxidation ditches (each 120 ft long by 24 ft wide with 12 ft long by 27 inch diameter rotors) was constructed and operated with fruit cannery wastes for the seasons 1965-66. These facilities were used for the demonstration grant study.

The development of facilities for the treatment of Campbells Soup waste followed a somewhat different course. Originally this factory proposed to manufacture soups and regular products only and a number of aerobic type lagoons (28 acres) in parallel and series were constructed to treat the waste. It was anticipated that nitrate or nutrient addition might be necessary and provision was made for recirculation.

However, before the lagoons were operative the company announced that it would also process tomatoes and citrus at the same factory and it was necessary to devise additional facilities within a period of six months.

There was no time for experimentation and as the initial experiments with an anaerobic lagoon to treat fruit wastes with sewage plant effluent had been successful, it was decided to add two anaerobic type lagoons in parallel (total 10 acres) to the existing 28 acres of aerobic type lagoons and hope that this would be adequate. The sewage plant effluent was also brought to the area and mixed with the waste before discharging to the lagoons. Detailed examination of performance showed this to be successful and with increasing factory production it has been possible to determine the maximum capacity of the installation from which additional facilities could be designed.

SECTION V

FACILITIES, OBSERVATIONS AND SAMPLING

FACILITIES

The layout of the experimental facilities is shown in Figure 1 and an aerial view in Figure 2. These consisted of two 10-acre anaerobic lagoons, known as S_2 and S_3. The two ponds were operated in parallel, one or both being operated at any one time. The flow to the lagoons could consist of wastes from Campbells Soup Co. (soup, citrus, tomato), Shepparton Preserving Co. (peach, pear), or mixed city sewage (including abattoirs and butter factory), or admixtures of two or more depending on the availability of each at any particular time of the year and the program being undertaken. The City sewage was supplied untreated or after primary or secondary treatment according to the operation of the sewage treatment plant.

The flow of each was regulated by penstocks at the distribution structure (Figure 3) and checked by measurement over V-notch weirs in the channel feeding the lagoons (Figure 4).

The outflow from the lagoons (Figure 5) was collected in a concrete channel and the portion of the flow as required taken off from a V-notch weir through a flume to the two oxidation ditches.

The two oxidation ditches were each 120 ft long, and 24 ft wide (each leg 12 ft wide) as shown in Figure 6.

The operating water depth was 39 inches but this could be varied over a range of 6 inches by alteration of the level of the outlet weir. By alteration of the water depth, effective variation in the depth of immersion of the teeth of the rotor could be achieved.

There was one rotor installed in ditch No. 1 and two rotors in ditch No. 2. The rotors were similar to those known as Pasveer cage type. Those used incorporated a number of novel modifications of the original Pasveer design. They were driven by a 12½ hp electric motor and reduction gears to achieve an operational speed of 72 rpm.

Each rotor was 12 ft in length 27 inches in diameter with 12 lines of angle iron with teeth, placed peripherally around the disc. The various rotors used are shown in Figures 7 and 8. Depth of immersion of the rotor teeth was 5 inches for all operations. Power consumption was recorded through a watt hour meter and read weekly.

The outflow from the ditches was over end weirs and the mixed liquor flumed to a 20 ft diameter secondary sedimentation tank of 60,000 gallons capacity. The sludge was returned by an electrical sludge pump operated continuously. The return sludge flow was split between the two ditches as required.

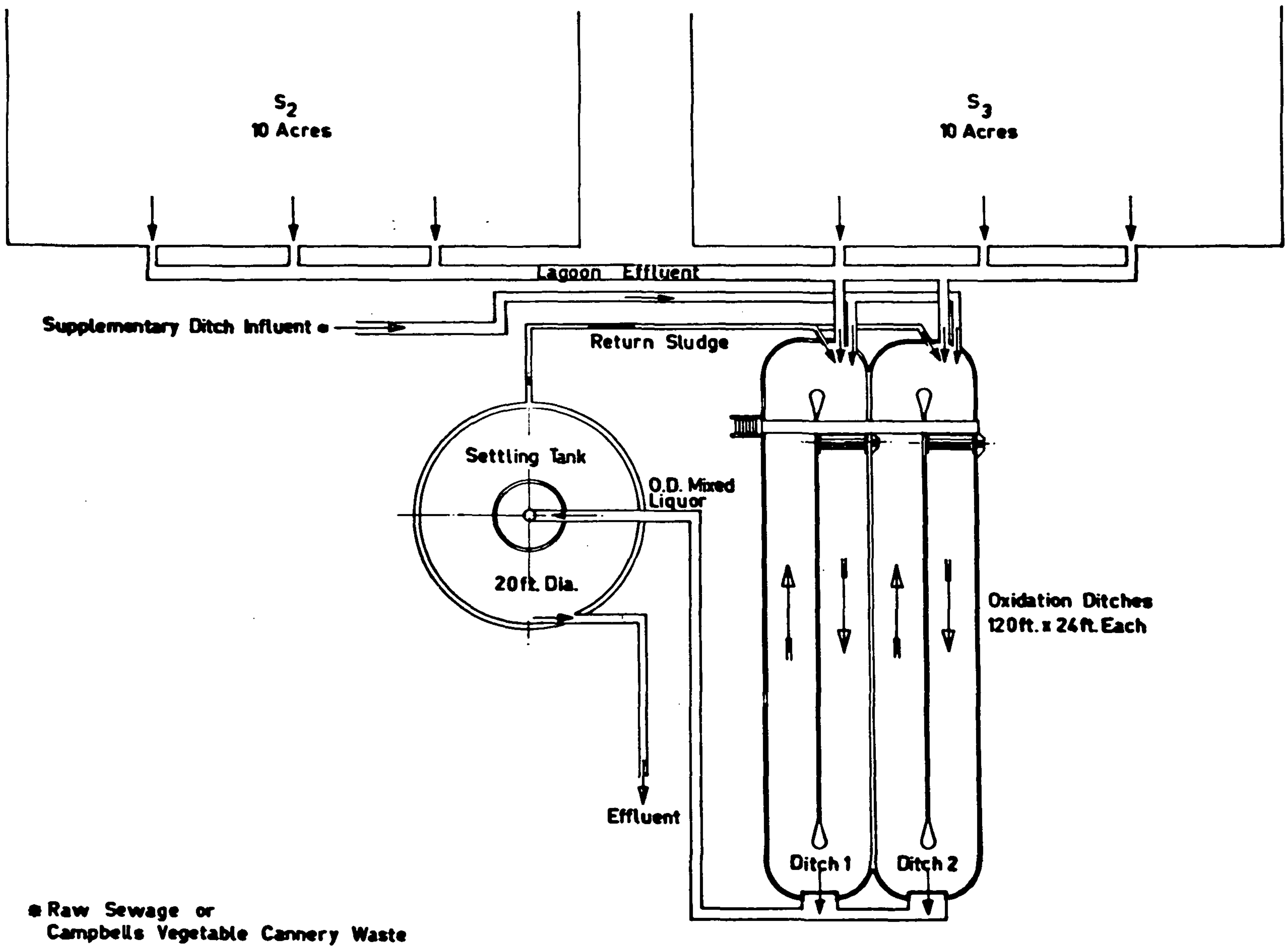

Figure 1. Layout of Experimental Plant

Figure 2. AERIAL VIEW OF PLANT

Figure 3. CHAMBER FOR DISTRIBUTION OF FLOWS

Figure 4. ANAEROBIC LAGOONS INLETS

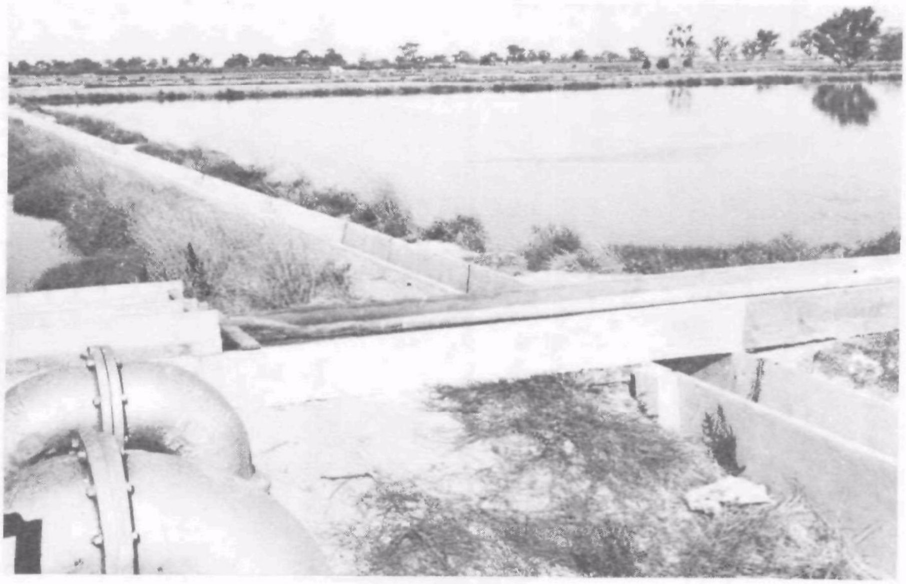

Figure 5. OUTLET CHANNELS FROM LAGOONS

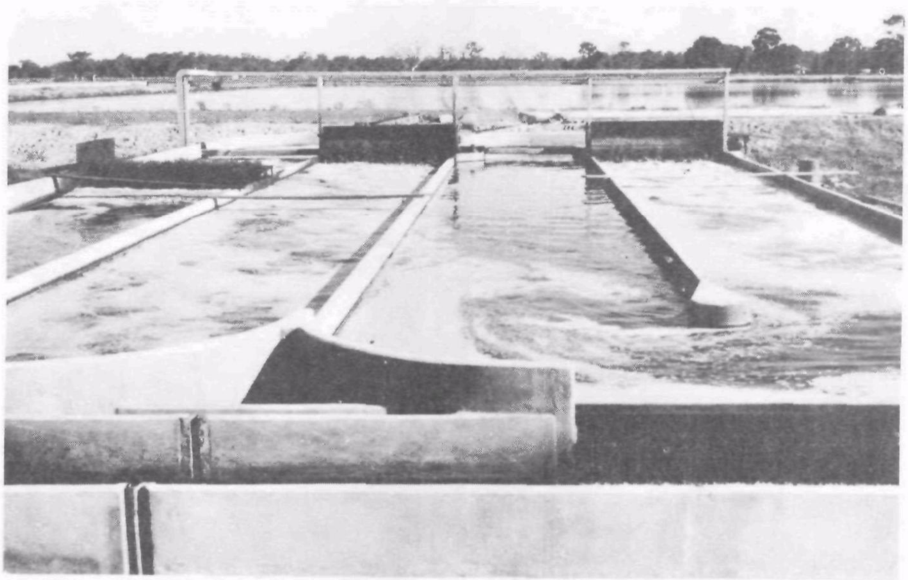

Figure 6. OXIDATION DITCHES

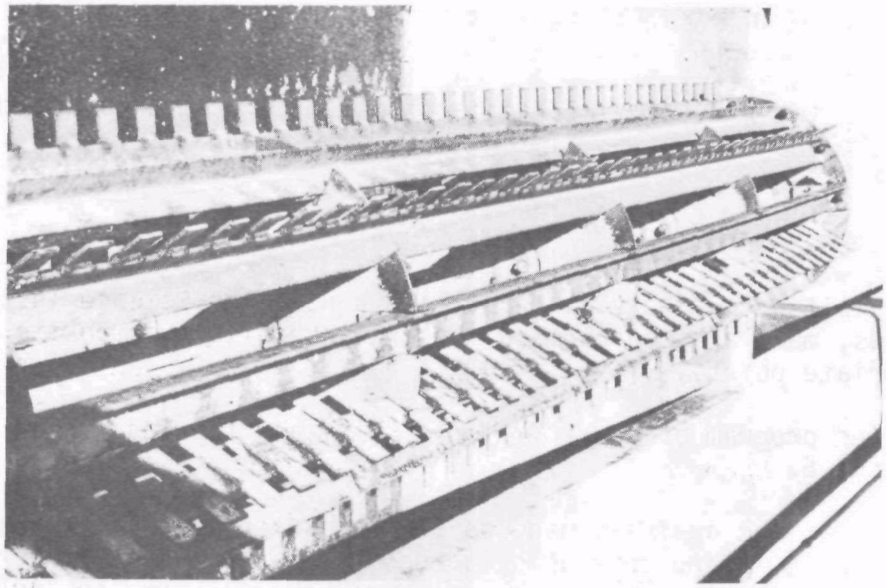

Figure 7. OXIDATION DITCH ORIGINAL ROTOR TYPE

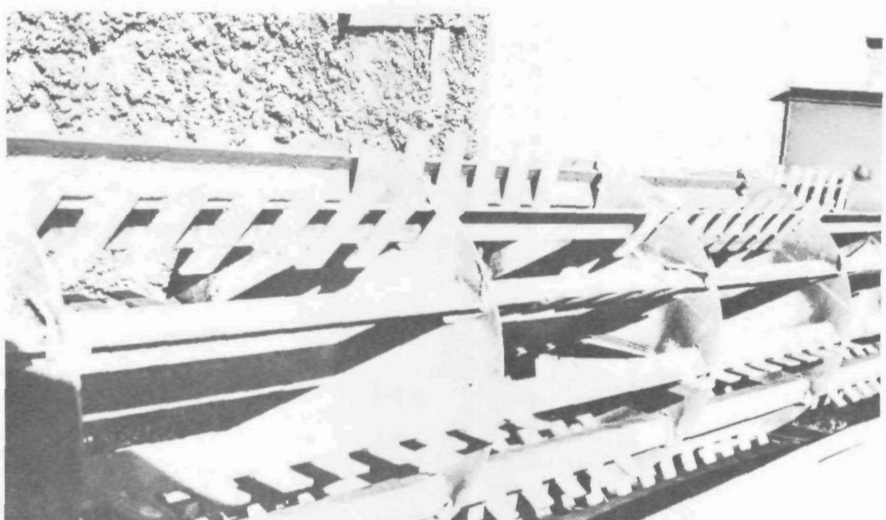

Figure 8. OXIDATION DITCH IMPROVED ROTOR TYPE

These facilities already existed at the Shepparton Sewerage Authority Plant and were made available by that Authority as a contribution to the Demonstration Grant Project. The day-to-day maintenance of the operation was looked after with the attendance of one man for one hour each day. His time and the cost of power for the operation of the rotors and pumps were a charge against the project.

OBSERVATIONS, SAMPLING & ANALYSIS

A weekly visit was made by staff of Melbourne Water Science Institute to check flows, make on-site chemical tests, and collect composite samples at appropriate points.

The detailed program of sampling, observation, and testing was as shown in Tables 5 and 6.

In addition to the analyses made on samples taken through the process, sludge sampling in the anaerobic lagoons was carried out at quarterly intervals to determine the depth and characteristics of the sludge present (Table 7).

Table 5. On Site Weekly Observations at Shepparton

Sampl Sample	pH	DO	Sul- phide	Settl. Solids	Flow gpd	Power consump.	Cond. of Rotor	Depth of Teeth Immersed	Temp.
Vegetable & soup process (comp.)	+								
Fruit cannery (comp.)	+								
Filter effluent (comp.) or	+								
Raw sewage (comp.)	+								
Lagoon influent (comp.)	+				+				
S_2 & S_3 lagoon influent					+				
S_2 lagoon effluent	+	+	+						
S_3 lagoon effluent	+	+	+						
Combined lagoon effluent to ditch	+	+	+		+				+
Ditch Influent	+	+	+		+				
Ditch effluent	+	+	+						+
Ditch M.L.	+			+					
Ditch return solids	+			+	+				
Meter Board						+			
Ditch rotor							+	+	

Table 6. Weekly Laboratory Examination on Shepparton Samples*

Sample	pH	BOD	Am -N	NO_3 -N	NO_2 -N	Org. -N	PO_4	SS	TDS	TS	VS	SVI	Algal Count
Vegetable & Soup Process (comp.)	+	+	+			+	+	+					
Fruit cannery (comp.)	+	+	+			+	+	+					
Seeded sewage (comp.) or Raw sewage (comp.)	+	+	+			+	+	+					
S_2 & S_3 lagoon infl. (comp.)	+	+	+			+	+	+					
**Ditch influent (comp.)	+	+	+			+	+	+	+				
S_2 lagoon eff.	+	+	+	+	+	+	+	+					+
S_3 lagoon eff.	+	+	+	+	+	+	+	+					+
Lagoon effluent to ditch	+	+	+	+	+	+	+	+	+				+
**Ditch effluent	+	+	+	+	+	+	+	+	+				+
Ditch mixed liquor	+							+		+	+	+	
Ditch return solids	+							+		+	+	+	

*All methods used according to procedure APHA Standard Methods.
**Two ditches sampled separately October 1969 - April 1970.

Table 7. Quarterly Observations & Analyses

Sample		pH	TS	VS	Purif. Index*	Gas* Yield	Bact. Count	Sludge Depth	DO	Sulphide	Temp.
S_2 Sludge	Inlet	+	+	+	+	+		+			
	Middle	+	+	+	+	+		+			
	Outlet	+	+	+	+	+		+			
S_3 Sludge	Inlet	+	+	+	+	+		+			
	Outlet	+	+	+	+	+		+			
S_2 & S_3 Lagoon Infl.		+					+		+	+	+
S_2 & S_3 Lagoon Effl.		+					+		+	+	+
Ditch Influent		+					+				+
Ditch Effluent		+					+				+

*Concept and measurement procedure as per reference (3).

SECTION VI

DESCRIPTION OF VARIOUS OPERATIONAL PHASES

The manner in which the facilities were operated from April 1, 1968, to May 7, 1970, is tabulated in Table 8.

<u>April 1 - June 1, 1968</u>

Lagoons were treating a mixture of trickling filter effluent and vegetable cannery waste. The ditch also treated filter effluent plus vegetable cannery waste.

<u>June 1-18, 1968</u>

Lagoons were treating raw sewage plus vegetable cannery plus citrus waste. The ditch treated raw sewage plus cannery waste.

<u>June 18 - August 5, 1968</u>

Lagoons were treating raw sewage plus vegetable cannery plus citrus waste. The ditch treated lagoon effluent plus vegetable cannery waste.

<u>August 5 - November 11, 1968</u>

Lagoons continued to treat raw sewage plus vegetable cannery plus citrus waste. A mechanical failure of the ditch rotor occurred on August 5, 1968. Funds for repair of the rotor did not become available until November 1968 and the rotor was repaired and put back into operation in January 1969.

<u>November 11, 1968 - January 4, 1969</u>

The lagoons treated filter effluent plus vegetable cannery plus citrus waste.

<u>January 4 - February 7, 1969</u>

Lagoons treated filter effluent plus vegetable cannery waste plus fruit cannery waste.

Mixed liquor solids were built up in the ditch by the addition of filter effluent.

<u>February 7 - May 15, 1969</u>

Lagoons treated filter effluent plus vegetable plus fruit cannery waste. The ditch treated lagoon effluent.

Table 8. Description of Operational Phases

Period	Lagoon Influent	Ditch Influent
4/1 - 6/1/68	Trickling filter effluent + vegetable cannery waste.	Domestic trickling filter eff. + vegetable cannery waste.
6/1 - 6/18/68	Raw sewage + vegetable cannery + citrus waste.	Raw sewage + vegetable cannery waste.
6/18 - 8/5/68	Raw sewage + vegetable cannery + citrus waste.	Lagoon effluent + vegetable cannery waste.
8/5 - 11/11/68	Raw sewage + vegetable cannery + citrus waste.	Ditch rotor failure.
11/11/68 - 1/4/69	Domestic trickling filter effluent + vegetable cannery + citrus waste.	Ditch rotor failure.
1/4 - 2/7/69	Domestic trickling filter effluent + vegetable cannery = fruit cannery waste.	Domestic trickling filter effluent to establish solids.
2/7 - 5/15/69	Domestic trickling filter effluent + vegetable cannery + fruit cannery waste.	Lagoon effluent.
5/15 - 6/20/69	Filter effluent + vegetable + fruit cannery waste.	Lagoon effluent + vegetable cannery waste.
6/20 - 12/19/69	Raw sewage + vegetable cannery + citrus waste.	Lagoon effluent + raw sewage.
1/8 - 2/11/70	Raw sewage + vegetable + fruit cannery waste.	2 ditches: raw sewage + lagoon effluent.
2/11 - 5/7/70	Raw sewage + vegetable + fruit cannery waste.	2 ditches: lagoon effluent.

May 15 - June 20, 1969

Lagoons treated filter effluent plus vegetable and fruit cannery waste. The ditch treated lagoon effluent plus vegetable cannery waste.

June 20 - December 19, 1969

The lagoon treated a mixture of raw sewage plus vegetable cannery plus citrus waste. The ditch treated lagoon effluent plus raw sewage.

January 8 - February 11, 1970

Lagoons treated raw sewage plus vegetable and fruit cannery waste. Two ditches were in operation treating raw sewage plus lagoon effluent at 3860 ppm and 2050 ppm suspended solids concentration in the mixed liquor.

February 11 - May 7, 1970

Lagoons treated raw sewage plus vegetable and fruit cannery waste. Two ditches were in operation treating lagoon effluent. Suspended solids concentration in the mixed liquor of the two ditches averaged 3230 ppm and 2080 ppm, respectively.

SECTION VII

OPERATION & EVALUATION PHASE -- ANAEROBIC LAGOONS

During the period of the Grant the lagoons treated mixtures of raw sewage or filter effluent together with fruit canning waste or vegetable canning wastes. A summary of the various operations carried out from April 1, 1968, to May 7, 1970, is presented in Table 8. The performance of the lagoons over the various periods is summarized in Tables 9, 10, and 11. Detailed analyses of lagoon influent, lagoon effluent analyses, and field observations are presented in the Appendix.

April 1 - June 1, 1968

During this period filter effluent from the Shepparton Treatment Plant was combined with vegetable cannery waste and fed to the lagoons at 190 lbs/acre/day. Influent BOD was 123 ppm and effluent 11 ppm, a removal of over 90%. The influent contained 25 ppm total nitrogen and 1.4 ppm phosphate which provided adequate nutrients for the organic carbon present. The lagoon functioned satisfactorily at a moderate loading under autumn temperatures (12°C). The green algae Chlorella was present at a level of 400,000 orgs/ml and dissolved oxygen was present (5 ppm) in the effluent.

June 1 - November 11, 1968

The Shepparton Sewerage Authority sludge digesters and trickling filters were not operated over this period and the lagoons treated a mixture of raw sewage combined with vegetable and citrus waste. The organic loading on the lagoons averaged 360 lbs BOD/acre/day with an influent BOD of 420 ppm. Over the whole period, 80% of the applied BOD load was removed. Water temperature varied from 11°C in the winter months to over 20°C in the late spring in October and November. An adequate balance of nutrients was always present with a total nitrogen content of 60 ppm and phosphorus 11 ppm. The lagoons performed satisfactorily with regard to BOD removal although the algal population dropped to only 40,000 orgs/ml during July, August, and early September, the winter months. It had recovered to 300,000 orgs/ml by October, with Chlorella being the predominant organism. Dissolved oxygen also disappeared over this period and some sulphide odors developed. In September dissolved oxygen was present in the supernatant but then disappeared until early November.

November 11, 1968 - January 4, 1969

The conventional treatment plant provided primary and secondary treatment of the town sewage, so that secondary effluent was combined with vegetable plus citrus waste and treated in the anaerobic lagoons. The strength of the combined wastes was similar to that of the previous period, but the flows available were split between two lagoons giving a much lower individual loading of 140 lbs/acre/day with an average influent BOD of 480 ppm. The total nitrogen was 44 ppm with 27 ppm of phosphate. Purification of 85%

Table 9. Performance of Anaerobic Lagoons

Date	Nature of Waste Treated	Load lbs/acre/day	BOD Removal lbs/acre/day	BOD Removal %	Influent Comp. (ppm) BOD	Influent Comp. (ppm) N	Influent Comp. (ppm) PO_4
4/1 - 6/1/68	Filter effluent + vegetable cannery waste.	190	171	90	123	25	1.4
6/1 - 11/11/68	Raw sewage + vegetable cannery + citrus waste.	360	290	80	420	60	11
11/11/68 - 1/4/69	Filter effluent + vegetable cannery + citrus waste.	140	120	85	480	44	27
1/4 - 2/7/69	Filter effluent + vegetable + fruit cannery.	227	195	86	630	37	20
2/7 - 6/20/69	Filter effluent + vegetable + fruit cannery.	250	190	75	580	30	7
6/20 - 12/19/69	Raw sewage + vegetable cannery + citrus waste.	105	84	80	520	50	25
1/8 - 5/7/70	Raw sewage + vegetable + fruit cannery waste.	600	Lagoon 1: 330 Lagoon 2: 240	Lagoon 1: 55 Lagoon 2: 40	2,100	36	

Table 10. Summary of Lagoon Performance*

	BOD (ppm)	pH	Total N (ppm)	PO_4 (ppm)	SS (ppm)	DO (ppm)	Flow gal/day
6/1 - 11/11/68							
Influent	416	6.0	60.4	10.8	340	---	---
S_2 Effluent	127	7.0	46.6	7.9	130	0.5	800,000
S_3 Effluent	103	7.2	58.7	17.1	180	1.3	350,000
11/11/68 - 1/4/69							
Influent	477	5.2	43.9	11.8	260	---	---
S_2 Effluent	67	7.1	38.8	19.0	230	5.0	409,000
S_3 Effluent	62	7.2	35.0	20.0	240	5.6	325,000
1/4 - 2/7/69							
Influent	630	5.9	37.0	20.4	190	---	---
S_2 Effluent	94	7.2	34.4	9.6	420	3.0	445,000
S_3 Effluent	65	7.2	29.1	20.6	150	6.6	445,000
2/7 - 5/15/69							
Influent	650	4.9	32.2	7.1	250	---	---
S_2 Effluent	190	6.7	31.5	7.8	290	0.6	520,000
S_3 Effluent	170	6.9	29.3	6.0	310	3.0	385,000
5/22 - 6/20/69							
Influent	315	6.3	23.5	9.3	140	---	---
S_2 Effluent	61	6.5	19.8	3.2	150	2.9	510,000
S_3 Effluent	52	6.6	19.8	1.8	200	0.7	330,000
6/20 - 12/19/69							
Influent	530	5.8	52.2	23.0	265	---	---
S_2 Effluent	92	6.6	37.1	16.7	110	4.0	170,000
S_3 Effluent	113	6.8	33.2	20.0	145	4.8	213,000
1/8 - 2/12/70							
Influent	1580	4.3	36.0	5.9	330	---	---
S_2 Effluent	300	6.2	24.7	19.3	235	4.4	262,000
S_3 Effluent	290	6.2	26.1	18.0	280	6.1	282,000
2/12 - 5/7/70							
Influent	2080	4.6	35.7	4.0	617	---	---
S_2 Effluent	1330	4.8	26.1	23.9	181	0	328,000
S_3 Effluent	1734	4.7	36.8	21.4	133	0	248,000

*Average values.

Table 11. Summary of Lagoon Performance*

	BOD (ppm)	pH	Total N (ppm)	PO_4 (ppm)	SS (ppm)	DO (ppm)	Flow Thousand gal/day
6/1 - 11/11/68							
Influent	212- 736	4.8-7.5	28.6-87.3	0.6-34.8	170-830	---	---
S_2 Effluent	24- 300	6.6-7.9	22.2-84.4	0.4-23.1	20-380	0- 4.4	145-1200
S_3 Effluent	17- 170	6.8-8.1	42.1-75.8	0.6-25.2	10-370	0- 3.3	145- 752
11/11/68 - 1/4/69							
Influent	196- 870	4.8-5.9	28.0-58.7	3.5-20.5	130-430	---	---
S_2 Effluent	30- 151	6.7-7.3	25.1-54.1	2.3-24.0	50-380	Nil-10.5	260- 640
S_3 Effluent	30- 119	6.8-7.6	26.4-43.2	3.6-27.0	30-440	Nil-13.6	160- 585
1/4 - 2/7/69							
Influent	158- 785	4.8-6.8	31.9-44.0	20.0-20.7	90-270	---	---
S_2 Effluent	82- 104	6.9-7.3	31.9-36.4	8.2-11.0	270-770	1.4- 4.4	392- 480
S_3 Effluent	51- 79	6.5-7.7	25.6-30.5	15.3-26.0	100-200	2.7-10.5	392- 480
2/27 - 5/15/69							
Influent	130-2500	4.2-7.3	14.1-43.2	3.0-11.2	20-790	---	---
S_2 Effluent	42- 415	4.7-7.4	19.9-46.4	2.0-20.5	150-370	Nil- 5.2	259- 820
S_3 Effluent	37- 320	5.6-8.9	14.6-62.8	0.6-26.8	110-490	Nil-11.3	259- 496

*Range of values.

Table 11. Summary of Lagoon Performance* (Cont'd)

	BOD (ppm)	pH	Total N (ppm)	PO_4 (ppm)	SS (ppm)	DO (ppm)	Flow Thousand gal/day
<u>5/22 - 6/20/69</u>							
Influent	182- 426	6.1-6.6	8.5-28.4	7.6-11.0	50-300	---	---
S_2 Effluent	46- 70	6.5-6.6	15.3-20.5	2.8- 3.6	100-220	Nil- 6.8	410- 576
S_3 Effluent	24- 82	6.5-6.7	18.7-21.4	1.7- 2.0	140-260	Nil- 1.5	320- 368
<u>6/20 - 12/19/69</u>							
Influent	127- 755	4.7-7.2	34.6-68.5	6.3-37.5	110-440	---	---
S_2 Effluent	38- 193	6.2-7.1	22.0-74.8	1.5-30.1	40-410	Nil-19.5	68- 309
S_3 Effluent	20- 204	6.2-7.2	20.1-54.4	3.1-26.1	40-660	Nil-20.0	56- 448
<u>1/8 - 2/12/70</u>							
Influent	1109-2575	3.8-4.9	29.4-43.3	3.7- 7.6	150-590	---	---
S_2 Effluent	78- 795	5.0-7.6	21.6-34.3	18.4-20.2	20-720	Nil-11.6	131- 336
S_3 Effluent	50- 795	5.0-7.4	23.5-29.5	11.5-22.6	60-900	Nil-15.0	226- 346
<u>2/19 - 5/7/70</u>							
Influent	425-3485	3.8-5.4	9.2-58.4	2.1- 6.6	50-510	---	---
S_2 Effluent	322-1835	4.3-5.6	14.4-44.3	11.9-29.1	20-400	Nil- 0	242- 400
S_3 Effluent	325-3416	4.3-5.4	27.9-48.5	10.6-31.6	10-450	Nil- 0	166- 288

*Range of values.

was achieved at this loading with an algal population of 350,000 orgs/ml (Chlorella). Dissolved oxygen was present in the lagoon throughout this period, and there were no odor problems.

January 4 - February 7, 1969

The composition of the waste over this period was secondary effluent together with vegetable, citrus, and fruit cannery waste. The BOD loading on the lagoons was 227 lbs/acre/day with an average removal of 86% of the applied BOD. Influent BOD averaged 630 ppm. Total nitrogen averaged 37 ppm with 20 ppm phosphate, which gave a waste well balanced with regard to nutrient content. The algal population in the supernatant during this midsummer period increased to several million orgs/ml (Chlorella).

February 7 - June 20, 1969

During the main fruit canning season, which extends over the first four months of the year with lesser activity for another 2 months, secondary effluent was combined with fruit and vegetable cannery wastes and fed to the lagoons. The strength of the waste was variable with a peak BOD of 2500 ppm in March, falling to a few hundred ppm in the latter part of the season. The average loading was 250 lbs BOD/acre/day. Influent BOD averaged 580 ppm with 75% removal by the anaerobic lagoon. The overall nitrogen content was 30 ppm with 7 ppm phosphorus. Algae were at all times present in the supernatant of the lagoons with an average population of 4 million orgs/ml (Chlorella).

June 20 - December 19, 1969

The fruit canning season had finished and the Sewerage Authority conventional plant had been shut down so that the anaerobic lagoons received a mixture of raw sewage, vegetable cannery and citrus wastes. With only the vegetable cannery operating, the flows over the second half of 1969 were not high and the lagoon BOD loading was 105 lbs/acre/day. The influent BOD was 520 ppm with over 80% removal of applied BOD. Total nitrogen content was 50 ppm with 23 ppm of phosphorus. The algal population of 3 million orgs/ml (Chlorella) was maintained throughout this period indicating that the lagoon was coping easily with the applied loading.

January 8 - May 7, 1970

The usual practice of the Sewage Authority with the onset of the peak fruit canning season in the early months of the year had been to operate the conventional treatment plant treating the town sewage. Secondary effluent from the plant would then be combined with the cannery wastes and the mixture purified in anaerobic lagoons. In this season it was decided not to operate the treatment plant because of the possibility of odors occurring, causing complaints from nearby residents. The Authority was also commissioning a much larger lagoon area consisting of 108 acres of anaerobic ponds followed by 140 acres of aerobic ponds at a new site. Most of the flow was being diverted to the new lagoon area as the new ponds were being brought into operation.

For this period the composition of the waste treated was a mixture of fruit cannery and vegetable cannery waste together with raw sewage. The loading over the whole period was 600 lbs BOD/acre/day. The removal of BOD was only 55% for lagoon S_2 and 40% for S_3. As discussed later, the BOD:nitrogen: phosphate ratio has a considerable influence on performance. As shown in Table 9, the BOD:nitrogen ratio was 60:1 for this period compared with a value of 20:1 for the 1969 fruit cannery operating period.

This reduction in nutrient content would appear to be responsible for relatively poor lagoon performance.

LAGOON SLUDGE CHARACTERISTICS

The lagoons had been operated three years prior to the present project. Sludge samples were collected near the inlet of the lagoons, 30 ft from the influent pipe, at the center of the lagoon, and 30 ft from the outlet weir. Sludge depths were measured at three points at inlet center, and outlet and the averaged results are presented in summary in Table 12. The table also includes results of laboratory analysis for total and volatile solids, laboratory purification index, and gas yield. Detailed results of purification index and gas yield tests are presented in the Appendix. The total solids content of the sludge depended on the depth of sludge at the collection point. A hand sludge pump was used to collect samples and it drew sludge from 1-3 inches above the mud bottom of the lagoon. The amount of volatile solids in the sludge collected varied considerably. In lagoon S_2 the volatile solids were higher at the inlet than the outlet which would be expected but accumulation of the sludge is influenced by the wind direction and at times the effluent sludge had a high volatile solids, indicating movement of sludge from the inlet. The least sludge was always at the center of the lagoons.

Lagoon S_3 sludges do not show the same pattern. The volatile solids are low during the low loading period of June 1969 and show a higher volatile solids content for the inlet in September 1969, but during the high loading period of 1970 there were in fact higher volatile solids in the outlet sludges, probably again due to wind movement of incompletely digested sludge from the inlets.

Purification Index:

The capacity of sludges to contribute to BOD removal in the supernatant water is an important function of their behavior.

To evaluate the activity of different sludges in this regard a detailed study was made to standardize conditions for a laboratory test procedure. As a result of these studies the following method was developed. It has already been described (3).

The test is carried out in a bank of 6 cells each 18 by 8 inches (46 by 20 cm) with a 6 inch (15 cm) depth of water.

Table 12. Sludge Characteristics -- Anaerobic Lagoons

Anaerobic Lagoon	Total Solids (ppm)	Volatile Solids (ppm)	Volatile Solids %	Purif. Index	Sludge Depth (in.)	Gas Yield ml gas/day/gm of Vol.Solids
			Inlet			
(S_2)						
June 1968	38,200	18,900	50	3.9	8	5.3
Nov. 1968	57,940	30,270	52	4.0	8	2.4
Jan. 1969	130,880	30,590	23	3.8	9	1.0
June 1969	88,150	26,380	30	3.2	12	1.0
Sept. 1969	59,860	36,780	62	1.4	9	1.0
Jan. 1970	41,960	25,690	61	3.5	5	1.2
May 1970	59,610	33,060	55	4.8	8	0.6
(S_3)						
June 1969	89,350	23,520	26	2.9	9	1.3
Sept. 1969	45,320	25,780	57	2.2	9	2.2
Jan. 1970	113,250	53,270	47	1.7	4	0.9
May 1970	84,940	39,120	46	4.3	9	0.2
			Center			
(S_2)						
June 1968	13,730	6,850	50	11.4	3	0.9
Nov. 1968	17,430	9,220	53	12.5	3	2.0
Jan. 1969	9,320	4,960	53	24	3	2.2
June 1969					3	
Sept. 1969	24,100	14,150	59	4.1	3	3.9
Jan. 1970	26,490	16,400	62	6.0	3	1.5
May 1970	21,880	10,280	47	16.8	4	5.3
			Outlet			
(S_2)						
June 1968	1,480	7,430	50	12.4	8	2.2
Nov. 1968	22,130	13,900	63	7.6	7	5.0
Jan. 1969	25,000	12,010	48	10.2	5	3.8
June 1969	65,760	16,880	25	3.8	7	2.2
Sept. 1969	35,120	17,110	49	2.1	6	3.8
Jan. 1970	52,520	22,520	43	4.0	6	1.0
May 1970	62,320	29,620	47	5.5	10	0.9
(S_3)						
June 1969	60,390	18,790	31	4.0	6	1.2
Sept. 1969	65,910	20,040	30	2.7	8	2.4
Jan. 1970	51,340	30,640	60	3.0	N.D.	1.2
May 1970	80,000	45,000	56	3.9	6	0.3

The 0.72 gal (U.S.) (2.7 liters) sludge sample is added to each of the cells and the cells are filled to overflow level, at total capacity 3.7 gal (14 liters), with standard synthetic sewage being treated by the sludge.

The synthetic sewage is pumped through the cell by a small pulsating-type pump at the rate of 0.96 gpd (3.6 liters/day) for 14 days, giving a 4-day detention period. The cells are operated at room temperature. Analyses are made on the sludge for total and volatile solids and on the influent and effluent from the cells for BOD and pH.

The index is calculated as pounds BOD removed per acre per day per pound of volatile solids in the sludge, from the formula:

$$\text{Purification Index (P.I.)} = \frac{(B_1 - B_2) \times F \times 36.3}{W \times V}$$

where: B_1 = BOD of influent, mg/l
B_2 = BOD of effluent, mg/l
F = rate of flow, gpd
W = dry weight of sludge added lb
V = percentage of volatile solids in dry weight, percent

i.e., Purification Index is a measure of the BOD removal capacity of sludge in the laboratory lagoon cell related to the surface area (1 sq ft) of the cell.

The figures for lagoon S_2 inlet sludge are fairly constant at between 3.5 and 5.0 for most of the sampling apart from a low figure in September 1969.

Outlet sludge shows considerably higher purification capacity than inlet, with sludges collected from the center of the lagoon having the highest purification capacity as measured by the laboratory test. The purification index figures are generally lower in S_3 lagoon, but the same pattern is maintained in that effluent sludges show the most activity.

Gas Production:

The ability of sludges to produce gas is indicative of the degree of digestion already achieved and the residual of unfermented organic matter. This is determined as described by (3).

The test is carried out as follows:

To a 220 ml sample of sludge, 380 ml of synthetic sewage substrate is added to fill a 20 oz (0.6 liter) bottle. The contents are incubated at the stated temperature and the gas collected by the downward displacement of a confining solution of saturated sodium sulphate plus 15% sulphuric acid in an inverted 100 ml measuring cylinder. The gas yield is measured daily.

The gas yield in lagoon S_2 was high at the inlet in the first sampling but then declined to relatively low figures. Several samples of the effluent sludge exhibited greater activity than the inlet.

Gas yields in lagoon S_3 were lower and did not vary from inlet to outlet. The highest activity was in the spring sampling in September 1969. There was no definite evidence of seasonal variations in activity.

Sludge solids accumulated to some extent during the peak fruit canning season and were not usually digested until the following spring, but by late in the year there was not more than 6 to 8 inches of solids accumulated at the lagoon inlet or outlet. These lagoons have been in operation for up to 5 seasons treating, in the main, fruit cannery waste so that sludge accumulation is not a problem with this type of waste.

INFLUENCE OF BOD:NUTRIENT RATIO ON ANAEROBIC LAGOON PERFORMANCE

Efficiency of purification by oxidative processes such as activated sludge has been shown by many authors to be dependent on the ratio of BOD:nitrogen: phosphate. Very little information has been published with regard to anaerobic processes particularly anaerobic type lagoons.

Complementary to the nutrient studies on the two anaerobic lagoons feeding the oxidation ditch, further investigations were carried out during the 1969 fruit cannery season with two other lagoons known as T_2 and S_1 which were dosed with S.P.C. waste with two different proportions of sewage to achieve two different ratios of BOD to nutrients.

The results of operation of these two lagoons for this season are shown in Table 13.

It will be seen that lagoon S_1 loaded at 520 lbs BOD/acre/day achieved the same percentage BOD removal and a removal of 430 lbs/acre/day compared with lagoon T_2 loaded at only 294 lbs/acre/day which only removed 240 lbs/acre/ day.

The BOD:nitrogen ratio for lagoon S_1 was 87:1 or BOD:N of 100:1.1 compared with a value of 134:1 or 100:0.75.

The performance of the test lagoons S_2 and S_3 as shown for the fruit cannery treatment periods 1/4/69 - 6/20/69 and 1/8/70 - 5/7/70, together with the results shown in Table 13 are summarized in Table 14.

They show the significant influence of BOD:nitrogen value on performance. The ranges studied are well below those considered optimum for oxidative processes (BOD:N = 20) but so far no attempt has been made to determine whether further improvement in performance can be achieved with nutrient contents of this order.

Table 13. Influence of Nutrients on Lagoon Performance

	Lagoon T_2	Lagoon S_1
Area (acres)	15	6
Flow (GPD)		
S.P.C.	209,000	106,000
Sewage	57,000	66,000
Influent load		
BOD (ppm)	1,658	1,810
BOD (lb/day)	4,420	3,120
BOD (lb/acre/day)	294	520
Nitrogen (lb/day)	36	33
BOD:N ratio	134	87
Effluent		
BOD (ppm)	310	304
Performance		
Removal		
BOD (lb/acre/day)	240	430
BOD (%)	81	82

Table 14. Effect of BOD Nutrient Ratio on Lagoon Performance

Period	BOD Load lb/acre/day	BOD Removal lb/acre/day	%	BOD:N Ratio
S_2 & S_3 1/4/69 - 6/20/69	240	190	80	17:1
S_2 1/8/70 - 5/ 7/70	600	330	55	60:1
S_3 1/8/70 - 5/ 7/70	600	240	40	60:1
T_2 1/4/69 - 6/20/69	294	240	81	134:1
S_1 1/4/69 - 6/20/69	520	430	82	87:1

SECTION VIII

OXIDATION DITCH EVALUATION PHASE

During the experimental period an oxidation ditch was run continuously from June 1968 to August 1968, when rotor failure occurred due to faults which had developed in the overall balance of the rotor. Funds were not available for its repair until November 1968 when the damaged section was replaced, stress points eliminated from the whole rotor, and the balance of the rotor carefully checked. After being palced back in operation in January 1969, the rotor then ran continuously until May 1970 apart from a three week shutdown in March 1969 when worn water jacketed bearings were replaced with grease packed roller bearings. Using the experience accumulated from the operation of three earlier rotors over fruit canning seasons of four to five months each, and of the single rotor continuously after six months of continuous running a new improved rotor was designed, built, and put into operation in January 1970. This ran continuously for four months without any operational problems or evidence of significant wear.

A summary of the operation of the oxidation ditches is presented in Table 15 and performance in Tables 16 and 17. The detailed analytical results appear in the Appendix. The various periods of ditch operation and performance are as follows: field observations and power consumption; dissolved oxygen and flow are also shown in the Appendix. Performance and power usage data are summarized in Table 18.

April 1 - June 1, 1968

The ditch treated a mixture of filter effluent plus vegetable cannery waste at a BOD loading of 45 lb/day. Influent BOD was 280 ppm and effluent 9 ppm, a removal of more than 95% over the short period of testing. The flow was 120,000 gpd giving a retention time in the ditch of 12 hours. The mixed liquor suspended solids was 1840 ppm which settled readily. The effluent contained 6 ppm nitrogen and 1.5 ppm phosphate. Power consumption averaged 100 Kwh/day giving a power to BOD ratio of 2.0 Kwh/lb of BOD removed.

June 1-18, 1968

During this short period the ditch was loaded with raw sewage, to build up mix liquor suspended solids, and cannery waste. The load applied was 325 lb/day at an average flow of 109,000 gpd giving approximately 12 hr detention in the ditch. BOD removal was over 95% with an effluent BOD of 5 ppm. Suspended solids in the mixed liquor were built up to 3,200 ppm which settled readily.

The effluent contained 7 ppm total nitrogen and 1.7 ppm phosphate. Power consumption averaged 110 Kwh/day giving a power:BOD ratio of 0.3 Kwh/lb of BOD removed.

Table 15. Oxidation Ditch Operational Details

Period	Ditch Influent
4/ 1/68 - 6/ 1/68	Domestic trickling filter effluent + vegetable cannery waste.
6/ 1/68 - 6/18/68	Raw sewage + vegetable cannery waste.
6/18/68 - 5/ 8/68	Lagoon effluent + vegetable cannery waste.
8/ 5/68 - 11/11/68	Ditch rotor failure.
11/11/68 - 1/ 4/69	Ditch rotor failure.
1/ 4/69 - 2/ 7/69	Domestic trickling filter effluent to establish solids.
2/ 7/69 - 5/15/69	Lagoon effluent.
5/15/69 - 6/20/69	Lagoon effluent + vegetable cannery waste.
6/20/69 - 12/19/69	Lagoon effluent + raw sewage.
1/ 8/70 - 2/11/70	2 ditches: Raw sewage + lagoon effluent.
2/11/70 - 5/ 7/70	2 ditches: lagoon effluent.

Table 16. Ditch Performance*

	BOD (ppm)	pH	Total-N (ppm)	PO_4 (ppm)	SS (ppm)	Settl. Solids %	DO (ppm)	Flow (gpd)	Power Kwh/day
<u>5/30/68</u>									
Ditch Influent	280	6.7	27.1	2.3	160			125,600	
Ditch Effluent	9	7.1	6.3	1.5	--		4.0		
Mixed Liquor					1,840	30			---
<u>6/1/68 - 6/18/68</u>									
Ditch Influent	200	6.8	38.4	2.3	390			137,000	
Ditch Effluent	14	7.0	11.9	1.8	40		3.1		
Mixed Liquor					2,870	58			110
<u>6/18/68 - 8/5/68</u>									
Ditch Influent	130	6.8	34.8	2.2	125			153,000	
Ditch Effluent	27	7.2	27.1	1.4	210		2.8		
Mixed Liquor					1,570	82			130
<u>2/7/69 - 5/15/69</u>									
Ditch Influent	155	7.2	29.9	5.3	280			93,200	
Ditch Effluent	66	7.6	22.1	3.8	140		3.8		
Mixed Liquor					3,010	45			105

Table 16. Ditch Performance* (Cont'd)

	BOD (ppm)	pH	Total-N (ppm)	PO_4 (ppm)	SS (ppm)	Settl. Solids %	DO (ppm)	Flow (gpd)	Power Kwh/day
5/15/69 - 6/20/69									
Ditch Influent	112	6.6	21.3	4.3	120			186,000	
Ditch Effluent	37	6.9	20.6	4.0	95		1.3		
Mixed Liquor					2,750	31			102
6/20/69 - 12/19/69									
Ditch Influent	258	6.4	47.5	24.5	275			92,000	
Ditch Effluent	114**	7.1	35.9	17.3	250		1.2		
Mixed Liquor					2,720				97
1/8/70 - 2/11/70									
Ditch Influent	350	6.1	31.8	25.3	130				
Ditch Effluent D_1	154	6.9	20.0	15.0	170		0.2	38,600	
Ditch Effluent D_2	207	6.9	22.1	17.5	182		0.4	49,000	
Mixed Liquor D_1					3,860	35			94
Mixed Liquor D_2					2,050	15			
2/11/70 - 5/7/70									
Ditch Influent	1,478	4.9	31.7	27.9	194				
Ditch Effluent D_1	425	6.3	20.8	24.7	260		0.7	17,800	
Ditch Effluent D_2	436	6.3	19.7	22.0	108		0.5	15,500	
Mixed Liquor D_1					3,230	50			92
Mixed Liquor D_2					2,080	38			

*Average values.
**45 after filtration to remove algae.

Table 17. Ditch Performance*

	BOD (ppm)	pH	Total-N (ppm)	PO_4 (ppm)	SS (ppm)	Settl. Solids %	DO (ppm)	Flow Thousand (gpd)	Power Kwh/day
6/1/68 - 6/18/68									
Ditch Influent	58- 317	6.7-6.9	28.9-58.2	1.4- 3.2	160- 660		2.3- 4.2	67-192	
Ditch Effluent	3.5- 34	6.7-7.2	4.7-24.2	1.2- 2.3	10- 90				
Mixed Liquor					1960-3450	30-86			89-126
6/18/68 - 8/5/68									
Ditch Influent	62- 246	6.4-7.1	32.1-37.1	2.2	60- 210		0.5- 4.6	67-240	
Ditch Effluent	1- 119	6.9-7.3	23.5-33.1	1.2- 1.6	8- 270				
Mixed Liquor					1040-6405	43-98			125-135
2/7/69 - 5/15/69									
Ditch Influent	45- 252	6.6-8.9	22.3-47.9	1.2-13.5	40- 480		Nil-15.5	41.6-135	
Ditch Effluent	16- 145	6.7-8.9	19.1-40.0	1.5- 9.0	20- 420				
Mixed Liquor					1710-4580	20-90			92-125
5/15/69 - 6/20/69									
Ditch Influent	47- 174	6.6-6.7	18.1-23.0	2.0- 6.6	20- 300		Nil- 2.1	125-269	
Ditch Effluent	8- 66	6.8-6.9	18.9-22.6	3.1- 5.0	40- 164				
Mixed Liquor					2560-2940	22-46			99-104
6/20/69 - 12/19/69									
Ditch Influent	79- 493	5.4-7.2	23.9-75.3	13.2-39.0	70- 780		Nil- 5.1	57.7-195	
Ditch Effluent	5- 168	6.2-7.2	22.1-49.7	10.4-30.0	20- 430				
Mixed Liquor					520-5540	5-46			85-114
1/8/70 - 2/11/70									
Ditch Influent	173- 795	5.1-7.0	27.9-37.9	22.9-28.9	80- 190				
Ditch Effluent D_1	44- 267	6.4-7.4	18.6-20.9	15.5-19.9	30- 240		Nil- 0.5	9.2- 55	
Ditch Effluent D_2	101- 362	6.5-7.3	16.0-20.0	10.5-24.6	40- 360		Nil- 1.0	18.2-58.3	
Mixed Liquor D_1					2420-5380	20-46			91-102**
Mixed Liquor D_2					760-2560	7-20			
2/11/70 - 5/7/70									
Ditch Influent	332-2360	4.3-6.7	18.3-44.0	12.0-53.4	10- 600				
Ditch Effluent D_1	8-1212	4.8-7.1	5.8-32.1	10.1-45.0	10- 920		Nil- 4.5	8- 48	
Ditch Effluent D_2	20-1208	4.8-7.2	6.0-34.0	21.9-22.0	10- 190		Nil- 4.0	8- 31	
Mixed Liquor D_1					660-5640	21-97			86-108
Mixed Liquor D_2					820-3120	22-97			

*Range of values.
**Power consumption was not measured separately for each ditch. Ditch 1 amp were 11.5; Ditch 2 12.5 amp.

Table 18. Summary of Ditch Performance and Power Consumption

Period	LOAD		PERFORMANCE			POWER CONSUMPTION
	lb BOD/day	lb BOD/day/ ft of Rotor	lb BOD Removed/day	lb BOD Removed/day/ ft of Rotor	% Removal	Kwh/lb of BOD Removed/day
4/ 1/68 - 6/ 1/68	45	3.8	43	3.6	95	2.0
6/ 1/68 - 6/18/68	325	27	310	26	95	0.3
6/18/68 - 8/ 5/68	180	15	145	12	80	0.9
8/ 5/68 - 2/ 7/69			Ditch Rotor Out of Order			
2/ 7/69 - 5/15/69	140	12	75	6.2	55	1.4
5/15/69 - 6/20/69	190	16	130	11	65	0.8
6/20/69 - 12/19/69	250	21	210	18.1	83	0.4
1/ 8/70 - 2/11/70 D_1	150	12.5	90	7.5	62	1.1
D_2	150	12.5	78	6.5	52	1.2
2/11/70 - 5/ 7/70 D_1	250	21	175	14.6	70	0.48
D_2	230	19	161	13.4	70	0.52

June 18 - August 5, 1968

As the lagoon effluent had declined in BOD value the ditch was operated with a mixture of vegetable cannery waste and lagoon effluent at an average loading of 180 lb BOD/day over the whole period with an average removal of 80%. Early in July heavy rain occurred at Shepparton causing a sudden hydraulic overload of the mixed liquor settling tank. A significant proportion of the solids was lost before the excess flow was cut off and mixed liquor suspended solids dropped to 640 ppm with little purification of the waste load. The ditch recovered rapidly after flows had returned to normal and within two weeks the mixed liquor suspended solids was 1360 ppm and the ditch was treating a load of 217 lb/day achieving a BOD removal of more than 95%.

August 5, 1968 - February 7, 1969

On August 5, 1968, an outer section of the cage rotor fractured and jammed the rotor. The rotor was repaired by late December, mixed liquor solids were built up in January and the ditch was replaced back into full operation by February 7, 1969.

February 7 - May 15, 1969

The anaerobic lagoons treated a mixture of filter effluent and vegetable and fruit cannery waste. The ditch purified lagoon effluent at a loading of 140 lb of BOD daily. The flow averaged 93,200 gpd giving approximately 16 hours detention in the ditch. The mixed liquor suspended solids content ranged from 1710 ppm to 4580 ppm during this period (averaged 3010 ppm) and settled readily. During this period ditch influent BOD averaged 155 ppm which was comparatively low due to the effectiveness of the anaerobic lagoon treatment. Effluent BOD, however, was 66 ppm only slightly better than 55% removal. Influent nitrogen averaged 29.9 ppm with 5.3 ppm phosphate and the mixed liquor temperature was 20°C, so that the unexpectedly poor performance of the ditch could not be due to lack of nutrients or low temperature. It was noted, however, that the algal population in the ditch was 2 million organisms/ml Chlorella and it was decided to perform BOD tests after this period on the effluent plus a sample that had been filtered to exclude BOD due to algal decomposition. (From July 1969 until December 1969 ditch influent BOD averaged 258 ppm while the BOD of ditch effluent which had been filtered to remove algae averaged 45 ppm compared with unfiltered effluent BOD of 114 ppm.) Effluent nitrogen was 22.1 ppm with 3.8 ppm phosphate. Average power consumption was 102 Kwh/day giving a power: BOD ratio of 1.4 Kwh/lb of BOD removed which is not consistent with previous experience. The value based on an algal free effluent would have been 0.48 Kwh/lb BOD.

May 15 - June 20, 1969

The anaerobic lagoon was still treating filter effluent plus vegetable and fruit cannery waste. Because of the decreasing BOD of the anaerobic lagoon effluent (69 ppm on May 15, 1969) vegetable cannery waste was added to the ditch to increase the BOD load without hydraulic overload. One hundred ninety lb/day of BOD was added to the ditch with 65% removal (influent BOD was 112 ppm and effluent BOD averaged 37 ppm). The average flow was 186,000 gpd giving a retention time of 8 hr in the ditch. In spite of heavy rain on May 29, 1969, mixed liquor suspended solids were maintained at an average of 2750 ppm during this period. Total nitrogen content of the effluent averaged 20.6 ppm with 4 ppm phosphate. The average power consumption was 102 Kwh/day giving a high ratio of 0.8 Kwh of power used/ lb of BOD removed.

June 20 - December 19, 1969

The anaerobic lagoons treated raw sewage plus vegetable cannery waste. The oxidation ditch treated a mixture of raw sewage and lagoon effluent at a loading of 250 lb of BOD daily at a flow rate of 92,000 gpd (14 hr detention in the ditch). Mixed liquor suspended solids averaged 2720 ppm over this period. The effluent nitrogen content averaged 35.9 ppm with 17.3 ppm of phosphate. The BOD removal averaged 83% after algae had been filtered from the effluent. Power usage averaged 87 Kwh/day, a much lower figure than for most previous periods equivalent to 0.4 Kwh/lb of BOD removed.

January 8 - February 11, 1970

The new rotor had been installed for this period in ditch 1 and both rotors were operated for the remainder of the grant period (the original rotor was in ditch 2).

The anaerobic lagoons were treating a mixture of raw sewage, vegetable cannery and fruit cannery wastes. The ditches treated a mixture of raw sewage and lagoon effluent. The load on each ditch was 150 lb BOD/day. The flow averaged 38,600 and 49,000 gpd to ditches 1 and 2, respectively, giving a detention time of about 32 hours in each ditch.

Ditch 1 with the new rotor was operated with a higher suspended solids content of the mixed liquor (3860 ppm average) and effluent BOD averaged 154 ppm, a removal of 62%. Effluent nitrogen content averaged 20 ppm with 15 ppm phosphate. Because of the low BOD load, power consumed/lb of BOD removed was 1.1 Kwh.

Ditch 2 operated at a mixed liquor suspended solids content of 2050 ppm and BOD removal averaged 52% with an effluent BOD of 207 ppm. Effluent nitrogen content averaged 22 ppm with 17 ppm phosphate. Again because of the low BOD load, the power/BOD ratio was 1.2 Kwh/lb of BOD removed. Over the last week of this period the strength of the lagoon effluent increased sharply as the effect of the high strength fruit cannery waste appeared in the anaerobic lagoon effluent.

February 11 - July 5, 1970

Both ditches treated anaerobic lagoon effluent from treatment of raw sewage, vegetable cannery and fruit cannery wastes. The load on ditch 1 with the new rotor was 250 lb of BOD/day with a removal of 70%. Because of the extremely high strength of the anaerobic lagoon effluent (1480 ppm) only 17,800 gpd was treated giving greater than three days detention time in the ditch. The suspended solids content of ditch 1 averaged 3230 ppm with the solids settling readily. Effluent BOD averaged 425 ppm. The nitrogen content of the effluent was 21 ppm with 25 ppm phosphate. Power/BOD removed ratio was 0.48 Kwh/lb of BOD removed.

The load on ditch 2 with the original rotor was 230 lb of BOD/day with a removal of 70%. The flow was 15,500 gpd giving greater than three days retention capacity in the ditch. Suspended solids content averaged 2080 ppm in the mixed liquor and settled readily.

Effluent BOD averaged 436 ppm with a nitrogen content of 20 ppm and 22 ppm phosphate. Power used was 0.52 Kwh/lb of BOD removed.

SECTION IX

BACTERIOLOGICAL AND ALGAL ASPECTS

BACTERIOLOGICAL EXAMINATION

Periodic examinations of the lagoon influent and effluent and the ditch influent and effluent were made to determine the efficiency of bacterial removal by the two processes. The results are shown in the Appendix. Average results are shown in Table 19.

Table 19. Bacteriological Examination*

Sample	E. Coli I	Confirmed Coliform Count
Anaerobic lagoon influent	18,000,000	105,000,000
Anaerobic lagoon effluent	400,000	2,500,000
% Removal	98%	97%
Oxidation ditch influent	14,000,000	166,000,000
Oxidation ditch effluent	300,000**	7,600,000
% Removal	97%	96%

*Averages for April 19, 1968, to May 7, 1970, in organisms/100 ml.
**Atypical result of May 7, 1970, not included in average.

On September 5, 1968, under winter low flow conditions, after approximately 150 days detention in lagoons, the lagoon effluent had an E. Coli count of 5 organisms/100 ml with a coliform count of 70 organisms/100 ml. The anaerobic lagoon influent over the two year period averaged 18,000,000 E. Coli/100 ml and 105,000,000 coliform/100 ml.

Effluent counts over the same period averaged 400,000 E. Coli and 2,500,000 coliforms, i.e., over 95% removal of organisms. Percentage removals on individual dates varied from 45% on June 5, 1959, to over 99% on September 4, 1969. The lower removal figure could have been caused by some short circuiting of the pond contents. Remvoals of over 95% of the bacterial count by anaerobic lagoon treatment are in line with previous experience.

The ditch influent and effluent were examined on eight occasions over the period June 4, 1968, through May 7, 1970. Average bacterial removals were over 95% but the effluent nevertheless had a high bacterial count and would require chlorination to reduce the count to low levels (100 organisms/100 ml or less).

ALGAL COUNTS

Weekly algal counts were made on the anaerobic lagoon effluents and on the ditch influent and effluent. Average results are shown in Table 20 and the weekly counts are shown in the Appendix. Algae were present in the lagoon effluent at all times. On most occasions the predominant organism was Chlorella which was usually present at a concentration of greater than 1,000,000 organisms/ml. An algal population can be maintained in an anaerobic lagoon above an actively digesting anaerobic sludge, with conditions of complete anaerobiosis and methane fermentation of the waste on the bottom of the lagoon.

Oxidation ditch treatment of the lagoon effluent did not substantially reduce the algal population in the effluent and high algal counts were usually obtained in the ditch effluent.

Table 20. Average Algal Counts*

Period	S_2 Effluent	S_3 Effluent	Ditch Influent	Ditch Effluent
4/ 1/68 - 6/ 1/68	400,000	---	4,000,000	600,000
6/ 1/68 - 6/18/68	800,000	---	---	500,000
6/18/68 - 8/ 5/68	700,000	---	---	400,000
8/ 5/68 - 11/11/68	150,000	---	---	---
11/11/68 - 1/ 4/69	300,000	---	---	---
1/ 4/69 - 2/ 7/69	1,700,000	---	3,000,000	2,800,000
2/ 7/69 - 5/15/69	4,000,000	4,000,000	6,000,000	900,000
5/15/69 - 6/20/69	2,000,000	2,000,000	1,800,000	1,400,000
6/20/69 - 12/19/69	3,000,000	3,000,000	4,000,000	2,600,000
1/ 8/70 - 2/11/70	1,300,000	6,000,000	3,000,000	3,000,000 (D_1) 3,000,000 (D_2)
2/11/70 - 5/ 7/70	600,000	2,500,000	4,000,000	2,100,000 (D_1) 2,700,000 (D_2)

*Organisms/ml.

SECTION X

DISCUSSION

PERFORMANCE OF ANAEROBIC LAGOON PROCESS

The operation of the anaerobic lagoons for two years has shown that a BOD reduction of 75 to 85% can be achieved with loading up to 400 lb/acre/day. The period of loading at 600 lb/acre/day was associated with a very high BOD/nutrient ratio and in view of five years experience with other lagoons it is considered that provided the BOD:nitrogen ratio is held below 50:1 a load of 600 lb/acre/day with 80% removal (480 lb BOD/acre/day removed) can be achieved.

SLUDGE

The capacity of lagoon sludges to remove BOD as measured by the laboratory purification index was reasonably constant for inlet sludges and did not change appreciably with the nature of the waste load or the season of the year. Outlet sludges generally possessed greater BOD purification capacity than those taken near the lagoon inlet. This is in line with previously reported work.

The gas activity of inlet sludges was highest at the beginning of the project and gradually stabilized under the relatively constant BOD loading conditions existing. There was some initial stimulation of gas yield in outlet sludges but this again stabilized to lower figures over the latter portion of the grant period.

NUTRIENTS

While the main objective of the project was to establish the reliability of the two stage process, some study was made of the influence of nutrients on BOD removal. Operation of lagoons with a range of BOD:nitrogen ratio achieved by varying the cannery waste:sewage flow ratio gave definite evidence of increased performance as the BOD:nitrogen ratio was reduced below 134:1.

It would appear, although very low ratios were not examined, that the optimum ratio is of the order of 50:1.

OXIDATION DITCH

The oxidation ditch stage of the process was marred initially by mechanical problems with bearing failure and metal fatigue cracking of the rotor bars. The newly designed rotor used at the latter stage of the project gave trouble free operation over the five month period of use.

The process showed no difficulty in maintaining sufficient solids content in the mixed liquor. It was found that the algal population of the lagoon effluent was carried through to the final effluent.

Considerable difficulty was experienced in maintaining the required load on the ditches owing to fluctuating BOD of the raw waste and consequent variations in the BOD of the lagoon effluent used as influent to the ditches. The BOD removal was consistent with earlier observations and under full load was of the order of 25 lb BOD/day/ft length of rotor. The power requirement was 0.4 to 0.5 Kwh/lb BOD removed.

The effect of overload on performance was demonstrated during the second fruit cannery season (1970). Despite an increase in the final effluent BOD to over 400 ppm a satisfactory fast settling sludge was maintained throughout.

The only operational factor which caused upset to the process was very heavy rain. This raised the level of water over the lagoon effluent weirs inducing a very considerable increase in flow into and out of the ditch. This increased flow through the final sedimentation tank caused sludge to rise over the weir and be lost. However, sludge solids were rebuilt within a matter of two weeks.

SECTION XI

COST PROJECTIONS

The Shepparton Sewerage Authority was obliged to make a decision concerning the design of new full-scale facilities to treat all of both raw cannery wastes and all the city sewage including abattoirs and butter factory after primary sedimentation and sludge digestion at the existing sewage treatment plant, while the Demonstration Project was in progress. Based on all the earlier experience and the early results of the demonstration project, a decision was made to treat initially by means of the anaerobic-aerobic lagoon system, in preference to anaerobic lagoon-oxidation ditch system. With regard to capital cost there was a slight advantage to the anaerobic lagoon-oxidation ditch but when power costs were considered the annual charge based on local rates, interest, and amortization and running costs, the anaerobic-aerobic lagoon system was preferred.

The installation has now been constructed and actual costs are available for the construction of the anaerobic units to treat this combined cannery-sewage effluent flow of 4 mgd with a BOD load of 70,000 lb/day.

They are as follows:

Land (@ $300/acre)	$35,000
Earth work (@ 35 cents/cu yd)	$40,000
Distribution pipes (inlets and outlets)	$24,000
	$99,000

With regard to oxidation ditch costs, data can be established from those used in the demonstration project. Based on a performance of 25 to 30 lb BOD/day/ft length of rotor and other established design parameters, there would be required in conjunction with the 110 acres of anaerobic lagoons, seven oxidation ditch units of similar dimensions to those observed in the demonstration project.

Concrete work (including channels)	$ 65,000
Rotors, motors, and gears (14)	$ 25,000
Electrical	$ 2,000
Sedimentation tank	$ 25,000
Miscellaneous	$ 7,000
Total	$114,000

Running Cost

Power for peak fruit cannery season only (3 months at 2 cents/Kwh)	$ 12,600
Maintenance	$ 5,000 p.a.

Summary of Costs for Load of 70,000 lb BOD/day Capital

lagoons	$ 99,000
ditches (7)	$114,000
	$213,000

Monthly Operating Cost

Power	$ 1,800
Maintenance	$ 400
Labor	$ 400
	$ 2,600

SECTION XII

ACKNOWLEDGEMENTS

The support of the Chariman (Councillor V. E. Vibert) and members of the Shepparton Sewerage Authority is gratefully acknowledged. In making available existing anaerobic lagoons and oxidation ditches previously constructed by the Authority, for the Demonstration Project a substantial constribution was made towards the progress of the project. Their interest in the progress of the study is sincerely appreciated.

The Chief Engineer (Mr. L. Plumridge) and the Deputy Engineer (Mr. L. Purdy) of the Shepparton Preserving Co. gave considerable assistance with information concerning cannery operation and flows.

Similar assistance was given by Mr. J. Davenport, General Manager of Campbells Soup (Aust.) Pty. Ltd. and this is also acknowledged with sincere thanks.

The Chief Engineer of the Shepparton Sewerage Authority Mr. W. C. Johnson (dec.) and later Mr. H. W. Terrill and particularly Mr. G. G. Porter, Deputy Engineer, gave valuable support. Our thanks are particularly due to Mr. R. Maher who was responsible for the day-to-day supervision of the operation and to Mr. C. Katerelos of Melbourne Water Science Institute Ltd. who was responsible for a large part of the field observations. A major part of the laboratory work was carried out by Mr. G. P. Skerry.

The project Director was Mr. C. P. Parker of Melbourne Water Science Institute Ltd. and the EPA Project Officer was Kenneth A. Dostal of the National Environmental Research Center, Corvallis, Oregon.

SECTION XIII

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SECTION XIV

APPENDICES

Table 1. Raw Sewage Composite

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm	TDS ppm
6/ 4/68	220	8.0	12.5	29.4	5.02	200	624
6/12/68	255	7.6	45.0	45.2	4.50	210	678
6/18/68	270	7.3	45	38.4	3.83	310	698
6/25/68	260	7.3	50	34.4	2.85	390	718
7/ 2/68	217	8.2	55	37.8	2.80	580	752
7/ 9/68	316	6.8	50	43.1	4.10	260	682
7/17/68	305	7.4	45	49.7		350	758
7/23/68	296	6.9	55	42.3		160	748
7/30/68	271	7.3	50	51.1		380	690
8/22/68	795	6.3	35	83.9	25.65	500	1370
8/29/68	858	5.4	35	104.2		490	1188
9/ 5/68	900	5.0	40	70.5	3.2	460	1268
9/13/68			40		32	1140	1102
9/19/68	820	5.1	30	90.4		480	
9/25/68	720	5.7	55	100.9		510	
10/ 4/68	680	5.3	45	85.1		480	
10/10/68	1042	5.3	40	86.2		500	
10/17/68		4.9	40				
10/23/68	1050	5.0	40	103.9	45	590	
11/ 1/68	1118	5.3	40	124.1		450	
11/ 8/68	1048	5.3	45	95.8	36.3	640	
Average	602	6.6	42	69.3	15.0	450	865
11/14/68	1072	5.0	40	70.0	6.3	410	
11/20/68	440	6.6	40	32.3	24.0	550	
11/28/68	340	6.8	60	28.6	44.5	160	
12/ 6/68	336	6.6	50	27.4	32.3	100	
12/13/68	327	6.6	45	10.3		80	
12/20/68	223	6.6	50	22.7	38.5	200	
Average	456	6.2	47	30.2	29.1	250	
5/22/69	25			10.0		160	
6/ 6/69	233				3.3	356	

Table 1. Raw Sewage Composite (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm	TDS ppm
6/27/69	377	8.5	45		36.0	560	
7/ 4/69	486	7.9	50			310	
7/11/69	306	7.7	55		35.0	410	
7/18/69	397	6.8	50	29.0	28.2	320	
7/25/69	419	7.6	45	29.5		320	
8/ 1/69	457	7.4	35	49.5		380	
8/ 8/69	358	7.1	4.0	16.5	31.0	280	
8/15/69	520	7.6	45	24.9		250	
8/22/69	920	5.7	40	53.6		520	
8/29/69	892	5.7	35			490	
9/ 4/69	1034	5.0	30.0	47.5	53.5	390	
9/12/69	1170	4.7	40	10.4		660	
9/19/69	512	5.2	35	58.3		810	
9/24/69	1286	5.1	40	71	55.0	520	
10/ 3/69	1395	5.1	40	72.1		660	
10/10/69	1086	5.1	40.0	77.6	42.2	640	
10/17/69	1070	5.3	4.5	63.4	36.3	520	
10/24/69	965	5.1	40.0	62.5	44.3	480	
10/31/69	744	5.4	50.0		26.0	330	
11/ 7/69	924	4.7	35.0		14.0	400	
11/13/69	786	5.1	40		14.4	230	
11/20/69	1118	4.8				510	
11/27/69	1120	4.9			12.7	540	
12/ 4/69	970	5.2	50.0	58.2		600	
12/12/69	940		60.0	5.6		240	
12/19/69	731					610	
Average	755	5.9	40	43.1	30.8	440	
1/ 8/70	659	7.7				270	
1/16/70	558	6.8				160	
1/22/70	1010	5.8	50.0	18.9	1.8	230	
1/30/70	532	5.6	45.0			280	
2/ 5/70	770	6.4	50.0	29.3	47.0	440	
Average	664	6.5	47	22.4	27.0	260	
2/19/70	430	6.3	80	23.5	46	180	
2/27/70	594	6.4	50	25.4	41	370	
3/ 6/70	472	5.8	45	30.1	38.7	320	
3/13/70	472	6.1	45			500	
3/20/70	620	6.4	35		36.5	520	
3/26/70	425	6.5	30			230	
4/ 6/70	540	6.4	35				
4/ 9/70	670	6.4	50	28.0		360	
4/17/70	510	6.4	50			200	
4/23/70	104	6.6			16.5	100	
5/ 7/70	350	6.5			53.8	60	
Average	440	6.3	47	26.8	38.8	284	

Table 2. Filter Effluent Composite

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm
1/10/69	420	6.9	50		19.5	400
1/24/69	294	6.9	45		31.3	60
1/30/69	294	6.9	55	29.7	4.6	260
2/ 7/69	242	6.7	50	21.9		130
Average	312	6.9	50	25.8	18.5	210

Table 3. Campbells Soup Vegetable Cannery Composite

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm	TDS ppm
6/ 4/68	276	5.2	0.1	21.3	2.07	210	388
6/12/68	322	5.6	3.4	34.8	1.33	210	374
6/18/68	375	5.8	0.8	39.2	2.70	270	336
6/25/68	340	9.7	10.0	60.8	1.3	570	282
7/ 2/68	335	5.1	2.5	40.0	0.3	590	376
7/ 9/68	462	5.9	2.0	44.2	1.9	480	582
7/17/68	221	5.3	2.0	39.3		350	378
7/23/68	712	5.8	1.0	49.7		390	252
7/30/68	190	6.0	1.2	23.0		300	274
8/22/68	594	5.6	1.4	31.5	2.82	300	588
8/29/68	468	6.6	1.7	33.0		210	628
9/ 5/68	401	6.5	1.4	36.0	0.4	460	588
9/13/68			1.4		2.8	210	354
9/19/68	325	5.8	1.7	30.2		230	
9/25/68	568	5.8	1.0	36.5		390	
10/ 4/68	438	5.1	1.4	43.9		250	
10/10/68	521	4.4	1.4	48.8		320	
10/17/68		6.5	2.0				
10/23/68	286	6.1	2.5	29.5	5.3	540	
11/ 1/68	285	6.3	1.7	24.4		260	
11/ 8/68	338	6.5	2.5	50.3	10.1	250	
Average	398	6.0	2.1	37.7	2.8	340	410
11/14/68	596	5.5	1.7	34.7	2.0	150	
11/20/68	436	6.3	1.4	28.8	6.7	260	
11/28/68	340	6.1	4.5	15.5	6.3	230	
12/ 6/68	364	4.7	1.7	13.8	6.8	90	
12/13/68	391	5.6	1.4	29.3		210	
12/20/68	433	4.2	2.5	17.3	9.0	180	
Average	425	5.9	2.2	23.0	6.2	190	
1/24/69	387	7.2	3.5		8.2	70	
1/30/69	403	6.1	4.0	8.6	11.7	150	
2/ 7/69	390	6.0	3.0			260	
2/14/69	386	5.9	1.7	11.8		140	
Average	391	6.3	3.1	10.2	10.0	155	

Table 3. Campbells Soup Vegetable Cannery Composite (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm	TDS ppm
2/20/69	270	6.2			7.1	210	
2/28/69	365	4.9	3.0	14.9	6.7	630	
3/ 6/69	278	5.7	1.4	29.9	2.6	210	
3/13/69	71	8.2	1.4	8.7	1.7	80	
3/21/69	579	5.2	1.0		2.1	250	
3/31/69	275	4.7	2.5		3.3	80	
4/ 3/69	340	5.7	2.5		2.2	200	
4/10/69	419	4.8	1.4		3.0	420	
4/18/69	135	5.1	2.5			280	
4/24/69	278	6.8	4.0		3.4	320	
5/ 1/69	272	5.5	2.0	18.6	3.9	140	
5/ 9/69	249	6.1	2.0	13.1		180	
Average	295	5.7	2.1	17.0	3.6	250	
5/22/69	628			31.2		650	
5/30/69		6.1	1.0	17.1		30	
6/ 6/69	197			8.5	31.6	240	
6/13/69	560		5.0	28.8		240	
6/20/69	337	5.6	1.0	17.0	2.4	100	
Average	430	5.9	2.3	20.5		250	
6/27/69	463	5.6	3.0		5.7	420	
7/ 4/69	223	5.8	2.0			130	
7/11/69	16	6.2	2.3		6.4	300	
7/18/69	251	6.8	4.5	31.4	9.4	320	
7/25/69	500	5.1	2.5	23.4		280	
8/ 1/69	291	6.2	3.5	14.7		140	
8/ 8/69	430	5.6	3.0	21.5	7.3	130	
8/15/69	402	9.9	2.5	29.7		360	
8/22/69	210	6.1	1.7	16.9		270	
8/29/69	416	5.2	2.5			140	
9/ 4/69	485	5.4	1.4		4.8	90	
9/12/69	337	8.0	2.5	5.6		280	
9/19/69	16	5.8	2.0	9.7		10	
9/24/69	371	5.3	2.0	10.7	5.0	140	
10/ 3/69	360	7.1	2.5	23.9		160	
10/10/69	263	6.1	2.5	11.3	4.3	140	
10/17/69	349	7.0	5.0	15.7	4.4	140	
10/24/69	517	5.7	3.0	16.8	5.4	230	
10/31/69	318	5.5	2.5		2.0	40	
11/ 7/69	476	4.8	2.0		3.1	260	
11/13/69	143	8.4			1.6	30	
11/20/69	399	8.9	1.0			350	
11/27/69	520	6.0			4.2	200	
12/ 4/69	305	5.9	6.0	10.5		160	
12/12/69	350		10.0	9.4		200	
12/19/69	233					210	
Average	330	6.0	2.7	16.7	4.9	200	

Table 3. Campbells Soup Vegetable Cannery Composite (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm	TDS ppm
1/ 8/70							
1/16/70	545	5.7	3.0	29.9		160	
1/22/70	534	6.6	3.5	14.5	7.5	90	
1/30/70	495	5.8	2.5			130	
2/ 5/70	410	6.1	3.0	16.3	7.3	180	
2/12/70	345	6.2	3.0	11.8	7.8	710	
Average	465	6.1	3.0	18.1	7.5	255	
2/19/70	457	6.3	3.0		7.3	150	
2/27/70	655	4.7	1.7	25.5	7.6	240	
3/ 6/70	486	5.1	2.0	1.7	5.4	1350	
3/13/70	396	5.1	2.0			270	
3/20/70	730	4.9	1.7		7.2	290	
3/26/70	330	5.6	2.0			40	
4/ 6/70	540	5.3	4.0				
4/ 9/70	413	5.9	4.0	7.7		780	
4/17/70	395	5.8	3.5			140	
4/23/70	204	6.9			7.4	10	
5/ 7/70	344	6.6			3.0	100	
Average	450	6.7	2.7	11.6	6.3	337	

Table 4. S.P.C. Fruit Cannery Composite

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm
1/10/69	1490	11.2	2.0		1.0	540
1/24/69	70	5.1	3.0		0.8	130
1/30/69	115	5.2	0.7	46.1	14.0	30
2/ 7/69	2240	6.7	0.7	33.9		690
2/14/69	2380	4.7	1.7	27.9		880
Average	1260	6.6	1.6	36.0	5.3	450
1/ 8/70	821	3.7				370
1/16/70	1500	4.9				340
1/22/70	1935	4.7	1.4	51.1	40.4	170
1/30/70	3030	4.1	2.0			630
2/ 5/70	2750	4.4	3.5	40.3	1.4	510
2/12/70	2765	4.4	1.4	25.1	0.52	820
Average	2140	4.4	2.1	38.0	14	470
2/19/70	3245	3.9	1.7	43.4	2.7	1520
2/27/70	356	4.2	0.7	32.5	1.55	140
3/ 6/70	3280	4.7	1.0	18.0	0.54	900
3/13/70	2660	4.4	2.0			950
3/20/70	3350	5.2	1.4	Nil		630
3/26/70	2550	4.5	1.7			700
4/ 6/70	3680	5.0	1.7			
4/ 9/70	2865	4.8	2.5		Nil	440
4/17/70	3305	4.2	2.0			590
4/23/70	1280	4.4			0.55	380
5/ 7/70	530	5.5			0.92	40
Average	2460	4.6	1.6	23.5	1.0	629

Table 5. Filter Effluent and Fruit Cannery Mixture

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm
2/20/69	1900	3.9			5.0	770
2/28/69	1250	4.7	35.0	36.1	21.9	660
3/ 6/69	2020	5.6	25	46.0	22.5	930
3/13/69	6140	5.6	10.0	22.4	6.5	310
3/21/69	1930	4.7	30		10.3	790
3/31/69	334	5.7	20.0		7.9	140
4/ 3/69	1290	4.8	20		7.2	560
4/10/69	2110	4.7	25		11.6	720
4/18/69	5550	7.4	45			60
4/24/69	85	8.0	40		26.0	230
5/ 1/69		7.1	50	16.5	12.5	140
5/ 9/69	95	7.0	40	11.6		80
5/15/69		7.0		15.9		50
Average	2060	5.9	31	24.7	13.1	420
5/22/69	523			21.5		390
5/30/69		7.1	50	121.8		100
6/ 6/69	99			13.8	25.4	272
6/13/69	120		27.5	11.8		240
6/20/69	97	7.2	50	18.2	11.2	150
Average	210	7.1	42.2	37.4	18.4	230

Table 6. Lagoon Influent Composite

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm
6/ 4/68	212	6.3	4.0	24.6	2.41	220
6/12/68	287	6.0	15	34.2	1.15	170
6/18/68	300	6.6	25	39.5	3.60	380
6/25/68	270	7.5	35	32.9	2.39	410
7/ 2/68	293	6.8	45	42.3	2.30	630
7/ 9/68	372	6.6	12.5	42.5		300
7/17/68	342	6.1	10	31.8		290
7/23/68	552	6.2	35.0	51.3		370
7/30/68	244	6.4	14.0	40.4		310
8/22/68	657	5.9	17.0	40.0	13.50	470
8/29/68	515	5.5	14	61.4		350
9/ 5/68	509	6.3	20	17.2	0.6	210
9/13/68			20		18	210
9/19/68	490	5.4	10	55.1		280
9/25/68	371	5.6	17	51.6		330
10/ 4/68	302	5.8	20	57.7		220
10/10/68	201	5.0	14	50.2		250
10/17/68		5.1	10			
10/23/68	670	4.8	20	58.6	34.8	290
11/ 1/68	736	6.7	25	16.8		300
11/ 8/68	586	5.6	25	19.9	29.1	830
Average	416	6.0	20	40.4	10.8	340
11/14/68	870	4.8	20	55.2	3.5	350
11/20/68	196	5.8	10.0	26.9	14.0	330
11/28/68	540	5.9	17	27.5	13.2	430
12/ 6/68	457	4.8	17.0	11.0	19.7	170
12/13/68	436	5.2	20	21.2		170
12/20/68	363	4.8	20	19.8	20.5	130
Average	477	5.2	17	26.9	11.8	260
1/10/69	700	6.6	40		20.5	250
1/24/69	158	6.8	14		20.7	90
1/30/69	264	6.5	20.0	12.1	20.0	110
2/ 7/69	785	4.8	14	30		270
2/14/69	620	4.8	14	17.9		220
Average	630	5.9	17	20	20.4	190

Table 6. Lagoon Influent Composite (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm
2/20/69	875	4.2		32.6	10.6	790
2/28/69	625	4.6	7.0	27.3	11.2	300
3/ 6/69	536	5.2	7.0	31.6	6.0	200
3/13/69	454	5.1	2.0	12.1	3.0	180
3/21/69	2500	4.3	7.0		4.2	380
3/31/69		5.2	10.0		6.7	130
4/ 3/69	514	4.8	20		5.0	170
4/10/69	362	4.6	1.7		7.4	380
4/18/69	130	7.3	17.0			90
4/24/69	208	7.3	14.0		6.8	360
5/ 1/69		6.2	20	13.8	10.5	20
5/ 9/69	258	6.3	7.0	19.1		200
5/15/69	192	5.8	15.0	19.1		10
Average	650	4.9	10.0	22.2	7.1	250
5/22/69	426			18.3		300
5/30/69		6.6	7.0	8.5		50
6/ 6/69	182			11.4	7.6	216
6/13/69	376		8.5	17.8		60
6/20/69	271	6.1	10.0	18.4	11.0	70
Average	315	6.3	8.5	15.0	9.3	140
6/27/69	287	6.6	25		16.0	260
7/ 4/69	345	6.4	20			250
7/11/69	144	7.1	25	14.7	22.2	130
7/18/69	197	6.8	40	25.8	21.4	370
7/25/69	511	6.5	20	30.3		440
8/ 1/69	127	7.2	30	11.7		180
8/ 8/69	447	6.2	20	25.8	19.4	250
8/15/69	350	6.2	20	25.6		110
8/22/69	540	5.7	20	33.1		360
8/29/69	622	6.1	25			180
9/ 4/69	755	5.2	20.0	25.3	37.5	260
9/12/69	719	5.0	30	25.9		260
9/19/69	385	5.1	25	34.2		430
9/24/69	711	5.3	25	29.3	36.4	320
10/ 3/69	807	5.3	25	41.6		210
10/10/69	601	5.6	20.0	33.9	29.1	260
10/17/69	655	5.6	25	30.9	37.3	120
10/24/69	735	5.4	25	40.5	36.0	370
10/31/69	530	5.5	30.0		20.8	230
11/ 7/69	614	4.7	17.0		19.5	270
11/13/69	673	5.2			8.8	120
11/20/69	739	5.4	25			250
11/27/69	730	5.4			6.3	190
12/ 4/69	670	5.5	40.0	28.5		390
12/12/69	650		30.0	4.6		280
12/19/69	165					400
Average	530	5.8	25	27.2	23.0	265

Table 6. Lagoon Influent Composite (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm
1/ 8/70	1109	3.8				450
1/16/70	1260	4.9				210
1/22/70	1620	4.8	2.0	41.3	6.5	220
1/30/70	1146	4.0	2.5			360
2/ 5/70	2575	4.3	2.0	32.9	7.6	150
2/12/70	1775	4.3	1.4	28.0	3.7	590
Average	1580	4.3	2.0	34.0	5.9	330
2/19/70	3385	3.8	2.0	56.4	2.6	1510
2/27/70	2825	4.1	0.7	39.9	2.1	1140
3/ 6/70	2775	4.5	7.0	25.6	5.35	860
3/13/70	2480	4.2	2.0			50
3/20/70	2680	4.9	5.0		2.3	630
3/26/70	2290	4.0	7.0			680
4/ 6/70	3020	4.7	3.4			
4/ 9/70	2255	4.7	3.4	5.4		400
4/17/70	3485	4.3	3.4			
4/23/70	570	4.6			4.95	260
5/ 7/70	425	5.4			6.6	80
Average	2080	4.6	3.8	31.9	4.0	617

Table 7. Anaerobic Lagoon Effluent S_2

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm
6/ 4/68	24	7.4	0.7	21.5	Nil	1.6	2.52	100
6/12/68	51	7.1	8	23.0	Nil	1.1	3.20	20
6/18/68	300	6.6	25	39.5	Nil		3.60	380
6/25/68	54	7.1	25	14.7	Nil		1.90	110
7/ 2/68	81	7.1	22.5	15.3	Nil		1.70	130
7/ 9/68	98	6.8	20	42.7	Nil		2.40	20
7/17/68	60	7.0	25	20	Nil			50
7/23/68	80	7.9	25	15.4	Nil			20
7/30/68	277	7.0	20.0	10.8	Nil			50
8/22/68	117	6.9	30.0	11.2	Nil		12.79	80
8/29/68	106	7.1	25	20.7				60
9/ 5/68	155	6.8	25	46.1	Nil	0.080	0.4	20
9/13/68			25				16	130
9/19/68	180	7.1	20	27.3	Nil	0.163		340
9/25/68	106	6.9	25	27.2	Nil	0.287		150
10/ 4/68	209	6.5	25	25.9				160
10/10/68	216	6.9	25	25.4	Nil	0.463		170
10/17/68		7.3	14		Nil	0.438		
10/23/68	144	6.7	30	41.7			20.3	260
11/ 1/68	50	6.9	35	47.1				210
11/ 8/68	112	6.8	30	54.4			23.1	240
Average	127	7.0	23	23.6		0.6	7.9	130
11/14/68	151	6.7	14	37.2	Nil		2.3	300
11/20/68	82	7.2	20	34.1	Nil		20	380
11/28/68	30	7.3	14	32.1	Nil		24.0	240
12/ 6/68	42	7.3	14	24.7	Nil		23.8	320
12/13/68	57	7.1	14	11.1	Nil			90
12/20/68	42	7.1	17	15.9	Nil		24.0	50
Average	67	7.1	13	25.8			19	230
1/24/69	93	7.2	14				8.2	270
1/30/69	104	7.3	7	29.4			11.0	290
2/ 7/69	82	7.3	10	21.9				340
2/14/69	98	6.9	4.0					770
Average	94	7.2	8.8	25.6			9.6	420

Table 7. Anaerobic Lagoon Effluent S_2

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm
2/20/69	134	6.7		33.5			17.0	310
2/28/69	127	7.2	7.0	39.4			15.8	300
3/ 6/69	160	6.0	4.0	28.4			20.5	570
3/13/69	140	6.6	2.0	32.3			2.0	350
3/21/69	291	6.2	4.0				3.8	370
3/31/69	415	4.7	2.0				2.4	250
4/ 3/69	306	6.5	17.0				3.5	260
4/10/69	289	6.8	1.4				4.0	260
4/18/69	62	7.1	3.5					190
4/24/69	153	8.9	0.8				6.0	340
5/ 1/69	50	7.4	1.4	20.7			2.7	170
5/ 9/69	106	6.6	1.4	20.6				150
5/15/69	42	7.0	2.0	17.9				
Average	190	6.7	4.0	27.5			7.8	290
5/22/69	69			17.4				160
5/30/69		6.6	3.0	17.5				160
6/ 6/69	46			18.8			2.8	220
6/13/69	70		2.0	18.3				100
6/20/69	60	6.5	5.0	10.3			3.6	100
Average	61	6.5	3.3	16.5			3.2	150
6/27/69	80	6.8	10.0				8.8	110
7/ 4/69	83	6.8	8.5					100
7/11/69	58	6.8	8.5	13.5			11.0	90
7/18/69	67	6.7	12.5	12.1			1.5	160
7/25/69	69	6.9	12.5	12.5				70
8/ 1/69	142	6.8	12.5	15.8				120
8/ 8/69	81	6.6	20	8.2			20.0	80
8/15/69	105	7.1	17.5	13.3				110
8/22/69	60	7.2	17.5	14.7				190
8/29/69	140	6.7	15.0					80
9/ 4/69	114	6.7	20.0				25.0	220
9/12/69	86	7.0	17.5	57.3				260
9/19/69	38	6.9	15.0	23.4				330
9/24/69	81	6.8	12.5	23.2			28.9	150
10/ 3/69	178	6.7	15.0	30.5				310
10/10/69	110	6.9	14.0	35.0			30.1	370
10/17/69	131	7.1	8.5	38.6			17.5	240
10/24/69	102	6.9	10.0	28.9			14.7	410
10/31/69	60	6.9	7.0				19.2	120
11/ 7/69	67	6.8	17.0				21.2	40
11/13/69	68	6.8					4.9	40
11/20/69	65	6.2	25					150
11/27/69	83	7.1					14.8	
12/ 4/69	193	6.7	10.0	29.5				310
12/12/69	90		6.0	20.7				230
12/19/69	62							250
Average	92	6.6	13.5	23.6			16.7	110

Table 7. Anaerobic Lagoon Effluent S_2 (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm
1/ 8/70	84	6.5			Nil	Nil		720
1/16/70	78	7.6	17.5	15.0	Nil	1.8		20
1/22/70	167	6.9	2.8		Nil		20.2	30
1/30/70	305	5.9	0.8		Nil	1.6		360
2/ 5/70	372	5.2	1.4	24.6	Nil			160
2/12/70	795	5.0	10.0	10.1	Nil	1.5	18.4	120
Average	300	6.2	6.5	17.0		1.2		235
2/19/70	322	4.6	8.0	25.4	Nil		28	190
2/27/70	361	4.7	10	5.1	Nil		26.4	200
3/ 6/70	1720	4.6	12.5	30.8	Nil	0.96	29.1	310
3/13/70	1610	4.3	22		Nil			370
3/20/70	1555	5.0	5.0		Nil		20.8	180
3/26/70	973	4.8	5.0		Nil			20
4/ 6/70	1850	4.7	1.4		Nil			
4/ 9/70	1805	4.9	1.4	13.0	Nil			400
4/17/70	1835	4.5	2.0		Nil			150
4/23/70	1270	4.7			Nil		11.9	20
5/ 7/70		5.6			Nil		27.2	20
Average	1330	4.8	7.5	18.6			23.9	181

Table 8. Anaerobic Lagoon Effluent S_3

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm
9/ 5/68	135	6.9	25	41.6	Nil	0.130	0.6	10
9/13/68			20				24.4	70
9/19/68	17	8.1	20	26.8	Nil	0.20		60
9/25/68	89	7.2	20	29.0	Nil	0.40		160
10/ 4/68	34	7.2	17	25.1				90
10/10/68	106	7.2	17	38.1	Nil	0.375		240
10/17/68		7.1	4			0.678		
10/23/68	170	6.8	20	55.0			18.2	280
11/ 1/68	164	7.0	25	50.8				370
11/ 8/68	109	7.0	20	50.9			25.2	340
Average	103	7.2	19	39.7		0.35	17.1	180
11/14/68	119	6.8	10	33.2	Nil		3.6	310
11/20/68	83	7.1	17	26.1	Nil		27.0	440
11/28/68	30	7.6	17.0	22.3	Nil		25.0	310
12/ 6/68	71	7.4	10	29.3	Nil		25.6	300
12/13/68	32	7.2	17	10.6	Nil			30
12/20/68	38	7.3	10	16.4	Nil		23.5	50
Average	62	7.2	12	23.0			20.0	240
1/24/69	79	7.7	7.0				15.3	100
1/30/69	65	7.2	10.0	20.5			26.0	120
2/ 7/69	51	7.3	2.0	23.6				200
2/14/69	63	6.5	7.0					190
Average	65	7.2	7	22.1			20.6	150
2/20/69	57	7.1		20.7			7.0	110
2/28/69	42	7.2	4.0	31.1			6.3	320
3/ 6/69	150	6.1	40	22.8			26.8	440
3/13/69	140	7.0	2.0	30.3			3.3	320
3/21/69	266	6.7	7.0				5.4	490
3/31/69	320	5.6	2.0				0.6	440
4/ 3/69	252	6.5	14				0.8	290
4/10/69	241	6.8	7.0				4.4	360
4/18/69	194	7.3	3.5					210
4/24/69	141	8.9	0.8				1.8	350
5/ 1/69	75	7.2	0.8	13.8				200
5/ 9/69	99	6.6	0.8	20.8				210
5/15/69	37	7.0	1.5	16.5				
Average	170	6.9	7.4	22.3			6.0	310

Table 8. Anaerobic Lagoon Effluent S_3 (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm
5/22/69	24			18.8				260
5/30/69		6.7	3.5	17.9				190
6/ 6/69	35			15.4			2.0	244
6/13/69	82		2.0	17.8				140
6/20/69	69	6.5	2.0	16.7			1.7	160
Average	52	6.6	2.5	17.3			1.8	200
6/27/69	73	6.5	5.0				3.1	530
7/ 4/69	65	6.8	5.0					170
7/11/69	43	6.4	7.0	13.1			7.8	220
7/18/69	46	6.6	8.5	15.9			10.0	220
7/25/69	37	7.0	8.5	15.7				40
8/ 1/69	183	7.0	10.0	14.1				130
8/ 8/69	95	6.6	10.0	10.6			17.0	140
8/15/69	149	6.8	15.0	21.9				230
8/22/69	180	6.6	17.5	21.5				180
8/29/69	165	6.7	20.0					110
9/ 4/69	204	6.5	22.5	19.4			24.5	210
9/12/69	100	7.1	17.5	2.7				220
9/19/69	20	7.0	17.5	36.9				240
9/24/69	133	6.8	15.0	21.4			22.4	110
10/ 3/69	83	7.2	15.0	25.7				
10/10/69	46	7.2	12.5	28.1			26.1	240
10/17/69	66	7.2	8.5	27.8			18.1	240
10/24/69	105	6.8	10.0	31.4			20.6	140
10/31/69	128	6.8	4.0				17.5	250
11/ 7/69	97	6.8	7.0				18.1	200
11/13/69	83	6.8					13.7	100
11/20/69	195	6.2	4.0					350
11/27/69	200	6.7					17.9	100
12/ 4/69	138	6.8	0.2	58.5				660
12/12/69	181		0.1					430
12/19/69	114							370
Average	113	6.8	10.4	22.8			20.0	145

Table 8. Anaerobic Lagoon Effluent S_3 (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm
1/ 8/70	50	6.3			Nil	0.8		150
1/16/70	93	7.4	2.0	20.4	Nil	1.1		70
1/22/70	172	6.9	2.8		Nil		21.3	60
1/30/70	255	6.2	0.8		Nil	0.4		290
2/ 5/70	372	5.2	2.0	25.8	Nil		11.5	900
2/12/70	795	5.0	8.0	19.7	Nil	1.8	22.6	210
Average	290	6.2	3.1	22.0		1.0	18.0	280
2/19/70	325	4.7	6.0	31.6	Nil		21	160
2/27/70	359	4.7	10.0	24.8	Nil		26.4	230
3/ 6/70	1620	4.5	10.0	38.5	Nil	1.16		450
3/13/70	1585	4.3	22		Nil			120
3/20/70	1975	4.9	5.0		Nil		17.4	140
3/26/70	1422	4.9	5.0		Nil			40
4/ 6/70	1765	4.6	8.0		Nil			
4/ 9/70	2115	4.9	10.0	17.9	Nil			90
4/17/70	3416	4.5	1.4		Nil			20
4/23/70	1370	4.7			Nil		10.6	10
5/ 7/70	3125	5.4			Nil		31.6	70
Average	1734	4.7	8.6	28.2			21.4	133

Table 9. Ditch Influent from Lagoon

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm	TDS ppm
7/ 9/68	119	6.7	20	14.3	Nil		2.2	60	500
7/17/68	86	6.9	20	17.1	Nil			140	390
7/23/68	246	6.4	14.0	20.6	Nil			90	276
7/30/68	62.5	7.1	17.0	15.1	Nil			210	362
Average	130	6.8	18	16.8			2.2	125	380
2/ 7/69	46	7.4	25	22.9				230	
2/14/69	80	6.7	5.5					480	
2/20/69	114	6.6		32.1			13.5	250	
2/28/69	71	7.7	4.0	33.4			10.2	290	666
4/ 3/69	252	6.6	17				1.2	250	712
4/10/69	252	6.9	7.0				1.6	370	1106
4/18/69	131	7.3	1.2					350	698
4/24/69	126	8.9	0.8				1.7	280	708
5/ 1/69	45	7.3	0.8	21.5			3.9	390	646
5/ 9/69	91	6.6	0.8	21.9				180	544
5/15/69		7.2		18.3				40	549
Average	155	7.2	4.5	25.4			5.3	280	700
5/22/69	74			23.0				300	574
5/30/69		6.7	3.5	18.8				210	
6/ 6/69	47			18.8			6.6	252	
6/13/69	71		3.5	15.1				20	
6/20/69	44	6.6	2.0	16.1			2.0	70	
Average	59	6.6	3.0	18.3			4.3	120	

Table 9. Ditch Influent from Lagoon (Cont'd)

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm	TDS ppm
6/27/69	64	6.7	5.0				2.7	350	
7/ 4/69	74	6.9	7.0					120	590
7/11/69	58	6.7	7.0				9.3	180	520
7/18/69	44	6.6	10.0	9.9			11.4	130	
7/25/69	74	7.0	8.5	19.0				90	
8/ 1/69	292	6.9	8.5	14.7				150	
8/ 8/69	69	6.6	8.5	13.7			16.8	170	538
8/15/69	123	6.9	15.0	20.5				240	664
8/22/69	125	6.9	15.0	18.2				200	492
8/29/69	135	6.7	17.5					90	444
9/ 4/69	161	6.7	22.5	22.6			29.5	160	458
9/19/69	23	7.0	15.0	22.9				300	570
9/24/69	94	6.9	12.5	22.9			23.5	80	538
10/ 3/69	183	7.0	15.0					240	734
10/10/69	116	6.9	10.0	33.8			16.3	310	484
10/17/69	84	7.3	8.5	38.2			16.8	160	498
10/24/69	148	7.0	10.0	28.6			23.2	150	566
10/31/69	125	6.9	4.0				19.5	310	524
11/ 7/69	69	6.8	4.0				17.5	180	532
11/13/69	79	6.9					15.1	80	
11/20/69	184	6.2	4.0					440	614
11/27/69	175	6.8					15.8	520	594
12/19/69	107							250	
Average	113	6.9	10.4	22.1			16.7	210	550
1/ 8/70	42					Nil		50	
1/16/70	60	7.5	2.0	8.8	Nil	1.1			
1/22/70	143	7.0			Nil		21.0	20	
1/30/70	315	6.1	1.4		Nil	1.1		120	536
2/ 5/70	372	5.2	1.4	25.8	Nil		22.1	210	918
2/12/70	795	5.0	7.0	12.9	Nil	2.1	23.9	230	706
Average	290	6.1	3.0	15.8		1.1	22.3	130	720
2/19/70	332	4.7	9.0		Nil		31	600	
2/27/70	1510	4.7	10.0	21.7	Nil		26.4	270	
3/ 6/70	1910	4.6	10.0	33.0	Nil	1.0		330	
3/13/70	1545	4.3	22		Nil			210	
3/20/70	1690	4.9	5.0		Nil		16.9	60	
3/26/70	1520	4.8	5.0		Nil			10	
4/ 6/70	1980	4.6	8.0		Nil				
4/ 9/70	2360	4.9	6.0	12.3	Nil				
4/23/70	1365	4.7					12.0	10	
5/ 7/70	570	6.7					53.4	60	
Average	1478	4.9	9.4	22.3			27.9	194	

Table 10. Combined Ditch Influent

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm	TDS ppm
5/30/68	280	6.7	10	17.1	0.12		2.27	160	390
6/ 4/68	223	6.7	0.5	28.7	Nil	0.25	1.37	660	1568
6/12/68	317	6.9	12.5	45.1	Nil	0.63	2.67	350	496
6/18/68	58	6.8	10	18.9	Nil	0.19	3.20	160	460
Average	200	6.8	7.5	30.9		0.36	2.3	390	840
7/18/69	79	6.8	8.5	15.4			13.2	150	440
7/25/69	102	7.2	12.5	21.3				70	300
8/ 1/69	361	7.0	15.0	18.2				130	
8/ 8/69	142	6.9	15.0	19.9			22.0	260	460
8/15/69	140	6.9	12.5	21.2				160	662
8/22/69	171	6.4	20	22.9				340	538
8/29/69	323	6.5	22.5					160	550
9/ 4/69	384	6.0	25.0	30.8			39.0	110	512
9/19/69	358	5.7	25.0					380	716
9/24/69	478	5.4	20.0	55.3			14.0	90	582
10/ 3/69	493	5.5	20.0	44.3				400	496
10/10/69	290	6.2	12.5	47.8			31.4	430	558
10/17/69	199	6.7	15.0	33.3			29.9	160	540
10/24/69	248	6.1	20.0	41.4			35.0	140	470
11/ 7/69	158	6.6	7.0				20.0	120	566
11/13/69	192	6.7					16.8	360	
11/20/69	375	6.0	7.0					400	756
12/ 4/69	95	6.9	0.2	56.6				780	692
12/12/69	190		4.0					440	1232
12/19/69	387							410	
Average	258	6.4	14.5	33.0			24.5	275	592
1/ 8/70	208	6.1			Nil			150	
1/16/70	211	7.1	15.0	22.9	Nil	Nil		100	
1/22/70	173	7.0			Nil	Nil	28.9	80	
1/30/70									
2/ 5/70	372	5.1	2.8	25.1	Nil	Nil	22.9	120	894
2/12/70	795	5.1	10.0	19.4	Nil	Nil	24.0	190	704
Average	350	6.1	9.3	22.5	Nil	Nil	25.3	130	800

Table 11. Oxidation Ditch Effluent

Date	BOD ppm	pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm	TDS ppm
5/30/68	9	7.1	0.2	6.0	0.11		1.51		420
6/ 4/68	3.5	7.2	0.7	4.3	Nil	2.0	1.21	10	256
6/12/68	6.3	6.7	1.4	2.0	Nil	1.26	2.32	12	300
6/18/68	34	7.1	10	12.6	Nil	1.63	2.00	90	440
Average	14	7.0	4.0	6.3		1.6	1.8	40	330
6/25/68	16.6	7.2	12.5	11.1	4.2		1.62	100	370
7/ 7/68	12	7.3	15.0	8.7	0.4		1.2	210	406
7/ 9/68	119	6.9	15.0	8.5	Nil		1.5	270	586
7/17/68	0.6	7.2	17.0	7.4	0.475			30	406
7/23/68	3.5	7.3	22.5	9.3	1.25			8	672
7/30/68	10.8	7.1	20.0	6.6	2.7			8	386
Average	27	7.2	17	8.6	1.5		1.4	210	470
2/ 7/69	42	8.4	17	14.6				110	
2/14/69	16	7.3	27.5					20	
2/20/69	37	6.7		13.3			9.0	60	
2/28/69	33	7.8	4.0	7.3			8.4	30	288
4/ 3/69	92	7.5	17				0.6	210	660
4/10/69	145	7.4	7.0				1.6	420	708
4/18/69	126	7.6	3.5					260	606
4/24/69	54	8.9	0.8				1.5	180	550
5/ 1/69		7.7	1.4	13.2			1.5	90	486
5/ 9/69	54	7.1	0.8	17.6				90	516
5/15/69		7.2		13.6				30	535
Average	66	7.6	8.8	13.3			3.8	140	540

Table 11. Oxidation Ditch Effluent (Cont'd)

Date*	BOD ppm		pH	NH_3 ppm	Organic-N ppm	NO_2 ppm	NO_3 ppm	PO_4 ppm	SS ppm	TDS ppm
5/22		26			13.9				110	503
5/30			6.8	3.5	16.2				110	
6/ 6		8			17.7			5.0	164	
6/13		66		5.0	13.9				50	
6/20		49	6.9	8.5	14.1			3.1	40	
Average		37	6.9	5.6	15.0			4	95	
6/27		51	6.9	1.0				10.8	240	
7/ 4		36	6.9	1.0					20	472
7/11		29	6.7	3.5				12.1	170	1168
7/18	0**	39	6.7		19.5			11.4	140	440
7/25	20	67	7.1	7.0	17.8				30	448
8/ 1	32	117	6.9	10.0					210	
8/ 8	27	57	6.7	5.0	17.1			10.4	170	314
8/15	47	168	7.1	12.5	24.7				260	652
8/22	20	31	7.2	12.5	31.3				410	496
8/29	23	181	7.0	10.0					280	474
9/ 4	25	141	6.9	20.0	26.7			27.5	190	434
9/19	168	212	6.5	22.5					430	650
9/24	92	204	6.5	15.0	27.6			15.1	120	562
10/ 3	52	133	7.1	15.0	30.5				370	548
10/10	26	126	7.0	10.0				30.0	410	504
10/17	31	135	7.2	8.5	41.2			24.4	200	542
10/24	17	42	6.8	10.0	35.8			19.3	160	
10/31	75	89	7.0	4.0				22.8	260	526
11/ 7	77	217	6.8	7.0					200	574
11/13	6	86	7.1					12.1	160	
11/20	116	249	6.2	4.0					260	646
11/27	5	108	7.1					11.3	420	612
12/ 4	23	218	6.7	5.0	31.6				380	686
12/12	35	40		2.0					360	594
12/19	33	75								
Average	45	114	7.1	8.2	27.7			17.3	250	570

*Year of sample is 1969.
**BOD after filtration to remove algae.

Table 12. Oxidation Ditch 2 Effluent

Date	BOD ppm	pH	NH_3 ppm	NO_2 ppm	NO_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm	TDS ppm
1/ 8/70	44	6.4			Nil			170	
1/16/70	63	7.4	2.0	Nil	0.4	17.8		30	
1/22/70	157	6.9	2.0	Nil			18.3	240	676
1/30/70									
2/ 5/70	242	6.9	1.4	Nil		17.2	19.9	190	712
2/12/70	267	6.9	0.8	Nil	7.4	12.7	15.5	210	654
Average	154	6.9	1.5	Nil	2.5	16.0	15	170	680
2/19/70	601	6.5	0.4	Nil			26	390	
2/27/70	750	5.1	8.5	Nil		22.1	45	300	
3/ 6/70	1212	4.8	3.5	Nil	1.4	27.2		160	
3/13/70	212	6.2	1.0	Nil				920	
3/20/70	680	6.8	1.0	Nil			10.1	120	
3/26/70	8	7.1	3.5	Nil					
4/ 6/70	20	6.7	0.4	Nil					
4/ 9/70	246	7.1	0.2	Nil		5.6		10	
4/17/70									
4/23/70	504	6.0					21.0	20	
5/ 7/70	444	6.8						170	
Average	425	6.3	2.5	Nil		18.3	24.7	260	

Table 13. Oxidation Ditch 2 Effluent

Date	BOD ppm	pH	NH_3 ppm	NO_2 ppm	NO_3 ppm	Organic-N ppm	PO_4 ppm	SS ppm	TDS ppm
1/ 8/70					0.3				
1/16/70	118	7.3	2.0	0.048	0.4	13.6		90	
1/22/70	101	7.1	2.0	Nil			17.4	40	614
1/30/70	124	6.9	0.8	Nil	0.9			360	918
2/ 5/70	362	6.5	1.4	Nil		18.6	24.6	220	796
2/12/70	331	6.8	0.8	Nil	2.9	14.6	10.5	200	664
Average	207	6.9	5.4		1.1	15.6	17.5	182	748
2/19/70	695	6.0	0.8	Nil			22	190	
2/27/70	1208	4.8	3.5	Nil		30.5		110	
3/ 6/70					1.1				
3/26/70	22	7.2	3.5	Nil				20	
4/ 6/70	20	6.8	0.4	Nil					
4/ 9/70	242	7.1	0.2	Nil		5.8		10	
4/17/70	447	5.9	0.4	Nil					
4/23/70	422	6.1					21.9	10	
5/ 7/70	436	6.7					22.0		
Average	436	6.3	1.5			18.2	22.0	108	

Table 14. Flow and D.O. Observations

	Flow - gpd				Dissolved Oxygen - ppm			
Date	S_2	S_3	D_1	D_2	S_2	S_3	D_1	D_2
5/30/68	1,100,000			125,600	4.8			4.0
6/ 4/68	960,000			67,200	4.4			4.2
6/12/68	1,040,000			151,000	1.3			2.3
6/18/68	1,144,000			192,000	0			2.7
Average	1,048,000			137,000	1.9			3.1
6/25/68	1,030,000			200,000	0			2.5
7/ 2/68	1,062,000			232,000	0			0.6
7/ 9/68	1,200,000			240,000	0			0.5
7/17/68	1,003,000			67,000	0.5			4.2
7/23/68	729,000			88,000	0.5			4.5
7/30/68	1,060,000			90,000	0			4.6
Average	1,014,000			153,000	0.2			2.8
8/22/68	320,000	320,000		Rotor	0			
8/29/68	145,000	145,000		break-	2.4	0.5		
9/ 4/68	300,000	300,000		down				
9/12/68	355,000	355,000		8/6/68	0.7	3.3		
9/18/68	344,000	344,000		to				
9/24/68	520,000			12/19/68	0	2.8		
10/ 3/68	606,000				0	2.3		
10/ 9/68	480,000	480,000			0	1.7		
10/16/68	720,000	204,000			0.2	Nil		
10/31/68	624,000	246,000			Nil	Nil		
11/ 7/68	752,000	752,000			0.4	0.2		
Average	470,000	350,000			0.4	1.3		

Table 14. Flow and D.O. Observations (Cont'd)

Date	Flow - gpd				Dissolved Oxygen - ppm			
	S_2	S_3	D_1	D_2	S_2	S_3	D_1	D_2
11/13/68	640,000	160,000			Nil	Nil		
11/19/68	288,000	288,000			10.5	1.3		
11/27/68	274,000	274,000			5.2	13.6		
12/ 5/68	260,000	320,000			6.5	3.0		
12/19/68	585,000	585,000			2.8	10.3		
Average	409,000	325,000			5.0	5.6		
1/ 9/69	392,000	392,000			4.4	10.5		
1/30/69	463,000	463,000			3.2	6.8		
2/ 6/69	480,000	480,000		84,900	1.4	2.7		0.7
Average	445,000	445,000			3.0	6.6		
2/13/69	259,000	259,000			Trace	0.8		3.3
2/20/69	384,000	384,000		41,600	0	10.6		15.5
2/26/69	480,000	320,000		57,600	1.3	1.7		3.7
3/ 6/69	318,000	318,000			0.6	4.4		
3/20/69	584,000	496,000			0	1.2		
3/29/69	820,000	260,000		128,000	0	0		
4/ 2/69	616,000	464,000		91,000	0	1.1		1.2
4/ 9/69	604,000	496,000		101,000	0	0		0
4/17/69	510,000	460,000		41,600	0.2	0		2.7
4/23/69	413,000	432,000		84,400	5.2	6.0		3.2
4/30/69	568,000	377,000		135,000	0.8	1.8		1.0
5/ 8/69	600,000	400,000		128,000	Nil	0.2		4.3
5/15/69	605,000	345,000		117,000	0.3	11.3		3.1
Average	520,000	385,000		93,200	0.6	3.0		3.8

Table 14. Flow and D.O. Observations (Cont'd)

	Flow - gpd				Dissolved Oxygen - ppm			
Date	S_2	S_3	D_1	D_2	S_2	S_3	D_1	D_2
5/22/69					2.9	0.8		2.1
5/29/69	576,000	304,000		269,000	0	0		0
6/ 5/69	410,000	320,000		163,000	6.8	1.5		2.0
6/12/69	557,000	368,000		125,000	1.9	0.5		1.1
Average	510,000	330,000		186,000	2.9	0.7		1.3
6/26/69	142,000	242,000		57,700	Nil	5.0		1.1
7/ 3/69	224,000	128,000		77,000	0	1.1		4.6
7/10/69	373,000	86,000		72,000	0.1	7.5		1.6
7/17/69	135,000	377,000		104,000	0	13.2		0.7
7/24/69	250,000	135,000		136,000	0	9.3		1.5
7/31/69	278,000	146,000		110,600	0	8.0		0.7
8/ 7/69	68,000	278,000		101,000	0.1	0		0.9
8/14/69	192,000	268,000		127,000	0.4	0		0.3
8/21/69	107,000	218,000		113,800	1.1	0		0.1
8/28/69	184,000	226,000		94,300	0	0.4		0.3
9/ 4/69	100,000	141,000		88,000				
9/11/69					0.7	0.6		
9/18/69	136,000	141,000		195,000	11.5	0.5		0.5
9/23/69	309,000	56,000		160,500	2.8	1.0		0
10/ 2/69	209,000	106,000		45,800	0	1.1		0.6
10/ 9/69	194,000	56,000		75,100	0.5	20.0		0.6
10/16/69	97,000	248,000		61,300	6.4	12.0		0.6
10/23/69	273,000	152,000		72,100	19.5	2.3		0.7
11/ 6/69	139,000	290,000		90,800	8.5	6.5		0.4
11/12/69	72,000	306,000		71,700	12.7	9.8		3.1
11/20/69	240,000	448,000		96,000	1.7	3.0		0
11/27/69	176,000	304,000		86,500	8.6	3.4		2.1
12/ 4/69	274,000	336,000		81,700	5.4	3.0		5.1
12/19/69	112,000	194,000			13.8	14.0		1.0
Average	170,000	213,000		92,000	4.0	4.8		1.2

Table 14. Flow and D.O. Observations (Cont'd)

Date	Flow - gpd				Dissolved Oxygen - ppm			
	S_2	S_3	D_1	D_2	S_2	S_3	D_1	D_2
1/ 8/70					6.5	4.5		1.0
1/16/70	131,000	226,000	55,000	55,000	11.6	12.2		
1/22/70	320,000	270,000	55,000	55,000	3.6	5.2	0.5	0.5
1/30/70	336,000	336,000	37,600	58,300	4.9	15.0		
2/ 5/70		346,000	36,200	58,500	0	0	Nil	Nil
2/12/70		234,000	9,200	18,200	0	0	Nil	Nil
Average	262,000	282,000	38,600	49,000	4.4	6.1	0.2	0.4
2/19/70	242,000	242,000	20,000	20,000	0	0	Nil	Nil
2/27/70		288,000	29,000		0	0	Nil	Nil
3/ 6/70	400,000	166,000	16,500	31,000	0	0	Nil	Nil
3/13/70		187,000	8,000	8,000	0	0	Nil	Nil
3/20/70	306,000	248,000	13,300	13,300	0	0		
3/26/70		216,000	12,000	12,000	0	0	4.5	4.0
4/ 6/70	365,000	288,000	8,000	8,000	0	0	1.2	0.8
4/ 9/70		327,000	8,000	8,000	0	0	0.5	0.1
4/17/70		237,000		24,000	0	0	Nil	Nil
4/23/70		272,000	15,000	15,000	0	0	Nil	Nil
5/ 7/70		259,000	48,000		0	0	Nil	Nil
Average	328,000	248,000	17,800	15,500	0	0	0.7	0.5

Table 15. Ditch Solids, Temperature and Power Consumption

Date	MLSS D_1 ppm	MLSS D_2 ppm	Return Sludge D_2 SS ppm	Return Sludge D_2 TS ppm	Return Sludge D_2 VS ppm	% Settl. Solids (½ hr) D_1	% Settl. Solids (½ hr) D_2	% Settl. Solids (½ hr) Return Sludge	Temp. °C	Power Kwh/day
5/30/68		1,840		5,936			30		16	
6/ 4/68		3,450	5,893	5,960				85	15	116.1
6/12/68		3,200	10,300	10,674			86	99	15	89
6/18/68		1,960	6,440	6,677			30	96	13	126
Average		2,870	7,540	7,770			58	93		110
6/25/68		2,520	17,200	26,313			68	86	11	130
7/ 2/68		2,660	5,575	5,620			43	96	12.5	133
7/ 9/68		6,405	2,100	2,442			91	98	13	135
7/17/68		1,200	3,400	3,917			95	99	11	129
7/23/68		1,360	2,540	3,310			98	99	11	125
7/30/68		1,040	1,960	2,401			98	98	11	125
Average		1,570	5,460	7,300			82	96	11	130
2/ 6/69		1,310	8,880				11	42	28	

Table 15. Ditch Solids, Temperature and Power Consumption (Cont'd)

Date	MLSS D_1 ppm	MLSS D_2 ppm	Return Sludge D_2 SS ppm	Return Sludge D_2 TS ppm	Return Sludge D_2 VS ppm	% Settl. Solids (½ hr) D_1	% Settl. Solids (½ hr) D_2	% Settl. Solids (½ hr) Return Sludge	Temp. °C	Power Kwh/ day
2/13/69		3,420	4,540				43	63	24	105
2/20/69		3,460	5,980				34	66		116
2/26/69							90	95	22	126
3/ 6/69										109
3/29/69		3,050							26	
4/ 2/69		2,780	7,000	7,465	5,564					
4/ 9/69		3,920	7,240	7,295	5,810		86	97		125
4/17/69		4,580	7,380	7,734	6,214		55	82	23	94
4/23/69		2,900	10,560	10,720	8,907		40	99	15	92
4/30/69		2,340	5,320	5,866	4,818		36	86	16	95
5/ 8/69		1,940	5,160				28	78		96
5/15/69		1,710	3,580	3,996	3,242		20	56	17	96
Average		3,010	6,300	7,200	5,900		45	80	20	105
5/22/69									14	99
5/29/69		2,560	10,780				22	98	15	100
6/ 5/69				10,858	9,105		24	98	13	104
6/12/69		2,940	10,580	14,003	11,952		46	98	13	104
Average		2,750	10,680	12,400	10,500		31	98	14	102

Table 15. Ditch Solids, Temperature and Power Consumption (Cont'd)

	MLSS		Return Sludge D_2			% Settle. Solids (½ hr)				
Date	D_1 ppm	D_2 ppm	SS ppm	TS ppm	VS ppm	D_1	D_2	Return Sludge	Temp. °C	Kwh/ day
6/26/69		5,540	11,300	11,475	9,920		39	95		103
7/ 3/69		2,160					12			100
7/10/69		2,960					23		9	106
7/17/69		900	4,625	19,465	16,592		23	100		85
7/24/69		520	9,040	9,290	7,660		17	91		94
7/31/69		3,280	9,160	9,430	7,681		20	94		99
8/ 7/69		3,580	8,740	9,784	7,911		26	96		100
8/14/69		3,060	11,860	11,962	9,817		17	97		97
8/21/69		3,060	10,920	11,026	9,130		18	74		101
8/28/69		640	4,120	4,725	3,759		5	26		102
9/ 4/69		1,580	13,780	13,304	9,626		8	61		84
9/18/69							12	98		85
9/23/69										93
10/ 2/69		3,780	41,000	45,418	38,489		25	75		102
10/ 9/69		3,420		7,662	6,988		24	95	16	99
10/16/69		2,120	12,180	12,702	10,280		22	78		101
10/23/69		2,840	7,580	8,340	6,784		21	91		93
10/31/69		1,500	10,860	11,369	9,100		22			
11/ 6/69		3,140	21,820	22,517	17,976		22	98		99
11/12/69		3,560		10,993	8,684		29	89	22.5	86
11/20/69		2,680	7,620	8,709	6,850		46	100		99
11/27/69		3,740	7,420	9,025	7,274		44	94		97
12/ 4/69		3,100	8,400	7,419	6,055		27	92		114
12/10/69							30 (1)			208
12/10/69							18 (2)			
12/19/69							37 (1)		25	
12/19/69							22 (2)			
Average		2,720	11,800	12,800	10,500		22	86	18	97

Table 15. Ditch Solids, Temperature and Power Consumption (Cont'd)

Date	MLSS D_1 ppm	MLSS D_2 ppm	Return Sludge D_2 SS ppm	Return Sludge D_2 TS ppm	Return Sludge D_2 VS ppm	% Settle. Solids (½ hr) D_1	% Settle. Solids (½ hr) D_2	% Settle. Solids (½ hr) Return Sludge	Temp. °C	Power Kwh/ day
1/ 8/70	2,420	2,400	8,720	9,791	7,881	20	15	56		
1/16/70	3,280	2,080		7,222	4,685	26	15	99		92
1/22/70	4,320			2,154	1,479	45	11	99		91
1/30/70		760					7	13		93
2/ 5/70	3,860	2,480	6,700	8,011	6,647	37	19	71		102
2/12/70	5,380	2,560	6,500	7,722	6,562	46	20	56		
Average	3,860	2,050	7,300	7,000	5,460	35	15	66		94
2/19/70	4,500	2,320	8,820	10,565	9,000	42	22	98		86
2/27/70	5,640			4,266	3,492	42		99		108
3/ 6/70	3,900	1,640	4,040			86	28	92		
3/13/70	3,600	2,240	4,940	5,573	4,602	97	97	99		87
3/20/70	2,560	2,700	8,180	9,160	7,807					88
3/26/70	660	2,360				35	33	32		90
4/ 6/70				5,023	4,066	39	27	50		91
4/ 9/70	3,660	2,660	4,580	5,895	4,887	49	32	61		93
4/17/70		850	710							
4/23/70	2,260	3,120	22,320	23,884	20,272	37	25	99		97
5/ 7/70	2,260	820	17,640	20,239	17,378	21		100		87
Average	3,230	2,080	8,900	10,600	8,940	50	38	81		92

Table 16. Lagoon Sludges, Laboratory Purification Index

June 1968		1	4	8	10	16	17	24	25	Average
Synthetic	pH	5.9	6.8	6.0	6.0	5.4		5.5	6.1	
Sewage	BOD	132	113	228		153	175	241	280	189
S_2 Inlet (1)	pH	7.2	7.6	7.1	7.4	6.8		6.9	6.6	
	BOD	53	47	64	57	79	94	80	10	60
S_2 Inlet (2)	pH	7.4	7.4	7.5	7.7	7.3		7.0	6.4	
	BOD	31	51	44	21	43	66	67	82	51
S_2 Mid	pH	7.2	7.3	7.9	7.6	7.2		7.1	6.6	
	BOD	45	37	34	33	51	72	70	96	55
S_2 Outlet	pH	7.6	7.8	7.9	7.5	7.7		7.5	6.6	
	BOD	17	32	19	21	30	49	31	54	32
Control (1)	pH	6.8	7.1	6.7	6.6	6.4		6.6	6.6	
	BOD	54	84	85	103	160	122	118	122	106
Control (2)	pH	6.9	7.0	7.0	6.9	6.8		6.7	6.6	
	BOD	116	50	60	46	71	94	60	82	72

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

Nov. 1968		1	3	8	15	19	23	26	Average
Synthetic Sewage	pH	7.1	6.5	7.3	7.1	5.3	7.6	7.8	
	BOD		218	316	345	112	176	242	235
S_2 Inlet (1)	pH	8.5	7.7	7.8	7.6	7.8	8.0	8.3	
	BOD		26	26	34	15	28	36	27
S_2 Inlet (2)	pH	8.1	8.0	8.3	7.8	7.8	7.8	8.4	
	BOD		63	28	26	8	18	20	27
S_2 Mid	pH	8.2	7.9	8.2	8.0	7.9	8.4	8.4	
	BOD			86	36	12	22	32	37
S_2 Outlet	pH	8.4	7.9	8.3	7.7	7.5	7.9	8.1	
	BOD	78	26	34	60	13	50	109	53
T_2 Inlet	pH	8.1	7.9	8.5	7.9	7.6	7.8	8.0	
	BOD	89	36	30	30	5	18	34	34
Control	pH	8.4	8.1	8.4	8.2			7.0	
	BOD	43	36	100	32		10		44

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

January 1969		1	4	10	11	13	16	17	25	27	Average
Synthetic	pH	7.2	6.2	6.7	7.1	7.0	6.4	7.0	7.5	7.3	
Sewage	BOD		183	265	224	263	282	234	288	272	251
S_2 Inlet (1)	pH	8.0	7.4	7.4	7.4	7.8	7.7	7.8	7.8	7.8	
	BOD		63	51	76	47	38	66	20	40	50
S_2 Inlet (2)	pH	7.4	7.2	7.2	7.5	7.9	7.6	7.9	7.8	7.7	
	BOD		61	45	86	41	22	70	72		49
S_2 Middle	pH	7.9	7.8	7.7	7.7	8.1	7.8	8.0	8.0	7.8	
	BOD		53	23	44	39	46	68	52	52	47
S_2 Outlet	pH	7.8	7.9	7.8	7.8	8.0	8.1	7.9	7.8	7.7	
	BOD		65	33	28	63	10	68	28	36	41
T_2 Inlet	pH	7.6	7.1	7.9	7.7	7.9	7.4	7.8	7.9	7.9	
	BOD		85	19	40	55	38	48	68	60	52
Control	pH	7.4	7.5	7.2	7.1	7.5	6.4	7.5	7.8	8.0	
	BOD		55	37	42	51	282	80	52	72	84

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

May 1969		1	2	7	8	11	12	13	15	Average
Synthetic	pH	6.2	6.2	6.4	6.0	6.5	6.2	5.8	6.0	
Sewage	BOD	250	250	250	288	182	149	225	N.D.	228
S_1 Inlet	pH	7.6	7.9	7.2	7.4	7.8	7.6	6.8	7.5	
	BOD	153	54	29	95	61	61	91	69	77
S_1 Outlet	pH	7.3	7.8	7.0	7.4	7.3	7.3	6.9	7.4	
	BOD	115	116	81	170	41	57	81	102	95
S_2 Inlet A	pH	7.2	7.2	7.8	7.5	7.7	7.8	7.2	7.6	
	BOD	81	90	150	111	57	55	119	127	99
S_2 Inlet B	pH	7.0	7.8	7.6	7.2	7.2	7.4	7.0	7.0	
	BOD	125	50	92	170	49	43	93	111	91
S_2 Inlet C	pH	7.4	7.4	7.8	7.1	7.4	7.5	7.1	7.0	
	BOD	11	61	88	170	83	43	132	87	84

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

June 1969		1	2	3	4	8	Average
Synthetic	pH	6.6	6.7	6.3	5.5		
Sewage	BOD	254	239	160	187	161	200
S_2 Inlet	pH	7.6	7.5	7.2	7.2		
	BOD	129	141	68	63	45	89
S_2 Outlet	pH	7.2	7.6	7.1	7.2		
	BOD	125	118	74	90	35	88
S_3 Inlet	pH	7.3	8.0	7.0	7.1		
	BOD	110	126	74	56	37	81
S_3 Outlet	pH	7.5	8.0	7.2	7.4		
	BOD	85	117	52	56	57	73
C_1 Inlet	pH	8.1	7.9	7.5	7.5		
	BOD	71	103	43	48	51	63
C_2 Outlet	pH	7.6	7.7	7.3	7.1		
	BOD	90	114	33	53	33	65

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

June 1969		1	2	3	6	7	8	Average
Synthetic Sewage	pH		5.9	6.5	6.8		6.9	
	BOD	238	160	207	180		177	192
C_2 Inlet	pH		7.7	7.6	7.5		7.7	
	BOD	76	72	66	36	52	79	63
C_2 Outlet	pH		7.9	7.4	7.7		7.6	
	BOD	170	180	76	24	20	43	85
T_2 Inlet	pH		7.8	7.3	7.8		7.7	
	BOD	102	56	113	55	20	95	73
T_2 Outlet	pH		7.8	7.1	7.7		7.8	
	BOD	138	66	43	92	51	39	71.5

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

Sept. 1969		3	4	5	6	10	11	12	15	16	Average
Synthetic	pH	7.0	6.1	7.2	6.5	6.3		6.5	6.6	7.3	
Sewage	BOD	185	30	170	138	193		120	205	83	141
S_2 Inlet	pH	7.8		7.7	7.0	7.3	7.3	7.2	7.3	7.8	
	BOD	98	76	60	45	53	40	77	34	13	55
S_2 Middle	pH	7.7	7.2	7.9	7.2	7.2	7.2	7.1	7.3	7.9	
	BOD	42	17	26	37	60	62	65	54	18	42
S_2 Outlet	pH	7.6	7.4	8.0	7.2	7.4	7.4	7.2	7.5	7.8	
	BOD	66	25	48	41	47	47	71	186	174	78
S_3 Inlet	pH	7.7	7.5	7.7	7.2	7.5	7.5	7.4	7.6	8.1	
	BOD	68	56	66	43	46	34	53	28	10	45
S_3 Outlet	pH	8.0	7.4	8.1	7.3	7.5	7.6	7.4	7.5	7.8	
	BOD	62	30	46	37	46	49	73	72	30	49
Control	pH	8.5	7.3	7.9	7.3	7.1	7.8	7.2	7.2	7.8	
	BOD	98	54	60	37	48	33	53	45	19	

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

January 1970		3	5	6	7	8	9	13	14	16	17	Average
Synthetic	pH	6.7	5.7	7.0	7.0	6.7	6.7	6.6	6.3	6.2	6.4	
Sewage	BOD	203	175	160	204	287	105	227	291	206	213	207
S_2 Inlet	pH	6.9	7.2	7.1	7.4	7.4	6.9	7.2	7.3	7.2	6.8	
	BOD	73	84	24	50	49	21	23	44	76	62	51
S_2 Middle	pH	6.4	7.0	7.2	7.2	7.3	6.9	7.4	7.3	7.3	6.9	
	BOD	60	66	18	55	53	19	24	33	40	28	40
S_2 Outlet	pH	7.1	7.3	7.6	7.5	7.3	7.1	7.3	7.5	7.3	7.0	
	BOD	86	72	21	74	65	16	38	34	45	75	52
S_3 Inlet	pH	7.2	7.5	7.6	7.6	7.3	7.2	8.0	7.6	7.6	7.2	
	BOD	71	66		39	32	23	32	51	73	85	52
S_3 Outlet	pH	7.1	7.2	7.5	7.5	7.3	7.1	8.0	7.6	7.5	7.2	
	BOD	80	64	20	51	55	9	22	41	60	77	48
Control	pH	7.2	7.4	7.3	7.0	7.6	7.2	7.8	7.3	7.5	7.3	
	BOD	83	96	22	37	29	15	20	20	62	55	44

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

May 1970		3	7	8	13	14	16	17	Average
Synthetic	pH	6.1	5.7	5.9	6.6	7.2	6.4	6.4	
Sewage	BOD	422	395	455	190	100	380	620	366
S_2 Inlet (1)	pH	6.9	7.3	6.9	7.1	7.3	7.1	6.9	
	BOD	79	127	161	40	40	112	76	91
S_2 Inlet (2)	pH	7.1	7.7	7.1	7.4	7.5	7.4	7.3	
	BOD	81	85	111	26	14	72	94	69
S_2 Outlet	pH	7.5	7.6	7.5	7.4	7.7	7.3	7.1	
	BOD	49	65	165	38	35	112	158	89
S_3 Inlet	pH	7.4	7.5	7.3	7.5	7.6	7.2	7.1	
	BOD	111	75	119	26	48	90	80	78
S_3 Outlet	pH	7.3	7.7	7.2	7.6	7.9	7.4	7.2	
	BOD	75	93	141	20	20	70	74	70

Table 16. Lagoon Sludges, Laboratory Purification Index (Cont'd)

June 1970		3	4	5	9	10	11	16	Average
Synthetic	pH	5.7	5.9	6.0	6.1	6.0	5.9	6.2	
Sewage	BOD	480	515	335	395	415	310	200	378
T_2 Inlet	pH	7.3	7.4	7.0	7.3	6.9	7.1	6.9	
	BOD	171	171	127	62	102	192	72	128
T_3 Inlet	pH	7.1	7.6	7.2	7.1	6.7	7.4	7.6	
	BOD	62	137	73	91	117	130	32	92
T_3 Outlet	pH	7.8	7.4	7.3	7.5	6.9	7.5	7.8	
	BOD	113	133	105	81	120	100	22	96
C_2 Inlet	pH	7.3	7.2	7.7	7.5	6.9	7.5	7.9	
	BOD	147	170	127	102	124	248	18	134
C_2 Outlet	pH	7.5	7.0	7.8	7.1	7.2	7.7	7.9	
	BOD	105	144	87	73	75	60	12	79

Table 17. Gas Yields on Lagoon Sludges Using 30°C Synthetic Sewage*

	S_2			S_3		S_1		C_1		C_2		T_2		T_3	
Date	In	Mid	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
6/68 A	3.6	3.4	6.3												
B	5.3	0.9	2.2												
C	14.0	0.8	N.D.												
11/68 A	1.4	5.1	4.2												
B	2.4	2.0	5.0									1.1	6.3		
D	3.2	3.3	2.5												
1/69 A_1	0.7	4.3	2.2												
A_2	0.5														
B_1	1.2	2.2	3.8									2.1	4.2		
B_2	0.8											2.5			
C_1	0.7	4.4	3.4												
C_2	0.8														
5/69 A	0.7														
B_1	1.0					1.3	0.7								
B_2	0.85														
C	1.0														
6/69 B_1	2.4			1.3	1.2			0.7	1.1	4.4	2.7	4.1	14.3		
B_2	0.2		2.2							3.5	3.2				
C			0.4												

Table 17. Gas Yields on Lagoon Sludges Using 30°C Synthetic Sewage* (Cont'd)

Date		S_2			S_3		S_1		C_1		C_2		T_2		T_3	
		In	Mid	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
9/69	A	1.4	0.3	0.8												
	B_1	0.9	4.3	3.2	1.0	3.0										
	B_2	1.1	3.5	4.4	3.5	1.9										
	C	0.9	3.3	3.8												
1/70	A	0.7	1.2	0.9												
	B_1	1.1	1.5	1.1	0.9	1.2										
	B_2	1.3	1.5	0.8												
	C	0.2	1.6	2.0												
5/70	A	0	3.6	0.5												
	B_1	0.6	5.3	0.8	0.2	0.3										
	B_2	0.5		1.0												
	C	0.8	5.6	2.3												
6/70	B_1										0.6	2.2	2.0	2.5	3.6	3.1
	B_2										0.6		1.8		3.5	

*Ml gas/gm of VS/day.

Table 18. Gas Yields on Lagoon Sludges

30°C Water*

Date	S_2 In	S_2 Mid	S_2 Out	S_3 In	S_3 Out	S_1 In	S_1 Out	C_1 In	C_1 Out	C_2 In	C_2 Out	T_2 In	T_2 Out	T_3 In	T_3 Out
6/68 A	1.4	0.4	4.6												
B	0.4	0.8	1.8												
C	12.9	0.5	N.D.												
5/69 B_1	1.4														
B_2	1.2														
6/69 B_1	1.3		1.5							0.9	0.4	0.9			
B_2			2.1												
1/70 B	0.7	1.3	0.5												
5/70 B	0.2	5.3	0.6												

Table 18. Gas Yields on Lagoon Sludges (Cont'd)

<u>37°C Synthetic Sewage*</u>

Date		S_2			S_3		S_1		C_1		C_2		T_2		T_3	
		In	Mid	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
11/68	B	2.0											0.8			
1/69	A	1.1														
	B	0.8											3.1	3.8		
	C	0.8														
6/69	B	2.3		2.8	1.9	1.4			2.5	3.1	3.1	2.8	3.2	16.0		
	C			0.3												
9/69	B	1.7	4.4	3.9	3.5	3.0										
1/70	B	2.3	3.3	1.7	0.8											
5/70	B	1.3	0.2	2.0												
6/70	B_1										0.6	2.6	2.0	0.8	3.4	3.1

*Ml gas/gm of VS/day.

Table 19. Anaerobic Lagoon Bacteriological Examination

	E. Coli I org/100 ml	Coliform Count org/100 ml	37° Plate Count org/ml	22° Plate Count org/ml
4/19/68				
Influent	17,000,000	160,000,000	24,000,000	26,000,000
Effluent	350,000	3,500,000	137,000	10,000,000
6/ 4/68				
Influent	1,800,000	35,000,000	2,840,000	3,500,000
Effluent	800,000	4,500,000	510,000	830,000
7/17/68				
Influent	3,500,000	225,000,000	7,300,000	13,800,000
Effluent	900,000	3,500,000	584,000	780,000
9/ 5/68				
Influent	1,100,000	55,000,000	2,250,000	3,480,000
Effluent	45,000	1,800,000	70,000	307,000
2/11/69				
Effluent	500,000	5,500,000	60,000	730,000
6/ 5/69				
Influent	700,000	55,000,000	260,000	600,000
Effluent	500,000	1,700,000	275,000	4,850,000
9/ 4/69				
Influent	90,000,000	250,000,000	5,890,000	11,920,000
Effluent	200,000	2,000,000	253,000	1,220,000
10/24/69				
Influent	35,000,000	110,000,000	3,570,000	4,400,000
Effluent	250,000	300,000	4,470,000	2,800,000
5/ 7/70				
Influent	17,000,000	50,000,000	3,000,000	24,900,000
Effluent	25,000	25,000	35,700,000	77,300,000

Table 20. Oxidation Ditch and Aerobic Lagoon Bacteriological Examination

	E. Coli I org/100 ml	Confirmed Coliform Count org/100 ml	37° Plate Count org/ml	22° Plate Count org/ml
4/19/68				
Intermediate				
Lagoon Effluent	30,000	350,000	348,000	300,000
Final Effluent	1,400	35,000	172,800	254,000
6/ 4/68				
Ditch Influent	200,000	4,500,000	4,010,000	6,050,000
Ditch Effluent	5,000	50,000	4,000	6,000
7/17/68				
Ditch Influent	N.D.			
Ditch Effluent	9,000	18,000	1,660	24,500
8/13/72				
Ditch Effluent	11	3,500	13,920,000	14,000,000
9/ 5/68				
Aerobic				
Lagoon Effluent	5	70	6,800	76,000
2/11/69				
Ditch Influent	5,000,000	170,000,000	9,600,000	16,200,000
Ditch Effluent	25,000	25,000	8,800	333,000
6/ 5/69				
Ditch Influent	350,000	16,000,000	1,120,000	1,600,000
Ditch Effluent	500,000	2,500,000	75,000	340,000
9/ 4/69				
Ditch Influent	17,000,000	90,000,000	4,710,000	9,660,000
Ditch Effluent	1,300,000	35,000,000	716,000	3,590,000
10/24/69				
Ditch Influent	50,000,000	550,000,000	34,900,000	34,300,000
Ditch Effluent	170,000	16,000,000	4,070,000	6,500,000
5/ 7/70				
Ditch Effluent	35,000,000	35,000,000	3,340,000	11,900,000

Table 21. Anaerobic Lagoon and Oxidation Ditch Algal Count and Identification

Date	S_2 Lagoon orgs/ml (thousands)	Effluent Predominant org	Ditch Influent orgs/ml (thousands)	Ditch Influent Predominant org	Ditch Effluent orgs/ml (thousands)	Ditch Effluent Predominant org
4/24/68	400	Chlorella				
5/ 1/68			300	Chlorella	200	Chlorella
5/ 7/68			7,500	Chlorella	10	
5/13/68			4,800	Chlorella	760	Chlorella
5/20/68			6,000	Chlorella	2,000	Chlorella
5/29/68	200	Chlorella			13	Chlorella
6/17/68	1,400	Chlorella			1,040	Chlorella
6/24/68	1,040	Chlorella			450	Chlorella
7/ 8/68	330	Chlorella			270	Chlorella
7/23/68	40	Chlorella			10	Chlorella
9/ 4/68	40	Flagellates				
9/18/68	150	Palmella				
9/27/68	110	Chlorella				
10/18/68	300	Chlorella				
11/20/68	350	Chlorella				
1/31/69	360	Micractinium				
2/ 6/69	3,200	Chlorella Ankistrodesmus	3,000	Chlorella	2,800	Micractinium
2/13/69	2,200	Chlorella			32	Chlorella
2/27/69	2,500	Closterium	3,800	Chlorella	480	Chlorella
3/ 6/69	2,400	Ankistrodesmus				
4/ 4/69	2,400	Ankistrodesmus	5,500	Chlorella	290	Chlorella
4/10/69	7,600	Chlorella	11,600	Chlorella	280	Chlorella
4/18/69	5,600	Chlorella	6,600	Chlorella	2,800	Chlorella
4/25/69	8,700	Chlorella	6,060	Chlorella	68	Chlorella
5/ 2/69	7,600	Chlorella	6,600	Chlorella	2,500	Chlorella
6/ 4/69	1,700	Chlorella	N.D.		1,600	Chlorella
6/10/69	1,540	Chlorella	2,300	Chlorella	2,580	Chlorella
6/13/69	1,800	Chlorella	3,290	Chlorella	N.D.	
6/20/69	3,460	Chlorella	170	Chlorella	240	Chlorella

Table 21. Anaerobic Lagoon and Oxidation Ditch Algal Count and Identification (Cont'd.)

Date	S_2 Lagoon orgs/ml (thousands)	Effluent Predominant org	Ditch Influent orgs/ml (thousands)	Ditch Influent Predominant org	Ditch Effluent orgs/ml (thousands)	Ditch Effluent Predominant org
6/27/69	3,970	Chlorella	4,640	Chlorella	680	Chlorella
7/ 4/69	3,000	Chlorella	1,030	Chlorella		Clumps of Cells
7/11/69	1,550	Chlorella	1,400	Chlorella	170	Chlorella
7/18/69	2,120	Chlorella				
8/ 1/69	880	Chlorella	970	Chlorella	350	Chlorella
8/ 8/69	4,300	Chlorella	3,090	Chlorella	830	Chlorella
8/15/69	4,120	Chlorella	412	Chlorella	1,050	Chlorella
8/22/69	2,200	Chlorella	3,210	Chlorella	1,990	Chlorella
8/29/69	3,050	Chlorella	2,040	Chlorella	1,600	Chlorella
9/ 4/69	4,170	Chlorella	4,050	Chlorella	1,650	Chlorella
9/12/69	5,100	Chlorella	1,200	Chlorella	2,700	Chlorella
9/24/69	2,612	Chlorella	1,740	Chlorella	3,800	Chlorella
10/ 3/69	2,400	Chlorella	760	Chlorella	340	Chlorella
10/10/69	4,910	Chlorella	10,500	Chlorella	3,450	Chlorella
10/24/69	10,240	Chlorella	20,000	Chlorella Aphanothece	14,800	Aphanothece Chlorella
11/ 7/69	1,070	Chlorella	10,200	Chlorella	5,100	Chlorella
11/13/69	42	Chlorella	4,200	Chlorella	1,200	Chlorella
11/19/69	5,469	Chlorella	15,200	Gloeothece Chlorella	8,600	Gloeothece Chlorella
11/27/69	1,200	Chlorella				

Table 22. Anaerobic Lagoon and Oxidation Ditch Algal Count and Identification

	S_2 Effluent		S_3 Effluent		Ditch 1 Influent		Ditch 1 Effluent		Ditch 2 Effluent	
Date	orgs/ml (thousands)	Dom.org	orgs/ml (thousands)	Dom.org	orgs/ml (thousands)	Dom.org	orgs/ml (thousands)	Dom.org	orgs/ml (thousands)	Dom.org
1/16/70	40	Closterium	107	Chlorella	117	Chlorella	300	Chlorella Closterium	120	Chlorella
1/22/70	188	Closterium	1,620	Chlorella	3,710	Chlorella	537	Chlorella	3,420	Chlorella
2/ 5/70	3,400	Closterium	17,750	Chlorella Merismopedia	4,800	Chlorella	6,300	Chlorella	5,850	Chlorella
2/11/70	1,700	Closterium	4,280	Chlorella	3,300	Chlorella	4,200	Chlorella	6,500	Chlorella
2/18/70	1,470	Closterium	5,610	Chlorella	3,230	Chlorella	4,250	Chlorella	6,100	Chlorella
3/ 6/70	680	Flagellates Closterium Gloeothece	1,130	Chlorella	1,700	Chlorella	880	Chlorella	1,900	Chlorella
3/13/70	250	Closterium	3,370	Chlorella	2,700	Chlorella	2,600	Chlorella		
4/ 6/70	230	Flagellates Closterium	260	Euglena Gloeothece						
5/ 1/70					3,250	Chlorella	290	Micractinium	290	Ulothrix

1 Accession Number	2 Subject Field & Group	
W	05D	**SELECTED WATER RESOURCES ABSTRACTS** INPUT TRANSACTION FORM

5 *Organization*

Melbourne Water Science Institute Ltd. Carlton, Victoria, Australia

6 *Title*

Cannery Waste Treatment by Anaerobic Lagoons and Oxidation Ditch

10 *Author(s)*

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21 *Note*

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23 *Descriptors (Starred First)*

*Industrial Wastes, *Canneries, *Waste Treatment, *Activated Sludge, *Anaerobic Digestion, Lagoons, Aeration, Capital Costs, Operating Costs, Sewage Treatment

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Oxidation Ditch, *Anaerobic Lagoons, *Food Processing Wastes, Organic Loadings, Efficiencies, Combined Treatment

27 *Abstract*

Various mixtures of fruit and vegetable cannery wastes, and domestic sewage were treated by anaerobic lagoons followed by an oxidation ditch for a two-year period. The anerobic lagoons consistently achieved BOD reductions of 75 to 85 percent at loadings up to 400 lbs BOD/day/acre provided adequate inorganic nutrients were present. The oxidation ditch reduced the BOD to low levels and was shown to be very stable against overload. Power requirements were less than 0.5 kw.hr./lb of BOD removed and the oxygenation capacity of the rotor was about 30 lbs of BOD per foot of length.

Twenty-one tables of raw data are included.

Abstractor K. A. Dostal

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