Arkansas Water Resources Center

EVALUATION OF WATER QUALITY DATA BEAVER LAKE

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Section I

SUMMARY AND CONCLUSIONS

Summary

This report includes a summary of the water quality information available for Beaver Lake. Beaver Lake is a multiple use project located on the White River in northwestern Arkansas. The lake is located in Benton, Carroll, Madison and Washington Counties in Arkansas.

White River Basin. The surface water resources in the White River Basin fall into several categories. With respect to designated uses, Beaver Lake is in the Ozark Highlands Ecoregion as defined by the Arkansas Department of Pollution Control and Ecology. Streams which have watersheds with areas greater than 10 square miles are classified as suitable for primary contact recreation. Beaver Lake is also designated as suitable for primary contact recreation. All surface water resources in the basin are designated as suitable for secondary contact recreation.

All surface water resources in the basin are designated as suitable for domestic, industrial and agricultural water supply purposes. Beaver Lake is classified as suitable for fisheries. Streams in the White River Basin which have watersheds with areas of less than 10 square miles are classified as seasonal Ozark Highlands Ecoregion fisheries. Streams which have watersheds with areas of 10 square miles, or larger are designated as perennial Ozark Highlands Ecoregion fisheries. Additionally, a stream which has a discharge of greater than one cubic foot per second is designated as a perennial Ozark Highlands Ecoregion fishery even though the watershed area may be less than ten square miles.

The applicable maximum temperatures are 29 ^{O}C (84.2 ^{O}F) and 32 ^{O}C (89.6 ^{O}F) for the streams and Beaver Lake, respectively. The White River immediately downstream from the dam is classified as suitable for trout waters. Consequently, the applicable maximum temperature for the White River is 20 degrees Celsius. The turbidity standard is 10 NTU for the streams and 25 NTU for Beaver Lake.

Beaver Lake. For most of the parameters, the quality of the water in the lake was very good. The concentrations of several of the metals were larger than usually encountered in lakes in Arkansas. In fact, some of the concentrations were very large.

The dissolved oxygen concentrations have been very good in the White River downstream from the dam at all times. The smallest concentration in the record was 6.2 mg/L.

The concentrations of fecal coliform bacteria have been very large at several of the sites. An extremely large count of 14,000 colonies per 100 mL occurred at the Goshen site. The counts at several of the sites were small.

The transparency of the water was often less than desired at some of the sites. At three of the sites, War Eagle, Goshen and Richland Creek, the average concentrations were less one-half of the of the recommended minimum of forty-eight inches for some of the seasonal periods.

Conclusions

1. The water in Beaver Lake may be characterized as being ordinarily suitable for the uses designated by the Arkansas Department of Pollution Control and Ecology. These include primary and secondary contact recreation, perennial fisheries, and as a source of agricultural, industrial and industrial water supplies.

2. Continuation and expansion of the water quality monitoring and surveillance measures is needed to protect the classified uses of water from the lake. Particular attention needs to be directed at monitoring the fecal coliform, nutrient, iron, manganese, copper, chromium, lead, chlorophyll a and chlorophyll b concentrations. The fecal coliform counts particularly need to be monitored at the War Eagle, Goshen and Richland Creek sites because of very large counts which have occurred at times at these sites. The chlorophyll a and b concentrations need to be monitored because of relatively large concentrations which have occurred at several of the sites.

3. Beaver Lake is a long, narrow lake with numerous contributing streams. Consequently, the number of sampling sites required to adequately monitor the lake is relatively large. There are currently ten sampling sites in the lake and one in the White River immediately downstream from the dam. The sampling sites include: 1) a sampling site on the receiving stream (White River) which allows monitoring of the quality of the water being discharged from the lake; 2) a site in the main part of the lake upstream from the dam

for which profile data for dissolved oxygen, temperature, pH and conductivity have been developed as well as data for other parameters (Eureka Springs site); 3) a sampling site in the Prairie Creek arm of the lake (Prairie Creek site); 4) a sampling site in the lake where Highway 12 crosses the lake east of Rogers (Highway 12 site); 5) a site in the lake near Monte Ne (Monte Ne site); 6) a site in the War Eagle arm of the lake (War Eagle site); 7) a site in the lake where the White River enters the lake (Goshen site); 8) a site in the lake in the Avoca Hollow arm near Avoca (Avoca site); 9) a site in the lake near the raw water intake structure for the Beaver Water District; 10) a site in the lake where Highway 68 crosses the lake east of Springdale (Highway 68 site), and; 11) a site in the lake near the confluence of Richland Creek and the White River (Richland Creek site).

The location of the existing sampling sites leaves a large portion of the lake undefined with respect to water quality. This is understandable because of access problems between the Eureka Springs site (Site Number 2) and the Highway 12 site (Site Number 4) which is closest upstream site.

It is doubtful that the number of existing sites is adequate for monitoring the quality of the lake. Consequently, the recommendation is not to eliminate any sites, but to add at least one additional site. If one site were added, it would preferably be between the Eureka Springs and Highway

12 sites. For example, a site could be included in the lake east of the Larue area.

A discussion of the rationale is included in the following paragraph. The White River site (Site Number 1) needs to be retained to allow continued monitoring of the quality of water entering the stream and because it has been designated as trout water. The Beaver Lake site (Site Number 2) immediately upstream from the dam needs to be retained to allow monitoring of the water quality above and below the thermocline and to develop periodic profile data. The Prairie Creek site (Site Number 3) needs to be retained because this site allows monitoring of water where Prairie Creek enters the lake. The Highway 12 site (Site Number 4) needs to be retained because it is the nearest site in the main stem of the lake to the Eureka Springs site immediately upstream from the dam. There is perhaps as much as thirty river miles between these two sites. The Monte Ne (Site Number 5) site needs to be retained because it allows monitoring of the water quality in the arm of the lake where Phillips Creek and Monte Branch enter the lake. The War Eagle site (Site Number 6) needs to be retained because it allows monitoring of the water near where War Eagle Creek enters the lake. The Goshen (Site Number 7) site needs to be retained because it allows monitoring of the water quality near where the White River enters the lake. The Avoca site (Site Number 8) needs to be retained because it allows monitoring of water quality in the Avoca Hollow arm of the lake. The Rogers site (Site Number 9) needs to be retained because is the nearest site upstream from the Highway 12 site. It is 47 river miles upstream from the Eureka Springs site with only one sampling site in between in the main part of the lake. The Highway 68 site (Site Number 10) needs to be retained because it is a uppermost main stem site. The Richland Creek site (Site Number 11) needs to be retained both because it allows monitoring of the lake near where Richland Creek enters the lake and because of the quality of water in this area of the lake.

If funding limitations absolutely require elimination of a site, there appears to be only one logical option. This would be to combine the Avoca and Prairie Creek sites by moving the site at some location downstream from the confluence of these two streams. This is not desirable but could be done. It is important to note that the records for both sites would essentially be lost by moving the site. Consequently, several years would be required before sufficient data were again available to evaluate any trends which might be occurring. Sampling would probably be more difficult than at the existing sites.

4. With respect to the types of analyses which should be conducted, the highest priority should be assigned to: 1) monitoring fecal coliform, metals at certain sites, chlorophyll a and b, nitrogen and phosphorous because of prior events; 2) monitoring activities above and below the thermocline at the Eureka Springs site which is immediately upstream from the dam including the development of periodic profile data, and: 3) continued seasonal sampling for dis-

solved oxygen, transparency, turbidity, color, five-day biochemical oxygen demand and pH. Only infrequent monitoring for chloride and sulfate, except at the Goshen site, is required because of the small concentrations for these two parameters.

Although monitoring water quality three times per year is adequate for most parameters, more frequent monitoring of the fecal coliform counts needs to be conducted at the site which have had large counts in the past.

5. Although providing background information, the frequency of sampling for several parameters which have small and/or relatively consistent concentrations could be reduced or eliminated. Conductivity, calcium and total hardness and total alkalinity analyses could be conducted on an annual basis.

Although they have not all been conducted on a continuous basis at all sites, analyses for carbon dioxide, dissolved calcium, dissolved magnesium, potassium, un-ionized ammonia nitrogen and Total Kjeldahl Nitrogen could be discontinued. Analyses for conductivity and pH for the profile data (Beaver Site) could be discontinued.

6. Priority should also be given to maintaining a complete record of the water quality at the White River site downstream from the dam as this site provides information about the quality of the water being discharged to the river. At this site, particular emphasis should be maintained with respect to temperature and dissolved oxygen, five-day biochemical oxygen demand, color, pH, nitrogen,

phosphorous, arsenic, chromium, copper, iron, lead, manganese, mercury, nickel and zinc and fecal coliform bacteria. The existing heavy metals concentrations at this site were small. However, continued monitoring is required to determine if any changes occur, particularly during the August period.

7. Several metals, including iron and manganese were present in unusually large concentrations at some of the sites. These need to be e monitored to determine long term trends. Manganese concentrations were unusually large on occasion at some of the sites.

8. The total alkalinity concentrations were moderate in Beaver Lake. The patterns for the total alkalinity concentrations as a function of the season of the year vary considerably among the eleven sampling sites. At some sites, the average concentrations were about the same for the three seasonal periods. For example, at the Eureka Springs site, the average seasonal concentrations were all 56 mg/L for the May, August and December periods. At other sites, there were substantial seasonal influences on the total alkalinity concentrations. For example, the average seasonal concentrations were 48, 55 and 113 mg/L, respectively, for the May, August and December periods at the Prairie Creek site. There were also variations in the patterns with respect to the season of the year which have the largest and smallest average total alkalinity concentrations. As indicated, the average total alkalinity concentrations were much larger in the December period at the Prairie Creek site. The average

total alkalinity concentrations were the largest during the August period at the War Eagle site. The average concentrations at this site were 70, 93 and 74 mg/L for the May, August and December periods. At the Goshen site, the average total alkalinity concentrations were the smallest in the December period. At most sites, the average concentrations were the smallest in the May period.

The total alkalinity concentrations also vary considerably from year to year at some of the sites. More variation in the May period was noted than in the August and December periods at some of the sites.

Although the total alkalinity concentrations were moderate in Beaver Lake, there was no indication of substantially increasing concentrations with the passage of time. Consequently, there were no indications of trouble spots in the lake with respect to total alkalinity.

9. The five-day biochemical oxygen demand concentrations varied considerably among the eleven sites. At some sites, such as the Eureka Springs site, the five-day biochemical oxygen demand concentrations were in the low end of the range usually encountered in lakes in Arkansas. At other sites, the concentrations were unusually large. For example, the average five-day biochemical oxygen demand concentration for the August period at the Goshen site was 4.6 mg/L which was large for a lake in Arkansas. There were also variations in the patterns with respect to which season of the year had the largest and smallest five-day biochemical oxygen demand concentrations. As an example, the aver-

age concentrations were the largest in the May period at the Avoca and the Eureka Springs sites. They were the largest in the August period at the War Eagle, Richland Creek and Goshen sites.

The five-day biochemical oxygen demand concentrations also varied as a function of time at the several sites. The variations were larger at some sites than at other sites.

Careful monitoring of the five-day biochemical oxygen demand concentrations at the Richland Creek site needs to be conducted because of the magnitudes of the concentrations at this site. The quality of water at several of the sites was very good to excellent at several sites. As examples, the average five-day biochemical oxygen demand concentrations were small at the Highway 68 and Eureka Springs sites.

10. The chloride concentrations at the White River site and the ten sampling sites in the lake were usually very small. However, the average chloride concentration for the August period at the Goshen site exceeds the stream standard of 20 mg/L for the White River.

The trends were mixed varying from site to site and among the seasons of the year. The chloride data were usually characterized by small and relatively uniform chloride concentrations as a function of time.

With the exception of the Goshen site, the quality of the water was excellent in Beaver Lake and in the White River with respect to chloride. Close monitoring of the chloride concentrations at the Goshen site is suggested.

11. Chlorophyll a is an algal biomass indicator which can be used to provide an indication of the relative populations of algae. The parameter does not distinguish between desirable and undesirable species of algae. Consequently, it does not provide an absolute scale by which water quality is either good or bad. However, the parameter can provide an indication that troublesome conditions may be developing or may not developing. Consequently, it is a useful parameter for surface water supplies.

The chlorophyll a concentrations varied considerably among the sites, as a function of time and as a function of the season of the year. There were alarming tendencies at several of the sites. For example, the average chlorophyll a concentration at the Rogers site was 10.3 micrograms per liter in the May period. This was a relatively large chlorophyll a concentration. The average concentration at the Goshen site was 13.9 micrograms per liter for the August period. The chlorophyll a concentrations were unusually large at the Avoca and War Eagle sites at least part of the time.

There were significant differences in the chlorophyll a concentrations among the sites. In the August period, for example, the average chlorophyll a concentrations ranged from 1.92 micrograms per liter at the Eureka Springs site to 13.9 micrograms per liter at the Goshen site.

The chlorophyll a concentrations also varied considerably as a function of the season of the year which would be expected. As an example, at the Rogers site, the average concentrations were 10.3 and 3.46 micrograms per liter in the May and August periods.

There were alarming patterns of relatively large chlorophyll a concentrations at several of the sites. These were not always in the most recent samples. However, the fact that microbiological events at the scale encountered on several occasions points out the need for continued and expanded monitoring of the water quality in the lake.

12. The chlorophyll b concentrations also varied as a function of the season of the year, among the ten sites in the lake, and as a function of time. The general tendency was for the chlorophyll b data to parallel the chlorophyll a data. This tendency was not always exerted, however. The chlorophyll b concentrations were alarming at some of the sites. At the Goshen site, the average chlorophyll b concentration was 2.05 micrograms per liter for the August period which was a large concentration for large lakes in Arkansas.

13. The color concentrations varied considerably as a function of the season of the year, as a function of time and as a function of the location of the site. At some sites, the color concentrations were small. As an example, the maximum color concentration in any sample at the White River site was 20 units which was considerably less than the rule of thumb maximum of 50 units for the protection of certain types of phytoplankton and the benthos. The color concentrations were also relatively small at the Eureka Springs site. The maximum concentration was 30 units at this site.

On the other hand, the maximum concentrations were 180, 240, 240, 400 and 450 units at the Highway 12, Monte Ne, Goshen, Rogers and Highway 68 sites. These were large color concentrations in a large lake such as Beaver Lake.

14. The conductivity values for the eleven sampling sites were moderate. There were considerable differences in the patterns with respect to season of the year. At some sites including the Eureka Springs, Highway 12, War Eagle, Goshen and Richland Creek sites, the largest average seasonal values occurred in the August period. At others including the White River, Prairie Creek, Monte Ne, Avoca and Highway 68 sites, the largest average seasonal values occurred in the December period. The largest conductivity values occurred at the Goshen site.

There were often significant differences as a function of the site location within each season. For example, the average seasonal conductivity values for the December period ranged from 120 micromhos per centimeter at the Richland Creek site to 215 micromhos per centimeter at the Prairie Creek site.

15. In general, the dissolved oxygen concentrations were usually very good at the White River sampling site. Surprisingly, the occasions in which the dissolved oxygen concentrations were less than 6 mg/L were usually in the December period. The minimum seasonal concentrations were 8.4, 5.6 and 3.9 mg/L for the May, August and December periods. The dissolved oxygen concentrations were very good in

the May period and almost always very good in the August period.

The dissolved oxygen concentrations were not good at the Highway 68 site in the August period. The average concentration for this period was 2.1 mg/L. The dissolved oxygen concentrations were less than 1 mg/L in each of the last three years of record. They were usually larger in the May period but still below 6 mg/L. In fact, the average concentration was only 5.6 mg/L. The dissolved oxygen concentrations were less than 6 mg/L in five of the seven years which were in the record.

The dissolved oxygen concentrations were also less than desirable at the Goshen site. The average concentration for the August period was 5.2 mg/L. As would be indicated by the average concentration, the dissolved oxygen concentrations were often less than 6 mg/L in the August period and on occasion in the December period.

As would be expected, the dissolved oxygen concentrations were often small in the samples collected at 0.8 depth at the deep sites in the main stem of the lake in the August period. However, they were generally good in the samples collected at 0.2 depth.

16. Since Beaver Lake and the White River are designated as suitable for primary contact recreation, the fecal coliform counts are of considerable importance. In general, the fecal coliform counts were small and well within the standard of 200 colonies per 100 mL at most of the sites. There were exceptions, however. The fecal coliform count at

the Richland site in the May, 1987 seasonal period was 14,000 colonies per 100 mL. This count was dangerously large for water used in primary contact recreational activities. The maximum count in the December period was 5,100 colonies per 100 mL at the Richland Creek site in 1984. The maximum count in the August period at the Richland Creek site was only 91 colonies per 100 mL.

The fecal coliform counts have also been large on occasion at the Goshen site. The count was 5,200 colonies per 100 mL in 1985 at this site in the August period. The maximum count was 1,400 colonies per 100 mL in the May period in 1979 at this site.

The fecal coliform counts have been large on occasion at the War Eagle site. The maximum counts were 400 colonies per 100 mL in the May period in 1983 and 1,500 colonies per 100 mL in the August period in 1981.

The fecal coliform counts were always less than the limit primary contact recreation in the May and August periods at the White River, Prairie Creek, Highway 12, Monte Ne, Avoca, Rogers and Highway 68 sites. The were nearly always less at the Eureka Springs site.

An expanded monitoring program needs to be implemented at, and around, the sites which had the extremely large fecal coliform counts. The count of 14,000 colonies per 100 mL was seventy times the maximum allowable count for primary contact recreation in the warmer months of the year.

17. The total hardness concentrations in the samples collected at the eight sites in and below Beaver Lake were

moderate. The patterns varied considerably from site to site with respect to the season of the year. For example, the average seasonal concentrations at the White River site were 64, 63 and 67 mg/L indicating little seasonal dependency. They were 42, 91 and 51 mg/L at the Goshen site indicating substantial seasonal dependency. At some sites, the average total hardness concentrations were the largest in the August period and at others they were the largest in the December period. There were also considerable variations as a function of site location within each seasonal period. As an example, the total hardness concentrations for the December period ranged from 51 mg/L at the Goshen site to 92 mg/L at the Prairie Creek site.

The calcium concentrations also varied as a function of the season of the year, as a function of the location of the site within and below the lake and as a function of time. As would be expected, the dissolved calcium concentrations also varied.

The average seasonal concentrations for dissolved magnesium were generally more consistent as a function of time, as a function of the season of the year and as a function of the location of the site than the dissolved calcium, calcium and total hardness concentrations. All of the average seasonal dissolved magnesium concentrations were between 1.44 and 3.58 mg/L. There was only a relatively small amount of magnesium in the water in Beaver Lake.

18. Metals analyses were conducted at seven of the eleven sampling sites for Beaver Lake. The metals concen-

trations varied considerably.

Considerable variation existed among the sites with respect to the aluminum concentrations. The concentrations ranged from small to very large. The maximum concentrations ranged from 160 micrograms per liter in the May period at the Eureka Springs site to 4,400 micrograms per liter in the May period at the Rogers site. The maximum aluminum concentrations were 4,200 micrograms per liter at the Highway 12 and Highway 68 sites in the December period. These were unusually large aluminum concentrations in a lake. The aluminum concentrations were usually small at the White River and Eureka Springs sites and were frequently large at the Rogers, Highway 68 and Highway 12 sites. There were significant seasonal dependencies in the average aluminum concentrations.

The arsenic concentrations were usually small at all seven sites at which samples were collected. The maximum concentration reported was 14 microgram per liter. This concentration was much less than the maximum contaminant level of 50 micrograms per liter for drinking water. For the protection of aquatic life, arsenic concentrations should be less than 20 micrograms per liter. Consequently, the quality of the water was good concerning this parameter.

The chromium concentrations were often larger than usually found in lakes in Arkansas. The maximum concentration reported was 100 micrograms per liter. Samples collected at both the White River and Eureka Springs sites had chromium concentrations of 100 micrograms per liter. For the protection of aquatic life, the chromium concentrations should be less than 10 to 15 micrograms per liter. The maximum concentrations were usually less than 60 micrograms per liter. The chromium concentrations varied as a function of the location of the sampling site, as a function of time and as a function of the season of the year.

The copper concentrations were somewhat larger than usual for lakes in Arkansas. The maximum concentration was 150 micrograms per liter which occurred at the Avoca site in the August period. Copper concentrations of 110 micrograms per liter also were reported for the White River and Eureka Springs sites. The copper concentrations should not be larger than 20 to 30 micrograms per liter for water in lakes which have hardness concentrations in the range of those in Beaver Lake. The peak copper concentrations occurred at the White River, Eureka Springs and Avoca sites.

The iron concentrations varied as a function of time, as a function of the season of the year and as a function of site location. At times, very large iron concentrations were reported for some of the sites. For comparison purposes, the recommended maximum contaminant level for drinking water is 300 micrograms per liter. For example, an iron concentration of 9,000 micrograms per liter occurred at the Rogers site. Iron concentrations of 4,100, 4000 and 4,000 micrograms per liter were reported at the Goshen, Highway 68 and Highway 12 sites. There were differences among the sites concerning the season of the year during which the largest average iron concentrations occurred. As an example, the average iron concentrations were the largest in the May period at the Avoca and Rogers sites. They were the largest in the August period at the White River site. The average iron concentrations were the largest in the December period at the Eureka Springs, Highway 12, Goshen and Highway 68 sites.

At times, the lead concentrations were somewhat larger than usual for lakes in Arkansas. The maximum concentration reported was 50 micrograms per liter in the May period at the Rogers site. The lead concentrations exceeded the action level of 15 micrograms per liter at some time for each of the seven sites. However, the lead concentrations were usually fairly small. The average concentrations were usually less than 6.5 micrograms per liter. The lead concentrations also varied as a function of time, as a function of site location and as a function of the season of the year.

There were surprisingly large concentrations of manganese at some of the sites. The maximum manganese concentrations were 4,100, 4,000, 4,000 and 2,800 micrograms per liter at the Goshen, Highway 68, Highway 12 and Rogers sites. The average manganese concentration in the August period at the Rogers site was greater than 1,000 micrograms per liter. The average concentrations exceeded 600 micrograms per liter at the Highway 12, Goshen, Rogers and Highway 68 sites. The manganese concentrations varied with the location of the site, with the season of the year and as a function of time.

The maximum mercury concentration in the record was 1.3 microgram per liter which was relatively small. The maximum contaminant level of 2 micrograms per liter for drinking water. The average mercury concentrations were all less than 0.3 micrograms per liter.

The maximum nickel concentration reported was 50 micrograms per liter which was somewhat larger than usual for lakes in Arkansas. However, it would be considered to be acceptably small.

The potassium concentrations were all small and relatively consistent. There were variations as a function of time, as a function of the season of the year and as a function of site location. However, there variations were relatively small.

The maximum zinc concentration was 870 micrograms per liter which was large. This zinc concentration occurred at the Highway 68 and Highway 12 sites. The zinc concentrations were 200 micrograms per liter or larger at the White River, Eureka Springs, Highway 12, Goshen and Highway 68 sites. The zinc concentrations should be less than about 100 micrograms per liter for the protection of aquatic life. The zinc concentrations were variable as a function of site location, as a function of time and as a function of the season of the year.

19. The un-ionized ammonia concentrations were unusually large in the August period at the Goshen site. The average concentration for the August period was 0.0200 mg/L. The maximum concentration was 0.11 mg/L. These were both

unusually large. The un-ionized ammonia concentrations varied as a function of the season of the year, as a function of time and as a function of site location.

The ammonia concentrations were relatively large for all three seasonal periods at the Goshen site. The average concentrations were 0.21, 0.94 and 0.51 mg/L, respectively, for the May, August and December periods. The ammonia concentrations were small at the White River, Eureka Springs, Highway 12 and Highway 68 sites. The ammonia concentrations also were variable from site to site, as a function of time and as a function of the season of the year.

Nitrate nitrogen measurements were made at all eleven sites. The maximum concentration was 2.20 mg/L at the Goshen site in the August period. This was an unusually large concentration. The nitrate concentrations were larger in the May and December periods than in the August period.

20. The pH values were usually well within the limits established by the Arkansas Department of Pollution Control and Ecology. These limits are from 6.0 to 9.0. There were occasions at the Eureka Springs and Avoca sites in which the pH values were larger than 9.0.

21. The total phosphorous concentrations were usually relatively small. The average seasonal concentrations were 0.05 mg/L or less at the White River, Eureka Springs, Prairie Creek, Highway 12, Monte Ne, Avoca, Rogers and Highway 68 sites. The average total phosphorous concentrations were unusually large at the Goshen site. They were 0.28, 1.13 and 0.33 mg/L, respectively, for the May, August and

December periods at this site. There were occasions, however, when relatively large total phosphorous concentrations were measured at other sites. The maximum total phosphorous concentrations were 0.44, 0.61, 0.61 and 0.32 mg/L at the White River, Highway 12, Highway 68 and Richland Creek sites, respectively. The total phosphorous concentrations varied among the sites, among the seasons of the year and as a function of time.

The orthophosphate concentrations were usually relatively small. However, one very large concentration of 2.20 mg/L was reported at the Goshen site. Larger than usual concentrations were also reported at the Richland Creek, Rogers, Avoca and War Eagle sites on occasion.

22. The sulfate concentrations were less than the stream standard of 20 mg/L for the White River at all of the sites except the Goshen site. The sulfate concentrations were as large as 51 mg/L at this site. The average concentration for the August period was 19 mg/L at this site. There were significant seasonal variations at some of the sites.

23. The transparency values were smaller than desired for several of the sites at times. Most notable were the War Eagle, Goshen and Richland Creek sites. The average transparency values were less than two feet for some of the seasonal periods at these sites. Conversely, the transparency values were excellent at the Eureka Springs site and were very good at the Highway 12 and Highway 68 sites. The

desired minimum transparency value is forty-eight inches for water used in primary contact recreation.

24. The turbidity values in the water at the White River site were usually very small. The stream standard at this site is 10 NTU. On one occasion the turbidity value was 14 FTU. Usually, however, the turbidity values were much less than 10 FTU. The turbidity values were very large at the Goshen site on occasion. The maximum values were 90, 60 and 120 FTU, respectively, for the May, August and December periods. They also exceeded the lake standard of 25 NTU on occasions at the Highway 12, Monte Ne, War Eagle, Avoca, Rogers, Highway 68 and Richland Creek sites.

Section II

BACKGROUND

Water Quality

Water quality requirements are basically determined by the use, or proposed use, of the water. Consequently, there are a variety of scales by which the quality of a water can be measured. The single most applicable scale for Beaver Lake is Regulation No. 2 issued by the Arkansas Department of Pollution Control and Ecology. Regulation No. 2 established water quality standards for surface waters in the State of Arkansas. It contains both guidelines and standards for a variety of parameters. A second scale includes the drinking water regulations promulgated by the Environmental Protection Agency. These contain both mandatory and recommended maximum contaminant levels for a variety of parameters.

Water Quality Standards for Surface Waters in Arkansas

Regulation No. 2 contains provisions for both streams and lakes. Since the water quality monitoring program for Beaver Lake includes stations both in the lake and downstream from the lake, a brief discussion of each is appropriate. The provisions included in Regulation No. 2 include both general and specific standards. The specific standards applicable for a particular stream are a function of the designated waterbody use for that stream.

Waterbody Uses. The designated waterbody uses are defined in Regulation No. 2 as follows:

Extraordinary Resource Waters-This beneficial use is a combination of the chemical, physical and biological characteristics of a waterbody and its watershed which is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential and intangible social values.

Ecologically Sensitive Waterbody-This beneficial use identifies segments known to provide habitat for threatened, endangered or endemic species of aquatic or semi-aquatic life forms.

Natural and Scenic Waterways-This beneficial use identifies segments which have been legislatively adopted into a state or federal system.

Primary Contact Recreation-This beneficial use designates waters where full body contact is involved. Any streams with watersheds of greater than 10 square miles are designated for full body contact. All streams with watersheds less than 10 square miles may be designated for primary contact recreation after site verification.

Secondary Contact Recreation-This beneficial use designated waters where secondary activities like boating, fishing or wading are involved.

Fisheries-This beneficial use provides for the protection and propagation of fish, shellfish and other forms of aquatic life. It is further subdivided into the following subcategories:

1) Trout - water which is suitable for the growth and survival of trout (Family: Salmonidae).

2) Lakes and Reservoirs - water which is suitable for the protection and propagation of fish and other forms of aquatic life adapted to impounded waters. Generally characterized by a dominance of sunfishes such as bluegill or similar species, black basses and crappie. May include substantial populations of catfishes such as channel, blue and flathead catfish and commercial fishes including carp, buffalo and suckers. Forage fishes are normally shad or various species of minnows. Unique populations of walleye, striped bass and/or trout may also exist.

3) Streams - water which is suitable for the protection and propagation of fish and other forms of aquatic life adapted to flowing water systems whether or not the flow is perennial.

   a) Ozark Highlands Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a preponderance of sensitive species and normally dominated by a diverse minnow community followed by sunfishes and darters. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Duskystripe shiner	Banded sculpin
Northern hogsucker	Ozark madtom
Slender madtom	Southern redbelly dace
"Rock" basses	White tail
Rainbow and/or Orangethroat darters	Ozark minnow
Smallmouth bass	

b) Boston Mountains Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a major proportion of sensitive species; a diverse, often darter-dominated community exists but with nearly equal proportions of minnows and sunfishes. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Bigeye shiner	Shadow bass
Black redhorse	Wedgespot shiner
Slender madtom	Longnose darter
Longear sunfish	Fantail darter
Greenside darter	
Smallmouth bass	

c) Arkansas River Valley Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a substantial proportion of sensitive species; a sunfish- and minnow-dominated community exists but with substantial proportions of darters and catfishes (particularly madtoms). The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Bluntnose minnow	Orangespotted sunfish
Golden redhorse	Blackside darter
Yellow bullhead	Madtoms
Longear sunfish	
Redfin darter	
Spotted bass	

d) Ouachita Mountains Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. The fish community is characterized by a major proportion of sensitive species; a sunfish-and minnow-dominated community exists but with substantial proportions of darters and catfishes (particularly madtoms). The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Bigeye shiner	Shadow bass
Northern hogsucker	Gravel chub
Freckled madtom	Northern studfish
Longear sunfish	
Orangebelly darter	
Smallmouth bass	

e) Typical Gulf Coastal Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a limited proportion of sensitive species; sunfishes are distinctly dominant followed by darters and minnows. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Redfin shiner	Pirate perch
Spotted sucker	Warmouth
Yellow bullhead	Spotted sunfish
Flier	Dusky darter
Slough darter	Creek chubsucker
Grass pickerel	Banded pygmy sunfish

f) Springwater-influenced Gulf Coastal Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a substantial proportion of sensitive species; sunfishes normally dominate the community and are followed by darters and minnows. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Redfin shiner	Pirate perch
Blacktail redhorse	Golden redhorse
Freckled madtom	Spotted bass
Longear sunfish	Scaly sand darter
Creole darter	Striped shiner
Grass pickerel	Banded pygmy sunfish

g) Least-altered Delta Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by an insignificant proportion of sensitive species; sunfishes are distinctly dominant followed by minnows. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Ribbon shiner	Pugnose minnow
Smallmouth buffalo	Mosquitofish
Yellow bullhead	Pirate perch
Bluegill	Tadpole madtom
Bluntnose darter	Banded pygmy sunfish
Largemouth bass	

h) Channel-altered Delta Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by an absence of sensitive species; sunfishes and minnows dominate the population followed by catfishes. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Blacktail shiner	Mosquitofish
Drum	Gizzard shad
Carp	Emerald shiner
Channel catfish	
Green sunfish	
Spotted gar	

Domestic Water Supply-This beneficial use designates water which will be protected for use in public and private water supplies. Conditioning or treatment may be necessary prior to use.

Industrial Water Supply-This beneficial use designates water which will be protected for use as process or cooling water. Quality criteria may vary with the specific type of process involved and the water supply may require prior treatment or conditioning.

Agricultural Water Supply-This beneficial use designates waters which will be protected for irrigation of crops and/or consumption by livestock.

Other Uses-This category of beneficial use is generally used to designate uses not dependent on water quality, such as hydroelectric power generation and navigation.

General Standards. The general standards are applicable to all surface waters of the State at all times. They are specifically applicable to substances attributed to discharges, nonpoint sources of instream activities rather than natural occurrences. The criteria do not apply to waters which have natural background levels of certain substances which exceed the limits. The general standards include the provision that all waters shall be free from substances attributed to man-caused point or nonpoint source discharges in concentrations that produce undesirable aquatic life or result in the dominance of nuisance species. Included also in the provision that true color shall not be increased in any waters to the extent that it will interfere with present or projected future uses of these waters. A third provision is that taste and odor producing substances shall be limited in receiving waters to concentrations that will not interfere with the production of potable water by reasonable water treatment processes, or impart unpalatable flavor to food, fish or result in offensive odors arising from the waters or otherwise interfere with the reasonable use of the water. A fourth provision is that receiving waters shall have no distinctly visible solids, scum or foam of a persistent nature, nor shall there be any formation of slime, bottom deposits or sludge banks.

Specific Standards. Regulation No. 2 requires that the following specific standards shall apply at all times except during periods when flows are less than the average minimum 7-day flow which occurs once in ten years (Q7-10). Streams with regulated flow will be addressed on a case-by-case basis to maintain designated instream uses. These standards apply outside the mixing zone to conditions resulting in frequent, persistent or long-term modification of the water quality and are not applicable to naturally-occurring excursions outside the standards.

Temperature-Heat shall not be added to any waterbody in excess of the amount that will elevate the natural temperature, outside the mixing zone, by more than 5 ^{O}F (2.8 ^{O}C) based upon the monthly average of the maximum daily temperatures measured at mid-depth or three feet (whichever is less) in streams, lakes or reservoirs. Maximum allowable temperatures from man-induced causes in the following waters are shown in Table I. Temperature requirements shall not apply to off-stream privately-owned reservoirs constructed primarily for industrial cooling purposes and financed in whole or in part by the entity or successor entity using the lake for cooling purposes.

Turbidity - There shall be no distinctly visible increase in turbidity of receiving waters attributable to municipal, industrial, agricultural, other waste discharges or instream activities. Specifically, in no case shall any such waste discharge or instream activity cause turbidity values to exceed those shown in Table II.

Table I

Maximum Allowable Temperatures
From Man-Induced Causes
For Waters in Arkansas

Waterbodies	Limit °C (°F)
Streams	
Ozark Highlands	29 (84.2)
Boston Mountains	31 (87.8)
Arkansas River Valley	31 (87.8)
Ouachita Mountains	30 (86.0)
Gulf Coastal	30 (86.0)
Least-Altered Delta	30 (86.0)
Channel-Altered Delta	32 (89.6)
White River (Dam #1 to mouth)	32 (89.6)
St. Francis River	32 (89.6)
Mississippi River	32 (89.6)
Arkansas River	32 (89.6)
Ouachita River (L. Missouri R. to state line)	32 (89.6)
Red River	32 (89.6)
Lakes and Reservoirs	32 (89.6)
Trout waters	20 (68.0)

Table II

Maximum Allowable Turbidity Values
From Man-Induced Causes
For Waters in Arkansas

Waterbodies	Limit (NTU)
Streams	
Ozark Highlands	10
Boston Mountains	10
Arkansas River Valley	21
Ouachita Mountains	10
Gulf Coastal	21
Least-Altered Delta	45
Channel-Altered Delta	75
Arkansas River	50
Mississippi River	50
Red River	50
St. Francis River	75
Trout	10
Lakes and Reservoirs	25

pH - As a result of waste discharges, the pH of water in streams or lakes must not fluctuate in excess of 1.0 unit over a period of 24 hours and pH values shall not be below 6.0 or above 9.0.

Dissolved Oxygen - In streams with watersheds of less than 10 mi^2, it is assumed that insufficient water exists to support a fishery during the critical season. During this time, a D.O. standard of 2 mg/L will apply to prevent nuisance conditions. However, field verification is required in areas suspected of having significant groundwater flows which may support unique aquatic biota. All streams with watersheds of less than 10 mi^2 are expected to support a fishery during the primary season when stream flows, including discharges, equal or exceed 1 cubic foot per second (CFS); however, when site verification indicates that a fishery exists at flows below 1 CFS such fishery will be protected by the appropriate standard. During the period when a fishery exists in these streams with watersheds of less than 10 mi^2, the primary season D.O. standard will apply. Also, in these streams where waste discharges are 1 CFS or more, they are assumed to provide sufficient water to support a perennial fishery and, therefore, must meet the dissolved oxygen standards of the next size category of streams.

For purposes of determining effluent discharge limits, the following conditions shall apply:

1) The primary season dissolved oxygen standard is to be met at a water temperature of 22 ^{o}C (71.5 ^{o}F) and at the minimum stream flow for that season. At water temperatures of 10 ^{o}C (50 ^{o}F), the dissolved oxygen standard is 6.5 mg/L.

2) During March, April and May, when background stream flows are 15 CFS or higher, the D.O. standard is 6.5 mg/L in all areas except the Delta Ecoregion, where the primary season D.O. standard will remain at 5 mg/L.

3) The critical season dissolved oxygen standard is to be met at maximum allowable water temperatures and at Q7-10 flows. However, when water temperatures exceed 22 ^{o}C (71.6 ^{o}F), a 1 mg/L diurnal depression will be allowed below the applicable critical standard for no more than 8 hours during any 24-hour period.

   The dissolved oxygen standards shown in Table III must be met.

Table III

Minimum Allowable Dissolved Oxygen Concentrations for Streams, Lakes and Reservoirs in Arkansas

Waterbodies	Limit (mg/L)	
Streams	Primary	Critical
Ozark Highlands		
<10 mi^2 watershed	6	2
10 to 100 mi^2	6	5
>100 mi^2 watershed	6	6
Boston Mountains		
<10 mi^2 watershed	6	2
>10 mi^2 watershed	6	6
Arkansas River Valley		
<10 mi^2 watershed	5	2
10 to 150 mi^2	5	3
151 mi^2 to 400 mi^2	5	4
>400 mi^2 watershed	5	5
Ouachita Mountains		
<10 mi^2 watershed	6	2
>10 mi^2 watershed	6	6
Typical Gulf Coastal		
<10 mi^2 watershed	5	2
10 to 500 mi^2	5	3
>500 mi^2 watershed	5	5
Spring-influenced Gulf Coastal		
All size watersheds	6	5
Delta		
<10 mi^2 watershed	5	2
10 to 100 mi^2	5	3
>100 mi^2 watershed	5	5
Trout Waters		
All size watersheds	6	6

Lakes and Reservoirs: Specific dissolved oxygen standards for lakes and reservoirs shall be 5 mg/L. Effluent limits for oxygen-demanding discharges into impounded waters are developed by the Effluent Policy contained in the "State of Arkansas Continuing Planning Process". However, the Commission may after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, establish alternative limits for dissolved oxygen in lakes and reservoirs where studies and other relevant information can demonstrate that predominant ecosystem conditions may be more accurately reflected by such alternate limits; provided that theses limits shall be compatible with all designated beneficial uses of named lakes and reservoirs.

<u>Radioactivity</u> - The Rules and Regulations for the Control of Sources of Ionizing Radiation of the Division of Radiological Health, Arkansas Department of Health, limits the maximum permissible levels of radiation that may be present in effluents to surface waters in uncontrollable areas. These limits shall apply for the purposes of these standards, except that in no case shall the levels of dissolved radium-226 and strontium-90 exceed 3 and 10 picocuries/liter, in the receiving water after mixing, nor shall the gross beta concentration exceed 1000 picocuries/liter.

<u>Bacteria</u> - The Arkansas Department of Health has the responsibility of approving or disapproving surface waters for public water supply and of approving or disapproving the suitability of specifically delineated outdoor bathing places for body contact recreation, and it has issued rules and regulations pertaining to such uses.

For the purposes of this regulation, all streams with watersheds less than 10 mi^2 shall not be designated for primary contact unless and until site verification indicates that such use is attainable. The determination of fecal coliform levels for the following waters shall be based on a minimum of not less than five samples taken over not more than a 30-day period.

1) Extraordinary Resource Waters and Natural and Scenic Waterways - At no time shall the fecal coliform content exceed a geometric mean of 200/100 mL in any size of watersheds.

2) Primary Contact Waters - Between April 1 and September 30, the fecal coliform shall not exceed a geometric mean of 200/100 mL nor shall more than 10 percent of the total samples during any 30-day period exceed

400/100 mL. During the remainder of the calendar year, these criteria may be exceeded, but at no time shall the fecal coliform content exceed the level necessary to support secondary contact recreation.

3) Secondary Contact Waters - The fecal coliform content shall not exceed a geometric mean of 1000/100 mL, nor equal or exceed 2000/100 mL in more than 10 percent of the samples taken in any 30-day period.

Toxic Substances - Toxic materials shall not be present in receiving waters, after mixing, in such quantities as to be toxic to human, animal, plant or aquatic life or to interfere with the normal propagation, growth and survival of the indigenous aquatic biota. Within the mixing zone there may be a zone of initial dilution which exceeds the acute toxicity. In no instance shall the entire mixing zone be acutely toxic. Compounds known to be persistent, cumulative, carcinogenic or to exhibit synergism with other waste or stream components shall be addressed on a case by case basis. Permitting of all toxic materials shall be in accordance with the toxic implementation strategy found in the Continuing Planning Process. The substances and criteria are listed in Table IV. Discharge limits based on the numeric criteria listed in Table IV may be modified in consideration of the following factors:

1) Analytical Detectability - concentration limits for specific toxic materials in discharge permits will not be required to be less than practical quantitative limits.

2) Bioavailability of specific toxics in the effluent.

3) Persistence and degradation rate of specific toxics in the mixing zone.

4) Synergistic or antagonistic interactions with other materials.

5) Technological or economic limits of treatability for specific criteria, in accordance with Section 302(b)(2)(B) of the Clean Water Act, as amended.

The permittee shall also have the option to develop specific numerical limits for toxic substances using EPA approved bioassay methodology and guidance contained in "Water Quality Standards Handbook", "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms", "Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms".

Table IV

Toxic Substances and Criteria
for
Waters in Arkansas

Substance	Chronic* Toxicity	Acute** Toxicity
PCBs	0.014	2.0
Aldrin		3.0
Dieldrin	0.0019	2.5
DDT (& metabolites)	0.0010	1.1
Endrin	0.0023	0.18
Toxaphene	0.0002[1]	0.73[2]
Chlordane	0.0043	2.4
Endosulfan	0.056	0.22
Heptachlor	0.0038	0.52
Hexachlorocyclohexane	0.080	2.0
Pentachlorophenol	e[1.005(pH)-5.290][1]	e[1.005(pH)-4.830]
Chloropyrifos	0.041[1]	0.083[2]
Selenium[3]	35	260
Silver[3]	0.12	***

*24 hour average (micrograms per liter)
**never to exceed (micrograms per liter)
*** e[1.72{ln(hardness)}-6.52]
1 - Four-day average
2 - One-hour average
3 - Total recoverable
4 - Total of all isomers

<u>Nutrients</u> Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation. As a guideline, total phosphorus shall not exceed 100 micrograms per liter in waters highly laden with natural silts or color which reduce the penetration of sunlight needed for plant photosynthesis, or in other waters where it can be demonstrated that algal production will not interfere with or adversely affect designated uses and/or fish and wildlife propagation.

The Commission may establish alternative nutrient limitations for lakes, reservoirs and streams, and appropriate water quality management plans.

Oil and Grease - Oil, grease or petrochemical substances shall not be present in receiving waters to the extent that they produce globules or other residue or any visible, colored film on the surface, or coat the banks and/or bottoms of the watercourses or adversely affect any of the associated biota. As a guideline, oil and grease shall not exceed 10 mg/L average or 15 mg/L maximum when discharging to surface waters.

Mineral Quality - Existing mineral quality shall not be altered by municipal, industrial, other waste discharges or instream activities so as to interfere with designated uses. The following limits apply to the streams indicated, and represent concentrations of chloride (Cl^-), sulfate ($SO_4^=$) and total dissolved solids (TDS) not to be exceeded in more than one (1) in ten (10) samples collected over a period of not less than 30 days or more than 360 days.

As a guideline for tributary streams not listed in Table V, an increase up to 15 mg/L chlorides and 15 mg/L sulfates or an increase of 1/3 over naturally occurring levels, whichever is greater, may be permitted. In no cases shall discharges cause concentrations in the tributary stream to exceed 250, 250 and 500 mg/L of chlorides, sulfates and total dissolved solids, respectively, or cause concentrations to exceed the applicable criteria in the streams to which they are tributary.

Modification of these standards on a site-specific stream segment must be made in accordance with the Antidegradation Policy Implementation Procedure. In no case shall discharges cause concentrations of Cl^-, $SO_4^=$ and TDS to exceed 250, 250 and 500 mg/L.

Drinking Water Regulations

In conformance with the Safe Drinking Water Act of 1974, the Environmental Protection Agency has established regulations for drinking water quality for public supplies in the United States. These include both primary and secondary drinking water quality requirements. The primary regulations represent maximum contaminant levels (not-to-exceed concentrations) for the various parameters included. The secondary regulations represent recommended standards, or guidelines. It is important to realize that both the pri-

Table V

Maximum Allowable Limits for Chloride, Sulfate And Total Dissolved Solids

Stream	Concentration mg/L		
	Cl^-	$SO_4^=$	TDS
Arkansas River Basin			
Arkansas River (Mouth to L&D #7)	250	100	500
Arkansas River (L&D #7 to L&D #10)	250	100	500
Cadron Creek	20	20	100
Arkansas River (L&D #10 to Oklahoma line, including Dardanelle Reservoir)	250	120	500
James Fork	20	100	275
Illinois River	20	20	300
White River Basin			
White River (Mouth to Dam #3)	20	60	430
Big Creek	20	30	270
Cache River	20	30	270
Bayou DeView	20	30	270
Little Red River (including Greers Ferry Reservoir)	20	30	100
Black River	20	30	270
Strawberry River	20	30	270
Spring River	20	30	270
Eleven Point River	20	30	270
South Fork Spring River	20	30	270
Myatt Creek	20	30	270
Current River	20	30	270
White River (Dam #3 to Missouri line including Bull Shoals Reservoir)	20	20	180
Buffalo River	20	20	200
Crooked Creek	20	20	200
White River (Missouri line to headwaters, including Beaver Reservoir)	20	20	160
Kings River	20	20	150
West Fork White River	20	20	150
St. Francis River Basin			
St. Francis River (Mouth to 36 ° N. Lat.)	10	30	330
L'Anguille River	20	30	235
Tyronza River	20	30	350
Little River	20	30	365
Pemiscot Bayou	20	30	380
St. Francis River (36 ° N. Lat. to 36 ° 30' N. Lat.)	10	20	180

Table V (Cont'd)

Maximum Allowable Limits for
Chloride, Sulfate And Total Dissolved Solids

Stream	Concentration mg/L Cl^-	$SO_4^=$	TDS
Ouachita River Basin			
Bayou Bartholomew	30	30	220
Chemin-A-Haut Creek	50	20	500
Overflow Creek	20	30	170
Bayou Macon	30	40	330
Boeuf River	90	30	460
Big Cornie Creek	230	30	500
Little Cornie Creek	200	10	400
Three Creeks	250	10	500
Little Cornie Bayou	200	20	500
Bayou D'Loutre	250	90	500
Ouachita River (Louisiana line to Camden)	160	40	350
Saline River	20	40	120
Hurricane Creek	20	250	500
Lost Creek	20	250	500
Holly Creek	20	250	500
Moro Creek	30	20	260
Smackover Creek	250	30	500
Ouachita River (Camden to Carpenter Dam)	50	40	150
Little Missouri River	10	10	90
Garland Creek	250	250	500
Ouachita River (Carpenter Dam to Headwaters, including Lake Ouachita tributaries)	10	10	100
Red River Basin			
Bayou Dorcheat	100	10	250
Cypress Creek	250	70	500
Crooked Creek	250	10	500
Bodcau Creek	250	70	500
Poston Bayou	120	40	500
Kelly Bayou	90	40	500
Red River	250	200	500
Sulphur River	120	100	500
Days Creek	250	250	500
McKinney Bayou	180	60	480
Little River	20	20	200
Saline River	20	10	90
Cossatot River	10	15	70
Rolling Fork	20	20	100
Mountain Fork	20	20	110

Table V (Cont'd)

Maximum Allowable Limits for
Chloride, Sulfate And Total Dissolved Solids

Stream	Concentration mg/L		
	Cl^-	$SO_4^=$	TDS
Mississippi River (Louisiana line to Arkansas River)	60	150	425
Mississippi River (Arkansas River to Missouri River)	60	175	450

mary and secondary drinking water regulations are for water following treatment, rather than for untreated (raw) water. The maximum contaminant levels for the National Interim Primary Drinking Water Regulations are shown in Table VI.

The National Secondary Drinking Water Regulations are shown in Table VII. As indicated, the secondary drinking water regulations are recommended (not mandatory) standards.

In addition to these standards, maximum contaminant levels have been established for trihalomethanes and for eight volatile organic chemicals. Standards for several other parameters have either recently been established or are under consideration. However, the primary and secondary drinking water regulations shown in Tables VI and VII provide a good basis for evaluating a potential water supply source.

Table VI

National Interim Primary
Drinking Water Regulations

Constituent	Maximum* Contaminant Level
Inorganic Chemicals	
Arsenic	0.05
Barium	1
Cadmium	0.010
Chromium (total)	0.05
Fluoride	1.4-2.4**
Lead	0.05
Mercury	0.002
Nitrate (as N)	10
Selenium	0.01
Silver	0.05
Organic Chemicals	
Chlorinated hydrocarbons	
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.05
Chlorophenoxys	
2,4-D	0.1
2,4,5-TP Silvex	0.01
Physical Parameters	
Turbidity	1
Radioactivity	
Gross alpha (pCi/L)	15
Radium-226 and 228 (pCi/L)	5
Tritium (pCi/L)	20,000
Strontium-90 (pCi/L)	8
Bacteriological factors	
Coliform bacteria (per 100 mL)	1

* All concentrations in mg/L unless otherwise indicated

** Temperature dependent

Table VII

National Secondary
Drinking Water Regulations

Constituent	Maximum Contaminant Level
Chloride	250 mg/L
Color	15 units
Copper	1 mg/L
Corrosivity	Noncorrosive
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 TON*
pH	6.5-8.5
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

* Threshold Odor Number

Section III

BEAVER LAKE BASIN DESCRIPTION

Project Description

Location. Beaver Lake is a multipurpose project located on the White River in northwestern Arkansas. Beaver Dam is located at river mile 609.0 on the White River. The reservoir is located in Benton, Carroll, Madison and Washington Counties in Arkansas. The dam is about nine miles northwest of Eureka Springs, Arkansas.

General Description. Beaver Lake is one of four multiple-purpose projects constructed in the upper White River Basin for the control of floods and the generation of hydroelectric power. Recreational opportunities are also available in and around the lake. Construction of the dam and appurtenant works began in November, 1960. Construction of the powerhouse and switchyard began in April, 1963. Commercial power generation began in May, 1965. The overall project was completed in May of 1965.

The upper levels of the lake are reserved for storage of flood water. At the top of the flood control pool, the lake will cover 31,700 surface acres and will contain 300,000 acre-feet of flood control storage. At the top of the conservation-water supply pool level, the lake stores 1,652,000 acre-feet of water. At the top of the conservation-water supply pool the lake covers 28,220 surface acres. There is one 5.67'x10' outlet conduit. There are seven 40'x37' spillway crest gates.

Tributary streams to Beaver Lake include Richland Creek, Roberts Creek, Friendship Creek, Hickory Creek, Nelson Hollow, Phillips Creek, Monte Branch, Esculapia Hollow, Falls Hollow, Sugar Hollow, Prairie Creek, Avoca Hollow, Coose Creek, Ventris Hollow, Fords Creek, Cedar Creek, Molder Hollow, Hoot Hollow, Ford Hollow, Horn Hollow, Honey Creek, Henry Hollow, North Fork and Big Clifty Creek. The tributary streams also include Penitentiary Hollow, Hogscald Hollow, Pemberton Hollow, Woods Hollow, Kirk Hollow, Devils Gap, Van Hollow, Rocky Branch, Shaddox Branch, Blackburn Creek, Joe Creek, Pine Creek, War Eagle Creek, Hickory Flat Hollow, Whitener Branch, Brush Creek, Mill Hollow, Mill Branch and the White River.

Facilities and Operations

Dam. Beaver Dam extends a distance of 2,575 feet across the White River valley. It rises to a height of 228 feet above the streambed. The spillway is 328 feet long.

Flood Control. Pertinent data concerning Beaver Lake and Dam are included in Table VIII.

Pool Fluctuation and Streamflow. The project was designed and constructed to provide for the top of the flood control pool to be at an elevation of 1,130 feet above mean sea level. The top of the conservation pool is 1,120 feet above mean sea level.

Lake Basin Characteristics.

General. Beaver Lake lies within the boundaries of Benton, Carroll, Madison and Washington Counties in Arkansas. The larger communities in the area include Bentonville, Eureka Springs, Fayetteville, Lowell, Rogers and Springdale.

Fish and Wildlife. Almost all of the varieties of fresh water game fish are found in Beaver Lake. These include smallmouth bass, largemouth bass, white bass, crappie, bream, channel catfish, northern pike, and walleye.

Hunting is popular in this general area. Species include deer, squirrels, rabbits, wild turkey and bobwhite quail.

Public Use Areas. There are eleven public use areas around the lake. These are the Big Clifty, Dam Site, Hickory Creek, Horseshoe Bend, Indian Creek, Lost Bridge, Prairie Creek, Rocky Branch, Starkey, Ventris and War Eagle areas. Available facilities include boat launching ramps, picnic areas, campgrounds, swimming beaches, playground, potable water supply and sanitary facilities. Swimming areas are at the Dam Site, Hickory Creek, Horseshoe Bend, Indian Creek, Lost Bridge, Prairie Creek, Rocky Branch and War Eagle sites.

Table VIII

Pertinent Data for Beaver Lake and Dam

Dam	
Length of Dam, feet	2,575
Concrete Section, feet	1,333
Earth Embankment, feet	1,242
Maximum height above streambed, feet	228
Spillway	
Length of spillway section, feet	328
Lake	
Top of flood control pool	
Elevation, feet above mean sea level	1,130
Surface Area, acres	31,700
Storage capacity of lake, acre-feet	300,000
Top of Conservation Pool	
Elevation, feet above mean sea level	1,120
Surface area, acres	28,220
Storage capacity of lake, acre-feet	1,642,000
Length of shoreline, miles	
Top of flood control pool	483
Top of conservation pool	449