FLOCCULATION/PRECIPITATION
OF
SOLIDS IN DAIRY LAGOONS

FINAL REPORT
TO USDA, NRCS, AS PART OF A
CONSERVATION INNOVATION GRANT

Prepared by
CALIFORNIA DAIRY CAMPAIGN
TURLOCK, CALIFORNIA

December, 2009

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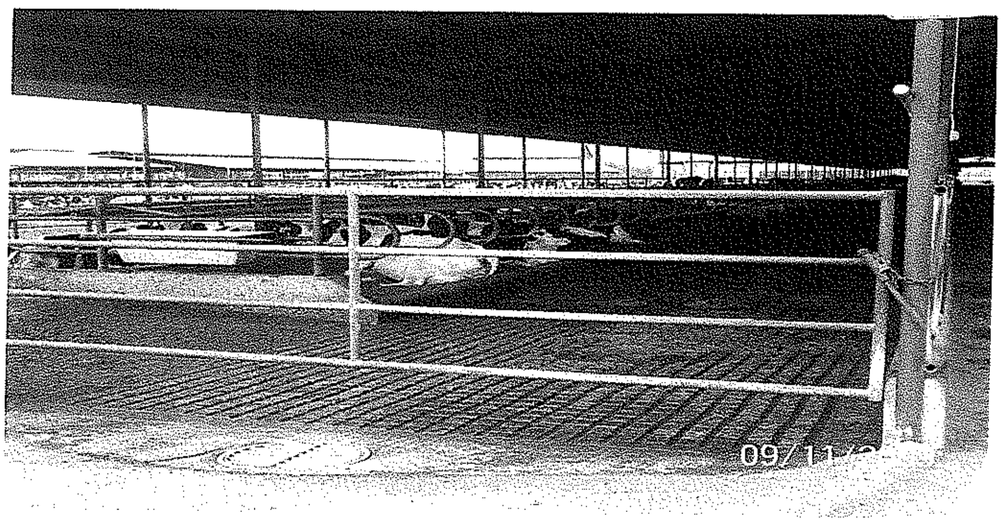
"FLOCCULATION/PRECIPITATION OF SOLIDS IN DAIRY LAGOONS"

This is California Dairy Campaign's final report on NRCS's Conservation Innovation Grant titled "Flocculation/Precipitation of Solids in Dairy Lagoons" and located in the San Joaquin Valley of California. The original grant period was from September 1, 2007 through December 31, 2008; however, CDC requested and received a six-month extension. The objectives of the project were to demonstrate the economic feasibility of using polymers to remove suspended solids in dairy wastewater, evaluate the nutrient and economic value of the solids removed, collect data, and prepare recommendations to NRCS California FOTG Committee.

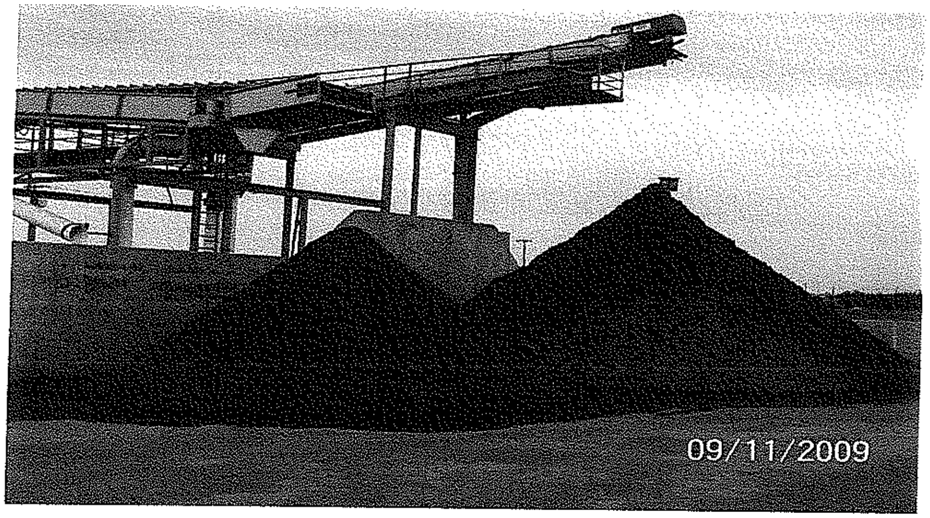
The strategy for the project was modified early in the process due to the overall economic conditions, especially the hard hit dairy industry in California. Over 200 dairies have gone out of business in California during the duration of this project. Eighteen dairies were envisioned in the original project; however, due to the economic conditions mentioned above, only four dairies directly participated. This change in strategy was documented in biennial progress reports submitted as part of requirements for the grant. The lower level of participation by the number of dairies, however, allowed more intense evaluations for those who did participate. This allowed the team to collect more and precise data than originally envisioned. Representatives from SNF, Inc., an international company in Georgia involved in polymers, joined the team effort and became very active in the demonstration and evaluation process. SNF employees Ed Valenter, Western Regional Field Representative, and Dr. George Tichenor, Research Chemist, provided vast amounts of technical assistance throughout the project, including laboratory and field work. SNF, Inc. also provided products to be used in the polymer evaluation including chemicals and laboratory equipment. Denele Lab's in Turlock, California, also provided a great deal of assistance including personnel, field work, laboratory, equipment, and laboratory analyses. An advisory team consisting of Kevin Abernathy (Executive Director of CDC), Joe Mullinax (Manager of Denele Lab's), Joe Melo (Field Technician of CDC), Pete Verburg (local dairyman, owner of Pete Verburg & Sons Dairy), Ed Valenter (Western Regional Field Representative of SNF, Inc.), Dr. George Tichenor (Research Chemist of SNF, Inc.) and Gary Bullard (Environmental Project Manager of CDC) interacted throughout the grant period. As part of field testing of polymers and their effects on flocculation of solids in dairy lagoons, lagoon waters from four dairies were collected and used for protocol development. Many samples were taken and treated to arrive at the best treatment options. See **Appendix 1** for the protocol development process. During this process six 250 gallon tote bins were used to simulate a lagoon system with three ponds. The totes were plumbed where two lagoon systems could be simulated and evaluated side-by-side. One three tote bin set was used as the treatment and one three tote bin set was used as a control. The lagoon water was hauled directly from the dairies in a 1,000 gallon tank truck and distributed equally to each bin set at designed rates. Previous lab work using lagoon water from several dairies was the basis for treatment rates used in the totes. Different molecular weighted and different electronically charged materials were used in the protocol development. During the protocol development, it was found that close to 50% of the phosphorous could be removed from the water profile with treatment. This is a very important finding since many soils irrigated in California are extremely high in phosphorous. If and when the State of California begins to regulate phosphorous as part of nutrient management, this finding will become more significant.

Once the evaluations with the totes were completed and protocol developed, further evaluations were moved to the Verburg & Sons Dairy. The dairy contains photosynthetic anaerobic purple sulfur bacteria in the lagoon system.

The Verburgs milk about 700 head of cows twice daily. The barns contain free stalls and flush lanes with exercise yards. Each lane is flushed five times per day for about 15 minutes (photo of flush lane and freestalls).

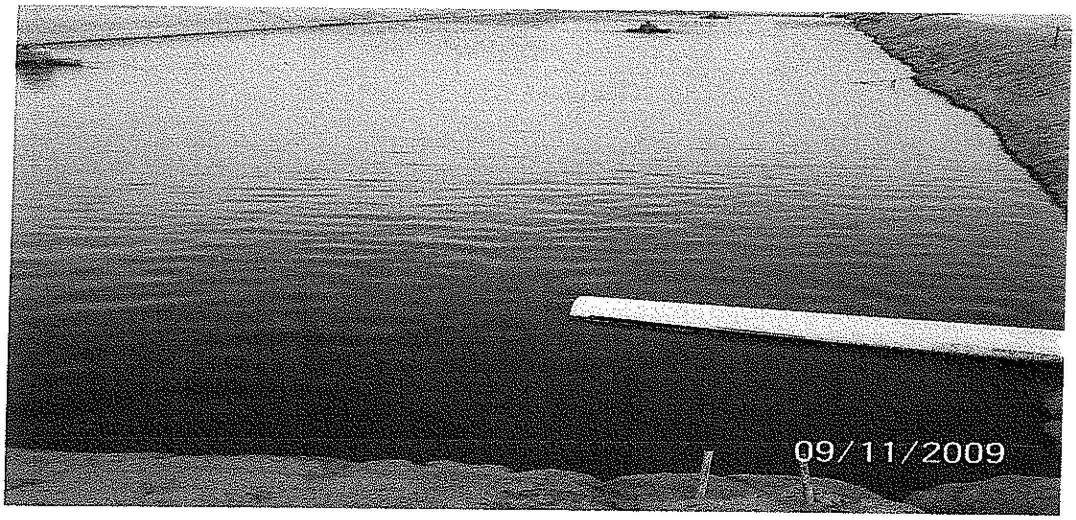


Each flush period of all lanes lasts about 45 minutes. The flush water goes to a receiving pit where sand settles out and waste water with solids are pumped at 1200 gallons per minute to two mechanical solids separators in series about 1400 feet away. The mechanical separators remove close to 50% of the solids (photo of solid piles).

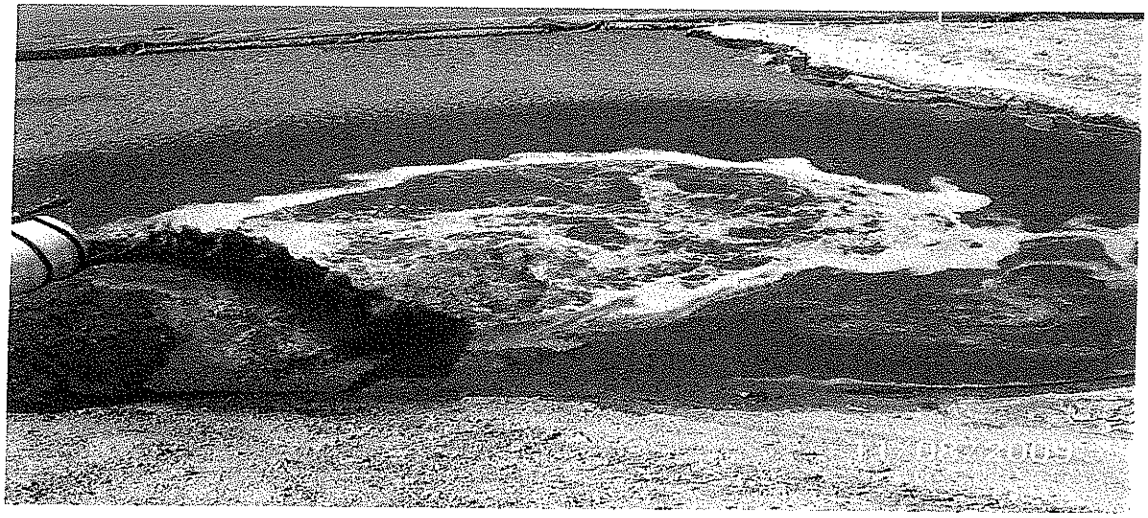


These solids are then composted with the compost being used as bedding in free stalls or for marketing off farm (photo of compost wind rows).

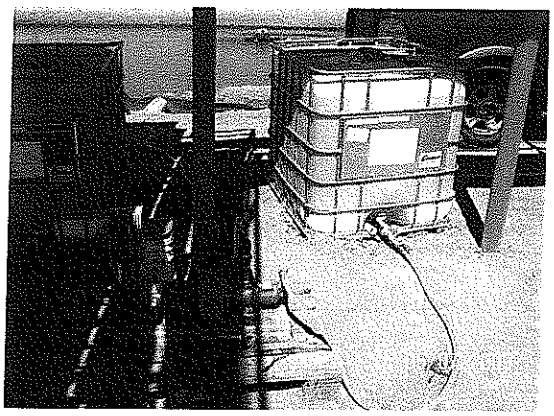
Below the separators are three large lagoons with circulators installed to maintain the phototrophic purple sulfur bacteria. The waste water below the separators is routed through a three lagoon system maximizing retention time. The water in the last lagoon is used for irrigating crops and flushing the lanes (photo).

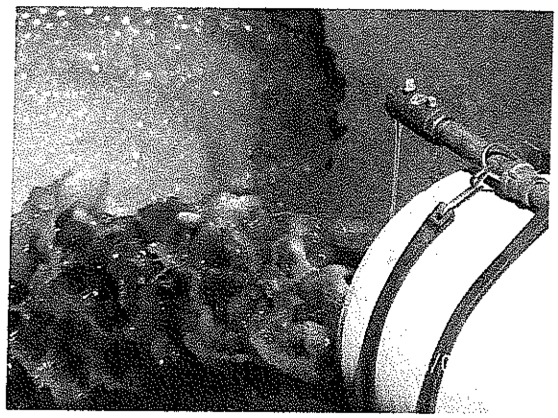


The remaining solids after separation are very fine suspended particles and are extremely difficult, if not impossible, to separate by mechanical means. Several polymer injection points were tried before arriving at the selected site. These included above the sand trap, at the sand trap, and just prior to the mechanical separators. Injection just prior to the separators was the desired location. However, the varying amounts of solids in the flush water, depending on whether it was the early part of the flush lane or the last part of the flush lane made this site unsuitable as well. It was finally decided to inject at the outfall below the separators. This would allow for adequate agitation for polymer action (see photo—outfall).



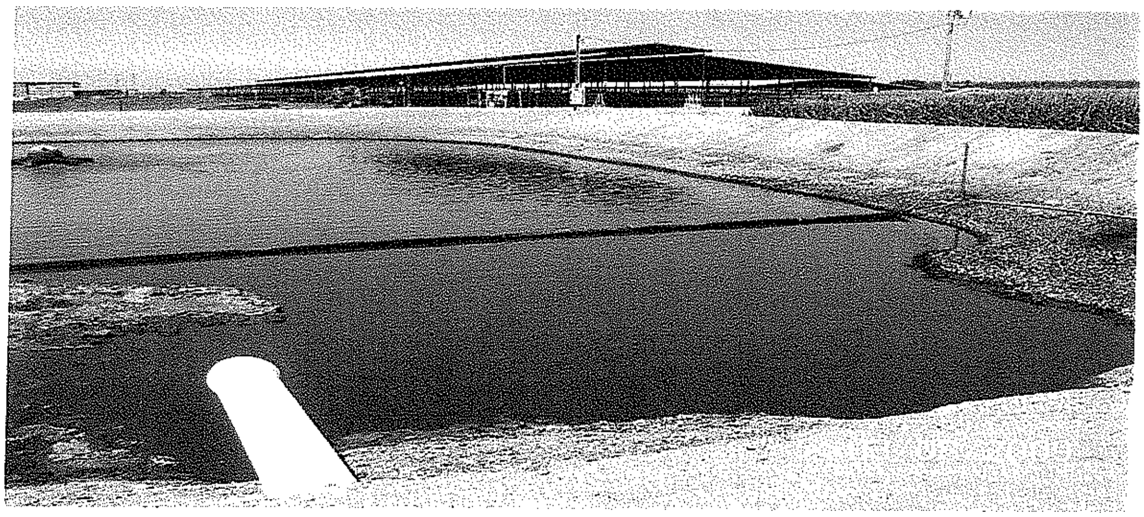
Injection below the separators would also require a minimum amount of polymers due to reduced solids in the effluent. A pump was used to inject the polymer into the outfall at a controlled rate between two and three hundred ppm (see photos).



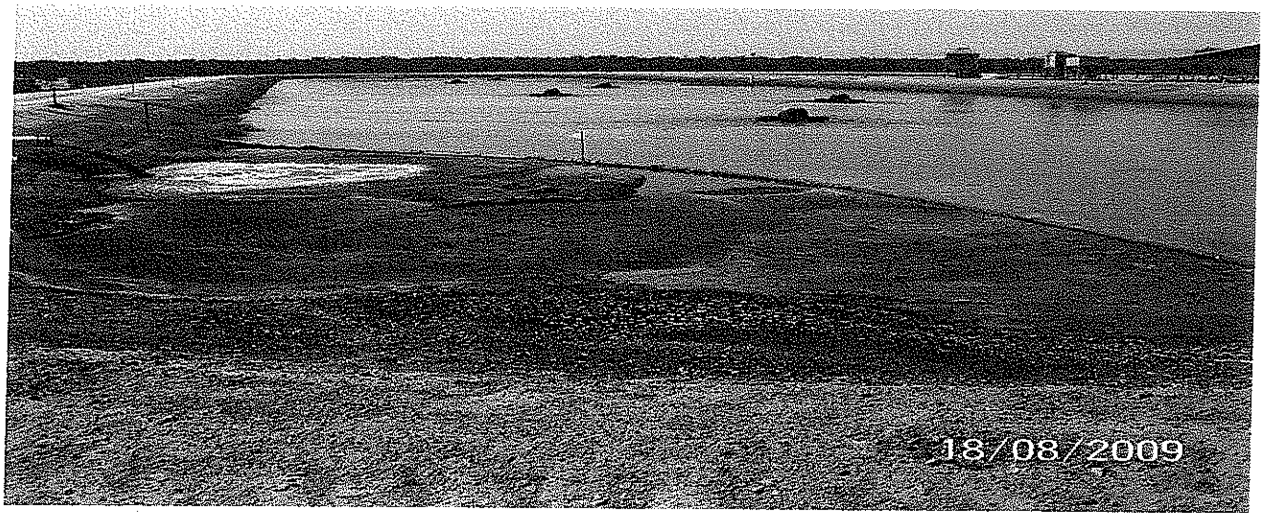


Trial runs were made on the dairy to adjust pump setting, etc., which resulted in very effective flocculation for these short periods. However, much of the flocculated solids floated and began covering the surface of the lagoon. This was unsightly as well as unacceptable since the floating solids prevented light penetration necessary for the phototrophic bacteria and made removal difficult.

The material accumulating on the surface would normally not be seen and would have settled to the bottom with other heavier flocculated material. Prior to the treatment there was some concern on where the flocculated material would accumulate. A floating suspended curtain that would go across the upper end of the entire lagoon would have probably worked; however, the cost exceeded the budget. Before any further treatment with polymers proceeded, some form of containment of flocculated solids was deemed necessary. The decision to install a 100 foot suspended curtain was made and the curtain was installed across a small corner of the lagoon immediately below the outfall from the separators (see photos of floating curtain).

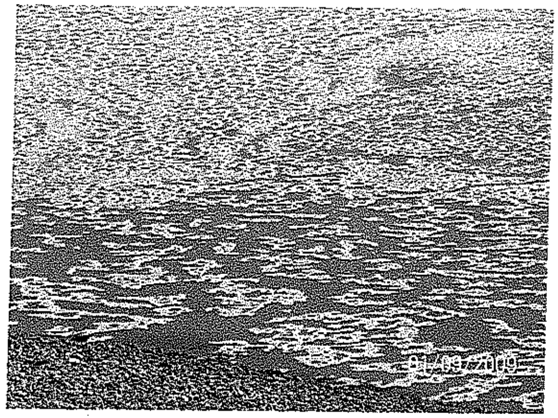


Once the curtain was installed, treatment with polymers was initiated again. Flocculated solids were being trapped and contained within the suspended curtain as planned (photo of trapped solids).



Polymer treatment continued for four and one-half days with positive results. However, once the treatment with polymers was stopped, the continuing agitation at the outfall appeared to dislodge and breakdown trapped flocculated solids and re-suspend/redistribute them throughout other parts of the lagoon. (See photos).

Also some flocculation and accumulation of solids on the surface demonstrated that some flocculation was continuing to occur beyond the small curtained off area (photo of floating material in lagoon).

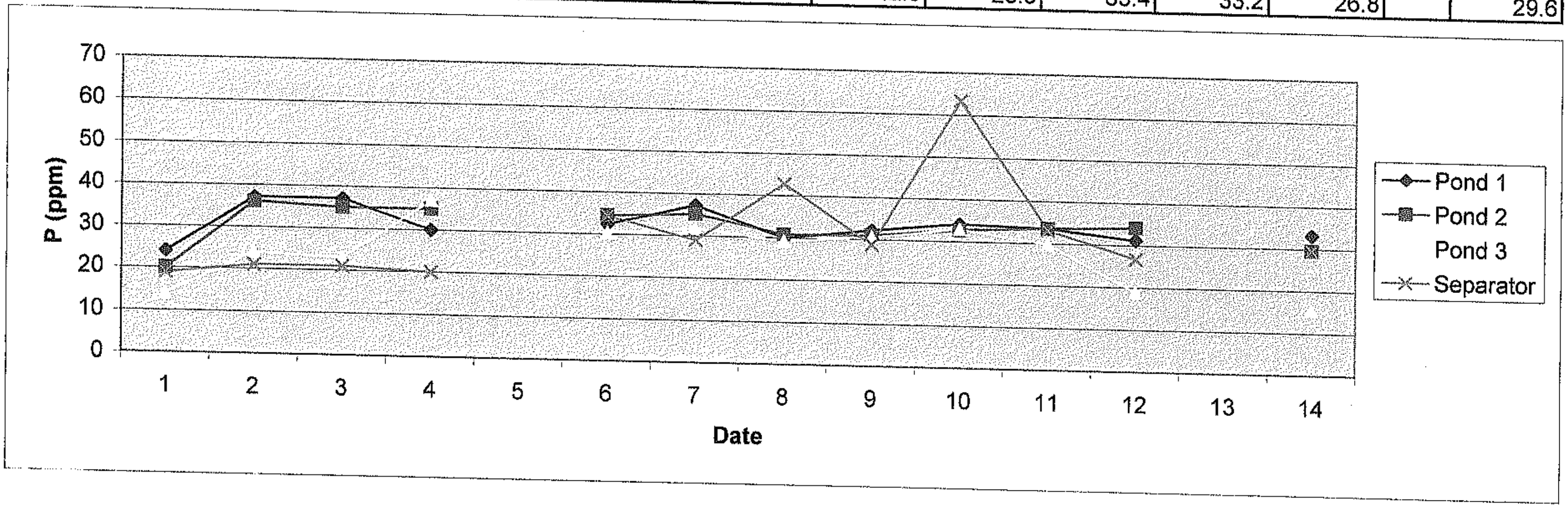


It appears that immediate removal of solids as they accumulate will be necessary to prevent this. This project did not evaluate gravity retention ponds; however, the data collected indicates that the gravity retention pond would be very effective with use of the polymers. Some device to trap, store and remove the treated solids prior to reaching the lagoon is imperative for success. As this project ends CDC is cooperating with an engineering firm that has a portable device that can be used for demonstration that might suffice for this need (Haul-A-Day). The device in brief would trap and dewater treated effluent for each flush possibly decreasing the volume needed for lagoon storage. This piece of equipment appears to be very promising and would be a desirable candidate for a future state or national CIG project. A report will be given to the California State Technical Guide Committee with recommendations for consideration for the Field Office Technical Guide (Appendix 2).

Special recognition deservingly goes to SNF, Inc., Denele's Lab, and the individual dairymen who participated in this project. For more information on this report please contact Gary Bullard at glbullard@comcast.net.

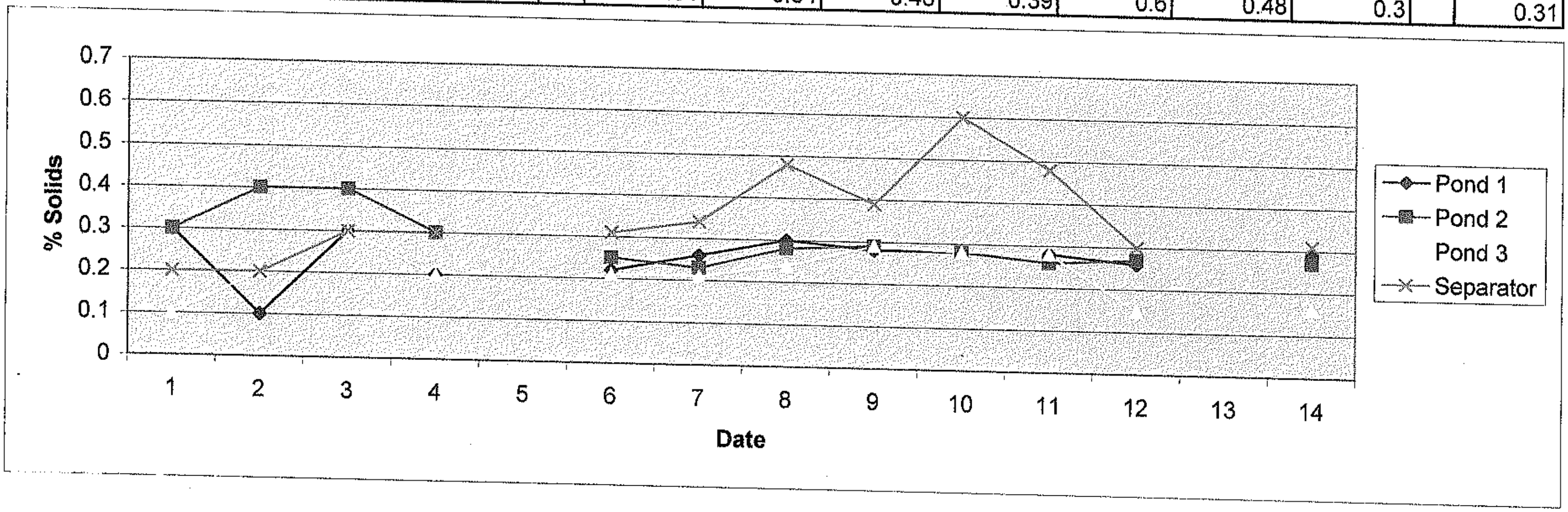
Phosphorus

	7/1/2009	7/1/2009	7/2/2009	7/4/2009		BT 8/17/2009	8/18/2009	8/19/2009	8/20/2009	8/21/2009	8/22/2009	8/26/2009		9/1/2009
	P (ppm)	P (ppm)	P (ppm)	P (ppm)		P (ppm)	P (ppm)	P (ppm)	P (ppm)	P (ppm)	P (ppm)	P (ppm)		P (ppm)
Pond 1	24	37	37	30		32.4	37.2	30	32.2	34.2	33.6	31.2		33.2
Pond 2	20	36	35	35		34.45	35.2	30.8	31	32.8	33.6	34.2		29.6
Pond 3	14	24	23	37		30.4	31.8	29.2	30.6	33	29.8	19		15.6
Separato	19	21	21	20		34.4	29	42.8	28.8	63.4	33.2	26.8		29.6



Solids

	7/1/2009	7/1/2009	7/2/2009	7/4/2009		BT 8/17/2009	8/18/2009	8/19/2009	8/20/2009	8/21/2009	8/22/2009	8/26/2009		9/1/2009
	Sol (%)	Sol (%)	Sol (%)	Sol (%)		Sol (%)	Sol (%)	Sol (%)	Sol (%)	Sol (%)	Sol (%)	Sol (%)		Sol (%)
Pond 1	0.3	0.1	0.3	0.2		0.22	0.26	0.3	0.28	0.28	0.28	0.26		0.29
Pond 2	0.3	0.4	0.4	0.3		0.25	0.23	0.28	0.29	0.28	0.26	0.27		0.27
Pond 3	0.1	0.2	0.3	0.2		0.21	0.21	0.24	0.29	0.28	0.28	0.15		0.16
Separato	0.2	0.2	0.3	0.3		0.31	0.34	0.48	0.39	0.6	0.48	0.3		0.31



VERBURG CALIBRATION & TREATMENT

Verburg & Sons

Lagoon Water Summary

Sample ID	Matrix	Sampling Date	Lab ID	Phosphorus ppm	Solids %	T. Coliform MPN/100ml	E. Coli. MPN/100ml
Floc 6-26	LW	6/26/2009	739877A	20	0.4	> 2,400,000	> 2,400,000
Floc 6-26	LW	6/26/2009	739877B	27	0.4	> 2,400,000	> 2,400,000
Floc 6-26	LW	6/26/2009	739877C	-	-	> 2,400,000	> 2,400,000
Floc 6-26	LW	6/26/2009	739877D	17	0.3	> 2,400,000	> 2,400,000
Pond 1	LW	7/1/2009	739948A	24	0.3	1,553,100	1,046,200
Pond 2	LW	7/1/2009	739948B	20	0.3	920,800	579,400
Pond 3	LW	7/1/2009	739948C	14	0.1	1,553,000	193,500
Sep	LW	7/1/2009	739948D	19	0.2	> 2,420,000	> 2,420,000
Pond 1	LW	7/1/2009	740049A	37	0.1	1,733,000	1,300,000
Pond 2	LW	7/1/2009	740049B	36	0.4	866,000	649,000
Pond 3	LW	7/1/2009	740049C	24	0.2	1,986,000	199,000
Sep	LW	7/1/2009	740049D	21	0.2	70,700,000	56,000,000
Pond 1	LW	7/2/2009	740049E	37	0.3	> 2,420,000	1,553,000
Pond 2	LW	7/2/2009	740049F	35	0.4	866,000	579,000
Pond 3	LW	7/2/2009	740049G	23	0.3	1,203,000	147,000
Sep	LW	7/2/2009	740049H	21	0.3	> 121,000,000	70,700,000
Pond 1	LW	7/4/2009	740049I	30	0.2	548,000	365,000
Pond 2	LW	7/4/2009	740049J	35	0.3	816,000	770,000
Pond 3	LW	7/4/2009	740049K	37	0.2	2,420,000	1,203,000
Sep	LW	7/4/2009	740049L	20	0.3	9,950,000	5,650,000
Floc below Sep	LW	7/6/2009	740049M	47	2.3	13,800,000	30,650,000
Floculated Solids	LW	7/6/2009	740049N	31	0.5	1,345,000	480,000
Mid Above	W	8/17/2009	740718A	-	-	310	< 100
Mid Below	W	8/18/2009	740718B	-	-	3,690	< 100
Pond 1 B/T	LW	8/17/2009	740718C	32.4	0.22	> 2,420,000	548,000
Pond 1	LW	8/18/2009	740718D	37.2	0.26	> 2,420,000	461,000
Pond 2 B/T	LW	8/17/2009	740718E	34.4	0.25	365,000	225,000
Pond 2	LW	8/18/2009	740718F	35.2	0.23	548,000	210,000
Pond 3 B/T	LW	8/17/2009	740718G	30.4	0.21	> 2,420,000	101,000
Pond 3	LW	8/18/2009	740718H	31.8	0.21	194,000	111,000
Seperator B/T	LW	8/17/2009	740718I	34.4	0.31	670,000	545,000
Seperator	LW	8/18/2009	740718J	29	0.34	19,350,000	5,750,000
Pond 1	LW	8/19/2009	740764A	30	0.3	-	-
Pond 2	LW	8/19/2009	740764B	30.8	0.28	-	-

Verburg & Sons

Lagoon Water Summary

Sample ID	Matrix	Sampling Date	Lab ID	Phosphorus ppm	Solids %	T. Coliform MPN/100ml	E. Coli. MPN/100ml
Pond 3	LW	8/19/2009	740764C	29.2	0.24	-	-
Seperator	LW	8/19/2009	740764D	42.8	0.48	-	-
Pond 1	LW	8/20/2009	740764E	32.2	0.28	-	-
Pond 2	LW	8/20/2009	740764F	31	0.29	-	-
Pond 3	LW	8/20/2009	740764G	30.6	0.29	-	-
Seperator	LW	8/20/2009	740764H	28.8	0.39	-	-
Flush Pond	LW	8/21/2009	740838A	33	0.28	1,125,000	228,500
2nd Pond	LW	8/21/2009	740838B	32.8	0.28	1,180,000	637,000
Sep	LW	8/21/2009	740838C	63.4	0.6	19,900,000	1,220,000
Sep Pond	LW	8/22/2009	740838D	34.2	0.28	2,030,000	630,000
Pond 1	LW	8/22/2009	740838E	33.6	0.28	2,895,000	710,000
Pond 2	LW	8/22/2009	740838F	33.6	0.26	750,000	495,000
Pond 3	LW	8/22/2009	740838G	29.8	0.28	2,305,000	322,000
Pond 3	LW	8/22/2009	740838H	33.2	0.48	5,230,000	3,435,000
Pond 1	LW	8/26/2009	740838I	31.2	0.26	4,605,000	1,540,000
Pond 2	LW	8/26/2009	740838J	34.2	0.27	1,455,000	610,000
Pond 3	LW	8/26/2009	740838K	19	0.15	7,765,000	137,500
Seperator	LW	8/26/2009	740838L	26.8	0.3	21,900,000	5,290,000
Solid Manure	M		740838M	-	-	13,000,000	8,200,000
Above Pond	W	8/26/2009	740847A	-	-	214	12
Below Pond	W	8/26/2009	740847B	-	-	248	105
Above Pond	W	8/28/2009	740905A	-	-	> 4,840	31
Below Pond	W	8/28/2009	740905B	-	-	> 4,840	138
Pond 1	LW	9/1/2009	740945A	33.2	0.29	2,176,000	1,093,500
Pond 2	LW	9/1/2009	740945B	29.6	0.27	1,049,000	495,500
Pond 3	LW	9/1/2009	740945C	15.6	0.16	1,641,000	163,500
Seperator	LW	9/1/2009	740945D	29.6	0.31	17,890,000	14,010,000
Above Lagoon	W	9/9/2009	741106A	-	-	85	88
Below Lagoon	W	9/9/2009	741106B	-	-	111	68

DATE	TIME	TYPE	LAB#	LINE #		BILL TO	SUBMITTOR	GROWER	CROP	SAMPLE I.D.	TEST PERFORMED	PO# MISC	PRICE	DATE COMPLETED
6/26/2009	4:00/JON	LW	739877	A		CDC		VERBURG & SONS DAIRY	LAGOON WATER	VERBURG FLOC 6-26	BACT, P, & SOLIDS		75	8/11/2009
6/26/2009	4:00/JON	LW	739877	B		CDC		VERBURG & SONS DAIRY	LAGOON WATER	VERBURG FLOC 6-26	BACT, P, & SOLIDS		75	8/11/2009
6/26/2009	4:00/JON	LW	739877	C		CDC		VERBURG & SONS DAIRY	LAGOON WATER	VERBURG FLOC 6-26	BACT		50	8/11/2009
6/26/2009	4:00/JON	LW	739877	D		CDC		VERBURG & SONS DAIRY	LAGOON WATER	VERBURG FLOC 6-26	BACT, P, & SOLIDS		75	8/11/2009
													275	

DATE	TIME	TYPE	LAB#	LINE #	BILL TO	SUBMITTOR	GROWER	CROP	SAMPLE I.D.	TEST PERFORMED	PO# MISC	PRICE	DATE COMPLETED
7/1/2009	5:00/JON	LW	739948	A	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 1 7/1/09	BACT, P % SOLIDS		75	8/11/2009
7/1/2009	5:00/JON	LW	739948	B	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 2 7/1/09	BACT, P % SOLIDS		.75	8/11/2009
7/1/2009	5:00/JON	LW	739948	C	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 3 7/1/09	BACT, P % SOLIDS		75	8/11/2009
7/1/2009	5:00/JON	LW	739948	D	CDC		VERBURG & SONS DAIRY	LAGOON WATER	SEP 7/1/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	A	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 1 7/1/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	B	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 2 7/1/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	C	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 3 7/1/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	D	CDC		VERBURG & SONS DAIRY	LAGOON WATER	SEP 7/1/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	E	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 1 7/2/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	F	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 2 7/2/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	G	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 3 7/2/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	H	CDC		VERBURG & SONS DAIRY	LAGOON WATER	SEP 7/2/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	I	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 1 7/4/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	J	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 2 7/4/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	K	CDC		VERBURG & SONS DAIRY	LAGOON WATER	POND 3 7/4/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	L	CDC		VERBURG & SONS DAIRY	LAGOON WATER	SEP 7/4/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	M	CDC		VERBURG & SONS DAIRY	LAGOON WATER	FLOC BELOW SEP 7/8/09	BACT, P % SOLIDS		75	8/11/2009
7/8/2009	3:00/JON	LW	740049	N	CDC		VERBURG & SONS DAIRY	LAGOON WATER	FLOCULATED SOLIDS 7/8/09	BACT, P % SOLIDS		75	8/11/2009
												1350	

DATE	TIME	TYPE	LAB#	[illegible]	BILL TO	SUBMITTOR	GROWER	CROP	SAMPLE I.D.	TEST PERFORMED	PO#,MISC	PRICE	DATE COMPLETED
8/21/2009	3:15/NOON	LW	740764	A	CDC		VERBURG & SONS	LAGOON WATER	8/19 2:50 POND 1	P% SOLIDS		25	9/8/2009
8/21/2009	[illegible]	LW	740764	B	CDC		VERBURG & SONS	LAGOON WATER	8/19 2:50 POND 2	P% SOLIDS		25	9/8/2009
8/21/2009	[illegible]	LW	740764	C	CDC		VERBURG & SONS	LAGOON WATER	8/19 2:50 POND 3	P% SOLIDS		25	9/8/2009
8/21/2009	[illegible]	LW	740764	D	CDC		VERBURG & SONS	LAGOON WATER	8/19 2:50 SEPERATOR	P% SOLIDS		25	9/8/2009
8/21/2009	[illegible]	LW	740764	E	CDC		VERBURG & SONS	LAGOON WATER	8/20 POND 1	P% SOLIDS		25	9/8/2009
8/21/2009	[illegible]	LW	740764	F	CDC		VERBURG & SONS	LAGOON WATER	8/20 POND 2	P% SOLIDS		25	9/8/2009
8/21/2009	[illegible]	LW	740764	G	CDC		VERBURG & SONS	LAGOON WATER	8/20 POND 3	P% SOLIDS		25	9/8/2009
8/21/2009	[illegible]	LW	740764	H	CDC		VERBURG & SONS	LAGOON WATER	8/20 SEPERATOR	P% SOLIDS		25	9/8/2009
8/26/2009	11:10	LW	740838	A	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/21 FLUSH POND	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	B	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/21 2ND POND	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	C	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/21 SEP	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	D	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/21 SEP POND	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	E	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/22 POND 1	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	F	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/22 POND 2	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	G	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/22 POND 3	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	H	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/22 POND 3	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	I	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/26 POND 1	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	J	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/26 POND 2	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	K	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/26 POND 3	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	LW	740838	L	CDC	JOE MELO	VERBURG & SONS	LAGOON WATER	8/26 SEPERATOR	BACT, P% & SOLIDS		75	9/8/2009
8/26/2009	11:10	M	740838	M	CDC	JOE MELO	VERBURG & SONS	MANURE	SOLID MANURE	BACT		50	9/8/2009
												1150	

DATE	TIME	TYPE	LAB#		BILL TO	SUBMITTOR	GROWER	CROP	SAMPLE I.D.	TEST PERFORMED	PO#/MISC	PRICE	DATE COMPLETED
8/19/2009	[illegible]	W	740718	A	CDC		VERBURG & SONS	IRRIGATION WATER	8/17 MID ABOVE	BACT		50	8/27/2009
8/19/2009	[illegible]	W	740718	B	CDC		VERBURG & SONS	IRRIGATION WATER	8/18 MID BELOW	BACT		50	8/27/2009
8/19/2009	[illegible]	LW	740718	C	CDC		VERBURG & SONS	LAGOON WATER	8/17 POND 1 B/T	BACT, P% & SOLIDS		75	8/27/2009
8/19/2009	[illegible]	LW	740718	D	CDC		VERBURG & SONS	LAGOON WATER	8/18 POND 1	BACT, P% & SOLIDS		75	8/27/2009
8/19/2009	[illegible]	LW	740718	E	CDC		VERBURG & SONS	LAGOON WATER	8/17 POND 2 B/T	BACT, P% & SOLIDS		75	8/27/2009
8/19/2009	[illegible]	LW	740718	F	CDC		VERBURG & SONS	LAGOON WATER	8/18 POND 2	BACT, P% & SOLIDS		75	8/27/2009
8/19/2009	[illegible]	LW	740718	G	CDC		VERBURG & SONS	LAGOON WATER	8/17 POND 3 B/T	BACT, P% & SOLIDS		75	8/27/2009
8/19/2009	[illegible]	LW	740718	H	CDC		VERBURG & SONS	LAGOON WATER	8/18 POND 3	BACT, P% & SOLIDS		75	8/27/2009
8/19/2009	[illegible]	LW	740718	I	CDC		VERBURG & SONS	LAGOON WATER	8/17 SEPERATOR B/T	BACT, P% & SOLIDS		75	8/27/2009
8/19/2009	[illegible]	LW	740718	J	CDC		VERBURG & SONS	LAGOON WATER	8/18 SEPERATOR	BACT, P% & SOLIDS		75	8/27/2009
8/28/2009	[illegible]	W	740905	A	CDC		VERBURG & SONS	CANAL WATER	ABOVE POND 8/28	COMPLETE + BACT		88	8/31/2009
8/28/2009	[illegible]	W	740905	B	CDC		VERBURG & SONS	CANAL WATER	BELOW POND 8/28	COMPLETE + BACT		88	8/31/2009
												876	

DATE	TIME	TYPE	LAB#	UNIT #	BILL TO	SUBMITTOR	GROWER	CROP	SAMPLE I.D.	TEST PERFORMED	PO#/MISC	PRICE	DATE COMPLETED
8/26/2009	3:45PM	W	740847	A	CDC		VERBURG & SONS	CANAL WATER	ABOVE POND 8/26	BACT		50	9/2/2009
8/26/2009	3:45PM	W	740847	B	CDC		VERBURG & SONS	CANAL WATER	BELOW POND 8/26	BACT		50	9/2/2009
												100	

DATE	TIME	TYPE	LAB#	LINE #	BILL TO	SUBMITTOR	GROWER	CROP	SAMPLE I.D.	TEST PERFORMED	PO#/MISC	PRICE	DATE COMPLETED
9/1/2009	10:30	LW	740945	A	CDC	GARY BULLARD	VERBURG & SONS	LAGOON WATER	9/1 POND 1	BACT, P% & SOLIDS		75	9/30/2009
9/1/2009	10:30	LW	740945	B	CDC	GARY BULLARD	VERBURG & SONS	LAGOON WATER	9/1 POND 2	BACT, P% & SOLIDS		75	9/30/2009
9/1/2009	10:30	LW	740945	C	CDC	GARY BULLARD	VERBURG & SONS	LAGOON WATER	9/1 POND 3	BACT, P% & SOLIDS		75	9/30/2009
9/1/2009	10:30	LW	740945	D	CDC	GARY BULLARD	VERBURG & SONS	LAGOON WATER	9/1 SEPERATOR	BACT, P% & SOLIDS		75	9/30/2009
9/9/2009	4:00/JON	W	741106	A	CDC		VERBURG & SONS	CANAL WATER	ABOVE LAGOON 9-9-09	BACT		50	9/16/2009
9/9/2009	4:00/JON	W	741106	B	CDC		VERBURG & SONS	CANAL WATER	BELOW LAGOON 9-9-09	BACT		50	9/16/2009
												400	

VERBURG RAW DATA DURING TREATMENT

Date	Lab Id	Code	Sample Location	Analyte	Result	units
08/17/09	740718	C	Pond 1 B/T	Phosphorus	32.4	ppm
08/17/09	740718	C	Pond 1 B/T	Solids	0.22	%
08/18/09	740718	D	Pond 1	Phosphorus	37.2	ppm
08/18/09	740718	D	Pond 1	Solids	0.26	%
08/17/09	740718	E	Pond 2 B/T	Phosphorus	34.4	ppm
08/17/09	740718	E	Pond 2 B/T	Solids	0.25	%
08/18/09	740718	F	Pond 2	Phosphorus	35.2	ppm
08/18/09	740718	F	Pond 2	Solids	0.23	%
08/17/09	740718	G	Pond 3 B/T	Phosphorus	30.4	ppm
08/17/09	740718	G	Pond 3 B/T	Solids	0.21	%
08/18/09	740718	H	Pond 3	Phosphorus	31.8	ppm
08/18/09	740718	H	Pond 3	Solids	0.21	%
08/17/09	740718	I	Separator B/T	Phosphorus	34.4	ppm
08/17/09	740718	I	Separator B/T	Solids	0.31	%
08/18/09	740718	J	Separator	Phosphorus	29	ppm
08/18/09	740718	J	Separator	Solids	0.34	%
08/19/09	740764	A	Pond 1 2:50	Phosphorus	30	ppm
08/19/09	740764	A	Pond 1 2:50	Solids	0.3	%
08/19/09	740764	B	Pond 2 2:50	Phosphorus	30.8	ppm
08/19/09	740764	B	Pond 2 2:50	Solids	0.28	%
08/19/09	740764	C	Pond 3 2:50	Phosphorus	29.2	ppm
08/19/09	740764	C	Pond 3 2:50	Solids	0.24	%
08/19/09	740764	D	Separator 2:50	Phosphorus	42.8	ppm
08/19/09	740764	D	Separator 2:50	Solids	0.48	%
8/20/09	740764	E	Pond 1	Phosphorus	32.2	ppm
8/20/09	740764	E	Pond 1	Solids	0.28	%
8/20/09	740764	F	Pond 2	Phosphorus	31	ppm
8/20/09	740764	F	Pond 2	Solids	0.29	%
8/20/09	740764	G	Pond 3	Phosphorus	30.6	ppm
8/20/09	740764	G	Pond 3	Solids	0.29	%
8/20/09	740764	H	Separator	Phosphorus	28.8	ppm
8/20/09	740764	H	Separator	Solids	0.39	%
8/21/09	740838	A	Flush Pond	Phosphorus	33	ppm
8/21/09	740838	A	Flush Pond	Solids	0.28	%
8/21/09	740838	B	2nd Pond	Phosphorus	32.8	ppm
8/21/09	740838	B	2nd Pond	Solids	0.28	%
8/21/09	740838	C	Sep	Phosphorus	63.4	ppm
8/21/09	740838	C	Sep	Solids	0.6	%
8/21/09	740838	D	Sep Pond	Phosphorus	34.2	ppm
8/21/09	740838	D	Sep Pond	Solids	0.28	%
08/22/09	740838	F	Pond 2	Phosphorus	33.6	ppm
08/22/09	740838	F	Pond 2	Solids	0.26	%
08/22/09	740838	G	Pond 3	Phosphorus	29.8	ppm
08/22/09	740838	G	Pond 3	Solids	0.28	%
08/22/09	740838	H	Pond 3	Phosphorus	33.2	ppm
08/22/09	740838	H	Pond 3	Solids	0.48	%
08/26/09	740838	I	Pond 1	Phosphorus	31.2	ppm
08/26/09	740838	I	Pond 1	Solids	0.26	%
08/26/09	740838	J	Pond 2	Phosphorus	34.2	ppm
08/26/09	740838	J	Pond 2	Solids	0.27	%
08/26/09	740838	K	Pond 3	Phosphorus	19	ppm

08/26/09	740838	K	Pond 3	Solids	0.15 %
08/26/09	740838	L	Separator	Phosphorus	26.8 ppm
08/26/09	740838	L	Separator	Solids	0.3 %
09/01/09	740945	A	Pond 1	Phosphorus	33.2 ppm
09/01/09	740945	A	Pond 1	Solids	0.29 %
09/01/09	740945	B	Pond 2	Phosphorus	29.6 ppm
09/01/09	740945	B	Pond 2	Solids	0.27 %
09/01/09	740945	C	Pond 3	Phosphorus	15.6 ppm
09/01/09	740945	C	Pond 3	Solids	0.16 %
09/01/09	740945	D	Separator	Phosphorus	29.6 ppm
09/01/09	740945	D	Separator	Solids	0.31 %
08/22/09	740838	E	Pond 1	Phosphorus	33.6 ppm
08/22/09	740838	E	Pond 1	Solids	0.28 %

APPENDIX 1

PROTOCOL DEVELOPMENT
FOR
POLYMER-ASSISTED REMOVAL
OF
SUSPENDED SOLIDS IN DAIRY LAGOON WATERS

CALIFORNIA DAIRY CAMPAIGN
TURLOCK, CALIFORNIA

Trials of two dairy farm feedlot wastes (Figure 1) were conducted September 30 – October 3, 2008, by Ed Valenter, (SNF), George Tichenor, (SNF), Gary Bullard (Environmental Project Manager, California Dairy Campaign) and Joe Mullinax (Denele Labs).

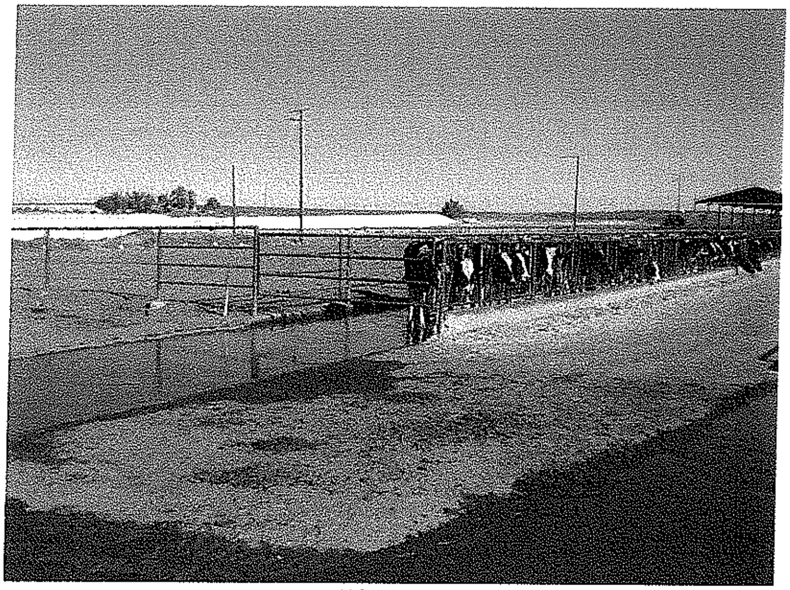


Figure 1

The objectives of the study include determining the feasibility of polymer-assisted removal of suspended solids and evaluation of nutrient and economic value of the removed solids. **With Magnusson Farm waste, at 400 ppm FL 4820 pDADMAC, we found P and % Solids removals of 40 and 25%, respectively, with floated solids as high as 4.6% with 76 ppm P after 36 hrs. On Melo Farm waste, at 460 ppm FL 4820, removal efficiencies were lower, but float solids were 3.4% with 72 ppm P after 20 hrs. Although floated floc was believed problematic at the time of our testing, it is now felt that any floc formed can be separated. Control samples exhibited little or no concentration for either waste and no evidence of flocculation.**

Prior lab testing had shown that FL 4820 pDADMAC would have the greatest probability of success under the conditions imposed (no makedown water for flocculant dilution) and this was the only program trialed at this time. Inorganic – organic coagulant blends had been investigated in the laboratory, but Al- and Fe- containing coagulants were ruled out. Since this trial, we have prepared a sample with a potentially novel alternative approach, but have not had the opportunity to evaluate it in the lab.

Equipment and Procedure

Waste from the first lagoon or sandpit was collected in 800 gal. portions (Figure 2) and hauled to Mullinax Farm for treatment. (Our intent was to obtain one 2000 gal sample, but the tank truck was not operable.) Waste was pumped from the feed tank (Figure 3), with partial recycle to prevent settling, at approximately 4 gpm through a 5 gal bucket equipped with an efficient mechanical mixer (Figure 4). (This provided approximately 5 minutes detention.) Floquat FL 4820 high mw pDADMAC (Figure 5) was added neat to the bucket with efficient agitation. The treated slurry passed (Figure 6) into the first of three 275 gal. tote bins (T1, Figure 7). Overflow from T1 passed into T2 and, when T2 was filled, into T3. Untreated waste was fed to three other tote bins, also in series (Control 1, 2 and 3). Aliquots were removed as noted and analyzed for P and % Solids at Denele AgriLab.

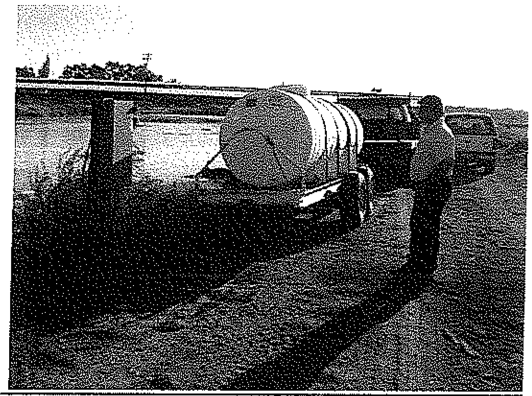


Figure 2

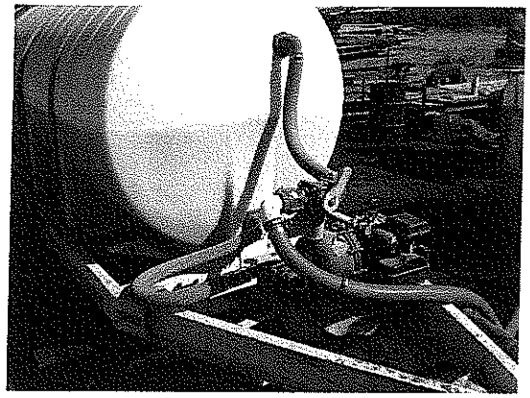


Figure 3

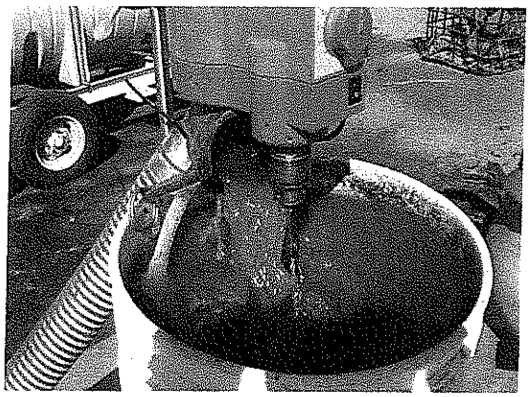


Figure 4

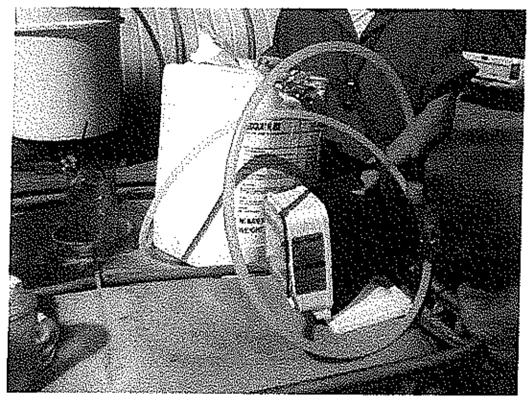


Figure 5

Figure 6

Figure 7

Magnusson Farm

Trial test results from the Magnusson waste are summarized in Table 1. Waste from the first lagoon (previously believed to be a sand pit) was collected in two 800 gal. portions, on September 30 and October 1. The 400 ppm dosage was a guesstimate, and it is possible (if not likely) that a lower dosage might have provided comparable or even better results. Removal data collected the first afternoon and the next morning are considered the most reliable, as they were obtained from the same batch of waste. At 5:30 pm on 9/30, reductions in P of 46% and Solids of 25% were observed for the supernatant of both T1 and T2 Top samples (Points 2 and 3). (T1 Top samples, labeled "T1 Top Below float," were taken from underneath a layer of floated solids always found in T1.) Control 1 and 2 Top samples (Points 4 and 5) actually showed slight increases in P but some settling of solids. (No bottom samples were obtained in the afternoon.)

The next morning, after 13 hrs settling, a float layer in T1 showed high concentrations of P and % Solids (Point 6), the T1 sample just under the float (Point 7) was higher than the night before (probably due to contamination by float), and T1 Bottom (Point 8) exhibited some concentration of P and Solids. T2 Top and Bottom samples (Runs 9 and 10) were effectively similar to each other and results from the night before, suggesting that virtually all the removal had occurred in T1, and most of the removed solids concentrated in the float. In contrast, Control 1 Top and Bottom and Control 2 Top and Bottom showed minimal changes from the feed either in the afternoon or the next morning (Points 4 and 5, and 11 – 14). Thus it appears that before the second batch of waste was introduced, the level of P in the body of the liquid could be reduced 40 – 45%, with flocculated (float) solids as high as 31% P. Note that T3 and C3 did not receive material until the second tank of substrate arrived on October 1

The morning of October 1, we began feeding the second batch of waste on top of the previous run. Since both P and % Solids were lower in this second batch (Point 15), and since there was likely short-circuiting across the tanks, percent changes in these parameters, although calculated, may be erroneous for Points 16 – 34. What is apparent, though, is that significant reductions had occurred in T1, T2 and T3 Top samples (to levels consistent with first batch results: 11 – 13 ppm P and 0.2 – 0.3% solids); in contrast, Control 1,2 and 3 Top samples exhibited no reduction in P or % Solids.

The morning of October 2, after 18 hr settling, a full set of samples was collected (Points 22 – 34). The T1 Float (Run 22) had continued to concentrate P (to 76 ppm) and % Solids (to 4.6%), an 11 – 15X concentration of solids and a 3 – 4X concentration of P. The T1 Bottom also exhibited some concentration of both (Point 24). For some reason (perhaps re-dispersion of solids or contamination from float) T1, T2 and T3 Top samples had all increased in P content (but not % Solids) (Points 24, 26 and 28). Interestingly, Control 1, 2 and 3 Top and Bottom samples (Points 29 – 34) all showed higher P levels than the Feed or samples from the previous afternoon. This cannot be explained by concentration of feed, as the % Solids was lower (except in Control 1.)

Melo Farm

In contrast to Magnusson, the Melo waste passes from a true sand pit to a lagoon. The test protocol duplicated the Magnusson trial, except that only one batch of waste was obtained; thus, after T1, T2 and T3 were filled, there was only enough substrate remaining to fill about half of Control 1.

Test results for Melo are presented in Table 2. Waste (approximately 800 gal) was collected the morning of October 2. As anticipated, P and % Solids levels (Point 1) were higher than Magnusson. Since we were not familiar with the Melo waste, we first ran a dosage curve at 335, 400, 460, 520 and 580 ppm, collecting aliquots of the conditioned waste (Points 2 – 6). Inspection of these samples suggested that 460 ppm would provide the best performance, as higher dosages yielded considerable floated floc (Figures 42, 53 and 56). The higher dosage requirement of the Melo waste probably reflects the higher % Solids and P levels. These cup samples of the dosage curve were held and observed later, as well. At the end of the afternoon, much of the floc which had settled at 15 min. was now floating (Figures 43, 54, 55, 57 and 58). The appearance of the later samples suggested that higher dosage would likely have provided better P removal.

T1, T2 and T3 Top samples drawn at the end of the test that afternoon indicated a reduction of P of 20 – 30% and % Solids of 25%. A complete set of samples the next morning suggested that 20% reduction of P was likely in the supernatants T1, T2 and T3 Top (Points 11, 13 and 15), with slight settling indicated by T1 and T2 Bottom samples (Points 12 and 14) but none by T3 (Point 16).

Future work

FL 4820 will be mini-trialed at the mechanical separators at Verburg Farm the week of October 20 by E. Valenter and P. Coulton.

Table 1
Magnusson Farm Test Data

Point #	Date	Time	FL 4820 (ppm)	Sample Reference	P (ppm)	% Solids	Delta P	Delta Solids	Figure	Comments
1	9/30	1725	-	Feed	24	0.4	-	-	8, 9	
2		1730	400	T1 Top	13	0.3	-46%	-25%	8, 10	Avoided floated solids
3		"	"	T2 Top	13	0.3	"	"	8, 11	No float
4		"	"	Control 1 Top	26	0.3	8%	-25%	8, 12	No visible separation
5			"	Control 2 Top	27	0.2	12%	-50%	8	No visible separation
6	10/1	0720	"	T1 Top Float	31	2.9	29%	725%	13, 14	
7			"	T1 Top Below float	17	0.2	-29%	-50%	13, 15	
8			"	T1 Bottom	20	1.3	-17%	325%	13, 16	
9			"	T2 Top	13	0.3	-46%	-25%	13, 17	
10			"	T2 Bottom	14	0.3	-42%	-25%	13, 18	
11			-	Control 1 Top	24	0.3	0	-25%	13, 19	
12			-	Control 1 Bottom	0.4?	0.4	?	0	13, 20	P content in error
13			-	Control 2 Top	24	0.3	0	-25%	13, 21	
14			-	Control 2 Bottom	28	0.3	16%	-25%	13	
15		1320	-	Feed	19	0.3	-	-	-	
16			400	T1 Top Below float	12	0.2	-37%	-33%	22, 23, 24	
17			"	T2 Top	11	0.2	-42%	-33%	22, 23, 25	
18			"	T3 Top	13	0.2	-32%	-33%	22, 23, 26	
19			-	Control 1 Top	19	0.3	0	0	22, 27, 28	
20			-	Control 2 Top	19	0.3	0	0	22, 27	
21			-	Control 3 Top	21	0.3	10%	0	22, 27	Inc. solids fr. 1st batch
22	10/2	0715	400	T1 Top Float	76	4.6	317%	1150%	29, 30	
23			"	T1 Top Below float	19	0.2	-21%	-50%	29, 31	
24			"	T1 Bottom	38	0.7	158%	175%	29, 32	
25			"	T2 Top	17	0.2	-29%	-50%	29, 33	
26			"	T2 Bottom	20	0.4	-17%	0	29, 34	
27			"	T3 Top	15	0.2	-38%	-50%	29, 35	
28			"	T3 Bottom	7	0.3	-70%	-25%	29	P content in error
29			-	Control 1 Top	30	0.2	125%	-50%	37, 38	Some separation or ?
30			-	Control 1 Bottom	27	0.5	112%	120%	37, 39	"
31			-	Control 2 Top	28	0.3	116%	-25%	37	"
32			-	Control 2 Bottom	33	0.2	137%	-50%	37	"
33			-	Control 3 Top	27	0.2	112%	-50%	37, 40	"
34			-	Control 3 Bottom	28	0.3	116%	-25%	37, 41	"

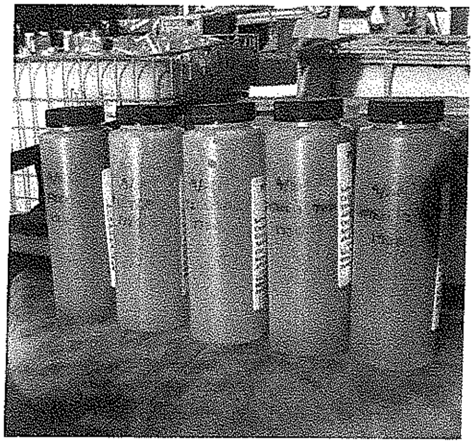


Fig. 8

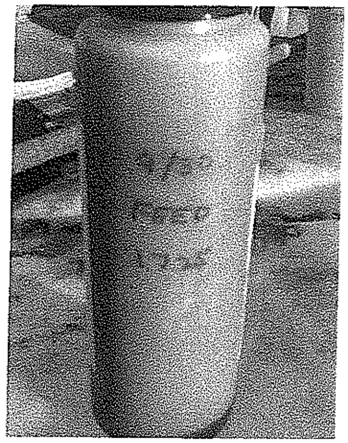


Fig. 9

Fig. 10

Fig. 11

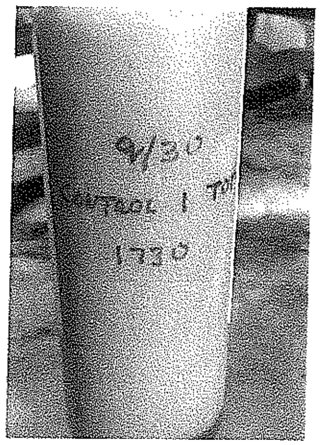


Fig. 12

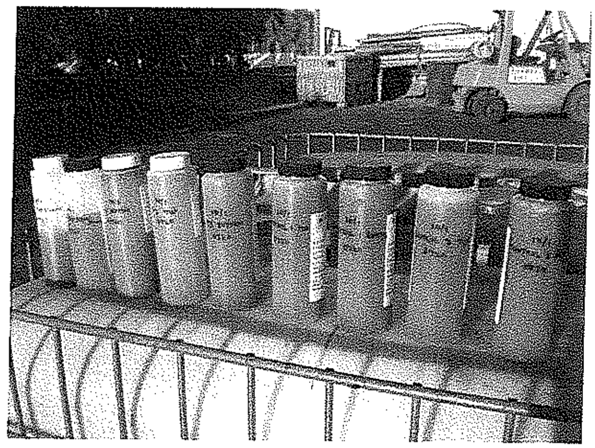


Fig. 13

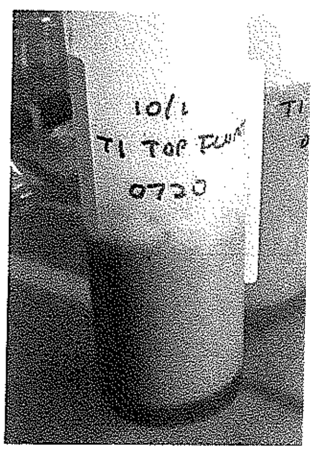


Fig. 14

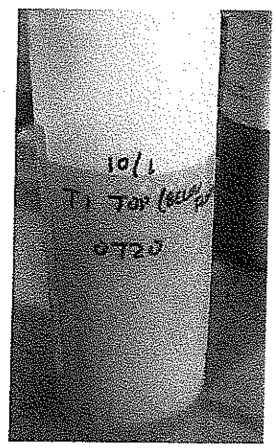


Fig. 15

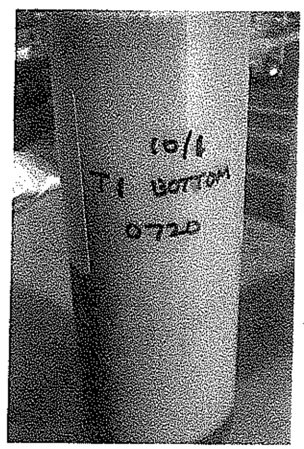


Fig. 16

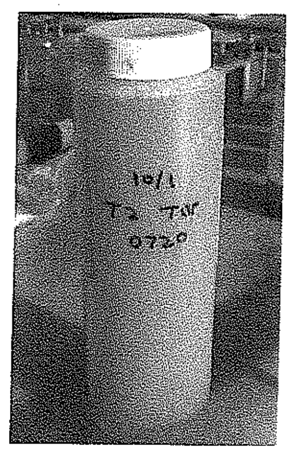


Fig. 17

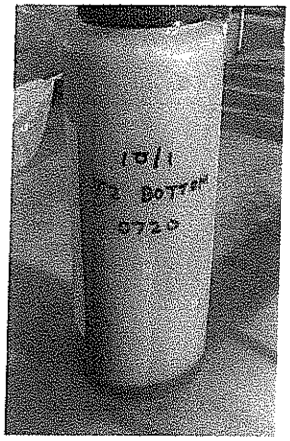


Fig. 18

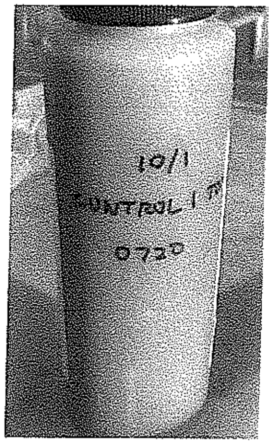


Fig.19

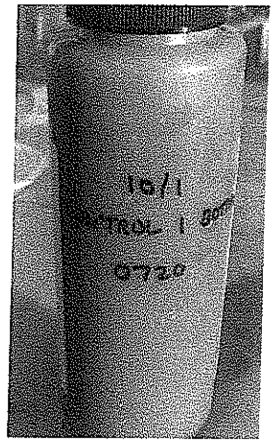


Fig. 20

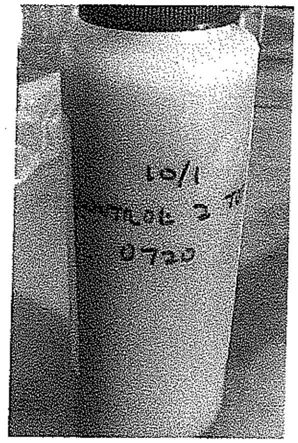


Fig. 21

Fig. 22

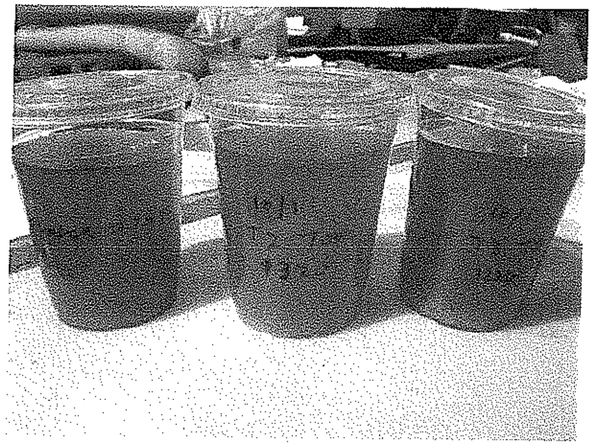


Fig. 23

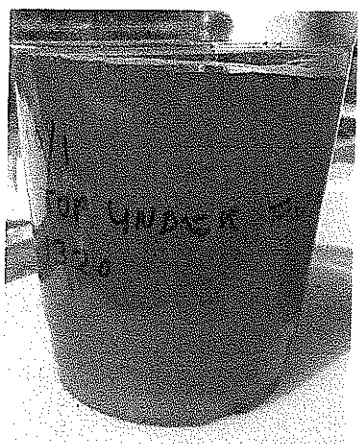


Fig. 24

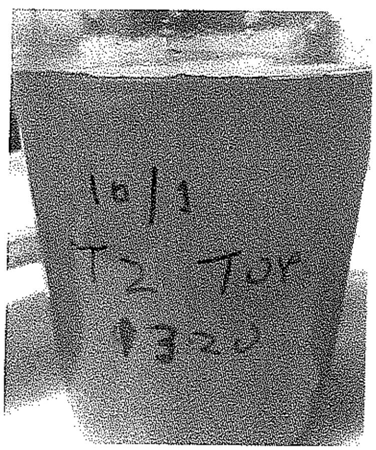


Fig. 25

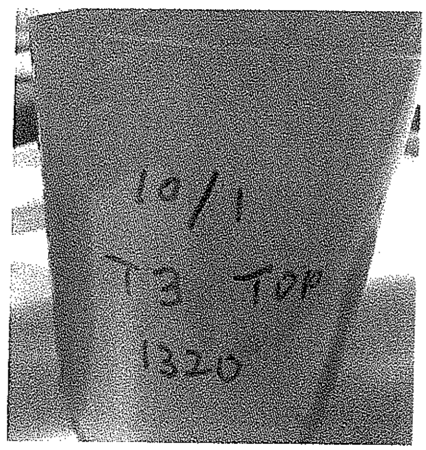


Fig. 26

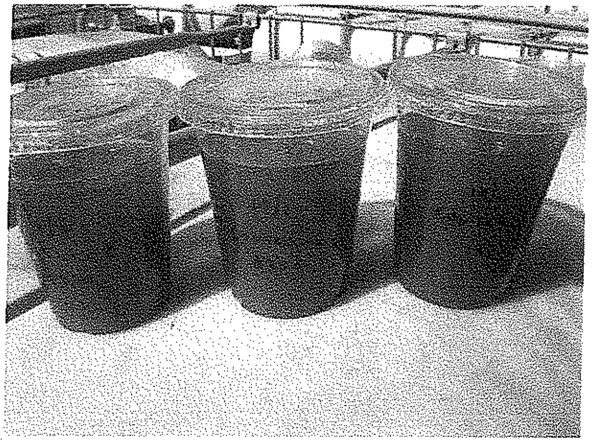


Fig. 27

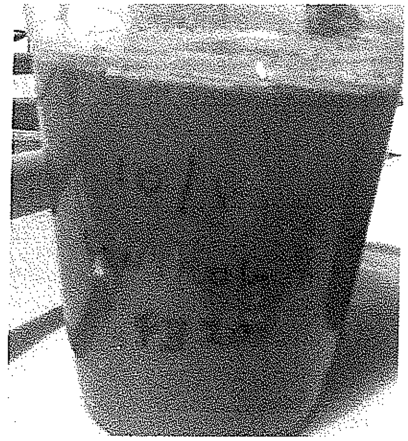


Fig. 28

Fig. 29

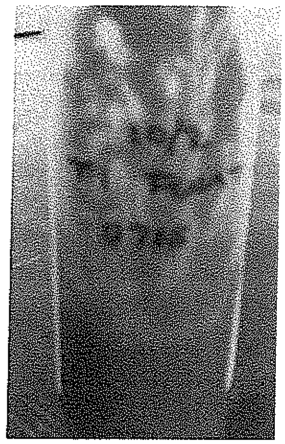


Fig. 30

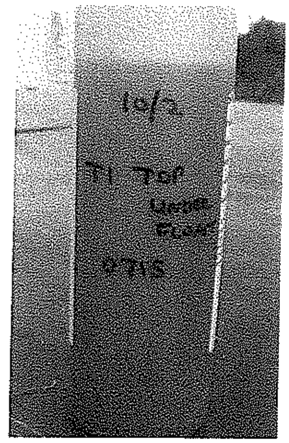


Fig. 31

Fig. 32

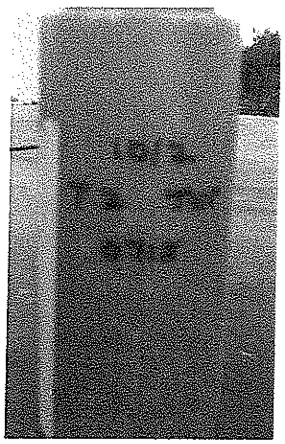


Fig. 33

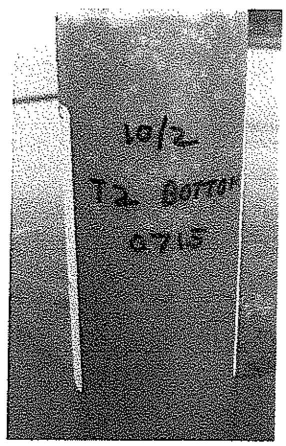


Fig. 34

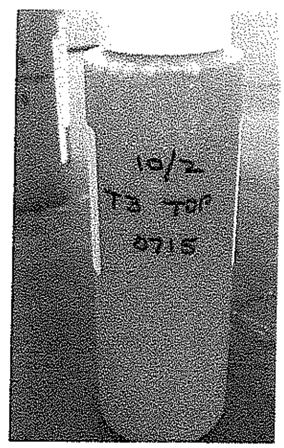


Fig. 35

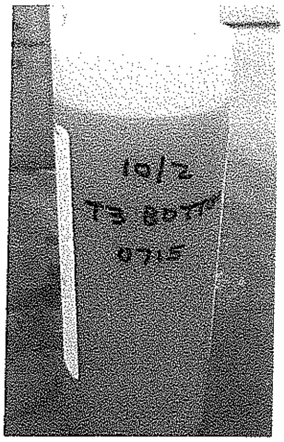


Fig. 36

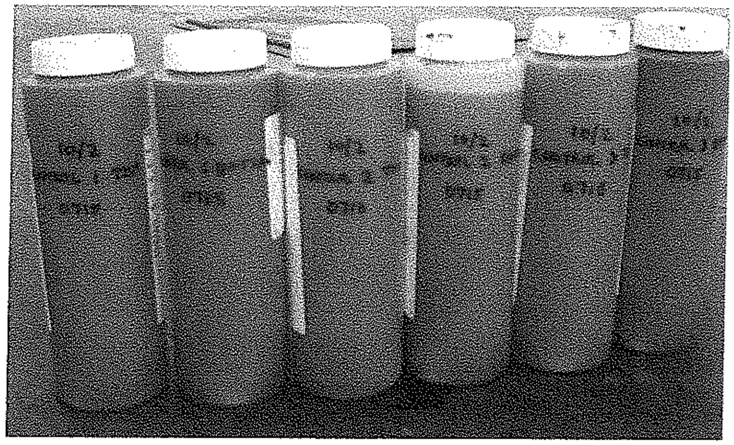


Fig. 37

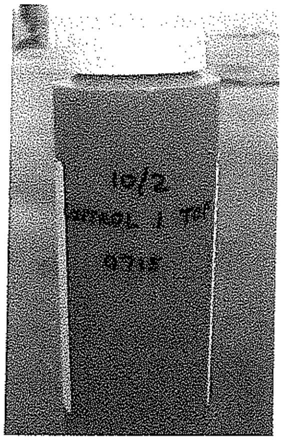


Fig. 38

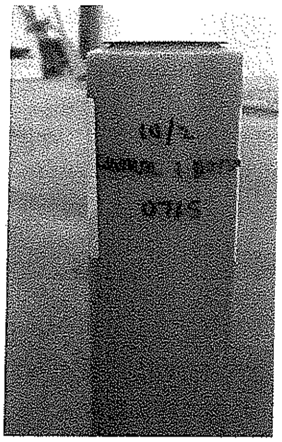


Fig. 39

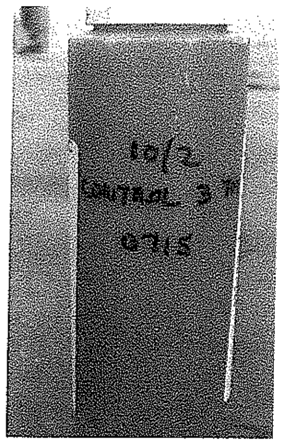


Fig. 40

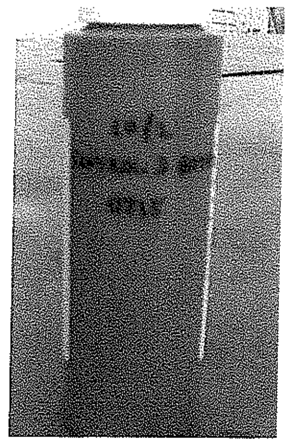


Fig. 41

Table 2

Melo Farm Test Data

Point #	Date	Time	FL 4820 (ppm)	Sample Reference	P (ppm)	% Solids	Delta P	Delta Solids	Figure #	Comments
1	10/2	1500	-	Feed	58	0.5	-	-		
2		1130	335	20/30 pump	50	0.4	-16%	-20%	42,43,44,45,46	Underdosed
3			400	30/30 pump	43	0.4	-26%	-20%	42,43,47,48,49	Sl. underdosed
4			460	40/30 pump	41	0.3	-29%	-40%	42,43,50,51,52	Near optimum
5			520	50/30 pump	41	0.3	-29%	-40%	42,43,53,54,55	Sl. overdosed
6			580	60/30 pump	35	0.3	-40%	-40%	42,43,56,57,58	Overdosed
7		1515	460	T1 Top Below float	42	0.3	-28%	-40%	-	
8			"	T2 Top	47	0.3	-19%	-40%	-	
9			"	T3 Top	47	0.3	-19%	-40%	-	
10	10/3	0700	"	T1 Top Float	72	3.4	124%	850%	59	
11			"	T1 Top Below float	57	0.3	-2%	-40%	59	
12			"	T1 Bottom	66	0.9	114%	180%	59	
13			"	T2 Top	46	0.2	-21%	-60%	59	
14			"	T2 Bottom	68	0.8	117%	160%	59	
15			"	T3 Top	45	0.4	-22%	-20%	59	
16			"	T3 Bottom	42	0.4	-28%	-20%	59	
17			-	Control 1 Top	62	0.5	107%	0	59	(partial fill)
18			-	Control 1 Bottom	64	0.4	110%	-20%	59	


Fig. 42 Dosage curve, 15 min.

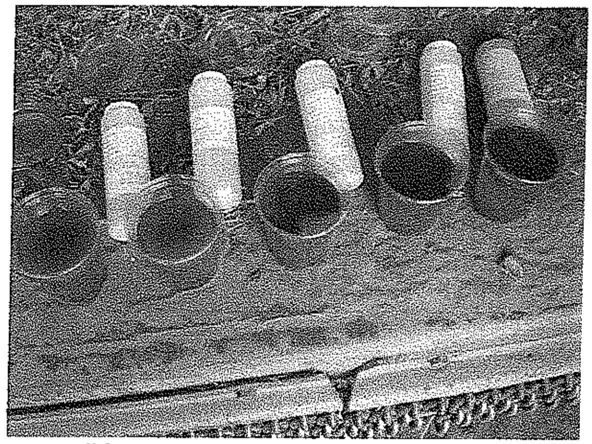


Fig. 43 Dosage curve, 4 hrs.

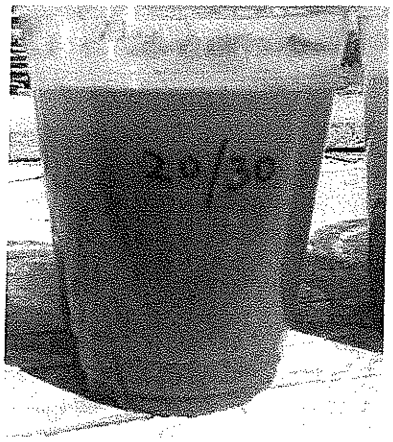
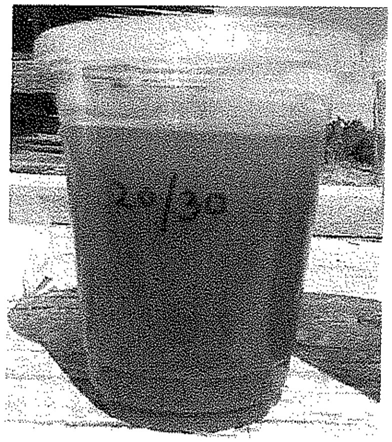


Fig. 44 (335 ppm, 15 min.)




Figs. 45, 46 (335 ppm, 4 hrs.)

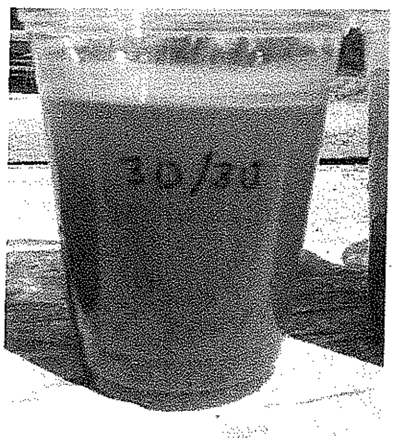
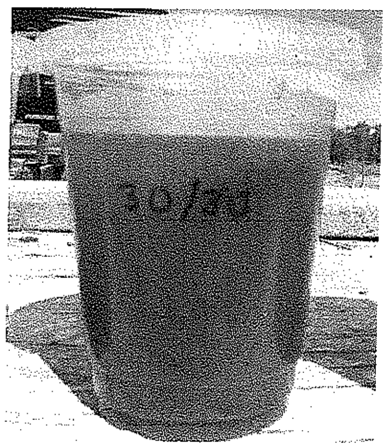
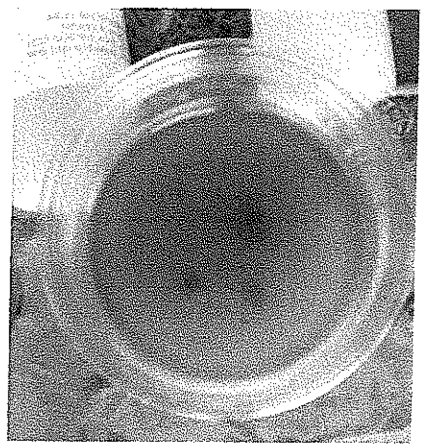


Fig. 47 (400 ppm, 15 min.)




Figs. 48, 49 (400 ppm, 4 hrs).

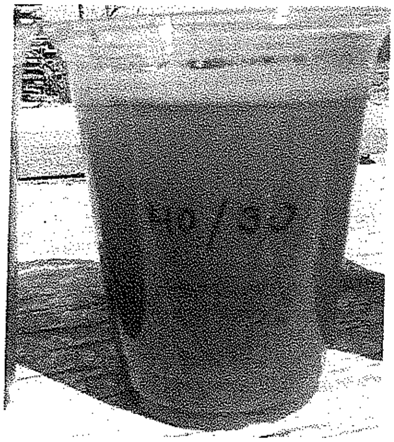
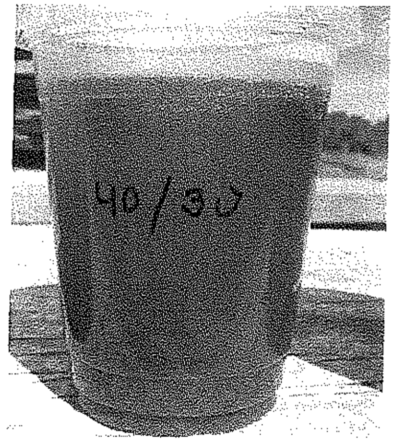
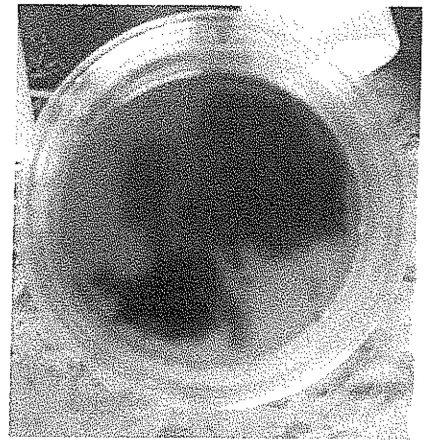


Fig. 50 (460 ppm, 15 min).





Figs. 51, 52 (460 ppm, 4 hrs.)

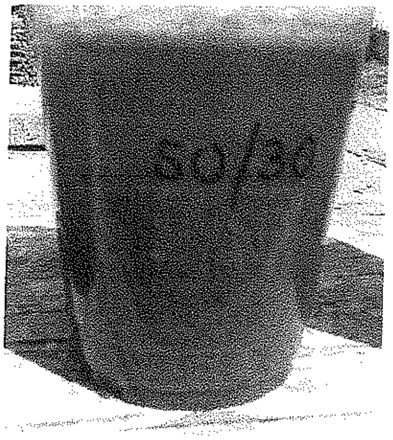
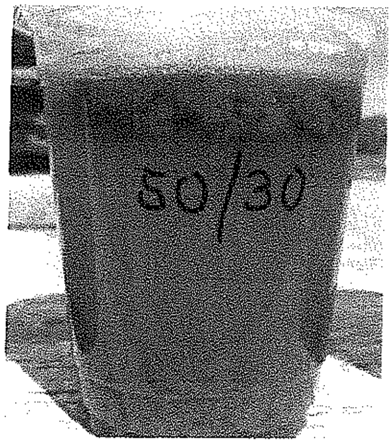
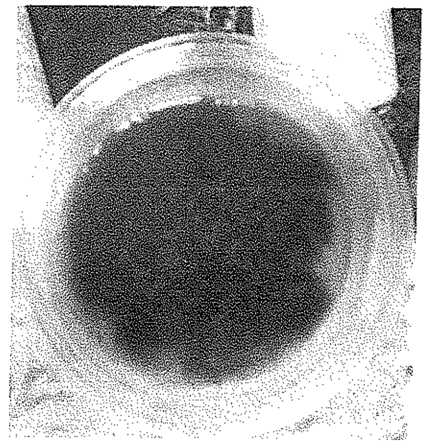


Fig. 53 (520 ppm, 15 min.)





Figs. 54, 55 (520 ppm, 4 hrs.)

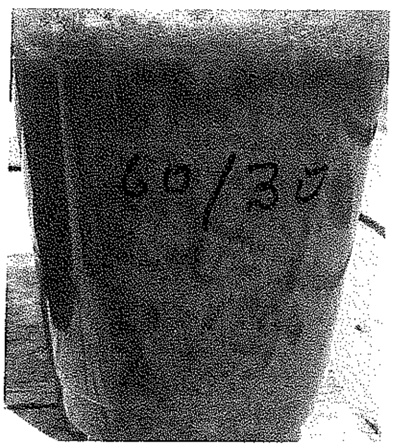
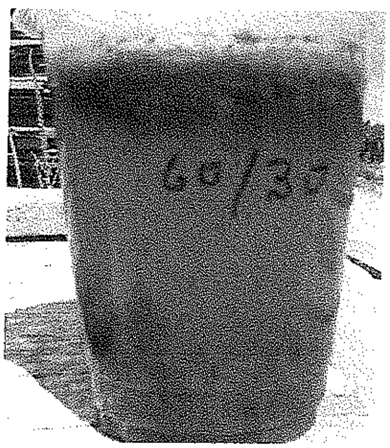
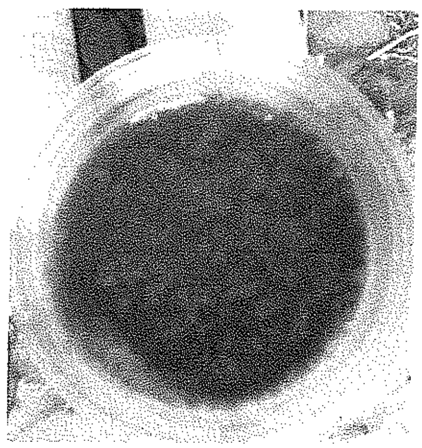


Fig. 56 (580 ppm, 15 min.





Figs. 57, 58 (580 ppm, 4 hrs.)

Figure 59

DETAILED INFORMATION ON PROTOCOL DEVELOPMENT

Gary Bullard

From: "Ed Valenter" <EValenter@snfhc.com>
To: "Gary Bullard" <glbullard@comcast.net>
Cc: "George Tichenor" <georget@polydyneinc.com>
Sent: Thursday, July 24, 2008 8:18 AM
Attach: Verburg Pit Clarif. 7-24-08.xls
Subject: FW: Laboratory testing: Verburg Dairy pit effluent 7-16-08

Gary,
Here is George Tichenor's analysis after you forwarded the P results to him.
I look forward to hearing your and Joe's recommendations about pumps so we can go to trial stage.

Thanks George for this report!

Ed Valenter

SNF Resale Manager

Cell: (360) 635-1825
Home office: (360) 834-4145
email: [illegible]
web: [illegible]

From: George Tichenor
Sent: Thursday, July 24, 2008 7:42 AM
To: Ed Valenter
Cc: Bob Keller; Scott Ramey; George Tichenor
Subject: Laboratory testing: Verburg Dairy pit effluent 7-16-08

We have completed another round of testing on the Verburg Dairy waste. After determining that the emulsion cationic flocculant found to perform well in prior lab testing required too much dilution water, our goal this trip was to identify a solution product which could be fed neat or at least with minimum dilution. We have found that FL 4820 pDADMAC is capable of a 32% reduction of P at reasonable dosages.

Laboratory jar test data is attached. Previous testing for Verburg had used 2nd stage mechanical separator feed as substrate (to minimize the amount of solids treated and thus polymer dosage). Our tests this time utilized sand pit effluent (1st stage separator feed) to provide adequate mixing for substrate and polymer, assuming we would be feeding neat (solution) polymer. Unfortunately, the % solids in our sample was extremely low, probably from the end of a wash cycle. Consequently, our polymer dosages may be significantly higher than reported below.

In the past tests, we had identified EM 445L (C-9455) as the emulsion product providing the best performance; our intent was to identify solution products (Mannich or copolymer flocculants, or pDADMAC or polyamine organic coagulants) which could effectively replace an emulsion program. Tests 2 – 8 showed that EM 840L could provide slightly better clarity, and (Tests 22 – 25) removal of 39% P from the supernatant after 5 min. settling at dosages of 200 – 300 ppm product. Mannich products (Test 9) would not work as the substrate pH is too high. Solution copolymers (5% active) were also capable of yielding performance similar to 840L at slightly higher polymer dosages; thus, C-8255 at 2500 – 3500 ppm (product) also gave 39% P removal (Tests 22 – 25).

Evaluation of organic coagulants was initiated at Tests 11 – 13, when polyamines and low mw pDADMACs were found inferior to high mw pDADMAC FL 4820. It was eventually established that 4820 could achieve 32% P removal over a wide range (250 – 750 ppm product, Tests 31 and 34 - 37) with optimum supernatant clarity at 375 ppm product (Test 35). A potential downside to this coagulant program is that it will not provide a large floc (required for mechanical separators), but should still provide settling, hence improved P removal, in the ponds.

We conclude that the best program for Verburg waste would be FL 4820, fed neat. As suggested by Joe Mullinax (Denele Labs), it is strongly recommended that we pilot-test this program on his farm, with Verburg waste brought in. (This is an especially attractive approach since we do not have a good handle on dosage. It would also provide a constant feed.) The C-8255 flocculant could yield larger floc and better solids (and P) removal at a mechanical separator but would be more costly from the standpoints of dosage and shipping costs.

Laboratory Clarification Test Data
Verburg Farm Sand Pit Effluent
Turlock, CA
July 16, 2008

Test #	Product	Dosage (ppm) Product	Dosage (ppm) Active	Floc Size*	Supernat. Clarity*	Supernat. P (ppm)	Comments (Pit effluent, 0.22% sol.)
1	Blank	-	-	-	-	0.27, 0.29	
2	EM 445L	100	40	5	5	-	
3	"	200	80	"	6	-	
4	"	300	120	"	7	-	Best
5	"	400	160	"	6	-	Overdosed
6	EM 445L	200	80	5	5	-	
7	EM 640L	"	82	"	4	-	
8	EM 840L	"	"	"	6	-	Best
9	C-331	2000	86	1	1	-	No floc
10	EM 445L	200	80	5	5	-	
11	FL 4820	400	"	3	3	-	
12	FL 4420	"	"	2	2	-	
13	FL 3249	160	"	1	1	-	
14	EM 840L	200	82	5	5	-	
15	EM 445L	"	80	"	4	-	
16	C-8240	1600	"	3	3	-	
17	C-8255	"	"	4	4	-	
18	C-8255	2000	100	5	5	18	36% P removal
19	"	2500	125	"	^	17	39% P removal
20	"	3000	150	"	"	17	"
21	"	3500	175	"	"	17	"
22	EM 840L	200	82	5	5	17	39% P removal
23	"	250	103	"	7	17	"
24	"	300	123	"	6	17	"
25	"	350	144	"	5	21	Overdosed
26	C-8240	2000	100	5	5	-	Poor clarity relative to C-8255
27	"	2500	125	"	6	-	"
28	"	3000	150	"	"	-	"
29	"	3500	175	"	"	-	"
30	FL 4820	500	100	5	5	19	Small floc
31	"	1000	200	4	4	-	Worse
32	"	1500	300	3	3	-	"
33	"	2000	400	2	2	-	"
34	FL 4820	250	50	5	5	19	Largest floc; 32% P removal
35	"	375	75	4	6	19	Best clarity; 32% P removal
36	"	625	125	3	3	19	
37	"	750	150	2	2	19	

* Rated from 1 to 10, with 1 = no floc, 10 = excellent , and 5 = Blank or Standard

Laboratory Clarification Test Data
Melo Farm Lagoon Feed
November 19, 2008

Test #	Product	Prod. Dosage (ppm)	Floc Size*	Settling Rate*	Supernat. Clarity*	Supernatant P (ppm)	Supernatant SS (%)	Comments (Lagoon feed:0.67% sol.)
1	Blank	-	-	-	-	50	0.7	No treatment
2	FL 4820	200 - 600	5	5	5	-	-	
3	"	300 - 700	6	6	6	-	-	
4	"	400 - 800	7	7	7	-	-	
5	"	500 - 900	8	8	8	-	-	
6	FL 4820	800	5	5	5	32	0.5	
7	"	900	6	6	6	30	0.5	
8	"	1000	7	7	7	26	0.4	Best organic-only
9	"	1100	8	8	8	26	0.4	No improvement
10	4820/aq. ferric sulfate (1:1)	1600	5	5	5	28	0.6	
11	"	1800	6	6	6	20	0.6	
12	"	2000	7	7	7	18	0.5	
13	"	2200	8	8	8	10	0.4	Best org./inorg. Blend
14	4820/aq. calcium chloride (1:1)	1600	5	5	5	28	0.4	
15	"	1800	6	6	6	24	0.4	
16	"	2000	6+	6+	6+	24	0.4	
17	"	2200	7	7	7	22	0.4	

* Rated from 1 to 10, with 1 = no floc, 10 = huge floc, and 5 = Blank or Standard

Laboratory Clarification Test Data
Verburg Farm Second Separator Feed
November 18, 2008

Test #	Product	Prod. Dosage (ppm)	Floc Size*	Settling Rate*	Supernat. Clarity*	Supernatant P (ppm)	Supernatant SS (%)	Comments Separator feed: ? %
1	Blank	-	-	-	-	43	0.7	No treatment
2	FL 4820/aq. ferric sulfate (1:1)	25 - 600	5	5	5	-	-	
3	" / " (1:9)	"	3	3	3	-	-	
4	" /aq. calcium chloride (1:1)	"	4	4	4	-	-	
5	" / " (1:9)	"	2	2	2	-	-	
6	Blank	-	5	5	5	-	-	
7	FL 4820	100 - 500	5+	5+	5+	-	-	
8	"	150 - 600	6-	6-	6-	-	-	
9	"	2-- - 700	6	6	6	-	-	Still underdosed
10	FL 4820	350	5	5	5	34	0.5	
11	"	450	6	6	6	33	0.4	
12	"	550	6+	6+	6+	28	0.5	
13	"	650	7	7	7	28	0.4	
14	FL 4820/aq. ferric sulfate (1:1)	700 - 900	5	5	5	-	-	
15	" / " (1:9)	"	3	3	3	-	-	
16	" /aq. calcium chloride (1:1)	"	4	4	4	-	-	
17	" / " (1:9)	"	2	2	2	-	-	
18	FL 4420	350	5	5	5	39	0.6	
19	"	450	6	6	6	34	0.5	
20	"	550	6+	6+	6+	32	0.4	
21	"	650	7	7	7	30	0.4	
22	4820/aq. ferric sulfate (1:1)	700	5	5	5	32	0.7	
23	" / "	900	6	6	6	30	0.5	
24	" / "	1100	7	7	7	26	0.5	
25	" / "	1300	8	8	8	24	0.5	
26	4820/aq. calcium chloride (1:1)	700	5	5	5	37	0.5	
27	" / "	900	6	6	6	31	0.5	
28	" / "	1100	7	7	7	28	0.5	
29	" / "	1300	8	8	8	20	0.4	Best org./inorg. blend
30	4820/aq. calcium chloride (1:1)	1500	5	5	5	26	0.4	
31	" / "	1700	6	6	6	21	0.4	
32	FL 4820	750	5	5	5	26	0.4	
33	"	850	5	5	5	24	0.4	Best organic-only

* Rated from 1 to 10, with 1 = no floc, 10 = huge floc, and 5 = Blank or Standard

Laboratory Clarification Test Data
Magnusson Farm Lagoon Feed
November 19, 2008

Test #	Product	Prod. Dosage (ppm)	Floc Size*	Settling Rate*	Supernat. Clarity*	Supernatant P (ppm)	Supernatant SS (%)	Comments (Lagoon feed: 0.51% sol.)
1	Blank	-	-	-	-	36	0.5	No treatment
2	FL 4820	200	5	5	5	30	0.2	
3	"	300	6	6	6	30	0.3	
4	"	400	7	7	7	28	0.3	
5	"	500	7	7	7	26	0.2	Best organic-only
6	4820/aq. ferric sulfate (1:1)	300 - 700	5	5	5	-	-	
7	" / " (1:9)	"	3	3	3	-	-	
8	" /aq. calcium chloride (1:1)	"	4	4	4	-	-	
9	" / " (1:9)	"	2	2	2	-	-	
10	4820/aq. ferric sulfate (1:1)	700	5	5	5	20	0.3	
11	"	800	6	6	6	18	0.3	
12	"	900	7	7	7	16	0.3	
13	"	1000	8	8	8	14	0.2	Best org./inorg blend
14	4820/aq. calcium chloride (1:1)	700	5	5	5	26	0.3	
15	"	800	5+	5+	5+	26	0.2	
16	"	900	6	6	6	26	0.3	
17	"	1000	6+	6+	6+	24	0.3	
18	FL 4420	200	5	5	5	32	0.3	
19	"	300	5+	5+	5+	32	0.3	
20	"	400	6	6	6	28	0.3	
21	"	500	6+	6+	6+	28	0.2	

* Rated from 1 to 10, with 1 = no floc, 10 = huge floc, and 5 = Blank or Standard

Gary Bullard

From: "Ed Valenter" <EValenter@snfhc.com>
To: "Gary Bullard" <glbullard@comcast.net>
Sent: Thursday, April 24, 2008 10:16 PM
Attach: Verburg Dairy drainage 4-15--08.xls; Verburg Dairy clarif. 4-16-08.xls; Duarte Dairy clarif. 4-16-08.xls
Subject: FW: Cal. Dairy Campaign lab testing 4-15, 16-08

Gary,
It was great visiting with you again today.
Here are the results from our lab work peformed during our last visit.

Ed Valenter

SNF Resale Manager

Cell: (360) 635-1825
Home office: (360) 834-4145
email: [illegible]
web: [illegible]

From: George Tichenor
Sent: Wednesday, April 23, 2008 10:24 AM
To: Ed Valenter
Cc: Scott Ramey
Subject: Cal. Dairy Campaign lab testing 4-15, 16-08

We have completed the second phase of dairy waste testing for the California Dairy Campaign. Results are as follows:

Verburg Dairy: Additional Gravity Drainage Testing (Table 1) for the mechanical separator (second stage) shows that C-9455 medium charge cationic emulsion (400 ppm) would provide approximately the same level of filtrate P as C-6228 low-medium charge (550 ppm). Filtrate P levels for those two products were 12 and 11 ppm respectively, corresponding to 57% and 60% reduction from an unfiltered blank (28 ppm P). In the previous test (1/30/08), C-6228 achieved a 43% reduction in filtrate P (28 ppm reduced to 16 ppm) over a wide dosage range on a 30% higher solids wastestream.

All products tested gave relatively small volumes of floc, however, (due to low feed solids) and consequently gave very sticky flocs at effective dosages. For this reason, it might be preferable to treat the mechanical separator influent (rather than the second stage influent) where the % SS would be higher. Another reason for treating the separator influent is the greater mix time available for polymer and substrate. (We had initially selected the second stage feed to reduce polymer costs.) It should be noted that any polymer overdose at either stage would increase the rate of settling of uncaptured solids in the ponds following the mechanical separator.) The small volumes of floc encountered in testing this time also mean that filtrate volumes in Table 1 have little significance.

A brief series of Jar Tests (Table 2) were also conducted to determine whether filtrate P levels obtained in the Gravity Drainage Testing were similar to values for supernatant P obtained by settling alone. (They were.) Aliquots for P testing were taken after 15 min. settling.

Finally, it should be noted that we had intended to investigate co-treatment with inorganic coagulants to improve P removal, but neither aluminum nor iron residuals in separator effluent are desirable.

Recommendation: We recommend trialing C-6228 and C-9455, with addition to the separator influent. (This might require additional minimal lab testing by Denele Labs on the influent, as all previous tests have been conducted on the secondary influent.)

Duarte Dairy: Jar Tests on the pond feed (Table 3) showed that C-6217 low charge cationic emulsion at 600 – 800 ppm could reduce the P level in the supernatant from 40 ppm to 12 – 13 ppm (67 – 70%) and yiels a rapid-settling floc. Programs evaluated included cationic flocculants from 10 to 45% charge, and dual treatment programs utilizing C-6217 and pDADMAC coagulants.

Recommendation: We recommend trialing C-6217, fed to the pond influent.

Laboratory Clarification Test Data: Pond Feed
Duarte Dairy, Turlock, CA
April 16, 2008

Test #	Product	Prod. Dosage (ppm)	Floc Size*	Settling Rate*	Supernat. Clarity*	Supernat. P (ppm)#	Comments Pond feed (1.46%)
1	C-6217	10 - 120	5	5	5	-	Start to floc at 30 ppm
2	C-6227	"	4	4	4	-	"
3	C-6237	"	3	3	3	-	"
4	C-6247	"	2	2	2	-	"
5	C-6217	30 - 50	5	5	5	-	
6	C-6215	"	4	4	4	-	
7	C-6219	"	3	3	3	-	
8	C-6228	"	2	2	2	-	
9	C-6217	100	5	5	5	30	
10	"	200	6	4	"	25	
11	"	300	7	3	"	25	
12	"	400	8	2	"	20	Floc too large to settle rapidly
13	C-6238	100	5	5	5	-	
14	"	200 + 400	7	7	9	21	
15	"	300 + 400	8	8	"	-	
16	"	400 + 400	9	9	"	17	Good floc and supernatant
17	C-6217	800	5	5	5	12	Best program
18	C-6237	"	4	8	"	13	Small rapid settling floc
19	C-9490	"	2	2	3	24	
20	C-6267	"	1	1	"	23	
21	C-6217	600	5	5	5	13	Equivalent performance
22	C-6217/FL 4620	600/50 - 800	1	1	1	-	
23	" /FL 4820	" / "	1	1	1	-	
24	" / "	100/800	3	3	3	10	
25	C-6217/FL 4820	100/100	5	5	5	28	
26	" / "	" /200	5+	5-	"	27	
27	" / "	" /400	6-	4+	"	23	
28	" / "	" /800	6	4	"	18	
25	Blank	-	-	-	-	40	

* Rated from 1 to 10, with 1 = no floc, 10 = huge floc, and 5 = Blank or Standard

Supernatant P aliquots removed after 15 minutes settling

Summary: C-6217 at 600 - 800 ppm can settle biosolids rapidly and reduce supernatant P by 67 - 70%

From: G. Tichenor To: E. Valenter, S. Ramey

Table 2
Laboratory Clarification Test Data: Mechanical Separator Second Stage Feed
Verburg and Sons Dairy, Modesto, CA
April 16, 2008

Test #	Product	Dosage (ppm) Product	Floc Size*	Settling Rate*	Supernat. Clarity*	Supernat. P (ppm)	Comments
							Separator feed (0.56%)
1	C-6217	550	5	5	5	12	
2	C-6228	"	4	4	4	13	P comparable to filtration
3	C-6238	"	4	7	3	16	Sl. worse P than filtration
4	C-6237	"	6	8	4	12	

* Rated from 1 to 10, with 1 = no floc, 10 = huge floc, and 5 = Blank or Standard

From: G. Tichenor — To: E. Valenter — Cc: S. Ramey

Table 1
Laboratory Gravity Drainage Tests: Mechanical Separator Second Stage Feed
Verburg and Sons Dairy, Modesto, CA
April 15, 2008

Test #	Product	Dosage (ppm)	Dosage (#/T)	Mixing (pours)	Filtrate Volume (mL) at t = sec. 5 sec.	10 sec.	15 sec.	20 sec.	30 sec.	Filtrate. Appear.	Filt. P (ppm)	Comments (Separator feed: 0.56% sol.)
1	Blank	-		-	-	-	-	-	-	bad	28	(Not filtered)
2	C-6228	200	71.4	10	190	193	193	194	-	"	-	No floc filtered
3		250	89.3	"	189	192	196	198	200	"	-	Sl. floc filtered
4		300	107	"	176	182	188	192	198	poor	-	Floc blinded fabric
5		400	143	"	150	160	170	180	188	post floc.	-	"
6		450	161	"	140	154	164	170	190	better	-	"
7		500	171	"	160	174	184	192	200	fines	-	Better
8		550	196	"	190	200	207	207	207	sl. fines	11	Optimum, but worse cake release
9	C-6227	350	125	"	-	-	-	-	-	bad	-	No floc
10	C-6238	200	71.4	"	191	193	196	197	197	"	-	Floc blinded fabric
11		250	89.3	"	190	200	202	202	202	"	-	"
12		300	107	"	170	187	192	193	195	sl. better	-	"
13		350	125	"	178	190	194	195	196	better	-	Better
14		400	143	"	171	191	200	201	203	"	-	"
15		450	161	"	190	200	200	200	201	sl. fines	13	Worse cake release
16	C-9455	350	125	"	180	200	200	201	202	fines	-	
17		400	143	"	190	200	200	200	201	sl. fines	12	Better
18	C-9490	400-475	143-170	"	196	197	197	197	198	bad	-	Worse

Summary: C-6228 (550 ppm) and C-9455 (400 ppm) provide high levels of P removal.

From: G. Tichenor   To: E. Valenter   Cc: S. Ramey

Gary Bullard

From: "Ed Valenter" <EValenter@snfhc.com>
To: "Gary Bullard" <glbullard@comcast.net>
Sent: Tuesday, February 12, 2008 5:59 PM
Attach: Borba Dairy Pit 1-29-08.xls; Borba Dairy Flush 1-30-08.xls; Verburg Dairy 1-30-08.xls; Magnusson Farm 1-30-08.xls
Subject: FW: DRAFT: Status Report on Dairy Feedlot Waste Treatment

Gary,
Please see attached Report from our visit. Is there a time on Friday that would work for you, George and I to have a teleconference call to discuss a pathforward?
If so, let me know when and I will see if George can meet with us at that time.

Ed Valenter

SNF Resale Manager

Cell: (360) 635-1825
Home office: (360) 834-4145
email:
web:

From: George Tichenor
Sent: Monday, February 11, 2008 10:39 AM
To: Ed Valenter
Cc: Scott Ramey
Subject: DRAFT: Status Report on Dairy Feedlot Waste Treatment

Ed,

Attached are the data from our lab testing with Gary Bullard at the Denele Agri-Link Lab, Turlock, CA on January 29 and 30, 2008. The tested substrates included dairy feedlot wastes from 3 dairies: Verburg, Borba and Magnuson; all 3 could flocculate their solids using 20 – 40% charge cationic emulsion flocculants at moderately high dosages. These will be discussed individually. We also trained several of the Denele employees in common lab testing for liquid – solid separation; the P analyses cited below were conducted by Kim Reed of Denele.

Borba Dairy: Mechanical separator: Pour tests conducted on the substrate from the pit (separator feed) using medium mw emulsion cationic flocculants from 15 to 80% charge and 20, 30 and 40% high mw cationics showed that C-6228 was the best program and not improved by substitution of higher mw C-6227. Subsequent Gravity Drainage Tests on C-6228 (119 – 159 #/T, 800 – 1066 ppm) and C-6244 (139 #/T, 933 ppm) showed the C-6244 would give the highest drainage rate (and best cake release (Test 4). Unfortunately, there was not sufficient sample to determine P levels for blank, cake or filtrate.

Additional investigations were performed on the Borba flush water (used for wash), as it was hypothesized that this lagoon supernatant was responsible for much of the (high) polymer demand of the pit sample above. (During the growing season, much cleaner irrigation water is used for flush.) Pour test results showed that the best apparent program, C-6227 at 101 – 135 #/T (325 – 500 ppm) would flocculate the solids and reduce supernatant P levels to 20 ppm, and that C-6228 was less effective (supernatant P at 24 ppm). P level in the supernatant was not sensitive to C-6227 dosage over the range investigated. These results indicate that half of the polymer demand of the waste in the pit (separator feed) could be due to the flush water recycled from the lagoon. Polymer treatment of the flush water is not an option, as the cattle would lose their footing in the slippery solution.

Verburg Dairy: 2-stage mechanical separator: Using the first stage filtrate as substrate to reduce polymer treatment requirements, preliminary pour tests of the intermediate mw cationic emulsions from 20 to 80 percent charge indicated that the 20 and 30% charge would provide floc at the lowest dosage. Gravity Drainage Tests showed that C-6228 at 96#/T (350 ppm product) would give rapid drainage and reduce the P content from 28 in the feed (Blank) to 16 ppm in the filtrate and yield cake with 0.11% P (Test 3). C-6244 (Test 7) gave even more rapid filtration but did not improve P content of either cake or filtrate. P removals were not affected by dosages of C-6228 fro 300 to 400 ppm (Tests 2 – 4).

Magnusson Dairy: Lagoon feed (sedimentation): Jar tests on the lagoon feed with cationic emulsions from 20 to 80% charge and medium mw, and high mw 20%, revealed thatC-6228 in the range of 250 – 1000 ppm (19 – 78 #/T) could reduce the P content (in the substrate) of 0.03% to 0.01% in the supernatant and 0.03% in the cake at 250 ppm polymer (Test 14) or 0% P in the supernatant and 0.09% in the cake at 1000 ppm polymer (Test 17)

Summary: Observed dosages are high in all cases, but might be feasible depending on the benefits derived (e.g., use of solids as fertilizer or removal from site, reduction of VOC's over lagoons.) Also, polymer dosages could be anticipated to drop when cleaner water is used for flushing. Additional investigations should be carried out to determine optimal charge and mw levels, not only in terms of drainage (or settling) rates, but P removal and incorporation into cake. Some additional training might be required for the Denele trainees, since determining the optimum polymer program may not be as straightforward as envisioned.

Laboratory Clarification Test Data
Magnusson Farm Lagoon Feed
January 30, 2008

Test #	Product	Dosage (ppm) Product	Floc Size*	Settling Rate*	Supernat. Clarity*	Supernat. P (%)	Floc P (%)	Comments (Lagoon feed: 2.58% sol.)
1	Blank	-	-	-	-	0.03	-	
2	C-6228	40 - 200	5	5	5	-	-	Slightly better at 200
3	C-6244	"	4	4	4	-	-	"
4	C-9545	"	3	3	3	-	-	"
5	C-6288	"	2	2	2	-	-	"
6	C-6228	220 - 400	5	5	5	-	-	Improved over lower dosage
7	C-6244	"	4	4	4	-	-	"
8	C-9545	"	3	3	3	-	-	"
9	C-6288	"	2	2	2	-	-	"
10	C-6228	2(250)	5	5	5	-	-	
11	C-6227	"	"	"	"	-	-	
12	C-6238	"	4	4	4	-	-	
13	C-6244	"	3	3	3	-	-	
14	C-6228	250	5	5	5	0.01	0.03	
15	"	500	6	6	6	-	-	
16	"	750	7	7	7	-	-	
17	"	1000	8	8	8	0	0.09	

* Rated from 1 to 10, with 1 = no floc, 10 = huge floc, and 5 = Blank or Standard

Laboratory Pour Test Data
Borba Dairy, Turlock, CA Flush Water
January 30, 2008

Product	Conc.	Rating and (Supernatant P Content) at Dosage (#/T)				Comments
	(%)	101	135	169	202	(Flush water: 0.74% sol.)
C-6227	0.50	Sl. (20 ppm)	OK (20 ppm)	Better (19 ppm)	Better (22 ppm)	Floc OK at 125#/T
C-6228	"	X	Sl. (24 ppm)	Fair	OK	Worse than 6227
C-6237	"	X	X	Sl.	Fair	3rd best
C-6238	"	X	X	X	Sl.	4th best
C-6247	"	X	X	X	Sl.	Tied for 5th
C-6244	"	X	X	X	Sl.	"

Laboratory Gravity Drainage Tests
Verburg Dairy, Turlock, CA
January 30, 2008

Test #	Product	Dosage (#/T)	Mixing (pours)	Filtrate Volume (mL) at t = sec. 5 sec.	10 sec.	15 sec.	20 sec.	30 sec.	60 sec.	Filtrate. Appear.	Filt. P (ppm)	Cake P (%)	Comments (Separator feed: 0.73% sol.)
1	Blank	-	-	192	193	193	193	193	193	(feed)	28	-	No polymer
2	C-6228	82.2	12	132	150	162	174	186	195	fair	16	0.11	Sheared
3		95.9	"	128	148	160	170	178	190	OK	16	0.11	Better
4		109.6	"	134	152	164	174	188	200	OK	16	0.10	Still sheared
5	C-6227	85.9	"	128	144	156	166	180	194	OK	16	0.10	Little slower than 240L
6	C-6238	"	"	164	186	194	197	200	200	fair	20	0.10	Sl. worse
7	C-6244	"	"	164	192	200	202	205	205	"	16	0.11	Fast, but similar P levels

Laboratory Gravity Drainage Test Data
Borba Dairy, Turlock, CA Separator Feed
January 29, 2008

Test #	Product	Dosage (#/T)	Mixing (pours)	Filtrate Volume (mL) at t = sec. 5 sec.	10 sec.	15 sec.	20 sec.	30 sec.	60 sec.	Filtrate Quality	Comments (150 mL aliquots: pit 1.34% sol.)
1	C-6228	119	20	90	114	128	138	150	157	poor	Underdosed
2		139	"	120	138	148	154	156	160	fair	Optimum
3		159	"	118	134	144	153	157	161	fair +	No improvement
4	C-6244	139	"	140	156	162	164	166	167	fair	Rapid drainage; better release

APPENDIX 2

FIELD OFFICE TECHNICAL GUIDE CONSIDERATIONS

CALIFORNIA DAIRY CAMPAIGN
TURLOCK, CALIFORNIA

Considerations for the Field Office Technical Guide

When using polymers to assist in the removal of solids from dairy waste water, one should consider the following:

1. Consider objectives closely as to why removing solids.
2. Review all alternatives for solids removal.
3. Evaluate options considered against stated objectives including economic and environmental.
4. Be aware that agitation is necessary for flocculation; however, too much continued agitation will cause the flocculated material to break down and become redistributed in the lagoon.
5. Assure that some method to trap and remove the flocculated material is available shortly after flocculating, otherwise the material will redistribute.
6. A basin such as a small gravity or retention pond would be ideal to trap solids after flocculated; however, clean out of the pond will be required more often due to more solids being trapped.
7. If phosphorous is a concern, polymers can be very effective at removing the very fine suspended particles from the waste pond.
8. Once a decision has been reached to use polymers, on site calibration of the injection system (pump) and product selected will be necessary. Exact treatment rates are hard to achieve due to the varying amounts in the solids removed from the flush lanes.
9. Liquid polymers are much easier and safer to use as opposed to powders.