FLOCCULATION/PRECIPITATION
OF
SOLIDS IN DAIRY LAGOONS

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

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"FLOCCULATION/PRECIPITATION OF SOLIDS IN DAIRY LAGOONS"

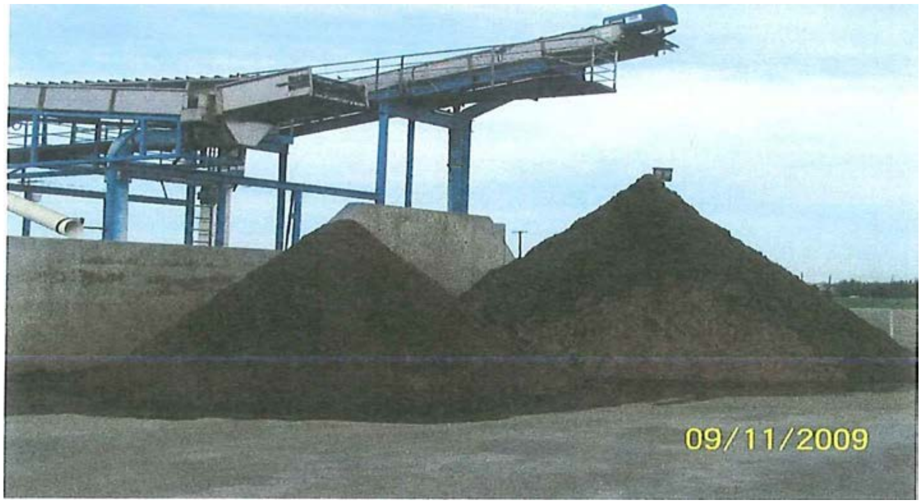
This is California Dairy Campaign's final report on NRCS's Conservation Innovation Grant titled "Flocculation/Precipitation of Solids in Dairy Lagoons" and located in the San Joaquin Valley of California. The original grant period was from September 1, 2007 through December 31, 2008; however, CDC requested 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. 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.

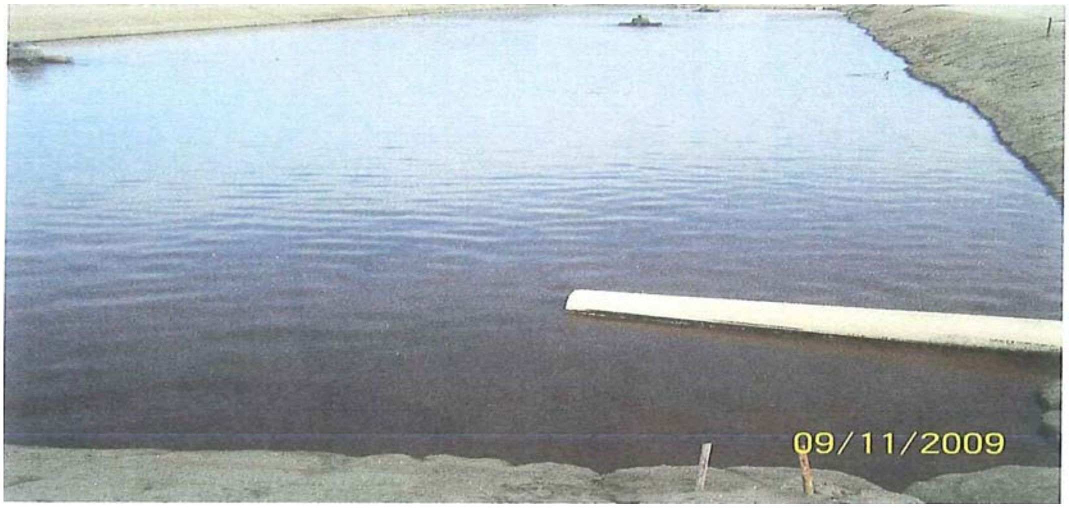
The Verburgs milk about 700 head of cows twice daily. The barns contain free stalls and flush lanes with exercise yards. Each lane is flushed five times per day for about 15 minutes (photo of flush lane and freestalls).

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)



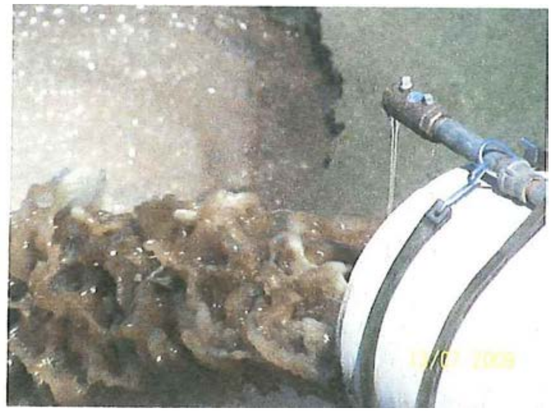
These solids are then composted with the compost being used as bedding in free stalls or for marketing off farm (photo of compost wind rows).

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).

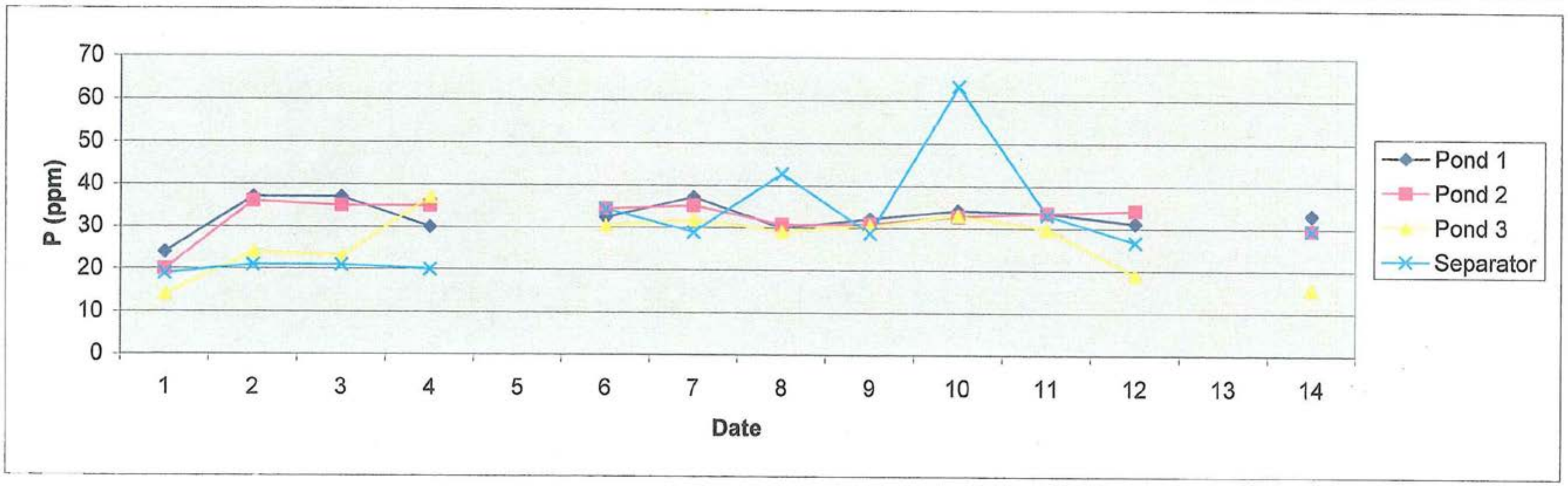
Also some flocculation and accumulation of solids on the surface demonstrated that some flocculation was continuing to occur beyond the small curtained off area (photo of floating material in lagoon). It appears that immediate removal of solids as

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.

Special recognition deservingly goes to SNF, Inc., Denele's Lab, and the individual dairymen who participated in this project.

Phosporus

	7/1/2009	7/1/2009	7/2/2009	7/4/2009		8/17/2009	BT 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
Separator	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		8/17/2009	BT 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
Separator	0.2	0.2	0.3	0.3		0.31	0.34	0.48	0.39	0.6	0.48	0.3		0.31