SUITABILITY OF WATER QUALITY FOR FISH PROPAGATION, WATERFOWL HABITAT, LIVESTOCK WATERING, AND RECREATIONAL USE AT 12 RESERVOIRS IN EASTERN MONTANA

By Rodger F. Ferreira and John H. Lambing

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CONVERSION FACTORS

The following factors can be used to convert from the International System of units (SI) in this report to the equivalent inch-pound units.

Multiply SI unit	By	To obtain inch-pound unit
hectare (ha)	2.471	acre
kilometer (km)	0.6214	mile (mi)
meter (m)	3.281	foot
microsiemens per centimeter at 25° Celsius (μS/cm)	1.000	micromho per centimeter at 25° Celsius
milliliter (mL)	0.0338	ounce (fluid)
millimeter (mm)	0.0394	inch (in.)

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by the formula:

$$°F = 9/5\ (°C) + 32$$

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ABSTRACT

Water-quality samples were collected at 12 reservoirs to determine the suitability of the reservoirs for fish propagation, waterfowl habitat, livestock watering, and recreational use. The reservoirs have an average surface area of about 7.5 hectares and an average depth of about 1.8 meters. Water-quality data from the reservoirs were compared to criteria that are protective of each proposed use.

Of the reservoirs studied, five generally had water quality that would not be detrimental to fish. All the reservoirs had one or more samples that indicated eutrophic conditions.

Three reservoirs had water quality that met all criteria for protection of waterfowl. One reservoir had a small dissolved-oxygen concentration in the bottom water that might be critical to the protection of waterfowl if botulism were to occur. The pH criterion was the most often exceeded criterion for the protection of waterfowl in the study reservoirs.

Three reservoirs met most of the criteria for protection of livestock. Among all reservoirs, the pH criterion for the protection of livestock was most often exceeded. Nine reservoirs contained species of phytoplankton potentially toxic to livestock.

Most of the reservoirs would not be conducive to swimming; turbidity restricted visibility in five of the reservoirs and the pH criterion was exceeded in all but one reservoir. In addition, submersed aquatic plants in most of the reservoirs would be a nuisance to swimmers.

INTRODUCTION

Federal lands in eastern Montana contain several small reservoirs that have an average surface area of about 5 ha and an average depth of about 2.5 m. These reservoirs are formed by earth-filled dams located on small ephemeral streams, which flow mostly during spring snowmelt and summer rainstorms. The U.S. Bureau of Land Management constructed most of the dams to provide water for livestock and to serve as sediment traps for decreasing the sediment load in streams. Outflow of surface water from most of the reservoirs is over the dam although a few have either earthen spillways or riser outlets. Water losses from the reservoirs occur by underground seepage, evaporation from the water surface, and transpiration by aquatic and riparian vegetation.

The U.S. Geological Survey, in cooperation with the U.S. Bureau of Land Management, collected water-quality data from 36 reservoirs in eastern Montana to assess the potential of managing the reservoirs for fish propagation, waterfowl habitat, livestock watering, and recreational use. A previous report describes the water quality of 24 reservoirs in Valley and Phillips Counties (Ferreira, 1983). This report describes the water quality of 12 reservoirs south of the Missouri River. These reservoirs have an average surface area of about 7.5 ha and an average depth of about 1.8 m.

Evaluation of the reservoirs in eastern Montana for fish propagation is based on whether they could maintain populations of game fish year after year. Fish propagation has been successful in a few reservoirs stocked with rainbow trout (*Salmo gairdneri*), largemouth bass (*Micropterus salmoides*), and crappie (*Pomoxis* sp.). However, in some reservoirs, problems could occur during certain times of the year that would prevent sustaining a resident fish population. Fish might grow well in certain reservoirs during the summer, but because of adverse water-quality changes under ice, these same fish might be unable to survive during winter. Other reservoirs might have good growing conditions for fish during the entire year but never have the required water quality for proper embryonic development.

Montana is located in the central flyway region of North America and provides many species of waterfowl with fresh and brackish water for nesting and feeding areas. Waterfowl utilize areas that range from temporarily flooded meadows to lakes several meters deep (Johnsgard, 1975). Reservoirs in eastern Montana could provide an increased number of breeding and stopover areas for waterfowl, which include Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), and pintails (*Anas acuta*). Unlike fish, waterfowl are not restricted to reservoirs they utilize. If the habitat is not satisfactory, waterfowl will not be attracted. Most studies of the welfare of waterfowl are concerned primarily with habitat improvement. Assuring that water quality is favorable for aquatic plants and unfavorable for disease organisms indirectly protects waterfowl.

Grazing livestock in eastern Montana generally consist of cattle, sheep, and horses. Water-quality criteria pertaining to these animals are based on the daily quantity of water each type of animal consumes. A common problem with a reservoir used for livestock watering is that detrimental concentrations of water-quality variables can result from improper management of livestock in the drainage area. This study is concerned with the concentrations of water-quality variables that would be detrimental to the welfare of the animal, rather than concentrations that would satisfy dietary requirements.

Recreation, as defined in this report, involves prolonged body contact with water. Body contact includes wading, swimming, and diving. For convenience, the term "swimming" will be used to include all three types of recreation. The greatest concern during swimming is the risk of ingesting water in quantities sufficient to pose a health problem if bacterial contamination is present.

Purpose and scope

The purpose of this report is to compare physical, chemical, and biological data from 12 reservoirs in eastern Montana to water-quality criteria for the proposed reservoir uses. Comparisons of the data to water-quality criteria are used to identify those reservoirs having water quality that might preclude successful management for fish propagation, waterfowl habitat, livestock watering, or recreational use. Water-quality values that do not meet the criteria indicate that detrimental conditions exist or that conditions during sampling pose a potential risk to the proposed reservoir use. Although certain management decisions can be based on this study, this report does not address the number and types of fish that can be stocked, specific improvements that would create more waterfowl habitat, or the maximum number of cattle that a given reservoir can sustain.

In 1980, specific conductance, pH, water temperature, and dissolved oxygen were profiled with depth in the reservoirs. These profiles were complemented with water samples collected for chemical and biological analyses. Most of the reservoirs were visited in February, May, and August. Limited access or complete desiccation of some of the reservoirs prevented sample collection during one or two of these sampling periods.

Study area

The study area is in eastern Montana, and extends from Fort Peck Lake to the southeastern corner of the State at the Wyoming border (fig. 1). Reservoir names and locations are listed in table 1. Each reservoir is described in the section Supplemental Information, Reservoir Descriptions.

Much of the land surface consists of gently rolling hills slightly eroded by intermittent and ephemeral streams. Natural vegetation of the region generally is sparse, but grasses such as Blue Grama (*Bouteloua gracilis*), Western Wheatgrass (*Agropyron smithii*), and Green Needlegrass (*Stipa viridula*) generally are adequate to support cattle in many areas. Willow (*Salix* spp.) and cottonwood (*Populus sargentii*) trees, as well as Kentucky Bluegrass (*Poa pratensis*), grow in localized areas where water is abundant.

The study was conducted in an area of eastern Montana commonly referred to as the Fort Union coal region. The hydrogeology of this region was mapped and described by Stoner and Lewis (1980). Some of the major geologic units underlying the reservoir watersheds are, in ascending order, the Bearpaw Shale and Hell Creek Formation of Late Cretaceous age and the Fort Union Formation of Tertiary (Paleocene) age.

The Bearpaw Shale consists of gray to black claystone and shale with thin beds of siltstone, sandstone, or bentonite occurring locally. This formation occurs predominantly in the southeastern part of the study area and along Cedar Creek. The Bearpaw Shale produces a gumbo soil that becomes slick and undrivable when wet.

The Hell Creek Formation is composed of olive-gray clayey shale and siltstone and fine- to medium-grained sandstone. A few thin lignite and subbituminous coal beds exist locally. The Hell Creek Formation is prevalent near Fort Peck Lake and in parts of the Cedar Creek drainage.

The Fort Union Formation occurs extensively throughout the central part of the study area and is the principal coal-bearing formation in the region. Light-gray to brown carbonaceous shale and siltstone occur throughout the formation. Thick beds of coal and sandstone in the Tongue River Member of the Fort Union Formation are major aquifers in the region.

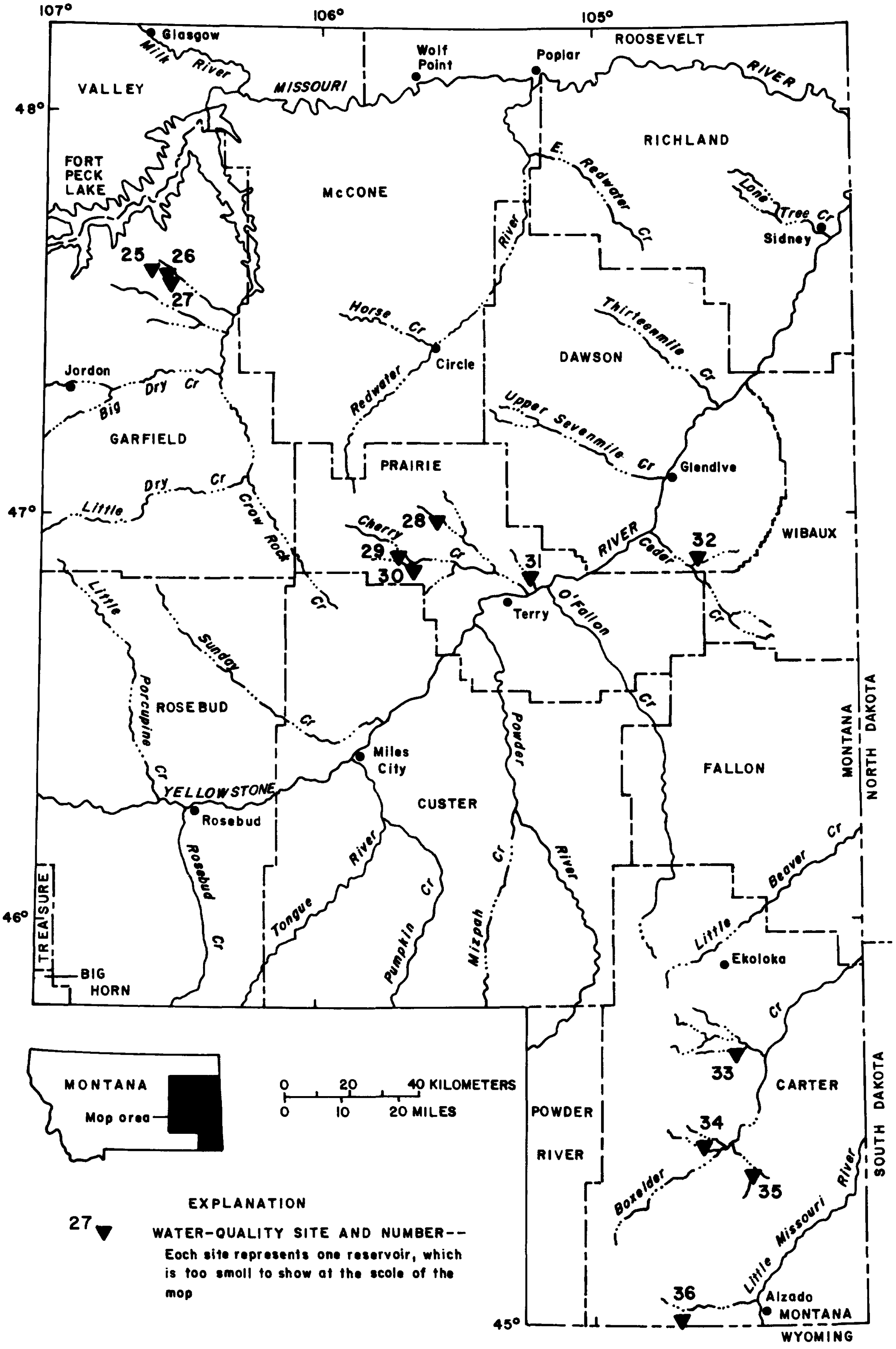

Figure 1.--Location of study area and reservoir water-quality sites.

Table 1.--*Name and location of reservoirs sampled*

Reservoir name	Number [1] (fig. 1)	Location			
		Land-line	Latitude	Longitude	County
Pass Creek Reservoir	25	sec. 5, T. 21 N., R. 40 E.	47°36'23"	106°36'38"	Garfield
Mid-Flat Creek Reservoir	26	sec. 4, T. 21 N., R. 40 E.	47°36'29"	106°35'32"	Garfield
Coldwell Reservoir No. 2	27	sec. 10, T. 21 N., R. 40 E.	47°35'27"	106°34'00"	Garfield
Homestead Reservoir	28	sec. 1, T. 14 N., R. 49 E.	47°00'30"	105°33'30"	Prairie
Clark Reservoir	29	sec. 18, T. 13 N., R. 48 E.	46°53'10"	105°42'20"	Prairie
Grant Reservoir	30	sec. 21, T. 13 N., R. 48 E.	46°52'23"	105°38'40"	Prairie
Coal Creek Reservoir	31	sec. 35, T. 13 N., R. 51 E.	46°50'50"	105°14'55"	Prairie
Big Drop Reservoir	32	sec. 9, T. 13 N., R.56 E.	46°53'39"	104°38'36"	Dawson
Jack Rabbit Detention Reservoir	33	sec. 13, T. 2 S., R. 58 E.	45°39'33"	104°29'57"	Carter
Ridge Reservoir	34	sec. 1, T. 5 S., R. 57 E.	45°25'49"	104°37'30"	Carter
Sidney Reservoir	35	sec. 29, T. 5 S., R. 59 E.	45°22'06"	104°28'22"	Carter
Side Hill Reservoir	36	sec. 34, T. 9 S., R. 57 E.	45°00'57"	104°42'52"	Carter

[1] Numbers consecutive with previous report (Ferreira, 1983).

Climate

The climate of eastern Montana is classified as continental and is characterized by large diel changes in temperature, low relative humidity, and little annual precipitation Moderate winds occur during much of the year. Summers are warm and typically sunny except for occasional localized rainshowers. Severe cold waves are common during the winter, but usually are of short duration.

Mean annual air temperatures from selected weather stations in the study area ranged from 5.8 to 7.4°C during 1971-80. The warmest month usually is July with a mean temperature of 22°C. January generally is the coldest month with a mean temperature of -11°C.

Mean annual precipitation at weather stations in the study area from 1971 to 1980 ranged from 316 to 459 mm. Generally, about one-half of this precipitation falls during May, June, and July. Annual snowfall varies from 890 to 1,270 mm; however, snow seldom accumulates to great depths because of intermittent thaws and wind. In general, conditions during the study (1980) were warmer and drier than mean annual conditions from 1971 to 1980.

METHODS OF DATA COLLECTION

Nine of the 12 reservoirs sampled were visited 3 times during 1980. The remaining three reservoirs were either dry or inaccessible during at least one sampling period. Sampling periods were chosen to characterize the reservoirs when limnological conditions would be most critical to the proposed reservoir uses. The first sampling was in late February when ice covered the reservoirs and prevented exchange of gases with the atmosphere. The second sampling was in May when no ice cover was present and the reservoirs were presumably at their maximum stage and well-mixed. The third sampling was in August when air temperatures were high and the possibility of thermal stratification and development of anoxic conditions in the hypolimnion was greatest.

Each reservoir was sampled at one location near the dam in what was estimated to be the deepest part of the original stream channel. Vertical profiles of specific conductance, pH, water temperature, and dissolved oxygen generally were measured at 0.5 m intervals with a multiparameter water-quality instrument on each visit.

At the same location as the profiles, water samples were collected during the May and August visits with a Kemmerer[1] water sampler. Reservoirs deeper than 2 m were sampled near the water surface and near the bottom. Reservoirs less than 2 m deep were sampled at middepth. All samples were pretreated onsite following methods of the U.S. Geological Survey (Friedman, 1979). Chemical constituents in water samples were analyzed at the U.S. Geological Survey laboratory in Denver, Colo., using methods described by Skougstad and others (1979). Samples for phytoplankton identification and enumeration were analyzed by a private laboratory.

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[1] The use of named products in this report is for identification only and does not imply endorsement by the U.S. Geological Survey.

Densities of total coliform, fecal coliform, and fecal streptococcus bacteria were determined from grab samples of water collected at the chemical sampling site and near the shore of each reservoir. Onsite analysis of bacterial samples followed techniques described by Greeson and others (1977).

Presence of benthic invertebrates was noted at each reservoir site. Bottom sediment was collected with an Eckman grab sampler having jaw dimensions of 152 x 152 mm to obtain samples for noting benthic invertebrates colonized away from shore.

As an indication of turbidity, depth of light penetration was estimated with a Secchi disk as the average depth of disappearance and reappearance of a black and white disk 200 mm in diameter (Hutchinson, 1967). Depth of the euphotic zone was determined with a relative irradiance meter, which was used at 0.5-m intervals to measure the percentage of light transmitted through the water column. The level at which light transmitted equals 1 percent of the incident surface light is considered to be the maximum depth at which photosynthesis equals respiration during the day (Talling, 1962).

RATIONALE FOR WATER-QUALITY CRITERIA

Water-quality criteria are recommended values which, if met, will protect most, but not necessarily all, aquatic life and wildlife. The water-quality criteria are based on physical measurements, major dissolved constituents, plant nutrients, trace elements, and biological analyses. Water-quality variables used as criteria are different for each proposed reservoir use. Reservoir uses considered in this report are fish propagation, waterfowl habitat, livestock watering, and recreational use. For each use, a set of several variables was included to provide a broad base for evaluation. In the following sections, the importance of several water-quality variables and processes that could prevent the reservoirs from meeting the criteria is discussed.

Water depth

Sediment transported by inflowing water accumulates in all reservoirs and results in a decrease in water depth with time. Inflows of sediment can transport nutrients and other constituents that increase the productivity of reservoirs. Generally, reservoirs that are decreased to 5 m or less in depth by sediment accumulation are enriched in nutrients and commonly have resultant phytoplankton concentrations that could cause stressful conditions for fish.

Although the depth of reservoirs is used mainly as a criterion indicative of eutrophic water, it can have an effect on other criteria. The large ratio of surface area to depth in shallow reservoirs allows a larger percentage of the total volume of water to be evaporated per unit time than in deep reservoirs. Because of this larger percentage of water loss, the rate of concentrating dissolved constituents during the summer is increased in shallow reservoirs. The larger percentage of water loss from ice formation during winter also results in a faster rate of concentrating dissolved constituents in shallow reservoirs compared to deep reservoirs.

Secchi-disk depth

All natural waters contain matter which is in either the dissolved or the suspended-particulate form. Although both forms can impart a color to the water, the suspended particulate form has the greatest effect on water clarity (Wetzel, 1975). Turbidity caused by suspended particulate matter can be estimated by the Secchi-disk depth. In many productive lakes suspended particulate matter is composed mostly of phytoplankton, resulting in Secchi-disk depths of 2.5 m or less. Because phytoplankton populations continually change throughout the season, water clarity also changes. In some lakes suspended particulate matter can be composed mostly of sediment, which could effectively suppress phytoplankton production by reflecting light needed for photosynthesis.

As a matter of safety, a water-clarity criterion for swimming is visibility from the surface to a depth of 1.2 m, which can be indicated by the Secchi-disk depth. This value is more critical in areas where people might be diving.

Dissolved solids and specific conductance

Dissolved-solids (salt) concentrations were calculated by summing major dissolved constituents determined for each water sample (Skougstad and others, 1979). Many plant and animal species are limited by dissolved-solids concentrations, although tolerance varies considerably among different species.

Large concentrations of dissolved solids can cause detrimental physiological effects in fish. Dissolved-solids concentrations in excess of 15,000 mg/L (milligrams per liter) are reported as unsuitable for most species of freshwater fish (Rawson and Moore, 1944; U.S. Environmental Protection Agency, 1977b). Most salmonids have been reported to survive dissolved-solids concentrations of 20,000 mg/L for 30 days (Forster and Goldstein, 1969). However, Swingle (1956) reports that concentrations in excess of 5,000 mg/L are unsuitable for spawning of largemouth bass (*Micropterus salmoides*), a species stocked in some reservoirs in the study area. Therefore, 5,000 mg/L is used as a safe limit for dissolved-solids concentration in this report. Based on the average ratio (1.6) between specific conductance and dissolved-solids concentrations of water samples collected in the 24 reservoirs previously studied in Valley and Phillips Counties, Montana (Ferreira, 1980; 1983), the corresponding calculated limit for specific conductance would be 8,000 µS/cm.

Many fish can tolerate wide ranges in dissolved-solids concentrations. However, their ability to survive changes in dissolved-solids concentration depends on the time they have to acclimate to the new concentration. In shallow reservoirs, because the rate of concentrating dissolved solids is faster than in deep reservoirs, the acclimation time for fish is decreased, resulting in more stressful conditions.

Water with excessive concentrations of dissolved solids can cause physiological distress or death of livestock. McKee and Wolf (1963) indicate that Montana water having a maximum dissolved-solids concentration of 2,500 mg/L is good for all livestock, and water having a dissolved-solids concentration of 3,500 mg/L is considered fair for livestock. The criterion selected for this study is based on a report by the National Academy of Sciences and National Academy of Engineering (1973), which states that 3,000 mg/L of dissolved solids is satisfactory for all livestock under most conditions. Based on the average ratio between specific conductance and dissolved solids of samples collected from several reservoirs in Valley and Phillips Counties, Montana, the specific-conductance criterion for protection of livestock would be 4,800 μS/cm.

pH

Values of pH larger than 8.0 in many reservoirs result from carbon dioxide (CO_2) intake by aquatic plants during photosynthesis (Vallentyne, 1974). Nighttime respiration and decomposition, which add CO_2 to the water, can decrease pH to toxic conditions.

Water having pH of less than 4.5 is toxic to most species of fish, although fish can be affected adversely at a pH of 5.0 (Fritz, 1980). In general, large concentrations of hydrogen ions, expressed as a small pH, affect fish by disrupting normal physiological processes. This disruption can increase the susceptibility of fish to disease and cause shifts in the degree of predator-prey relationships. Both extremely large and extremely small concentrations of hydrogen ions also can increase the availability of toxic substances in water. Therefore, pH values ranging from 6.5 to 9.0 are considered protective of fish and fish food organisms (U.S. Environmental Protection Agency, 1977b). A more specific interpretation of the effects of pH on fish is difficult because toxic effects differ among species, populations, and age groups of the same species.

The pH criterion for waterfowl is 7.0 to 9.2, based on values at which submersed aquatic plants thrive best (National Technical Advisory Committee to the Secretary of the Interior, 1968). The range of pH values listed as water-quality criteria is compared to pH of the study reservoirs during spring and summer when aquatic plants are at their maximum growth.

The pH of water is important to livestock because the concentration of hydrogen ions affects the solubility of toxic elements in water. Limits for pH (5.0 to 9.0) are the suggested criteria for domestic water supplies (U.S. Environmental Protection Agency, 1977b). Values of pH less than or greater than these limits could indicate potential toxicity from trace elements.

The lacrimal fluid of the human eye has a normal pH of about 7.4. Although strongly buffered, once buffering capacity of the fluid is exhausted during swimming, eye irritation results. Swimmers' eyes could become irritated if the fluid in contact with the eye changes as little as 0.1 pH unit (National Technical Advisory Committee to the Secretary of the Interior, 1968). With eye irritation, there also could be subsequent infection. In most waters with pH values ranging from 6.5 to 8.3, the buffering capacity of lacrimal fluid will prevent eye irritation during swimming (National Technical Advisory Committee to the Secretary of the Interior, 1968).

Water temperature

Water temperature is one of the most important water-quality variables affecting chemical and biological processes. Temperature affects the reaction rate and solubilities of chemicals in water; it also controls spawning and hatching of young, regulates their activity, and stimulates or suppresses their growth and development. Generally, with increased temperatures, both the chemical reaction rates within the reservoir and the activity and metabolic rates of organisms increases, toxicity of certain constituents in water increases, synergistic actions of these constituents become more severe, and organisms subjected to stress from toxic material are less tolerant of temperature extremes (U.S. Environmental Protection Agency, 1977b; Mackenthun, 1969).

Because temperature is such a major factor controlling life processes, many species of fish have been studied to determine optimum water temperatures required for reproduction. Maximum water temperatures tolerated by several species of fish during growth, spawning, and embryo development are given in table 2.

Increased water temperature does not have a direct detrimental effect on waterfowl habitat, livestock watering, or recreational use like it does on fish production. In fact, with increasing water temperature, waterfowl habitat potentially could improve as a result of increased plant production, which provides more food and cover. In addition, waterfowl, livestock, and swimmers can immediately respond by not using a reservoir if the water temperature is not satisfactory. Because of the ability of waterfowl, livestock, and swimmers to immediately respond to water temperature, and because of the numerous water-temperature criteria for fish, water temperature of the reservoirs is not compared to criteria in this report. However, temperature data presented in table 14 (Supplemental Information section at back of report) can be used by fisheries managers for comparison with maximum temperatures of the type given in table 2 for individual fish species.

Table 2.--*Maximum weekly average water temperatures for growth and spawning, and short-term maximum water temperatures for embryo survival of selected fish species during the spawning season*[1]

Common name	Species	Water temperature, in degrees Celsius, for indicated condition		
		Growth	Spawning	Embryo survival
Black crappie	*Pomoxis nigro maculatus*	27	17	20
Bluegill	*Lepomis macrochirus*	32	25	34
Largemouth bass	*Micropterus salmoides*	32	21	27
Rainbow trout	*Salmo gairdneri*	19	8	15
Smallmouth bass	*Micropterus dolomieui*	29	17	23
White crappie	*Pomoxis annularis*	28	18	23
Yellow perch	*Perca flavescens*	29	12	20

[1] From U.S. Environmental Protection Agency (1977b).

Dissolved oxygen

A major concern in reservoirs managed for fish propagation is the availability of dissolved oxygen. Oxygen solubility in water is a function of water temperature, atmospheric pressure, and dissolved-solids concentration. Aquatic plants, through photosynthesis, produce oxygen during the day. Photosynthesis can cause an increase in the dissolved-oxygen concentration in water to more than saturation. Respiration by organisms and decomposition of organic matter are the main factors in water that can decrease the dissolved-oxygen concentration to less than saturation. For most reservoir uses, large dissolved-oxygen concentrations are desirable.

The natural progression in the successional stages of a reservoir generally is a slow change from an oligotrophic state (unenriched with plant nutrients) to an eutrophic state (enriched). This process is termed eutrophication. An increase of nutrients can significantly increase algal concentrations; then because of nighttime respiration without production, dissolved oxygen can decrease to concentrations that are detrimental to other aquatic organisms. Nutrient and phytoplankton analyses can be used to indicate the trophic state of reservoirs. If reservoirs are eutrophic, the potential exists that small dissolved-oxygen concentrations may occur.

Dissolved-oxygen requirements of fish depend on their species, age, and physiological condition. Although some species of fish tolerate concentrations of dissolved oxygen less than 5.0 mg/L, this limit is considered to be the minimum concentration needed to maintain a diverse fish population (U.S. Environmental Protection Agency, 1977b). Dissolved-oxygen concentrations that become extremely small can result in fishkills. In eutrophic reservoirs, an oxygen deficit can exist in water where gases are prevented from exchanging with the atmosphere. This condition can occur during winter under snow-covered ice and during the summer in the deep water of stratified lakes (Nickum, 1970). After oxygen has been depleted by respiration and decomposition, fish additionally could be stressed from toxic effects of large concentrations of hydrogen sulfide (H_2S) (Johnson, 1970). Hydrogen sulfide is produced by sulfur-reducing bacteria during anaerobic decomposition (Hem, 1960).

Disease accounts for the largest percentage of nonhunting deaths of waterfowl (Bellrose, 1976). Botulism, which is caused by the anaerobic bacterium *Clostridium botulinum*, is a disease that can reach epidemic proportions. Water that does not become anaerobic helps prevent the spread of botulism. Therefore, reservoirs that have large dissolved-oxygen concentrations throughout the water column during non-ice periods would be more suitable for waterfowl habitat than reservoirs that are anaerobic (0 mg/L dissolved oxygen) near the bottom.

Alkalinity

Alkalinity is a measure of the ability of water to buffer acid (hydrogen ions). To provide safety for fish against changes in hydrogen-ion loading (pH), which in turn affects the toxicity of other constituents, the National Technical Advisory Committee to the Secretary of the Interior (1968) recommends a minimum alkalinity of 20 mg/L as calcium carbonate ($CaCO_3$).

Generally, few water bodies with total alkalinity less than 25 mg/L as $CaCO_3$ have been observed to support aquatic plants favorable to waterfowl. In temperate climates, shallow reservoirs with alkalinity concentrations greater than 25 mg/L as $CaCO_3$ and with a good supply of nutrients can develop extensive growths of aquatic plants (Boyd, 1971). Aquatic plants not only benefit waterfowl but also provide food and shelter for other aquatic organisms that become additional food for waterfowl and fish.

Nitrogen and phosphorus

Although nitrogen and phosphorus are major plant nutrients, they can be toxic in large concentrations. Nitrogen (N) can be toxic in the form of un-ionized ammonia (NH_3) or nitrite (NO_2^-). In water, ammonia exists in both the un-ionized form (NH_3) and the ionized form (NH_4^+); however, most chemical analyses report both forms together as aqueous ammonia (NH_3 + NH_4^+). The percentage of un-ionized ammonia increases with temperature and pH (Thurston and others, 1974).

Concentrations of aqueous ammonia for which the un-ionized ammonia component exceeds the criterion (0.016 mg/L NH_3 as N, U.S. Environmental Protection Agency, 1977b) for the protection of fish are given in table 3. In most reservoirs, the percentage of un-ionized ammonia increases during late summer as a result of a general increase in pH with photosynthesis and a general increase in water temperature.

Table 3.--*Concentrations of aqueous ammonia (NH_3 + NH_4^+) as nitrogen (N) that contain an un-ionized ammonia concentration of 0.016 milligram per liter of NH_3 as N* [1,2]

[°C, degree Celsius]

Temperature (°C)	Concentration, in milligrams per liter, for indicated values of pH								
	pH--6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
0	200	63	20	6.3	2.0	0.65	0.22	0.079	0.036
5	130	42	13	4.1	1.3	.43	.15	.058	.030
10	88	28	8.9	2.8	.90	.30	.10	.044	.025
15	60	19	6.0	1.9	.62	.21	.076	.035	.022
20	41	13	4.2	1.3	.43	.15	.058	.030	.021
25	29	9.1	2.9	.93	.31	.11	.045	.026	.019
30	20	6.5	2.1	.66	.22	.081	.037	.023	.019

[1] Modified after Thurston and others (1974).

[2] (NH_3 + NH_4^+) as N equals nitrogen ammonia dissolved as N in the table of selected plant nutrients (table 16 in Supplemental Information section at back of report).

Nitrite interferes with oxygen transport in the bloodstream of animals, including fish. Most studies (Russo and others, 1974; Russo and Thurston, 1975) indicate that salmonids (salmon, trout, whitefish, and grayling) are more sensitive to large concentrations of nitrite than are warm-water species (bass, sunfish, and minnows). The U.S. Environmental Protection Agency (1977b) concludes that 5 mg/L NO_2^- as N would be protective of warm-water fish and 0.06 mg/L NO_2^- as N would be protective of salmonids. For this study a safe criterion of 0.06 mg/L NO_2^- as N is used for the protection of all fish. Concentrations of this magnitude generally are unlikely in most surface waters because of oxidation to the nitrate ($NO_3^=$) form. However, such concentrations can be attained in water intensely used by livestock where animal wastes accumulate.

The nitrite criterion for protection of livestock is 10 mg/L NO_2^- as N. Nitrate generally is much less toxic to livestock than nitrite; however, because the biological reduction of nitrate ($NO_3^=$) forms nitrite in the rumen of cattle and sheep, a criterion of 100 mg/L $NO_2^- + NO_3^=$ as N also is used.

Elemental phosphorus in large concentrations is considered toxic to fish. However, because this form of phosphorus rarely occurs in natural water, it is not included as a criterion. The most probable forms of phosphorus in natural waters are phosphate ions, complexes with metal ions, and colloidal particulate material. Although these forms of phosphorus are not considered toxic to animals, they can stimulate plant growth to nuisance conditions. All forms of phosphorus indirectly can be toxic to fish and other organisms if toxic forms of algae, particularly blue green algae, are stimulated to excessive growths.

Trace elements

Trace elements are included in water-quality criteria because of their possible toxic effects when concentrations are large. Different species of organisms and different life stages of the same species are able to tolerate different trace-element concentrations. Prescribing suitable criteria to protect each species would result in a number of values for each criterion. Therefore, the trace-element concentrations used for criteria in this study are approximate averages to protect most of the organisms considered.

In addition to the species of fish, trace-element toxicity will differ according to the form of the ion (valence) and synergistic effects of other water-quality variables. Criteria concentrations for trace elements that are protective of fish generally are small because of the continuous exposure of fish gill structure to ions dissolved in water. However, the most recent criterion for mercury is 0.00057 μg/L (microgram per liter) (U.S. Environmental Protection Agency, 1980a; 1980b); this concentration is so small that the detection limit of 0.1 μg/L for mercury analyses in this study is of limited use in evaluating potential mercury hazards.

The most commonly occurring trace element causing toxicity to waterfowl is lead. Lead poisoning in waterfowl occurs mainly from the toxic effect of ingested lead shot and not from concentrations of lead in water. Studies have indicated that ingestion of a single lead shot can result in a bird's death (Bellrose, 1976).

Criteria for trace-element concentrations in water for the protection of livestock apply to all types of livestock. The margin of safety the criteria provide varies depending on the species of livestock, the conditions to which they are acclimated, and their health.

Trace-element concentrations toxic to man are not included as criteria for swimming, because the quantities most likely to be ingested would not be toxic. However, if there is a possibility of large quantities of water being ingested over a long time, 2.0 μg/L of mercury, 10 μg/L of cadmium or selenium, and 50 μg/L of chromium, lead, or silver are drinking water standards that would provide protection for swimmers (U.S. Environmental Protection Agency, 1977a).

Phytoplankton, benthic invertebrates, and fecal bacteria

Biological analyses that would be helpful in evaluating the study reservoirs are species identification of phytoplankton and benthic invertebrates and enumeration of fecal bacteria. A balance of benthic invertebrates and phytoplankton would be beneficial as food organisms for fish and waterfowl. Fecal bacteria are not beneficial; when present in large numbers, they indicate that water-quality conditions may be unsuitable for recreation.

Although phytoplankton serve as food for some fish and other aquatic organisms (particularly zooplankton), large phytoplankton concentrations can result in small dissolved-oxygen concentrations (see Dissolved-oxygen section). Large phytoplankton concentrations generally occur in early spring when nutrients are transported to the reservoirs with spring runoff, and late summer when warm water temperatures stimulate phytoplankton reproduction. During these intervals, byproducts from certain phytoplankton taxa can attain concentrations potentially toxic to livestock and other animals that drink water at these reservoirs.

The presence of benthic invertebrates in a reservoir generally indicates the availability of food for fish and waterfowl. A large number of organisms evenly distributed among several taxa (types) of organisms indicates a balanced stable community that would be best for fish propagation.

Wastes from warm-blooded animals probably are the most significant potential sources of waterborne pathogens (bacteria that cause diseases in man). Pathogens that are responsible for diseases of the intestinal tract include species of the genera *Salmonella, Shigella, and Escherichia* (Greeson, 1981). Diseases of the skin, eyes, ears, nose, and urogenital system also can be contracted from waterborne pathogens. Pathogens that occur in bathing waters and can cause disease even when not ingested are *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* (U.S. Environmental Protection Agency, 1977b).

The use of fecal coliform bacteria as a water-quality criterion for swimming is related to the probable occurrence of waterborne pathogens for a given concentration of fecal coliform bacteria. In freshwater, *Salmonella* sp. has been recovered in 85 to 98 percent of samples having fecal coliform concentrations ranging from 201 to 2,000 organisms per 100 mL (U.S. Environmental Protection Agency, 1977b) and could be near 100 percent with fecal coliform concentrations greater than 2,000 organisms per 100 mL (Geldreich, 1972).

The criterion for fecal coliform for the protection of swimmers is based on a minimum of five samples collected during an interval of 30 days. According to the U.S. Environmental Protection Agency (1977b), the log mean of fecal coliform bacteria samples should not exceed 200 coliform organisms per 100 mL for the protection of people who directly contact water by swimming. Because this study was of a reconnaissance nature, the number of fecal coliform samples collected was less than the minimum number specified to compute a log mean. However, a maximum of 200 fecal coliform organisms per 100 mL is used as a criterion in this report to identify reservoirs in which contamination might exist.

The ratio of fecal coliform to fecal streptococcus bacteria (FC/FS) can indicate the source of pollution, particularly in distinguishing human waste from livestock and waterfowl wastes. Although the ratios of fecal coliform to fecal streptococcus bacteria for ducks, sheep, and cattle are shown in figure 2, the ratio from a single sample of water does not necessarily indicate which animal is the source of pollution. A larger number of samples would allow a more accurate interpretation of the pollution source. A significant limitation in the use of bacterial ratios is that a combination of animal types as the source of fecal contamination along with bacterial die-off could yield a ratio similar to the ratio of any one animal type. Therefore, these ratios need close evaluation. If a reservoir is to be developed for swimming, grazing records would be useful in delineating recent livestock sources of fecal contamination as opposed to waterfowl sources.

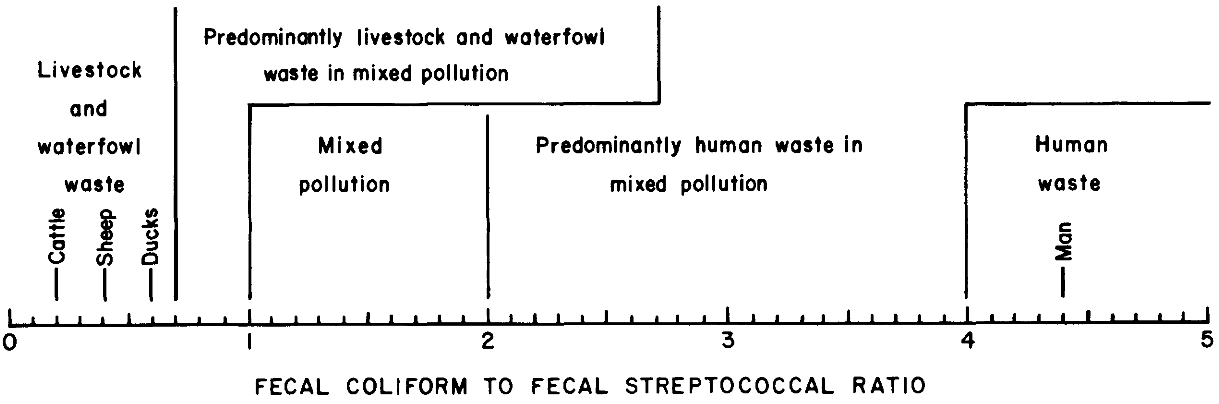

Figure 2.--Relationship of the ratio between fecal coliform and fecal streptococcal bacteria to source of pollution. The ratio equals the number of fecal coliform bacteria per 100 milliliters divided by the number of fecal streptococcal bacteria per 100 milliliters.

COMPARISON OF WATER-QUALITY CRITERIA TO RESERVOIR DATA

Water-quality criteria presented in this report provide a wide range of values within which fish propagation, waterfowl habitat, livestock watering, and recreation can be managed successfully. The criteria are general estimates of the minimum or maximum "safe" water-quality values. Certain species of organisms may require more stringent criteria to be protected fully. A comparison of criteria to data collected from the reservoirs serves only as a guideline for management.

Although samples were collected during the winter, spring, and summer, the reconnaissance nature of this study did not define seasonal or diel water-quality changes in the reservoirs. Substantial seasonal and diel water-quality changes in a reservoir can result from fluctuations in water content and succession of large populations of phytoplankton. At times these water-quality changes can be detrimental to fish, making knowledge of detailed water-quality changes important before any full-scale reservoir management plan can be developed.

Samples from each reservoir were collected from a single location and may not represent conditions at other locations. In addition, replicate analyses were not made; consequently statistical significance of water-quality values that exceed the criteria is not known. Therefore, the possibility exists that a reservoir might be managed successfully even though several water-quality parameters exceed the criteria. However, the suitability of each reservoir for the proposed uses generally can be evaluated by data presented in this report.

Reservoir-data summary

The 12 reservoirs sampled in this study, although generally similar in their physical characteristics, represented a variety of chemical and biological conditions. Water depths at sampling points during May ranged from 0.1 m at reservoir 33 to 3.5 m at reservoir 28 (table 14). Several of the reservoirs had become very shallow by the August sampling period and reservoirs 33 and 34 were dry. Ice thickness during the winter sampling period ranged from 0.2 to 0.5 m and reservoir 33 was frozen solid. Light penetration as estimated by Secchi-disk depths varied among reservoirs and with season. Secchi-disk depths ranged from 0.1 m at reservoir 34 to 3.4 m at reservoir 28 (see Supplemental Information, Reservoir Descriptions).

Specific conductance varied with season at each reservoir (table 14). Maximum values of specific conductance generally occurred during either the winter or the summer sampling, with values for both seasons being similar. With few exceptions, specific conductance increased with depth, and maximum values ranged from 1,180 µS/cm at reservoir 29 to 6,110 µS/cm at reservoir 26. Maximum values exclude the one specific-conductance concentration from reservoir 33, which was collected in the spring. Minimum specific-conductance values ranged from 717 µS/cm at reservoir 33 to 4,720 µS/cm at reservoir 36 and usually occurred during the spring when reservoirs were at their maximum stage.

Dissolved-solids concentration varied with season at each reservoir (table 15 in Supplemental Information section at back of report). The dissolved-solids concentration generally was smallest during the spring sampling, with concentrations ranging from 428 mg/L at reservoir 33 to 2,410 mg/L at reservoir 27. During the summer sampling, dissolved-solids concentrations ranged from 701 mg/L at reservoir 29 to 5,260 mg/L at reservoir 36.

Based on relative quantities of major dissolved cations and anions, the reservoirs can be classified into several water types (table 15). Most of the reservoirs contain sodium sulfate water. However, reservoirs 30 and 33 contain sodium bicarbonate sulfate water, and reservoir 28 has a magnesium sodium sulfate water. Reservoir 29 has significant quantities of calcium in addition to magnesium and sodium, and sulfate as the dominant anion.

Variation in pH with season was evident in some reservoirs but not in others (table 14). The smallest pH (7.6) was measured under the ice at reservoir 36. In many instances, pH decreased with depth although generally not significantly. Maximum pH values ranged from 8.0 at reservoir 36 (August) to 10.5 at reservoir 33 (May).

Water temperature in the reservoirs varied during each sampling in response to changes in ambient air temperatures. Water temperatures ranged from 0.1°C during February in reservoir 26 to 20.8°C during August in reservoir 31 (table 14). None of the reservoirs became thermally stratified although many of them had a temperature gradient from surface to bottom. The weak thermal structure of all the reservoirs indicates that they would be subject to frequent mixing by slight winds. Temperatures larger than 3.9°C during ice cover in reservoirs 28, 29, 30, 31, and 35 could be the result of instrument malfunction or absorption of solar radiation. During sampling in February, ice on the reservoirs was clear with no snow cover; air temperatures during sampling ranged from 1.0 to 17.0°C.

Large dissolved-oxygen concentrations were common at most of the reservoirs, with values near or greater than saturation (table 14). Generally, the percentage of dissolved-oxygen saturation was smaller during August than during February or May. In several reservoirs, dissolved-oxygen maximums occurred near the middle or bottom depths during the February and May visits. The August concentrations generally indicated a decrease in dissolved oxygen with depth. Reservoirs 30, 31, and 36 showed a marked decrease in dissolved oxygen at the bottom during one of the sampling dates. A hydrogen sulfide odor was noted in reservoir 30 and sediments in all three reservoirs were enriched with organic matter.

Nutrient concentrations, as indicated by total nitrogen and total phosphorus, did not change significantly between the May and August samples; however, dissolved organic carbon was almost always greater in August than in May (table 16 in Supplemental Information section at back of report). Total phosphorus concentrations were less than 0.10 mg/L at all reservoirs except reservoir 34 (0.29 mg/L). In addition, reservoir 34 had the largest total nitrogen concentration (8.2 mg/L), which was due primarily to large concentrations of ammonia and organic nitrogen.

Trace-element concentrations were variable among the reservoirs (table 17 in Supplemental Information section at back of report). Of the five trace elements analyzed in two samplings, dissolved manganese and zinc concentrations in many of the reservoirs were larger in the spring than in the summer. Where reservoir samples were collected at two depths, no consistent difference was found between concentrations near the surface and near the bottom.

The concentration of phytoplankton collected from the study reservoirs generally ranged from 180 to 2,900 cells per milliliter (table 18 in Supplemental Information section at back of report). In reservoir 34 a spring bloom of Anabaena spiroides produced more than 1,100,000 cells per milliliter. Generally, the concentration of phytoplankton in the August samples was larger than in the May samples. However, in reservoirs 26, 31, and 32 the largest phytoplankton concentrations occurred in May. There was virtually no difference between the May and August concentrations in reservoir 29. The number of phytoplankton taxa ranged from 5 to 21. In all reservoirs, phytoplankton of the orders *CYANOPHYTA* (blue-green algae) and *CRYPTOPHYTA* (cryptomonads) were most commonly dominant.

Benthic invertebrates were observed in all reservoirs where bed samples were collected (see Supplemental Information, Reservoir Descriptions). In many reservoirs, the benthic invertebrate community consists mainly of scuds (*Amphipoda*), water boatmen (*Corixidae*), and back-swimmers (*Notonectidae*) along the shore. In the bottom sediment of deeper water, midge larvae (*Chironomidae*) generally were abundant along with a few aquatic worms (*Oligochaeta*). In reservoirs with submersed and emersed plants, damselfly nymphs (*Zygoptera*), mayflies (*Ephemeroptera*), caddis flies (*Trichoptera*), and beetles (*Coleoptera*) sometimes were present.

Bacterial analyses indicated a large variation in numbers of bacteria among reservoirs (table 19 in Supplemental Information section at back of report). No consistent differences in bacterial concentration were apparent between midpoint and shore samples or between sampling dates. Most bacterial concentrations were based on non-ideal numbers of colonies per plate, and they serve only as estimates. Fecal coliform concentrations in colonies per 100 mL ranged from <1 at five reservoirs to 295 at reservoir 32. Fecal streptococcus concentrations ranged from <1 at reservoirs 35 and 36 to 2,200 at reservoir 30.

Fish propagation

Water-quality criteria for protection of fish are given in table 4. Comparisons of water-quality data to criteria are given in table 5. Reservoir 28 is within the limits of all but one criterion. Other reservoirs fail to meet the criteria for as many as four variables.

The dissolved-solids criterion for protection of fish was exceeded only in reservoir 36. However, the August dissolved-solids concentrations in reservoirs 26 and 27 were close to 4,000 mg/L, and therefore could possibly exceed the criterion in years of less precipitation. Because reservoir 36 is deeper than reservoirs 26 and 27, the larger dissolved-solids concentration in reservoir 36 probably is a result of differences in local mineralogy rather than water loss through evaporation. The specific-conductance criterion was not exceeded in reservoirs 26, 27, and 36 because of their small mean ratio (about 1.3) of specific conductance to dissolved solids compared to the mean ratio in Phillips and Valley Counties (Ferreira, 1980; 1983).

The pH criterion was exceeded in at least one sample from all the reservoirs except reservoirs 28 and 36. Generally, the pH criterion was exceeded in the August samples. However, in reservoir 32, the May sample rather than August exceeded the pH criterion. These large pH values may decrease to within the criteria at night in response to respiration and decomposition without production. Therefore, the exceedance of pH criteria may not necessarily be significant to fish propagation because fish may be able to survive periods of large pH during the day.

With the exception of reservoir 30, the reservoirs in the study area had dissolved-oxygen concentrations that would not be detrimental to fish. Although reservoirs 31 and 36 had dissolved-oxygen concentrations less than the criterion protective of fish, these small concentrations were restricted to the bottom water during times of thermal stratification. In reservoir 30, the small concentration of dissolved oxygen in most of the water column during winter would be stressful to fish.

All reservoirs had one or more samples that exceeded at least two criteria indicative of eutrophic conditions (tables 6 and 7); therefore, they all have the potential of attaining small dissolved-oxygen concentrations. Of the reservoirs that had dissolved-oxygen concentrations larger than 5.0 mg/L, the potential of attaining dissolved-oxygen concentrations that are detrimental to fish is greatest for reservoir 34. Reservoir 34 had samples that exceeded more criteria indicative of eutrophic conditions than the other reservoirs.

Table 4.--*Criteria for protection of fish against toxicity of selected water-quality variables*

[Abbreviations: mg/L, milligram per liter; µg/L, microgram per liter; µS/cm, microsiemens per centimeter at 25° Celsius; min, minimum; max, maximum; EPA, U.S. Environmental Protection Agency; NTAC, National Technical Advisory Committee to the Secretary of the Interior]

Variable	Criteria			Source
Dissolved solids	5,000 mg/L, max			Swingle (1956).
Specific conductance	8,000 µS/cm, max			See text.
pH	6.5-9.0, min-max			EPA (1977b).
Dissolved oxygen	5.0 mg/L, min			EPA (1977b).
Alkalinity, total	20 mg/L as $CaCO_3$, min			NTAC (1968).
Ammonia, dissolved	0.016 mg/L NH_3 as N, max			EPA (1977b); see table 3.
Nitrite, dissolved	0.06 mg/L NO_2^- as N, max			EPA (1977b).
Arsenic, total	440 µg/L, max			EPA (1980b).
Total recoverable:				
Copper	5.6 µg/L, max			EPA (1980b).
Iron	1,000 µg/L, max			EPA (1977b).
Manganese	1,000 µg/L, max			McKee and Wolf (1963).
Mercury	0.00057 µg/L, max			EPA (1980a).
Selenium	35 µg/L, max			EPA (1980b).
Zinc	47 µg/L, max			EPA (1980b).
Maximum concentration at hardness (as calcium carbonate) of:	75 mg/L	150 mg/L	300 mg/L	
Total recoverable:				
Cadmium	0.018 µg/L	0.038 µg/L	0.079 µg/L	EPA (1980b).
Chromium	3,400 µg/L	7,300 µg/L	15,000 µg/L	EPA (1980b).
Lead	1.9 µg/L	9.9 µg/L	51 µg/L	EPA (1980b).
Nickel	77 µg/L	130 µg/L	220 µg/L	EPA (1980b).

Phosphorus, which is the nutrient most commonly limiting to phytoplankton growth, did not exceed the criterion indicative of eutrophic conditions in reservoirs 26, 27, 28, and 29 (tables 6 and 7). If phosphorus is the limiting nutrient in these reservoirs their relatively small phosphorus concentrations indicate that they have less potential of attaining dissolved-oxygen concentrations detrimental to fish compared to the other reservoirs. Although the remaining reservoirs had large phosphorus concentrations, only reservoir 34 had large phytoplankton concentrations indicative of eutrophic conditions. However, reservoirs 27, 29, 31, 33, 34, and 36 each contained phytoplankton taxa associated with eutrophic conditions.

Table 5.--*Comparison of reservoir water quality to criteria for protection of fish*

[X denotes water-quality variables that do not meet the criterion in at least one sample]

	Reservoir											
Variable	25	26	27	28	29	30	31	32	33	34	35	36
Dissolved solids	-	-	-	-	-	-	-	-	-	-	-	X
Specific conductance	-	-	-	-	-	-	-	-	-	-	-	-
pH	X	X	X	-	X	X	X	X	X	X	X	-
Dissolved oxygen	-	-	-	-	-	X	X*	-	-	-	-	X*
Alkalinity	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia	-	-	X	-	X	-	-	-	X	X	-	-
Nitrite	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-
Copper	X	X	X	X	-	-	X	X	-	-	X	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	X	-	-	-	-	-	-
Manganese	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	X	X	-	-	-	-	X	X	-	-	X	X
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	X	X	X	-	-	-	-	-	-	-	-	-

*Denotes that sample not meeting criterion for dissolved oxygen was bottom sample of a vertical profile.

Reservoirs 27, 29, 33, and 34 had ammonia concentrations that exceeded the criterion for protection of fish (tables 4 and 5). These reservoirs coincide with four of the six reservoirs supporting phytoplankton taxa associated with eutrophic water. These phytoplankton are blue-green algae, which have the ability to fix dissolved nitrogen to form ionized ammonia. If formed in this manner, a large percentage of the ionized ammonia in these reservoirs would be converted to the toxic un-ionized form as a result of the large pH values at all water depths.

Reservoirs 29, 33, and 34 did not have trace-element concentrations exceeding criteria protective of fish. However, several trace-element analyses were not performed for reservoirs 33 and 34, and how they compare to the criteria is unknown. Copper, lead, mercury, or zinc criteria were exceeded at least once in one or more of the remaining reservoirs. The largest exceedance of the criterion for copper (by 15.4 μg/L) occurred in reservoir 28 from a special April sample collected after a reported fishkill. However, the source of the copper and its effect on the fish

Table 6.--*Criteria indicative of eutrophic conditions in reservoirs*

[Abbreviations and symbols: m, meter; mg/L, milligram per liter; mL, milliliter; ≤, equal to or less than; ≥, equal to or greater than]

Variable	Criteria	Source
Reservoir depth	≤ 5 m	Nickum (1970).
Secchi-disk depth	≤ 2.5 m	Taylor and others (1980).
Nitrogen, total	≥ 1.1 mg/L N	Wetzel (1975).
Orthophosphate, dissolved	≥ 0.025 mg/L PO_4 as P	U.S. Environmental Protection Agency (1977b).
Phosphorus, total	≥ 0.03 mg/L P	Taylor and others (1980).
Phytoplankton concentration	≥ 15,000 cells per mL	Taylor and others (1980).
Phytoplankton, dominant taxa (any one of the indicated taxa ≥ 15 percent of total cells per mL)	*Ceratium*, *Peridinium*, *Melosira*, *Stephanodiscus*, or *Pediastrum*.	Naumann (1931), cited in Hutchinson (1967).
	Cyclotella nana	Taylor and others (1980).
	Anabaena, *Aphanizomenon*, *Microcystis*, or *Oscillatoria rubescens*.	Fruh and others (1966).
	Microcystis flos-aquae	Rawson (1956).
	Cosmarium punctulatum, *Staurastrum polytrichum*, or *Micrasterias apiculata*.	Coesel and others (1978).

are unknown. Copper concentrations analyzed from this reservoir for the other sampling periods were less than the criterion. Lead exceeded the criterion only in reservoir 30 during the August sampling. The largest reported value for mercury, 0.2 µg/L, occurred in reservoir 32. Other reservoirs in which mercury was in exceedance had concentrations of 0.1 µg/L. Zinc exceeded the criterion protective of fish in reservoirs 25, 26, and 27. There is no indication of a detrimental effect of these trace elements on fish and other biota, because benthic invertebrates were observed in all reservoirs except one which was not sampled for benthic invertebrates.

Waterfowl habitat

Water-quality criteria for protection of waterfowl against disease and for maintenance of desirable habitat are given in table 8. These criteria are compared

Table 7.--*Comparison of reservoir water quality to criteria indicative of eutrophic conditions*

[X denotes water-quality variables that do not meet the criterion in at least one sample]

Variable	Reservoir 25	26	27	28	29	30	31	32	33	34	35	36
Reservoir depth	X	X	X	X	X	X	X	X	X	X	X	X
Secchi-disk depth	X[1]	X	X	-	-	X[1]	X	X[1]	X	X	([2])	([2])
Nitrogen	X	X	X	X	X	X	X	X	-	X	X	X
Orthophosphate	-	-	-	-	-	-	-	-	X	-	-	-
Phosphorus	X	-	-	-	-	X	X	X	X	X	X	X
Phytoplankton concentration	-	-	-	-	-	-	-	-	-	X	-	-
Phytoplankton, dominant taxa	-	-	X	-	X	-	X	-	X	X	-	X

[1] Secchi disk is visible to bottom of reservoir and reservoir depth is less than 2.5 meters.
[2] Secchi-disk depth not available.

to data collected from each reservoir in table 9. Water-quality criteria for protection of waterfowl were met in three of the study reservoirs.

Reservoirs 28, 32, and 36 were within the pH criteria during each sampling period. Reservoirs that did not meet the pH criteria generally had excessive pH values in the August samples.

Anaerobic conditions were not measured in any of the study reservoirs. However, the 0.8-mg/L dissolved-oxygen concentration in the bottom water of reservoir 31 was small enough to indicate that anaerobic conditions likely existed in the bottom sediments. These conditions would be of concern if an outbreak of botulism were to occur.

The criterion for alkalinity protective of waterfowl habitat was met by all reservoirs. Although reservoirs supported growths of aquatic plants, most supported only submersed plants, which do not provide cover for waterfowl. Reservoirs 28, 31, 34, and 36 also had growths of emersed plants consisting of cattail (*Typha* spp.) and bulrush (*Scirpus* spp). As sediments and nutrients accumulate with time, emersed plants could become established in all the study reservoirs.

Table 8.--*Criteria for protection of waterfowl against disease and for maintenance of desirable waterfowl habitat* [1]

[Abbreviations: mg/L, milligram per liter; min, minimum; max, maximum; NTAC, National Technical Advisory Committee to the Secretary of the Interior]

Variable	Criteria	Source
pH	7.0-9.2, min-max	NTAC (1968).
Dissolved oxygen	Greater than 0 mg/L	NTAC (1968).
Alkalinity, total	25 mg/L as $CaCO_3$, min	NTAC (1968).

[1] Criteria pertain to open-water conditions.

Table 9.--*Comparison of reservoir water quality to criteria for protection of waterfowl*[1]

[X denotes water-quality variables that do not meet the criterion in at least one sample]

	Reservoir											
Variable	25	26	27	28	29	30	31	32	33	34	35	36
pH	X	X	X	-	X	X	X	-	X	X	X	-
Dissolved oxygen	-	-	-	-	-	-	X[2]	-	-	-	-	-
Alkalinity	-	-	-	-	-	-	-	-	-	-	-	-

[1] Criteria pertain to open-water conditions.
[2] The bottom-water sample had 0.8 mg/L of dissolved oxygen, which indicates anaerobic condition in the bottom sediment.

Livestock watering

Water-quality criteria for protection of livestock are given in table 10. Reservoir water-quality data are compared to water-quality criteria for the protection of livestock in table 11. All reservoirs except reservoir 28 exceeded one or more criteria.

The criterion for dissolved solids was exceeded in reservoirs 26, 27, and 36. Reservoirs 26 and 36 were also in exceedance of the specific-conductance criterion.

Table 10.--*Criteria for protection of livestock against toxicity of selected water-quality variables*

[Abbreviations: mg/L, milligram per liter; µg/L, microgram per liter, µS/cm, microsiemens per centimeter; min, minimum; max, maximum; EPA, U.S. Environmental Protection Agency; NAS/NAE, National Academy of Sciences and National Academy of Engineering]

Variable	Criteria	Source
Dissolved solids	3,000 mg/L, max	NAS/NAE (1973).
Specific conductance	4,800 µS/cm, max	See text.
pH	5.0-9.0, min-max	EPA (1977b).
Fluoride, total recoverable	2.0 mg/L, max	NAS/NAE (1973).
Nitrite plus nitrate, dissolved	100 mg/L as N, max	NAS/NAE (1973).
Nitrite, dissolved	10 mg/L as N, max	NAS/NAE (1973).
Sulfate, dissolved	2,500 mg/L, max	Digesti and Weeth (1973).
Arsenic, total	200 µg/L, max	NAS/NAE (1973).
Total recoverable:		
Chromium	1,000 µg/L, max	NAS/NAE (1973).
Copper	500 µg/L, max	NAS/NAE (1973).
Lead	100 µg/L, max	NAS/NAE (1973).
Mercury	0.15 µg/L, max	EPA (1980a, 1980b).
Selenium	50 µg/L, max	NAS/NAE (1973).
Zinc	25,000 µg/L, max	NAS/NAE (1973).
		NAS/NAE (1973).
Phytoplankton taxa that can produce toxins.	*Aphanizomenon flos-aquae, Anabaena flos-aquae, Coelosphaerium Kuetzingianum, Gloeotrichia aechinulata, Microsystis eruginosa,* and *Nodularia spumigena*.	

Specific conductance in reservoir 27 did not exceed the criterion because of its small ratio of specific conductance to dissolved-solids (about 1.3). Dissolved-solids concentrations in reservoirs 25, 28, and 35 were sufficiently close to the criterion to indicate that in years of less precipitation they might exceed the criterion.

The pH criteria were met only in reservoirs 28 and 36. In the reservoirs that did not meet the criteria, the maximum criterion value was exceeded in the August samples. The large August pH values probably were the result of increased phytoplankton productivity.

Only reservoirs 26 and 36 exceeded the sulfate criterion for protection of livestock. In both reservoirs the sulfate criterion was exceeded in the August

Table 11.--*Comparison of reservoir water quality to criteria for protection of livestock*

[X denotes water-quality variables that do not meet the criterion in at least one sample]

Variable	Reservoir 25	26	27	28	29	30	31	32	33	34	35	36
Dissolved solids	-	X	X	-	-	-	-	-	-	-	-	X
Specific conductance	-	X	-	-	-	-	-	-	-	-	-	X
pH	X	X	X	-	X	X	X	X	X	X	X	-
Fluoride	-	-	-	-	-	-	-	-	-	-	-	X
Nitrite plus nitrate	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate	-	X	-	-	-	-	-	-	-	-	-	X
Arsenic	-	-	-	-	-	-	-	-	([1])	([1])	-	-
Chromium	-	-	-	-	-	-	-	-	([1])	([1])	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	-	-	-	-	-	-	-	X	([1])	([1])	-	-
Selenium	-	-	-	-	-	-	-	-	([1])	([1])	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-
Phytoplankton	X	X	X	-	X	X	X	X	-	-	X	X

[1] Analysis not available

sample. Although reservoirs 27, 28, and 35 did not exceed the sulfate criterion, their August water samples had sulfate concentrations close to the criterion.

Mercury was the only trace element measured in excess of the criterion for protection of livestock. However, mercury was in excess only in the August sample from reservoir 32. Because the detection limit for the mercury analysis is 0.1 μg/L and the precision is small, the occurrence of mercury in reservoir 32 could be insignificant.

Nine reservoirs contained species of phytoplankton (*Aphanizomenon flos-aquae* and *Coelosphaerium Kuetzingianum*) that have been associated with livestock poisonings. Research has not defined the particular variety nor the concentration of phytoplankton that is toxic to livestock. Consequently, it is important to monitor livestock watering at these reservoirs when either species attain large concentrations.

Recreational use

Criteria for protection of swimmers are given in table 12. These criteria are compared to water-quality data collected from each reservoir in table 13.

Table 12.--*Criteria for protection of people who directly contact water by swimming*

[Abbreviations: m, meter; min, minimum; max, maximum; mL, milliliter; EPA, U.S. Environmental Protection Agency; NTAC, National Technical Advisory Committee to the Secretary of the Interior]

Variable	Criteria	Source
Secchi-disk depth	1.2 m, min	NTAC (1968).
pH	6.5-8.3, min-max	NTAC (1968).
Fecal coliform	200 organisms per 100 mL, max	EPA (1977b).

Table 13.--*Comparison of reservoir water quality to criteria for protection of people*

[X denotes water-quality variables that do not meet the criterion in at least one sample]

	Reservoir											
Variable	25	26	27	28	29	30	31	32	33	34	35	36
Secchi-disk depth	X [1]	X [1]	-	-	-	-	X	-	X [1]	X	([2])	([2])
pH	X	X	X	X	X	X	X	X	X	X	X	-
Fecal coliform	-	-	-	-	-	-	-	X	-	-	-	-

[1] Secchi disk was visible to bottom of reservoir and reservoir depth is less than 1.2 meters.
[2] Secchi-disk depth not available.

Secchi-disk depths of five reservoirs did not meet the criterion protective of swimmers. Of the five reservoirs, reservoir 34 had the least clarity, with a Secchi-disk depth of 0.1 m. The greatest clarity was in reservoir 28, which had a Secchi-disk depth of 3.4 m.

Reservoir 36 was the only reservoir that did not exceed the pH criterion. The near-surface pH of water in August was 8.0. For most of the other reservoirs, pH values ranged from 9.0 to 10.0 in August, which is probably one of the more desirable periods for recreation because of warmer air temperatures. Reservoir 32 had a pH value of 7.8 in August; however, pH during the May sampling was 9.1.

The criterion for fecal coliform bacteria was exceeded only during the August sampling in reservoir 32. However, because the FC/FS ratio indicates a predominance of human waste, which is unlikely, the fecal coliform concentration of 295 organisms per 100 mL may overestimate the actual concentration. The same could be true for the August sampling in reservoir 25, in which the fecal coliform concentration was 130 organisms per 100 mL. The larger concentration of fecal streptococcus in the May shore sample of reservoir 30 could have resulted from the large number of cattle that were in the area during the May sampling. Conditions in the reservoir might have caused a quicker dieoff rate for fecal coliform than for fecal streptococcus.

WATER-QUALITY CHANGES IN RESPONSE TO RESERVOIR USE

Several studies have outlined the effects of livestock grazing on water quality. Increased sediment, turbidity, pathogens, and nutrients are major water-quality changes associated with livestock grazing (Moore and others, 1979). Also of major concern are the effects of livestock grazing on aquatic plants and vegetation around the reservoirs. Moore and others (1979) have outlined several best-management practices that prevent or minimize the effects of livestock on water quality. These practices include adjusting the rate of stocking, fencing certain areas, and providing alternative sources of water. Information that compares livestock density to major water-quality variables associated with grazing would enable the best management practices to be chosen to prevent increasing the natural rate of eutrophication. These practices would increase the useful duration of reservoirs in the study area.

Fish, waterfowl, and people also can affect the quality of water. Fish and waterfowl would add to the nutrient cycling in reservoirs. Use of reservoirs by waterfowl and people could increase the probability of exposure to disease through bacterial contamination of the water. Certain species of fish and waterfowl in large densities would increase the turbidity of water along the shore through foraging and other activities; turbidity in open water would result if winds circulated the turbid water from shore. Activities of people along the shore also could increase turbidity; however, increases probably would be minimal compared to long-term turbidity increases resulting from motor-vehicle destruction of vegetation surrounding the reservoir.

Because reservoirs progress through different stages as they age, it might be appropriate to manage reservoirs for fish propagation and waterfowl habitat in succession, while also providing water for livestock. Newly formed reservoirs would be less stressful to fish because of less variable seasonal and diel dissolved-oxygen concentrations. As the reservoirs become more enriched with aquatic plants and phytoplankton, seasonal and diel dissolved-oxygen concentrations will become more variable. However, the increase in aquatic plants and phytoplankton will improve the waterfowl habitat.

Final management decisions for reservoirs that have questionable water quality might best be made after a small-scale pilot program is conducted. Because different species have different tolerances that could restrict their use of certain reservoirs, more specific criteria may be required for proper management. Additional information such as reservoir location and access also may be important in management decisions for a particular reservoir.

CONCLUSIONS

At least one sample from each of the reservoirs had water quality that did not meet one or more criteria protective of fish propagation. In addition, all reservoirs had one or more samples that contained water quality indicative of eutrophic conditions. Considering all criteria, reservoirs 25, 28, 29, 32, and 35 had the best water quality for fish propagation among the study reservoirs. Water quality in these reservoirs generally would not be detrimental to fish.

The shallowness of reservoirs 25 and 32 could allow them to freeze solid during extremely cold winters or become too concentrated or even dry completely during extremely hot dry summers. Conversely, wet years could add a wider margin of safety to these reservoirs and improve the water quality of other reservoirs, particularly reservoirs 30 and 31, which were generally less than 2 m deep. Reservoirs 30 and 31 did not exceed the criteria by large concentrations. Perhaps if the sampling did not occur during a warm dry year, these reservoirs might have met most of the criteria. Reservoir 36 had the largest dissolved-solids concentration, and this reservoir was one of the deepest reservoirs sampled. The mineralogy in the drainage area, rather than water loss through evaporation, could be the main cause of extremely large dissolved-solids concentrations.

Periodic occurrence of large pH values in all reservoirs may not be detrimental to fish. Most likely these larger pH values are caused by uptake of CO_2 during photosynthesis and therefore could decrease at night during respiration. The largest pH values occurred during the August sampling, which is a peak growing season for phytoplankton. During other times of the year, pH values may be much smaller. Fish may be able to survive periods of large pH during the day, and therefore exceedance of the pH criteria in the study reservoirs may not be significant to fish propagation.

Trace-element criteria are not consistently exceeded in any one reservoir. Because benthic invertebrates were observed in all but one unsampled reservoir, trace-element concentrations do not seem to be critical to fish and other biota. Only in reservoir 28 might trace elements cause a problem. In April, a fishkill occurred at a time when copper concentrations were in excess of the criteria. However, copper concentrations in reservoir 28 were less than the criterion in May and August. Therefore, it is difficult to determine the source of copper and its effect on fish.

Reservoirs 28, 32, and 36 had the best water quality among the study reservoirs for the protection of waterfowl. Among the other reservoirs, the pH criterion, which protects growths of aquatic plants, was exceeded most often and generally in August. Because of small dissolved-oxygen concentrations in August, reservoir 31 would be of greatest concern if botulism were to occur in the area. Alkalinity, a criterion that also protects growths of aquatic plants, was met in all the reservoirs. Even though all reservoirs supported growths of submersed aquatic plants, only reservoirs 28, 31, 34, and 36 had growths of emersed aquatic plants. It is possible that, with time, an accumulation of nutrients and sediment will allow emersed plants to become established in all the study reservoirs.

Reservoirs 28, 33, and 34 met most criteria for protection of livestock. Reservoirs 26, 27, and 36 would be the least desirable reservoirs for livestock watering mostly because of their large dissolved-solids concentrations, which include large concentrations of sulfate. Many of the reservoirs exceeded the pH criterion. However, the significance of large pH values is not known because the length of time that the criterion is exceeded may be short, and cattle have been watering at some of the reservoirs with no reported ill effect.

The only trace element exceeding criteria for the protection of livestock was mercury, which occurred in reservoir 32. The toxic potential of mercury in reservoir 32 is difficult to evaluate, because the concentration is close to the criteria protective of livestock and the detection limit of the analysis. Except for the presence of phytoplankton taxa that can produce toxins and large pH values, reservoirs 25, 29, 30, 31, and 35 have water quality within criteria protective of livestock. Because research has not determined specific concentrations or varieties of phytoplankton taxa that produce toxins, using these reservoirs for watering livestock may need to be done with caution.

Most of the reservoirs would not be conducive to swimming. Limited visibility in reservoirs 25, 26, 31, 33, and 34 would be hazardous to swimmers. The large pH values during late summer at all reservoirs except reservoir 36 might cause eye irritation. Although only reservoir 32 had fecal coliform concentrations in excess of the criterion, other reservoirs may need to be monitored, especially when cattle are in the area. Submersed aquatic plants in most of the reservoirs would be a nuisance to swimmers.

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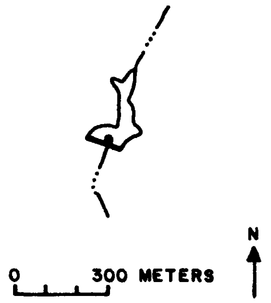
SUPPLEMENTAL INFORMATION

Reservoir descriptions

A brief description of the physical features of each reservoir is accompanied by a small index map outlining the reservoir-surface configuration and indicating the sampling site by means of a dot. Also included in the reservoir descriptions are some observations on aquatic flora and fauna made during sampling visits.

Reservoir 25, Pass Creek Reservoir



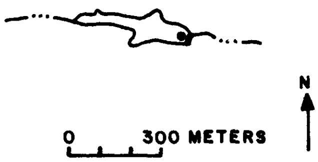
Reservoir 25 is a small reservoir located in the headwaters of Pass Creek about 0.3 km west of Haxby Road. Surface area of the reservoir is about 1.6 ha. The drainage basin upstream from the reservoir consists of a deeply incised channel surrounded by a relatively high ridge.

Grasses line the entire shore of the reservoir, whereas aquatic plants such as pond weed (*Potamogeton* spp.) and coontail (*Ceratophyllum* spp.) occur in shallow areas along the water's edge. Algae generally is abundant along much of the reservoir bottom. Saline deposits were conspicuous in the mud flats around the perimeter of the reservoir.

The reservoir sediment along the shore was black, indicating an accumulation of organic matter. Benthic invertebrates such as midge larvae (Chironomidae) and leeches (Hirudinea) were present in the sediments near the shore. Sediment collected near the middle of the reservoir was brown and no benthic invertebrates were observed. Numerous unidentified microcrustaceans were seen in water samples collected in May.

In August the water was turbid and brown in color. Measured Secchi-disk depths were 1.6 m in May and 1.0 m in August. Both Secchi-disk depths correspond to the reservoir depth at the sampling point.

Reservoir 26, Mid-Flat Creek Reservoir

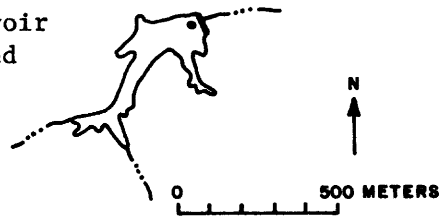


Reservoir 26 is located about 1.1 km southeast of Haxby Road and 1.6 km east of Reservoir 25. Mid-Flat Creek Reservoir with a surface area of 2.0 ha, is similar in both size and shape to reservoir 25. The surrounding landscape consists of gently rolling grasslands and a moderately incised stream channel upstream from the reservoir. Saline deposits line the shore where the water has receded.

Grasses cover the entire perimeter of the reservoir with horsetail (*Equisetum* spp.) and watermilfoil (*Myriophyllum* spp.) growing in shallow water. A small number of aquatic macrophytes were also observed in deeper water, with coontail (*Ceratophyllum* spp.) being the most predominant. Strands of coarse algae were growing on the reservoir bottom. The reservoir sediment was light gray on the surface and black a few millimeters below. Midge (Chironomidae) were observed within the sediments and some snails (Gastropoda) and scuds (Amphipoda) were found along the shore. Aquatic insects observed included mayflies (Ephemeroptera), water bugs (Hemiptera), and diving beetles (Coleoptera).

The water of reservoir 26 was dark brown, indicating the possible presence of humic acids. The water was turbid in May, with a Secchi-disk depth of 1.4 m in a total depth of 1.6 m. The reservoir was clear in August and the Secchi disk was visible to the bottom at a depth of 0.8 m.

Reservoir 27, Coldwell Reservoir No. 2

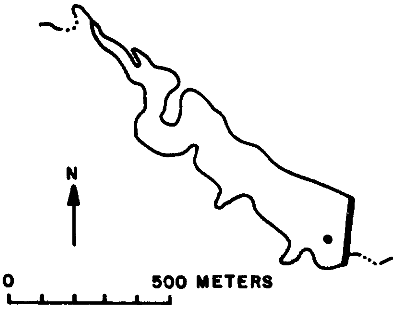


Reservoir 27 is in the headwaters of a tributary to Flat Creek and has a surface area of 5.1 ha. The reservoir is encircled by a low-lying ridge with a few interspersed hills. Vegetation on the surrounding hills generally is sparse grasses and sagebrush. Water was observed to be seeping from the base of the dam in May.

Grasses are the predominant vegetation along the shoreline, with watermilfoil (*Myriophyllum* spp.) occurring at the water's edge. A grass-like macrophyte was also observed growing on the bottom of the reservoir. Sediment in the middle of the reservoir consisted of an unconsolidated gray mud, whereas that near shore was black. Benthic invertebrates found on the reservoir bottom include midge larvae (Chironomidae), mayfly (Ephemeroptera) and damselfly (Zygoptera) nymphs, and scuds (Amphipoda). The reservoir has been stocked with bass and sunfish. Saline deposits were present on the shore.

Water in the reservoir was slightly turbid and green in May, and although clear in August, the water had a brown humic coloration. The Secchi-disk measurement in May was 1.5 m of the 1.8 m total depth at the sampling point. In August the Secchi disk was visible to the bottom at 1.2 m.

Reservoir 28, Homestead Reservoir

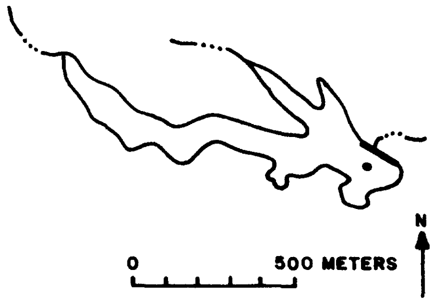


Reservoir 28 is located midway in the drainage basin of a tributary to Cedar Creek. Access to the reservoir is good from State Highway 253 about 31 km northwest of Terry. Homestead Reservoir is relatively large, with a surface area of 15.2 ha. Unlike the smaller reservoirs sampled, the dam for reservoir 28 contains both a riser and a spillway to allow discharge of flows in excess of storage capacity. The land surrounding the reservoir is of low relief and vegetated primarily by sagebrush (*Artemisia* sp.) and grass.

The shoreline of the reservoir is lined by terrestrial grasses and aquatic macrophytes such as bulrush (*Scirpus* spp.) and water weed (*Elodea* spp.). Sediment near the middle of the reservoir generally was more firm than in most of the other reservoirs sampled. Bottom-dwelling organisms observed in the reservoir included midge (Chironomidae) and caddis fly (Trichoptera) larvae. Scuds (Amphipoda) and aquatic beetles (Coleoptera) were seen in the shallow water and frogs and ducks were observed along the shore.

Reservoir 28 is one of the deeper reservoirs sampled and also the least turbid. The Secchi-disk depth of 3.4 m in May was close to the total depth at the sampling point. Although no Secchi-disk measurement was made in August, the water was light brown in color and turbid, presumably as a result of cattle in the area.

Reservoir 29, Clark Reservoir

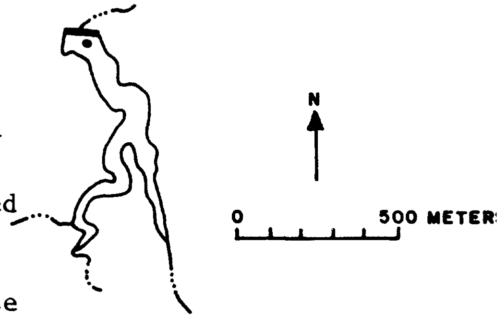


Clark Reservoir is a relatively large reservoir (15.3 ha) situated about midway in the South Fork Cherry Creek basin, 2.4 km west of Cherry Creek Road. The reservoir has been developed as a recreational site, with a picnic area and restroom facilities provided. Terrain around the reservoir is mostly flat with a few small hills in the distance. The landscape is vegetated predominantly by grasses and sagebrush (*Artemisia* spp.).

Grasses and sagebrush line most of the reservoir, although some trees occur along the upper reaches of the north-shore arms. Bulrush (*Scirpus* spp.), water weed (*Elodea* spp.), and pondweed (*Potamogeton* spp.) were growing along the shore, and watermilfoil (*Myriophyllum* spp.) was found submersed in deeper water. Scuds (Amphipoda) and midge larvae (Chironomidae) were observed in the shallow water near the shore. The reservoir has reportedly been stocked with rainbow trout (*Salmo gairdneri*), and in May fish were seen rising to the water surface.

The reservoir water was green in both May and August owing to suspended algae. This is a relatively deep, clear reservoir, which had a Secchi-disk measurement of 2.9 m in May in a total depth of 3.2 m.

Reservoir 30, Grant Reservoir

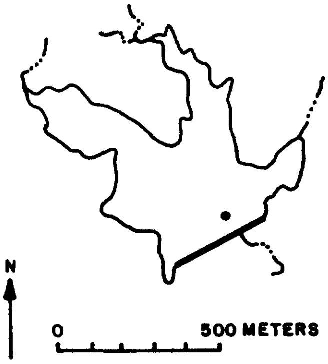


Grant Reservoir, with a surface area of 6.4 ha., is located in the downstream reaches of a tributary to Cherry Creek, about 1.9 km south of Cherry Creek Road. The watershed of this reservoir is generally flat and vegetated by grass.

Trees are sparse along the reservoir's edge, but dense growths of aquatic plants line parts of the shoreline and cover part of the reservoir bottom. Pondweed (*Potamogeton* spp.), water weed (*Elodia* spp.), and watermilfoil (*Myriophyllum* spp.) are in abundance at the shoreline. These emergent macrophytes also occur along with algae in the middle of the reservoir. Excessive organic accumulation is indicated by the presence of a hydrogen sulfide (H_2S) odor and an organic foam on the water surface. Phantom midges (*Chaoborus* spp.) were observed in the water.

There was a tan color to the water, which may have been caused by humic acids released from organic detritus. The discolored water was clear, however, in May and August. Secchi-disk depths indicated little turbidity as measurements of 2.1 m in May and 1.9 m in August equaled the reservoir depth at the sampling site.

Reservoir 31, Coal Creek Reservoir

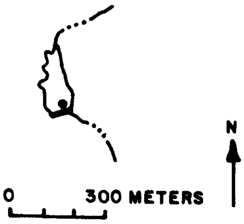


Coal Creek Reservoir, with a surface area of 24.0 ha., is the largest reservoir sampled. Located in the downstream reaches of Coal Creek, the reservoir is surrounded by numerous sparsely vegetated ridges and buttes to the north and a more open, flat landscape to the west. Grasses predominate over most of the area adjacent to the reservoir. A riser and spillway are incorporated into the dam for release of large flows. Although large in area, the reservoir averaged only about 1 m in depth during the three sampling visits.

The banks of the reservoir are lined primarily with grasses and a few scattered cottonwood (*Populus sargentii*) and willow (*Salix* spp.) trees along the upper shore. Cattails (*Typha* spp.) and horsetails (*Equisteum* spp.) occur in some shallow areas, and watermilfoil (*Myriophyllum* spp.) and algae were observed on the reservoir bottom near the shore. Reservoir sediments ranged from gray to black and consisted largely of organic material. Scuds (*Amphipoda*) were observed in the shallow water along the shoreline and damselfly niads (*Zygoptera*) were collected in water samples. Mayflies (*Ephemeroptera*) were emerging during the August sampling period and frogs were seen on the shoreline.

On both sampling visits in May and August the water was turbid and discolored. In May the water was green as a result of suspended algal cells, and the Secchi disk was visible to the bottom at 0.9 m. In August, the reservoir had a brown humic coloration and the Secchi-disk measurement was 1.0 m of a total depth of 1.5 m.

Reservoir 32, Big Drop Reservoir

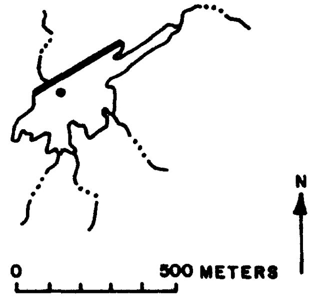


Big Drop Reservoir is the smallest of the reservoirs sampled, having a surface area of 1.3 ha. The reservoir is located on a small branch of a tributary to Cedar Creek. The drainage basin upstream from the reservoir is little more than an encircling ridge consisting of some steep-sided barren slopes and rolling hills. Gullies in the basin are deeply incised and local vegetation includes grasses, sagebrush, and junipers. As a result of washed-out roads in August, the reservoir was not accessible by vehicle and only surface grab samples were possible.

Grasses and sagebrush (*Artemisia* spp.) line the banks of the reservoir and some scattered junipers (*Juniperus* spp.) occur on the east shore. A few juniper stumps remain in the shallow water. Aquatic plants such as pondweed (*Potamogeton* spp.), watermilfoil (*Myriophyllum* spp.), and algae grow along the shoreline and on the reservoir bottom. Sediment in the reservoir was black on the surface and gray underneath. Many microcrustaceans were seen along the bottom of the reservoir, including scuds (*Amphipoda* spp.), water fleas (*Daphnia* spp.), and copepods (*Cyclops* spp.). Midge larvae (Chironomidae) were found within the sediment along with mayfly (Ephemeroptera) and damselfly (Zygoptera) nymphs. Ducks were in the vicinity of the reservoir in May.

A green coloration of the water was evident during both May and August as a result of suspended algae. The water appeared clear, however, in May and the Secchi disk was visible to the bottom at 2.0 m. Although no Secchi-disk measurement was possible in August, the water appeared more turbid in response to an intense rainfall several days prior to the visit.

Reservoir 33, Jack Rabbit Detention Reservoir

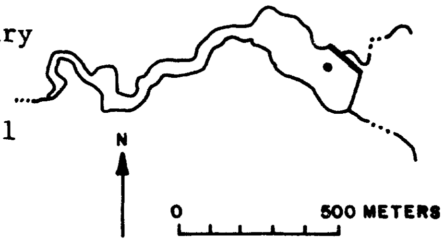


Reservoir 33 is a shallow reservoir on a branch of a tributary to Buffalo Creek. When full, the reservoir has a surface area of about 6.7 ha. Although numerous tributary channels enter the reservoir, flow is usually absent and the reservoir stores little water. On the February sampling visit, the reservoir was frozen solid to the bottom and in August it was dry. Several relatively high hills are present in the eastern headwater areas of the drainage basin, but the rest of the basin is flat. Grasses and sagebrush (*Artemisia* spp.) are predominant in the watershed.

Grass and sagebrush line the perimeter of the reservoir, cattails (*Typha* spp.) and bulrush (*Scirpus* spp.) occur along parts of the shoreline, and watermilfoil (*Myriophyllum* spp.) and algae grow on the bottom throughout the entire reservoir. Burrowing midge larvae (Chironomidae) were found in bottom sediments and microcrustaceans such as waterfleas (*Daphnia* spp.) and copepods (*Cyclops* spp.) were observed along the bottom. Water bugs (back-swimmers, *Notonectidae*) and aquatic beetles (*Coleoptera*) were among the aquatic insects observed. Adult mayflies (Ephemeroptera) were present on the water surface. Ducks and shore birds were seen close to the reservoir during the May visit.

The water in May appeared clear with little coloration. The Secchi disk was visible to the bottom, which was 0.3 m in depth.

Reservoir 34, Ridge Reservoir

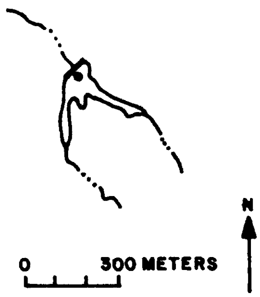


Ridge Reservoir is a shallow impoundment on a tributary to Boxelder Creek. This reservoir was dry during the August sampling visit, at which time dead carp were noted in the mud bed. When sufficient water is available to fill the reservoir, the surface area is about 9.4 ha. Gently rolling hills surround the relatively low gradient channel which enters the reservoir. Grasses predominate in the vicinity of the reservoir.

Cattails (*Typha* spp.) occur in scattered areas around the shoreline and algae is present along the bottom. The sediment is black and no benthic organisms were found in a bottom grab sample. However, several water boatmen (*Corixidae*) were observed swimming in the water.

Water beneath the ice appeared very turbid in February and continued to be turbid in May. A green coloration was imparted to the water as a result of suspended algae in May. A Secchi-disk measurement in May of 0.1 m in a total depth of 0.4 m confirms this reservoir as being the most turbid sampled.

Reservoir 35, Sidney Reservoir

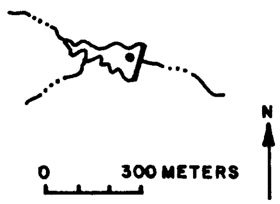


Sidney Reservoir is a relatively small (1.7 ha), but deep, reservoir. Located on a branch of a tributary to Boxelder Creek, the reservoir basin drains a small area of gentle upland slope. Grasses are the predominant vegetation in the watershed and along the banks of the reservoir.

Watermilfoil (*Myriophyllum* spp.), pondweed (*Potamogeton* spp.), and algae grow along the bottom of the reservoir. Detritus suspended by wind-caused turbulence was observed in water samples. No samples of bottom sediment were taken and no benthic organisms or adult insects were observed. However, large fish were seen rising to the water surface in August.

The depth of the reservoir at the sampling point was about 3.5 m during both February and May visits and about 2.5 m during August. Although no Secchi-disk measurements were made because of choppy water-surface conditions, a photometer reading of 72 percent light transmittance at the reservoir bottom (2.5 m) in August indicates little turbidity.

Reservoir 36, Side Hill Reservoir



Reservoir 36 is a small reservoir (1.4 ha) on a tributary to Thompson Creek near the Montana-Wyoming border. The reservoir is situated at the base of a moderately steep ridge and is relatively deep in comparison to its surface area. Grasses cover most of the surrounding landscape. Access to this reservoir is limited during wet conditions; consequently, no sample was possible in May and only a surface grab sample from shore was collected in August.

Dense stands of cattail (*Typha* spp.) line much of the shoreline. Water weed (*Elodea* spp.) and algae grow along the bottom in shallow water. The sediment was black and organically enriched, with some aquatic worms (*Oligochaeta*) present. Several crustaceans were seen in the water near the shore.

The water during the August visit had a brown organic color and was observed to foam easily when agitated. The reservoir also appeared slightly turbid, probably as a result of intense rainfall the previous week. No Secchi-disk measurements were possible to assess turbidity.

Table 14.--*Vertical profiles*

[Analyses by U.S. Geological Survey. All values are onsite determinations. Sampling depth: asterisk denotes depth of ice/water interface. Abbreviations: m, meter; °C, degree Celsius, µS/cm, microsiemens per centimeter at 25° Celsius; mg/L, milligram per liter]

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
		RESERVOIR 25--PASS CREEK RESERVOIR					
FEB , 1980							
25...	0930	0.0	--	--	--	--	--
25...	0931	.5*	--	--	--	--	--
25...	0932	.8	3,280	8.3	1.5	13.8	107
25...	0933	1.2	3,300	8.3	1.9	13.6	106
MAY							
13...	0930	.0	2,050	8.3	14.0	8.6	92
13...	0931	.5	2,050	8.3	14.0	8.6	92
13...	0932	1.0	2,050	8.3	14.0	8.6	92
13...	0933	1.5	2,060	8.3	13.9	8.6	92
13...	0934	1.6	2,060	8.3	13.9	8.6	92
AUG							
21...	1230	.0	3,500	9.4	18.0	9.1	106
21...	1231	.5	3,500	9.4	18.0	9.0	105

Table 14.--*Vertical profiles*--Continued

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
RESERVOIR 26--MID-FLAT CREEK RESERVOIR							
FEB , 1980							
25...	1030	0.0	--	--	--	--	--
25...	1031	.5*	--	--	--	--	--
25...	1032	.8	6,110	8.2	0.1	11.4	85
25...	1033	1.3	6,070	8.2	.3	11.1	83
MAY							
13...	1200	.0	3,100	8.5	14.9	9.3	102
13...	1201	.5	3,160	8.5	14.8	9.3	102
13...	1202	1.0	3,190	8.4	14.7	9.2	100
13...	1203	1.5	3,210	8.4	14.1	9.2	99
13...	1204	1.6	3,200	8.4	13.7	9.3	99
AUG							
21...	1100	.0	4,810	9.6	16.8	9.5	108
21...	1101	.5	4,820	9.6	17.0	9.2	105
21...	1102	.8	4,820	9.6	17.2	9.2	106

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
			RESERVOIR 27--COLDWELL RESERVOIR NO. 2				
FEB , 1980							
25...	1130	0.0	--	--	--	--	--
25...	1131	.2*	--	--	--	--	--
25...	1132	.5	4,540	8.3	3.1	13.8	111
25...	1133	1.0	4,490	8.2	3.0	13.9	112
25...	1134	1.5	4,450	8.2	2.9	14.4	115
25...	1135	1.9	4,400	8.2	2.9	14.4	115
MAY							
13...	1800	.0	3,300	8.6	15.7	10.0	112
13...	1801	.5	3,310	8.6	15.7	9.9	110
13...	1802	1.0	3,320	8.6	15.6	10.0	111
13...	1803	1.5	3,370	8.6	14.8	10.5	115
13...	1804	1.8	3,330	8.4	14.7	10.8	117
AUG							
21...	0930	.0	4,490	9.8	17.2	9.1	104
21...	0931	.5	4,490	9.8	16.0	9.1	102
21...	0932	1.0	4,490	9.8	16.0	9.1	102
21...	0933	1.2	4,490	9.8	16.1	9.0	101

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
RESERVOIR 28--HOMESTEAD RESERVOIR							
FEB , 1980							
25...	1945	0.0	--	--	--	--	--
25...	1946	.5*	--	--	--	--	--
25...	1947	.8	3,210	8.7	4.1	14.4	120
25...	1948	1.0	3,180	8.7	4.1	14.1	118
25...	1949	1.5	3,190	8.7	4.1	14.0	117
25...	1950	2.0	3,190	8.7	4.0	14.0	117
25...	1951	2.5	3,190	8.7	4.0	13.9	116
25...	1952	3.0	3,180	8.7	4.2	14.0	117
25...	1953	3.5	3,170	8.7	4.3	14.4	121
25...	1954	3.8	3,150	8.7	4.8	15.2	129
APR							
11...	1030	--	2,470	8.6	7.0	--	--
MAY							
14...	1430	.0	2,890	8.6	14.7	9.9	108
14...	1431	.5	2,890	8.6	14.7	9.9	108
14...	1432	1.0	2,890	8.6	14.6	9.9	108
14...	1433	1.5	2,900	8.6	14.5	9.8	107
14...	1434	2.0	2,920	8.6	14.1	9.9	107
14...	1435	2.5	2,900	8.6	14.1	10.0	108
14...	1436	3.0	2,900	8.6	14.0	10.0	108
14...	1437	3.5	2,900	8.6	14.9	10.3	113
AUG							
20...	1430	.0	3,300	9.0	17.2	10.0	115
20...	1431	.5	3,300	9.0	17.0	9.7	111
20...	1432	1.0	3,300	9.0	16.8	9.5	108
20...	1433	1.5	3,300	9.0	16.6	9.3	106
20...	1434	2.0	3,300	9.0	17.0	9.2	105
20...	1435	2.5	3,300	9.0	17.2	9.1	105
20...	1436	3.0	3,300	9.0	17.3	8.9	103
20...	1437	3.1	3,300	9.0	17.5	8.8	102

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
RESERVOIR 29--CLARK RESERVOIR							
FEB , 1980							
25...	1500	0.0	--	--	--	--	--
25...	1501	.2*	--	--	--	--	--
25...	1502	.5	1,130	9.4	5.1	16.8	144
25...	1503	1.0	1,150	9.4	5.2	16.7	144
25...	1504	1.5	1,150	9.4	5.2	16.8	144
25...	1505	2.0	1,160	9.4	5.3	17.3	149
25...	1506	2.5	1,160	9.5	5.3	17.8	153
25...	1507	3.0	1,170	9.5	5.4	17.8	154
25...	1508	3.2	1,180	9.5	5.4	17.8	154
MAY							
14...	1730	.0	1,040	9.6	15.3	12.4	138
14...	1731	.5	1,040	9.6	15.2	12.5	139
14...	1732	1.0	1,040	9.6	15.1	12.5	138
14...	1733	1.5	1,050	9.6	14.8	12.9	142
14...	1734	2.0	1,050	9.6	14.4	13.4	146
14...	1735	2.5	1,050	9.7	14.3	14.8	161
14...	1736	3.0	1,050	9.7	13.9	14.5	156
14...	1737	3.2	1,050	9.4	13.5	13.4	143
AUG							
20...	1200	.0	999	9.1	16.8	9.1	105
20...	1201	.5	999	9.1	16.8	9.1	105
20...	1202	1.0	999	9.1	17.0	9.0	104
20...	1203	1.5	999	9.1	17.1	8.9	103
20...	1204	2.0	999	9.1	17.2	8.7	101
20...	1205	2.5	999	9.1	17.3	8.7	101
20...	1206	3.0	999	9.1	17.5	8.7	102
20...	1207	3.5	999	9.1	17.8	8.7	102

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
			RESERVOIR 30--GRANT RESERVOIR				
FEB , 1980							
25...	1645	0.0	--	--	--	--	--
25...	1646	.3*	--	--	--	--	--
25...	1647	.5	1,370	9.6	5.8	16.1	141
25...	1648	1.0	1,350	--	5.9	2.3	20
25...	1649	1.5	1,390	--	5.8	1.8	16
25...	1650	1.9	1,500	--	5.8	.2	2
MAY							
14...	1900	.0	1,040	9.3	16.8	13.5	155
14...	1901	.5	1,040	9.3	16.8	13.5	155
14...	1902	1.0	1,040	9.3	16.7	13.7	157
14...	1903	1.5	1,060	9.3	15.2	14.8	164
14...	1904	2.0	1,060	9.3	14.4	16.3	177
14...	1905	2.1	1,060	9.3	14.3	16.7	181
AUG							
20...	1030	.0	1,460	9.9	16.0	7.0	79
20...	1031	.5	1,460	9.9	15.2	6.9	77
20...	1032	1.0	1,460	10.0	15.2	6.9	77
20...	1033	1.5	1,460	9.9	15.1	6.8	75
20...	1034	1.9	1,460	9.9	15.8	6.8	76

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
			RESERVOIR 31--COAL CREEK RESERVOIR				
FEB , 1980							
26...	1630	0.0	--	--	--	--	--
26...	1631	.3*	--	--	--	--	--
26...	1632	.6	1,380	9.7	4.8	15.6	132
26...	1633	1.0	1,410	9.7	4.9	15.6	132
26...	1634	1.2	1,440	9.2	4.9	15.6	132
MAY							
14...	2100	.0	1,060	9.5	16.1	11.6	129
14...	2101	.5	1,060	9.5	16.2	11.6	129
14...	2102	.9	1,060	9.3	16.2	11.3	126
AUG							
19...	1400	.0	1,220	10.0	20.8	9.3	114
19...	1401	.5	1,220	10.0	19.2	9.4	112
19...	1402	1.0	1,230	10.1	19.0	9.6	114
19...	1403	1.2	--	9.1	17.0	.8	9

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
			RESERVOIR 32--BIG DROP RESERVOIR				
FEB , 1980							
26...	1130	0.0	--	--	--	--	--
26...	1131	.5*	--	--	--	--	--
26...	1132	.8	3,130	9.0	2.0	12.0	94
26...	1133	1.0	3,120	9.0	2.0	11.8	92
26...	1134	1.5	3,120	9.0	2.0	11.7	92
26...	1135	2.0	3,120	9.0	2.1	11.6	91
26...	1136	3.0	3,120	9.0	2.1	11.4	89
MAY							
14...	1000	.0	2,460	9.1	14.2	10.6	113
14...	1001	.5	2,460	9.1	14.3	10.6	113
14...	1002	1.0	2,460	9.1	14.2	10.6	113
14...	1003	1.5	2,480	9.1	13.9	10.6	112
14...	1004	1.8	2,480	9.1	13.8	10.5	111
AUG							
19...	0930	.0	1,530	7.8	18.0	7.0	81

Table 14.--*Vertical profiles*--Continued

Date	Time	Sampling depth (m)	Specific conductance (μS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
			RESERVOIR 33--JACK RABBIT DETENTION RESERVOIR				
MAY , 1980							
15...	1000	0.1	717	10.5	15.0	13.0	146

Table 14.--*Vertical profiles*--Continued

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
			RESERVOIR 34--RIDGE RESERVOIR				
FEB , 1980							
27...	1200	0.0	--	--	--	--	--
27...	1201	.3*	--	--	--	--	--
27...	1202	.4	2,290	7.7	1.9	23.0	189
MAY							
15...	1230	.0	1,140	10.1	16.6	12.2	142
15...	1231	.4	1,140	10.1	16.6	12.4	144

Date	Time	Sampling depth (m)	Specific conductance (μS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
			RESERVOIR 35--SIDNEY RESERVOIR				
FEB , 1980							
27...	1300	0.0	--	--	--	--	--
27...	1301	.2*	--	--	--	--	--
27...	1302	.5	2,660	8.2	4.8	14.7	131
27...	1303	1.0	2,660	8.2	4.8	14.2	127
27...	1304	1.5	2,690	8.2	4.8	14.4	129
27...	1305	2.0	2,730	8.2	4.8	14.3	128
27...	1306	2.5	2,780	8.2	4.8	14.3	128
27...	1307	3.0	2,790	8.2	4.7	14.3	127
27...	1308	3.5	2,800	8.2	4.7	14.2	127
MAY							
15...	1530	.0	2,760	8.6	14.3	10.0	111
15...	1531	.5	2,760	8.6	14.3	10.1	113
15...	1532	1.0	2,760	8.6	14.3	10.1	113
15...	1533	1.5	2,760	8.6	14.4	10.1	113
15...	1534	2.0	2,760	8.6	14.3	10.2	114
15...	1535	2.5	2,760	8.6	14.3	10.2	114
15...	1536	3.0	2,760	8.6	14.3	10.2	114
15...	1537	3.4	2,760	8.6	14.4	10.3	115
AUG							
18...	1330	.0	3,370	9.8	17.8	9.4	115
18...	1331	.5	3,370	9.8	16.5	9.4	111
18...	1332	1.0	3,390	9.8	16.2	9.3	110
18...	1333	1.5	3,410	9.8	16.2	9.2	108
18...	1334	2.0	3,420	9.7	15.7	8.9	104
18...	1335	2.5	3,430	9.7	15.0	8.5	98

Table 14.--*Vertical profiles*--Continued

Date	Time	Sampling depth (m)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)
RESERVOIR 36--SIDE HILL RESERVOIR							
FEB , 1980							
27...	1545	0.0	--	--	--	--	--
27...	1546	.3*	--	--	--	--	--
27...	1547	.6	4,720	7.8	3.6	16.0	139
27...	1548	1.0	4,750	7.8	3.6	15.8	137
27...	1549	1.5	4,780	7.8	3.4	16.6	144
27...	1550	2.0	4,770	7.8	3.3	15.6	135
27...	1551	2.5	4,750	7.7	3.3	14.5	125
27...	1552	3.0	4,770	7.7	3.4	9.6	83
27...	1553	3.2	4,800	7.6	3.7	3.8	33
AUG							
18...	0930	.0	5,900	8.0	18.0	6.1	75

Table 15.--*Major dissolved chemical constituents*

[m, meter; mg/L, milligram per liter; <, less than]

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
RESERVOIR 25--PASS CREEK RESERVOIR								
MAY , 1980								
13...	0932	1.0	620	120	77	260	47	4.6
AUG								
21...	1230	.0	860	130	130	580	58	8.6

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
13...	15	200	950	5.7	0.4	0.6	1,550
AUG							
21...	31	130	1,700	12	.4	1.0	2,660

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
RESERVOIR 26--MID-FLAT CREEK RESERVOIR								
MAY , 1980								
13...	1202	1.0	770	150	96	490	58	7.7
AUG								
21...	1101	.5	1,000	170	150	880	64	12

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
13...	10	170	1,500	4.9	0.3	0.6	2,350
AUG							
21...	15	130	2,600	10	.4	2.0	3,910

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
RESERVOIR 27--COLDWELL RESERVOIR NO.2								
MAY , 1980								
13...	1802	1.0	480	80	69	620	73	12
AUG								
21...	0931	.5	530	62	91	970	80	18

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
13...	8.6	210	1,500	1.6	0.4	0.6	2,410
AUG							
21...	10	120	2,400	3.3	.5	1.1	3,610

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
			RESERVOIR 28--HOMESTEAD RESERVOIR					
APR , 1980								
11...	1030	--	1,200	86	230	260	32	3.3
MAY								
14...	1432	1.0	1,200	93	230	300	35	3.8
14...	1436	3.0	1,300	95	250	300	39	4.1
AUG								
20...	1431	.5	1,400	72	300	390	37	4.5
20...	1435	2.5	1,400	74	300	380	36	4.4

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
APR , 1980							
11...	17	270	1,300	9.4	0.2	0.1	2,070
MAY							
14...	19	290	1,400	8.5	.2	.3	2,230
14...	19	290	1,400	8.5	.2	.4	2,250
AUG							
20...	18	250	1,900	12	.1	.1	2,840
20...	18	250	2,000	11	.1	.3	2,930

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
RESERVOIR 29--CLARK RESERVOIR								
MAY , 1980								
14...	1732	1.0	420	62	64	68	26	1.4
14...	1735	2.5	430	63	66	68	25	1.4
AUG								
20...	1203	1.5	410	70	56	62	25	1.3

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
14...	6.7	54	490	5.8	0.1	0.3	730
14...	6.6	53	480	2.9	.1	.3	719
AUG							
20...	6.7	56	470	2.5	.2	.1	701

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
			RESERVOIR 30--GRANT RESERVOIR					
MAY , 1980								
14...	1902	1.0	140	21	22	210	75	7.6
AUG								
20...	1032	1.0	93	11	16	310	87	14

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
14...	7.3	310	290	1.8	0.3	<0.1	739
AUG							
20...	9.3	310	440	6.1	.1	.5	979

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
			RESERVOIR 31--COAL CREEK RESERVOIR					
MAY , 1980								
14...	2100	0.0	120	18	19	210	77	8.2
AUG								
19...	1401	.5	130	21	18	230	78	8.9

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
14...	7.7	200	350	4.3	0.5	0.2	730
AUG							
19...	9.9	110	480	3.5	.6	3.3	833

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
RESERVOIR 32--BIG DROP RESERVOIR								
MAY , 1980								
14...	1002	1.0	580	94	83	370	57	6.7
AUG								
19...	0930	.0	300	57	39	220	60	5.5

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
14...	17	100	1,200	4.8	0.7	1.0	1,830
AUG							
19...	11	41	710	3.2	.6	3.2	1,070

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
			RESERVOIR 33--JACK RABBIT DETENTION RESERVOIR					
MAY , 1980								
15...	1000	0.1	64	9.3	10	140	81	7.6

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
15...	5.3	210	130	6.2	0.3	0.9	428

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
			RESERVOIR 34--RIDGE RESERVOIR					
MAY , 1980								
15...	1230	0.0	230	38	32	160	60	4.6

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
15...	3.4	84	430	13	0.4	2.5	730

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
			RESERVOIR 35--SIDNEY RESERVOIR					
MAY , 1980								
15...	1530	0.0	880	140	130	320	44	4.7
15...	1535	2.5	860	130	130	330	45	4.9
AUG								
18...	1332	1.0	1,000	150	160	490	50	6.6

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
MAY , 1980							
15...	9.0	130	1,400	13	0.9	0.5	2,090
15...	8.9	130	1,500	13	.9	.3	2,190
AUG							
18...	14	66	1,900	17	1.3	.3	2,770

Table 15.--*Major dissolved chemical constituents*--Continued

Date	Time	Sampling depth (m)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium adsorption ratio
			RESERVOIR 36--SIDE HILL RESERVOIR					
AUG , 1980								
18...	0930	0.0	2,000	300	300	920	50	9.0

Date	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)
AUG , 1980							
18...	23	160	3,600	15	2.6	0.1	5,260

Table 16.--*Selected plant nutrients*

[m, meter; mg/L, milligram per liter; <, less than]

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
RESERVOIR 25--PASS CREEK RESERVOIR									
MAY , 1980									
13...	0932	1.0	1.5	0.01	<0.01	<0.01	0.01	0.23	0.21
AUG									
21...	1230	.0	2.2	<.01	<.01	<.01	<.01	<.01	.02

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
13...	1.4	1.3	0.02	0.03	0.02	0.02	32	0.2
AUG								
21...	2.1	2.2	.01	.03	<.01	<.01	48	.1

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 26--MID-FLAT CREEK RESERVOIR					
MAY , 1980									
13...	1202	1.0	2.8	0.04	<0.01	<0.01	0.01	0.10	0.10
AUG									
21...	1101	.5	2.2	<.01	.01	<.01	<.01	<.01	.02

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
13...	1.4	2.7	0.01	0.02	0.02	0.02	31	0.4
AUG								
21...	2.1	2.2	.01	.02	<.01	<.01	48	.1

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 27--COLDWELL RESERVOIR NO.2					
MAY , 1980									
13...	1802	1.0	1.2	0.03	<0.01	<0.01	0.01	0.65	0.03
AUG									
21...	0931	.5	1.5	<.01	.01	<.01	<.01	<.01	<.01

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
13...	0.45	1.2	0.02	0.02	0.02	0.02	19	0.3
AUG								
21...	1.4	1.5	.01	.02	<.01	<.01	26	.1

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 28--HOMESTEAD RESERVOIR					
MAY , 1980									
14...	1432	1.0	1.4	0.01	<0.01	<0.01	0.02	0.05	0.03
14...	1436	3.0	1.0	.01	<.01	<.01	.02	.01	.01
AUG									
20...	1431	.5	1.5	<.01	.01	.01	<.01	.02	<.01
20...	1435	2.5	1.5	<.01	.01	.01	<.01	.03	<.01

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
14...	1.1	1.4	0.01	0.01	0.02	0.03	18	0.1
14...	.99	.99	.01	--	.02	.02	18	.1
AUG								
20...	1.5	1.5	.02	.01	<.01	<.01	38	.2
20...	1.5	1.5	.02	.01	<.01	<.01	34	.2

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 29--CLARK RESERVOIR					
MAY , 1980									
14...	1732	1.0	0.71	0.03	<0.01	<0.01	<0.01	0.04	0.04
14...	1735	2.5	.91	.03	<.01	<.01	<.01	.10	.06
AUG									
20...	1203	1.5	1.3	<.01	.01	<.01	<.01	.08	<.01

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
14...	0.08	0.67	0.01	0.02	<0.01	<0.01	7.0	0.3
14...	<.01	.85	.01	.02	<.01	<.01	7.2	.4
AUG								
20...	1.0	1.3	.01	<.01	<.01	<.01	13	.2

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 30--GRANT RESERVOIR					
MAY , 1980									
14...	1902	1.0	1.5	0.01	<0.01	<0.01	0.01	0.03	0.06
AUG									
20...	1032	1.0	2.7	<.01	.01	.01	<.01	<.01	<.01

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
14...	1.5	1.4	0.05	0.06	0.02	0.02	26	0.2
AUG								
20...	2.0	2.7	.06	.06	<.01	<.01	49	.2

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 31--COAL CREEK RESERVOIR					
MAY , 1980									
14...	2100	0.0	1.7	0.02	<0.01	<0.01	0.01	0.03	0.04
AUG									
19...	1401	.5	1.2	.07	.01	.02	.09	<.01	<.01

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
14...	--	1.7	0.02	0.02	0.02	0.02	16	0.3
AUG								
19...	1.1	1.1	.03	.04	<.01	.02	18	.3

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 32--BIG DROP RESERVOIR					
MAY , 1980									
14...	1002	1.0	1.3	0.02	<0.01	<0.01	0.01	0.04	0.04
AUG									
19...	0930	.0	.92	.09	.01	.02	.07	1.2	.03

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
14...	1.2	1.3	0.03	0.04	0.02	0.02	14	0.1
AUG								
19...	<.01	.82	.06	.06	<.01	.02	8.9	.2

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
			RESERVOIR 33--JACK RABBIT DETENTION RESERVOIR						
MAY , 1980									
15...	1000	0.1	0.75	0.02	0.01	<0.01	0.01	0.04	0.02

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
15...	0.73	0.72	0.06	0.06	0.03	0.01	16	0.3

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 34--RIDGE RESERVOIR					
MAY , 1980									
15...	1230	0.0	8.2	0.03	<0.01	<0.01	0.01	0.12	0.41

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
15...	0.10	7.8	0.04	0.29	<0.01	0.05	20	12

Table 16.--*Selected plant nutrients*--Continued

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				RESERVOIR 35--SIDNEY RESERVOIR					
MAY , 1980									
15...	1530	0.0	0.79	0.03	<0.01	<0.01	<0.01	<0.10	0.06
15...	1535	2.5	.87	.03	<.01	<.01	<.01	.08	.04
AUG									
18...	1332	1.0	1.1	<.01	<.01	.01	<.01	<.01	<.01

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
MAY , 1980								
15...	0.07	0.73	0.01	0.02	<0.01	<0.01	9.0	0.4
15...	.01	.83	.01	.02	<.01	.01	8.4	.3
AUG								
18...	.94	1.1	.02	.03	<.01	<.01	11	.2

Date	Time	Sampling depth (m)	Nitrogen, total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
RESERVOIR 36--SIDE HILL RESERVOIR									
AUG , 1980									
18...	0930	0.0	2.1	<0.01	0.01	0.01	<0.01	0.44	0.19

Date	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)
AUG , 1980								
18...	1.7	1.9	0.05	0.05	<0.01	0.02	40	0.3

Table 17.--*Trace elements*

[m, meter; µg/L, microgram per liter; <, less than]

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
				RESERVOIR 25--PASS CREEK RESERVOIR						
MAY , 1980										
13...	0932	1.0	--	--	--	--	--	1	--	30
AUG										
21...	1230	.0	8	<10	<10	10	17	1	150	30

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
MAY , 1980									
13...	--	<1	--	190	--	--	--	--	10
AUG									
21...	4	<1	50	30	0.1	5	1	80	10

Table 17.--*Trace elements*--Continued

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
				RESERVOIR 26--MID-FLAT CREEK RESERVOIR						
MAY , 1980										
13...	1202	1.0	--	--	--	--	--	3	--	30
AUG										
21...	1101	.5	5	<10	<10	10	11	1	100	30

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
MAY , 1980									
13...	--	<1	--	90	--	--	--	--	30
AUG									
21...	2	<1	30	10	0.1	6	1	60	10

Table 17.--*Trace elements*--Continued

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
				RESERVOIR 27--COLDWELL RESERVOIR NO.2						
MAY , 1980										
13...	1802	1.0	--	--	--	--	--	1	--	30
AUG										
21...	0931	.5	4	<10	<10	<1	7	1	100	30

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
MAY , 1980									
13...	--	<1	--	20	--	--	--	--	60
AUG									
21...	1	<1	20	10	<0.1	4	1	30	10

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
				RESERVOIR 28--HOMESTEAD RESERVOIR						
APR , 1980										
11...	1030	--	--	--	--	--	--	21	--	20
MAY										
14...	1432	1.0	--	--	--	--	--	2	--	20
14...	1436	3.0	--	--	--	--	--	1	--	20
AUG										
20...	1431	.50	--	--	--	--	--	1	--	30
20...	1435	2.5	4	<10	<10	<1	4	1	80	30

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
APR , 1980									
11...	--	1	--	10	--	--	--	--	40
MAY									
14...	--	<1	--	20	--	--	--	--	10
14...	--	<1	--	20	--	--	--	--	10
AUG									
20...	--	2	--	10	--	--	--	--	10
20...	<1	2	20	<1	<0.1	3	<1	10	10

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
			RESERVOIR 29--CLARK RESERVOIR							
MAY , 1980										
14...	1732	1.0	--	--	--	--	--	2	--	<10
14...	1735	2.5	--	--	--	--	--	3	--	10
AUG										
20...	1203	1.5	3	<10	<10	<1	3	<1	100	<10

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
MAY , 1980									
14...	--	<1	--	<1	--	--	--	--	<3
14...	--	<1	--	1	--	--	--	--	<3
AUG									
20...	3	3	20	3	<0.1	3	<1	10	4

Table 17.--*Trace elements*--Continued

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
				RESERVOIR 30--GRANT RESERVOIR						
MAY , 1980										
14...	1902	1.0	--	--	--	--	--	1	--	20
AUG										
20...	1032	1.0	18	<10	<10	10	5	1	90	30

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
MAY , 1980									
14...	--	<1	--	2	--	--	--	--	<3
AUG									
20...	5	3	20	4	<0.1	2	<1	30	<3

Table 17.--*Trace elements*--Continued

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
				RESERVOIR 31--COAL CREEK RESERVOIR						
MAY , 1980										
14...	2100	0.0	--	--	--	--	--	2	--	20
AUG										
19...	1401	.5	5	<10	<10	<1	8	4	320	70

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
MAY , 1980									
14...	--	<1	--	3	--	--	--	--	10
AUG									
19...	5	<1	10	<1	0.1	3	1	10	<3

Table 17.--*Trace elements*--Continued

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
				RESERVOIR 32--BIG DROP RESERVOIR						
MAY , 1980										
14...	1002	1.0	--	--	--	--	--	<1	--	20
AUG										
19...	0930	.0	5	10	<10	20	11	<1	190	<10

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
MAY , 1980									
14...	--	<1	--	60	--	--	--	--	10
AUG									
19...	4	2	40	30	0.2	5	<1	10	4

Table 17.--*Trace elements*--Continued

Date	Time	Sampling depth (m)	Copper, dissolved (μg/L as Cu)	Iron, dissolved (μg/L as Fe)	Lead, dissolved (μg/L as Pb)	Manganese, dissolved (μg/L as Mn)	Zinc, dissolved (μg/L as Zn)
RESERVOIR 33--JACK RABBIT DETENTION RESERVOIR							
MAY , 1980							
5...	1000	0.1	2	<10	<1	2	<3
RESERVOIR 34--RIDGE RESERVOIR							
MAY , 1980							
15...	1230	0.0	2	10	<1	2	<3

Date	Time	Sampling depth (m)	Arsenic, total (μg/L as As)	Beryllium, total recoverable (μg/L as Be)	Cadmium, total recoverable (μg/L as Cd)	Chromium, total recoverable (μg/L as Cr)	Copper, total recoverable (μg/L as Cu)	Copper, dissolved (μg/L as Cu)	Iron, total recoverable (μg/L as Fe)	Iron, dissolved (μg/L as Fe)
				RESERVOIR 35--SIDNEY RESERVOIR						
MAY , 1980										
15...	1530	0.0	--	--	--	--	--	1	--	30
15...	1535	2.5	--	--	--	--	--	1	--	30
AUG										
18...	1332	1.0	5	10	<10	<1	6	<1	100	20

Date	Lead, total recoverable (μg/L as Pb)	Lead, dissolved (μg/L as Pb)	Manganese, total recoverable (μg/L as Mn)	Manganese, dissolved (μg/L as Mn)	Mercury, total recoverable (μg/L as Hg)	Nickel, total recoverable (μg/L as Ni)	Selenium, total (μg/L as Se)	Zinc, total recoverable (μg/L as Zn)	Zinc, dissolved (μg/L as Zn)
MAY , 1980									
15...	--	<1	--	220	--	--	--	--	30
15...	--	<1	--	230	--	--	--	--	10
AUG									
18...	3	<1	20	20	0.1	38	<1	10	10

Table 17.--*Trace elements*--Continued

Date	Time	Sampling depth (m)	Arsenic, total (µg/L as As)	Beryllium, total recoverable (µg/L as Be)	Cadmium, total recoverable (µg/L as Cd)	Chromium, total recoverable (µg/L as Cr)	Copper, total recoverable (µg/L as Cu)	Copper, dissolved (µg/L as Cu)	Iron, total recoverable (µg/L as Fe)	Iron, dissolved (µg/L as Fe)
				RESERVOIR 36--SIDE HILL RESERVOIR						
AUG , 1980										
18...	0930	0.0	3	10	0	30	3	1	90	40

Date	Lead, total recoverable (µg/L as Pb)	Lead, dissolved (µg/L as Pb)	Manganese, total recoverable (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Mercury, total recoverable (µg/L as Hg)	Nickel, total recoverable (µg/L as Ni)	Selenium, total (µg/L as Se)	Zinc, total recoverable (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)
AUG , 1980									
18...	5	2	190	220	0.1	2	<1	<10	10

Table 18.--*Taxa and numbers of phytoplankton*

[m, meter; mL, milliliter]

	RESERVOIR 25 PASS CREEK RESERVOIR				RESERVOIR 26 MID-FLAT CREEK RESERVOIR			
Date:	5-13-80		8-21-80		5-13-80		8-21-80	
Time:	0932		1230		1202		1101	
Depth:	1.0 m		0 m		1.0 m		0.5 m	
	Cells per mL	Percent	Cells per mL	Percent	Cells per mL	Percent	Cells per mL	Percent
BACILLARIOPHYTA		6.80		3.08		2.41		3.22
Bacillariophyceae (diatoms)								
Amphiprora ornata							2	.36
Cocconeis placentula			30	2.80			14	2.50
Cyclotella bodanica	1	.40						
Navicula heufleri					2	.22		
N. simplex					3	.33		
N. spp.							2	.36
Nitzschia acicularis					3	.33		
N. spp.	16	6.40			14	1.53		
Synedra pulchella			3	.28				
CHLOROPHYTA (green algae)		.40		.56		10.61		
Chlorophyceae								
Elakatothrix viridis					5	.55		
Oocystis spp.			6	.56	12	1.31		
Scenedesmus abundans	1	.40						
S. bijuga					19	2.08		
S. denticulatus					31	3.39		
S. opoliensis					6	.66		
S. quadricauda					16	1.75		
Tetraedron minimum					8	.87		
CHRYSOPHYTA				11.56		41.86		4.11
Chrysophyceae (yellow-brown algae)								
Chrysochromulina parva			124	11.56	383	41.86	23	4.11
CRYPTOPHYTA (cryptomonads)		74.40		84.44		7.65		87.50
Cryptophyceae								
Chroomonas spp.	37	14.80	863	80.43	67	7.32	460	82.14
Cryptomonas spp.	149	59.60	43	4.01	3	.33	30	5.36
CYANOPHYTA (blue-green algae)		13.20				36.72		5.18
Cyanophyceae								
Aphanizomenon flos-aquae	33	13.20						
Coelosphaerium Kuetzingianum					78	8.52		
Merismopedia punctata					258	28.20	29	5.18

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 25--continued PASS CREEK RESERVOIR				RESERVOIR 26--continued MID-FLAT CREEK RESERVOIR			
Date:	5-13-80		8-21-80		5-13-80		8-21-80	
Time:	0932		1230		1202		1101	
Depth:	1.0 m		0 m		1.0 m		0.5 m	
	Cells per mL	Per-cent	Cells per mL	Per-cent	Cells per mL	Per-cent	Cells per mL	Per-cent
EUGLENOPHYTA (euglenoids)		5.20				.22		
Euglenophyceae								
Euglena spp.	13	5.20			2	.22		
PYRRHOPHYTA (fire algae)				.38		.55		
Dinophyceae (dinoflagellates)								
Gymnodinium spp.			2	.19	2	.22		
Peridinium spp.			2	.19	3	.33		
Total number of cells (rounded)	250		1,100		920		560	
Total number of taxa	7		8		19		7	

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 27 COLDWELL RESERVOIR NO.2				RESERVOIR 28 HOMESTEAD RESERVOIR			
Date:	5-13-80		8-21-80		5-14-80		8-20-80	
Time:	1802		0931		1432		1431	
Depth:	1.0 m		0.5 m		1.0 m		0.5 m	
	Cells per mL	Percent	Cells per mL	Percent	Cells per mL	Percent	Cells per mL	Percent
BACILLARIOPHYTA		41.72		0.25		0.68		0.21
Bacillariophyceae (diatoms)								
Gyrosigma spp.	21	12.00						
Nitzschia acicularis	3	1.71						
N. spp.	11	6.29			3	.68	2	.21
Rhopalodia gibba			3	.25				
Synedra radians	32	18.29						
S. ulna	6	3.43						
CHLOROPHYTA (green algae)		8.57		.34		14.16		20.42
Chlorophyceae								
Ankistrodesmus falcatus	13	7.43						
Cosmarium granatum			2	.17				
C. spp.	2	1.14						
Gloeocystis vesiculosa							178	18.45
Oocystis spp.					62	14.16	19	1.97
Tetraedron minimum			2	.17				
CHRYSOPHYTA		8.00		41.61		50.68		35.65
Chrysophyceae (yellow-brown algae)								
Chrysochromulina parva	14	8.00	496	41.61	222	50.68	344	35.65
CRYPTOPHYTA (cryptomonads)		36.00		14.93		34.47		43.21
Cryptophyceae								
Chroomonas spp.	63	36.00	155	13.00	140	31.96	414	42.90
Cryptomonas spp.			23	1.93	11	2.51	3	.31
CYANOPHYTA (blue-green algae)				42.20				
Cyanophyceae								
Aphanizomenon flos-aquae			203	17.03				
Coelosphaerium Kuetzingianum			300	25.17				
EUGLENOPHYTA (euglenoids)		4.00		.17				
Euglenophyceae								
Euglena spp.	5	2.86						
Phacus spp.	2	1.14	2	.17				

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 27--continued COLDWELL RESERVOIR NO.2				RESERVOIR 28--continued HOMESTEAD RESERVOIR			
Date:	5-13-80		8-21-80		5-14-80		8-20-80	
Time:	1802		0931		1432		1431	
Depth:	1.0 m		0.5 m		1.0 m		0.5 m	
	Cells per mL	Per- cent	Cells per mL	Per- cent	Cells per mL	Per- cent	Cells per mL	Per- cent
PYRRHOPHYTA (fire algae)		1.71		.50				.52
Dinophyceae (dinoflagellates)								
Gymnodinium spp.	3	1.71						
Peridinium spp.			6	.50			5	.52
Total number of cells (rounded)	173		1,192		438		965	
Total number of taxa	12		10		5		7	

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 29 CLARK RESERVOIR				RESERVOIR 30 GRANT RESERVOIR			
Date:	5-14-80		8-20-80		5-14-80		8-20-80	
Time:	1732		1203		1902		1032	
Depth:	1.0 m		1.5 m		1.0 m		1.0 m	
	Cells per mL	Percent	Cells per mL	Percent	Cells per mL	Percent	Cells per mL	Percent
BACILLARIOPHYTA		3.84		2.03		4.03		0.91
Bacillariophyceae (diatoms)								
Amphora veneta							2	.07
Cocconeis placentula	2	.45	2	.45				
Fragilaria vaucheriae					16	4.03		
Nitzschia gracilis	15	3.39						
N. palea							14	.51
N. spp.			7	1.58			9	.33
CHLOROPHYTA (green algae)		4.51		43.88		17.87		6.16
Chlorophyceae								
Ankistrodesmus falcatus							7	.26
Closterium spp.							2	.07
Cosmarium formosulum							3	.11
C. spp.			2	.45				
Crucigenia truncata			155	35.07				
Dictyosphaerium Ehrenbergianum					12	3.02		
D. pulchellum					16	4.03		
Oocystis crassa					1	.25	2	.07
O. spp.	20	4.51	10	2.26	11	2.77	69	2.53
Scenedesmus abundans							12	.44
S. arcuatus							16	.59
S. denticulatus			20	4.52	28	7.05	28	1.03
S. dimorphus							16	.59
Scenedesmus opoliensis							8	.29
Schroederia setigera					1	.25	2	.07
Selenastrum minutum					1	.25		
Tetraedron minimum			7	1.58				
T. trigonum					1	.25		
Treubaria setigerum							3	.11
CHRYSOPHYTA		49.66		2.94				
Chrysophyceae (yellow-brown algae)								
Chrysochromulina parva	220	49.66	13	2.94				
CRYPTOPHYTA (cryptomonads)		12.86		41.85		78.08		41.30
Cryptophyceae								
Chroomonas spp.	23	5.19	63	14.25	229	57.68	1,112	40.79
Cryptomonas spp.	34	7.67	122	27.60	81	20.40	14	.51

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 29--continued CLARK RESERVOIR				RESERVOIR 30--continued GRANT RESERVOIR			
Date:	5-14-80		8-20-80		5-14-80		8-20-80	
Time:	1732		1200		1902		1030	
Depth:	1.0 m		1.5 m		1.0 m		1.0 m	
	Cells per mL	Per- cent	Cells per mL	Per- cent	Cells per mL	Per- cent	Cells per mL	Per- cent
CYANOPHYTA (blue-green algae)		28.67		.90				51.61
Cyanophyceae								
Anabaena spp.							50	1.83
Aphanizomenon flos-aquae	130	28.67						
Chroococcus limneticus							17	.62
C. Prescotti							220	8.07
Coelosphaerium Kuetzingianum							1,120	41.09
Merismopedia punctata			2	.45				
M. tenuissima			2	.45				
PYRRHOPHYTA (fire algae)		.45		8.37				
Dinophyceae (dinoflagellates)								
Ceratium hirundinella	2	.45						
Gymnodinium spp.			30	6.79				
Peridinium spp.			7	1.58				
Total number of cells (rounded)	440		440		400		2,700	
Total number of taxa	8		14		11		21	

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 31 COAL CREEK RESERVOIR				RESERVOIR 32 BIG DROP RESERVOIR			
Date:	5-14-80		8-19-80		5-14-80		8-19-80	
Time:	2100		1401		1002		0930	
Depth:	0 m		0.5 m		1.0 m		0 m	
	Cells per mL	Percent	Cells per mL	Percent	Cells per mL	Percent	Cells per mL	Percent
BACILLARIOPHYTA		0.21		6.70		0.62		5.43
Bacillariophyceae (diatoms)								
Amphora veneta			7	.96				
Cocconeis placentula			2	.27			5	.97
Cyclotella bodanica					2	.07	13	2.52
Navicula cryptocephala							2	.39
N. spp.			40	5.47			3	.58
Nitzschia spp.	2	.21			14	.48	5	.97
Synedra ulna					2	.07		
CHLOROPHYTA (green algae)		11.02		1.84		1.39		13.39
Chlorophyceae								
Cosmarium formosulum			2	.27				
C. meneghinii	1	.10						
Cosmarium venustum			4	.55				
Elakatothrix gelatinosa							3	.58
Gloeocystis vesiculosa	72	7.56					53	10.29
Oocystis spp.	28	2.94	4	.55				
Scenedesmus denticulatus	2	.21			8	.27	8	1.55
S. opoliensis					20	.69		
S. quadricauda					7	.26		
Schroederia setigera	2	.21			2	.07		
Selenastrum minutum			2	.27				
Tetraedron minimum					3	.10		
Tetrastrum staurogeniaeforme							5	.97
CRYPTOPHYTA (cryptomonads)		20.56		65.39		87.85		58.83
Cryptophyceae								
Chroomonas spp.	187	19.62	395	54.04	2,432	83.46	226	43.88
Cryptomonas spp.	9	.94	83	11.35	128	4.39	77	14.95
CYANOPHYTA (blue-green algae)		68.21		26.26		10.16		22.33
Cyanophyceae								
Aphanizomenon flos-aquae	650	68.21			296	10.16		
Aphanocapsa elachista			134	18.33				
Merismopedia tenuissima			58	7.93			115	22.33
Total number of cells (rounded)	950		730		2,900		520	
Total number of taxa	9		11		11		12	

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 33 JACK RABBIT DETENTION RESERVOIR				RESERVOIR 34 RIDGE RESERVOIR			
Date:	5-15-80		--		5-15-80		--	
Time:	1000		--		1230		--	
Depth:	0.1 m		--		0 m		--	
	Cells per mL	Per- cent	Cells per mL	Per- cent	Cells per mL	Per- cent	Cells per mL	Per- cent
BACILLARIOPHYTA		6.70				0.05		
Bacillariophyceae (diatoms)								
Cocconeis placentula	3	.11						
Epithemia spp.	2	.07						
Gyrosigma spp.					40	<.01		
Navicula cryptocephala					319	.03		
N. cuspidata	3	.11						
N. heufleri	150	5.62						
N. salinarum	5	.19						
Nitzschia spp.	7	.26			239	.02		
Stephanodiscus spp.					40	<.01		
Surirella angustata	9	.34						
CHLOROPHYTA (green algae)		6.25				.40		
Chlorophyceae								
Actinastrum Hantzschii					1,754	.16		
Ankistrodesmus falcatus					199	.02		
Closterium spp.	2	.07						
Cosmarium granatum	7	.26						
C. meneghinii	3	.11						
Dictyosphaerium pulchellum					957	.09		
Elakatothrix gelatinosa	4	.15						
Golenkinia radiata					159	.01		
Micractinium pusillum					478	.04		
Oocystis spp.	103	3.86			80	.01		
Pandorina morum	32	1.20						
Pediastrum tetras					319	.03		
Scenedesmus abundans	4	.15						
S. denticulatus	12	.45						
S. opoliensis					319	.03		
S. quadricauda					80	.01		

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 33--continued JACK RABBIT DETENTION RESERVOIR				RESERVOIR 34--continued RIDGE RESERVOIR			
Date:	5-15-80		--		5-15-80		--	
Time:	1000		--		1230		--	
Depth:	0.1 m		--		0 m		--	
	Cells per mL	Per- cent	Cells per mL	Per- cent	Cells per mL	Per- cent	Cells per mL	Per- cent
CRYPTOPHYTA (cryptomonads)		1.87				.01		
Cryptophyceae								
Chroomonas spp.	3	.11			159	.01		
Cryptomonas spp.	47	1.76			40	<.01		
CYANOPHYTA (blue-green algae)		85.18				99.54		
Cyanophyceae								
Anabaena spiroides					1,112,440	99.54		
A. spp.	2,125	79.56						
Coelosphaerium Naegelianum	150	5.62						
Total number of cells(rounded)	2,700				1,100,000			
Total number of taxa	19				16			

Table 18.--*Taxa and numbers of phytoplankton*--Continued

	RESERVOIR 35 SIDNEY RESERVOIR				RESERVOIR 36 SIDE HILL RESERVOIR			
Date:	5-15-80		8-18-80		--		8-18-80	
Time:	1530		1332		--		0930	
Depth:	0 m		1.0 m		--		0 m	
	Cells per mL	Per-cent	Cells per mL	Per-cent	Cells per mL	Per-cent	Cells per mL	Per-cent
BACILLARIOPHYTA		1.80		5.58				4.78
Bacillariophyceae (diatoms)								
Achnanthes spp.			25	.86				
Amphiprora alata			2	.07				
Cocconeis placentula			15	.52				
Gyrosigma spp.							1	.18
Navicula directa			7	.24				
N. simplex	2	.09						
Nitzschia acicularis							2	.37
N. communis			74	2.55				
N. gracilis			3	.10				
N. holsatica							20	3.68
N. palea			16	.55				
N. spp.	36	1.71	20	.69			3	.55
CHLOROPHYTA (green algae)		1.66		1.66				
Chlorophyceae								
Gloeocystis vesiculosa			46	1.59				
Oocystis crassa	12	.57	2	.07				
Schroederia setigera	23	1.09						
CRYPTOPHYTA (cryptomonads)		96.54		9.31				21.14
Cryptophyceae								
Chroomonas spp.	2,037	96.54	249	8.59			73	13.42
Cryptomonas spp.			21	.72			42	7.72
CYANOPHYTA (blue-green algae)				83.45				74.09
Cyanophyceae								
Aphanizomenon flos-aquae							221	40.63
Coelosphaerium Kuetzingianum			593	20.46				
Synechocystis aquatilis			1,826	62.99				
EUGLENOPHYTA (euglenoids)								
Euglenophyceae								
Euglena spp.							182	33.46
Total number of cells(rounded)	2,110		2,899				544	
Total number of taxa	5		14				8	

Table 19.--*Bacterial analyses of water samples*

[< less than; >, more than]

Bacteria	Location	Number of organisms per 100 milliliters in water samples from indicated reservoir											
		25	26	27	28	29	30	31	32	33	34	35	37
							May sampling period						
Total coliform	Midpoint	15*	<2*	18*	42	<2*	<10*	12*	6*	40	10*	66	--
	Shore	3*	<2*	8*	10*	<2*	27*	5*	14*	6*	<10*	210	--
Fecal coliform	Midpoint	<2*	<2*	16*	3*	<2*	<10*	2*	<1*	<1*	20*	4*	--
	Shore	<2*	<2*	16*	3*	<2*	9*	7*	1*	<1*	<10*	7*	--
Fecal streptococcus	Midpoint	<2*	5*	<2*	3*	15*	55*	37*	7*	2*	300	26*	--
	Shore	<2*	<2*	28*	4*	3*	2,200*	15*	2*	13*	<10*	<2*	--
FC/FS ratio[1]	Midpoint	1*	<.40*	>8*	1*	<.13*	<.18*	.05*	<.14*	<.50*	.07*	.15*	--
	Shore	1*	1*	.57*	75*	<.67*	<.004*	.47*	.50*	<.08*	1*	>3.5*	--
							August sampling period						
Total coliform	Midpoint	2*	28*	<3*	3*	<1*	1*	14*	--	--	--	5*	--
	Shore	2*	20*	<3*	3*	<1*	<1*	5*	>400	--	--	--	7*
Fecal coliform	Midpoint	130	3*	3*	8*	<1*	<1*	1*	--	--	--	<1*	--
	Shore	17*	12*	<3*	2*	4*	6*	39*	295	--	--	--	1*
Fecal streptococcus	Midpoint	<3*	<3*	3*	1*	145	15*	66	--	--	--	<1*	--
	Shore	25*	29*	3*	2*	355	7*	350	136	--	--	--	<1*
FC/FS ratio[1]	Midpoint	>43*	>1*	1*	8*	<.007*	<.07*	.02*		--	--	1*	--
	Shore	.68*	.41*	<1*	1*	.01*	.86*	.11*	2.17	--	--	--	>1*

*Estimated number of organisms based on nonideal colony count.
[1]Fecal coliform organisms per 100 milliliters divided by fecal streptococcal organisms per 100 milliliters.