MONITORING FOR LAS IN NORTHERN CALIFORNIA SLUDGE DIGESTERS

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by

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I. INTRODUCTION

NEED FOR INVESTIGATION

The investigation reported herein was performed in response to a rash of operational difficulties arising at many treatment plants in the Northern California area in 1963 and continuing for several years thereafter. An unprecedented number of digester failures and upsets were occurring for no apparent reason. These problems were also being experienced in other sections of the United States as well as in the United Kingdom, and the universality of these complaints suggested a universal cause.

Synthetic detergents were considered by many to be a possible causative agent despite the 1965 industry-wide conversion from the biologically resistant alkyl benzene sulfonate-based detergents (ABS) to the more easily biodegradable linear alkylate sulfonate-based detergents (LAS). Although LAS is highly biodegradable in aerobic sewage treatment processes, it does not degrade to an appreciable extent in anaerobic systems [1].

ABS was found by the author [2] to cause digester failure at a level of 750 mg/ℓ. Other investigators [3-7] have reported similar findings in the 600 to 900 mg/ℓ range. Since ABS and LAS differ only slightly in chemical structure and physical behavior, it was thought that their critical levels might be nearly the same.

The critical level would be reached sooner in the United Kingdom where per capita water use is less and the detergent concentration in wastewater is approximately twice that found in the United States.

Whether or not detergents were responsible, there was indeed prior concern in the United Kingdom over digester problems. This concern was serious enough that in 1961 the Water Pollution Research Laboratory at Stevenage began a series of investigations into the causes of digester failures. Based on these laboratory studies Swanwick, Bruce, and Vandyke [8] reported that a 2 percent detergent concentration (dry weight total solids basis) in sewage sludge could cause severe inhibition of sludge digesters, although it was possible to operate above this level provided careful operating conditions were observed. It was further found that initiation of digestion was hampered by a concentration as low as 1 percent. A survey of twenty-five failed digesters revealed that the concentration of detergents in the digester sludge ranged from 0.6 to 1.8 percent, but it was not determined that detergents caused these failures.

A more recent survey by Swanwick, Shurben, and Jackson [9] of 142 sewage works with a total of 342 mesophilic digesters indicated that only 5.2 percent of digester problems were attributed to detergents. The majority of difficulties were attributed to inadequate design or operation (56.2 percent), and 37.2 percent of the difficulties were attributed to trade wastes.

To assess the United States position more carefully with respect to the levels of synthetic detergents present in digesters, in 1968 a monitoring program was established at five Northern California sewage treatment plants. This program was designed to provide baseline information during normal operation which should prove useful if an upset occurs in the future. In that event the relationship between detergent concentration and digester performance can be evaluated,

and the role of synthetic detergents as a primary cause of the digester difficulty in question might then be established.

NATURE AND SCOPE OF INVESTIGATION

A year-long study was initiated in June of 1968. Of the five treatment plants selected for inclusion in the study, four had experienced severe and recurring digester problems for several years while the fifth, Stege Sanitary District Wastewater Treatment Plant, remained relatively free of operational difficulties. It was of interest then to determine whether there was a significant difference in detergent concentration between Stege and the other plants which might be correlated to digester upsets.

The Stege plant is located on the east side of San Francisco Bay and serves an estimated population of 45,000 persons. The district is largely residential in nature, with only a small number of light industries in the area.

Largest of the plants monitored is the East Bay Municipal Utility District Water Pollution Control Plant which serves a population of 600,000. Also in the East Bay area are the City of Richmond Sewage Treatment Plant serving a population of 75,000 and the Central Contra Costa Sanitary District serving a population of 200,000.

The only West Bay plant studied was the North San Mateo County Sanitary District Sewage Treatment Plant serving approximately 50,000 residents of Daly City, California.

The monitoring program consisted of sampling influent raw sludge and circulating digester sludge on a once-per-week basis. The plants involved in the program followed their customary routine of analyzing the sludge samples for pH, total solids, volatile solids, alkalinity, and volatile acids. Results of these analyses and other pertinent data on hydraulic and organic loading were recorded on data sheets. This information, together with a portion of the sludge samples, was submitted to the Sanitary Engineering Research Laboratory for analysis of synthetic detergent concentration reported as Methylene Blue Active Substances (MBAS).

ORGANIZATION OF STUDY

The monitoring program was conducted by the Sanitary Engineering Research Laboratory of the University of California at Berkeley under the terms of Research Grant No. 442418-52600-K by the Soap and Detergent Association to The Regents of the University. Professor P. H. McGauhey served as Faculty Investigator and Mr. S. A. Klein as Project Engineer.

Mr. Glenn Davis, Superintendent of the Operation Section of the East Bay Water Pollution Control Plant, selected and organized a steering committee. It consisted of plant operators or delegated personnel from the participating treatment plants and was established to coordinate and guide the study. The committee members were as follows:

Glenn Davis, Committee Coordinator
David Niles, Central Contra Costa Plant
Bob Bernicchi, North San Mateo Plant
Ed Macdonald, Richmond Plant
Fred Lowell, Stege Plant
S. A. Klein, SERL

Under the guidance of this committee the research program was established and carried out.

ACKNOWLEDGMENTS

The project staff is indebted to the committee members and other personnel of the participating plants for their cooperation in collecting, analyzing, and transporting samples to SERL and to Mr. Paul Graham of the SERL staff for conducting MBAS analyses.

II. MATERIALS AND METHODS

DATA COLLECTION

Sample data sheets (see Figure 1) were provided to participating plants for ease of data transmittal. Each week the information indicated was recorded and submitted to SERL along with raw and digested sludge samples. At SERL these data were transferred to a master sheet (see Figure 2) and results of MBAS analyses were added.

Several departures from the normal sampling schedule were made. Starting in January of 1969, two additional digesters were sampled each week at the Central Contra Costa plant. This was done to compare the MBAS levels in different digesters of the same plant. Also, one digester (Digester A) functioned at an unusually high volatile acids concentration, which led to speculation regarding its general condition and whether its MBAS concentration was measurably different.

The operation of the Stege plant was severely impaired by winter rain storms, and the added burden of making repairs forced the plant personnel to withdraw from the program in February of 1969.

At the conclusion of the monitoring period, bottom sludge samples were collected from the East Bay and Central Contra Costa plants. This was done in order to determine the MBAS content of this thick, sandy material which accumulates and may have an effect on digester performance.

SAMPLE PREPARATION

Due to the extremely high viscosity of raw sludge samples, an initial 1:1 dilution had to be made before an aliquot could be pipetted.

Date __________

Weather __________

Average Daily Flow, mgd __________

Flow at Time of Sampling, mgd __________

Digester Loading

Total, lb solids/cu ft/day __________

Volatile, lb VS/cu ft/day __________

Raw Sludge

Time __________

Total Solids, % __________

Volatile Solids, % __________

Circulating Digester Sludge

Time __________

Total Solids, % __________

Volatile Solids, % __________

pH __________

Volatile Acids, mg/ℓ HOAc __________

Alkalinity, mg/ℓ $CaCO_3$ __________

FIGURE 1. SAMPLE DATA SHEET

Plant ____________

Date	Flow, mgd		Digester Loading lb/cu ft/day		Raw Sludge			Circulating Digester Sludge						MBAS			
														Raw Sludge		Digester Sludge	
	Daily Avg.	Sampling Time	Total	Volatile	Time	TS %	VS %	Time	TS %	VS %	pH	VA mg/ℓ	Alk. mg/ℓ	mg/ℓ	% of Solids	mg/ℓ	% of Solids

FIGURE 2. MASTER DATA SHEET

This dilution was accomplished by measuring 250 mℓ of sludge into a graduated cylinder and transferring to a Waring blender. The cylinder was thoroughly rinsed with distilled water and a total volume of 250 mℓ distilled water was added. The blender contents were mixed for one minute and then transferred to a jar. After a three-hour period, provided to allow entrained air to escape, the sample was ready for the extraction procedure.

EXTRACTION PROCEDURE

Although MBAS determinations may be performed directly on sludge samples, it is desirable to initially desorb MBAS from sludge to avoid the formation of stable emulsions during the determination.

At the Water Pollution Research Laboratory at Stevenage an extraction procedure was adopted from the method described by Hussman, Malz, and Jendreyko [3]. A modification of the WPR procedure was used at SERL and is described in Appendix A.

MBAS DETERMINATION

For purposes of data comparison with similar surveys made in the United Kingdom, the MBAS procedure used at the WPR was applied to the samples collected in this study. The method (see Appendix B) is based on the Longwell and Maniece method [10] as modified by Slack [11].

III. RESULTS

In Appendix C a complete tabulation of plant data and MBAS results for each week is presented. Had a digester upset occurred during the monitoring period the plant data on loading and pH equilibrium response would be helpful in determining the exact cause. Inasmuch as all the digesters functioned normally, this information serves as a background to be relied upon should a future incident occur. In this event, samples will be taken and comparisons of the current data to background data will be made.

ORGANIC LOADING

Organic loading of the digesters is shown in Table I with average monthly values indicating seasonal variation — particularly at the East Bay plant which receives cannery wastes. The overall average loading values indicate the digesters surveyed represent a broad range of rates. Notable are low rates at Stege, Richmond, and North San Mateo; an intermediate rate at Central Contra Costa; and a fairly high rate at East Bay.

The results of MBAS analyses are summarized in Table II in terms of the monthly average as percent MBAS of total solids on a dry weight basis.

MBAS CONCENTRATION OF RAW SLUDGE

The overall average indicates that concentrations are similar at all five plants. The minimum value was 0.48 percent MBAS at Stege and the maximum value was 0.63 percent MBAS at Central Contra Costa.

TABLE I

MONTHLY AVERAGES OF DIGESTER LOADING
Volatile Solids, lb/(cu ft/day)

Plant / Month	Stege STP	Richmond STP	East Bay STP	North San Mateo STP	Central Contra Costa STP		
					Digester A	Digester B	Digester D
Jun 68	0.0374	0.0412	0.2670	0.0487		0.0632	
Jul 68	0.0470	0.0425	0.0997	0.0478		0.0750	
Aug 68	0.0465	0.0975	0.1655	0.0492		0.0740	
Sep 68	0.0475	0.0725	0.1240	0.0485		0.0770	
Oct 68	0.0512	0.0782	0.0930	0.0465		0.1470	
Nov 68	0.0538	0.0550	0.0772	0.0398		0.0750	
Dec 68	0.0486	0.0572	0.0884	0.0460		0.0900	
Jan 69	0.0636	0.0472	0.0860	0.0450	0.0600	0.0400	0.0500
Feb 69	0.0450	0.0350	0.0715	0.0480	0.1790	0.0860	0.0852
Mar 69		0.0550	0.3030	0.0430	0.0692	0.0775	0.0880
Apr 69		0.0500	0.1364	0.0428	0.0862	0.0774	0.0704
May 69		0.0570	0.1320		0.0875	0.0850	0.0933
Jun 69		0.0850			0.0980	0.0543	0.1010
Avg.	0.049	0.059	0.137	0.046	0.097	0.079	0.081

TABLE II

MONTHLY AVERAGES OF MBAS CONCENTRATION
(% MBAS of Total Solids, Dry Weight Basis)

Month \ Plant	Stege STP		East Bay STP		Richmond STP		Central Contra Costa STP		North San Mateo STP	
	Raw Sludge	Digester Sludge	Raw Sludge	Digester Sludge	Raw Sludge	Digester Sludge	Raw Sludge	Digester Sludge	Raw Sludge	Digester Sludge
Jun 68	0.49	1.24	0.65	1.24	0.63	1.32	0.76	2.33	0.61	1.80
Jul 68	0.53	1.24	0.64	1.27	0.85	1.28	0.74	1.68	0.55	2.05
Aug 68	0.60	1.19	0.56	1.08	0.62	1.03	0.63	1.75	0.67	1.91
Sep 68	0.46	0.96	0.70	0.89	0.46	0.84	0.62	1.59	0.54	1.55
Oct 68	0.62	1.33	0.54	1.00	0.70	0.73	0.67	2.05	0.62	1.78
Nov 68	0.55	1.30	0.60	1.10	0.59	0.87	0.54	1.70	0.36	1.55
Dec 68	0.36	1.16	0.48	0.93	0.49	0.91	0.55	1.10	0.45	1.45
Jan 69	0.23	1.11	0.34	0.90	0.34	0.79	0.32	1.47	0.46	1.34
Feb 69	0.51	1.22	0.44	1.24	0.50	0.86	0.46	1.50	0.55	1.68
Mar 69			0.62	1.16	0.52	0.83	0.94	1.13	0.62	1.58
Apr 69			0.47	1.02	0.66	1.03	0.68	1.29	0.51	1.41
May 69			0.60	1.04	0.63	0.85	0.68	1.25		
Avg.	0.48	1.19	0.55	1.07	0.58	0.95	0.63	1.57	0.54	1.65

The range for individual monthly values was 0.23 to 0.94 and, as would be expected, the higher concentrations occurred during the dry season of the year.

It is evident then that the normal concentration of MBAS in raw sludge is considerably less than the 1 percent level, which Swanwick et al. [8] stated could inhibit digester recovery from upsets. Only very occasionally did individual samples approach this level, and two samples were higher with one sample at 1.02 percent (the 24 September sample from the East Bay plant) and surprisingly the other sample even exceeded 2 percent (the 11 March sample from the Central Contra Costa plant, see Appendix C). The MBAS concentration is also expressed on a wet basis as mg/ℓ in the tables presented in Appendix C. Reporting MBAS in terms of mg/ℓ is not as meaningful as percent of total solids when applied to sludges, since MBAS concentration is largely a function of total solids concentration, i.e., surface-active materials adsorb readily on solids. Expressed in terms of mg/ℓ, the concentration was in several instances near 1000 mg/ℓ (see Appendix C) but usually this simply indicated an unusually thick raw sludge, i.e., high total solids.

MBAS CONCENTRATION OF DIGESTED SLUDGE

The MBAS content of the digested sludges proved to be similar for three plants (Stege, East Bay, and Richmond) at approximately 1 percent of total solids, but the Central Contra Costa and North San Mateo plants had an overall average of over 1.5 percent. Individual monthly averages for the latter plants rose to over 2 percent on three occasions.

Information is not abundant on the critical levels of MBAS in digested sludges. A large-scale survey in England, Scotland, and Wales [9] indicated that out of 92 cases of digester difficulties only 5 were considered to be caused by anionic detergents, and one of these sewage works reported a concentration of 2.5 percent in the digested sludge, the other 2.6 percent. The literature dealing with laboratory studies generally report MBAS concentration on a wet basis which is subject to the limitations mentioned previously, and unfortunately solids concentrations are seldom given, thus preventing conversion of results to the dry basis. It has been established by laboratory studies that values ranging from approximately 600 to 900 mg/ℓ (reported as ABS) cause retardation of anaerobic digestion. The range of values determined in this survey (see Appendix C) generally show concentrations of 200 to 400 mg/ℓ, which indicates that all five digesters are well below this retardation level.

IN-PLANT VARIATION IN MBAS CONTENT

Three digesters at the same plant were sampled because of two unique circumstances. One of the digesters at the Central Contra Costa plant had not been cleaned in the past fifteen years and would be expected to contain a large quantity of ABS-bearing bottom sludge in addition to more recent deposits of LAS-bearing sludge. This digester (designated as Digester A) also operated at an unusually high volatile acids concentration — often the concentration exceeded 2000 mg/ℓ. In contrast to Digester A, two digesters (B and D) functioned normally and have been cleaned in recent years.

As part of the investigation, these three digesters were sampled to determine if there were an observable difference in MBAS content resulting from their differing histories.

For a period of three months from February through March of 1969, each of these digesters was sampled on a weekly basis. The circulating digester sludge was examined for MBAS during this period and the results are given in Table III. (Samples of bottom sludge were later analyzed and these results are reported later.)

TABLE III

CENTRAL CONTRA COSTA PLANT DIGESTER STUDY

Date	MBAS, mg/ℓ			% MBAS of Total Solids		
	A	B	D	A	B	D
28 Jan 69	275	380	225	1.78	1.47	1.45
5 Feb 69	400	520	500	2.01	2.44	2.01
11 Feb 69	200	220	290	1.45	1.90	1.57
18 Feb 69	195	175	225	1.48	1.72	1.34
25 Feb 69	175	115	155	1.07	1.07	0.86
4 Mar 69	155	125	200	0.98	1.08	0.83
11 Mar 69	185	155	215	1.29	1.38	1.12
18 Mar 69	185	150	195	0.93	0.72	0.76
25 Mar 69	215	180	230	1.32	1.13	1.10
1 Apr 69	330	230	265	1.32	1.45	1.30
8 Apr 69	345	190	240	1.36	1.17	1.40
15 Apr 69	315	205	170	1.23	1.03	0.70
22 Apr 69	255	215	255	1.13	1.33	1.14
Avg.	248	220	243	1.33	1.38	1.20

The average results of the weekly samples are nearly the same for all three digesters. In fact considering the degree of experimental error that exists in analyzing sewage sludges for MBAS, the results are amazingly close and may be considered identical. On individual test days there were large differences between the three results, but based on the overall values it may be concluded that no significant difference exists insofar as the synthetic detergent content of the circulating sludge is concerned.

EFFECT OF BOTTOM SEDIMENTS

In anaerobic digesters sediments are deposited on the bottom and accumulate to such an extent that unless regular maintenance is practiced the effective capacity is significantly reduced. It is not uncommon for the tanks to contain 20, 30, 40, and even 50 percent bottom sludge. Plant operators are well aware of this problem, but cleaning digesters is a cumbersome task and therefore often postponed as long as possible. Digesters which have not been cleaned in the past several years would be expected to contain ABS in the bottom sludges, since ABS does not degrade appreciably under anaerobic conditions.

In 1966 operational difficulties at an East Bay plant digester, which had not been cleaned for 10 years, induced an investigation of the bottom sludge characteristics. The sludge was found to contain a 50-55 percent total solids concentration and an MBAS concentration of 3500 mg/ℓ. Subsequently, the digester was cleaned, restored to normal operation, and no further upsets have occurred. As part of the present investigation samples of this bottom sludge were again analyzed (on 16 July 1969) and indicated reduced concentration of total solids (19.1 percent) and MBAS (900 mg/ℓ).

These reductions in concentrations are not surprising as a shorter time period of accumulation (4 years) is involved. This is explainable in that the organic fraction of sludge degrades leaving the inorganic fraction, i.e., sand, which gradually accumulates or thickens. Similarly, anionic detergents degrade very slowly and as the sand builds up the adsorbed detergents also become more concentrated.

Under equilibrium conditions this detergent probably has little effect on digester operation, but its presence may cause problems if the equilibrium is disturbed. Other investigations by the author [12] on adsorption and desorption phenomena of ABS on soils indicated that anionic detergents are readily desorbed from soil particles by equilibrium changes. It is notable that peak troubles occurred at the East Bay plant digester in the 1966-1967 storm season shortly after a new sludge recirculation system was installed.

In order to determine the quantity of MBAS present in other bottom sludges, depth samples were obtained from a digester at the Contra Costa plant. Digester A, which also has not been cleaned in over 10 years, was sampled at 3 depths. The results are shown in Table IV and indicate that the bottom sludge has a concentration of 1075 mg/ℓ MBAS, but on a percent total solids basis the concentration is only one-half that of the circulating digester sludge. This reflects the distribution of sandy material which is less adsorptive than the silty material predominating in the upper regions.

TABLE IV

VARIATION IN MBAS CONCENTRATION OF SLUDGES
SAMPLED AT DIFFERENT DEPTHS
(Central Contra Costa Plant)[a]

Digester	Sample	Total Solids %	MBAS	
			mg/ℓ	% of Total Solids
A	Circulating Digester Sludge	2.93	320	1.09
A	Thief – Circulate Ring	6.24	690	1.11
A	Thief – Bottom	19.50	1075	0.54

[a]Sampled on 17 June 1969.

IV. DISCUSSION

Digester upsets generally occur just after storms, apparently due to variable loading conditions, but prompt recovery is expected by plant operators when loading adjustments are made. The period of peak digester problems was characterized by difficulty in restoring upset digesters to normal operation following storms. Had there been less than normal rainfall during the monitoring period of June 1968 to June 1969 it might be expected that little importance could be attached to the absence of sustained digester troubles. However, during this period there was more rainfall than normal and more significantly the winter storms were unusually severe. Therefore, if bad weather was in part responsible for the troubles which instigated this study, then it appears likely that whatever the other contributing factors were have now been eliminated.

If ABS was the culprit in causing digester difficulties, then that problem has been eliminated by the conversion to LAS. Although both LAS and ABS degrade very slowly under anaerobic conditions, it is well known that considerable decomposition of LAS occurs in the sewers. The changeover from ABS to LAS resulted in an approximate 30 percent decrease in synthetic detergent concentrations of raw sewage entering treatment plants. (This figure is, of course, variable depending on the size of individual sewerage systems.) The net result then is a 30 percent decrease in the synthetic detergent concentration of the raw sludge pumped to anaerobic digesters.

V. CONCLUSIONS

The monitoring program reported herein supported the following conclusions:

1. MBAS levels in raw sludge proved to be on the order of 0.5 percent (dry solids basis), and therefore below the critical level of 1 percent, which has been found to cause digester problems in laboratory studies conducted in England.
2. In the circulating digester sludge the MBAS content was generally in the 200 to 400 mg/ℓ range (or 1.0 to 1.5 percent of dry solids). This is also below the reported retardation level of 600 to 900 mg/ℓ for digester sludge.
3. Bottom sludge samples contained MBAS concentrations of approximately 1000 mg/ℓ, but calculated on a dry solids basis they measured only approximately 0.5 percent MBAS. Therefore, a large accumulation of bottom sludge is probably not significant to performance from the standpoint of LAS detergents, but is otherwise quite significant in that the effective digester capacity is reduced.
4. The cause of the unusual number of digester upsets during the period from 1963 to 1967 remains unknown, but trouble-free digester performance since that period and the data obtained in this study lead to

the conclusion that the new LAS detergents present no identified problem for sludge digesters in the Northern California area.

APPENDICES

A. Extraction Procedure for Circulated Digester Samples and Diluted Raw Sludge Samples

B. Determination of Methylene Blue Active Substances

C. Master Data Sheets

APPENDIX A

EXTRACTION PROCEDURE FOR CIRCULATED DIGESTER SAMPLES AND DILUTED RAW SLUDGE SAMPLES

Shake sample well, and rapidly pour 80-100 mℓ into 150 mℓ beaker. Stir on magnetic stirrer and withdraw 10 mℓ (use widetip volumetric pipette). Transfer into 250-mℓ round bottom flask washing down pipette with a few mℓ of methanol. Add 10 mℓ of 0.1 N NaOH in methanol, 150 mℓ of methanol. Then reflux vigorously for 30 minutes. After refluxing allow sludge to settle, then decant on a methanol-wetted glass-fiber filter paper (Whatman GF/C) on a Buchner funnel. Then transfer entire contents of the flask to the filter paper. Wash the flask out twice with 20-mℓ portions of methanol, transferring each to filter paper.

The methanolic extract (filtrate) is then transferred to a 500-mℓ Erlenmeyer, washing with two 20-mℓ portions of methanol to insure a complete transfer. Add 10 boileezers and place on steam bath. Distill off methanol until a residue of about 10 mℓ remains in the volumetric flask. Wash the Erlenmeyer 5 times with 25-mℓ portions of distilled water to insure complete transfer. Make to volume (250 mℓ). Invert flask completely and slowly 25 times for complete mixing.

APPENDIX B

DETERMINATION OF METHYLENE BLUE ACTIVE SUBSTANCES

REAGENTS

1. Alkaline Phosphate Solution. Dissolve 10 g A.R. grade disodium hydrogen phosphate (anhydrous) in about 800 mℓ distilled water. Adjust the pH value to 10.5 by addition of sodium hydroxide and make up to 1 liter.
2. Methylene-Blue Solution. Dissolve 0.20 g methylene blue B.P. in 1 liter of distilled water.
3. Sulphuric Acid, concentrated.
4. Chloroform. Reagent grade redistilled over silica gel.
5. Manoxol OT Solution. Dissolve 0.100 g of the solid in 1 liter of distilled water to obtain a 100 mg/ℓ solution.

PROCEDURE

1. The volume of sample taken should be chosen when possible to contain 20 to 150 μg anion-active material. It is generally impracticable to take more than 10 mℓ of sewage, owing to the degree of emulsion formation on shaking with chloroform, but it is possible to take up to 100 mℓ of good quality effluent and river water. Highly saline samples, however, should be limited to 20 mℓ.
2. Place the sample in a 250 mℓ separating funnel and make up to 100 mℓ with distilled water. Add 10 mℓ alkaline phosphate

solution followed by 5 mℓ methylene-blue solution and 40 mℓ chloroform.

3. Shake gently and evenly twice a second for 1 minute. Allow to separate, breaking up any emulsion formed by gentle agitation with a glass rod. Now run the chloroform layer into a second separating funnel containing 110 mℓ distilled water, 0.2 mℓ sulphuric acid, and 5 mℓ methylene-blue solution. Rinse the first separating funnel with 2 mℓ chloroform and run this into the second separating funnel.
4. Shake the second separating funnel as in paragraph 3 above and allow the layers to separate. Run the chloroform layer through a small funnel plugged with absorbent cotton wool moistened with chloroform into a 50-mℓ standard flask, rinsing with a further 2 mℓ chloroform.
5. Make up to the mark with chloroform.
6. Before carrying out a further determination, the separating funnels should be rinsed with dilute nitric acid followed by water to remove adsorbed methylene blue.

Sulphide Interference. Sulphide, if present, should be oxidized before extraction. Place the required volume of sample in the first separating funnel, add 10 mℓ alkaline phosphate solution and 2 mℓ of 20 volume hydrogen peroxide. Stand for 5 minutes and bulk to 110 mℓ with distilled water. Add 5 mℓ methylene-blue solution, 15 mℓ chloroform, and proceed as before.

Measurement. The optical density of the chloroform extract is measured in a suitable photoelectric absorptiometer or spectrophotometer either at 650 mμ or with an Ilford No. 607 orange filter. The blank value, determined using distilled water instead of the sample, is subtracted.

Calibration. Suitable volumes of a standard solution of reference LAS material are treated as above and the optical densities of the extracts determined. The optical density of a reagent-blank extract is also measured. The differences between the optical densities of the standards and the reagent-blank are plotted against concentrations to give a calibration curve. The detergent concentration of a sample can then be determined from this curve, which, in practice, is a straight line.

The results are expressed as mg MBAS per liter.

APPENDIX C

MASTER DATA SHEETS

CENTRAL CONTRA COSTA SANITARY DISTRICT

Date	Flow, mgd		Digester Loading lbs/cu ft/day		Raw Sludge			Circulating Digester Sludge						MBAS			
														Raw Sludge		Dig. Sludge	
	Daily Average	Sampling Time	Total	Volatile	Time	TS %	VS %	Time	TS %	VS %	pH	VA mg/ℓ	Alk. mg/ℓ	mg/ℓ	% of Solids	mg/ℓ	% of Solids
4 Jun 68	19.5	17.0	0.065	0.054	0930	5.81	4.86	0800	1.16	0.75	7.3	231	3850	437	0.75	350	3.01
11 Jun 68	16.8	15.0	0.069	0.059	0930	6.00	5.15	0930	1.11	0.72	7.3	128	4200	380	0.63	235	2.12
18 Jun 68	17.7	20.0	0.030	0.020	1430	4.65	3.53	1430	1.02	0.69	7.3	120	4150	440	0.95	245	2.40
25 Jun 68	22.6	10.0	0.140	0.120	0800	5.96	5.00	0800	1.40	0.86	7.2	506	4200	430	0.72	250	1.78
3 Jul 68	16.6	10.0	0.110	0.090	0800	6.09	5.10	0800	1.37	0.84	7.4	248	4000	520	0.86	355	2.59
9 Jul 68	18.4	14.0	0.070	0.060	0830	5.87	4.84	0830	7.90	5.89	7.2	1243	4250	400	0.68	900	1.14
16 Jul 68	18.7	20.0	0.040	0.030	1730	5.70	4.50	1730	4.68	3.13	7.3	1209	4500	440	0.77	750	1.60
23 Jul 68	17.7	17.0	0.160	0.120	0930	6.97	5.30	0800	3.95	2.57	7.4	514	4100	620	0.89	585	1.48
30 Jul 68	17.2	25.0	0.091	0.075	1200	5.94	4.94	0800	3.46	2.24	7.3	300	4200	300	0.51	545	1.57
6 Aug 68	19.0	7.0	0.110	0.090	1245	5.00	4.05	0800	2.36	1.47	7.4	137	4100	260	0.52	420	1.78
13 Aug 68	15.3	7.0	0.074	0.061	1300	6.33	5.16	0800	1.40	0.88	7.3	120	4150	450	0.71	290	2.07
20 Aug 68	15.0	20.0	0.067	0.055	1400	5.46	4.55	0800	1.49	0.95	7.3	223	4050	360	0.66	235	1.58
27 Aug 68	17.9	25.0	0.106	0.090	1300	5.46	4.61	0800	1.50	0.92	7.3	128	4000	350	0.64	235	1.57
3 Sep 68	15.7	10.0	0.110	0.090	1300	5.12	4.26	0800	1.48	0.96	7.4	94	4000	340	0.66	285	1.92
10 Sep 68	17.1	9.5	0.097	0.081	1330	5.07	4.27	0800	1.32	0.83	7.4	102	4050	330	0.65	265	2.00
17 Sep 68	18.1	25.0	0.103	0.087	1130	5.54	4.67	0800	2.61	1.35	7.5	154	4100	270	0.49	215	0.82
24 Sep 68	16.1	11.0	0.064	0.053	1330	5.22	4.33	0800	1.66	0.96	7.3	154	3950	350	0.67	270	1.62
1 Oct 68	18.9	7.0	0.096	0.080	1045	5.76	4.79	0800	1.17	0.76	7.4	86	3950	430	0.75	245	2.10
8 Oct 68	16.7	12.0	0.102	0.087	1400	5.70	4.80	0800	1.34	0.85	7.3	326	3500	310	0.54	215	1.60
15 Oct 68	17.3	22.0	0.110	0.090	1415	6.25	5.36	0800	1.33	0.84	7.4	120	3600	410	0.66	235	1.77
22 Oct 68	17.7	25.0	0.110	0.094	1100	4.87	4.14	0800	1.19	0.75	7.2	77	3500	400	0.82	340	2.90
29 Oct 68	18.0	5.0	0.086	0.073	0800	5.40	4.43	0800	1.33	0.85	7.2	111	3350	300	0.56	250	1.88
5 Nov 68	19.0	9.0	0.090	0.080	1100	5.08	4.23	0800	1.35	0.82	7.2	146	3550	280	0.55	220	1.63
12 Nov 68	17.1	22.0	0.073	0.061	1350	5.62	4.70	0800	1.31	0.81	7.3	103	3450	240	0.43	245	1.87
19 Nov 68	17.5	20.0	0.128	0.109	1330	5.50	4.68	0800	1.25	0.74	7.2	60	3250	290	0.53	220	1.76
26 Nov 68	14.8	6.0	0.070	0.050	1300	5.68	4.45	0800	1.33	0.83	7.1	120	3200	370	0.65	205	1.54
3 Dec 68	17.4	7.0	0.110	0.090	1400	6.51	5.58	0800	1.88	1.09	7.2	180	3250	430	0.66	225	1.20
10 Dec 68	20.5	34.0	0.150	0.120	1300	5.59	4.41	0800	1.58	0.87	7.1	334	3250	300	0.54	160	1.01
17 Dec 68	16.2	23.0	0.070	0.060	1430	4.89	4.01	0800	4.62	3.20	7.1	1003	3700	220	0.45	508	1.10
24 Dec 68	No Sample																
31 Dec 68	No Sample																
7 Jan 69	20.1	26.0	0.100	0.090	1300	6.15	5.34	0800	2.09	1.26	7.3	205	3550	360	0.59	195	0.94
14 Jan 69	26.8	16.0	0.068	0.053	1300	4.80	3.75	0800	1.52	0.96	7.2	514	3850	110	0.23	220	1.51
21 Jan 69	59.5	62.0	0.075	0.053	1300	4.43	3.11	0800	1.19	0.74	7.3	94	3750	80	0.18	195	1.64
28 Jan 69	45.5	37.0	0.050	0.040	1330	4.90	3.80	0800	2.58	1.64	7.2	677	3400	140	0.29	380	1.47
5 Feb 69	29.4	36.0	0.114	0.094	1330	5.53	4.56	0800	2.13	1.23	7.4	240	4000	360	0.65	520	2.44
11 Feb 69	45.9	18.0	0.140	0.110	1330	5.57	4.52	0800	1.16	0.71	7.3	94	3950	300	0.54	220	1.90
18 Feb 69	42.7	34.0	0.080	0.070	1400	5.20	4.17	0800	1.02	0.63	7.3	111	3800	190	0.37	175	1.72
25 Feb 69	36.3	36.0	0.090	0.070	1400	5.35	4.09	0800	1.07	0.62	7.3	188	3600	150	0.28	115	1.07
4 Mar 69	37.5	36.0	0.090	0.070	0910	5.76	4.70	0800	1.16	0.67	7.4	85	3400	160	0.28	125	1.08
11 Mar 69	24.3	30.0	0.080	0.065	1415	4.77	3.86	0800	1.12	0.69	7.3	163	3450	980	2.05	155	1.38
18 Mar 69	26.3	21.0	0.090	0.075	1300	5.18	4.33	0800	2.08	1.16	7.3	257	3600	350	0.68	150	0.72
25 Mar 69	23.9	20.0	0.130	0.100	1300	5.47	4.47	0800	1.59	0.94	7.2	205	3750	410	0.75	180	1.13
1 Apr 69	21.8	32.0	0.105	0.085	1300	6.11	4.94	0800	1.58	0.93	7.3	163	3900	400	0.65	230	1.45
8 Apr 69	26.0	32.0	0.072	0.057	1300	4.92	3.93	0800	1.63	0.98	7.3	206	3750	360	0.73	190	1.17
15 Apr 69	23.3	31.0	0.105	0.084	1300	5.28	4.22	0800	2.00	1.02	7.3	214	3500	420	0.80	205	1.03
22 Apr 69	26.0	17.0	0.110	0.090	1330	6.21	4.99	0800	1.62	0.98	7.3	206	3600	420	0.68	215	1.33
29 Apr 69	21.9	29.0	0.092	0.071	1355	5.34	4.15	0800	1.81	1.07	7.2	205	3650	300	0.56	200	1.10
6 May 69	23.2	11.0	0.120	0.090	1330	5.36	4.24	0800	1.74	1.07	7.1	206	3900	390	0.73	200	1.15
13 May 69	23.1	10.0	0.080	0.060	1530	6.46	5.24	0800	1.82	1.14	7.2	240	3850	370	0.57	285	1.56
20 May 69	22.8	10.0	0.120	0.090	1430	6.20	4.85	0800	3.01	2.05	7.4	926	3750	450	0.73	390	1.29
27 May 69	22.5	10.0	0.050	0.046	1830	6.56	5.38	0800	3.91	2.74	7.2	1741	4250	450	0.69	540	1.38
3 Jun 69	23.0	10.0	0.069	0.053	1430	5.66	4.38	0800	3.40	2.25	7.3	711	4500	410	0.73	430	1.26

STEGE SANITARY DISTRICT

Date	Flow, mgd		Digester Loading lbs/cu ft/day		Raw Sludge			Circulating Digester Sludge						MBAS			
														Raw Sludge		Dig. Sludge	
	Daily Average	Sampling Time	Total	Volatile	Time	TS %	VS %	Time	TS %	VS %	pH	VA mg/ℓ	Alk. mg/ℓ	mg/ℓ	% of Solids	mg/ℓ	% of Solids
4 Jun 68	3.39	-	0.045	0.035	0800 to 1500	5.57	4.34	0800	2.56	1.33	7.0	103	4490	296	0.53	300	1.17
11 Jun 68	3.58	-	0.051	0.038	"	6.45	4.77	0800	2.72	1.44	7.2	103	4350	380	0.59	350	1.29
18 Jun 68	3.30	-	0.048	0.037	"	5.98	4.67	0800	2.69	1.40	7.2	120	4450	310	0.52	310	1.15
25 Jun 68	3.16	-	0.051	0.040	"	6.36	4.96	0800	2.62	1.36	7.2	120	4400	190	0.30	355	1.35
2 Jul 68	3.00	-	0.058	0.045	"	5.54	4.32	0800	2.62	1.36	7.2	128	4410	310	0.56	325	1.24
9 Jul 68	3.37	-	0.062	0.046	"	6.18	4.57	0800	2.58	1.31	7.2	103	4430	260	0.42	325	1.26
16 Jul 68	3.19	-	0.062	0.047	"	5.82	4.42	0800	2.61	1.31	7.3	94	4480	300	0.52	305	1.17
23 Jul 68	3.46	-	0.063	0.050	"	5.98	4.72	0800	2.60	1.32	7.1	129	4430	350	0.59	340	1.35
30 Jul 68	3.23	-	0.058	0.043	"	5.76	4.32	0800	2.58	1.29	7.4	103	4430	310	0.54	310	1.20
6 Aug 68	3.44	-	0.057	0.044	"	6.04	4.64	0800	2.57	1.31	7.2	103	4390	350	0.58	305	1.19
13 Aug 68	3.16	-	0.063	0.046	"	5.69	4.20	0800	2.64	1.32	7.0	81	4340	220	0.39	315	1.19
20 Aug 68	3.27	-	0.069	0.052	"	6.28	5.02	0800	2.48	1.22	7.2	103	4440	500	0.80	315	1.27
27 Aug 68	3.16	-	0.058	0.044	"	5.76	4.44	0800	2.56	1.26	7.2	120	4380	360	0.63	280	1.09
3 Sep 68	3.49	-	0.065	0.053	"	6.66	5.33	0800	2.52	1.21	7.2	132	4350	340	0.51	305	1.21
10 Sep 68	3.27	-	0.061	0.048	"	5.62	4.38	0800	2.51	1.23	7.2	112	4350	240	0.43	300	1.19
17 Sep 68	3.20	-	0.053	0.044	"	5.91	4.85	0800	2.41	-	7.2	94	4380	170	0.29	30	0.12
24 Sep 68	2.83	-	0.058	0.045	"	5.78	4.45	0800	2.44	1.22	7.1	103	4300	340	0.59	325	1.33
1 Oct 68	2.65	-	0.071	0.057	"	5.88	4.70	0800	2.44	1.22	7.0	139	4370	300	0.51	330	1.35
8 Oct 68	2.57	-	0.058	0.046	"	5.54	4.32	0800	2.41	1.21	7.2	120	4540	410	0.74	315	1.31
15 Oct 68	3.64	-	0.055	0.043	"	5.23	4.08	0800	2.61	1.33	7.1	129	4570	390	0.75	365	1.40
22 Oct 68	3.71	-	0.066	0.053	"	6.02	4.75	0800	2.53	1.29	7.1	120	4420	400	0.67	340	1.34
29 Oct 68	4.05	-	0.072	0.057	"	5.96	4.71	0800	2.50	1.27	7.0	137	4370	270	0.45	315	1.26
5 Nov 68	4.12	-	0.072	0.056	"	6.26	4.89	0800	2.46	1.25	7.0	146	4470	350	0.56	325	1.32
12 Nov 68	2.91	-	0.061	0.048	"	5.76	4.60	0800	2.58	1.34	7.0	146	4480	310	0.54	300	1.16
19 Nov 68	3.73	-	0.073	0.058	"	5.84	4.61	0800	2.44	1.29	7.1	120	4460	300	0.51	340	1.39
26 Nov 68	3.25	-	0.062	0.051	"	5.66	4.64	0800	2.44	1.24	7.0	103	4600	320	0.57	325	1.33
3 Dec 68	3.20	-	0.062	0.050	"	5.63	4.56	0800	2.34	1.22	7.0	120	4440	270	0.48	265	1.13
10 Dec 68	6.70	-	0.082	0.059	"	8.62	6.20	0800	2.26	1.15	7.1	129	4440	330	0.38	290	1.28
17 Dec 68	4.38	-	0.048	0.038	"	6.02	4.76	0800	2.16	1.10	7.0	94	4300	190	0.32	270	1.25
24 Dec 68	6.69	-	0.062	0.047	"	6.26	4.70	0800	2.24	1.12	7.1	86	4260	200	0.32	260	1.16
31 Dec 68	4.52	-	0.065	0.049	"	5.08	4.17	0800	2.14	1.09	7.4	86	4250	160	0.32	210	0.98
7 Jan 69	3.72	-	0.077	0.063	"	5.93	4.86	0800	2.10	1.09	7.0	94	4300	300	0.51	220	1.05
14 Jan 69	6.30	-	0.157	0.108	"	10.82	7.47	0800	2.38	1.24	7.0	120	4480	110	0.10	285	1.20
21 Jan 69	4.68	-	0.030	0.020	"	5.12	3.74	0800	2.14	1.09	7.1	86	4300	40	0.08	230	1.07
28 Jan 69	No Sample																
4 Feb 69	7.82	-	0.056	0.045	"	5.93	4.68	0800	1.76	0.91	7.0	86	3820	300	0.51	215	1.22
11 Feb 69	No Sample																

NORTH SAN MATEO SANITARY DISTRICT

Date	Flow, mgd		Digester Loading lbs/cu ft/day		Raw Sludge			Circulating Digester Sludge						MBAS			
														Raw Sludge		Dig. Sludge	
	Daily Average	Sampling Time	Total	Volatile	Time	TS %	VS %	Time	TS %	VS %	pH	VA mg/ℓ	Alk. mg/ℓ	mg/ℓ	% of Solids	mg/ℓ	% of Solids
4 Jun 68	3.59	4.7	0.052	0.047	1100	6.5	5.85	1100	1.20	0.83	7.3	292	3800	250	0.38	195	1.62
11 Jun 68	3.56	5.4	0.051	0.045	1100	6.3	5.60	1100	1.10	0.77	7.3	275	4000	320	0.51	180	1.64
18 Jun 68	3.48	5.0	0.063	0.056	1100	7.9	6.95	1100	1.06	0.75	7.3	257	4100	760	0.96	205	1.93
25 Jun 68	3.50	4.6	0.054	0.047	1100	6.7	5.90	1100	1.10	0.78	7.3	360	4050	390	0.58	220	2.00
2 Jul 68	3.47	5.0	0.055	0.047	1100	6.9	5.90	1100	1.01	0.72	7.3	292	4200	360	0.52	210	2.08
9 Jul 68	3.51	4.8	0.046	0.039	1100	5.8	4.87	1100	1.04	0.73	7.2	360	4150	290	0.50	210	2.02
16 Jul 68	3.55	5.0	0.051	0.046	1100	6.4	5.70	1100	1.09	0.79	7.2	309	4150	360	0.56	210	1.93
23 Jul 68	3.35	5.2	0.056	0.052	1100	7.7	6.46	1100	1.06	0.76	7.2	343	4170	480	0.62	260	2.45
30 Jul 68	3.47	4.8	0.066	0.055	1100	8.2	6.89	1100	1.25	0.85	7.2	360	4350	450	0.55	220	1.76
6 Aug 68	3.52	5.0	0.056	0.049	1100	7.1	6.19	1100	1.19	0.84	7.4	137	4500	380	0.54	220	1.85
13 Aug 68	3.38	4.5	0.062	0.053	1100	7.7	6.61	1100	1.15	0.82	7.4	189	4475	500	0.65	230	2.00
20 Aug 68	3.45	5.0	0.054	0.048	1100	6.7	5.95	1100	1.16	0.82	7.5	103	4400	350	0.52	220	1.90
27 Aug 68	3.50	5.2	0.054	0.047	1100	6.8	5.91	1100	1.18	0.81	7.4	154	4500	650	0.96	225	1.90
3 Sep 68	3.63	5.3	0.053	0.047	1100	6.6	5.80	1100	1.30	0.87	7.4	189	4500	360	0.62	215	1.65
10 Sep 68	3.62	4.8	0.063	0.054	1100	7.9	6.80	1100	1.10	0.79	7.3	206	4400	510	0.65	215	1.95
17 Sep 68	3.61	4.3	0.053	0.047	1100	6.6	5.86	1100	1.25	0.89	7.3	189	4350	210	0.32	135	1.08
24 Sep 68	3.66	5.0	0.051	0.046	1100	6.4	5.70	1100	1.16	0.82	7.4	189	4550	370	0.58	175	1.51
1 Oct 68	3.61	4.6	0.056	0.049	1100	7.0	6.16	1100	1.33	0.93	7.4	257	4600	530	0.76	245	1.84
8 Oct 68	3.55	4.9	0.047	0.042	1100	5.9	5.25	1100	1.28	0.91	7.3	292	4600	360	0.61	215	1.68
15 Oct 68	3.72	4.9	0.052	0.045	1100	6.5	5.65	1100	1.29	0.89	7.3	257	4550	370	0.57	220	1.70
22 Oct 68	3.71	5.1	-	-	1100	5.9	5.1	1100	1.31	0.97	7.4	274	4500	390	0.66	260	2.00
29 Oct 68	3.77	4.9	0.056	0.050	1100	7.0	6.2	1100	1.31	0.92	7.3	275	4650	360	0.51	220	1.68
5 Nov 68	3.89	4.3	0.053	0.045	1500	6.6	5.7	1500	1.29	0.89	7.3	275	4650	290	0.44	220	1.70
12 Nov 68	3.67	4.9	0.040	0.033	1100	5.0	4.2	1130	1.40	0.97	7.3	257	4600	90	0.18	180	1.28
19 Nov 68	3.72	5.1	0.052	0.045	1100	6.5	5.7	1100	1.45	0.99	7.3	240	4650	-	-	-	-
26 Nov 68	3.68	4.8	0.041	0.036	1100	6.8	6.0	1045	1.40	1.01	7.3	257	4700	320	0.47	235	1.68
3 Dec 68	3.62	5.2	0.054	0.049	1000	6.8	6.1	1030	1.40	1.00	7.3	240	4350	320	0.47	220	1.57
10 Dec 68	4.40	5.6	0.050	0.043	1040	6.3	5.4	1020	1.40	0.97	7.3	223	4750	270	0.43	185	1.32
17 Dec 68	No Sample																
24 Dec 68	No Sample																
31 Dec 68	No Sample																
7 Jan 69	3.49	4.7	0.051	0.046	1030	6.4	5.8	1100	1.90	1.37	7.3	206	4400	300	0.47	165	0.87
14 Jan 69	3.75	5.1	0.060	0.049	1045	7.5	6.1	1000	1.40	0.98	7.4	173	4300	340	0.45	160	1.14
21 Jan 69	4.27	5.6	0.058	0.047	1045	7.2	5.8	1015	1.20	0.80	7.4	170	4150	280	0.39	195	1.62
28 Jan 69	3.94	5.7	0.044	0.038	1030	5.5	4.7	1000	1.20	0.80	7.3	206	4175	290	0.53	205	1.71
4 Feb 69	4.01	4.8	0.054	0.046	1050	6.7	5.8	1000	1.20	0.89	7.3	189	4100	400	0.60	200	1.67
11 Feb 69	4.39	5.8	0.061	0.053	1000	7.6	6.6	1030	1.10	0.76	7.3	154	4050	440	0.58	200	1.82
18 Feb 69	4.01	5.2	0.051	0.045	1005	6.4	5.7	0940	1.10	0.72	7.3	226	4050	300	0.47	200	1.82
25 Feb 69	4.26	5.4	0.056	0.048	1000	7.0	6.0	1015	1.10	0.73	7.3	223	4050	370	0.53	155	1.41
4 Mar 69	3.94	5.4	0.051	0.045	0940	6.4	5.6	1000	1.20	0.79	7.2	206	4050	410	0.64	180	1.50
11 Mar 69	3.87	5.2	0.060	0.049	1005	7.5	6.1	0940	1.20	0.77	7.3	223	4150	470	0.63	185	1.54
18 Mar 69	3.77	5.2	0.046	0.040	1000	5.7	5.0	0940	1.10	0.72	7.3	223	4050	310	0.54	180	1.64
25 Mar 69	3.79	5.6	0.043	0.038	0900	5.4	4.8	0930	1.10	0.73	7.3	223	4150	360	0.67	180	1.63
1 Apr 69	3.69	5.3	0.051	0.046	1015	6.4	5.7	1000	1.10	0.74	7.3	206	4200	250	0.39	150	1.36
8 Apr 69	3.87	4.6	0.051	0.043	1030	6.3	5.4	0940	1.00	0.68	7.3	223	4100	390	0.62	145	1.45
15 Apr 69	3.72	5.5	0.046	0.042	0900	6.0	5.3	0915	1.10	0.71	7.3	257	3950	310	0.52	155	1.41

RICHMOND SANITARY DISTRICT

Date	Flow, mgd		Digester Loading lbs/cu ft/day		Raw Sludge			Circulating Digester Sludge						MBAS			
														Raw Sludge		Dig. Sludge	
	Daily Average	Sampling Time	Total	Volatile	Time	TS %	VS %	Time	TS %	VS %	pH	VA mg/ℓ	Alk. mg/ℓ	mg/ℓ	% of Solids	mg/ℓ	% of Solids
4 Jun 68	8.0	8.0	0.061	0.046	1100	5.1	3.88	1105	2.5	1.36	7.0	51	2310	271	0.53	350	1.40
11 Jun 68	8.0	3.8	0.071	0.054	0830	6.2	4.70	1300	3.4	1.95	7.0	51	2300	270	0.44	445	1.31
18 Jun 68	8.0	3.5	0.042	0.033	0900	4.7	3.64	0930	3.3	1.78	7.0	120	2400	440	0.94	410	1.24
25 Jun 68	8.0	3.5	0.041	0.032	0900	4.1	3.23	0900	3.2	1.72	7.0	103	2400	250	0.61	425	1.33
2 Jul 68	8.0	7.5	0.049	0.032	1120	4.9	3.16	1300	2.8	1.50	7.0	51	2280	460	0.94	365	1.30
9 Jul 68	8.0	8.2	0.040	0.028	1245	3.9	2.71	1300	3.0	1.65	7.0	86	2280	350	0.90	400	1.33
16 Jul 68	8.0	7.8	0.040	0.030	1130	3.9	2.94	1315	3.0	1.62	7.0	86	2340	260	0.67	405	1.35
23 Jul 68	8.0	8.8	0.030	0.020	1230	4.3	3.32	1300	2.8	1.50	7.0	69	2380	350	0.82	360	1.29
30 Jul 68	8.5	8.2	0.070	0.060	0900	4.4	3.50	0915	3.4	1.91	7.0	120	2180	400	0.91	385	1.13
6 Aug 68	9.7	8.0	0.130	0.100	0915	7.4	5.79	1330	3.0	1.79	7.0	120	1940	500	0.68	340	1.13
13 Aug 68	9.8	8.0	0.120	0.100	0930	7.6	6.06	1315	3.3	2.05	6.9	291	1780	460	0.61	340	1.03
20 Aug 68	9.9	8.0	0.130	0.100	1015	5.7	4.51	0900	3.9	2.45	7.0	223	2080	390	0.69	415	1.06
27 Aug 68	9.7	9.2	0.110	0.090	1030	6.1	4.81	0930	4.0	2.53	7.0	103	2290	300	0.49	360	0.90
3 Sep 68	9.1	9.8	0.130	0.090	1130	8.0	5.74	0930	4.4	2.90	7.0	103	2080	310	0.39	405	0.92
10 Sep 68	10.2	9.2	0.100	0.080	0930	4.3	3.38	1015	4.4	2.90	6.9	120	2180	240	0.56	355	0.81
17 Sep 68	9.5	8.2	0.110	0.080	0930	5.1	3.84	1000	4.1	2.65	6.9	120	2100	220	0.43	330	0.81
24 Sep 68	9.3	9.0	0.060	0.040	1300	3.2	2.10	1300	3.8	2.11	7.0	120	2050	140	0.44	315	0.83
1 Oct 68	8.8	8.0	0.120	0.090	0930	5.2	3.69	0930	4.6	3.19	7.0	86	1980	270	0.52	325	0.71
8 Oct 68	9.1	8.0	0.100	0.080	0900	3.6	2.89	0900	4.5	3.03	7.0	103	1930	210	0.58	370	0.82
15 Oct 68	7.7	8.0	0.110	0.081	0900	5.1	3.78	0900	4.8	3.32	6.9	171	1990	410	0.81	240	0.50
22 Oct 68	7.6	8.0	0.140	0.080	0930	6.3	4.65	0930	4.4	2.90	7.0	154	2180	510	0.81	350	0.80
29 Oct 68	7.9	7.0	0.080	0.060	0930	6.1	4.70	0930	3.8	2.70	7.0	86	2270	460	0.76	315	0.83
5 Nov 68	8.6	8.5	0.070	0.050	1000	6.2	4.68	1000	3.7	2.80	7.0	86	2300	330	0.53	305	0.60
12 Nov 68	8.2	8.0	0.080	0.060	0930	6.7	5.07	0930	3.5	2.10	6.9	120	2240	320	0.48	330	0.94
19 Nov 68	8.4	7.9	0.080	0.060	0930	5.5	4.20	0930	3.5	2.00	7.0	120	2220	380	0.69	310	0.89
26 Nov 68	7.6	3.5	0.060	0.050	0900	5.2	4.06	0900	3.5	2.00	7.0	86	2240	340	0.66	360	1.03
3 Dec 68	7.6	3.5	0.050	0.040	0900	4.2	3.20	0900	3.3	1.90	7.0	103	2240	330	0.79	375	1.13
10 Dec 68	17.2	8.5	1.100	0.700	0900	8.9	5.70	0900	3.5	2.20	7.0	51	2280	280	0.31	290	0.83
17 Dec 68	9.6	8.0	0.070	0.050	0900	4.8	3.33	0900	3.6	2.10	7.0	154	2190	190	0.40	310	0.86
24 Dec 68	14.9	13.0	0.080	0.060	0900	5.7	4.48	0900	3.2	1.70	6.9	137	2120	270	0.47	270	0.84
31 Dec 68	8.4	7.9	0.090	0.066	0830	6.7	4.90	0830	3.6	2.00	6.9	120	2180	330	0.49	315	0.88
7 Jan 69	8.4	4.5	0.110	0.090	0830	7.2	5.80	0845	3.0	1.70	7.0	103	2290	600	0.83	195	0.65
14 Jan 69	8.0	11.0	0.006	0.004	1000	4.7	3.80	0930	3.0	1.60	7.0	120	2310	50	0.11	210	0.70
21 Jan 69	8.0	30.0	0.037	0.025	0900	4.1	2.78	0900	2.7	1.40	7.0	86	2100	50	0.12	255	0.95
28 Jan 69	8.0	14.5	0.090	0.070	0900	7.0	5.08	0900	2.9	1.60	7.0	69	2090	200	0.29	250	0.86
4 Feb 69	8.0	7.5	0.040	0.020	0830	3.5	2.26	0830	2.9	1.50	7.0	103	2210	270	0.77	280	0.97
11 Feb 69	8.0	24.0	0.060	0.040	0830	5.6	4.25	0830	2.8	1.50	7.0	86	2120	300	0.54	260	0.93
18 Feb 69	8.0	12.0	0.090	0.060	0915	6.0	4.17	0915	2.4	1.20	7.0	120	2050	210	0.35	175	0.73
25 Feb 69	8.0	12.5	0.040	0.020	0830	3.0	1.96	0845	3.1	1.50	7.0	69	2100	100	0.33	255	0.82
4 Mar 69	8.0	13.5	0.080	0.050	1100	4.9	3.22	1100	3.2	1.60	7.0	171	1950	130	0.27	175	0.55
11 Mar 69	8.0	8.0	0.050	0.040	1100	5.0	3.8	1115	3.0	1.57	7.0	69	2100	80	0.16	235	0.78
19 Mar 69	8.0	8.0	0.130	0.090	0830	7.1	5.1	0830	2.3	1.19	7.0	103	2250	500	0.71	230	1.00
25 Mar 69	8.0	4.0	0.050	0.040	0815	3.8	2.7	0820	2.9	1.50	7.0	206	2250	360	0.95	280	0.97
1 Apr 69	8.0	4.0	0.110	0.090	0830	6.7	5.1	0830	3.1	1.69	7.0	154	2340	400	0.60	290	0.94
8 Apr 69	8.0	8.0	0.040	0.030	1300	3.5	2.4	1300	3.1	1.65	7.0	51	2250	230	0.66	305	0.99
15 Apr 69	8.0	12.0	0.075	0.050	0845	5.7	3.8	0845	3.3	1.81	7.0	51	2390	420	0.74	340	1.03
22 Apr 69	8.0	5.5	0.047	0.030	1300	4.1	2.9	1300	3.3	1.73	7.0	69	2460	230	0.56	365	1.10
29 Apr 69	8.0	8.0	0.070	0.050	0915	5.3	3.7	0915	3.3	1.69	7.1	34	2310	400	0.76	355	1.08
6 May 69	No Sample																
13 May 69	8.0	8.0	0.077	0.056	1300	5.6	4.1	1300	3.0	1.57	7.0	43	2350	450	0.80	320	1.07
20 May 69	8.0	7.0	0.078	0.058	0900	5.8	4.3	0900	3.1	1.61	6.9	69	2300	265	0.46	365	0.63

EAST BAY MUNICIPAL DISTRICT

Date	Flow, mgd		Digester Loading lbs/cu ft/day		Raw Sludge			Circulating Digester Sludge						MBAS			
														Raw Sludge		Dig. Sludge	
	Daily Average	Sampling Time	Total	Volatile	Time	TS %	VS %	Time	TS %	VS %	pH	VA mg/ℓ	Alk. mg/ℓ	mg/ℓ	% of Solids	mg/ℓ	% of Solids
4 Jun 68	77.0	54.0	0.139	0.108	0130	8.6	6.7	0100	2.2	1.1	7.2	172	3200	542	0.63	260	1.18
11 Jun 68	80.6	54.0	0.113	0.088	0715	7.0	5.4	0715	2.4	1.1	7.2	137	2950	500	0.72	250	1.04
18 Jun 68	68.0	68.0	0.131	0.102	0100	7.3	5.7	0100	2.4	1.2	7.0	172	3250	400	0.55	300	1.25
25 Jun 68	66.3	68.0	0.102	0.077	0100	6.9	5.2	0100	2.2	1.2	7.0	103	3750	480	0.70	325	1.48
2 Jul 68	67.5	67.7	0.099	0.074	0030	6.3	4.7	0030	2.3	1.2	7.0	137	3600	470	0.75	315	1.37
9 Jul 68	75.9	54.7	0.095	0.072	0130	6.6	5.0	0130	3.1	1.8	7.5	206	3950	380	0.58	380	1.22
16 Jul 68	86.9	90.0	0.118	0.081	0015	7.7	5.5	0015	3.5	1.8	7.0	194	4150	500	0.65	465	1.33
23 Jul 68	84.1	66.0	0.206	0.151	0100	8.8	6.5	0100	3.3	1.8	7.4	172	3100	550	0.63	450	1.36
30 Jul 68	85.6	54.7	0.176	0.121	0100	7.5	5.2	0100	3.6	1.9	7.0	120	4050	450	0.60	380	1.05
6 Aug 68	82.6	122.4	0.187	0.120	0030	7.2	4.6	0030	4.0	1.9	7.0	223	3550	350	0.49	410	1.02.
13 Aug 68	64.9	123.0	0.208	0.145	0030	9.1	6.4	0030	3.3	1.5	7.1	154	4100	670	0.74	370	1.12
20 Aug 68	80.3	123.0	0.281	0.198	0030	10.4	7.4	0030	3.5	1.7	7.1	154	3700	580	0.56	405	1.16
27 Aug 68	85.2	67.7	0.295	0.199	0100	10.1	6.8	0100	3.3	1.4	7.1	240	3900	430	0.43	340	1.03
3 Sep 68	83.5	67.7	0.242	0.172	0130	10.4	7.4	0130	3.0	1.3	7.2	69	3800	810	0.78	345	1.15
10 Sep 68	83.8	67.7	0.182	0.131	0130	5.8	3.5	0130	7.1	5.1	6.9	395	2450	370	0.64	430	0.61
17 Sep 68	76.4	67.4	0.129	0.083	0200	6.0	4.3	0200	3.3	1.4	7.2	137	3800	220	0.37	215	0.65
24 Sep 68	80.7	70.0	0.155	0.109	0100	7.0	4.9	0100	4.3	2.1	7.1	154	3800	500	1.02	485	1.13
1 Oct 68	79.7	67.7	0.118	0.085	0200	6.2	4.5	0200	3.7	1.9	7.2	103	3750	350	0.57	405	1.09
8 Oct 68	79.8	65.0	0.140	0.094	0100	7.5	5.0	0100	3.3	1.4	7.2	206	3500	270	0.36	325	0.99
15 Oct 68	76.4	50.0	0.129	0.089	0100	7.7	5.3	0100	3.6	1.6	7.2	257	3600	410	0.53	370	1.03
22 Oct 68	77.1	67.7	0.142	0.098	0100	7.5	5.2	0100	7.6	5.0	7.3	120	3750	450	0.60	620	0.82
29 Oct 68	69.5	54.7	0.121	0.099	0100	7.3	6.0	0100	2.9	1.4	7.2	69	3850	480	0.66	315	1.09
5 Nov 68	77.2	67.7	0.089	0.066	0100	6.4	4.7	0100	4.5	2.5	7.2	86	4300	450	0.70	500	1.11
12 Nov 68	81.6	122.4	0.118	0.092	0100	7.4	5.8	0100	2.7	1.3	7.2	120	3600	380	0.51	330	1.22
19 Nov 68	75.5	67.7	0.084	0.065	0100	5.5	4.3	0100	7.2	4.7	7.2	103	3650	350	0.64	510	0.71
26 Nov 68	69.5	54.7	0.114	0.086	0100	7.0	5.3	0100	2.5	1.3	7.2	86	3500	380	0.54	340	1.36
3 Dec 68	67.3	54.7	0.114	0.086	0100	6.1	4.6	0100	2.8	1.7	7.1	120	3500	300	0.49	265	0.95
10 Dec 68	87.8	54.7	0.144	0.095	0100	10.3	6.8	0100	2.2	1.2	7.1	103	3350	270	0.26	205	0.93
17 Dec 68	84.1	54.7	0.115	0.083	0130	6.7	4.8	0330	2.9	1.5	7.2	103	3450	300	0.45	285	0.99
24 Dec 68	64.3	54.7	0.111	0.087	0115	6.5	5.0	0330	2.8	1.4	7.1	103	3450	530	0.82	265	0.95
31 Dec 68	82.6	57.7	0.126	0.091	0115	7.3	5.2	0345	2.3	1.2	7.2	120	3000	270	0.37	195	0.85
7 Jan 69	73.4	54.7	0.105	0.082	0130	7.8	6.1	0400	2.3	1.2	7.2	120	3050	360	0.46	230	1.00
14 Jan 69	176.1	123.0	0.340	0.104	0200	19.2	5.8	0400	2.0	1.0	7.0	86	3050	220	0.11	195	0.98
21 Jan 69	205.4	-	-	-	-	-	-	0515	1.9	0.9	7.1	86	2700	-	-	190	1.00
28 Jan 69	134.5	94.0	0.118	0.072	0300	7.6	4.6	0430	2.0	1.1	7.1	103	2550	350	0.46	125	0.63
4 Feb 69	93.0	47.0	0.093	0.067	0130	6.2	4.8	0345	1.5	0.8	7.0	103	2450	320	0.52	300	2.00
11 Feb 69	93.0	122.4	0.124	0.096	0045	7.5	5.9	0330	1.7	1.0	7.0	172	2250	450	0.60	155	0.91
18 Feb 69	127.0	94.0	0.087	0.063	0300	6.1	4.4	0400	1.7	1.0	7.1	86	2500	270	0.44	180	1.06
25 Feb 69	162.4	94.0	0.098	0.060	0200	6.2	3.8	0400	1.9	0.9	7.0	69	2450	130	0.21	190	1.00
4 Mar 69	110.4	67.8	0.102	0.077	0130	7.3	5.5	0430	1.1	0.6	6.9	275	1900	310	0.43	200	1.82
11 Mar 69	83.7	67.6	1.212	0.948	0130	5.5	4.3	0100	3.6	2.2	6.9	961	2700	370	0.67	340	0.95
18 Mar 69	89.3	54.7	0.110	0.087	0130	7.3	5.8	0130	6.1	3.6	7.1	206	3150	460	0.63	510	0.84
25 Mar 69	76.2	67.6	0.128	0.100	0130	6.2	4.8	0100	2.5	1.4	7.0	137	2850	450	0.73	260	1.04
1 Apr 69	77.2	67.6	0.137	0.110	0130	7.5	6.0	0100	2.8	1.7	7.2	240	3250	460	0.61	290	1.04
8 Apr 69	91.2	67.6	0.142	0.107	0130	7.3	5.5	0100	3.9	2.2	7.0	154	3350	290	0.40	420	1.07
15 Apr 69	83.3	54.7	0.164	0.126	0130	7.0	5.4	0100	5.4	3.5	7.1	223	3300	330	0.47	485	0.90
22 Apr 69	77.8	54.7	0.154	0.117	0130	7.7	5.9	0100	3.1	1.7	7.1	172	3300	350	0.46	325	1.05
29 Apr 69	77.2	67.6	0.166	0.122	0130	8.0	5.9	0030	2.5	1.3	7.2	103	3400	310	0.39	260	1.04
6 May 69	79.7	67.6	0.177	0.127	0130	7.7	5.6	0100	2.3	1.2	7.2	86	3300	440	0.57	205	0.89
13 May 69	76.8	67.6	0.179	0.137	0130	7.4	5.6	0100	3.3	1.9	7.1	86	3500	360	0.49	305	0.93
20 May 69	79.8	67.6	0.129	0.100	0130	5.4	4.1	0100	2.1	1.2	6.9	69	3550	370	0.69	245	1.17
27 May 69	76.3	67.6	0.222	0.163	0130	8.9	6.5	0100	2.3	1.3	7.1	103	3200	570	0.64	270	1.17
3 Jun 69	76.4	67.6	0.198	0.144	0130	7.4	5.4	0100	2.7	1.5	7.0	86	3050	400	0.54	280	1.04

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