LAKE COCHRANE

LAKESIDE DWELLING SURVEY
DEUEL COUNTY

OCTOBER 1981

BULLHEAD LAKE

NORTHEAST LAKES
REGIONAL OFFICE

Lake Cochrane and Bullhead Lake

Lakeside Dwelling Survey

10/26/81

Prepared By

South Dakota
Department of Water and Natural Resources
Northeast Lakes Regional Office

First District Association of Local Governments

South Dakota
Department of Game, Fish and Parks

Soil Conservation Service

Concern had been expressed about the effects on water quality resulting from the development of Lake Cochrane, and what effects on water quality could be expected if Bullhead Lake were to undergo development as Lake Cochrane had. As a result of this concern, the Deuel County Planning Commission requested that the South Dakota Department of Water and Natural Resources, South Dakota Department of Game, Fish and Parks and the Soil Conservation Service conduct a joint study of the lakes and their respective watersheds. This study was to determine in what areas the water quality of the lakes had been or could be affected and provide recommendations and comments as to what action could be taken by the Planning Commission to restore and preserve the water quality of the lakes. The Department of Game, Fish and Parks provided their Lake Manage- Plans which give information about the origin and physical aspects of the lakes and watersheds, recreational uses, management plans, and their recommendations. The Soil Conservation Service conducted a soil survey of the area adjacent the lakes, and the Department of Water & Natural Resources, in cooperation with the First District Association of Local Governments, conducted a septic tank survey and provided the final summary, comments and recommendations.

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SECTION 1

LAKE COCHRANE SANITARY SURVEY

The Watertown Regional Office of the Department of Water & Natural Resources (DWNR) was asked by the Deuel County Planning Commission to conduct a sanitary survey of lakeside dwellings on Lake Cochrane. Planning Commission members were concerned that improper wastewater treatment was resulting in a source of pollution to the lake. Because Lake Cochrane is one of the most extensively developed lakes in the Coteau region, the potential for a severe pollution problem exists along the lake's shoreline.

In an effort to assess the amount of pollution by improper wastewater treatment, DWNR, in cooperation with the Deuel County Auditor, mailed explanatory letters and sanitary surveys to all owners of lakeshore property on Lake Cochrane. Of the 219 surveys mailed, 84 were returned. These 84 surveys represented 77 residences and 7 vacant lots. The First District Association of Local Governments analyzed the surveys, and prepared the Lake Cochrane Survey portion of this report.

The types of wastewater treatment systems that were used by the 77 residences are as follows:

-- 49 of the residences had sealed holding tanks;

-- 26 of the residences had septic tanks with either drain fields or seepage pits;

-- 1 resident had a privy;

-- 1 resident had no knowledge of his system

The reason that such a high percentage (64.5%) of the known systems employed sealed holding tanks, is that in recent years the Deuel County Planning Commission has required holding tanks before issuing building permits for lakeside dwellings.

The water supply of the 77 residences is as follows:

-- 50 residences are hooked up to the Brookings-Deuel Rural Water System;

-- 10 residences had their own well;

-- 17 residences hauled water of had a cistern.

Of the residences that had their own well, three had an insufficient distance between the well and their individual systems according to ARSD 34;04;01 (Administrative Rules of South Dakota; Private Sewage Disposal Regulations). Although two of these wells were in excess of 100' in depth, they were only 60' and 50' respectively, from a drainfield. The third well was only 10' in depth and was located 25' from a holding tank.

Regarding minimum lot sizes, very few lots met the standards of ARSD 34:04:01 whether the residence used rural water or had a private well. However, most lots surrounding Lake Cochrane had been plotted before February 28, 1975, and, thus, are exempt from minimum lot size requirements.

Only those residents having a drainfield or a seepage pit were asked for the distance between their septic system and the lake. Of the 26 residents with such systems, 20 were 100' or more from the lake; 5 were not in conformity with ARSD 34:04:01; and 1 response could not be analyzed. The distance from the lake of four of the five systems not in conformity were 75', 80', 85', and 90'. The fifth system could not be measured from the information supplied, but was judged to be in nonconformity because the depth of the lot on which it was located was only 100'.

By examining the diagrams supplied by the respondents, some information regarding the 49 systems employing sealed holding tanks could be obtained. Of the 49 such systems, 25 were located 100 or more feet from the lake, and 7 were located less than 100' from the lake. Estimates concerning the 17 remaining systems could not be obtained from the information that was provided. Of those systems that are less than 100' from the lake, estimates concerning the distance could be made for five of them. The distances of these systems from the lake were 80', 85', 90', 93' and 95'. Two other systems were located on lots with 100' depths. Although the distances of these two systems from the lake could not be estimated, it was assumed that they were in violation of ARSD 34:04:01.

DWNR personnel from the Watertown Regional Office have estimated that there are 150 dwellings surrounding Lake Cochrane. If the 77 residents that responded to the sanitary survey can be considered to be a representative sample, pollution from improper wastewater treatment does not seem to be a major problem at Lake Cochrane at this time. A large percentage (64.5%) of the systems employ sealed holding tanks, and no system was located closer to the lake than 75' (only 12 systems were located less than 100' from the lake).

The comparison of water quality samples taken at Lake Cochrane over the past several years with samples taken at other lakes in the area with developed shorelines also indicates that improper wastewater treatment is not a major pollution problem at Lake Cochrane. The following table compares the fecal coliform counts per 100 ml for Lake Cochrane, Lake Kampeska, Lake Poinsett and West Oakwood Lake. These samples were taken by DWNR personnel on the specified dates. The symbol 3K means that the fecal coliform count was less than three per 100 ml. The dates chosen for the table were those dates when water quality sampling was carried out on at least three of the lakes involved.

DATE	LAKE COCHRANE	LAKE KAMPESKA	LAKE POINSETT	WEST OAKWOOD
9/13 & 14/76	3K	3K	3K	27
11/15 & 17/76	3K	3	3K	3K
1/17 & 18/77	3K	3K	23	13
3/7 & 8/77	3K	3K	3K	3K
5/2 & 3/77	3K	3K	3K	--
12/12 & 13/77	3K	3K	3K	3K
3/6 & 7/78	3K	3K	3K	3K
5/9 & 11/78	3K	3K	3K	3K
8/1 & 2/78	3K	3K	7	3K
8/30/78	3K	10	--	3
1/10 & 11/79	7	10	--	3K
4/25 & 26/79	3	63,17,3K	--	3K
5/16 & 17/79	330	3K,3K,7	--	7
6/11 & 13/79	3	7,300,3K	--	280
7/11 & 12/79	3	10,70,10,000	--	60
8/15 & 16/79	3K	120,3,3	--	20

See appendix for the results of additional sample results for Lake Cochrane.

The last five dates for Lake Kampeska show three numbers for each date. This is due to the fact there were three samples taken of the lake on each date.

From this table, it can be seen that Lake Cochrane only exceeds the Water Quality Standards for Immersion Recreation (200/100 ml) on one occasion--May 16, 1979. There is the possibility that this was a contaminated sample, since on no other occasion was the fecal coliform count in the lake in excess of 7/100 ml. Lake Kampeska exceeded Water Quality Standards on two occasions and exceeded 7/100 ml on six different dates. West Oakwood Lake exceeded Water Quality Standards on one occasion and exceeded 7/100 ml on five different dates. Comparing the nine dates when both Cochrane and Poinsett were sampled, it is seen that Lake Cochrane had a lower average fecal coliform count. It should be noted that this difference in average was minute, and at no time did either lake come close to exceeding Water Quality Standards.

While it can be said that improper wastewater treatment is not a major pollution problem at Lake Cochrane, it should not be assumed there are no problems associated with wastewater treatment at the lake. Of the approximately 150 dwellings on the lake, only 77 responded to the sanitary survey. There may be a number of problems found among those approximately 73 dwellings that did not respond. In addition, it is important not only to know the location of an individual dewage disposal system, but it is also important to know if the system is operating properly. This type of information could not be derived from the sanitary survey. DWNR personnel will continue to investigate potentially faulty systems when complaints are received.

In summary, it appears that improper wastewater treatment is not a major pollution problem at Lake Cochrane. This is not to say that no problems concerning wastewater treatment exist at the lake. It is recommended that DWNR personnel continue to investigate sanitary systems when complaints are received. It is also recommended that the Deuel County Planning Commission require the

installation of sealed holding tanks before building permits are issued for lakeside dwellings.

BULLHEAD LAKE SANITARY SURVEY

Bullhead Lake contains just one small lakeside development consisting of seven part-time residences. These cabins and trailers are located on the Northeast corner of the lake, and as they stand, this small development does not pose a serious pollution threat to the lake.

Due to the large amount of public land and two sloughs which border the lake, Bullhead will not undergo the development that of Lake Cochrane has, however, care must be taken with future development of this lake for several reasons. One aspect of this lake that requires special care be taken is that it is classified as a eutrophic lake. Eutrophic is a term which means that the lake is naturally rich in nutrients, as are most if not all of the lakes in this region. Since Bullhead Lake is already high in nutrients, additional nutrients, particularly those found in septic wastes if they were allowed to enter the lake, would lead to excessive algae blooms which would make Bullhead Lake all but unuseable for recreational purposes.

The extent of the natural eutrophication of Bullhead Lake can be seen by examining DWNR's monitoring results for Bullhead (see Appendix), and Game, Fish and Park's sampling results listed in their Lake Management Plan. Although Bullhead has not been sampled as excessively as Lake Cochrane has, by comparing what results are available for Bullhead to Cochrane's analyses listed in the appendix; it can be seen that the water in the undeveloped Bullhead Lake is higher in the major nutrients, nitrogen and phosphorus due to natural conditions (see columns labeled $NH_3 + NH_4$, total N and phos.) then the well developed and heavily used Lake Cochrane.

An additional problem facing Bullhead Lake is that the soil types surrounding the lake are incompatible with conventional sewage treatment systems. The details of the soil types and related problems are listed in the soil

survey section, but what it means is that both the builders and county officials will need to take special care in evaluating wastewater systems with regards to soil conditions when developing the lake shore property.

In conclusion, Bullhead Lake has it's own special problems, but they can be overcome if care and caution are exercised by all persons involved and interested in the lake's future.

SECTION 2

MANAGEMENT PLAN FOR LAKE COCHRANE

DEUEL COUNTY

by

Bruce Harris

Origin of Lake

Lake Cochrane is located 5 1/2 miles south of the town of Gary, 1/2 mile from the Minnesota state line, in Sections 4, 5 and 8 of Norden Township (Figure 1). It is a natural, meandered body of water covering approximately 366 acres. The Lake Cochrane watershed is comparatively small, totaling about 900 acres, with drainage into the Lac qui Parle and Minnesota rivers. Water levels are maintained to a considerable degree by several springs feeding into the lake; these springs are found on the shores of the lake as well as on the lake bottom.

Physical

The contour map of Lake Cochrane was printed by the Department of Game, Fish and Parks in 1964 (Figure 2). Maximum depth is shown as 26 feet (but only 21 feet now), and the average depth is 11 feet. Length of the shoreline is more than 3 1/2 miles; the lake is about 1 1/2 miles long and 1/2 mile wide.

Silt and sand-rubble make up the bottom of the lake. There are rather large deposits of silt found at the junction of three drainages feeding into the lake on the SW and SE corners. These deposits resulted from poor agricultural practices within the watershed. In 1976 a cooperative erosion control program was effected by five agencies that is designed to prevent siltation from entering the lake in future years. These developments consisted of dams across the two deep drainages entering the lake on the southwest corner, and a smaller sediment control dam, with settling pond, on the southeast corner of the lake.

All structures are part of the perimeter road that encircles the lake. The two dams on the southwest end of the lake were developed in conjunction with completion of the perimeter road around that portion of the lake. Both dams were designed by Game, Fish and Parks engineers to be used as fish rearing ponds. The agencies involved in these significant developments were: East Dakota Conservancey Sub-District, Department of Game, Fish and Parks, Deuel County Commission, Norden Township Board of Supervisors, and the Soil Conservation Service.

Several aquatic plants are found in Lake Cochrane, including species of Potamogeton, Ceratophyllum, and Scirpus. Bullrush (Scirpus, sp.) is now found only in a small area on the southwest corner of the lake, where it was much more extensive prior to cottage development on the lake.

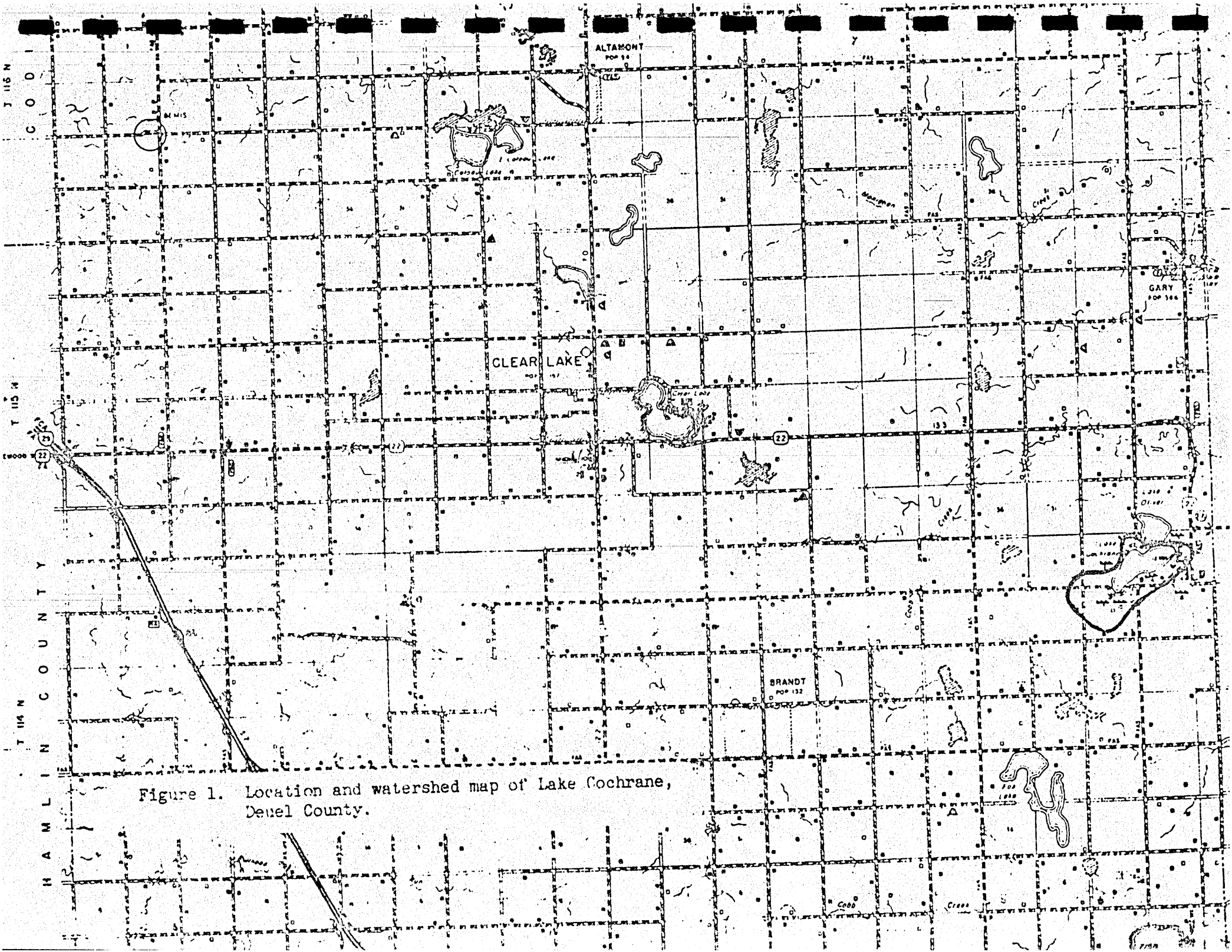


Figure 1. Location and watershed map of Lake Cochrane, Deuel County.

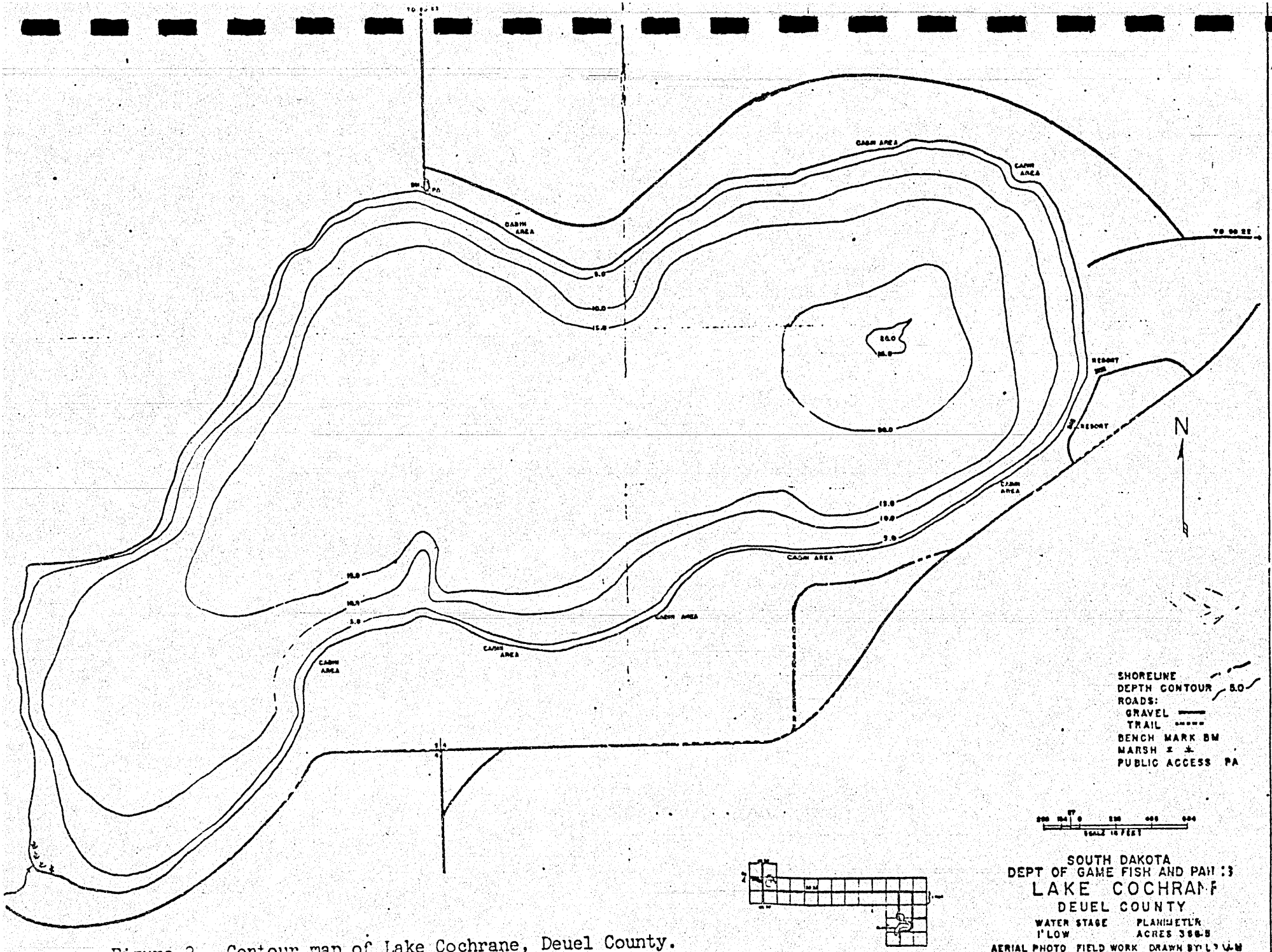


Figure 2. Contour map of Lake Cochrane, Deuel County.

The abundance of several species of submerged aquatics has increased considerably during the past ten years in the shallower southwest portion of the lake, presenting a problem for fishermen and water skiers. This increase in aquatics was apparently a result of increasingly heavy siltation of the lake during this period.

The Lake Cochrane watershed covers about 1 1/2 sections, totaling approximately 900 acres (Figure 1). The watershed consists of hilly glacial moraines and steep slopes along drainageways. Soils are primarily of the Buse Association, loamy, with thin surface layers, and are developing in glacial till. The Forman-Aastad-Parnell Association soils are on gently undulating to rolling topography. Soils are deep, dark, well-drained to moderately well-drained loamy soils. (Deuel County Agriculture, 1967, p. 33.)

Approximately 80 percent of the watershed is cropland, primarily row crops and grains. The remaining 20 percent is pasture, consisting mainly of bluegrass, bluestem and brome grasses.

"Lake Cochrane is positioned in an area of uncertain geological stratigraphy. Subsurface deposits of sand and gravel may exist, but extensive aquifer recharge is doubtful (Kume, 1976). The high concentration of dissolved solids indicate poor flushing characteristics, yet the stable water level implies groundwater recharge presumably emanating from deep high-pressure clay springs which receive their source and pressure from the morainic highlands to the west. The contributing and immediate watersheds ..... are nearly of equal size. However, in 1976 sediment dams were constructed in the lower reaches of the major tributaries reducing the immediate watershed by sixty percent. The relatively good TSI is attributable to the insulating capacities of the deep waters and the wind protection afforded by the surrouning hills.

Lake Cochrane is one of the most severely developed lakes in the Coteau district. It is recommended therefore that in addition to dredging, a waste collection system be established. Siphoning of nutrient-rich bottom water is recommended as a supplement to dredging". (Lake Preservation Report, pps. 104-105).

Lake Cochrane has thinly wooded areas only on the south and northeast shores of the lake. Five small sloughs are also within the Lake Cochrane watershed, the largest about 30 acres in size. The three major inlets previously mentioned are intermittent, depending on snow runoff and seasonal rains, although one of the draws contains a good spring flow. The only outlet for Lake Cochrane is located on the southeast end of the lake. This natural outlet flowed only during periods of high water, with overflow from the lake going down a gully, through several wetlands to Florida Creek, then to the Lac qui Parle and Minnesota River drainages. However, about 20 years ago this outlet was filled during adjacent land development. From that time until the summer of 1973, when the Department installed a water control structure on the site, water flowed from the lake only over the fill area and down a roadside ditch into the above described drainage systems.

The area around Lake Cochrane is intensively farmed, and good soil conservation is not always used. This situation has contributed to siltation of

the lake by wind and water erosion. Silt deposits at the three problem areas discussed above measure at least 12 inches in depth. Fortunately, it appears that incoming waters were not high in nutrients, and pollution is not considered serious in this regard. The Department of Game, Fish and Parks, in cooperation with the Department of Health and the East Dakota Conservancy Sub-District, conducted a survey in 1972 of sewage systems of the approximately 150 cabins that were on the lake. It was found that only about a dozen cottage owners were in violation of the County Zoning Law, and that pollution from this source was also minimal, probably because of its above-average depth (for South Dakota lakes).

Lake Cochrane was one of ten lakes in South Dakota rated in Priority Group 1 by the Lake Preservation-Restoration Committee. This rating is based on a number of factors, including depth, recharge quality, fisheries present, public accessibility and public use. The same Committee gave Lake Cochrane a rating of 56 on the Trophic State Index, a rating from 0-100 that provides an index of potential nuisance algal bloom conditions; this is one of the better ratings for all lakes in the state. (Lake Preservation Report, p. 66.)

Other ratings given by the Lake Preservation-Restoration Committee were:

Total Dissolved Solids (TDS)	---- 3000	(5,000 mg/liter is high; 10,000 is excessive for fish production)
Aquifer Connection	---- M	(has moderate ground water recharge)
Soil Drainage	---- Good	
Slope	---- 4.1	percent (on Immediate Watershed)
Land Use	---- 80	(percent of land in Immediate Watershed under cultivation)

Extensive water sampling of Lake Cochrane has been accomplished from 1976 thru 1974 (op. cit., pps. 203-204), and field analysis shows the following:

Total Alakalinity ranges from 167 to 330
Ph range from 8.3 to 8.8
Magnesium range from 343 to 521
Total hardness range from 167 to 485

Cochrane has maintained adequate supplies of oxygen, both summer and winter. There has been no known winterkill of fish in the lake.

Recreational Aspects

Lake Cochrane is widely known, and intensively used, as a summer and winter recreation area. There are good all-weather roads leading to the lake from all directions, and its proximity to Minnesota has drawn non-residents to the lake for many years; more than half of the cottages are owned by Minnesota residents. Two resorts are located on the lake, but only one of these provide boats and minnows for fishermen. This operator has had only two boats for hire during the past ten years, due to the preference of fishermen to provide their own boats and motors.

Until 1972 there was only one small (1.5 acres) public access on the lake maintained by the Department, but two additional swimming beaches were made available to the public by the two resorts located on the lake. In 1972 the Department purchased 25 acres of land on the northwest corner of the lake for fishing access, and in 1974 the Parks Division acquired an additional 174 acres of land on the north side of the lake. The Parks Division now provides a swimming beach with a dock, and a boat ramp and dock intended exclusively for boaters. Development of a 30-unit campground was begun in 1976 and is scheduled for completion during 1977.

Waterskiing is a popular pastime for many boaters during the summer months, sometimes hindering fishermen on weekends. Camper units have overused the small access area available for the past six years. Excellent catches of northern pike, walleye, and bass are taken regularly from Lake Cochrane; crappie provide fair to good fishing. Small perch, bluegill and sunfish are always available in unlimited numbers because of an overpopulation of these species in the lake.

The lake receives heavy fishing pressure throughout the year, including ice fishing during the winter months. There are usually from 25 to 35 houses on the lake during the winter season.

Past Management

Lake Cochrane has been managed as a northern pike, walleye, panfish lake for the past twenty years. Heavy stocking of adult northerns began in 1962, in a compromise effort to control the overpopulation of panfish. In that year 2,178 adult northern pike were planted, and an additional 1,200 were stocked during the three-year period 1966-68 (Table 1). During commercial fish operations of Fish Lake in 1974 and 1976 a total of 166 adult northerns and 116 adult walleye were transplanted to Lake Cochrane. Water levels in Fish Lake were very low during these years. Some of the northerns weighed from 12-16 pounds, and the walleye ranged up to 4-5 pounds. Several thousand fingerling northern pike were also stocked in the lake during this period, and up to the present time. So fishing for northerns has been good to excellent at various times, although there was a restriction on fishing for this species during 1967-1971, a five-year period. This restriction was part of the overall program designed to allow predator species to control the stunted population of panfish.

Walleye pike have been stocked on a three year plan during the past ten years; prior to this heavy stocking of fingerling walleye was made in 1964, when 5,000 were planted in Cochrane. Good to excellent fishing for walleyes has been experienced during this entire period. Largemouth bass were stocked only three times during the past twenty years, but these plantings have been quite effective, and good bass fishing has resulted during the past six years, at least. Bass were last stocked in 1970. There is no record on file regarding introduction of crappie in the lake, but this species has provided fair to good fishing in Cochrane for a number of years, dating back to 1959.

Fair to excellent spawning areas are present in the lake for all fish species except northern pike, and it is assumed that natural reproduction

Table 1. Stocking record for Lake Cochrane, Deuel County.

Year	Northern Pike	Walleye Pike	Largemouth Bass
1959	112 Ad. 2,500 Fgl.	5 Ad. 190,000 Fry	
1961	3,020 Ad.	79 Ad.	7 Ad.
1962	1,796 Hammerhandle 382 Fgl.		
1963	52 Ad.	800,000 Fry	
1964		5,000 Fgl.	
1966	62 Ad.		7,500 Fgl.
1967	590 Ad. 4,940 Fgl.		
1968	5,597 Fgl.		
1969	540 Ad. 9,266 Fgl.	15,000 Fgl.	
1970	2,500 Fgl.	24,000 Fgl.	6,000 Fgl.
1971	1,300 Fgl.		
1972		190,000 Fry	
1973		925 Fgl.	
1974	89 Ad. 580,300 Fry	50 Ad. 350,000 Fry	
1975	2,160 Fgl. 400,000 Fry	350,000 Fry	
1976	77 Ad.	66 Ad.	
1977	1,630 Fgl.		

is replenishing the populations of most fish present in the lake. Carp, bullhead and white suckers are found in Lake Cochrane, but present no particular problems at this time.

Several public meetings and hearings were conducted by the Department in 1965 to explore the possibilities of eradication of stunted panfish populations in the lake. These meetings were sometimes controversial and invoked spirited discussions, but a decision was finally reached that would allow the Fisheries Division to proceed with eradication of the perch-bluegill fishery. However, before field work began, strong opposition to the eradication program developed, and the plan was abandoned. A compromise program was substituted whereby stocking of predator fish (walleye, northern pike and black bass) would control the stunted panfish. Emphasis was put on stocking adult and fingerling northern pike, with complete protection from fishing provided for the northerns. This program was in effect from 1966 to 1971, at which time it did not appear that the panfish populations were being affected to an extent to justify costs of stockings, and protection for the northerns. Average weight and size of the perch increased only slightly during the experimental period, and this was the main reason for dropping the experiment. Also, complete protection for the northern pike from fishing pressure was becoming more difficult, due to increased public apathy for the project. When the lake was opened to fishing of northerns on January 1, 1972, the Deuel County Izaak Walton Club held a fishing contest on the opening date that was quite successful. More than 600 fishermen were estimated on the lake at this time, and many game fish, chiefly northern pike, were taken. Fishing for northerns was excellent for about 60 days, with many fish in the 10-12 pound range taken, including one that weighed 22 pounds.

Increased development of cottage sites around the lake, particularly during the 1960's, brought about the formation of Lake Cochrane Improvement Association in 1965. This active organization has been helpful and instrumental in bringing about a number of beneficial programs effecting the lake. Several years of above-normal precipitation and very high water levels resulted in extensive bank erosion and pollution of the lake in 1972. The Lake Cochrane Association requested that the Department of Game, Fish and Parks install a water control structure on the natural outlet site on the east side of the lake. Partial payment was made by the Lake Cochrane Association. Water level in the lake was pulled down approximately 20 inches; the permanent water level for the lake has been set at 95.8. Below normal annual precipitation since the installation of the water control structure has kept water levels very low in the lake, and there has been no flow out of the lake as of March 1980. A Minnesota landowner whose land was flooded to a limited extent during the 1972 drawdown operation sued the Department for damages, and after a court trial in 1976, was awarded damages of $1500.

A heavy growth of submerged aquatic plants has been more or less of a problem on Lake Cochrane since at least 1949 (GF&P report by Robert Gibbs), particularly in the shallower west end of the lake. Silting problems above-mentioned probably accelerated growth of these aquatics during the past three years of low water levels in the lake, being a hinderance to water skiers and boaters. During recent years beaver have established

themselves along the lakeshore in several locations, doing some damage to trees; it is expected that these animals will leave the lake for more suitable habitat when water levels stabilize.

Public hearings or meetings affecting Lake Cochrane have been held in conjunction with the following developments or actions: public access perimeter road on NE end of lake in 1957; attempts to eradicate stunted fish in 1964 and 1965; opening of lake to northern pike fishing in 1972; establishment of water control structure in 1973; extension of road around west end of lake, with development of rearing ponds and new park and boat ramp area in 1976. All actions taken have been in agreement with the Lake Cochrane Improvement Association. Enactment of a Deuel County Zoning Ordinance in 1972 has helped in the control of siltation, pollution, littering and other problems occurring at Lake Cochrane.

The lake is used by migratory water birds both spring and fall. There is some waterfowl hunting done in late fall, primarily on diving ducks, but the lake is not a good waterfowl hunting area due to lack of shore vegetation and topography of the lake. The wooded areas around the lake provide good cover for a variety of migratory breeding land birds. Heavy development of the lakeshore has limited use of the lake by most mammals and game birds, but deer, partridge and pheasant are sometimes seen.

Test netting has been carried out at Lake Cochrane during the following years: 1959, 1962, 1968, 1971, 1973 and 1974. Table 2 shows average catch and average size for various species (per frame net) for the period 1968-1976. This shows that the average size per fish for the stunted perch population remained constant until 1973; the average length per fish increased from 6.15 inches to 7.4 inches in 1976. Percent of total catch is difficult to evaluate, because small perch are not easily caught in frame sets. Stunted bluegill-sunfish combined shows that the percent of these species in the total catch (frame nets) declined considerably from 1973 to 1976. Black bass are seldom taken in frame nets, but shoreline seining in 1971 and 1976 indicated that bass populations are maintaining themselves quite well, a conclusion also verified by fishermen success on this species during the period. Walleye pike are not taken in frame nets consistently and trends are rather difficult to follow, but fair numbers of young-of-year walleye were taken in trawling seines in July and September 1976 during survey work on a project designed to evaluate walleye fry stocking in lakes with existing walleye populations (Federal Aid Project 1514). This study, including 5 other lakes in the northeast, will continue for a ten year period. Plans are for Lake Cochrane to receive very heavy stocking of walleye fry on a three-year schedule, in order to compare production from these plantings with production from existing populations of walleye in other lakes that will receive no hatchery fish. Average size of northern pike appears to remain stable. As mentioned previously, it is assumed that there is little if any spawning of northerns in Lake Cochrane, since shoreline development has eliminated most of the limited spawning habitat that was available for this species. Crappie populations appear to maintain themselves; average size of crappies taken in frame nets has increased slightly from 1971 to 1976. Average catch per net has fluctuated over the years, being particularly high in 1971 and 1973 test netting (this is typical for the species, where natural production is concerned).

Table 2. Average size and average catch per frame net on Lake Cochrane, Deuel County.

Species	Average Size (Inches)					Average Catch (% of Total)				
	1968	1969	1971	1973	1976	1968	1969	1971	1973	1976
Perch	6.5	6.95	-	6.15	7.4	2.91	8.78	-	7.6	16.2
Bluegill	6.05	6.35	3.6	4.76	-	85.43	36.36	51.03	25.4	-
Sunfish	5.37	-	4.6	5.13	-	1.57	47.77	14.0	20.7	-
Combined	5.7		4.2	4.94	5.4	87.00	84.13	65.03	46.1	57.0
Walleye	14.63	22.5	16.6	14.93	11.4	1.34	0.31	0.82	0.3	0.3
N. Pike	26.19	25.0	24.8	26.0	27.95	7.17	3.24	15.23	0.3	0.4
Bass	-	-	-	-	-	-	-	-	-	-
Crappie	9.65	8.0	7.4	7.68	8.0	0.45	0.15	18.93	39.1	11.5
Bullhead	11.5	12.3	-	10.7	-	1.12	2.0	-	0.2	1.0
Sucker	-	22.55	-	-	-	-	1.39	-	-	0.2

Management

Lake Cochrane has been a popular fishing area for many years. The experienced fishermen go to Cochrane for quality walleye and black bass fishing; the general public get more out of the crappie, and northern pike fisheries. The stunted panfish species provide consistent fishing for the youngsters, and this population has also been utilized by the Department in re-stocking winterkilled lakes. Emphasis should be put on maintaining the lake for walleye-northern pike and panfish, with regular stocking of black bass whenever possible. Every effort should be made to reduce the stunted panfish populations, thus increasing the average size and quality of the fish available for the public. Test netting should be continued as in the past, and regular shoreline seining, or other methods, should be utilized to evaluate and monitor bass-crappie populations, about which comparatively little is known. Practically nothing is known about angler success, other than casual observations made by the Conservation Officer. If money is available creel censuses would be a valuable aid to management of the fisheries. The walleye research study will not permit introduction of walleye fingerlings into the lake during the study period, but fingerling northerns and possibly bass can be raised in the rearing ponds.

Demand, as expressed by Martin (Documenting Needs for Fish and Wildlife) is defined as the opportunity goal (set by South Dakota at 6.5 user days/year) multiplied by the census data within the adjacent 40 miles surrounding the lake. The population within a 40-mile radius of Lake Cochrane is 98,220 people (about half live in Minnesota). The demand expressed at 6.5 times 98,220 is a projected 648,430 user-days. The supply provided by a lake of 366 acres times 41.5 (an average figure for user days applied for South Dakota), and an adjusted latitude of .75 (from Martin's formula) gives us 11,391 user-days with a minimum of two pounds of fish harvested per user day, the lake has a projected harvest of 22,782 pounds of fish annually, or 62 pounds of fish per surface acre.

IMMEDIATE PLAN OF MANAGEMENT AND RECOMMENDATIONS

1. Continue Walleye Study begun in 1976, with more information obtained on size and population of adult fish in the lake.

2. Reduce stunted panfish by use of these fish to restock winterkilled lakes, and by continued stocking of predator species.

3. Make full use of the two rearing ponds to produce fingerling fish.

4. Continue close watch of pollution sources around the lake and on the watershed.

FUTURE MANAGEMENT

1. Continue test netting, with emphasis on gaining more information on bass and crappie fisheries.

2. Work closely with Parks Division to ensure safe distribution of boating and camping activity on newly developed areas.

3. Encourage SCS and landowners to implement good agricultural cropping practices to cut down soil erosion on the watershed and drainages entering the lake.

4. Dredging of siltation deposits in W & SW if possible.

5. Establishment of a waste collection system.

REFERENCES

1. Deuel County Agriculture, 1967. South Dakota Crop and Livestock Reporting Service.

2. Lake Cochrane file - Official Records of South Dakota Department of Game, Fish and Parks (Webster Office).

3. Martin, Dale N. - Documenting Needs for Fish and Wildlife Expenditures. 1970.

4. Official Records from Clear Lake Office of Soil Conservation Service, Department of Agriculture.

5. State Lake Preservation Committee, July 1977. A Plan for the Classification Preservation-Restoration of Lakes in Northeastern South Dakota.

BULLHEAD LAKE

Deuel County

by

Bruce Harris

ORIGIN

Bullhead Lake is a natural, medium size lake classified semi-permanent, warmwater. It is one of three lakes in the immediate vicinity, (Round, School and Bullhead) and many maps refer to it as Two Woods Lake or Twin Lake. The Sioux Indians called the lake Chanonpa, which means Two Woods, and used the area as a summer campground long before the white man came to Deuel County.

Bullhead Lake is located five miles north and two miles east of the town of Goodwin, Rome Township (Figure 1). Its boundaries are included in Sections 10, 11, 14 and 15, Township 17, Range 50. It is a meandered lake with no major inlet or outlet. Water levels are maintained from a relatively small watershed totaling 1,900 acres, and by several springs that feed into the lake, primarily on the lake bottom. There appears to be underground flow between School Lake and Bullhead Lake, but this has not been verified. During periods of very high water levels Bullhead Lake flows into Round Lake, and then Willow Creek into the Big Sioux drainage system. Good access to the lake is provided on the northwest and northeast corners. Included in the lake's meandered zone on the south end is a slough that is about 100 acres in size. This slough is a major source of pollution into the lake during high water periods (see comments below). The Department of Game, Fish and Parks owns most of the west side of the lake, and about one-half mile of lakeshore on the east side.

PHYSICAL

Bullhead Lake has a surface area of 465 acres, with a maximum depth of 12 feet and an average depth of 6 feet. Length of the shoreline is about three miles, and the greatest length of the lake is one mile (Figure 2). The 1973 lake survey indicates that 70% of the shoal water soils are sand, and 30% are rubble. Only 1% of the shoreline is covered with emergent vegetation (Round Stem Bullrush) but there is a large amount of submergent vegetation growing in the lake (Potamogeton sp.) which is a problem for fishermen.

The small watershed area (Figure 1) consists of 40% pasture and haylands, 37% croplands (primarily grain crops), 3% woodlands (ash, oak, boxelder and elm), and 1% feedlot. Eighty percent of the watershed is privately owned. The immediate shoreline is approximately 75% pasture-hayland, and 25% woodland. About 50% is private land (Figure 2). The entire shoreline is made up of fine

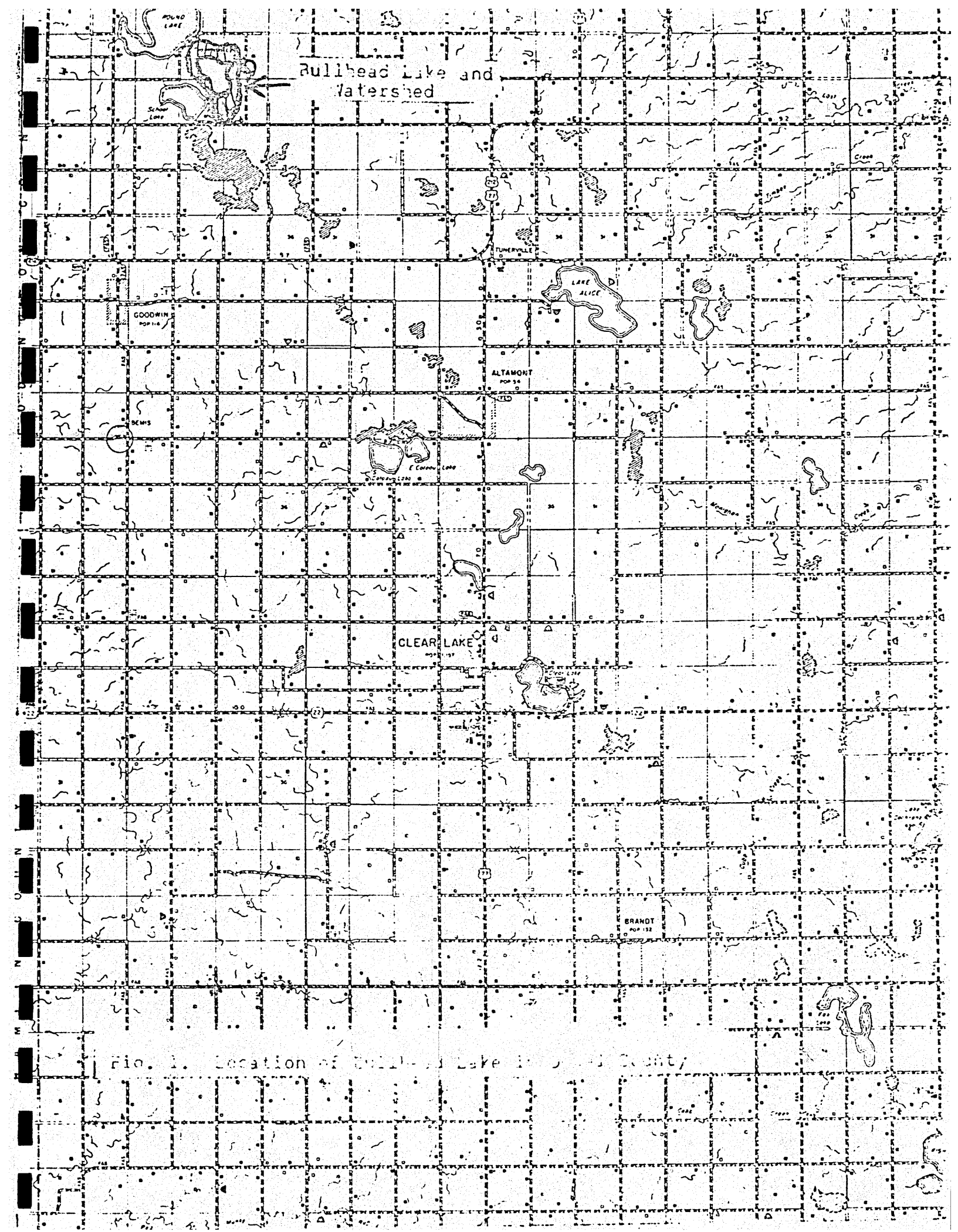


Fig. 1. Location of Bullhead Lake in [illegible] County

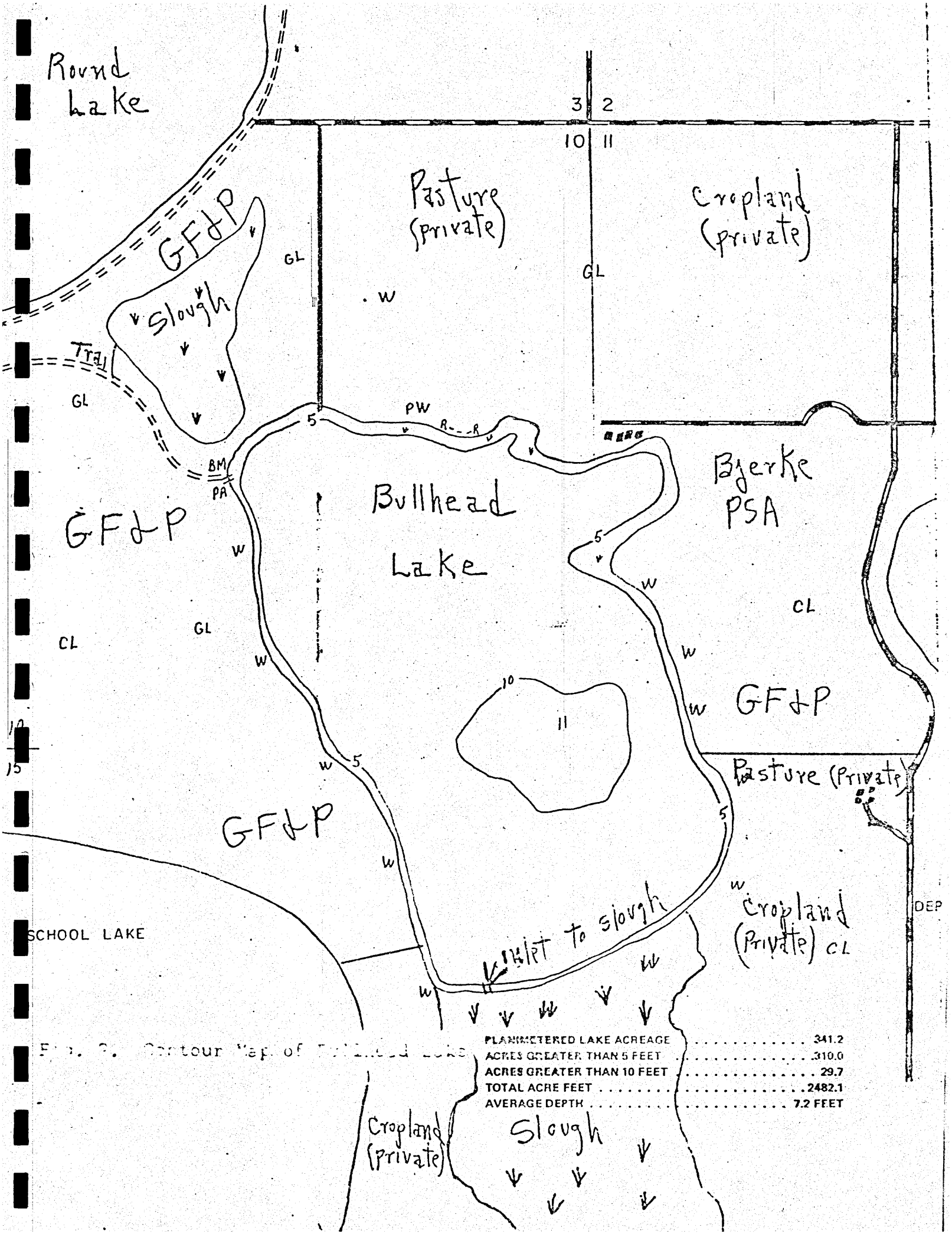


Fig. 2. Contour Map of Bullhead Lake

sand, and course, rocky gravel. The surrounding uplands are undulating to hilly, pockmarked with ten small sloughs and marshy wetlands. Soils around Bullhead Lake are characteristically droughty, moderately sandy to medium textured, underlain with gravel and course sand to a depth of 15 inches. These soils are of marginal value for croplands, unless carefully tilled. "Bullhead Lake rests in the lower reaches of the Antelope Valley outwash deposit and is a closed lake. However, it is positioned atop an area of steep eastward topographic decline. Underground seepage to the east apparently keeps the lake well flushed. Both the contributing and the immediate watersheds are small, and recharge is primarily from groundwater. The moderate TSE may be attributed to nutrient release from the bottom deposits. This lake has natural retention basins on all sides and an immediate watershed of minute proportion. Direct purchase of the remainder of this watershed (a substantial propotion is currently owned by Game, Fish and Parks) would preserve this lake for generations to come. The local funding base is probably not sufficient to support dredging." (A Plan for the Classification-Preservation-Restoration of lakes in Northeastern South Dakota, pps. 102-103. State Lake Preservation Committee 1977).

The report of the State Lakes Preservation Committee ranks Bullhead Lake in Group 2 among 200 lakes classified in northeast South Dakota. This grouping of 30 lakes is based, in part, on Trophic State Indexes and Typology ratings worked up for each lake, and includes lakes Alice, Clear, Round and School in Deuel County. Bullhead Lake is, overall, a much cleaner lake than any of the other Deuel County lakes listed in Group 2, and it can be assumed that it is one of the better lakes among all listed in that category.

The Trophic State Index assigned to Bullhead Lake was 63. The TSI values, ranging from 0-100, provide an index of potential nuisance algal bloom conditions. Higher values indicate greater potential for nuisance algal blooms (op. cit., p. 66). Lakes Cochrane and Alice (Deuel County) recieved TSI ratings of 56, reflecting better rantings in this regard; other Deuel County lakes were not given TSI ratings.

Lake Typology ratings, as used by the Lakes Preservation Committee, (op. cit., pps. 66-70) is based on the following:

Total Dissolved Solids (TDS)	- 1200 (5000 mg/liter is high; 10,000 is excessive for fish production).
Trophic State Index (TSI)	- 63 (based on scale of 1 to 100).
Aquifer Connection	- E (has extensive ground water recharge).
Wc/L	- 2.49 (the ratio of Contributing Watershed to lake area).
Soil Drainage	- E (Excellent).
Slope	- 4.2 percent (on Immediate Watershed).
Land Use	- 15 (15 percent of land in Immediate Watershed is under cultivation).

These ratings are above average for lakes in the Group 2 category, and verify the classification of Bullhead Lake as one of the better lakes in the northeast area of the state.

As mentioned above, water quality of the lake is possibly influenced by nutrient releases from bottom deposits. There is direct flow of nutrients into the lake from pastured cattle on the north and southeast ends of the lake that is probably not excessive. At the present time the most detrimental source of pollution to the lake is the 100 acre slough on the south end which, during periods of high water levels, allows heavily polluted waters to enter the lake, and provides a fertile spawning area for rough fish that move from the lake into the slough. When water levels drop, the rough fish re-enter Bullhead Lake, causing extra nutrient loads in the lake, and adding to further stress to oxygen contents in the lake during the winter months. This situation last occurred during the spring of 1972, resulting in very heavy growth of emergent water plants during the summer of 1972. This heavy aquatic growth is a handicap to fishermen as well. Although not documented, the slough waters probably came into the lake also in the spring of 1969, following runoff of record snowfalls during the winter of 1968-69. The slough waters are heavily polluted because the adjacent landowner (Larson Bros.) using the slough and nearby uplands (all within the meander line) grazes the area with dairy cattle and uses the west side of the slough as a winter feeding lot for his cattle. The landowner was not receptive to suggestions that the waters of the slough be shut off from the lake during the spring of 1972, although he agreed to cooperate in allowing a fish screen to be placed at the outlet of the lake. This would not have prevented the infiltration of heavy sediment loads from the slough to the lake, which is the most serious problem presented by this situation. Efforts by the local Conservation Officer to alleviate this situation in the spring of 1972 was unsuccessful.

Water quality analysis in 1973 and 1974 indicates that Bullhead Lake is very fertile (Table 1). It should be noted that these analysis were taken following the influx of heavy nutrient loads into the lake as detailed above. Current water quality analysis is much needed.

Table 1. Water quality analysis for Bullhead Lake, Deuel County*.

Date	NA	K	MG	CA	SO_4	Cl	Alkal. Cond.	Cond. umhos	TDS	p total	p ortho	No3-N No2-N	NH3-N	Nk-N
6/21/73					540	8.3				<.01	<.01	.04	0	1.63
10/12/73					614	11				.03	.01	.02	0	1.31
1/15/74					704	14.5				.05	0	.05	0	1.87
5/21/74					614	12				.06	.01	.19	0	1.08
5/21/74	25	24	150	53	510	11	311	1370	940	.15	-	.06	-	-
7/30/75					630	12				.09	.01	.04	.21	2.8
11/14/75					900	10				.18	.06	.04	0	1.87
2/24/76					980	10				.04	<.01	.02	0	2.89
8/6/76								1333	1443					

*Classification-Preservation-Restoration of Lakes in Northeastern South Dakota (p.202)

Winter oxygen tests for Bullhead Lake have been safe but marginal (3.5-4.0 ppm) except for February 1972 and January 1977 when readings were 0.5 and 2.0 ppm, respectively. Nevertheless, noticeable winterkill did not occur in the spring of 1972. The only severe winterkill that has been documented in Bullhead Lake came during the winter of 1976-77, when many lakes throughout the northeast suffered heavy fish losses as a result of low water levels brought on by the preceding three-year drought. Statements in various Bullhead Lake reports showing partial winterkill in 1968-69, 1969-70, and 1971-72 are unconfirmed, and were apparently based on the assumption that low oxygen readings will bring about partial winterkill. Field checks by the Deuel County Conservation Officer did not indicate winterkill in 1971-72. In fact, fishing for walleye pike was very good during the summers of 1969 and 1970. A reported winterkill in 1955-56 is also questionable; no local fishermen can recall any winterkills in Bullhead Lake during this period, although it is possible that the lake may have suffered partial kills from time to time. As Bullhead Lake apparently receives most of its recharge from groundwater, these underground sources probably provide adequate oxygen to bring fish through all but the most unusual and severe circumstances, such as occurred during 1976-77.

RECREATIONAL ASPECTS

Bullhead Lake is primarily utilized as a fishing lake by the public, but during the past five years six cottages have been developed in the northeast corner of the lake. There is good public access to the lake from the northwest and on the east side where the Department owns large areas of land. A boat ramp and toilets are provided by the Department on the northwest access area. One would expect that the excellent sandy beaches would attract many picnickers, but most of this activity is carried on at nearby Round Lake, where picnic tables are available in addition to a boat ramp and toilets. Boating, hunting and trapping activities are light at Bullhead Lake.

Fishing for walleye and perch has been fair to excellent over the years, both summer and winter. It is interesting to note that two of the better summer seasons for walleye fishing occurred during 1969 and 1970, following the severe winter of 1968-69, when many lakes in the northeast suffered heavy winterkill. Waterfowl use the lake to some extent as a resting area, both spring and fall, but Round and School lakes are more heavily utilized by ducks and geese at all seasons.

PAST MANAGEMENT

There are no stocking records available prior to 1961, when 7,000 adult perch were placed in Bullhead Lake. Northern pike were heavily stocked in 1962, but since that date all stocking has been directed towards management of the lake as a walleye-perch fishery, for which it is most suited. (Table 2.) Bullheads have been found in the lake, at least since 1971, presumably introduced by misguided or careless fishermen, but they have not created any problems as of date. Carp, buffalo and sucker populations were found in the lake in large numbers during moderately successful commercial fishing operations in December 1976 (30,000 pounds removed). The rough fish probably entered the lake from Round Lake during high water levels recorded in the spring of 1968, 1969 and

Table 2. Fish stocking record for Bullhead Lake.

Date	Species	Size	Number
1961	Perch	Adult	7,000
1962	Northern Pike	Fry	250,000
1962	Northern Pike	Hammerhandle	486
1962	Perch	Adult	500
1964	Perch	Fingerling	1,905
1964	Walleye	Fingerling	31,430
1969	Walleye	Fry	150,000
1971	Walleye	Fingerling	25,000
1972	Walleye	Fry	300,000
1973	Perch	Fingerling & Adult	5,000
1976	Perch	Adult	200
1977	Perch	Adult	180
1978	Perch	Adult	700
1978	Walleye	Fingerling	300,000
1978	Crappie	Adult	90
1979	Perch	Adult	700
1979	Walleye	Fingerling	300,000

again in 1972. These rough fish populations have no adequate spawning habitat in Bullhead Lake, but if they are able to move into the slough on the south side of the lake they will have excellent spawning grounds. Commercial operations in 1976 were handicapped by a number of submerged trees and stumps in the lake. Bullhead Lake has regularly provided some of the better fishing in Deuel County, except during the past 3-year drought period.

MANAGEMENT

Bullhead Lake suffered severe loss of fish during the winter of 1976-77. Some fish did survive, and 180 adult perch were stocked in the lake during June 1977. (Table 3.) Stocking should be restricted to walleye and perch, as in the past. It is essential that every effort be made to prevent rough fish movement to Bullhead during the spring runoff. All efforts should be made to prevent heavily polluted waters in the slough on the south end of Bullhead from flowing into the lake. This can be done by building up the bank of the lake near the overflow area into the slough. As the entire slough is meandered land, there should be no problem in working out an arrangment for access to the lakeshore with the adjacent farmer. Test netting has been conducted regularly at Bullhead Lake to check fish growth and reproduction. (Table 3 and 5.)

Demand, as expressed by Martin Documenting Needs for Fish and Wildlife) is defined as the opportunity goal (set by South Dakota at 6.5 user days per year) multiplied by the census data within the adjacent 40 miles surrounding the lake. The population within a 40 mile radius of Bullhead Lake is 77,700 people. The demand, expressed at 6.5 times 77,700 is a projected 505,050 user days. The supply provided by a lake of 465 acres time 41.5 (an average figure for user days applied for South Dakota lakes) and an adjusted latitude of .75 (from Martin's formula) gives us 14,473 user days, and a deficient of 63,227 user days annually. On the basis of 14,473 user days with a minimum of two pounds of fish harvested per user day, the lake has a projected harvest of 28,946 pounds of fish annually, or 62 pounds of fish per surface acre.

RECOMMENDATIONS

1. A fish screen, or complete blocking of the channel from Bullhead Lake to Round Lake should be effected.

2. Any flow of water from the slough on the south end of Bullhead Lake should be stopped with effective rebuilding of the shore of the lake at that location.

3. Stocking of perch and walleye will be necessary to return the lake to its former productivity.

4. Regular test netting should be conducted to study growth rates and productivity of the fishery.

Lake Bullhead
County(ies) Deuel
Date 7/19/78
Collectors Cavanaugh, Barber

Table 3. Test Netting Results for Bullhead Lake.

Seine Measurements: Length 40 feet, Depth 6 feet,
Mesh size 1/4 inch square.

	Station Number in ( )		Show number of seine hauls made at each station				Totals
	1 (1)	2 (2)	3 ( )	4 ( )	5 ( )	6 ( )	
Total linear distance covered-feet	400 Ft.	700 Ft.					1100 Linear Feet
Greatest water depth - feet	4 Ft.	4 Ft.					44,000 Sq. Ft.
Bottom Soil Type Amount of Vegetation ++	Sand, Mud Light						1.0 Acre(s)
Water Temperature-°F.	76°						
Wind Intensity & Direction +	West Strong						C/A=Catch/Acre Seined
Time of Day & Date	10:30A	10:45A					
Location on Lake	NW side	N side					

SIZE AND NUMBERS / C/A / TOTALS

Species ***	YY**	O*	YY	O	YY	O	YY	O	YY	O	YY	O	YY	O	All
Perch	24		25		50						99		99		99
Walleye	1		1		2						4		4		4
Bluegill	2										2		2		2
Fathead Minnows		4		2		6						12		12	

++ Heavy, Moderate, Light, None, etc. + Strong, Moderate, Light, Calm.

*** Group separately minnows and darters without identifying them, unless readily identifiable in field. Preserve sample for later identification in laboratory.

** YY - Young-of-year or fingerlings.

* Others, includes yearlings and adults, minnows and darters. Take scale samples from sizes of fish, especially game fish, not taken in test nets.

Table 4. Size and Age of Fish in Bullhead Lake, 1975 Test Netting.

Walleye Pike			Northern Pike			Yellow Perch		
Length	Weight	Age	Length	Weight	Age	Length	Weight	Age
9.6	0.28	1+	15.8	0.82	2+	6.0	0.14	3+
9.8	0.34	1+				6.4	0.12	3+
10.2	0.34	1+				6.4	0.14	2+
10.4	0.36	1+				6.6	0.12	2+
10.5	0.32	1+				7.8	0.18	3+
10.6	0.38	1+						
12.4	0.64	1+						
12,7	0.64	2+						
13.0	0.70	2+						
13.1	0.74	2+						
13.2	0.78	2+						
13.6	0.94	2+						
14.5	0.98	3+						
21.0	3.2	3+						
21.9	3.38	3+						
22.2	3.37	4+						
24.0	3.08	5+						
25.2	5.50	5+						

Table 5. Fish age-class distribution in Bullhead Lake, 1975 test netting.

Species	Sample Size	Subsample Size	No. Fish in Age Group				
			I	II	III	IV	V
Walleyed Pike	127	18	6	7	2	1	2
Northern Pike*	2	1		1			
Yellow Perch	294	5		2	3		

*Northern Pike probably planted by sportsmen; no Department releases since 1962.

REFERENCES

Bullhead Lake file - Official records of South Dakota Department of Game, Fish and Parks (Webster Office).

Martin, Dale. Documenting Needs for Fish and Wildlife.

Official records from Clear Lake office of Soil Conservation Service, Department of Agriculture.

State Lakes Preservation Committee. A Plan for the Classification, Preservation, and Restoration of Lakes in Northeastern South Dakota. July 1977.

SECTION 3

SOIL SURVEY

An important part of determining the possible effects of individual septic systems on a lake such as Cochrane or Bullhead, is to examine the soil types surrounding the lake with regards to it's suitability for accepting and treating wastewater. The following document contains information about the soil types and characteristics, not only around Lake Cochrane and Bullhead Lake, but for all of Deuel County. The entire document was included because of the valuable information and insight it will provide for all the residents of Deuel County along with the information required to effectively plan waste disposal needs for lakeshore property.

The Soil Conservation Service conducted a comprehensive survey around Lake Cochrane so that a more detailed survey could be included in this report than is available in the Soil Interpretations Document. The soil survey findings were that approximately 95% of the land immediately adjacent to Lake Cochrane were of the Forman-Aastad-Buse association with one area on the East end of the lake, the Sugar Sand Beach area, composed entirely of fine sand with a thin covering of soil. The Forman-Aastad-Buse Soil, a soil that is similar to the Forman-Aastad-Parnell Soil Series which is the predominant soil type in the Lake Cochrane area, contains a large amount of clay which results in a soil which is poorly suited to conventional septic system drain fields. The reason for this is that the clay restricts the passage of water through the soil, (low percolation rates), therefore the drain fields must be considerably oversized to compensate for the slow dispersal of water from the system. Details of the Minimum and Maximum recommended and allowable percolation rates are given in the tables in the Soil Interpretations Document and the Private Sewage Disposal System regulations.

Bullhead Lake is surrounded entirely by Renshaw-Fordville soils. This soil type is the complete opposite of the soils surrounding Lake Cochrane, and is equally unsuited for wastewater disposal systems but for different reasons. Composed of sand and gravel with a thin layer of top soil, Renshaw-Fordville has such a high (rapid) percolation rate, that contamination of the shallow aquifer from septic drain fields can easily occur. For lakeside development this could also lead to sewage passing from the drain field almost directly into Bullhead Lake without receiving adequate treatment by the soil. The dangers in allowing the nutrients contained in the relatively untreated wastes to reach the lake is outlined in Section 1, Bullhead Lake Sanitary Survey.

Due to the soil types, which are incompatible with septic system drain fields surrounding both Lake Cochrane and Bullhead Lake, the Planning Commission policy of requiring holding tanks should be continued and in fact, is the only acceptable method of disposal for current and future residents of these two lakes.

S O I L I N T E R P R E T A T I O N S

For Broad Planning Purposes
Based on General Soil Map

MODEL RURAL DEVELOPMENT PROGRAM
DISTRICT I

DEUEL COUNTY, SOUTH DAKOTA

Prepared by

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE
Huron, South Dakota

March 1973

TABLE OF CONTENTS

LIMITATIONS

The information contained herein is the best available estimate of the specific soil properties. The user is cautioned that for on-site construction, more complete data should be obtained through on-site detailed investigations.

HOW TO USE THIS REPORT

The soils of Deuel County are shown on a general soil map in this report. It is a small scale map on which the soil boundaries have been drawn.

This map can be used to locate broad tracts of land of interest to the user. After locating the tract of land of interest, the soils symbols which identify the general soil associations on the tract are noted and used to locate information about the kinds of soil and the suitability of the land for different uses. Use the soil association symbol, and Table 1, page 6. This table lists the soil association symbols, name of the soil association, percent composition of the major soils in each soil association, and ratings of each of these major soils for selected land uses.

Following Table 1 are explanations of the columns and interpretations of this table. Guide sheets showing criteria used in rating soils for specific uses are included on pages 11 through 17.

A glossary of terms is included starting on page 18.

GENERAL SOIL MAP

The general soil map included with this report shows the soil associations in Deuel County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the

GENERAL SOIL MAP LEGEND

DEUEL COUNTY, SOUTH DAKOTA

SOIL ASSOCIATION

Well-drained through very poorly drained soils formed in glacial till and alluvium; on uplands and in depressions.

BY - Buse Association: Well-drained, undulating to hilly, loamy soils.

FU-AA-BY - Forman-Aastad-Buse Association: Well-drained and moderately well drained, gently undulating to hilly, loamy soils formed in loamy glacial till.

FU-AA-PA - Forman-Aastad-Parnell Association: Well-drained and moderately well drained loamy soils formed in loamy glacial till; and very poorly drained silty and clayey soils in depressions.

FU-BY - Forman-Buse Association: Well-drained, undulating to hilly, loamy soils formed in loamy glacial till.

PF - Peever Association: Well-drained, nearly level to strongly sloping, loamy soils formed in clayey glacial till.

Well-drained to moderately well drained soils formed in loess and glacial till; on uplands.

KN-BW-VS - Kranzburg-Brookings-Vienna Association: Well-drained and moderately well drained, nearly level to gently undulating, silty soils formed in loess over glacial till.

SJ-NL - Singsaas-Oak Lake Association: Well-drained and moderately well drained, nearly level to gently undulating silty and loamy soils.

VS-LP - Vienna-Lismore Association: Well-drained and moderately well drained, nearly level to undulating, silty soils.

Poorly drained soils formed in alluvium; on bottomlands.

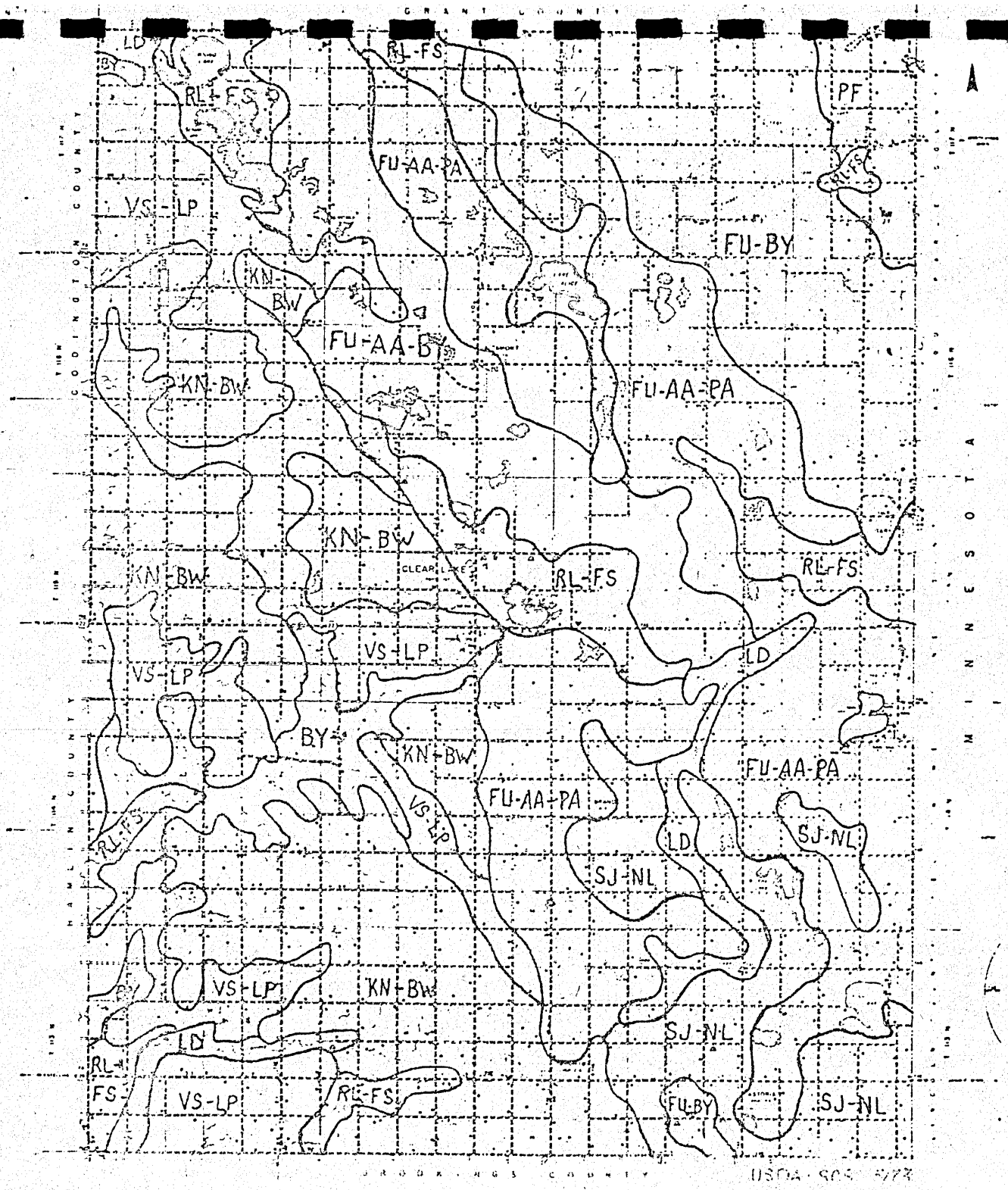
LD - Lamoure Association: Poorly drained, nearly level, silty soils.

Somewhat excessively drained and well drained soils formed in outwash sediments; on terraces and outwash plains.

RL-FS - Renshaw-Fordville Association: Somewhat excessively drained and well drained, nearly level to moderately steep, loamy soils that are shallow and moderately deep over outwash sand and gravel.

U.S. Department of Agriculture
Soil Conservation Service
March 1973

[redacted]
GENERAL SOIL MAP



major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soils associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the locations of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning and management of a firm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management. The terms of texture used in the title of the associations apply to the texture of the surface layer.

SOIL INTERPRETATIONS

TABLE 1, "Interpretations of Engineering Properties of Soils" is an index to suitability of soils for selected land uses. Suitability is indicated in degrees of hazards or limitations - Slight, Moderate, or Severe - and one or more of the limiting soil characteristics or qualities are cited. A severe limitation does not mean that the soil is excluded from a specific land use. Soils having severe limitations require more inputs to overcome limitations for some land uses.

In selecting a site for a particular use, the soil limitation rating given a named kind of soil, while important, is only one of the criteria a user considers. Location, land values, aesthetic values, etc. are examples of other criteria. In some circumstances soil limitations can be modified or removed so that the soil can be used safely for the intended use. For this reason some kinds of soil rated as severe can be used for the intended use. This is especially important where good sites are scarce.

EXPLANATION OF TABLE 1

Interpretations of Engineering Properties

Table 1 contains selected information useful to those who plan to use soil material in construction of local roads and streets, foundations, excavations, sanitary land fills, sewage lagoons, and sewage disposal systems. Detrimental or undesirable features are emphasized. The ratings and other interpretations in this table are based on estimated engineering properties of the soils, on available test data, and on field experience. The information is reasonably reliable to depths of about 5 feet. The following defines the items for which interpretations have been expressed. Items are identified by the column numbers of Table 1.

Model Rural Development Planning District No. 1

Interpretations of engineering properties of soils 1/

Deuel County, South Dakota

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

12/72

Table 1 - 1

Soil association and percent composition of major soils (Col. 1)	Degree and kind of limitation for — Septic tank absorption fields (Col. 2)	Sewage lagoons (Col. 3)	Shallow excavations (Col. 4)	Dwellings with basements (Col. 5)	Sanitary land fill (trench type) (Col. 6)	Sanitary land fill (area type) (Col. 7)	Local roads and streets (Col. 8)
BY	Slight - 5%	Slight - 5%	Slight - 15%	Slight - 10%	Slight - 10%	Slight - 20%	Slight - 10%
Buse association	Moderate - 10%	Moderate - 20%	Moderate - 35%	Moderate - 40%	Moderate - 40%	Moderate - 30%	Moderate - 50%
	Severe - 85%	Severe - 75%	Severe - 50%	Severe - 50%	Severe - 50%	Severe - 50%	Severe - 40%
Buse-55%	Severe;moderately slow permeability in substratum	Severe;slopes are more than 7 percent	Moderate if slopes are 8 to 15 percent;severe if slopes exceed 15 percent	Moderate;moderate shrink-swell potential;severe if slopes exceed 15 percent	Moderate if 15 to 25 percent slopes severe if slopes exceed 15 percent	Moderate if less than 15 percent slopes;severe if slopes exceed 15 percent	Moderate;moderate shrink-swell potential;Severe if slopes exceed 15 percent
Forman-25%	Severe;moderately slow permeability in substratum	Slight if less than 2 percent slopes;moderate if 2 to 7 percent slopes;severe if more than 7 percent slopes	Slight or moderate;loam and clay loam textures;moderate if 8 to 15 percent slopes	Moderate or severe;moderate or high shrink-swell potential	Moderate;loam and clay loam textures;severe if slopes exceed 25 percent	Slight if less than 8 percent slopes;moderate if 8 to 15 percent slopes,severe if slopes exceed 15 percent	Moderate or severe;moderate or high shrink-swell potential;severe if slopes exceed 15 percent
Aastad and other soils-20%							
FU-AA-BY	Slight - 5%	Slight - 20%	Slight - 20%	Slight -10%	Slight - 10%	Slight - 25%	Slight - 5%
Forman-Aastad-Buse association	Moderate - 10%	Moderate - 30%	Moderate - 55%	Moderate -50%	Moderate - 65%	Moderate - 45%	Moderate - 55%
	Severe - 85%	Severe - 50%	Severe - 25%	Severe -40%	Severe - 25%	Severe - 30%	Severe - 40%
Forman-46%	Severe;moderately slow permeability in substratum	Slight if less than 2 percent slopes;moderate if 2 to 7 percent slopes;severe if more than 7 percent slopes	Slight or moderate;loam and clay loam textures;moderate if 8 to 15 percent slopes	Moderate or severe;moderate or high shrink-swell potential	Moderate;loam and clay loam textures;severe if slopes exceed 25 percent	Slight if less than 8 percent slopes;moderate if 8 to 15 percent slopes,severe if slopes exceed 15 percent	Moderate or severe;moderate or high shrink-swell potential;severe if slopes exceed 15 percent
Aastad-22%	Severe;moderately slow permeability in substratum	Slight if slopes are less than 2 percent;moderate if slopes are 2 to 7 percent	Moderate;loam and clay loam textures	Moderate or severe;moderate or high shrink swell potential;subject to run-in water from adjacent slopes	Moderate;loam or clay loam textures;severe if not protected from run-in water from adjacent slopes	Severe;most areas subject to run-in water from adjacent slopes	Moderate or severe;moderate or high shrink-swel potential

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Table 1 - 2

Soil association and percent composition of major soils (Col. 1)	Degree and kind of limitation for — Septic tank absorption fields (Col. 2)	Sewage lagoons (Col. 3)	Shallow excavations (Col. 4)	Dwellings with basements (Col. 5)	Sanitary land fill (trench type) (Col. 6)	Sanitary land fill (area type) (Col. 7)	Local roads and streets (Col. 8)
Buse-45%	Severe;moderately slow permeability in substratum	Severe;slopes are more than 7 percent	Moderate if slopes are 8 to 15 percent;severe if slopes exceed 15 percent	Moderate;moderate shrink-swell potential;severe if slopes exceed 15 percent	Moderate if 15 to 25 percent slopes;severe if slopes exceed 15 percent	Moderate if less than 15 percent slopes;severe if slopes exceed 15 percent	Moderate;moderate shrink-swell potential; Severe if slopes exceed 15 percent
Parnell and other soils-18%							
FU-AA-PA Forman-Aastad-Parnell association	Slight - 5% Moderate - 10% Severe - 85%	Slight - 40% Moderate - 25% Severe - 35%	Slight - 20% Moderate - 60% Severe - 20%	Slight - 10% Moderate - 55% Severe - 35%	Slight - 10% Moderate - 70% Severe - 20%	Slight - 30% Moderate - 35% Severe - 35%	Slight - 5% Moderate - 55% Severe - 40%
Forman-45%	Severe;moderately slow permeability in substratum	Slight if less than 2 percent slopes;moderate if 2 to 7 percent slopes;severe if more than 7 percent slopes	Slight or moderate;loam and clay loam textures;moderate if 8 to 15 percent slopes	Moderate or severe;moderate or high shrink-swell potential	Moderate;loam and clay loam textures;severe if slopes exceed 25 percent	Slight if less than 8 percent slopes;moderate if 8 to 15 percent slopes,severe if slopes exceed 15 percent	Moderate or severe;moderate or high shrink-swell potential; severe if slopes exceed 15 percent
Aastad-20%	Severe;moderately slow permeability in substratum	Slight if slopes are less than 2 percent;moderate if slopes are 2 to 7 percent	Moderate;loam and clay loam textures	Moderate or severe;moderate or high shrink swell potential;subject to run-in water from adjacent slopes	Moderate;loam or clay loam textures;severe if not protected from run-in water from adjacent slopes	Severe;most areas subject to run-in water from adjacent slopes	Moderate or severe;moderate or high shrink-swell potential
Parnell-15%	Severe;ponded; slow permeability	Severe;subject to ponding;high water table	Severe;very poorly drained; subject to ponding	Severe;very poorly drained; high shrink-swell potential; subject to ponding	Severe;very poorly drained, subject to ponding	Severe;very poorly drained; subject to ponding	Severe;very poorly drained; high shrink-swell potential; high susceptibility to frost action
Buse and other soils-20%							

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Table 1 - 3

Soil association and percent composition of major soils (Col. 1)	Degree and kind of limitation for — Septic tank absorption fields (Col. 2)	Sewage lagoons (Col. 3)	Shallow excavations (Col. 4)	Dwellings with basements (Col. 5)	Sanitary land fill (trench type) (Col. 6)	Sanitary land fill (area type) (Col. 7)	Local roads and streets (Col. 8)
FU-BY Formon-Buse association	Slight - 5% Moderate - 10% Severe - 85%	Slight - 15% Moderate - 25% Severe - 60%	Slight - 20% Moderate - 50% Severe - 30%	Slight - 5% Moderate -50% Severe -45%	Slight - 10% Moderate - 60% Severe - 30%	Slight - 25% Moderate - 40% Severe - 35%	Slight - 5% Moderate -45% Severe -50%
Formon-42%	Severe;moderately slow permeability in substratum	Slight if less than 2 percent slopes;moderate if 2 to 7 percent slopes;severe if more than 7 percent slopes	Slight or moderate;loam and clay loam textures;moderate if 8 to 15 percent slopes	Moderate or severe;moderate or high shrink-swell potential	Moderate;loam and clay loam textures;severe if slopes exceed 25 percent	Slight if less than 8 percent slopes;moderate if 8 to 15 percent slopes,severe if slopes exceed 15 percent	Moderate or severe;moderate or high shrink-swell potential;severe if slopes exceed 15 percent
Buse-28%	Severe;moderately slow permeability in substratum	Severe;slopes are more than 7 percent	Moderate if slopes are 8 to 15 percent;severe if slopes exceed 15 percent	Moderate;moderate shrink-swell potential;severe if slopes exceed 15 percent	Moderate if 15 to 25 percent slopes severe if slopes exceed 15 percent	Moderate if less than 15 percent slopes;severe if slopes exceed 15 percent	Moderate;moderate shrink-swell potential;severe if slopes exceed 15 percent
Aastad and other soils-30%							
PF Peever association	Slight - 1% Moderate - 9% Severe - 90%	Slight - 50% Moderate - 35% Severe - 15%	Slight - 5% Moderate - 80% Severe - 15%	Slight - 5% Moderate - 15% Severe - 80%	Slight - 10% Moderate - 70% Severe - 20%	Slight - 85% Moderate - 5% Severe - 10%	Slight - 5% Moderate - 10% Severe - 85%
Peever-70%	Severe;moderately slow to slow permeability	Slight on nearly level areas;moderate on 2 to 7 percent slopes	Moderate or severe;clay loam and clay textures	Severe;high shrink-swell potential	Moderate or severe;clay loam and clay textures	Slight	Severe;high shrink-swell potential
Cavour and other soils-30%							
KN-BW-VS Kranzburg-Brookings-Vienna association	Slight - 10% Moderate - 10% Severe - 80%	Slight - 30% Moderate - 55% Severe - 15%	Slight - 20% Moderate - 65% Severe - 15%	Slight - 10% Moderate - 65% Severe - 25%	Slight - 15% Moderate - 55% Severe - 30%	Slight - 55% Moderate - 25% Severe - 20%	Slight - 10% Moderate - 15% Severe - 75%

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Table 1 - 4

Soil association and percent composition of major soils (Col. 1)	Degree and kind of limitation for — Septic tank absorption fields (Col. 2)	Sewage lagoons (Col. 3)	Shallow excavations (Col. 4)	Dwellings with basements (Col. 5)	Sanitary land fill (trench type) (Col. 6)	Sanitary land fill (area type) (Col. 7)	Local roads and streets (Col. 8)
Kranzburg-40%	Severe;moderately slow permeability in substratum (20 to 40 inches)	Slight if less than 2 percent slopes;moderate if 2 to 7 percent slopes;severe where slopes exceed 7 percent	Moderate;clay loam textures at 20 to 40 inches	Moderate or severe;moderate or high shrink-swell potential	Moderate;silty clay loam and clay loam textures	Slight if slopes are less than 8 percent;moderate if slopes are 8 to 15 percent	Severe;AASHO Group Index more than 8; plasticity index more than 15
Brookings-20%	Severe;moderately slow permeability in substratum;some areas subject to occasional flooding	Slight;moderately slow permeability in substratum;severe where flooding of dikes is a hazard	Moderate or severe;moderately well drained;severe in areas subject to occasional flooding	Moderate;moderate shrink-swell potential;severe in swales that receive run-in water	Severe in swales that receive run-in water;moderate on upland flats; silty clay loam textures	Severe in areas subject to occasional flooding; slight on upland flats	Moderate on upland flats;severe in areas subject to run-in water
Vienna-15%	Severe;moderately slow permeability in substratum	Slight if less than 2 percent slopes;moderate if 2 to 7 percent slopes;severe if slopes exceed 7 percent	Slight where slopes are less than 8 percent; moderate if slopes are 8 to 15 percent	Moderate;moderate shrink-swell potential	Slight or moderate;dominantly loam or clay loam textures	Slight if slopes are less than 8 percent	Severe;AASHO Group Index more than 8;plasticity index more than 15
Lismore and other soils-25%							
SJ-NL	Slight - 10%	Slight - 30%	Slight - 50%	Slight - 10%	Slight - 40%	Slight - 55%	Slight - 5%
Singsaas-Oak-Lake association	Moderate - 10%	Moderate - 55%	Moderate - 35%	Moderate - 75%	Moderate - 45%	Moderate - 30%	Moderate - 10%
	Severe - 80%	Severe - 15%	Severe - 15%	Severe - 15%	Severe - 15%	Severe - 15%	Severe - 85%
Singsaas-60%	Severe;moderately slow permeability in substratum	Slight if less than 2 percent slopes;moderate if 2 to 7 percent slopes;severe if slopes exceed 7 percent	Slight where slopes are less than 8 percent; moderate if slopes are 8 to 15 percent	Moderate;moderate shrink-swell potential	Slight or moderate;dominantly loam or clay loam textures	Slight is slopes are less than 8 percent	Severe;AASHO Group Index more than 8

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Table 1 - 5

Soil association and percent composition of major soils (Col. 1)	Degree and kind of limitation for — Septic tank absorption fields (Col. 2)	Sewage lagoons (Col. 3)	Shallow excavations (Col. 4)	Dwellings with basements (Col. 5)	Sanitary land fill (trench type) (Col. 6)	Sanitary land fill (area type) (Col. 7)	Local roads and streets (Col. 8)
Oak Lake-20% Parnell and other soils-20%	Severe; moderately slow permeability in substratum; some areas subject to run-in water	Slight; moderately slow permeability in substratum; severe where flooding of dikes is a hazard	Moderate or severe; severe in areas subject to run-in water	Moderate; moderate shrink-swell potential; severe in swales that receive run-in water	Severe in swales that receive run-in water; moderate on upland flats; loam and clay loam textures	Severe in areas that receive run-in water; slight on upland flats	Moderate on upland flats; severe in areas subject to run-in water
VS-LP Vienna-Lismore association	Slight - 10% Moderate - 10% Severe - 80%	Slight - 30% Moderate - 55% Severe - 15%	Slight - 50% Moderate - 40% Severe - 10%	Slight - 10% Moderate - 75% Severe - 15%	Slight - 40% Moderate - 50% Severe - 10%	Slight - 55% Moderate - 30% Severe - 15%	Slight - 5% Moderate - 10% Severe - 85%
Vienna-65%	Severe; moderately slow permeability in substratum	Slight if less than 2 percent slopes; moderate if 2 to 7 percent slopes; severe if slopes exceed 7 percent	Slight where slopes are less than 8 percent; moderate if slopes are 8 to 15 percent	Moderate; moderate shrink-swell potential	Slight or moderate; dominantly loam or clay loam textures	Slight if slopes are less than 8 percent	Severe; AASHO Group Index more than 8; plasticity index more than 15
Lismore-15%	Severe; moderately slow permeability in substratum	Slight	Moderate; moderately well drained	Moderate; moderate shrink-swell potential; severe in areas that receive run-in water from adjacent slopes	Moderate; moderately well drained; silty clay loam and clay loam textures	Slight or moderate; some areas receive run-in water from adjacent slopes	Severe; AASHO Group Index more than 8; plasticity index more than 15
Kranzburg and other soils-20%							
LD Lamoure association	Slight - 5% Moderate - 5% Severe - 90%	Slight - 0% Moderate - 5% Severe - 95%	Slight - 5% Moderate - 5% Severe - 90%	Slight - 0% Moderate - 5% Severe - 95%	Slight - 0% Moderate - 5% Severe - 95%	Slight - 0% Moderate - 5% Severe - 95%	Slight - 0% Moderate - 5% Severe - 95%

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Table 1 - 6

Soil association and percent composition of major soils (Col. 1)	Degree and kind of limitation for — Septic tank absorption fields (Col. 2)	Sewage lagoons (Col. 3)	Shallow excavations (Col. 4)	Dwellings with basements (Col. 5)	Sanitary land fill (trench type) (Col. 6)	Sanitary land fill (area type) (Col. 7)	Local roads and streets (Col. 8)
Lamoure-65%	Severe; frequent flooding; water table at 2 to 5 feet	Severe; moderately rapid permeability in substratum; water table at 2 to 5 feet	Severe; poorly drained; water table at 2 to 5 feet	Severe; poorly drained; frequent flooding	Severe; poorly drained; frequent flooding	Severe; poorly drained; frequent flooding	Severe; poorly drained, frequent flooding; high potential frost action
Marysland and other soils-35%							
RL-FS	Slight - 70%	Slight - 5%	Slight - 5%	Slight - 70%	Slight - 5%	Slight - 5%	Slight - 80%
Renshaw-Fordville association	Moderate - 15%	Moderate - 5%	Moderate - 10%	Moderate - 20%	Moderate - 10%	Moderate - 15%	Moderate - 10%
	Severe - 15%	Severe - 90%	Severe - 85%	Severe - 10%	Severe - 85%	Severe - 80%	Severe - 10%
Renshaw-60%	Slight; possible pollution of ground water supplies	Severe; rapid permeability in substratum	Severe; sand and gravel substratum (10 to 20 inches)	Slight if less than 8 percent slopes; moderate if 8 to 15 percent slopes	Severe; rapid permeability in substratum	Severe; rapid permeability in substratum	Slight if less than 8 percent slopes, moderate if 8 to 15 percent slopes
Fordville-20%	Slight; possible pollution of ground water supplies	Severe; rapid permeability in substratum	Severe; sand and gravel substratum (20 to 40 inches)	Slight	Severe; rapid permeability in substratum	Severe; rapid permeability in substratum	Slight
Divide and other soils-20%							

1/ Interpretations based on "Guide for Interpreting Engineering Uses of Soils" United States Department of Agriculture, Soil Conservation Service, 1971, 87 pages, illus. For use with General Soil Map for Broad Planning Purposes.

Soil association and percent composition of major soils (Column 1) contains the soil association symbols used for the general soil map and the percent composition of the major soils of each soil association. The items in columns 2 through 8 are soil evaluations for the degree and kind of limitation for seven engineering uses. An estimated percentage of degree of each limitation is given by selected uses for the associations. Three degrees of suitability are used. Slight, Moderate, and Severe. The kind of limitation that contributes to the suitability is given following the degree of limitation. Soil evaluations are given only for the major two or three soils of each soil association.

Septic tank absorption fields (Column 2) are the soil absorption systems for sewage disposal. It is a subsurface tile system laid in such a way the effluent from a septic tank is distributed uniformly into the natural soil. Features affecting the rate and uniformity of distribution are permeability of soil, depth to bedrock, flooding, seasonal and annual ground water level, and soil slopes. Also considered is the opportunity of contamination or pollution of local subsurface water supplies. The criteria used in evaluating soils for use as septic tank absorption fields are given on Guide Sheet 1.

Sewage Lagoons (Column 3) are shallow basins or lakes used to hold sewage for the time required for bacterial decomposition. Requirements for lagoons are twofold; as a vessel for the impounded area and as soil material for the dam or dikes. Soil features affecting are permeability, location of water table, susceptibility to flooding, and soil slope. Criteria used in evaluating soils for use as sewage lagoons are given in Guide Sheet 2.

Shallow Excavations (Column 4) are those that require soil removal to a depth of 6 feet or less. Such uses include underground utility lines (pipelines, sewers, cables), cemeteries, sanitary landfills, basements, and open ditches. Additional criteria must be considered for specific uses such as pipelines or cemeteries. Ratings are based upon the workability of soil material; slopes, susceptibility to sloughing or sliding, water (free water-high water table or flooding), stones and sand or gravel. See Guide Sheet 3 for criteria used in evaluating soils for shallow excavations.

Dwellings with basements (Column 5) refers to foundations for single family dwellings and other buildings with similar foundation requirements. While the main emphasis is on evaluation for foundations, other features affecting these sites are also considered. These include slope gradients, flooding and seasonal wetness, and depth to bedrock and gravel. The properties affecting foundations include shear strength, bearing capacity, shrink-swell, plasticity, and density. Excluded from the rating are considerations of soil corrosion, suitability for septic tank absorption fields and landscaping. Criteria used to make these evaluations are given in Guide Sheet 4.

Sanitary land fill-trench type (Column 6) is a trench type land fill with the excavated soil material to serve as blanket and cover. Excavations for trench type landfill is often 15 feet or more deep. There is often a need for geological investigation when trenches are this deep. Routine soil investigations are normally confined to less than 5 or 6 feet. The ratings included here involve only those characteristics of the soil to about 5 feet. Soil qualities and characteristics used are depth to water table, soil drainage, flooding, permeability, soil slope,

texture, and depth to sand and gravel. Criteria for trench type sanitary landfills are given in Guide Sheet 5.

Sanitary land fill-area type (Column 7) is a type of sanitary land fill where refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 2 feet thick is placed over the fill when it is completed. Soil properties to consider are flooding, depth to water tables, permeability and soil slope. Consideration is also given to the probability of contamination of water supplies. See Guide Sheet 6 for criteria used in evaluating soils for use as are a type of sanitary land fills.

Local roads and streets (Column 8) refers to improved roads and streets having some kind of all-weather surfacing and are expected to carry automobile traffic all year. Excluded are highways designed for heavy traffic. The roads and streets are built mostly from soil materials at hand and cuts and fills are usually less than 6 feet. Ratings are made on qualities and features that affect the stability and load supporting capacity, the workability, and include site factors such as wetness, flooding, slopes, depth to bedrock, and relief as it affects cut and fill. Criteria used in evaluating soils for use as local roads and streets are given in Guide Sheet 7.

SINGLE PURPOSE INTERPRETATIVE MAPS

Single purpose maps are used to show suitability of soils for a specific land use. Such a map is interpreted from the general soil map and each of the major soils of the soil associations is rated as having Slight, Moderate, or Severe limitations for the selected land use. These maps are coded to show the degree of suitability for a land use by cross hatch. The main purpose of single purpose maps is to provide a visual indication of suitability for a land use.

Table 1 and the discussion in the following sections give the information necessary to develop single purpose maps.

GUIDE SHEETS FOR SOIL LIMITATION RATINGS

The following Guide Sheets show the soil criteria that were used for rating the soils in this report for use as:

1. Septic tank absorption fields
2. Sewage lagoons
3. Shallow excavations
4. Dwellings with basements
5. Trench-type sanitary land fills
6. Area-type sanitary land fills
7. Local roads and streets

The guide sheets are included to provide the reader with a better understanding of how the ratings were determined for the soils in this report. The criteria in these guide sheets were designed by engineers and soil scientists of the Soil Conservation Service.

Guide Sheet 1.--Soil limitation ratings for septic tank absorption fields

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Permeability class[1]	Rapid[2], moderately rapid, and upper end of moderate	Lower end of moderate	Moderately slow[3] and slow
Hydraulic conductivity rate (Uhland core method)	More than 1 in.hr[2]	1-0.6 in./hr	Less than 0.6 in./hr
Percolation rate (Auger hole method)	Faster than 45 min/in.[2]	45-60 min/in.	Slower than 60 min/in.
Depth to water table	More than 72 in.	48-72 in.	Less than 48 in.
Flooding	None	Rare	Occasional or frequent
Slope	0-8 pct	8-15 pct	More than 15 pct
Depth to hard rock,[4] bedrock, or other impervious materials	More than 72 in.	48-72 in.	Less than 48 in.
Stoniness class[5]	0 and 1	2	3, 4, and 5
Rockiness class[5]	0	1	2, 3, 4, and 5

1/ Class limits are the same as those suggested by the Work-Planning Conference of the National Cooperative Soil Survey. The limitation ratings should be related to the permeability of soil layers at and below depth of the tile line.

2/ Indicate by footnote where pollution is a hazard to water supplies.

3/ In arid or semiarid areas, soils with moderately slow permeability may have a limitation rating of moderate.

4/ Based on the assumption that tile is at a depth of 2 feet.

5/ For class definitions see Soil Survey Manual, pp. 216-223.

Guide Sheet 2.--Soil limitation ratings for sewage lagoons

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Depth to water table (seasonal or year-round)	More than 60 in.	40-60 in. 1/	Less than 1/ 40 in.
Permeability	Less than 0.6 in./hr	0.6-2.0 in./hr	More than 2.0 in./hr
Depth to bedrock	More than 60 in.	40-60 in.	Less than 40 in.
Slope	Less than 2 pct	2-7 pct	More than 7 pct
Coarse fragments, less than 10 inches in diameter: percent, by volume	Less than 20 pct	20-50 pct	More than 50 pct
Percent of surface area covered by coarse fragments more than 10 inches in diameter	Less than 3 pct	3-15 pct	More than 15 pct
Organic matter	Less than 2 pct	2-15 pct	More than 15 pct
Flooding 2/	None	None	Soils subject to flooding
Soil groups (Unified) 3/ (rated for use mainly as floor of sewage	GC, SC, CL, and CH	GM, ML, SM, and MH	GP, GW, SW, SP, OL, OH, and PT

1/ If the floor of the lagoon is nearly impermeable material at least 2 feet thick, disregard depth to watertable.

2/ Disregard flooding if it is not likely to enter or damage the lagoon. (low velocity and the depth less than about 5 feet.)

3/ For interpretations for material for embankments see "Embankments, dikes, and levees."

Guide Sheet 3.--Soil limitation ratings for shallow excavations

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Soil drainage class	Excessively drained, somewhat excessively drained, and well drained	Moderately well drained	Somewhat poorly drained, poorly drained, and very poorly drained
Seasonal water table	Below a depth of 60 in.	Between depths of 30 and 60 in.	Above a depth of 30 in.
Flooding	None	Rare	Occasionally or frequent
Slope	0-8 pct	8-15 pct	More than 15 pct
Texture of soil to depth to be excavated[1/], [2/]	fsl, sl, l, sil, sicl, scl	si[3/], cl, sc; all gravelly types	c[4/], sic[4/], s, ls; organic soils; all very gravelly types
Depth to bedrock[5/]	More than 60 in.	40-60 in.	Less than 40 in.
Stoniness class[6/]	0 and 1	2	3, 4, and 5
Rockiness class	0	1	2, 3, 4, and 5

1/ Texture is used here as an index to workability and sidewall stability.

2/ If soil contains a thick fragipan, duripan, or other material difficult (but not impossible) to excavate with handtools, increase the limitation rating by one step unless it is severe.

3/ If soil stands in vertical cuts like loess, reduce rating to slight.

4/ If the soil is friable, as are some kaolinitic Paleudults, reduce rating to moderate.

5/ If bedrock is soft enough so that it can be dug out with ordinary handtools or light equipment, such as back hoes, reduce ratings of moderate and severe by one step.

6/ For class definitions see Soil Survey Manual, pp. 218-223.

Guide Sheet 4.--Soil limitation ratings for dwellings[1/]

Item affecting use	Degree of soil limitation[2/]		
	Slight	Moderate	Severe
Soil drainage class[3/]	With basements: Excessively drained, somewhat excessively drained, well drained Without basements: Excessively drained, somewhat excessively drained, well drained, moderately well drained	With basements: Moderately well drained Without basements: Somewhat poorly drained	With basements: Somewhat poorly drained, poorly drained, very poorly drained Without basements: Poorly drained, very poorly drained
Seasonal water table (Seasonal means for 1 month or more)	With basements: Below a depth of 60 in. Without basements: Below a depth of 30 in.	With basements: Below a depth of 30 in. Without basements: Below a depth of 20 in.	With basements: Above a depth of 30 in. Without basements: Above a depth of 20 in.
Flooding	None	None	Rare, occasional or frequent
Slope[4/]	0-8 pct	8-15 pct	More than 15 pct
Shrink-swell potential	Low	Moderate	High
Unified soil group	GW, GP, SW, SP, GM, GC, SM, SC, CL with PI[6/] less than 15	ML, CL with PI[6/] 15 or more	CH, MH[5/], OL, OH,
Potential frost action[7/]	Low	Moderate	High
Stoniness class[8/]	0 and 1	2	3, 4, and 5
Rockiness class[9/]	0	1	2, 3, 4, and 5
Depth to bedrock[9/]	With basements: More than 60 in. Without basements: More than 40 in.	With basements: 40-60 in. Without basements: 20-40 in.	With basements: Less than 40 in. Without basements: Less than 20 in.

1/ If slope limits are reduced 50 percent, this table can be used for evaluating soil limitation for shopping centers and for small industrial buildings with foundation requirements not exceeding those of ordinary three-story dwellings.

2/ Some soils given limitation ratings of moderate or severe may be good sites from the standpoint of esthetics but require more preparation or maintenance.

3/ For class definitions see Soil Survey Manual, pp. 169-172.

4/ Reduce slope limits 50 percent for those soils susceptible to hillside slippage.

5/ Upgrade to moderate if MH is largely kaolinitic, friable, and free of mica.

6/ PI means plasticity index.

7/ Use this item only where frost penetrates to assumed depth of footings and where soil is moist during freezing weather. See section "Potential Frost Action" for guidance in determining classes.

8/ For class definitions see Soil Survey Manual, pp. 216-223.

9/ If bedrock is soft enough so that it can be dug out with light power equipment, such as backhoes, reduce ratings of moderate and severe by one step.

Guide Sheet 5.--Soil limitation ratings for trench-type sanitary landfills[1/]

Item affecting use		Degree of soil limitation		
		Slight[2/]	Moderate[2/]	Severe
Depth to seasonal high water table		Not class determining if more than 72 in.		Less than 72 in.
Soil drainage class		Excessively drained, somewhat excessively drained, well drained, and some[3/] moderately well drained	Somewhat poorly drained and some[3/] moderately well drained	Poorly drained and very poorly drained
Flooding		None	Rare	Occasional or frequent
Permeability[4/]		Less than 2.0 in./hr	Less than 2.0 in./hr	More than 2.0 in./hr
Slope		0-15 pct	15-25 pct	More than 25 pct
Soil texture[5/] (dominant to a depth of 60 in.)		Sandy loam, loam, silt loam, sandy clay loam	Silty clay loam[6/] clay loam, sandy clay, loamy sand	Silty clay, clay, muck, peat, gravel, sand
Depth to bedrock	Hard	More than 72 in.	More than 72 in.	Less than 72 in.
	Rippable	More than 60 in.	Less than 60 in.	Less than 60 in.
Stoniness class[7/]		0 and 1	2	3, 4, and 5
Rockiness class[7/]		0	0	1, 2, 3, 4, and 5

1/ Based on soil depth (5-6 feet) commonly investigated in making soil surveys.

2/ If probability is high that the soil material to a depth of 10-15 feet will not alter a rating of slight or moderate, indicate this by an appropriate footnote, such as "Probably slight to a depth of 12 feet," or "Probably moderate to a depth of 12 feet."

3/ Soil drainage classes do not correlate exactly with depth to seasonal water table. The overlap of moderately well drained soils into two limitation classes allows some of the wetter moderately well drained soils (mostly in the Northeast) to be given a limitation rating of moderate.

4/ Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

5/ Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

6/ Soils high in expansive clays may need to be given a limitation rating of severe.

7/ For class definitions see Soil Survey Manual, pp. 216-223.

Guide Sheet 6.--Soil limitation ratings for area-type sanitary landfills

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Depth to seasonal water table 1/	More than 60 in.	40-60 in.	Less than 60 in.
Soil drainage class 1/	Excessively drained, somewhat excessively drained, well drained, and moderately well drained	Somewhat poorly drained	Poorly drained and very poorly drained
Flooding	None	Rare	Occasional or frequent
Permeability 2/	Not class determining if less than 2 in./hr		More than 2 in./hr
Slope	0-8 pct	8-15 pct	More than 15 pct

1/ Reflects influence of wetness on operation of equipment.

2/ Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

Guide Sheet 7.--Soil limitation ratings for local roads and streets

	Degree of soil limitation		
	Slight	Moderate	Severe
Soil drainage class 1/	Excessively drained, somewhat excessively drained, well drained, and moderately well drained	Somewhat poorly drained	Poorly drained and very poorly drained
Flooding	None	Soils flooded less than once in 5 years	Soils flooded more than once in 5 years
Slope	0-8 pct	8-15 pct	More than 15 pct
Depth to bedrock 2/	More than 40 in.	20-40 in.	Less than 20 in.
Subgrade 3/			
a. AASHO group index 4/	0-4	5-8	More than 8
b. Unified soil group	GW, GP, SW, SP, GM, GC 5/, SM 5/, SC 5/	CL with PI 6/ less than 15,	CL with PI 6/ 15 or more, CH, MH 7/, OH, OL, Pt
Shrink-swell potential	Low	Moderate	High
Susceptibility to frost action 8/	Low	Moderate	High
Stoniness class 9/	0, 1, and 2	3	4 and 5
Rockiness class 9/	0	1	2, 3, 4, and 5

1/ For class definitions see Soil Survey Manual, pp. 169-172.

2/ If bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery, reduce limitation ratings of moderate and severe by one step.

3/ Use AASHO Group Index values if available from laboratory tests; otherwise, use the estimated Unified soil groups.

4/ Use Group Index values according to AASHO Designation M 145-49 and M 145-66I; for most soils with group index values below about 8, both designations (methods) give results nearly enough alike to be considered alike for the purpose of this guide.

5/ Downgrade limitation rating to moderate if content of fines is more than about 30 percent.

6/ PI means plasticity index.

7/ Upgrade limitation rating to moderate if MH is largely kaolinitic, friable, and free of mica.

8/ Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front. See section "Potential Frost Action" for guidance in determining classes.

9/ For class definitions see Soil Survey Manual, pp. 216-223.

GLOSSARY OF TERMS

Bearing Capacity - the load supporting strength of a soil.

Bedrock - the solid rock underlying soils that has not been weathered.

Clay - as a soil separate, the mineral soil particles less than 0.002 mm. in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clayey - containing large amounts of clay or having properties similar to those of clay.

Clay Loam - soil material that contains 27 to 40 percent clay and 20 to 45 percent sand.

Coarse Texture - the texture exhibited by sand, loamy sands, and sandy loams, except very fine sandy loams.

Deposits - material left in a new position by a natural transporting agent such as wind, water, ice, or gravity or by the activity of man.

Drainage - the removal of water by natural or artificial means.

Drainage Class - the rate of removal or extent of removal of water from the soil. Eight drainage classes are recognized:

Very poorly drained or ponded - water is removed so slowly that the soil remains water logged or covered with water throughout most of the year.

Poorly drained - water is removed so slowly that the soil remains wet throughout most of the year.

Somewhat poorly drained - water is removed slowly so that the soil is wet through certain times of the year.

Moderately well drained - water is removed at a rate that the soil is moist for significant periods of time.

Well drained - water is removed at a rate that most operations are not hampered by moisture.

Somewhat excessively drained - water is removed at a rapid rate so that a moisture deficit somewhat larger than normal exists.

Excessively drained - water is removed from the soils at a very rapid rate so that a large moisture deficit exists.

Fine Texture - consisting of or containing large quantities of the fine fractions, particularly of silt and clay. (Includes silty clay and clay textural classes.)

Fine Sandy Loam - soil material that contains either 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30, and 52 percent sand. The sand fraction consists of 30 percent or more fine sand and less than 30 percent very fine sand or between 15 and 30 percent very coarse, coarse, and medium sand.

Frost Heave - the formation of ice crystals in voids of the soil that expand the volume of the soil.

Glacial Drift - rock debris that has been transported by glaciers, and deposited, either directly from the ice or from the meltwater. The debris may or may not be heterogeneous.

Glacial Till - unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel and boulders intermingled in any proportion.

Glacial Outwash - the material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice.

Gravel - rounded or partially rounded rock fragments 2 mm. to 3 inches in size.

Internal Drainage - the downward movement of water through the soil.

Interpretations, soil - the science and art of explaining the meaning or significance of basic soils information for various land uses.

Liquid Limit and Plastic Index - liquid limit and plastic index relate to soil moisture and provide important clues to soil behavior. If water is added to a dry soil containing at least some clay or silt, the soil will become plastic. The moisture content at which the soil just becomes plastic is the plastic limit. This limit is needed to compute the plasticity index. If more water is added, the soil will become fluids. The moisture content at which the soil changes from a plastic to a fluid state is the liquid limit. The differences between the liquid limit and the plastic limit is the plasticity index - the range over which the soil is plastic.

Loam - soil material with 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Loamy Sand - soil material that contains at the upper limit 85 to 90 percent sand, and the percentage of silt plus 1.5 times the percentage of clay is not less than 15; at the lower limit it contains not less than 70 to 85 percent sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.

Loamy Texture - intermediate in texture and properties between fine-textured and coarse-textured soils. Includes very fine sand loam, silt loam, and loam textures.

Parent Material - the unconsolidated and more or less chemically weathered mineral or organic matter from which the soil is developed by pedogenic processes.

Permeability - the ease with which gases, liquids or plant roots penetrate or move through a bulk mass of soil or a layer of soil.

Permeability classes

Very slow	- less than .06 inches per hour
Slow	- .06 to .2 inches per hour
Moderately slow	- .2 to .6 inches per hour
Moderate	- .6 to 2. inches per hour
Moderately rapid	- 2. to 6. inches per hour
Rapid	- 6. to 20. inches per hour
Very rapid	- More than 20. inches per hour

Piping - the formation of subterranean voids or tunnels in soil material.

Plastic Index - (See definition for Liquid Limit and Plastic Index).

Plastic Limit - the minimum moisture percentage by weight soil at which a small sample of soil material can be deformed without rupture.

Profile, soil - a vertical section of the soil through all its horizons and extending into the parent material.

Sand - a soil particle between 0.05 and 2.0 mm. in diameter.

Sandy Soil - soil containing a large amount of sand. Includes sand, except loamy very fine sand.

Sandy Loam - soil material that contains either 20 percent clay or less and the percentage of silt plus twice the amount of clay exceeds 30, and 52 percent or more sand; or less than 7 percent clay, less than 50 percent silt, and between 43 and 52 percent sand.

Silt - a soil separate consisting of particles between 0.05 and 0.002 mm. in equivalent diameter.

Silt loam - soil material that contains 50 percent or more silt and 12 to 27 percent clay or 50 to 80 percent silt and less than 12 percent clay.

Silty Clay Loam - soil material that contains 27 to 40 percent clay and less than 20 percent sand.

Silty Clay - a soil texture that contains 40 percent or more clay and 40 percent or more silt.

Slope - the rise and fall of the land surface measured in percent.

Shapes of slope:

Concave - slopes that are dish shaped.
Convex - slopes that are rounded in shape.

Stability - the ability of a soil to resist slippage or sliding.

Subsoil - that part of the soil below the surface soil and above the substratum.

Substratum, substrata, underlying materials - that part of the soil below the subsoil, commonly the parent material.

Surface Soil, surface layer - that portion of the soil that overlies the subsoil layers. Generally includes that portion with highest amount of organic matter and the most weathered part of the soil. Sometimes used interchangeably with topsoil.

Terrace (geological) - an old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains and are seldom subject to overflow.

Water Table - the highest part of the soil or underlying rock material that is wholly saturated with water. In some places, an upper or perched, water table may be separated from a lower one by a dry zone.

COMMENTS AND RECOMMENDATIONS

A brief review of the information contained in the previous sections and the Appendix is as follows:

1.) The sanitary surveys of Lake Cochrane and Bullhead Lake indicate that both lakes are relatively free from septic tank discharges, Cochrane due to the efforts of the Planning Commission requiring holding tanks for new construction, (also required by State regulations), and Bullhead because the lake has yet to be heavily developed. The lakes themselves are vastly different in nature, Bullhead is a shallow lake, typical to the Coteau area, whereas Cochrane is one of the deepest natural bodies of water found in South Dakota. Since this greater depth gives Cochrane a considerably higher volume to surface area and volume to shoreline ratio than Bullhead Lake, Cochrane is able to absorb far more nutrients without showing any visible effects. This is why Bullhead is a more eutrophic lake than Cochrane is, (see Section 1 Bullhead Lake Sanitary Survey), even though Cochrane receives far more nutrients through residential and recreational use than Bullhead does.

2.) The Game, Fish and Park's Lake Management Plans deal with both lakes primarily from a fisheries standpoint. Game, Fish and Parks rate Bullhead and Cochrane as two of the lakes in Deuel County best suited for fishing and other water recreation on the basis of water quality monitoring and physical aspects of the lakes which relate to Game, Fish and Parks interests. The Lake Cochrane Management Plan also refers to several sediment traps on the perimeter of the lake, sections of the final report on the retention structures are included in the Appendix. This document, (Sediment Trap Report), provides insight into an aspect of lake preservation as important as proper septic tank practices, prevention of sedimentation and nutrification from streams which feed the lake, and from run-off during rain storms and snow melt. Additional Game, Fish and Parks comments and recommendations are well outlined in the Lake Management Plans.

3.) Soil types surrounding both lakes are unsuited for conventional sewage treatment. In Bullhead Lake's case the soil is too coarse, with a resulting rapid percolation through the soil which could result in contamination of the lake and the aquifer. The soil around Lake Cochrane contains such a large amount of clay that drain fields and seepage pits cannot disperse the wastewater rapidly enough to be effective. In special cases, such as the resort on Lake Cochrane, where water useage creates a volume of waste that cannot be economically stored in a holding tank and where sufficient land exists to construct an on-site treatment system, specialized wastewater disposal facilities can be designed and installed.

The recommendations that are offered as a result of information received from the survey and a review of the information provided by all agencies and organizations involved are as follows:

1.) The Deuel County Planning Commission should continue it's policy of requiring holding tanks for lakeside dwellings. The legislation to uphold this policy is found in the Private Sewage Disposal Regulations under minimum and and maximum allowable percolation rates; minimum lot size requirements; minimum required distance from wells and the wastewater; and several other specifications detailed in the regulations. The enforcement of the Private Sewage Disposal Regulations is difficult for the Department of Water and Natural Resources due to limited staff, and we hope that the Deuel County Planning Commission will review all new building permits for conformity to our requirements, and along with the Lake Associations encourage owners of existing systems to upgrade their current wastewater disposal facilities to minimum standards if they have not already done so.

2.) Further study is needed to determine if nutrification and sedimentation from run-off has been effectively controlled by the sediment traps on

Lake Cochrane and if any major problems exist in Bullhead's watershed. In any event, the Planning Commission should work with the agencies with Soil Conservation Programs (SCS, ASCS, DWNR, GF & P) and the area landowners in the watersheds and institute Best Management Practices (BMP's) on as much land in the watersheds as possible. Any and all action taken to prevent sediment and nutrients from reaching the lakes, both from agricultural land and lakeshore lots, will lead to improvements in water quality.

In conclusion, there are no major changes in policy required for planning of future developments around either lake, or any existing problems which constitute a serious threat to Lake Cochrane or Bullhead Lake. The items noted from the septic tank surveys and from several field surveys that are a cause for concern; drain fields too close to the lake, wells, or aquifer; pit privies; poor land management, etc.; are all isolated cases, few in number and relatively minor as a threat to water quality. However, even minor problems should be corrected whenever detected, and hopefully this report will provide some basic education and insight into lake preservation which will encourage people to care enough to correct any environmentally unsafe systems or practices they may be using. If all persons involved with Lake Cochrane and Bullhead Lake; the lake residents, nonresidents, landowners, local, county and State officials; do their part to protect the lakes, they will be enjoyed for many years to come.

APPENDIX

ENVIRONMENTAL PROTECTION DEPARTMENT

CHAPTER 34:04:01

PRIVATE SEWAGE DISPOSAL SYSTEMS

Sections

34:04:01:01 Definitions. Words defined in SDCL 46-25-24 shall have the same meaning when used in this chapter. In addition, terms used in this chapter, unless the context plainly requires otherwise shall mean:

(1) "Absorption field," soils through which sewage from an absorption pipe or system of such pipes percolate;

(2) "Absorption line," a pipe which may be perforated, that is installed in the ground which distributes sewage to the surrounding soil through any perforations or spaces between sections of the pipe;

(3) "Absorption system," a type of water-carriage disposal system which utilizes an absorption line;

(4) "Adequate sewage disposal," disposal of sewage in a manner which does not cause pollution of ground or surface waters, or does not create a public health problem or odors;

(5) "Aerobic system," a system which utilizes the principle of oxidation in the decomposition of sewage by the introduction of air into the sewage or by surface absorption of air as a method of treatment and disposal of sewage;

(6) "Alternate design," an individual sewage disposal system which will provide adequate sewage disposal;

(7) "Biological decomposition toilet," a toilet for human excretion which disposes of sewage biologically through a process of aerobic decomposition;

(8) "Central disposal system," a disposal system serving two or more individual households or businesses with a common unit for treatment of sewage;

(9) "Cesspool," a covered underground receptacle which receives untreated domestic sewage and permits the untreated domestic sewage to seep into surrounding soils;

(10) "Chemical toilets," a nonwater-carriage toilet constructed to discharge human excreta directly into a deodorizing and liquifying chemical solution contained in a water-tight tank;

(11) "Department," the South Dakota department of environmental protection;

(12) "Distribution box," a chamber below the outlet level of a septic tank or other types of disposal systems and from which effluent enters the absorption line;

(13) "Domestic sewage," wastes derived from premises in the nature of dwellings, business buildings, and institutions. The term does not include wastes from industrial processes;

(14) "Effluent," the liquid waste discharge from an individual sewage disposal system;

(15) "Evapotranspiration," the process by which water is withdrawn from the soil by evaporation and plant transpiration;

(16) "Groundwater table," the upper surface of groundwater in the zone of saturation of a geologic formation;

(17) "Holding tank or vault," a water-tight, covered receptacle which is designed to receive and store the discharge of domestic sewage and is accessible for periodic removal of its contents;

(18) "Incinerator toilet," a disposal system which operates using natural gas, propane gas or electricity to incinerate wastes;

(19) "Individual sewage disposal system," a system or facility for treating, neutralizing, stabilizing, or disposing of wastes which is not a part of or connected to a public disposal system;

(20) "Mechanical sewage treatment plants," aerobic systems and package plants;

(21) "No dak system," a shallow type disposal system located partially above ground;

(22) "Oxidation pond," a basin used for retention of sewage before final disposal;

(23) "Owner," the person who is the owner of record of the land on which an individual sewage disposal system is to be designed, constructed, installed, altered, extended, or used;

(24) "Package plants," small or scaled down versions of municipal sewage treatment works which are generally assembled and shipped as complete units by the manufacturer;

(25) "Percolation test," a soil test at the depth of a proposed absorption system, or, other subsurface absorption device to determine the water absorption capability of the soil, the results of which are normally expressed as the rate at which one inch of water is absorbed;

(26) "Private water supply system," the system of pipes and structures, including wells and well structures, pumping stations, treatment facilities, storage tanks and appurtenances, through which water is obtained and distributed to persons other than the public. The term shall include a person supplying water to his own premises;

(27) "Private water system," any publicly or privately owned private water supply system which provides drinking water for human consumption to systems which supply less than five premises or twenty-five individuals, whichever is less;

(28) "Privy," a structure which allows for disposal of human excreta into a pit or vault;

(29) "Public disposal systems," a disposal system which serves five or more premises;

(30) "Public water system," is any publicly or privately owned water supply system which provides drinking water for human consumption. The

term shall not include systems which supply less than five premises or less than twenty-five individuals, whichever is less;

(31) "Secretary," the secretary of the department of environmental protection or his authorized representative;

(32) "Sedimentation tank," a water-tight basin or tank in which waste containing settleable solids are retained to remove by gravity a part of the suspended matter;

(33) "Seepage pit," a subsurface absorption device which consists of a covered pit no deeper than four feet with open-jointed walls through which effluent, after treatment, may seep or leach into the surrounding soil;

(34) "Self-contained system," individual sewage disposal systems which completely treat or contain toilet wastes so that no treatment load or only limited treatment load is placed upon the immediately surrounding environment. Such systems are not limited to, but can be, holding tanks, privies, incinerator toilets, chemical toilets or biological decomposition toilets;

(35) "Septic tank," a water-tight, accessible, covered receptacle designed and constructed to receive domestic sewage to settle solids from the liquid, to digest organic matter and store digested solids through a period of retention and allow the clarified liquids to discharge to other treatment works for final disposal;

(36) "Sewage," liquid waste containing animal or vegetable matter in suspension or solution and which may include liquids containing chemicals in solution from water closets, urinals, lavatories, bathtubs, laundry tubs or devices, floor drains, drinking fountains, or other sanitary devices;

(37) "Shallow disposal system," a type of absorption system that relies primarily upon evapotranspiration rather than percolation for final treatment of wastes;

38) "Suitable soil," a soil which will act as an effective filter in the removal of organisms and suspended solids prior to the effluent

reaching any highly permeable earth such as joints in bedrock, gravels, or very coarse soils;

(39) "Underground disposal means," an absorption system;

(40) "Water-carriage disposal system," the system of disposing of wastes from buildings by using water to carry it hydraulically in a piping system;

(41) "Water supply system," the system of pipes and structures through which water is obtained and distributed to the public, including wells and well structures, intakes and cribs, pumping stations, treatment plants, reservoirs, storage tanks and appurtenances.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-107.

34:04:01:02 Disposal systems comply with rules. All disposal systems designed for the reception and treatment of sewage from premises including, but not limited to homes, commercial establishments, businesses, and institutions, where public disposal systems are not available, constructed after February 28, 1975, shall be constructed, added to and altered in accordance with this chapter. No disposal system, regardless of when constructed, shall cause a violation of any existing water quality standard, cause a health hazard, or fail to meet the requirements of § § 34:04:01:03 to 34:04:01:08, inclusive.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:03 Private systems prohibited when public disposal systems are available. The operation, construction or installation of an individual sewage disposal system by any person is prohibited where a public disposal system is available. A public disposal system shall be

deemed to be available to any premise when: both are located within the jurisdictional boundaries of a municipality or sanitary district; the sewers of the public disposal systems exist within two hundred feet of the home, commercial establishment, business, or institution; and the municipality or sanitary district is willing and requests to provide such service to the premise.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:04 Sewage not to be discharged into unused wells or rock formations. Sewage, treated or untreated, shall not be discharged into any abandoned or unused well, nor shall it be discharged into any crevice, sink hole or other openings, either natural or artificial, in a rock formation.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:05 Sewage to receive primary treatment prior to discharge to absorption system. Sewage shall pass through a septic tank, other sedimentation tank, or aerobic system prior to discharge to an absorption system.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:06 Disposal systems to be used where water systems unavailable. Privies, chemical toilets, or incinerator toilets shall be used when a water-carriage disposal system is not available.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:07 Abandoned systems to be disconnected and filled. Abandoned disposal systems shall be disconnected from buildings, and any receptacles or excavations in which such receptacles were contained shall be filled with earth.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:08 Sewage not allowed to surface on ground. No perso shall cause sewage from any individual disposal system to be deposited upon the ground surface, nor shall any person operate any individual disposal system which causes sewage to surface upon the ground.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:09 Drainage not to enter disposal systems. Drainage and runoff from footings, roofs and groundwater sump pumps shall not be allowed to enter an individual sewage system.

General Authority: SDCL 46-25-107. Law Implemented: 46-25-38.

34:04:01:10 Systems not to be less than four feet above groundwater table. No subsurface filtration system shall be installed where the groundwater table is within, or likely to be within, four feet of an absorption trench bottom or any other absorption or evapotranspiration system or receptacle for sewage in the individual disposal system.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:11 Systems not to be within one hundred feet of lakes, streams or impoundments. No components of any individual sewage disposal system shall be located within one hundred feet, measured horizontally, of the high water line of any lake, stream or impoundment of water.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:12 Cesspools prohibited. The construction of a cesspool after February 28, 1975, is prohibited.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:13 Distance of well, spring or cistern from seepage pit, absorption systems, pit privies, barnyard or farm silo. No seepage pit, absorption system, pit privy, barnyard, barn gutter, animal pens or farm silo shall be installed closer than one hundred and fifty feet from wells

less than one hundred feet deep or from springs, or closer than one hundred feet from cisterns or from wells more than one hundred feet deep.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:14 Wells, or springs or cisterns distance from disposal systems. No septic tank, aerobic system, vault privy, holding tank, sewer line of tightly jointed tile or equivalent material, shall be closer than seventy-five feet from wells less than one hundred feet deep or from springs, or fifty feet from cisterns or from wells which are more than one hundred feet deep.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:15 Distance of plastic or cast iron pipes from systems. Sewer lines of schedule forty plastic or cast iron with leaded or gasketed joints shall not be closer than fifteen feet from any well or spring.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:16 Distance of septic tank or aerobic unit from a building. No septic tank or aerobic unit shall be closer than ten feet from any dwelling or occupied building.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:17 Privies and absorption systems, seepage pit distance from building. No pit privy, absorption system, or seepage pit shall be closer than twenty feet from any dwelling or occupied building.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:18 Distance of disposal systems from property lines. Septic tanks, aerobic systems, pit privies, vault privies, absorption systems and seepage pits shall be at least ten feet from the property line of the owner.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:19 Types of water-carriage systems allowed. An individual water-carriage sewa disposal system shall have at least one of the following alternati treatment processes within the system:

(1) A septic nk with an absorption system or a holding tank;

(2) An aerobi treatment unit with an absorption system or a holding tank; or

(3) A chemica treatment unit with a holding tank.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:20 Types of treatment available to water-carriage systems. A central water-car iage disposal system not part of a public disposal system may apply ei ier types of treatment allowed under subdivisions (1) or (2) of § 34:04:0 :19, or oxidation ponds may be used when plans and specifications are repared and approved in accordance with Chapter 34:04:05.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38, 46-25-47.

34:04:01:21 Sewage flow capability requirements of certain premises of public accomodat on. Premises whose sewage is disposed of by a water-carriage system sha l have a disposal system designed for a minimum waste flow capability as ollows:

(1) Schools w th toilets and hand washing sinks: fifteen gallons per day per person;

(2) Schools w th toilets, hand washing sinks and cafeteria: twenty-five gallons per day per person;

(3) Schools w th toilets, hand washing sinks, cafeteria and showers: thirty-five gallons per day per person;

(4) Schools a i offices with day workers: fifteen gallons per day per person;

(5) Day campe twenty-five gallons per day per person;

(6) Residence : one hundred gallons per day per bedroom;

(7) Mobile home parks: four hundred gallons per day per mobile home;

(8) Travel trailer parks without individual sewer hook-ups: fifty gallons per day per space;

(9) Travel trailer parks with individual water and sewer hook-ups: one hundred gallons per day per space;

(10) Work construction camps: forty gallons per day per person;

(11) Public picnic parks which provide for toilet waste only: five gallons per day per person;

(12) Public picnic parks with bath houses, showers and flush toilets: ten gallons per day per person, based upon projected use;

(13) Swimming pools and beaches: ten gallons per day per person, based upon projected use;

(14) Country Clubs: twenty-five gallons per day per person, based upon projected membership;

(15) Rooming houses: forty gallons per day per person;

(16) Boarding houses: fifty gallons per day per each person for which space is available;

(17) Hotels: fifty gallons per day per each person for which space is available;

(18) Boarding schools: one hundred gallons per day per person, based upon projected enrollment;

(19) Factories, exclusive of industrial wastes: twenty-five gallons per day per person employed;

(20) Nursing homes: seventy-five gallons per day per person;

(21) General hospitals: one hundred and fifty gallons per day per person;

(22) Public institutions other than hospitals: one hundred gallons per day per person;

(23) Food service facilities: twenty-five gallons per day per person served;

(24) Bars and taverns: two gallons per day per person served;

(25) Motels: fifty gallons per day per each person for which there is space available;

(26) Motels with bath, toilets, and kitchen wastes: sixty gallons per day per each person for which there is space available;

(27) Drive-in theatre: five gallons per day per toilet space;

(28) Stores: four hundred gallons per day per toilet space;

(29) Service stations: four hundred gallons per day per toilet space;

(30) Airports: four hundred gallons per day per toilet space;

(31) Assembly halls: two gallons per day per person based upon seating capacity;

(32) Bowling alleys: seventy-five gallons per day per lane;

(33) Churches: five gallons per day per sanctuary seat;

(34) Churches with kitchens: seven gallons per day per sanctuary seat;

(35) Dance halls: two gallons per day per person;

(36) Coin operated laundries: eight hundred gallons per day per machine;

(37) Gas station with a service bay: one thousand gallons for the first bay per day and five hundred for each additional service bay per day; all in addition to the requirements of subdivision (28);

(38) Marinas, for each flush toilet: thirty-five gallons per fixture per hour;

(39) Marinas, for each urinal: ten gallons per fixture per hour;

(40) Marinas, for each wash basin: fifteen gallons per fixture per hour;

(41) Marinas, for each shower: one hundred gallons per fixture per hour;

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:22 Calculation of the minimum square feet of absorption trench. There shall be a minimum area of absorption trench or trenches, in a water-carriage disposal system, which utilizes an absorption system. Such an area shall be expressed in terms of square feet, that is, the length times the width of the trench or trenches. The square feet of such an absorption trench or trenches shall be equal to the number derived by multiplying the gallons per day of waste flow (Q), for which the system is designed, times the square root of the rate of percolation (as determined pursuant to § 34:04:01:25) expressed in minutes per inch (t) and dividing this product by five. This can also be expressed as $A = \frac{Q\sqrt{t}}{5}$. In no case shall the gallons per day of waste used in this formula be less than seven hundred and fifty. The absorption trench area calculated by such formula shall be increased by an additional twenty percent when wastes from a garbage grinder are discharged into the disposal system, and the area shall further be increased by an additional forty percent when an automatic washing machine discharges into the disposal system.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:23 Alternative methods of determining required absorption trench area. In lieu of calculating the absorption trench area required pursuant to § § 34:04:01:21 and 34:04:01:22, the following criteria may be used for a residential dwelling as an alternative means of determining the area; provided, the absorption trench must be of an area sufficient for at least three bedrooms. Where the percolation rate is:

(1) At least five minutes, but slower than ten minutes per inch, the minimum absorption shall be one hundred and twenty-five square feet per bedroom;

(2) At least ten minutes, but slower than fifteen minutes per inch, the minimum absorption trench area shall be one hundred and sixty-five square feet per bedroom;

(3) At least fifteen minutes, but slower than thirty minutes per inch, the minimum absorption trench area shall be two hundred square feet per bedroom;

(4) At least thirty minutes, but slower than forty-five minutes per inch, the minimum absorption trench area shall be two hundred and fifty square feet per bedroom;

(5) At least forty-five minutes, but slower than fifty-five minutes per inch, the minimum absorption trench area shall be three hundred square feet per bedroom;

(6) At least fifty-five minutes, but slower than sixty minutes per inch, the minimum absorption trench area shall be three hundred and fifty square feet per bedroom.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:24 Percolation test to be conducted before constructed. Any person who constructs or causes to be constructed or installed, a subsurface absorption system shall first conduct a percolation rate test, in accordance with § 34:04:01:25 before installation of any such system.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:25 Manner in which percolation test shall be conducted. A soil percolation test shall be made with a minimum of two test holes within five feet of where the absorption trench or shallow disposal system is desired to be located. The holes shall be in soil representative and of similar character as the rest of the area where the system will be placed. The percolation test is as follows:

(1) The horizontal dimension of the percolation test hole shall be from six to twelve inches and the vertical sides shall be terminated at the maximum depth of the proposed absorption trench or at a depth of at least thirty inches, whichever depth is greater;

(2) Test holes shall be located in unfrozen soil and shall be filled at least fifty percent full at least eight hours, but not more than sixteen hours before making the soil percolation test; immediately prior to making the test, each hole shall be refilled to at least fifty percent of its volume. When the water reaches the lower twenty-five percent of the test hole, the test shall be commenced. The percolation rate, in a test hole shall be expressed in the number of minutes which it took the water level to drop one inch. The percolation rate for the area where the subsurface infiltration system is desired shall be the average percolation rate of all the test holes.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:26 Absorption or evapotranspiration system permitted - exceptions. Either an absorption system or evapotranspiration system may be used when the percolation rate is between five and sixty minutes per inch, providing all other requirements for a disposal system are met. No subsurface absorption system shall be installed where the percolation rate is faster than five minutes per inch. An evapotranspiration system, but not an absorption system, may be used when the percolation rate is slower than sixty minutes per inch.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:27 Minimum capacity of septic tanks. All septic tanks shall have a minimum capacity of at least one thousand gallons of liquid

before there will be an overflow into the septic tank outlet. When a housing unit or units serviced by a septic tank contain more than three bedrooms, each additional bedroom, in excess of three, shall require an additional two hundred and fifty gallon increase in the capacity of the septic tank beyond the one thousand gallons. Septic tanks serving premises other than housing units shall have a minimum capacity to permit retention of incoming sewage for thirty hours at one hundred and fifty percent of the average daily flow.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:28 Requirements for an absorption trench. An absorption system shall have at least two absorption trenches of approximately equal length. The length of a trench shall not exceed one hundred feet; the width of a trench shall not exceed three feet; and a trench shall be at least four inches below the ground surface but the depth shall not exceed four feet. The trench shall be formed by a filler material of washed gravel, crushed stone, slag, or clean bank run gravel ranging in size from one-half inch to two and one half inches in diameter. An absorption line shall be placed within each trench and shall run along the length of the trench. The filler material shall be at least six inches deep below the bottom of the line and two inches deep above the top of the line. The bottom of a trench be uniformly graded to a slope from a minimum of two inches to a maximum of four inches per one hundred feet. Trenches shall be at least six feet apart.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38.

34:04:01:29 Seepage pits are allowable. A seepage pit is permissible at the end of an absorption line if the bottom of the pit is no more than

four feet below the ground surface.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:30 Separation required. There shall be at least four feet of soil between an absorption trench or seepage pit bottom or any other component of a subsurface absorption system and the high groundwater table elevation or rock formations or other impervious soil strata.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-39.

34:04:01:31 Minimum lot size required. A water-carriage disposal system can only be installed and operated on a lot which is at least forty-three thousand, five hundred and sixty square feet (one acre), when the potable water is supplied by a private water supply system. A water-carriage disposal system can only be installed and operated on a lot which is twenty thousand square feet or larger when the premises are supplied by a public water supply system. The requirements of this section do not apply where sewage is emptied into a holding tank.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38,46-25-39.

34:04:01:32 Water-carriage disposal not permitted in insufficient lot area unless holding tank installed. When a lot size is smaller than that specified in § 34:04:01:31 or the rate is faster than five minutes per inch, no water-carriage disposal system shall be permitted, unless a holding tank is installed.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38,46-25-39.

34:04:01:33 Individual sewage disposal system design considerations. The design of each individual sewage disposal system must take into consideration well locations, topography, groundwater table, elevations, soil characteristics, available area, and maximum occupancy of the building.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38,46-25-39.

34:04:01:34 Determination of type of system. The type of disposal system shall be determined on the basis of location, soil permeability, and groundwater elevation.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38, 46-25-39.

34:04:01:35 Review of plans for construction not required unless deviations desired. Individual sewage disposal systems may be designed and installed in accordance with this chapter without submission of project plans and specifications to the secretary for review and approval. Where deviation from this chapter is desired by the owner, the proposed change or plans and specifications and supporting information shall be submitted to the secretary for review and approval in accordance with chapter 34:04:05.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38, 46-25-47.

34:04:01:36 Existing systems not affected by this chapter - exceptions. Individual sewage disposal systems existing prior to February 28, 1975 are not subject to this chapter except when the systems are changed, the groundwater becomes polluted, or sewage is surfacing. Existing abandoned sewage disposal systems are not exempt from this chapter and shall be abandoned in accordance with § 34:04:01:07.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38, 46-25-39, 46-25-40.

34:04:01:37 Existing subdivisions and developments exempted from lot size requirements - proviso. Housing subdivisions and housing developments platted before February 28, 1975 are exempt from the lot size requirements of § 34:04:01:31 provided compliance with other provisions of this chapter can be achieved.

General Authority: SDCL 46-25-107. Law Implemented: SDCL 46-25-38, 46-25-39, 46-25-40.

March 11, 1975

Check Sheet for Private Sewage Disposal Systems Based on 34:04:01

(NA) Not applicable
(?) Information not provided
(NS) Not satisfactory
(X) If ok

_____ Sewage shall pass through a septic tank, sedimentation tank or aerobic system prior to an absorption system.

_____ Drainage and runoff shall not enter sewage system.

_____ Absorption field shall be greater than 4 feet from water table.

_____ All components of the sewer disposal system shall be 100 feet or greater from watercourse or impoundment.

_____ Cesspools are prohibited.

_____ Wells less than 100 feet deep must be 150 feet from absorption systems, barns, etc.

_____ Wells greater than 100 feet deep must be 100 feet from absorption systems, barns, etc.

_____ No septic tank, holding tank, or sewer line shall be closer than 75 feet from wells less than 100 feet deep or from springs.

_____ No septic tank, holding tank, or sewer line shall be closer than 50 feet from wells greater than 100 feet.

_____ Sewer lines of schedule 40 plastic or cast iron with leaded or gasketed joints shall be greater than 15 feet from any well or spring.

_____ Septic tanks shall be 10 feet or greater from buildings.

_____ Privies, absorption systems, shall be 20 feet or greater from buildings.

_____ Septic tanks and absorption systems shall be 10 feet or greater from the property line of the owner.

_____ Sewage flow - see 34:04:01:21.

_____ Absorption trench area = $\frac{Q\sqrt{t}}{5}$. Q = flow in gallons per day.

t = percolation in min/inch.

or

_____ Absorption trench area for three bedroom house.
___ 5 - 10 min/in = 125 ft^2/bedroom
___ 10 - 15 min/in = 165 ft^2/bedroom
___ 15 - 30 min/in = 200 ft^2/bedroom
___ 20 - 45 min/in = 250 ft^2/bedroom
___ 45 - 55 min/in = 300 ft^2/bedroom
___ 55 - 60 min/in = 350 ft^2/bedroom

_____ Percolation tests must be made with a minimum of 2 test holes within 5 feet of the absorption trench.

_____ Septic tank capacity must be at least 1,000 gallons plus 250 for each bedroom more than 3.

_____ Septic tanks serving premises other than housing units shall have a minimum capacity to permit retention of incoming sewage for 30 hours at 150 percent of the average daily flow.

_____ The absorption trench shall have at least 2 trenches of approximately equal length.

_____ The length of an absorption trench shall not exceed 100 feet.

_____ The width of an absorption trench shall not exceed 3 feet.

_____ The absorption trench shall be between 4 inches below ground and 4 feet deep.

_____ Filler material in trench shall be at least 6 inches deep below the bottom of the line and 2 inches above the top of the line.

_____ Absorption trenches shall be at least 6 feet apart.

_____ Slopes of absorption trench shall be between 2 and 4 percent.

_____ A seepage pit is permissable at the end of the absorption line if the pit is no more than 4 feet below ground level.

_____ There shall be 4 feet of soil between the absorption line and water table.

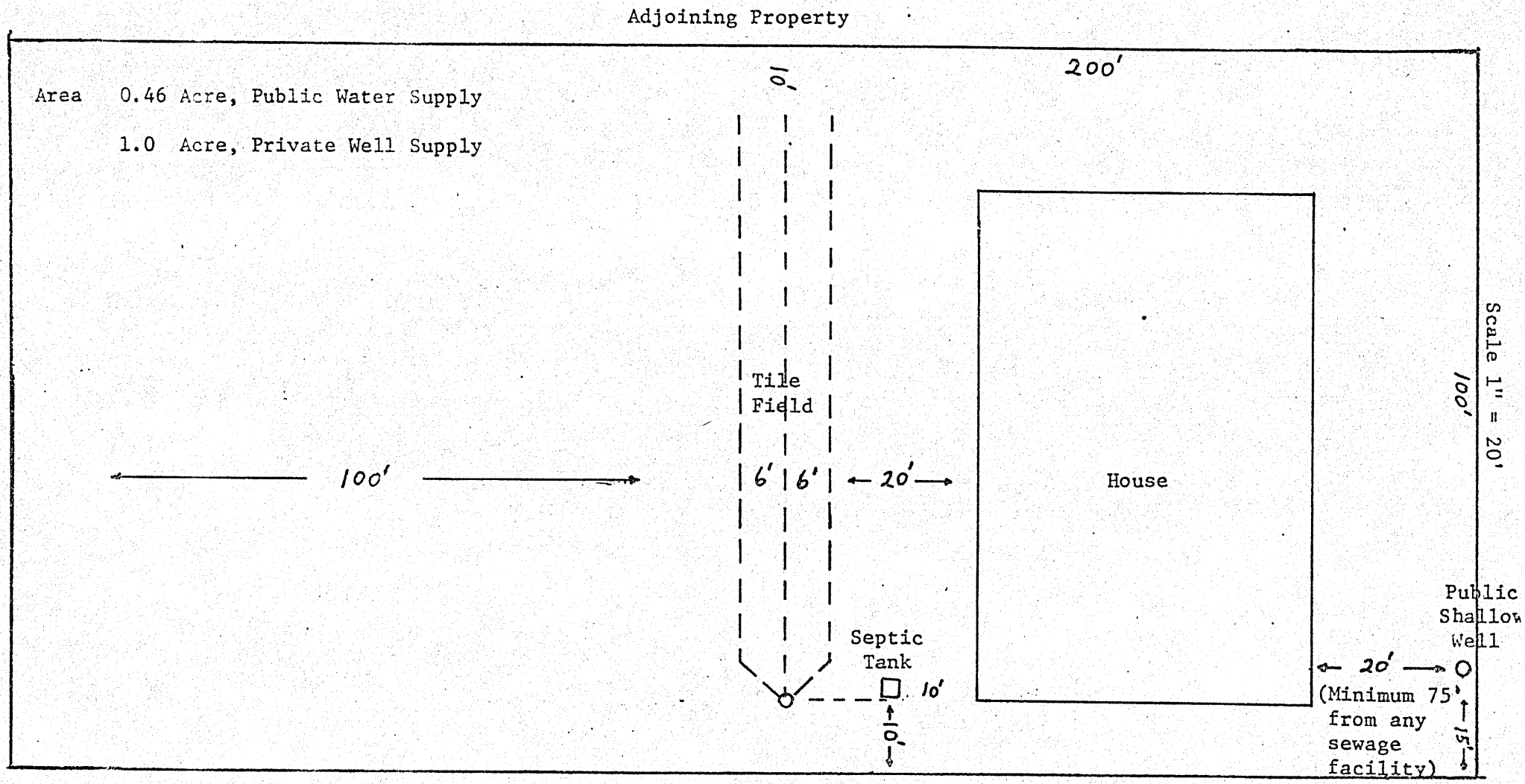
_____ 43,560 ft^2 of lot is required for the installation of a septic tank and absorption system if a private well supplies the lot.

_____ A septic tank and absorption line can be installed and operated on a lot which is greater than 20,000 ft^2 if the lot is supplied by a public water supply system.

_____ No subsurface absorption system shall be installed where the percolation rate is faster than 5 minutes per inch.

_____ An evapotranspiration system, but not an absorption system, may be used when the percolation rate is slower than 60 minutes per inch.

RURAL HOME - TYPICAL LAYOUT
All Distances Minimum



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460005
44 42 32.8 096 28 40.2 1
COCHRANE IN DEUEL COUNTY
46039 SOUTH DAKOTA
HUDSON BAY 2304
MINNESOTA RIVER
21SDAKOI 771110
0000 FEET DEPTH CLASS 00 CSN-RSP 0310366-0553246

/TYPA/AMBNT/LAKE

DATE FROM TO	TIME OF DAY	DEPTH FEET	00011 WATER TEMP FAHN	00021 AIR TEMP FAHN	00300 DO MG/L	00400 PH SU	31616 FEC COLI MFM-FCBR /100ML	31615 FEC COLI MPNECMED /100ML	00610 NH3+NH4-N TOTAL MG/L	00608 NH3+NH4-N DISS MG/L	00625 TOT KJEL N MG/L	70507 PHOS-T ORTHO MG/L P
75/09/03	16 30		74.0	77.0	12.8		3K					0.024
75/11/13	11 00		32.0	30.0	11.6			3K		0.040		
75/12/21	12 00		32.0	18.0	13.1			3K		0.210		
76/05/23	15 00		32.0	55.0	11.8		600			0.310		0.022
76/05/24	11 00		62.0	64.0	10.1		3K			0.020		0.017
76/08/02	16 30		65.0	66.0	7.9		3K			0.020K		0.019
76/09/14	11 30		66.0	61.0	8.5		3K			0.020		0.024
76/11/17	12 00		32.0	38.0	12.3		3K			0.190		0.011
77/01/18	11 30		32.0	10.0	6.0		3K			0.540		0.019
77/05/08	11 45		32.0	40.0	4.2		3K			0.520	1.880	0.005K
77/05/03	16 30		51.0	57.0	6.8		3K			0.230	1.600	0.009
77/08/09	16 00				9.3		3K		0.020K		1.510	
77/12/13	09 30		32.0	33.8	11.1		3K		0.310		1.520	0.005
78/03/07	16 00		32.0	17.6			3K		0.650		2.110	0.022
78/05/11	14 00		57.2	68.0	10.6		3K		0.410		1.630	0.007
78/08/02	16 30		72.0	66.0	11.5		3K		0.040		1.030	0.005K
78/08/30	11 30		72.0	78.0	7.5		3K		0.020K		2.400	0.025
78/10/12	11 45											
CP(S)-G*	AVE		52.0	56.0	10.2	8.35	3K		0.060		1.450	0.005K
78/10/12	12 15											
78/11/15	10 15											
CP(S)-G	AVE		32.0	28.0	13.0	8.65	3K		0.060		1.300	0.005K
78/11/15	10 45											
78/12/12	11 00											
CP(S)-G	AVE		32.0	32.0	12.0	8.60	3K		0.150		1.300	0.005K
78/12/12	11 30											
79/01/11	10 30		32.0	2.0	10.0	8.50	7		0.260		1.530	0.005K
79/04/25	11 20											
CP(S)-G	AVE		39.0	59.0	9.0	8.35	3		0.310		1.200	0.005K
79/04/25	11 45											
79/05/16	10 50											
CP(S)-G	AVE		54.0	63.0	9.4	8.35	330		0.220		1.330	0.011
79/05/16	11 15											
79/06/11	10 50											
CP(S)-G	AVE		62.0	70.0	9.1	8.65	3		0.020K		1.670	0.005K
79/06/11	11 20											

*CP(S)-G AVE This indicates that the results are of a composite sample taken from several locations on the lake.

STORET RETRIEVAL DATE 81/05/21.

/TYPA/AMBNT/LAKE

460005
44 42 32.8 096 28 40.2 1
COCHRANE IN DEUEL COUNTY
46039 SOUTH DAKOTA
HUDSON BAY 2304
MINNESOTA RIVER
21SDAK01 771110
0000 FEET DEPTH CLASS 00 CSN-RSP 0310366-0553248

DATE FROM TO	TIME OF DAY	DEPTH FEET	00930 SODIUM NA,DISS MG/L	00916 CALCIUM CA-TOT MG/L	00915 CALCIUM CA,DISS MG/L	00927 MGNSIUM MG,TOT MG/L	00925 MGNSIUM MG,DISS MG/L	00620 NO3-N TOTAL MG/L	00618 NO3-N DISS MG/L	00613 NO2-N DISS MG/L	00940 CHLORIDE CL MG/L	00945 SULFATE SO4-TOT MG/L
75/09/03	10 30			87.9		395.0		1.000K			22	1800
75/11/13	11 00		105.00		90.3		415.0		1.00K		21	
75/12/21	12 00		115.00		97.9		455.0		1.00K		25	
76/03/23	15 00			43.6		107.0		1.000K			5	489
76/05/24	11 00			87.9		402.0		1.000K			21	1820
76/08/02	10 30			87.7		432.0		1.000K			22	1960
76/09/14	11 30			92.8		460.0		1.000K			22	2040
76/11/17	12 00			104.0		521.0		1.000K			31	2240
77/01/18	11 30			113.0		580.0		0.040		0.000	31	2570
77/05/08	11 45			117.0		599.0		0.100K		0.010	30	2590
77/05/03	10 30			85.7		437.0		0.100K		0.010	24	2000
77/08/09	16 00							0.100K		0.010K	32	2220
77/12/13	09 30							0.100K		0.010	27	2250
78/03/07	10 00							0.100K		0.010K	38	2520
78/05/11	14 00							0.100K		0.010	19	1790
78/08/02	10 30							0.100		0.010K	19	1830
78/08/30	11 30								0.10K	0.010	13	522
78/10/12	11 45											
CP(S)-C	AVE							0.100K		0.010K	20	1990
78/10/12	12 15											
78/11/15	10 15											
CP(S)-G	AVE							0.100K		0.010K	20	2020
78/11/15	10 45											
78/12/12	11 00											
CP(S)-G	AVE							0.100K		0.010K	21	2130
78/12/12	11 30											
79/01/11	10 30							0.100K		0.010K	23	2320
79/04/25	11 20											
CP(S)-G	AVE							0.100		0.010K	17	1650
79/04/25	11 45											
79/05/16	10 50											
CP(S)-G	AVE							0.100K			19	1740
79/05/16	11 15											
79/06/11	10 50											
CP(S)-G	AVE							0.100K		0.010K	19	1720
79/06/11	11 20											

STORET RETRIEVAL DATE 81/05/27

460005
44 42 32.8 096 28 40.2 1
COCHRANE IN DEUEL COUNTY
46039 SOUTH DAKOTA
HUDSON BAY 2304
MINNESOTA RIVER
21SDAK01 771110
0000 FEET DEPTH CLASS 00 CSN-RSP 0310366-0553248

/TYPA/AMBNT/LAKE

DATE FROM TO	TIME OF DAY	DEPTH FEET	00671 PHOS-DIS ORTHO MG/L P	70505 T PO4 P-COL MG/L	70506 SOL PO4- T P-COL MG/L	00095 CNDUCTVY AT 25C MICROMHO	00500 RESIDUE TOTAL MG/L	00530 RESIDUE TOT NFLT MG/L	00515 RESIDUE DISS-105 C MG/L	00403 LAB PH SU	00410 T ALK CACO3 MG/L	00929 SODIUM NA,TOT MG/L
75/09/03	16 30			0.04		2700	3098	17	3081	8.8	246	101.00
75/11/13	11 00		0.024		0.03	3010	3185	176	3009	8.6	246	
75/12/21	12 00		0.019		0.03	3450	3409	103	3306	8.5	273	
76/05/23	15 00			0.04		1010	863	51	812	7.8	102	26.10
76/05/24	11 00			0.03		2820	3198	33	3165	8.7	246	104.00
76/08/02	10 30			0.04		3060	3433	23	3410	8.8	252	113.00
76/09/14	11 30			0.05		3230	3728	21	3707	8.8	260	121.00
76/11/17	12 00			0.03		3770	3872	12	3860	8.5	265	127.00
77/01/18	11 30			0.04		2990	4495	9	4486	8.3	330	150.00
77/03/08	11 45			0.03		4080	4449	74	4375	8.2	329	144.00
77/05/03	10 30			0.04		3330	3401	69	3332	8.4	251	108.00
77/08/09	16 00		0.015	0.05		3570	3836		3833	8.8	256	
77/12/13	09 30			0.03		3500	3722	226	3496	8.3	250	
78/03/07	16 00			0.03		3900	4187	21	4166	8.0	299	
78/05/11	14 00			0.02		2800	3263	86	3177	8.3	231	
78/08/02	16 30			0.03		2950	3236	150	3086	8.9	229	
78/08/30	11 30			0.06		1150	1071	89	982	9.0	154	
78/10/12	11 45											
CP(S)-6	AVE			0.04		3100	3242	138	3104	8.7	232	
78/10/12	12 15											
78/11/15	10 15											
CP(S)-6	AVE			0.03		3100	3326	177	3149	8.6	239	
78/11/15	10 45											
78/12/12	11 00											
CP(S)-6	AVE			0.03		3200	3484	122	3362	8.6	254	
78/12/12	11 30											
79/01/11	10 30			0.02		3420	3729	128	3601	8.4	270	
79/04/25	11 20											
CP(S)-6	AVE			0.04		2440	2657	191	2466	8.3	199	
79/04/25	11 45											
79/05/16	10 50											
CP(S)-6	AVE			0.03		2720	2991	158	2833	8.4	218	
79/05/16	11 15											
79/06/11	10 50											
CP(S)-6	AVE			0.02		2800	3158	136	3022	8.6	218	
79/06/11	11 20											

STORET RETRIEVAL DATE 81/05/27

460005
44 42 32.8 096 28 40.2 1
COCHRANE IN DEUEL COUNTY
46039 SOUTH DAKOTA
HUDSON BAY 2304
MINNESOTA RIVER
21SDAK01 771110
0000 FEET DEPTH CLASS 00 CSN-RSP 0310366-0553248

/TYPA/AMBNT/LAKE

DATE FROM TO	TIME	DEPTH FEET	00011 WATER TEMP FAHN	00021 AIR TEMP FAHN	00300 DO MG/L	00400 PH SU	31616 FEC COLI MFM-FCBR /100ML	31615 FEC COLI MPNECMED /100ML	00610 NH3+NH4- N TOTAL MG/L	00608 NH3+NH4- N DISS MG/L	00625 TOT KJEL N MG/L	70507 PHOS-T ORTHO MG/L P
79/07/11	08	15										
CP(S)-G	AVE		72.0	73.0	9.8		3		0.020K		1.610	0.005K
79/07/11	08	45										
79/08/15	11	45										
CP(S)-G	AVE		68.0	64.0	8.4	8.50	3K		0.020K		1.310	0.010
79/08/15	12	15										

DATE FROM TO	TIME	DEPTH FEET	00671 PHOS-DIS ORTHO MG/L P	70505 T PO4 P-COL MG/L	70506 SOL PO4- T P-COL MG/L	00095 CNDUCTVY AT 25C MICROMHO	00500 RESIDUE TOTAL MG/L	00530 RESIDUE TOT NFLT MG/L	00515 RESIDUE DISS-105 C MG/L	00403 LAB PH SU	00410 T ALK CACO3 MG/L	00929 SODIUM NA,TOT MG/L
79/07/11	08	15										
CP(S)-G	AVE			0.04		2800	3421	329	3092	8.9	224	
79/07/11	08	45										
79/08/15	11	45										
CP(S)-G	AVE			0.06		2800	3114	65	3049	8.8	244	
79/08/15	12	15										

DATE FROM TO	TIME	DEPTH FEET	00930 SODIUM NA,DISS MG/L	00916 CALCIUM CA-TOT MG/L	00915 CALCIUM CA,DISS MG/L	00927 MGNSIUM MG,TOT MG/L	00925 MGNSIUM MG,DISS MG/L	00620 NO3-N TOTAL MG/L	00618 NO3-N DISS MG/L	00613 NO2-N DISS MG/L	00940 CHLORIDE CL MG/L	00945 SULFATE SO4-TOT MG/L
79/07/11	08	15										
CP(S)-G	AVE							0.100K		0.010K	16	1730
79/07/11	08	45										
79/08/15	11	45										
CP(S)-G	AVE							0.100K		0.010K	17	1760
79/08/15	12	15										

STORET RETRIEVAL DATE 81/05/27

46D003
44 57 15.0 096 48 47.0 1
BULLHEAD IN DEUEL COUNTY
46039 SOUTH DAKOTA
HUDSON BAY 2304
MINNESOTA RIVER
21SDAKOI 771110
0000 FEET DEPTH CLASS 00 CSN-RSP 0510364-0553246

/TYPA/AMONT/LAKE

DATE FROM TO	TIME OF DAY	DEPTH FEET	00011 WATER TEMP FAHN	00021 AIR TEMP FAHN	00300 DO MG/L	00400 PH SU	31616 FEC COLI MFM-FCBR /100ML	31615 FEC COLI MPNECMED /100ML	00610 NH3+NH4-N TOTAL MG/L	00608 NH3+NH4-N DISS MG/L	00625 TOT KJEL N MG/L	70507 PHOS-T ORTHO MG/L P
77/08/09	14	30	73.4	73.4	9.3					0.330	4.140	
77/12/13	11	30	32.0	33.8	4.5		3K			0.810	5.390	
78/03/07			32.0	19.4	6.0		3K			2.370	7.120	
78/05/11	12	15	60.6	66.2	11.6		3K			0.790	3.970	
78/08/02	15	25	70.0	64.0	7.4		3K		1.940		3.950	0.014

DATE FROM TO	TIME OF DAY	DEPTH FEET	00671 PHOS-DIS ORTHO MG/L P	70505 T PO4 P-COL MG/L	70506 SOL PO4-T P-COL MG/L	00095 CNDUCTVY AT 25C MICROMHO	00500 RESIDUE TOTAL MG/L	00530 RESIDUE TOT NFLT MG/L	00515 RESIDUE DISS-105 C MG/L	00403 LAB PH SU	00410 T ALK CACO3 MG/L	00929 SODIUM NA,TOT MG/L
77/08/09	14	30	0.035	0.14		1960	2027		1993	9.0	250	
77/12/13	11	30	0.011	0.12		1960	1833	79	1754	7.9	286	
78/03/07			0.024	0.10		2700	2658	22	2636	7.6	443	
78/05/11	12	15	0.016	0.11		1440	1510	5	1505	8.6	246	
78/08/02	15	25		0.07		1590	1515	22	1493	8.3	268	

DATE FROM TO	TIME OF DAY	DEPTH FEET	00930 SODIUM NA,DISS MG/L	00916 CALCIUM CA-TOT MG/L	00915 CALCIUM CA,DISS MG/L	00927 MGNSIUM MG,TOT MG/L	00925 MGNSIUM MG,DISS MG/L	00620 NO3-N TOTAL MG/L	00618 NO3-N DISS MG/L	00613 NO2-N DISS MG/L	00940 CHLORIDE CL MG/L	00945 SULFATE SO4-TOT MG/L
77/08/09	14	30							0.10	0.010K	30	
77/12/13	11	30						0.100K		0.010	24	920
78/03/07								0.100K		0.010	36	1350
78/05/11	12	15						0.100K		0.010	15	620
78/08/02	15	25						0.100K		0.010	16	710

FINAL REPORT

LAKE COCHRANE PERIMETER ROAD-SEDIMENT TRAPS PROJECT

by

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East Dakota Conservancy Sub-District
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EPA CLEAN LAKES GRANT NO. S804248-01-2

Ron Eddy, Project Officer
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Water Quality Division
Denver, Colorado 80203

ABSTRACT

Lake Cochrane is one of the few deep high quality prairie lakes in northeastern South Dakota. Local interests tried unsuccessfully for several years to develop measures to reduce sediment inflow. The proposal to develop sediment traps as a part of the lake's perimeter road system was selected for a grant award under EPA's "Clean Lakes" program initiated in 1975.

This small lake preservation project utilized the technical and/or financial resources of every level of government. For an allocated cost of about $20,000, three sediment traps were developed to control the sediment inflow from 66% of the lake's watershed area. By incorporating the sediment traps into the perimeter road system, 2700 feet of new gravel road, the sediment traps, and a new boat access area were constructed at a cost of $34,700. In addition, two of the sediment traps have been utilized as fish rearing ponds.

Due to limited data and numerous sediment-nutrient producing activities occurring concurrently, it has been difficult to evaluate the impact of the project on the lake. Preliminary evidence indicates good suspended solids removal in the sediment traps. There is evidence, however, that temporary storage of runoff water may not provide any nutrient removal. A comprehensive evaluation program needs to be developed.

The completed project has demonstrated a low cost, effective technique for reducing sediment inflow into a lake which may have application in other areas.

SECTION 1

INTRODUCTION

THE LAKE COCHRANE RESOURCE

Lake Cochrane is a very pretty 366-acre lake located close to the South Dakota-Minnesota border in Deuel County, South Dakota. The lake has intermitten surface water inflow, very infrequent surface outflow, and moderate groundwater recharge. Although the Prairie Coteau region in northeastern South Dakota has about 250 natural lakes, Lake Cochrane is one of a very few having a maximum depth greater than 200 feet.

The lake was ranked into the first priority grouping by the South Dakota State Lakes Preservation Committee (1977), meaning that it was ranked as one of the top ten lake resources of eastern South Dakota.

The lake is unique in this area in that it did not experience a noticeable algal bloom until the summer of 1971. Prior to this 1971 algal bloom, most local people felt that the lake would remain "crystal clear" forever.

Figure 1 is a map showing Lake Cochrane, its drainage area, and the surrounding area.

The total direct drainage area of the lake is very small at about 765 acres.

PROBLEMS AFFECTING THE LAKE

The major watershed problem affecting the lake before this project was developed was the sediment-nutrient inflow from three small drainage areas located on the southwest side of the lake. Heavy shoreline and lake bottom sediments found in that area provided strong evidence that these three watershed inflows were adversely affecting the lake.

The other main input of lake sediments and nutrients prior to 1976 was erosion and runoff resulting from sometimes careless construction of lakeshore residences. Although there are a number of lakeshore residences, seepage from domestic wastes has

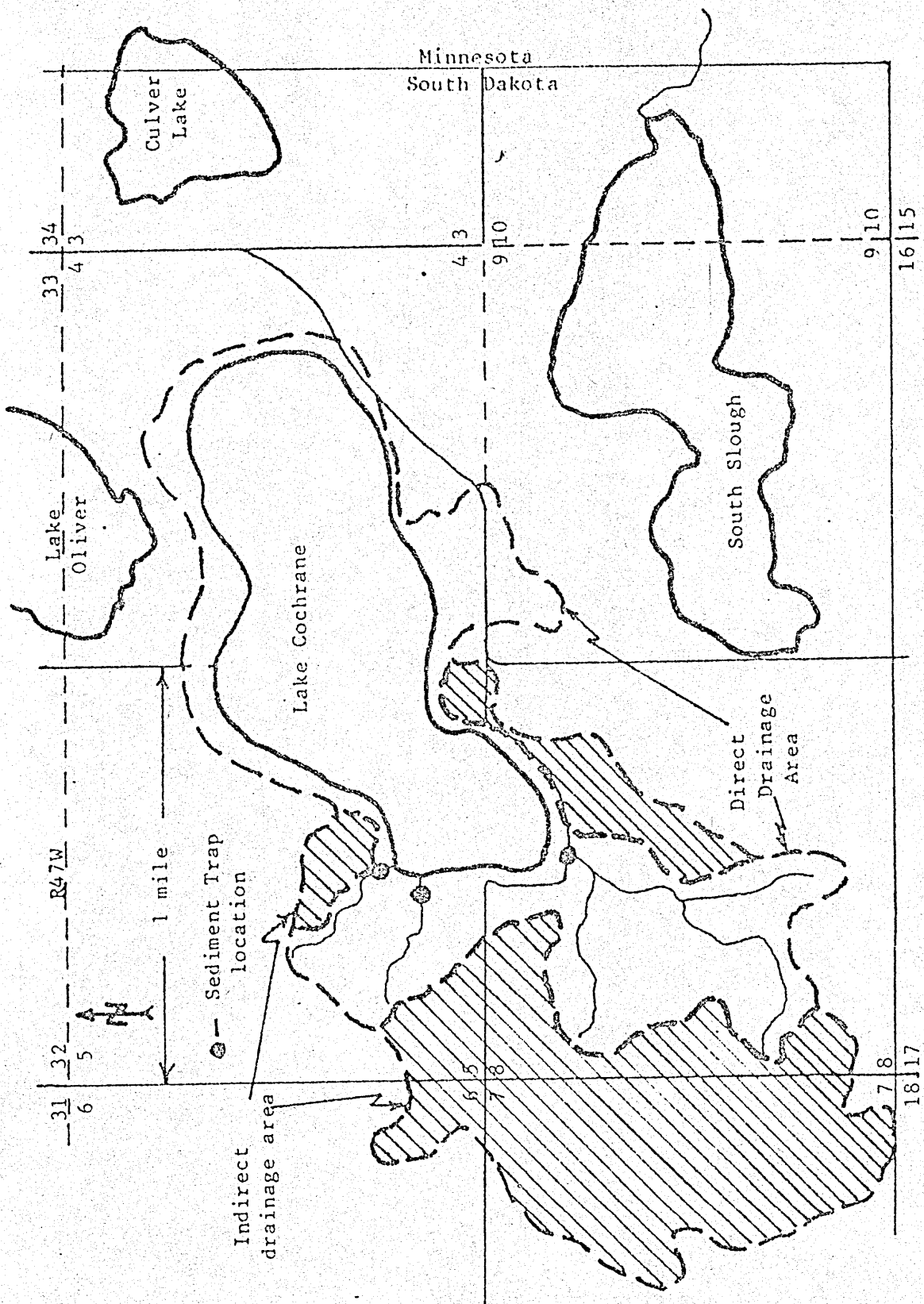

Figure 1. Map showing Lake Cochrane, the lake watershed, and surrounding area.

been minor due to a strong push to install sealed tanks as opposed to septic tanks and drainfields.

PUSH FOR ACTION TO PRESERVE THE LAKE

The urgency for reducing sediment and nutrient inflows received a strong boost from the 1971 algal bloom which was the first major evidence that this lake was becoming euthrophic. This interest received another boost in study reports prepared by Dr. Lois Haertel (1972), a biologist at South Dakota State University, and by Douglas Hansen (1973), a Watershed Biologist for the South Dakota Department of Game, Fish and Parks. Both reports strongly recommended development of sediment control measures for the lake.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

This project accomplished the stated project objective of demonstrating a low cost, effective technique for reducing sediment inflow into a lake by incorporating sediment traps into either existing or new roads located along the perimeter of the lake.

Nearly every high quality, heavily used lake has some type of access road developed around all or a portion of the perimeter of the lake. The landowners along this road system are generally willing to participate in efforts to preserve the lake because the quality of the lake directly affects their land values and their enjoyment of the lake.

Limited water quality data collected as a part of this project and research conducted by Dr. Haertel (1978) has provided evidence that temporary storage of runoff water will provide a significant reduction of suspended solids but may not provide any nutrient removal. This is a significant conclusion since a large portion of lake sediments in many prairie lakes is organic material produced within the lake itself. Thus, trapping inorganic sediments in watershed control structures while allowing nutrients which stimulate lake productivity to pass through will reduce but will not stop the filling of a lake with sediment and will not likely improve lake water quality.

The development of sediment control was cost effective under this multi-purpose technique because the road function financed a portion of the cost of the (a) earth fill, (b) structures to carry water through the roadway and (c) land rights.

This technique in many instances would have the following advantages:

(a) Because land requirements for developing sediment control measures are reduced, land rights are also generally easier to secure.

(b) The sediment control structures by being located on the perimeter road are located relatively close to the lake; thus sediments are restricted from adjacent

lands which often contribute a high percentage of the lake's sediment load.

(c) By being located on a road, access for operation and maintenance purposes is much easier.

It is recommended that a comprehensive, well-planned monitoring program be developed which is geared to evaluating the efficiency of these sediment traps and their specific impact on the quality of Lake Cochrane.

The project facilities offer an opportunity to research the effectiveness of two different sediment trap designs. More importantly, the sediment traps with controlled drawdown tubes offer an important research facility for making a thorough evaluation of the impact of temporary versus more permanent water storage on nutrient removal efficiency. As noted above, the initial evaluation of this project has indicated that temporary water storage may not have a positive impact on lake water quality beyond restriction of inorganic sediments. There are many important questions in this regard that need to be answered before large amounts of public funds are used to develop sediment and/or nutrient control measures for shallow glacial lakes in the United States.

SECTION 3

DEVELOPMENT OF LAKE PRESERVATION PROJECT

DEVELOPMENT OF PROJECT CONCEPT AND GRANT PROPOSAL

In the early 1970's various local and state interests in eastern South Dakota began searching in earnest for methods and programs to accomplish the goal of developing sediment control measures for Lake Cochrane. They explored the possibility of reconstructing an existing township road crossing the lake's largest drainage course to make it function as a sediment trap. At the same time there was a strong interest in completing the perimeter road system around the lake's western side where the next two largest drainage inlets are located. Unsuccessful attempts were made to secure funds through the U.S. Department of Agriculture, South Dakota's Water Resources Institute and other programs.

The project did not fit any ongoing program in the early 1970's.

The U.S. Environmental Protection Agency, in releasing the first $4 million of funds appropriated under Sections 104(h) and 314 of PL92-500 in 1976, stressed that high priority would be given to lake preservation and/or restoration proposals that

(a) would demonstrate innovative new techniques,

(b) would attack sources of lake problems such as sediment-nutrient inflows, and

(c) could have wide application.

The East Dakota Conservancy Sub-District, working with other local interests, developed a project proposal to construct three low-cost sediment traps; the first by redesigning and reconstructing an existing township road and the other two by altering the design of a proposed new perimeter road where it would cross the two other main drainage inlets. The proposal was one of eleven projects in six states initially funded under the new federal "Clean Lakes" program.

TECHNICAL ASPECTS OF MULTI-PURPOSE PROJECT FEATURES

The multi-purpose project features were as follows:

(a) Construction of 2700 feet of gravel road, this completing the lake's perimeter road system.

(b) Development of three sediment traps, thus reducing the sediment inflow from 66% of the lake's total direct drainage area.

(c) Development of a major new boat access area. This access area was developed as a multi-purpose use of a needed project borrow pit.

(d) Multi-purpose use of two of the sediment traps as fish rearing ponds by the South Dakota Department of Game, Fish and Parks.

The two sediment traps incorporated into the construction of the new road (known as Sites 1 and 2), shown in Figure 2, were designed with manually controlled drawdown openings to allow permanent storage of water if desired up to the top of the riser pipes.

A schematic diagram of the sediment trap developed by reconstruction of the existing road (known as the Cochrane Site) is shown in Figure 3. Water cannot be permanently impounded because it has an uncontrolled drawdown tube.

Table 1 contains summary design information for all three sediment traps.

TABLE 1. DESIGN SUMMARY FOR ALL THREE SEDIMENT TRAPS

Design Feature	New Road		Existing Road
	North Site	South Site	Cochrane Site
Drainage Area (Acres)	41	57	411
Height of Fill (Feet)	15	19	7
Pool height at main overflow tube (Feet)	10	11	4
Storage at main overflow tube (Ac-ft)	5.0	3.4	11.6
Length - Main overflow tube (Feet)	108	128	84
Diameter - Main overflow tube (Inches)	24	24	30
Diameter - Riser pipe (Inches)	30	30	
Diameter - Drawdown tube or opening (Inches)	9	9	12
Controlled drawdown tube	Yes	Yes	No

MULTI-AGENCY PARTICIPATION IN PROJECT DEVELOPMENT

It is pertinent to review the participation of the six main governmental entities involved in the development of the overall project.

At the local level, Deuel County and Norden Township played a strong role by financing the construction of the new road and securing easements for the entire project. The county also handled the construction contracts for the project.

At a multi-county level, the East Dakota Conservancy Sub-District provided a $10,000 grant toward the additional cost of incorporating the three sediment traps into the road system. The Sub-District also applied for and administered the EPA "Clean Lakes" grant and served as overall project coordinator

At the state level, the Department of Game, Fish and Parks contributed $3,000 in cash and designed and supervised the construction of the new road portion of the project.

At the federal level, the Soil Conservation Service, assisting the local Deuel County Conservation District, designed and supervised the reconstruction of the Cochrane Site and EPA provided a $9,906 grant toward the allocated cost of incorporating the three sediment traps into the road system.

Whenever a large number of entities are involved in the financing, design, construction and/or operation of a project, there is the strong likelihood that problems will develop. The five non-federal entities sought to avoid such problems by discussing in detail and arriving at clear-cut agreements on all aspects of project development. These agreements were incorporated into a five-party Memorandum of Agreement which all parties signed.

OBJECTIVES OF THE DEMONSTRATION PROJECT

According to the grant application, the objective of the project was to demonstrate a simple low-cost method of reducing lake sediment and nutrient inflow which should have wide applicability in the United States and to demonstrate the technique for both existing and planned new perimeter road systems.

PROJECT ACTIVITIES DURING GRANT PERIOD

It was noted in the original grant proposal that the Soil Conservation Service would design all project works. When all the non-federal entities met on August 21, 1976 and developed a Memorandum of Agreement for the project, it was decided to have the Department of Game, Fish and Parks design Sites 1 and 2 since the Department had offered to design and supervise construction of the road itself.

After the EPA grant was officially awarded on January 8, 1976 local entities took immediate steps to secure needed project easements and to ready the project for construction.

In early March the Project Manager notified Barbara Schroeder, who was placed in charge of the project by EPA officials in Denver, that Deuel County was ready to open bids for the project and asked for instructions. Construction bids were opened for the new road portion of the project on March 29, 1976 with six firms bidding. Halstead and Lewis Construction of Brookings, South Dakota submitted the low bid of $21,089.47 which was accepted by the county commissioners.

Bids were opened by the commissioners for the Cochrane Site on April 20. The commissioners awarded the contract to Annet Construction, Inc. of Milbank, South Dakota who submitted a low bid of $6,912.

On June 8, Bruce Perry, EPA-Denver, informed the Project Manager that John Brink was replacing Barbara Schroeder as Project Officer. On June 22, Mr. Brink toured the project and noted he was impressed with the construction work in progress.

The Game, Fish and Parks Department Engineer noted after a June 23 inspection of the new road portion of the project that

SECTION 4

RESULTS AND DISCUSSION

ECONOMIC FEASIBILITY OF THE TECHNIQUE

The cost of developing the sediment traps was reduced below the costs of normal development under this lake preservation technique because the raod function financed a portion of the cost of

(a) the earth fill,

(b) structures to carry water through the roadway, and

(c) needed land rights for the structures.

The full cost of reconstructing the existing road was allocated to the lake project since the road was already suitable for transportation purposes. The existing road fill and road easements reduced the costs of this construction, however.

Due to these multi-function cost savings, the cost allocated to the sediment traps was slightly less than $20,000.

The $20,000 allocated to the lake preservation project covered the following items not required in normal road construction.

(a) Flood easements for the sediment pool areas;

(b) Rip-rap of the face of these areas;

(c) Increased fill height and width to provide desired water storage;

(d) Excavation and refilling of a core trench, and

(e) Increased costs resulting from design changes in the drainage structures; the added cost resulting from the need for caulked, close-riveted seams, water seepage collars and secondary overflow tubes is somewhat counterbalanced because when water can be stored behind the road fill, the diameter and thus the cost of the main drain tubes can be reduced.

TECHNICAL EFFECTIVENESS

Concurrent Impact of Other Activities

It is somewhat difficult at this point to draw definite conclusions on the impact of the completed sediment traps on lake water quality because very limited project data have been collected on the actual inflow-outflow of the sediment traps. It is very difficult to evaluate the sediment traps using in-lake data because of the concurrent impact on the lake of a number of sediment-nutrient producing construction activities. This construction has included a number of lakeshore homes, a new state park area on the north side of the lake, and the project works including the associated new road.

In addition, the lake area exprienced a severe drought during 1974-77 which reduced normal surface and groundwater inflows and resulted in a lower than normal lake level.

Summary of Project Water Quality Data

There were no funds in the EPA grant to cover water quality monitoring. During the period of the grant, water quality samples were generally collected bi-monthly by the Project Manager under a cooperative East Dakota Conservancy Sub-District/Department of Environmental Protection lake monitoring program. Samples were analyzed by the State Health Laboratory in Pierre. It was difficult to meet grant requirements for chlorophyll a data since none of the main water quality laboratories in the state were equipped to analyze chlorophyll a.

The grantee did contract with Randall Brich, a Department of Biology graduate student at South Dakota State University, in July, 1977 for collect of chlorophyll a data which is shown in Table 2.

TABLE 2. LAKE CHOCHRANE CHLOROPHYLL a DATA

Station	Chlorophyll a mg/l - Average of 3 grab samples		
	8/16/77	9/4/77	9/22/77
1-S (southwest bay - surface)	12.1	11.2	11.4
3-S (northeast quadrant - surface)	13.1	10.4	13.2
3-B (northeast quadrant - bottom)	11.3	11.6	12.9

All water quality data collected under this grant agreement has been transmitted to the EPA regional office in Denver.

Table 3 contains average annual values for selected water quality parameters for the period 1975-1978.

TABLE 3. AVERAGE VALUES OF SELECTED WATER QUALITY PARAMETERS

	Unit	1975	1976	1977	1978
No. of Samples		3	5	4	4
Conductivity	micromho	3053/22	2782/23	3535/24	2700/23
Suspended Solids	mg/l	99	28	103	87
NH_3-N	mg/l	.125	.11	.34	.28
Ortho PO_4-P	mg/l	.022	.018	.011	.014
Total PO_4-P	mg/l	.034	.037	.036	.087

Table 4 contains values for selected constituents from samples collected and analyzed from the three sediment traps during the spring runoff of 1978.

TABLE 4. ANALYSIS OF SEDIMENT TRAP INFLOW/OUTFLOW

Parameter		Cochrane Site (uncontrolled drawdown) Inflow/Outflow		Inflow/Outflow		Inflow/Outflow	
			March 29, 1978				
Suspended Solids	mg/l	121	17	25	-	31	-
NH_3-N	mg/l	.23	.48	.037	-	.07	-
TKN-N	mg/l	1.65	1.21	1.67	-	.086	-
Ortho PO_4-P	mg/l	.089	.150	.033	-	.082	-
Total PO_4-P	mg/l	.168	.192	.111	-	.131	-
			April 4, 1978				
Suspended Solids	mg/l	54	25	40	23	33	8
NH_3-N	mg/l	.15	.19	.34	.19	.04	.07
TKN-N	mg/l	.72	.80	1.71	.073	.82	.70
Ortho PO_4-P	mg/l	.060	.108	.027	.018	.044	.053
Total PO_4-P	mg/l	.075	.135	.075	.038	.062	.067

These limited samples indicate good removal of suspended solids in the sediment traps.

Project Evaluation through other Research

Dr. Lois Haertel (1978) has evaluated lake water quality and algal abundance before, during and after construction of the sediment dams through a grant funded by the Office of Water Resources Research and Technology. Her data is much more complete than the project data noted above. The most recent project evaluation report is contained in the Appendix.

OPERATION OF THE SEDIMENT TRAPS

Effects of Design and Use for Fish Rearing

Multi-purpose use of two of the sediment traps as fish rearing ponds imposed two requirements in this case (a) the sediment traps had to be designed with manually controlled devices to close the drain tubes during spring and early summer and (b) efficient removal of the fingerlings required emptying the water in the sediment trap which allowed nutrient-laden runoff water to pass into the lake as noted below.

Use of the sediment traps for fish rearing might have either a desirable or undesirable impact on nutrient concentrations in the ponds. This aspect should be evaluated further.

Nutrient Removal Efficiency

For sediment control purposes only a structure is designed to reduce the velocity of water to the point that suspended solids will drop to the bottom of the pool area. This requires very little storage time except for the very fine sediment particles.

Theoretically a significant portion of the phosphorus load will be trapped along with these sediments because phosphorus is presumed to be attached to the soil particles. The limited sampling from the spring runoff of 1978, however, did not indicate good phosphorus removal. The phosphorus may be attached to the very fine particles which do not readily settle and stay at the bottom of the pond.

Nitrogen is dissolved in the runoff water and according to Dr. Haertel is probably equal in importance to phosphorus as a limiting factor in algal production in Lake Cochrane. A long detention period will be required for nitrogen removal in the sediment pools because the nitrogen will need to be taken up by plant growth.

Table 2. Difference between Measurements of Variables above and below Sediment Control Dams (ppm)

Year	1977		1978									1977	1978
Date	5/3	9/20	4/20	5/16	5/31	6/14	6/28	7/12	7/26	8/17	8/31	Mean	Mean
# reps			1	2	2	2	2	2	2	2	2		
Dam #			#2	#2	#2	#2	#2	#2	#2	#2	#2		
Above-below:*													
NO_3-N	.47	-.01	.20	.06	-.95	-.04	-.08	-.02	-.11	-.26	-.24	.23	-.16
NH_3-N	.05	-.10	.10	-.05	-.32	-.15	-.60	-.70	.45	-.33	-.23	-.03	-.20
Org.-N	0	-.05	-.18	-.12	.02	.28	-.31	.23	-.22	-.05	.77	-.03	.05
Ortho-PO_4	.02	.02	-.02	-.01	-.05	-.73	-1.22	-.12	.08	.18	.34	.02	-.17
Total-PO_4	.06	.09	-.02	.01	.04	-.97	-1.57	-.59	-.48	.10	.32	.08	-.36
HCO_3	0	-	120	-65	76	-109	-89	-85	-111	-144	-114	0	-58
CO_3	0	-	0	5	0	0	0	0	0	-5	-39	0	-4
Si	-0.4	-	-	-2.1	7.5	-9.8	-8.8	6.7	-8.4	-22.0	-21.3	-.02	-15.3

*A negative value means the concentration was higher below the sediment control dam than above it.