

Lagoon Solids Removal, Lessons Learned

for Purdue Manure Management Workshop

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A Water for Food Production Systems project under USDA-NIFA



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Objectives

Background, dairy farm and lagoon

Documents procedures for complete lagoon solids removal

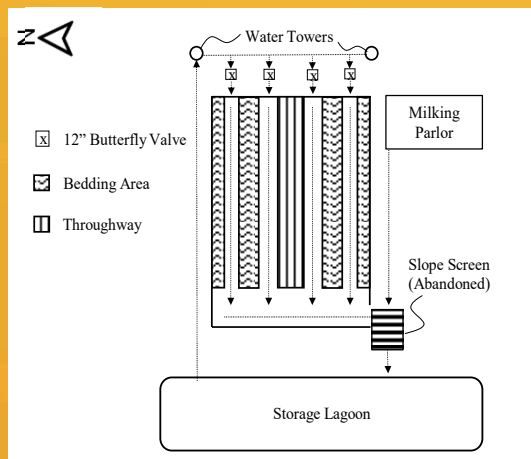
Equipment/crew to dilute, agitate, pump and land apply

Lagoon effluent characteristics and lessons learned



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Dairy Barn Information



Freestall barn for 160 lactating cows,
100'x200'

Mattress bedding with cedar shavings

Barn is flushed 3 times/day

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Dairy Lagoon



Lagoon is 400' x 280', 10-12'
deep

Volume estimated: 7.5M gallons

Significant solids built up over
years, affected dairy operation

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Lagoon Solids Issues



Elevated screen system failed and abandoned

Solids accumulation had become so great that, by 2020, islands could be seen in the middle of the lagoon

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Nutrient Management

Lagoons can be an effective means of treating and storing flushed manure

Annual pump-out: mixing and pumping and spread on nearby fields as supplemental crop fertilizer

Build-up of solids is expected over time, and many factors to consider

Manure Nutrient Management Plan: Considers crop yield and nutrient uptake, weather and soil

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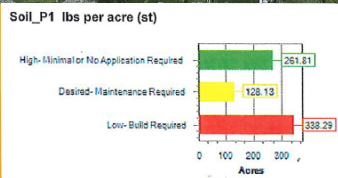
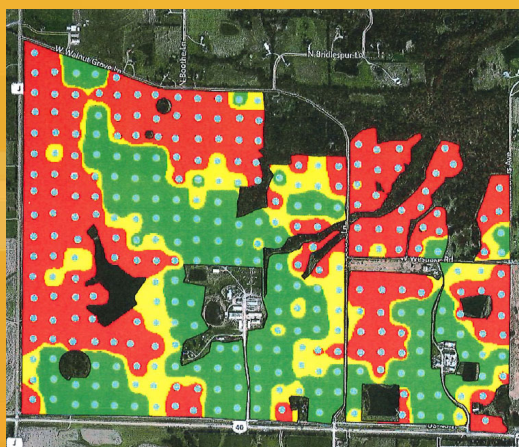
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The “Plan”

- Sludge sampling and volume estimation
- Nearby fields for application, consider Nutrient Management Plan
- Custom application job for bid
- Monitoring of volume and nutrients removed, and land application

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Soil Sampling



Farm has 200 acres fields, and neighbor has 400 acres

Lessons: Nutrients vs. distances!

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Sludge Sampling



- Experienced crew
- Water depth and sludge levels measurement
- 24 readings planned
- Cost estimated: \$2,600 USD

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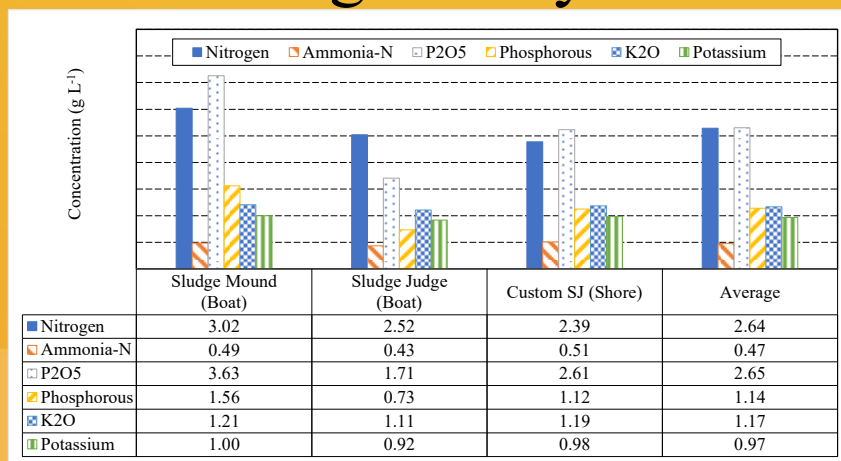
Sludge Sampling



The sludge survey was not fully executed. Surveyors discovered the sludge blanket in the lagoon was so high that the boat would get stuck.

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Sludge Analysis



The moisture contents were 86%, 94% and 88% for the sludge mound, lagoon center, and shore samples, and averaged 89%. The contractor pumps at 5-8 % and would use water from a nearby pond to dilute the solids.



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Considerations

Costs

Equipment and crew

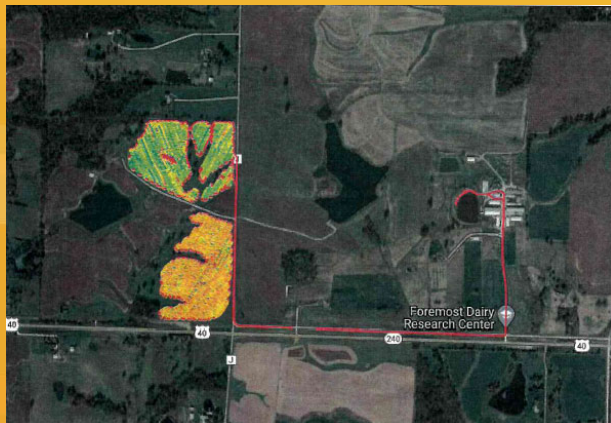
Availability and timing of the work

Experience and reputation

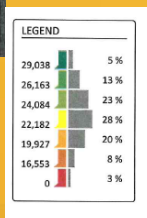


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Land Application



The main purpose is to agitate and dilute the lagoon, and use drag hose systems to deliver to nearby fields



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Lagoon Agitation



The process of agitation, dilution, pumping, and land application began on May 21, 2020

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Application Equipment



Primary lagoon pump (trailer mounted, left) and dilution pump (right).

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Application Equipment

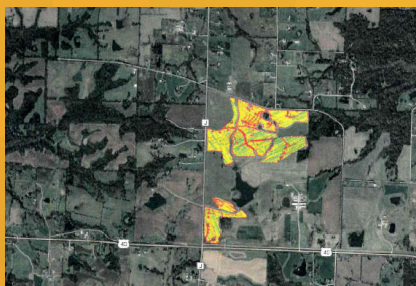
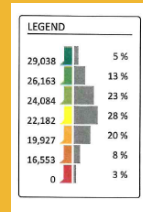
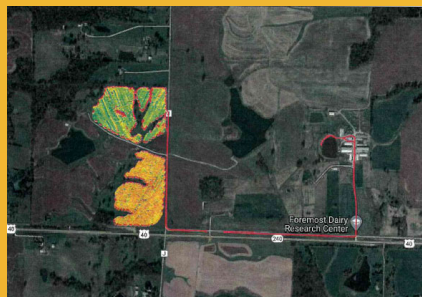


Booster pump (left), application toolbar/tractor (center), and hose cart/humper (right).

A booster pump was used to maintain a flowrate over 1,800 gallon/min through the drag hose, which was reduced from 20 cm to 15 cm immediately after the booster pump

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Fields for Land Application



Total=890 acres, the furthest=1.6 mile from the lagoon. Data included GPS maps, field area, application rate, and total volume

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Sampling of Effluent

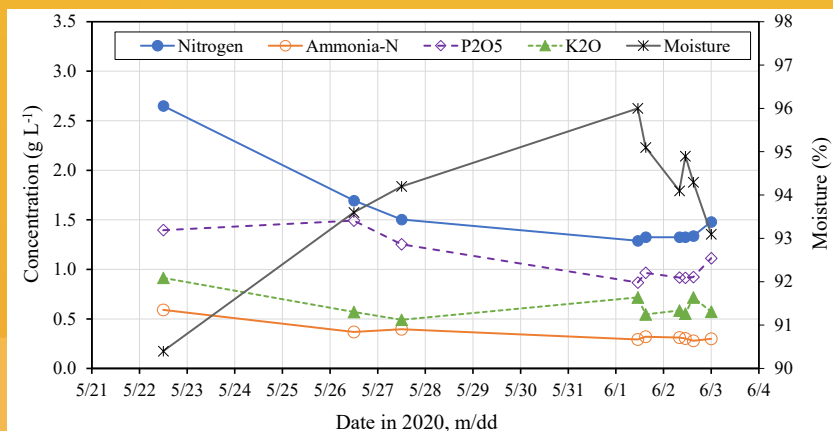


- Samples were collected at the primary pump, collected at least daily
- Analysis included NPK, pH, MC, others
- Samples were analyzed by a certified lab, University of Missouri Soil and Plant Testing Laboratory

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Nutrient Contents

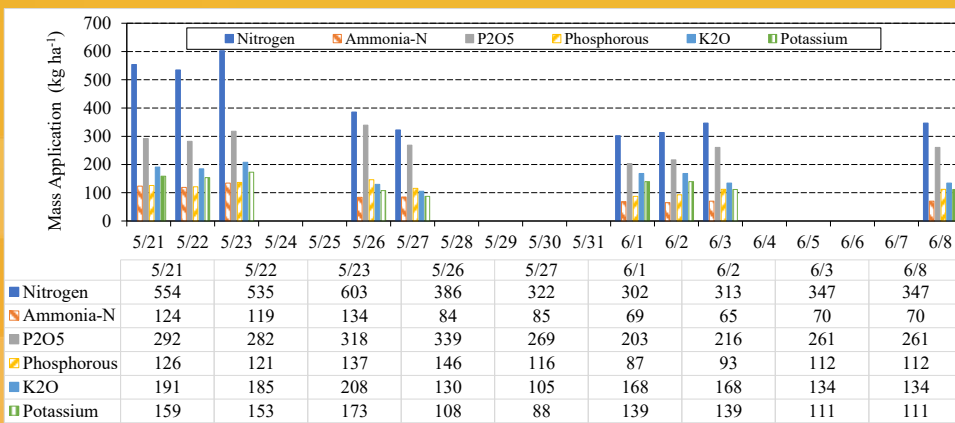


Note: application did not occur on Saturday or Sunday (May 24-25 and May 30-31), as well as on May 28 and May 29 due to inclement weather



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Land Applications



The contractor provided data that included GPS descriptions and field maps, field size, average application rate (m³/ha), and volume.
Consider real-time nutrient measurement and adjusting application rate soon?



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Costs

Price to agitate and land apply the effluent was \$0.0188/gallon

Application rates were 22-28K gallon/ac, averaged 25K gallon/ac

Total effluent pumped was 8 million gallon, completed 8 days

Total cost was \$151K USD

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Conclusions

Sludge sampling was unable to be fully executed

Must consider nearby fields and Nutrient Management Plan

Custom application job for bid: large volume injected in short time period

Monitoring of volume and nutrients removed, and land application

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Conclusions 2

Considerations and training needed to prepare for potential safety hazards

Complete agitation and homogeneity was very difficult to achieve

Land application: most effective for recycling the manure nutrients if proper nutrient management plan is followed

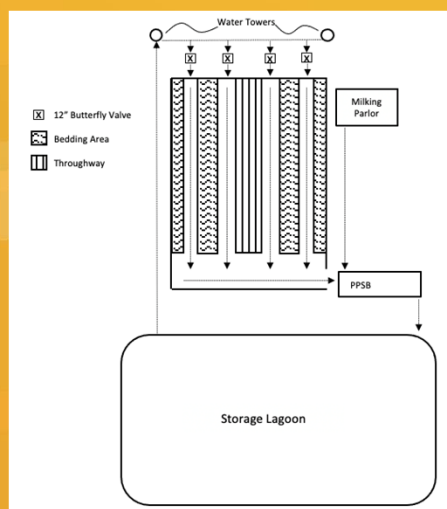
Proper solids removal before entering the lagoon can save costs

Canter, T., Lim, T.-T., and J. A. Zulovich. 2021. Field Experience of Removing and Land Application of Dairy Lagoon Solids. In International Symposium on Animal Environment and Welfare. Rongchang, Chongqing, China

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PPSB Installation



The farm installed a pull-plug sediment basin (PPSB) system (Canter et al., 2020) to help remove solids in the manure flush.

The PPSB is relatively low-maintenance and easy to operate.

Cost was ~\$26,000 USD for 160 lactating cows (\$163/head)

<https://extension.missouri.edu/publications/eq302>

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PPSB



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PPSB – Solids Removal



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Acknowledgements

- USDA NIFA
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- Custom applicators



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