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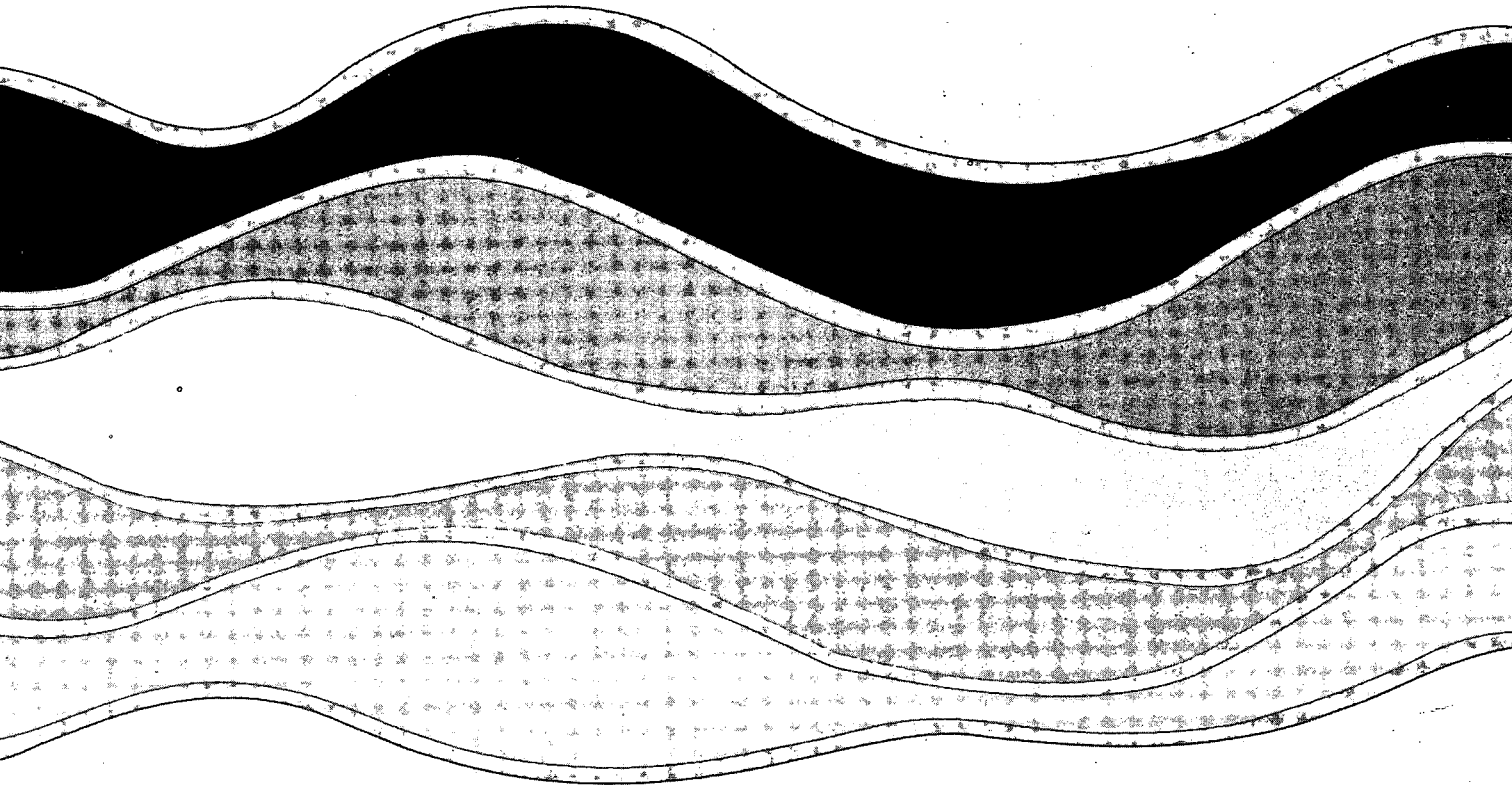

FARM WATER DUGOUTS

A MANUAL ON THE USE OF LIME TO PROVIDE GOOD WATER QUALITY

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A MANUAL

ON THE USE OF LIME TO PROVIDE GOOD WATER QUALITY

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Management Perspective

Dense algal blooms in farm dugouts cause taste and odour problems, clog filters, and at times kill livestock. The common copper sulfate treatment must be applied frequently, it leaves a residual taste, and it can be toxic to sheep. Lime treatment has been shown by earlier studies by the National Water Research Institute and the University of Alberta to effectively improve water quality. The application of calcium hydroxide to dugouts precipitated more than 99% of the algal biomass and the dugouts remained clear for two years. Farmers reported that the taste and odour of the water was greatly improved after the calcium hydroxide treatments and the effect continued into the next year.

In this publication, we provide a simple review of how to add lime to dugouts. The technical details are supplied to enable a farmer to build his own lime slurry maker. A lime application protocol is presented that allows a farmer to treat his dugout without professional supervision.

PERSPECTIVE-GESTION

La prolifération des algues dans les mares artificielles cause des problèmes de goût et d'odeur, encrasse les filtres et entraîne parfois la mort chez le bétail. Il faut appliquer fréquemment le traitement au sulfate de cuivre, qui laisse un goût dans l'eau et qui peut être toxique pour les moutons. Il a été montré, au cours d'études effectuées plus tôt par l'Institut national de recherche sur les eaux et par l'Université de l'Alberta, qu'un traitement à la chaux améliore réellement la qualité de l'eau. L'application d'hydroxyde de calcium a provoqué la précipitation de plus de 99 % des algues, et l'eau est restée limpide pendant les deux années suivantes. Les fermiers ont signalé que le goût et l'odeur de l'eau s'étaient grandement améliorés après le traitement à l'hydroxyde de calcium, et que l'effet avait persisté pendant plus d'un an.

Dans cette publication, on examine rapidement la méthode de chaulage employée. On donne aussi des détails de nature technique pour que les fermiers puissent fabriquer eux-mêmes leur propre système de préparation de lait de chaux. On présente aussi un protocole de chaulage qui permet aux fermiers de traiter leur propre mare artificielle sans la surveillance d'un professionnel dans le domaine.

INTRODUCTION

In agricultural districts where good quality drinking water is not available, many farms obtain water for livestock and household use from dugouts. Dugouts are shallow depressions, used to store water. They may be man-made or they may be streams and ponds which are dammed up. Water draining into dugouts (i.e., rainfall and snowmelt) from fields and ditches is generally nutrient-rich. The most important nutrient in water used to fill the dugouts is phosphorus. Excessive levels of phosphorus can cause excessive greeness (i.e., algal growth) in dugouts.

Algae are small plants; high densities of certain species, often referred to as algal blooms, can decrease the quality of drinking water. Algal blooms in dugouts are undesireable since they can:

1) cause taste and odor problems,
2) clog filters, and
3) have toxins associated with them which can be lethal to livestock and cause health problems for humans.

Existing methods to control algae in dugouts involve the regular treatment with the herbicides copper sulfate (bluestone), or Diquat (Reglone A). Algal control using these traditional herbicides is unreliable for the following reasons:

1) non-target organisms can be affected (e.g., fish and invertebrates),

2) with regular treatments, target algae (i.e., blue-green algae) can become resistant to traditional herbicide control,
3) nutrients that are responsible for the algal bloom are not removed, consequently the period of algal control is short and retreatment is necessary, and
4) possible human health problems may persist for a period of time after treatment.

Researchers at the University of Alberta, Edmonton Alberta, and the National Water Research Institute, Burlington Ontario, have found an inexpensive and non-toxic method to control algal blooms in drinking water dugouts. They found that calcium hydroxide (hydrated lime), when added to dugouts, will remove most of the algae and phosphorus from the water. Phosphorus is the most important nutrient for algal growth in freshwater and control of this nutrient is essential for control of algal blooms. Hydrated lime induces chemical precipitation of calcite, and both the algae and phosphorus precipitate with the calcite. Evidence suggests that phosphorus concentrations in the open water will remain depressed for at least two years after lime additions, assuming simple precautions are taken.

This manual was prepared to assist dugout users in applying lime to dugouts. Although lime treatment will help control algal blooms in drinking water dugouts, a good dugout maintenance program will enhance the effects of the lime treatment and ensure good water quality.

Routine dugout maintenance should include:

1) diversion of barnyard runoff away from the dugout,
2) farm animals should not be allowed direct access to the dugout since hoof damage to the banks can occur as well as manure contamination,
3) the land surrounding the dugout and all waterways leading to the dugout should be grass,
4) fertilizer application should be kept to a minimum around the dugout, and
5) all organic matter (i.e., leaves, straw, hay, etc.) should be kept out of the dugout.

APPLICATION OF LIME

Users should note and understand that hydrated lime is a powerful corrosive chemical that when mixed with water forms a caustic solution capable of causing chemical burns. Thus, it is necessary to wear protective clothing including dust masks, goggles and rubber gloves and boots when dealing with this chemical. Skin and eye contact with lime dust and lime/water mixtures (slurry) should be followed with thorough rinsing with water.

CALCULATING THE AMOUNT OF LIME NEEDED

The pH of treated water will increase after lime has been added. The aim of the treatment is to add enough lime to the dugout to eliminate most algae and phosphorus, but not enough to increase the pH unnecessarily high (above 10.5). The magnitude

of the pH increase is dependent upon two things: 1) the natural ability of the dugout to resist a change in pH (the buffering capacity), and 2) the amount of lime added. The buffering capacity of the dugout is called alkalinity, and is expressed as mg/L CaCO3. The alkalinity of your dugout can be determined by Alberta Agriculture, the local health unit or from a private laboratory. The amount of lime to be added to the dugouts is determined by the following schedule:

ALKALINITY (mg/L CaCO3)	DOSAGE (mg/L of hydrated lime)	SCHEDULE	CORRECTION FACTOR
50 to 100	100	A	0.000455
100 to 200	150	B	0.000682
more than 200	200	C	0.000910

To determine the amount of lime to be added, complete the following calculations:

1) Determine the volume of the dugout in gallons.
2) Determine the alkalinity of the water in the dugout.
3) Multiply the volume of the dugout by the correction factor in the above table based on the alkalinity of the dugout.
4) Divide the value in '3)' by 25 to determine the number of 25 kilogram bags of lime required.
5) Round off the answer in '4)' to the nearest bag.
6) Apply all of the recommended lime in one application.

The following example will illustrate how to determine the amount of lime required:

1) Dugout volume is 388,500 gallons.
2) Alkalinity of the dugout is 121 mg/L, therefore a correction factor of 0.000682 is used (from Schedule B).
3) 388,500 X 0.000682 = 265 (approximately), therefore 265 kilograms of hydrated lime are needed for the dugout.
4) 265 / 25 = 10.6 bags of hydrated lime.
5) 11 bags of lime should be added to the dugout.

25 kilogram bags of hydrated lime are available at your local farm supply dealer. Hydrated lime is often used in livestock shelters to reduce odor and insects.

HOW TO APPLY LIME TO YOUR DUGOUT

Lime should be applied as a slurry for best results. A slurry is made up by mixing one part lime with four parts water. The slurry is then sprayed onto the dugout. Be sure to apply the slurry to the entire surface of the dugout. To ensure good algal and nutrient control, more slurry should be sprayed onto the dugout where the water is deepest and less slurry should be sprayed onto shallow areas.

Hydrated lime may be slurried and sprayed in many ways. You may use any equipment available but remember that hydrated lime is caustic and may damage equipment if not thoroughly rinsed immediately after use. Figure 1 illustrates the design of a

slurry system that has been used successfully to treat numerous dugouts. This system is made up of two 45-gallon drums and two 3-horsepower water pumps. Pump "a" delivers water to drum "a" where the hydrated lime is added and the resulting slurry is formed. Note: fill the barrel with water before any lime is added and always add the lime to water, do not add water to lime otherwise it may cake-up. The slurry drains into drum "b" through a 4-inch diameter rubber hose. Pump "b" then sprays the slurry onto the dugout. This system may be mounted on a trailer and towed by a truck or tractor.

It will take 7 to 10 days for the lime to settle to the bottom of the dugout and the water to clear up. The lime will settle out of the surface waters first and this is where the best quality water will be found. You should adjust your intake line to draw off the top water in the dugout. Avoid use of dugout water for a couple of days after lime treatment since the lime that is still suspended in the water column may clog filters in household filtration systems.

WHEN TO APPLY LIME

Apply hydrated lime when the water temperature is above 15°C. Water in dugouts usually reaches this temperature by mid-May or early June. This is also the time when the pH is usually low and alkalinity is high. Work is continuing on the best time for application of hydrated lime to dugouts. Research into the usefulness of applying lime on the ice cover of dugouts is currently under investigation.

If you plan to stock fish in your dugout, stock the fish no sooner than two weeks after the dugout has been treated. Hydrated lime treatments may cause stress to fish through an increase in pH or by clogging the gills with fine particles.

The following publications on lime treatments and dugouts can be obtained from the National Water Research Institute.

Babin, J.M., E.E. Prepas, T.P. Murphy, and H. Hamilton. 1989. A test of the effects of lime on algal biomass and phosphorus concentrations in Edmonton stormwater retention lakes. Lake Reser. Man. 5(1):129-135.

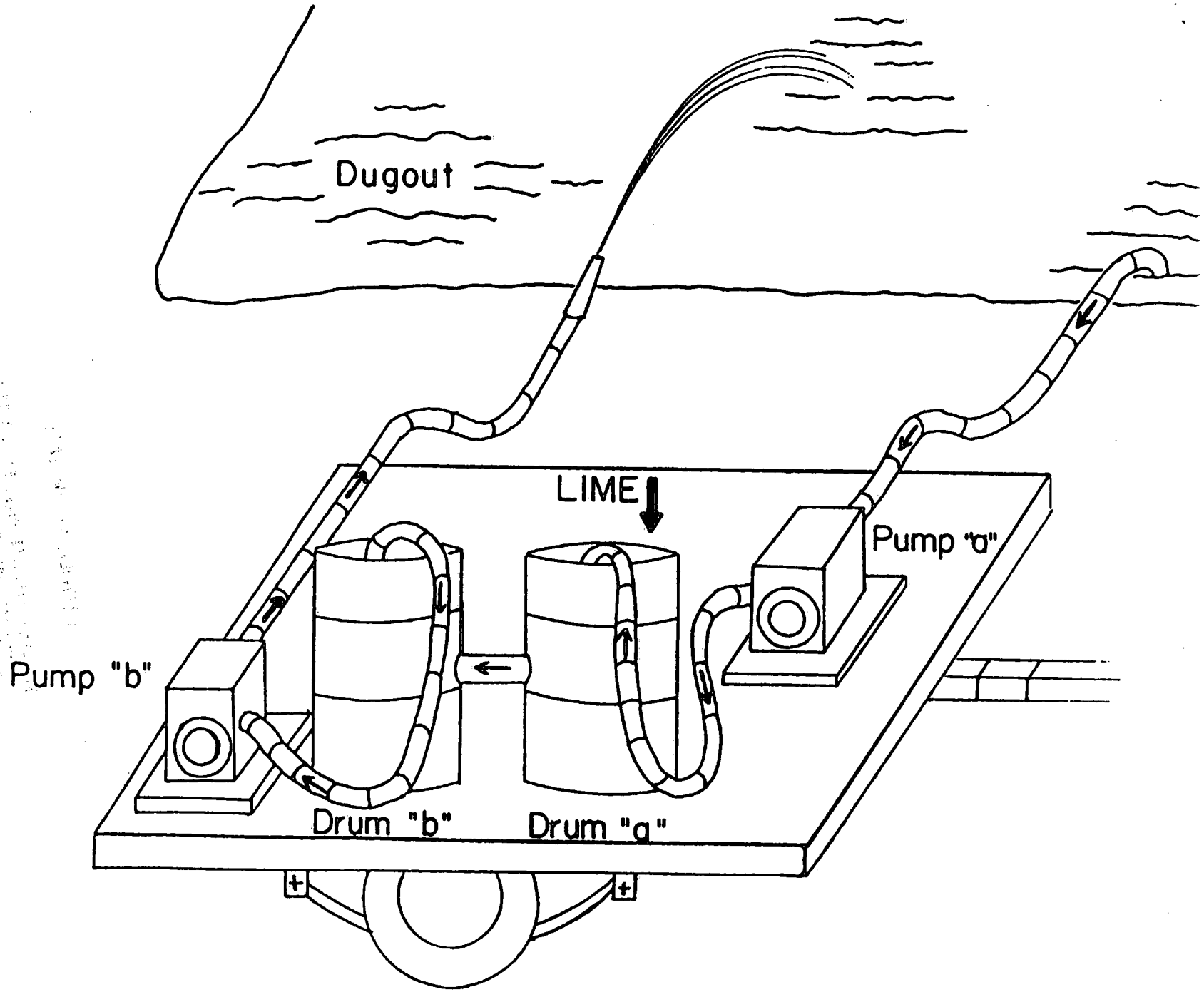
Murphy, T.P., K.G. Hall, and T.G. Northcote. 1988. Lime treatment of a hardwater lake to reduce eutrophication. Lake Reserv. Man. 4(2)51-62.

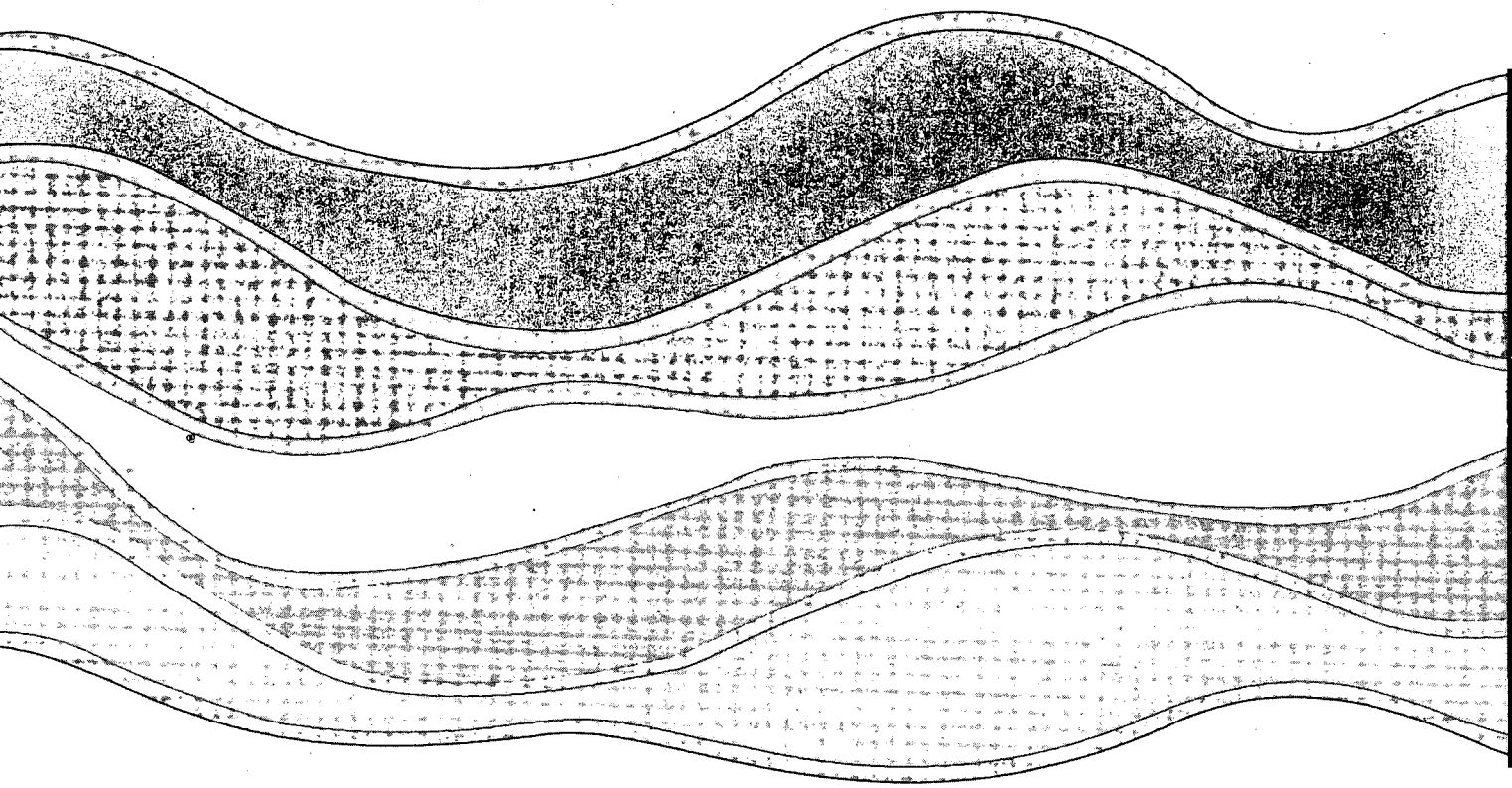
Murphy, T.P., E.E. Prepas, J.T. Lim, J.M. Crosby, and D.T. Walty. 1989. Evaluation of $CaCO_3$ and $Ca(OH)_2$ as algicides in prairie drinking water dugouts. NWRI Report 89-.

Murphy, T.P. and E. E. Prepas, 1989 Lime Treatment of Hardwater Lakes to Reduce Eutrophication. NWRI Report 89-.

Prepas, E.E. and T.P. Murphy. 1988. Sediment-water interactions in farm dugouts previously treated with copper sulphate. Lake Reserv. Man. 4(1):161-168.

Prepas, E.E., T.P. Murphy, J.M. Crosby, D.T. Walty, J.T. Lim, J. Babin, P. Chambers, 1989. The impact of $CaCO_3$ and $Ca(OH)_2$ additions on hypereutrophic Figure Eight Lake. NWRI Report 90-


Dugout
LIME
Pump "a"
Pump "b"
Drum "b"
Drum "a"
+
+



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