Report and Recommendations

of the

Coeur d'Alene River

and

Lake Commission

to the

Twenty-Second Session

of the

State Legislature of Idaho

Members of Commission

FRED J. BABCOCK, *Attorney General*

E. O. CATHCART

Chairman, Board of County Commissioners, Kootenai County

JAMES H. TAYLOR

Chairman, Board of County Commissioners, Shoshone County

ACKNOWLEDGMENT

The Commission desires to express its appreciation of the cooperation given in this investigation by

H. S. Cumming, Surgeon General, U. S. Public Health Service, Washington, D. C., and

J. K. Hoskins, Sanitary Engineer in Charge Stream Pollution Investigations Station, U. S. Public Health Service, Cincinnati, Ohio.

W. P. Yant, Supervising Engineer,

R. D. Leitch, Associate Chemical Engineer,

J. B. Littlefield, Junior Chemist,

R. R. Sayers, Chief Surgeon, and

A. C. Fieldner, Supervising Engineer, of the Bureau of Mines, Pittsburgh, Pa.

Dr. M. M. Ellis, in Charge, Interior Fisheries Investigations, U. S. Bureau of Fisheries, and his staff of assistants, at Columbia, Missouri.

Bureau of Biological Survey, U. S. Department of Agriculture, Washington, D. C.

Webster H. Ransom, U. S. Game Protector, Bureau of Biological Survey, U. S. Department of Agriculture, Spokane, Washington.

H. P. Magnuson, Head of Department of Agricultural Chemistry, University of Idaho, Moscow, Idaho.

Hilton A. Smith, D. V. M., College of Veterinary Medicine, State College of Washington, Pullman, Washington.

John E. Guberlet, Professor of Zoology, Department of Zoology and Physiology, University of Washington, Seattle, Washington.

C. C. Todd, Head of Department of Chemistry, College of Sciences and Arts, State College of Washington, Pullman, Washington.

Captain E. F. Eaton of Coeur d'Alene, Idaho.

and to the citizens of Shoshone and Kootenai Counties.

The first settlement in the Coeur d'Alene mining country, which developed into a gold rush, was in 1883 following the discovery of gold by A. J. Pritchard on the North Fork of the Coeur d'Alene River. The later development of the lead-silver mines, such as the Bunker Hill, Hercules, Star, Hecla, Sunshine, Page, Tiger and many other mines resulted in a large tonnage of rock being ground and the tailings therefrom dumped into the South Fork of the Coeur d'Alene River. The Bunker Hill, the oldest of the mines named, was discovered in 1885, and since that time the Coeur d'Alene Mining District has developed to the present proportions. Until within fifteen or twenty years ago the jig-table or gravity system of separating the ore from the waste rock was employed. Since that time the flotation process has been used, both of which will be referred to later in this report. During this period of time enormous quantities of finely powdered rock and ores have been deposited in the channel of Coeur d'Alene River and on lands adjacent to this river in the Coeur d'Alene River valley, from the town of Cataldo to the mouth of the river near Harrison, where it empties into Coeur d'Alene Lake.

Actions were commenced by landowners along the river for alleged damages resulting to their lands and livestock by reason of these deposits. They contended that these mine wastes were of a highly toxic nature and were injurious to vegetation as well as fish and animal life. Much reference was made to leaded water, leaded hay and leaded soil. As a result of this litigation the mine owners procured easements which were to be in payment of damages for the loss of crops, domestic animals, etc.

Later a dam was constructed by the Washington Water Power Company at Post Falls in the Spokane River, a few miles down the river from Coeur d'Alene. Under an

agreement with the state the power company was permitted to leave the gates of the dam closed until such time as the level of Coeur d'Alene Lake had been raised to a specified stage. This also resulted in certain litigation which was settled by the power company, which procured easements from all whose land was overflowed along this valley as well as other tributaries of the lake.

However, the pollution problem affecting the Coeur d'Alene River and subsequently Coeur d'Alene Lake has resulted in the creation of this commission with the powers and duties hereinafter set forth. This report and the recommendations of the commission contained therein will be based upon the reports of the various agencies hereinafter referred to.

The Twenty-first Session of the State Legislature enacted Chapter 199 Session Laws of 1931, Sections 68-201 to 68-208, I. C. A., inclusive, creating the Coeur d'Alene River and Lake Commission, composed of the Chairmen of the Boards of County Commissioners of Kootenai and Shoshone Counties in this state and the Attorney General of the State of Idaho, and provides for the organization of said commission, and that said commission shall meet at such times and places as shall be designated by the Chairman.

Section 4 of Chapter 199 (Section 68-204 I. C. A.) provides as follows:

"The duties of said commission shall be to study and investigate ways and means of eliminating from the Coeur d'Alene River and Coeur d'Alene Lake, so far as practicable, all industrial wastes which pollute or tend to pollute the same, and to determine and recommend methods of preventing pollution detrimental to vegetation and domestic crops; to public health or to the health of animals, fish or aquatic life, or detrimental to the use of waters for recreational purposes, and in the performance of such duties, the commission shall have the power to investigate the character of all wastes discharged into or

deposited on the banks of said waters. A report of the findings and recommendations of the commission shall be made to the Twenty-second Legislature of the State of Idaho for its information."

The act then gives the commission power to hold hearings, require the attendance of witnesses and take testimony whenever it shall be deemed necessary, and provides for the payment of expenses and sets up an appropriation.

The first meeting of the commission was held at Wallace, Idaho, on Saturday, May 2, 1931, in the commissioners' room at the Shoshone County Court House, at which time Fred J. Babcock was elected Chairman and E. O. Cathcart, Secretary.

The minutes of the meeting held on May 2 are quoted below:

"The first meeting of the Coeur d'Alene River and Lake Commission which was created by Chapter 199 of the 1931 session of the Idaho Legislature, was held at Wallace, Idaho, on Saturday, May 2, in the commissioners' room of the Shoshone County Court House, the time of meeting being one o'clock P. M.

"Commissioners Fred J. Babcock, Attorney General, James H. Taylor of Shoshone County, and E. O. Cathcart of Kootenai County were present.

"By common consent of Commissioners Taylor and Cathcart, Commissioner Fred J. Babcock was chosen temporary Chairman of the meeting.

"Upon motion made by Cathcart and seconded by Taylor and carried, Commissioner Fred J. Babcock was regularly elected permanent Chairman of the Commission.

"Upon the request of Commissioner Taylor and the approval of Commissioner Babcock, E. O. Cathcart acted as Secretary of the meeting.

"It was moved by Cathcart, seconded by Taylor and regularly carried that the Commission immediately require the services of the State Sanitary Engineer in taking and analyzing samples of the lake and river waters, beginning at Coeur d'Alene, Idaho, and sampling at numerous points in the lake and river up to and including waters direct from the mills of the Bunker Hill, Sunshine, Federal and Hecla mines. That this investigation shall also include the sampling and analyzing of mud, muck or slimes deposited in and around the said lake and river.

"This investigation shall be made in accordance with the provisions of Section Four of Chapter 199 of the 1931 Idaho Session Laws.

"The State Sanitary Engineer may incorporate in his report facts determined from any previous investigation which he may have made relative to the pollution of the Coeur d'Alene Lake and River.

"It was moved by Taylor and seconded by Cathcart that the Commission contact the U. S. Biological Survey, the Federal Fish and Game Commission, or any Federal Agency, requesting the assistance of a Federal Sanitary Engineer to work with the State Engineer in the study of the Coeur d'Alene Lake and River pollution condition.

"It is the intention of this Board that the engineer or engineers making this investigation do so during this time of the 1931 freshet condition of the Coeur d'Alene River and also at the time of the spring freshet of 1932.

"It was moved by Cathcart and seconded by Taylor that the Chairman of this Commission call a public hearing at Harrison, Idaho, some time during the summer of 1931, at which time interested parties shall be given an opportunity to make their testimony before this Commission, and that additional hearings shall be held in Shoshone County when and if it seems advisable.

"It was agreed that Commissioner Babcock should call by phone or otherwise contact the State Sanitary Engi-

neer, as soon as possible and 'require' his services as herein stated.

"It was agreed that E. O. Cathcart should continue the efforts in the name of the Commission attempting to obtain the assistance of a Federal Sanitary Engineer to assist the State Engineer in this investigation.

"It was moved by Cathcart, seconded by Taylor and carried, that the meeting adjourn subject to the call of the Chairman.

"FRED J. BABCOCK,
Chairman.

"Attest: E. O. CATHCART,
Secretary."

A public hearing was subsequently held at Rose Lake on the 29th of August, 1931, at which various persons appeared and testified regarding conditions along the Coeur d'Alene River and Lake.

Thereafter, certain governmental agencies, both state and federal, were requested to make studies of the pollution of the Coeur d'Alene River and Lake incident to industrial wastes and make a report and recommendations in connection therewith.

The U. S. Bureau of Mines, the Surgeon General of the U. S. Public Health Service, the U. S. Bureau of Fisheries, the Bureau of Biological Survey of the U. S. Department of Agriculture, and the Department of Public Welfare of the State of Idaho conducted examinations in accordance therewith and submitted reports, which reports are on file in the office of the Attorney General. These reports vary in length from a few pages to 136 and are too lengthy to include here.

The U. S. Bureau of Mines, the U. S. Public Health Service, and the Department of Public Welfare of the State of Idaho correlated their investigations in order to avoid duplication. Accordingly, the Department of Pub-

lic Welfare and the U. S. Public Health Service conducted the investigation with respect to the pollution of Coeur d'Alene Lake and the U. S. Bureau of Mines investigated the phases dealing with the Coeur d'Alene River and mills with a view to making such recommendations as would assist the commission in making its report to the legislature.

Captain E. F. Eaton of Coeur d'Alene was employed by the River and Lake Commission to collect samples for the use of these three agencies. Sampling stations were established in Lake Coeur d'Alene between Harrison and the city of Coeur d'Alene. (See Table No. 1).

The lead pollution problem is summarized by J. K. Hoskins, Sanitary Engineer in Charge of the Stream Pollution Investigation Station at Cincinnati, Ohio, on pages 1 and 2 of his report, as follows:

"The Coeur d'Alene River, approximately 40 miles in length, flows westwardly through an extremely narrow valley bordered on each side by high mountains. It discharges into Coeur d'Alene Lake, a body of water extending northward about 25 miles to the outlet, which is the source of the Spokane River. The lake is from ¾ to 1 mile wide, and in places 150 feet deep. The Coeur d'Alene River is not used as a source of water supply but the lake furnishes the domestic supply for Harrison (population 493) located near the mouth of the river, and for the town of Coeur d'Alene (population 8,297) situated near the outlet of the lake.

"The mountains near the head of the Coeur d'Alene River valley contain rich deposits of lead and zinc ore, including some silver. Numerous extensive mines have been operated in this area for about 40 years. The minerals, which occur principally in the form of sulphides, are recovered from the accompanying rock by the flotation process. The mined ore is ground exceedingly fine, mixed with water, and small amounts of oil and acid, and vigorously agitated. The oil and acid form a strong

lather or froth to which the finely divided particles of metal adhere and are floated off. The remaining inert, finely ground rock is held in temporary suspension in the water which is discharged as a waste to the Coeur d'Alene River. It is stated that, when the mines are in normal operation, from 5,000 to 5,500 tons of such pulverized rock is handled daily.

"It is this finely divided material which constitutes the stream pollution problem of the Coeur d'Alene area. Through long operation of the mines the entire river bed has become silted up. At times of high river discharge this silt is carried to the lake and, when the river overflows its banks, is deposited on the fertile meadow lands along the lower reaches of the stream.

"These land owners contend that their farms have been ruined by these periodic deposits of mud, that because of the lead content of the water and mud their stock cannot use the river water or graze on the land, that fish have been exterminated in the river and that these same conditions are now occurring in the lake. To offset these claims the mining interests have purchased easements from most of the land owners for the damage that may be caused by flooding or destruction of property by mine wastes. Such settlements have not been effective, however, in quieting the demand for a more comprehensive solution. This demand is perhaps more insistent because two counties of the state are involved in the dispute, the upper or Shoshone County in which the mines are located and the lower or Kootenai County within the boundaries of which the meadow lands and lake are to be found."

The pollution problem arises from the dumping of what is termed "tailings" or "slimes" from the mills into the branches of the Coeur d'Alene River, particularly the South Fork at Mullan, Gem, and Kellogg. A brief description of the terms "tailings" or "slimes" may be found in the report of the Bureau of Mines, pages 3 to 6, inclusive:

"The operations involved in the production of the metals may be divided into three major processes: (1) mining the ore; (2) dressing the ore and concentrating the mineral; and (3) smelting and metal recovery. The ore, or what may be loosely termed rock, that comes from the mine may be considered to have two intermingling components; (1) the valuable mineral which is usually the metal or metals in chemical combination with other elements, as with sulphur to constitute sulphides, or it may be a free elementary metal, and (2) the accompanying valueless rock or gangue, which may be non-metalliferous or non-valuable metalliferous. The object of the ore dressing and the concentration processes is to separate the valuable portion from the non-valuable portion. This is accomplished by crushing, grinding, washing, gravity separation, and flotation processes. The crushing and grinding cause the valuable mineral particles to be freed from the non-valuable, and the separation is then carried out by mechanical means which take advantage of the differences in gravity between the valuable and the non-valuable portions, and by differences in behavior to flotation reagents. The gravity separations are carried out in a water medium. Flotation is the final process. It involves vigorous agitation of the finely ground ore with water, air and a small amount of flotation reagents. These reagents form a froth to which the mineral adheres and by which it is carried upward as the froth rises. The mineral-containing froth is taken off the top of the flotation cell, while the non-adherent, non-valuable portion of the ore sinks and is taken off with the water from the bottom.

"The entire process of separation out and concentrating the valuable mineral is in some mills a progressive series of stages, in each of which the ore is crushed and a concentrate of the mineral particles released by the crushing is recovered. The residue from each stage is subjected to a succeeding grinding which releases more of the mineral particles for separation and recovery. Following the final

stage of gravity separation, the residue is finely ground (65 to 90 per cent through 200 mesh) and subjected to flotation. A considerable number of the mills have abandoned gravity separation and use an all grinding—all flotation process—that is, the initial grinding is fine and the ore passed directly to the flotation cells. The non-valuable rock residue from the flotation process, and which is also the valueless rock from the original ore, is the tailings. If non-valuable rock wastes are discharged from any stage of the entire recovery process or from the last mechanical stage in event flotation is not used, the material is also designated as tailings.

"The amount of metalliferous mineral left in the tailings is determined by the limitations of economic recovery by the process in use. Improvements in processes, particularly flotation, have increased recovery over that of former practice, and as a result, piles of old tailings containing approximately 2.5 per cent lead are now being re-processed. Flotation has, however, resulted in an increased production of fine size tailings so that from the viewpoint of contamination of waters, the lead content of the tailings has been reduced, but on the other hand the amount of very fine material which is difficult to remove from the water has been increased.

"The mineral concentrates, consisting of the desired minerals with some non-valuable minerals owing to the difficulty of making complete separation from the ore, are subjected to smelting and processes for recovery of the metals in salable form."

At the public hearing held by the commission at Rose Lake on August 29, 1931, all members of the commission were present; also W. P. Yant, Supervising Engineer of the Bureau of Mines, Pittsburgh Station; R. D. Leitch, Associate Chemical Engineer, A. C. Fieldner, Supervising Engineer, Experiment Stations, Bureau of Mines; J. K. Hoskins, Sanitary Engineer In Charge of the Stream Pollution Investigation Station at Cincinnati,

Ohio; W. V. Leonard, State Chemist and Sanitary Engineer of the Department of Public Welfare, State of Idaho; and approximately seventy residents of Kootenai and Shoshone Counties.

Considerable testimony was introduced by farmers residing in the Coeur d'Alene River valley with respect to the death of horses and cattle occasioned by grazing on meadow lands which had been overflowed. The testimony of witnesses who had resided there over a long period of years was to the effect that this valley, prior to the dumping of tailings into the river, was a fertile valley similar to that of the St. Joe River.

Testimony was introduced regarding the loss in taxable valuation of Kootenai County land in the river valley.

Mr. Coe, editor of the Coeur d'Alene Press, also testified regarding his observations and theories as to the conditions of Coeur d'Alene Lake, particularly the north end adjacent to Coeur d'Alene.

Pursuant to an agreement reached between the Bureau of Mines, the U. S. Public Health Service, and the Department of Public Welfare of the State of Idaho, work was commenced on the entire project and reports of these various agencies were submitted to the commission.

A separate and independent investigation was made of the waters of Coeur d'Alene River and Lake and the Spokane River as far as the state line between Washington and Idaho at Spokane Bridge by M. M. Ellis, Ph.D., Sc.D., In Charge of Interior Fisheries Investigations for the U. S. Bureau of Fisheries, headquartered at Columbia, Missouri. This investigation was made by Dr. Ellis, in person, together with his staff of three assistants, and was commenced on July 9, 1932, and completed on August 3, 1932. Dr. Ellis procured samples of the water and silt from the Coeur d'Alene and St. Joe Rivers and Coeur d'Alene Lake at various points, the samples from the St. Joe River being used for the reason that these two rivers drain similar watersheds and the conditions along the

rivers, aside from the fact that mining operations are carried on in Coeur d'Alene and logging operations chiefly on the St. Joe River, are the same.

Dr. Ellis and party, together with Mr. Cathcart of the commission, also made a trip to Kimberley, British Columbia, to observe the manner in which the tailings and slimes question is being handled by the Sullivan Mining & Milling Company at Kimberley. A trip also was made by Dr. Ellis in company with Mr. Cathcart to Seattle to confer with the Engineers of the War Department.

Laboratory examination was made of specimens of dead swans which were shipped from Harrison to the Bureau of Biological Survey at Washington, D. C. These samples consisted of nine entire birds and four complete sets of internal organs. A report of this Bureau was received by the commission setting forth their observations as a result of both physical and chemical analyses made of these birds, the amount of lead, copper and zinc found in the samples being shown in Table No. 1 in this report.

At the hearing held in Rose Lake in August, 1931, certain exhibits were introduced, which are on file with the commission.

Examinations were made of the viscera of dead swans by certain other laboratories with respect to whether or not any shot were found to determine whether or not lead poisoning could have resulted from shot. Statements to the effect that no shot were found in the gizzards of these birds are on file from the University of Idaho, H. P. Magnuson, Head of the Department of Agricultural Chemistry; State College of Washington, H. A. Smith, D. V. M., College of Veterinary Medicine; and the University of Washington Department of Zoology and Physiology, John E. Guberlet, Professor of Zoology.

A copy of a letter from W. H. Ransom, United States Game Protector of Spokane, Washington, contains a copy

of a statement from C. C. Todd, Head of the Department of Chemistry of the State College of Washington, under date of June 20, 1931, stating that the examinations of these birds for mineral poisons which might be due to the tailings from mines were negative. Also a copy of a letter from H. P. Sheldon, U. S. Game Conservation Officer, Washington, D. C., to W. H. Ransom of Spokane, contains information to the effect that none of the swans showed in their pathological condition anything suggesting western duck sickness or botulism.

At the hearing at Rose Lake, certain exhibits were introduced, Exhibit No. 1 being a letter from George R. Fowler, College of Veterinary Medicine, State College of Washington, dated June 21, 1927, in which he states that he had examined the specimen of the liver and lungs of a cow showing chronic inflammation of both organs not caused by tuberculosis; that there was a slight chance of arsenic poisoning, but he was not positive.

Exhibit No. 2 is a letter from H. P. Magnuson, Associate Soil Chemist, Department of Agricultural Chemistry, College of Agriculture, University of Idaho, to Carl Schwiger, Dudley, Idaho, under date of March 7, 1928, to the effect that he was making some examination for arsenic and lead in some samples sent by Mr. Schwiger.

Exhibit No. 3 is another letter from Mr. Magnuson to Mr. Schwiger regarding samples.

Exhibit No. 4. A statement entitled "Samples taken from Horse and Samples of Hay, March 12, 1928, sent in by Carl Schwiger, Cataldo, Idaho." Mr. Schwiger testified that he had sent the liver and lungs and some of the brains to have them analyzed, that his brother had sent them to Pullman. There was nothing to show in connection with this exhibit whether it was made at Pullman or Idaho.

Exhibit No. 5. A letter from Donald A. Callahan, Attorney at Law, Wallace, Idaho, to Mr. Schwiger re-

garding claim of damages by reason of the death of certain horses and a cow from lead poisoning brought about by eating hay produced on the Steltz place, with the statement that the mine owners could not consider his claim, as a previous settlement had been made in the matter.

Edgar Oehrling of Rose Lake introduced two pictures, Exhibits Nos. 6 and 7, of threshing machines operated on the Triplett place on the river below Rose Lake in 1916.

Exhibits Nos. 8, 9, and 10 are pictures taken on the Triplett Ranch between Lane and Rose Lake.

Exhibits Nos. 11 and 12 are pictures of a field of oats being harvested on the Harris Ranch near Lane, Idaho.

Copies of reports made by Edward C. O'Keeffe and W. L. Zeigler for the Federal Mining & Smelting Company, Wallace, Idaho, dated September 30, 1930, were furnished the commission and may be found in the files under Exhibit No. 13.

A copy of a memorandum by W. V. Leonard, State Chemist and Sanitary Engineer, under date of January 2, 1931, is also filed as Exhibit No. 14.

A summary of the testimony introduced at a hearing before the Coeur d'Alene River and Lake Commission under date of August 29, 1931, is also filed as Exhibit No. 15.

Exhibit No. 16 is the Forty-second Annual Report of the Bunker Hill & Sullivan Mining & Concentrating Company for the year ended December 31, 1929.

Exhibit No. 17 is Bulletin No. 793 published by the U. S. Department of Agriculture under date of July 31, 1919, entitled "Lead Poisoning in Waterfowl," by Alexander Wetmore, Assistant Biologist.

Exhibit No. 18 is the "Report of the Lead Content of the Waters of Coeur d'Alene River and Lake in Idaho," by the U. S. Public Health Service, October, 1932.

Exhibit No. 19. "Pollution of Coeur d'Alene River and Lake by Mill Tailings, Report of U. S. Bureau of Mines to the Coeur d'Alene River & Lake Commission," December 9, 1932.

Exhibit No. 20. "Pollution of the Coeur d'Alene River and Adjacent Waters by Mine Wastes," by M. M. Ellis, Ph.D., Sc.D., In Charge of Interior Fisheries Investigations, U. S. Bureau of Fisheries, dated November 26, 1932.

Exhibit No. 21. "Report of the Lead Content of the Waters of Coeur d'Alene Lake," by W. V. Leonard, State Chemist and Sanitary Engineer, Department of Public Welfare, Boise, Idaho, dated December 21, 1932.

Exhibit No. 22. "Report of Investigations of Deaths in Swans on Coeur d'Alene River, Harrison, Idaho, During 1931," by the Bureau of Biological Survey, U. S. Department of Agriculture, dated December 15, 1932.

Exhibits Nos. 23 to 27 show suction dredge and pipe line comprising the plant established during the present year by the mining industries to remove tailings from the Coeur d'Alene River bed and stack them on adjacent land.

Exhibit No. 28 shows a portion of the pipe line and settling bed.

Exhibit No. 29 shows another view of the pipe line and settling bed.

Exhibit No. 30 shows the dredge laying in the basin which has been excavated.

Exhibit No. 31 shows another view of the basin.

Exhibit No. 32 is a letter from W. V. Leonard, State Chemist and Sanitary Engineer, to the commission under date of December 24, 1932, showing a report of the total lead in suspension and solution of three samples of water furnished by the Washington Water Power Company from the distribution system of the city of Coeur d'Alene.

From a consideration of the reports of the various agencies, it appears that lead is present, in suspension, in the waters of the Coeur d'Alene River and Coeur d'Alene Lake to some extent. (See Reports of U. S. Public Health Service, Tables 1 to 11, inclusive, of U. S. Bureau of Fisheries, Pages 108 to 111 inclusive, U. S. Bureau of Mines, Pages 53, 56 and 87, and the Department of Public Welfare of the State of Idaho, Tables 3 to 11 inclusive).

It is also apparent that there is a certain amount of lead in solution both in the river and lake. (See reports of the U. S. Bureau of Mines, Page 88, the U. S. Public Health Service, Page 18, and the U. S. Bureau of Fisheries, Page 121.)

From an examination of these various reports, it is apparent that the greater amount of lead in the waters is found in suspension rather than in solution. It is the latter which, of course, presents the more serious problem. Material in suspension may be handled by a process of filtration, while the elimination of the lead in solution is not so easy of disposal. In the report of the U. S. Bureau of Mines, Page 87, the author says:

"A tendency for the lead content of deposits in the river and lake to be higher than the average lead content of the tailings at the mills is observed. Whether this is due to the average lead content for the discharge being non-representative; to differential settling and concentration; or to the remains of tailings from former milling or concentrating processes which allowed more lead to escape with the tailings is not known. The latter is indicated by the general agreement between lead content of the present water-borne solids and the average lead content found in the tailings. On the other hand, the lower lead in the water-borne solids, as compared with deposits in the lake and river may be the result of the dilution of the former with organic matter."

The report then refers to the very slight lead content of samples of solids taken in the St. Joe River where the question of tailings is practically nil, and indicates that mill tailings is the major source of lead found in the deposits on the fields, deposits in the Coeur d'Alene River channel, and in the lake.

LEAD IN SUSPENSION.

Since the adoption of the flotation process as compared with the old jig-table or gravity method, the rock is ground much finer; in fact, so that it may pass through a 200 mesh screen. This means, of course, that material much finer than that passes through, which would be composed of both lead ore or other ore and waste rock; and because of the more efficient flotation method, there would be a smaller mineral content.

Lead in suspension is found in samples of tailings taken from the mills, from the river water and from water in the lake, from samples of slimes taken from the river and lake bottom, and from the land in the valley adjacent to the river. The amount of lead in suspension diminishes as the distance increases below the head of navigation near Cataldo. Also a lower lead content is noted in the slimes as they come from the mill than from the samples of slimes taken from the river and lake beds. This, of course, is a result of the more efficient flotation method which replaces the old gravity or jig-table method, coupled with the fact that there is possibly a greater concentration of the various minerals which are deposited by the action of the water carrying them; also the fact that heavier bodies in suspension settled first, causing greater concentration. (See report of Bureau of Mines, Pages 53, 56, and 87.)

LEAD IN SOLUTION.

Reports of the various agencies establish this fact: That the lead which is found in solution is the result of water soluble salts having been formed through weather-

ing; that is, the lands adjacent to the river have overflowed, and lead and other minerals in suspension have been left deposited on this land.

Through evaporation and leaching, lead in solution is then returned to the river, and is traceable throughout the length of the river and lake, increasing from the upper portions of the river to the mouth and decreasing by dilution from the mouth of the river to the lower end of the lake.

From these observations, it is apparent that if the lead or other minerals in suspension could be retained in a settling bed and the process of evaporation and oxidation could be controlled, then the question of lead in solution would also be controlled.

The Coeur d'Alene River periodically overflows its banks and creates a settling basin of some 25,000 acres upon which this lead or other mineral may be settled and is probably the chief contributing factor to the problem of lead in solution through the process of weathering; while if these slimes or tailings could be confined to a settling bed of a few hundred acres and the process of oxidation through weathering controlled, then both the question of lead in suspension and solution will be solved from a practical standpoint.

Dr. Ellis, in his report, gives a brief description of the settling basins used by the Sullivan Mining & Milling Company at Kimberley, British Columbia. In this case, the mine wastes are flumed to the settling basins. The water is run through the first basin, a portion of the rock and other material settled out, filtered through into a second settling basin, and then carried by ditch into the river. He reports this system as being quite effective.

He also refers to a suction dredge which is being used at Mission Flats below Cataldo to pump the mine slimes from the river and deposit them on land nearby. This will, no doubt, result in a partial removal of the mine

slimes and prevent lead in suspension so far as can be done by using the river channel to transport the slimes to this point, where a sump or excavation has been made in the river bed and the settled slimes pumped into the adjacent settling basin.

No information nor evidence regarding the construction of this dredge and settling basin or the feasibility of the same has been officially presented to the commission. It is referred to in the various reports and some pictures of the same, Exhibits Nos. 23 to 31, inclusive, were received by the commission at the time of making this report.

There is no question but that the slimes could be more effectively removed from the river by the construction of flumes or pipe lines to transport them from the mills to the settling basins, as much material will pass over the sump in the river. The feasibility of transporting these materials by flume or pipe line is, of course, an engineering question.

The land available at Mission Flats is undoubtedly ample for the construction of settling beds to handle these slimes.

RECOMMENDATIONS.

Based upon the reports submitted by the various cooperating agencies, upon hearings conducted by the commission, and upon the observations of its members, the commission is of the opinion:

First, that the use of the dredge may be very effective in cleaning the deposits of slimes out of the Coeur d'Alene River and reclaiming that portion of the river below Cataldo, and

Second, that the most efficient method of handling the slimes which come from the mills is to transport them to the settling beds by some method other than by using the river channel.

Minutes of Special Meeting of the Coeur d'Alene River and Lake Commission Held in the Office of the Chairman at Boise, Idaho

Pursuant to the call of the Chairman, a meeting of the Coeur d'Alene River and Lake Commission was held in the office of the Attorney General in the Capitol Building, Boise, Idaho, on December 22nd, 1932, at the hour of 10 o'clock A. M., all members being present.

The commission, at this time, took up the drafting and compilation of a report to the legislature in accordance with the provisions of Chapter 199 of the 1931 Session Laws.

At the hour of 5 P. M., the meeting was adjourned until 10 o'clock A. M., December 23rd at the same place. At that time, the commission continued the work of compiling the report to the legislature.

At the hour of 5 P. M., the meeting was adjourned until 10 o'clock A. M., December 24th at the same place, at which time the compilation of the report to the legislature was continued.

Said report having been completed, it was moved that the same be approved and accepted as the report of the commission, and that a copy thereof be attached to and made a part of these minutes, and that these minutes be included in the report to the legislature.

Mr. Taylor stated that he did not agree with nor approve of the recommendations contained on page 24 of the report, that it is his position that the dredge as set up and operated at the present time will satisfactorily handle the question of slimes in the Coeur d'Alene River.

Commissioners Cathcart and Babcock voted to approve the report and make recommendations as set up therein.

Upon motion duly made, seconded and carried, the meeting was adjourned at 2:30 P. M., December 24th.

FRED J. BABCOCK,
Chairman.

Attest:
E. O. CATHCART, *Secretary.*

APPENDIX

Table No. 1

LOCATION OF SAMPLING STATIONS

Used by

J. K. Hoskins, Sanitary Enginer in Charge
Stream Pollution Investigations Station
Cincinnati, Ohio

and

W. V. Leonard, State Chemist and Sanitary Engineer,
Department of Public Welfare
Boise, Idaho

Sta. No.	Coeur d'Alene	Location	Remarks
1.	Lake	Opposite Harrison City Intake.	Above Harrison boat landing at log buoy 100 ft. off shore.
2.	River	Harrison Highway Bridge.	River about 27 ft. deep.
3.	Lake	Opposite Mouth Coeur d'Alene River.	Approx. 500 ft. out in lake from last piling. About 20 ft. deep.
4.	Lake	Opposite Harlow Point.	Opposite old sheds, 150 ft. off East shore lake; about 25 ft. deep.
5.	Lake	Opposite East Point.	Opposite pine tree, 150 ft. off East shore lake; about 60 ft. deep.
6.	Lake	Opposite McDonald Point.	Middle of lake; about 175 ft. deep.
7.	Lake	Opposite Driftwood Point.	Off East shore about 1000 ft.
8.	Lake	Opposite Nigger Head.	Off East shore about 500 ft.
9.	Lake	Over Coeur d'Alene City Intake.	Water about 132 ft. deep.

Table No. 1, Page 4 of Mr. Hoskins' Report.

Table No. 1, Page 3 of Mr. Leonard's Report.

See Map, Figure No. 1.

Table No. 2

Lead in Coeur d'Alene River Water at Harrison Highway Bridge
Sampling Point No. H. I., Figure 1

Sample No.	Date	Total lead in solution and in suspension: Depth sampled, feet	Total, p.p.m. or mg./L	Separate determination of lead in solution and in suspension: Depth sampled, feet	Solution, p.p.m. or mg./L	Suspension, p.p.m. or mg./L
1	11/ 5/31	....	Lost	....	.....	.....
2	11/20/31	....	0.39	....	.....	.....
3	12/10/31	....	0.29	....	.....	.....
4	12/24/31	....	0.59	....	.....	.....
5	1/ 7/32	....	0.21	....	.....	.....
6	1/21/32	20	0.43	20	0.07	.....
7	3/26/32	10 and 20*	1.17	10 and 20*	0.02	.....
8	4/ 9/32	10 and 20*	0.58	10 and 20*	0.02	.....
9	4/21/32	10	0.82	20	0.12	0.58
10	5/ 4/32	10	0.52	20	0.18	0.27
11	5/19/32	10	0.56	10	0.17	0.34
12	6/ 9/32	10	0.72	....	.....	.....
13	6/23/32	10	0.35) Ave.	....	.....	.....
13b	6/23/32	20	0.49) 0.44	....	.....	.....
14	7/ 7/32	10	0.27) Ave.	....	.....	.....
14b	7/ 7/32	20	0.83) 0.55	....	.....	.....
15	8/ 4/32	10	0.35) Ave.	....	.....	.....
15b	8/ 4/32	20	0.35) 0.35	....	.....	.....
16	9/ 1/32	10	0.25) Ave.	....	.....	.....
16b	9/ 1/32	20	0.44) 0.35	....	.....	.....
17	9/23/32	10	0.31) Ave.	....	.....	.....
17b	9/23/32	20	0.32) 0.32	....	.....	.....

* Composite of two samples from the depths designated.

Report of Bureau of Mines, Table No. 2, Page 43

Table No. 3

Lead in Water Samples Above Mouth of Coeur d'Alene River and St. Joe River

Sample	Location of Sample	Lead in solution, p.p.m. or mg./L	Lead in suspended matter in water: p.p.m. or mg./L	Lead in suspended matter in water: Per cent of dry solids	Total lead, p.p.m. or mg./L
A	South Fork, Coeur d'Alene River, above junction with North Fork	<0.002*	10	0.23	10
B	North Fork, Coeur d'Alene River, above junction with South Fork	<0.002*	0.006†	0.02	0.006†
H	Coeur d'Alene River under highway bridge at Harrison—one foot under surface	<0.002*	0.12	0.14	0.12
N	Coeur d'Alene River above Cataldo	<0.002*	0.23	0.21	0.23
O	Thompson Lake near canal to Coeur d'Alene River, current toward river	<0.002*	0.003†	0.03	0.003†
P	Slough halfway between Thompson Lake and Harrison. Swamps where wild fowl feed	0.104	68‡	0.32	68.1‡
R	Eagle Creek, 60 feet below Jack Waite Mill impounding dam	0.16	1.37	0.30	1.53
M	St. Joe River, 600 yards above mouth	<0.002*	0.003†	0.03	0.003†

* Less than 0.005 milligrams lead found (limit of method) in samples of 2241 to 2733 gram size; essentially no lead present.
† Less than amount reported.
‡ Large amount of solids due to stirring up bottom sediment when taking sample of water.

Report of Bureau of Mines, Table No. 3, Page 47.

Table No. 4

LEAD IN SAMPLES OF SOLIDS FROM BOTTOM SURFACE OF COEUR D'ALENE RIVER AND LAKE, AND FROM ST. JOE RIVER

Sample No.	Location and Description	Lead found, per cent of dry solids
2	Coeur d'Alene River government gaging station, Cataldo	0.93
22	Coeur d'Alene River at center of mouth. Luxuriant growth of water weeds. Water about 19 ft. deep	0.70
23	Coeur d'Alene Lake about 300 yds. out from Harlow Point. Water about 63 ft. deep	0.87
26	Coeur d'Alene Lake about 1 mi. south of Harrison	0.68
24	St. Joe River about 3 mi. above mouth. Water 42 ft. deep	0.04

Report of Bureau of Mines, Table No. 4, Page 53.

Table No. 5

LEAD IN SOIL SAMPLES

Sample No.	Location and Description	Lead found, per cent by weight of dry solids
3	Slimes along bank, government gaging station, Cataldo	0.58
4	Barren field, government gaging station	0.59
5	Fertile field 400 yds. from river, government gaging station	0.02
6	Deposit from floods at Enaville	0.57
7	Same location as sample 6 but 30 ft. nearer river	0.87
8	Mission Flats, soil 60-75 ft. from river	0.72
11	Dudley, white crusty deposits on bank	0.88
15	Harrison, river bank at bridge, clay-like soil	0.02
17	Same location as sample 15; white crusty deposit along road in barren ground near river	0.11
18	St. Joe River, soil off bank 6½ mi. below St. Maries	<0.001

Report of Bureau of Mines, Table No. 5, Page 54.

Table No. 6

GENERAL CHEMICAL COMPOSITION OF SOIL INCRUSTATIONS ALONG THE COEUR D'ALENE RIVER AS SHOWN BY ANALYSES OF SAMPLES FROM NEAR HARRISON, IDAHO, FROM THOMPSON FLAT, AND FROM BRADLEY, IDAHO, DURING JULY, 1931* and 1932**

By M. M. Ellis, Ph.D., Sc.D., In Charge, Interior Fisheries Investigations, United States Bureau of Fisheries.

Total zinc as Zn	5.0 to 12.0 per cent
Total lead as Pb	0.3 to 0.8 per cent
Total iron as Fe	trace to 9.0 per cent
Total manganese as Mn	trace to 4.0 per cent
Total copper as Cu	traces in some samples
Total arsenic as As	traces in some samples
Material freely soluble in water	3.0 to 39.0 per cent
Soluble zinc as zinc sulphate	60 to 85 per cent of soluble fraction
Other soluble sulphates, computed as sodium sulphate	5 to 20 per cent of soluble fraction
Soluble chlorides	small amounts
Soluble carbonates	small amounts

* Analysis from laboratory of the Division of Soils Chemistry and Physics, United States Department of Agriculture.

** Analysis from laboratories of the U. S. Bureau of Fisheries, Columbia Field Station, and from Department of Physical Chemistry, University of Missouri.

Report of U. S. Bureau of Fisheries, Table No. 4, Page 102.

Table No. 7

SUMMARY OF LEAD EXAMINATIONS COEUR D'ALENE LAKE WATERS

By J. K. Hoskins, Sanitary Engineer in Charge Stream Pollution Investigations Station, Cincinnati, Ohio.

Sta. No.	Location	Lead Content in P. P. M. Max.	Min.	Ave.	Ave. for Flood Period*
1.	Lake at Harrison Intake	2.25	0.10	.36	0.88
2.	River at Harrison Highway Bridge	1.60	0.12	.43	0.55
3.	Lake at mouth Coeur d'Alene River	0.75	0.12	.27	0.45
4.	Lake off Harlow Point	0.30	0.06	.17	0.24
5.	Lake off East Point	0.37	0.08	.15	0.25
6.	Lake off McDonald Point	0.32	0.06	.13	0.21
7.	Lake off Driftwood Point	0.20	0.06	.12	0.18
8.	Lake off Niggerhead Point	0.19	0.07	.12	0.15
9.	Lake at Coeur d'Alene Intake	0.96	0.06	.22	0.12

* Flood period assumed to comprise samples of March 26, April 9 and 21 and May 5, 1932.

Table No. 11, Page 17 of Mr. Hoskins' Report.

Table No. 8

SUMMARY OF LEAD EXAMINATIONS COEUR D'ALENE WATERS

By W. V. Leonard, State Chemist and Sanitary Engineer, Department of Public Welfare, Boise, Idaho

Sta. No.	Location	Lead Content in P. P. M. Max.	Min.	Ave.
1.	Lake at Harrison Intake	0.60	0.08	0.26
2.	River at Harrison Highway Bridge	1.60	0.14	0.40
3.	Lake opposite mouth of Coeur d'Alene River	1.00	0.10	0.31
4.	Lake opposite Harlow Point	0.30	0.04	0.17
5.	Lake opposite East Point	0.40	0.06	0.17
6.	Lake opposite McDonald Point	0.30	0.08	0.15
7.	Lake opposite Driftwood Point	0.20	0.08	0.11
8.	Lake opposite Nigger Head	0.30	0.06	0.14
9.	Lake over Coeur d'Alene City Intake	0.38	0.05	0.15

Compiled from Tables Nos. 3 to 11, inclusive, of W. V. Leonard's Report.

Table No. 9

LOCALITIES OF COEUR D'ALENE INVESTIGATION

By M. M. Ellis, Ph.D., Sc.D.

In Charge, Interior Fisheries Investigations
United States Bureau of Fisheries
July, 1932

Locality Number	Description of Locality
C1	Coeur d'Alene Lake; at mouth of St. Joseph River, a little below Ramsdale, along the log boom.
C2	St. Joe River; along the log boom at St. Maries near Powell Sanders Co. store; depth 4.6 meters.
C3	St. Joe River; 10 miles above St. Maries and a little below Rochett Creek at foot of St. Joe Baldy.
C4	Coeur d'Alene Lake; in front of Harrison, Idaho, a series of six stations in a line from 500 feet to one-half mile from Andy Botham's boat house; depth 3, 6, 9, 12, 15, and 18 meters.
C5	Coeur d'Alene River; along the log boom at Export Mill, near mouth of the river.
C6	Anderson Lake; near south end; water sparkling, clear, brownish.
C7	Anderson Lake Ditch; halfway between lake and Coeur d'Alene River; water not sparkling, ditch water with yellow-green cast of the river water.
C8	Thompson Lake and ditch.
C9	Blue Lake; about the middle of the lake.
C10	Blue Lake; in Saggitaria and grass near margin.
C11	Cave Lake; in front of John Snider's boat house at Medimont, Idaho; water sparkling, clear, brownish.
C12	Cave Lake; deepest place in the lake, three-fourths mile south of Medimont, in a bay with a wall of lava and basalt rock some ten feet above the lake surface to the west; depth 6 meters.
C13	Cave Lake; alongside a bed of "Nupar," across the lake from Medimont.
C14	Medicine Lake; deepest place in the lake, east of the center of the south end of the lake; depth 6 meters. A series of 5 bottom samples in the immediate vicinity were at depth 4, 3, 2, and 1 meters.
C15	Medicine Lake; at mouth of small inlet stream; depth 1 meter.

Locality Number	Description of Locality
C16	Coeur d'Alene River; at lower Medimont Ferry, in midstream; depth 12 meters.
C17	Coeur d'Alene River; just inshore from Andy Botham's boat house at Harrison, Idaho.
C18	Coeur d'Alene Lake; about mid-lake opposite Farmington Landing, between the landing and East Point; depth 22 and 25 meters.
C19	Coeur d'Alene Lake; mid-lake two miles west from mouth of Coeur d'Alene River.
C20	Coeur d'Alene Lake; 100 yards off shore at Harrison, pumping station.
C21	Coeur d'Alene Lake at mouth of St. Joe River, alongside the sorting boom on the east side of the river.
C22	Piling at Springton Mill beside Coeur d'Alene River.
C23	Thompson Flat; alongside of Thompson Lake ditch.
C24	Coeur d'Alene River; just below mouth of Thompson Lake Ditch; depth 17 meters.
C25	Coeur d'Alene Lake; in center of Windy Bay; depth 32 meters.
C26	Coeur d'Alene Lake, off Black Rock; depth 39 meters.
C27	Coeur d'Alene Lake; between Loft's Bay and Bellegrove Bay, opposite Turner's Bay and Spokane Mountain; depth more than 50 meters.
C28	Coeur d'Alene Lake; along the boom one-half mile above Blackwell's Mill at the foot of the lake; depth 5 meters.
C29	Coeur d'Alene Lake; half way between Blackwell's Mill and Three Mile Point; depth 16 meters.
C30	Coeur d'Alene Lake; mid-channel at Niggerhead Point; depth 49 meters.
C31	Coeur d'Alene Lake; mid-channel between Echo Bay and Bellegrove, out from the reef; depth 60 meters.
C32	Coeur d'Alene Lake; near shore at East Point.
C33	Lake Chatcolet; off Rocky Point; depth 11 meters.
C34	Lake Chatcolet; across bay from Rocky Point, alongside a weed bed; depth 2.5 meters.
C35	Lake Chatcolet; at the west end of the lake just off mouth of Plummer Creek; depth 2 meters.
C36	St. Joe River; just above outlet from Lake Chatcolet; depth 6 meters.

Locality Number	Description of Locality
C37	Black Lake; off Foster Point; depth 5 meters.
C37.5	Bradley, Idaho; just below Bunkerhill Mills, on flat 200 yards from South Fork of Coeur d'Alene River.
C38	South Fork of Coeur d'Alene River; one-fourth mile above Larson, Idaho. Above the mines, river a cold swift mountain stream; depth 1 meter.
C39	South Fork of Coeur d'Alene River below Golconda Mill; depth 0.6 meters. This station is also below Morning Mill and Mullan but as these mills were not in operation at the time samples were taken (July 19) the river was clear.
C40	Placer Creek; just above Wallace, Idaho, a little above the swimming pool, source of Wallace water supply, shallow.
C41	South Fork of Coeur d'Alene River; near Wallace, Idaho, just at the bridge east of the County Hospital; depth 8 inches. This is below Wallace and the stream was turbid with mine waste. Considerable floating garbage was noted a mile upstream from this point.
C42	South Fork of Coeur d'Alene River; just above the bridge below which the Sunshine waste flume empties into the river; depth 7 inches.
C43	South Fork of Coeur d'Alene River; 240 feet below the mouth of the Sunshine waste flume; depth 6 inches.
C44	Hecla Mill; above Wallace, Idaho.
C45 A	Hecla Mill; above Wallace, Idaho.
C45 B	Hecla Mill; above Wallace, Idaho.
C46	Canyon Creek; at the dam, above Wallace, Idaho.
C47	Gem Mine; (inactive) on Canyon Creek.
C48	Tiger Mine; (inactive) on Canyon Creek.
C49	Morning Mine Tunnel; Morning, Idaho.
C50	South Fork of Coeur d'Alene above Deadman, Idaho.
C51	South Fork of Coeur d'Alene below Deadman and above Mullan, Idaho.
C52	Coeur d'Alene River; under bridge and opposite Dudley, Idaho (Kootenai County).
C53	Fourth-of-July Creek; opposite Dudley.
C54	Rose Lake; at swimming beach near Rose Lake, Idaho.
C55	Old Mission Slough; flows into Coeur d'Alene River at Old Mission near Cataldo, Idaho.

Locality Number	Description of Locality
C56	Coeur d'Alene River; one-fourth mile above the mouth of the river and a little below the Export Mill, along the log boom; depth 9 meters.
C57	Coeur d'Alene River; at mouth of Swan Lake Ditch, alongside the sheer boom.
C58	Swan Lake; in the open water of the main lake basin, water not very clear, looks like the water and bottom of the river; depth 4.5 meters.
C59	Sullivan Mine, Kimberley, British Columbia.
C60	Sullivan Mill, Kimberley, British Columbia, just below the south
a & b	dam of the settling basin below the iron sulphide pile.
C60c	Sullivan Mill, Kimberley, British Columbia, waste flume as it leaves the mill.
C61	Little stream carrying settled out run-off from the Sullivan Mill settling basins bound for St. Maries River, a point where the stream crosses the Kimberley-Cranbrook road near the school house west of St. Mary's, British Columbia.
C62	Corbin Irrigation Ditch from Spokane River where the "feeder" crosses the second road south of the Idaho-Washington state line, about one-fourth mile east of "Apple Road."
C63	Flat below the bridge over the Spokane River on the "Apple Road." This is in Green Acres Irrigation Project, Washington.
C64	Pool in Canyon Creek back of water-supply dam above Burke, Idaho; depth approximately 4 meters.
C65	Conklin Park, Coeur d'Alene Lake.

Pages 14 to 18, inclusive, of Dr. Ellis' report.

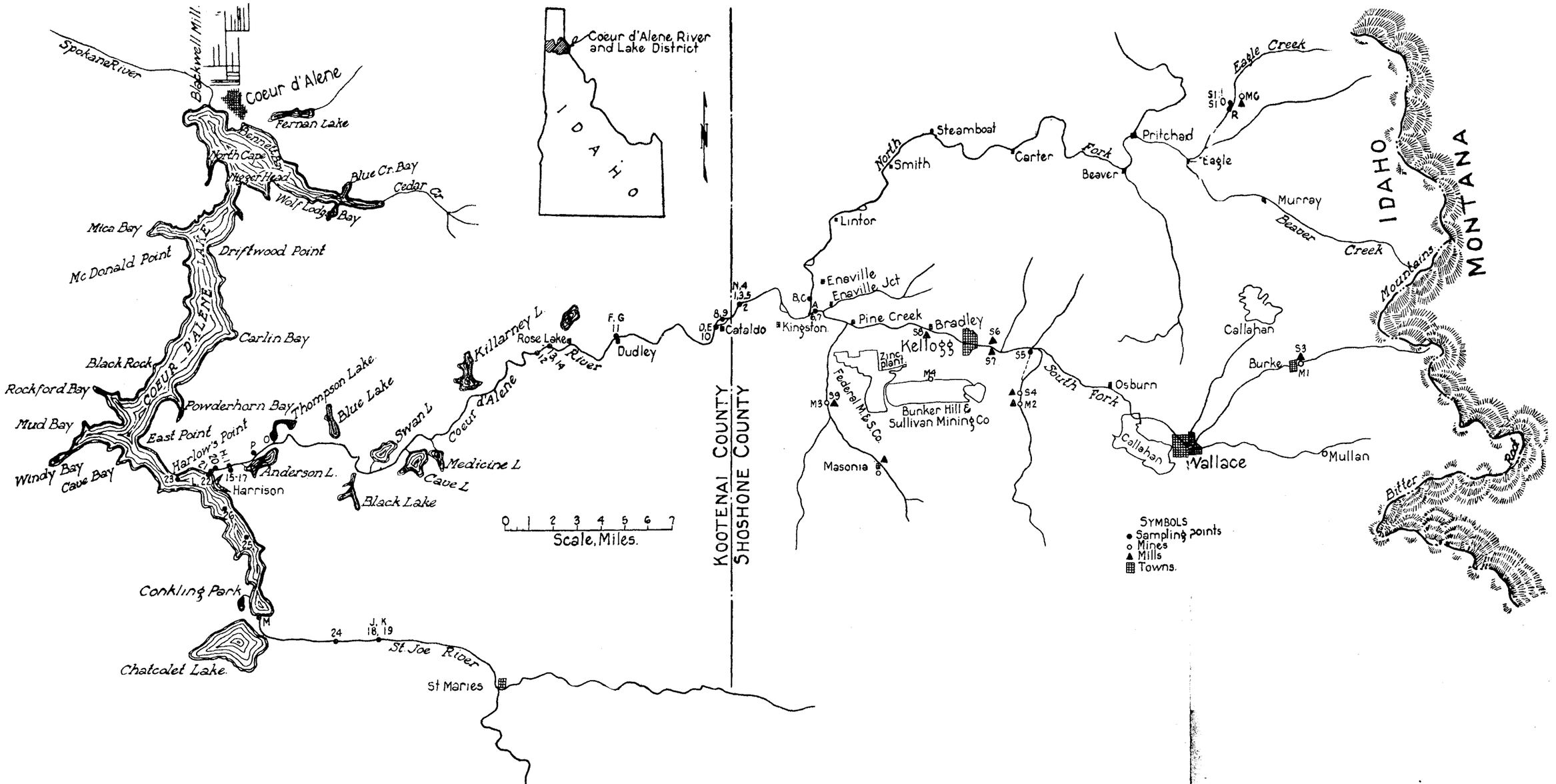

Figure 1. Map of Coeur d'Alene River and Lake district showing sampling points, mines and mills. From Idaho State Dept. of Agriculture, Fred Callaway and others.

RECAPITULATION AND GENERAL SUMMARY

By the U. S. Bureau of Mines

"The Coeur d'Alene River and Lake Commission requested the U. S. Bureau of Mines to make an investigation of alleged material damage to farm land in the Coeur d'Alene River valley and harmful pollution of the water of the Coeur d'Alene River and Lake resulting from discharge of mill tailings from mining operations at the headwaters of the river. By mutual agreement between the U. S. Bureau of Mines, the U. S. Bureau of Public Health and the Idaho State Department of Public Welfare, the work of the Bureau of Mines was confined mainly to the source of the tailings and to investigating the pollution of the river. The other two agencies were assigned the portion of the study that dealt with conditions in Coeur d'Alene Lake. This report deals only with the part of the investigation performed by the Bureau of Mines.

"Representatives of the Bureau of Mines visited the site of alleged trouble between August 28, 1931, and September 13, 1931, at which time they studied the situation by interviewing persons, making observations of conditions, and by taking specimens of water and solid material for determination of lead and arsenic content, the alleged poisonous constituents contributed by the tailings. The report includes a description of the physical features of the site, the industry, a brief history of past complaints from mill tailings in this region, and detailed observations and results of chemical analyses, with discussion. With the exception of the results of analysis of samples of water taken at the mouth of the Coeur d'Alene River by a local resident during a 10-month period and shipped to the Bureau of Mines for analysis, the observations made by this Bureau are confined to the conditions at the time of the visit of its representatives to the site, supplemented by such information and observations as are deemed in-

dications of conditions during other seasons of the year and during past years.

"1. It is evident, and known and admitted by all concerned, that tailings are discharged by the mills into the waters of the Coeur d'Alene River; that differential settling of these tailings accompanies their transportation by the river with the result that they are normally deposited in the stream bed, along the river, and in the lake, in decreasing amounts from the point of discharge to the body of the lake; that high water or flood stages picks up previous deposits and carries them further down stream and in greater proportions into the lake; and that inundation of land with water burdened with tailings causes tailings deposits on the land with damage to its productivity and value.

"2. Chemical analysis of grab samples of the tailings taken at the mills show a range of 0.02 to 1.77 per cent lead with a weighted average for all the mills of about 0.4 per cent lead. However, owing to differential settling the tailings are subject to change in composition between the point of discharge and any later point from which they are obtained. The lead content of total water-borne solids* in water samples taken from the Coeur d'Alene River, with the exception of the North Fork, contained from 0.14 to 0.30, or an average of 0.24, per cent lead. Similar material from the North Fork, from a lake adjacent to the Coeur d'Alene River and from the St. Joe River, all of which had from slight to no source of contamination by mill tailings, contained from 0.02 to 0.03 per cent lead. Samples of bottom surface from the Coeur d'Alene River and Lake contained from 0.68 to 0.93 per cent lead while a sample taken from the bottom of the St. Joe River contained but 0.04 per cent lead. Samples of top stratum taken from the bank of the Coeur d'Alene River and from barren deposits on adjacent fields con-

* Total organic and inorganic solids on a dry basis.

tained from 0.57 to 0.87 per cent lead; a sample of soil taken from an apparently fertile field along the river and adjacent to a barren deposit, and a sample of clay-like soil near the river contained but 0.02 per cent, while a sample of soil taken in a field along the St. Joe River contained less than 0.001 per cent.

"A tendency for the lead content of deposits in the river and lake to be higher than the average lead content of the tailings at the mills is observed. Whether this is due to the average lead content for the discharge being non-representative; to differential settling and concentration; or to the remains of tailings from former milling and concentrating processes which allowed more lead to escape with the tailings is not known. The latter is indicated by the general agreement between the lead content of the present water-borne solids and the average lead content found in the tailings. On the other hand, the lower lead in the water-borne solids as compared with deposits in the lake and river may be the result of the dilution of the former with organic matter.

"A comparison of the lead content of samples of solids taken from the St. Joe River water and bottom and all samples obtained from sources where inappreciable contamination with tailings would be expected, indicates that mill tailings is the major source of lead found in deposits on fields, deposits along the Coeur d'Alene River in the river channel and in the lake in the vicinity of the mouth of the river; or conversely that the deposits are chiefly tailings. The comparison also shows that but little of the lead has been deposited as a product of natural erosion.

"3. Chemical analyses of water samples show that the water contains lead but that the lead is present mainly as a suspension of tailings. Only a small part of the lead is in solution. It is indicated that enough tailings can be carried in suspension by rapidly moving and turbulent water to cause chronic lead poisoning to man or stock that drink the normal amounts of water for several days

or longer. The physical appearance of this water, however, would be distinctly turbid. If the water became stilled for only a short period, the tailings settle rapidly and the possibility of poisoning becomes remote. Not enough lead to cause poisoning was found in any specimens of water that were without distinct visible signs of turbidity.

"The quantity of tailings that would be required to cause acute lead poisoning is above practical acquirement.

"No evidence, hearsay, or complaint relative to cases of poisoning of persons in the Coeur d'Alene River valley by constituents discharged into the water by the mills, was revealed.

"The description of signs of posoning related by the farmers and records of testimony does not reveal conclusive evidence that stock has been poisoned in the past by constituents discharged into the river water by the mining and milling operations. The evidence presented other causes to be equally probable. No evidence or hearsay of comparatively recent deaths from poisoning of stock could be found. On the contrary and notwithstanding the claims and complaints of the farmers that it was sure death for stock to be watered from the river, it was observed that stock was pastured on land covered with tailings and that they were watered from the river at places where there was marked deposition of tailings and where the water contained enough tailings to impart a distinct turbidity. The comparatively recent observation that a number of deaths occurred in a band of swans that settled in the marshes adjacent to the river, and that lead was found in the viscera of these dead swans is not conclusive evidence that lead poisoning was the cause of death, or if so that the source of the lead was mill tailings. Lead in the viscera indicates that lead had been ingested, very possibly as solids in the course of feeding in the marshes, because it has been shown by chemical analysis that the top stratum of a marsh contained 0.32 per cent

lead. Higher amounts, up to 0.7 to 0.8 per cent were found in other possible places of feeding.

"It is very possible that some lead would be found in viscera of all animals that fed in the marshes, along the river or on land covered with tailings, and particularly in animals that have the feeding habits of water fowl. However the presence of the lead in the viscera merely indicates ingestion and does not indicate that enough lead is absorbed to cause poisoning. For the purpose of establishing lead absorption, examination for lead in the tissues other than the alimentary canal, particularly the bones, should be made. Even though small amounts are found in these tissues, a quantitative interpretation is required because a small amount of lead is found in the tissues of practically all animals.

"In the course of its investigation the Bureau of Mines attempted to obtain specimens of blood from stock that pastured on tailings-covered land and watered from the river, for examination for signs of lead poisoning, but permission for taking the specimens was refused by the owner of the stock.

"4. The amount of arsenic found in the water and in tailings shows arsenic to be of no practical consideration from the viewpoint of poisoning or harmful pollution of the water.

"5. Previous to 1917 at least two of the milling companies had constructed impounding dams for retaining their tailings. These dams, however, were washed out by an unusual flood in that year and the tailings scattered over considerable areas of farm land in the valley below and resulted in many claims for damage. Owing to the natural topography and flood conditions, the sites for impounding dams at the mills on the South Fork of the Coeur d'Alene River are few, and none are satisfactory from all considerations. The one mill on the watershed of the North Branch of the Coeur d'Alene River is situated on Eagle Creek, a comparatively small tributary that

has also a comparatively small drainage area above the mill to create flood conditions. At this place there is in operation an impounding dam that retains all but a small amount of the fine tailings. As stated, this is the only mine on the North Branch and the amount of tailings is small in comparison with the total amount discharged from the several mills on the South Branch.

"At the time representatives of the Bureau of Mines were conducting the investigation described in this report they were shown by representatives of the mining industry plans for a plant to remove tailings from the Coeur d'Alene River and stack them on adjacent land. This plant was to be located below the confluence of the two forks of the Coeur d'Alene River, and consequently below all of the mills, where the valley opens and provides an area of suitable size and which apparently has natural barriers against subsequent removal and distribution of the tailings. The principle involved in the plan was, briefly, to provide settling basins or reservoirs and to remove the tailings from these by means of a floating electrically operated suction dredge, the tailings being discharged and stacked on adjacent land provided therefor. A plant designed along these lines started operation July 15, 1932, eight hours daily and later increased to 20 hours daily. It is estimated that to date, December 5, 1932, 500,000 tons of material have been removed from the river channel, the present rate being 2,500 to 3,000 tons daily. The present plans are to continue operation, except as prevented by sub-zero weather.

"Owing to tailings deposits in the river channel and on the banks and adjacent land it is probable that conditions, particularly at high water and flood stages, the operation of the plant may not show immediate marked improvement but there are no apparent reasons for believing that it will not be an amelioration, and ultimate improvement can be expected. Plants that operate on the same basic principles for removing tailings from water have proven to be satisfactory in other situations.

"The installation and operation of this tailings disposal plant effects such a potential change in the tailings pollution problem of the river below this point and the lake, as to render inapplicable much of the data obtained during the course of this investigation on the degree of pollution and potential harm. It is of value, however, as a basis for judging the efficacy of the disposal plant and as a contribution to general information on the subject of harm and damage from tailings."

Pages 84 to 94, Inclusive, of Bureau of Mines Report.

SUMMARY OF INVESTIGATIONS

By J. K. Hoskins, Sanitary Engineer in Charge
Stream Pollution Investigation Station
Cincinnati, Ohio

"Discussion of Results

"An examination of the tabulated data discloses that for the larger proportion of the samples the total lead content ranged from 0.08 to 0.20 parts per million, but that for a number of individual samples lead was present in much higher amounts, such as on March 26, 1932 at the Harrison City intake when 2.25 parts per million were found and on November 5, 1931 at the Coeur d'Alene intake when 1.75 p.p.m. were observed. Three other samples from this latter source at the 100 ft. depth (Station No. 9) likewise showed high lead content. These four samples increase the average lead value for this station materially. If these four results should be omitted, for which there is no logical justification, the average lead content for the entire year at Station No. 9 would be reduced from 0.22 to 0.12 p.p.m. which latter figure is in harmony with the averages of the three preceding stations (Nos. 6, 7, and 8).

"There is a very definite tendency exhibited by the results for the lead content in the lake water to diminish as the distance from the mouth of the Coeur d'Alene River increases. This is most plainly indicated in the average figures for the flood period derived from the analytical results of samples collected March 26, April 9, 21 and May 5, 1932. (See Table No. 11). It appears logical to assume that this gradual reduction in lead content is caused by the settlement in the lake of the suspended matter carried in the Coeur d'Alene River.

"From the few determinations made of the lead in solution in certain of the samples, the indication appears to be that under normal conditions the lake water is practi-

cally saturated continuously with lead in solution and that higher amounts, when present are most likely to be in the form of suspended material or turbidity.

"Effect Upon the Public Health

"No information is available regarding the occurrence of lead poisoning among persons regularly using these lake waters for drinking water and domestic purposes. The Drinking Water Standards adopted by the Treasury Department for drinking and culinary water supplied by common carriers in interstate commerce specify that lead shall not exceed 0.1 part per million. There is no general agreement among authorities as to the lowest amount of lead in drinking water that will cause lead poisoning. In a review of the literature on the subject H. Berger [Kl. Mitt. ver Wasserversorg Abwasser Beseitig 2.171-3 (1926)] states that these limits vary from 0.025 to 1.0 p.p.m. Mason in his book on Water Supply (1916) page 459 cites several references to authorities regarding the permissible amounts of lead in drinking water among which are: (1) The Massachusetts State Board of Health Report for 1898 notes that 0.5 p.p.m. of lead has caused serious injury (2) Whitelegge holds that no water should be used for drinking which contains more than 1.0 p.p.m. and any trace however minute, indicates danger and (3) Dr. Summerville states that lead to the extent of 0.25 p.p.m is sufficient to condemn a potable water.

"Legge in an article on lead [Jour. Roy. Soc. Arts LXXVII, 4007: 1023-1039 (Sept. 6, 1929)] states that 1/32 grain of lead absorbed daily will in time undermine the constitution and set up chronic lead poisoning. For purposes of estimation, assuming that the Coeur d'Alene City supply carries an average of 0.22 p.p.m. of lead, there would be present in each gallon of such water 0.22 x .0584 or 0.0128 grains of lead. If an intake of 1/32 or 0.0313 grain of lead daily is harmful, the water consumer would therefore need to drink $\frac{0.0313}{0.0128} = 2.4$ gallons of this water daily to acquire a harmful dose. This is,

of course, in excess of the volume of water normally consumed although lead absorbed by foods cooked in such water would doubtless reduce the factor of safety materially."

Pages 18, 19, and 20 of Mr. Hoskin's Report.

SUMMARY OF 1932 INVESTIGATIONS

By M. M. Ellis, Ph. D., Sc. D., In Charge, Interior Fisheries Investigations, United States Bureau of Fisheries

"1. The polluted portion of the Coeur d'Alene River, that is, the South Fork from a short distance above Wallace, Idaho to its junction with the North Fork above Cataldo, and the main Coeur d'Alene River from the junction of the forks to its mouth near Harrison, Idaho was found (July, 1932) to be practically devoid of fish fauna, bottom fauna or plankton organisms.

"2. The unpolluted small lakes adjacent and tributary to the Coeur d'Alene River between Cataldo and Harrison, were supporting normal fish fauna of bass, sunfish, perch, and minnow, together with ample aquatic vegetation and plankton fauna.

"3. Thompson Lake and Swan Lake, both rather heavily polluted by recent backwaters from the Coeur d'Alene River, were almost without plankton fauna.

"4. The plankton fauna of Coeur d'Alene Lake as a whole was rather sparce, and particularly poor at the south end. No plankton were taken off Harrison and at the mouth of the Coeur d'Alene River; and very few as far up the lake as East Point. A comparison of the plankton data obtained by Kemmerer in 1911 with those collected in 1932 showed a decline in the plankton fauna, but the same general distribution, Kemmerer having

noted the poor plankton fauna near the mouth of the Coeur d'Alene River.

"5. The bottom fauna of Coeur d'Alene Lake was very meager, and seemed to be declining.

"6. Minnows, dace, bass, and perch were found and trout reported as living in Coeur d'Alene Lake.

"7. The decrease in the numbers of trout living in Coeur d'Alene Lake during recent years, should not be attributed to mine wastes alone as various other factors have been operative to cause these fish to become less plentiful in this lake.

"8. The St. Joe River and Chatcolet Lake were maintaining good plankton, bottom insect, and fish faunæ. Bass, trout, perch, minnows and dace were all found in these waters.

"9. No significant differences in dissolved gases, pH, carbonates, and other factors dependent upon these were found between the waters of the polluted portion of the Coeur d'Alene River, and those of the St. Joe River or of the unpolluted portions of the South Fork. The specific conductance of the polluted water was higher than that of the unpolluted water but did not indicate an excessive amount of soluble material in the polluted water.

"10. Comparisons of the dissolved gases, relative acidity, and carbonates in Coeur d'Alene Lake during July, 1932 with the analyses made by Kemmerer in this lake in 1911 showed the values reported by both surveys to be essentially the same, indicating little change in the condition of the lake with regards to these factors over a period of 20 years.

"11. The bottom of the polluted portion of the Coeur d'Alene River was deeply covered with shifting deposits of very fine rock powder which not only overwhelmed the mottom fauna but prevented the development of any bottom consocies of animals either adult or immature.

"12. Along the polluted portion of the Coeur d'Alene River the banks, flats, and low lands were covered often to a depth of several feet with deposits of mine slimes which had been left there during high water and which were continually being returned to the river by wind, rain, and current action, thus producing a constant re-pollution of the river with the slimes previously dropped by the river.

"13. Deposits of mine slimes more or less mixed with other soil components, were dredged from the floor of Coeur d'Alene Lake at various stations, showing that the mine slimes have spread rather generally over the bottom of Coeur d'Alene Lake, particularly in the line of flow between the mouth of the Coeur d'Alene River and the outlet of Coeur d'Alene Lake west of Coeur d'Alene City. These bottom deposits contained lead and zinc in small amounts, and soil samples from the banks of the Spokane River near Green Acres, Washington also contained traces of lead, zinc and copper, suggesting that some of the mine slimes or their products are not only carried across the lake but out of the lake and sown the Spokane River.

"14. Dace and minnows living in Coeur d'Alene Lake near Conklin Park, when transferred to live cages in the Coeur d'Alene River a short distance above the mouth of the river died in 72 hours while controls under the same conditions of confinement showed no ill effects after 120 hours' exposure to the lake water off Harrison.

"15. Water from the polluted portion of the Coeur d'Alene River near Harrison was definitely toxic to plankton crustacea, killing all plankton animals placed in this water in 18 hours or less.

"16. All of the milling chemicals with the exception of sodium carbonate were very toxic to both fish and plankton. The milling chemicals, however, do not present any particular pollution hazard except in the immediate vicinity of the emptying flumes as only part of these mill-

ing chemicals leave the mill and the organic derivatives as potassium xanthate and the cresols are soon broken down in the stream.

"17. The milling products, that is, the rock powder and sodium compounds were relatively non-toxic except as they disturbed the natural salt balance in the river water. Plankton animals were fairly sensitive to such changes.

"18. The washed sulphid ores of both lead and zinc were non-toxic to fish in 31 days' exposure, but the washed lead ore was quite toxic to plankton.

"19. Mine waters and flume waters were quite toxic to plankton.

"20. Large amounts of incrustations were observed on the exposed mine slimes on the flats along the polluted portion of the river and in soils more or less impregnated with mine slimes. The incrustations formed hard coatings over the soil in many places and often covered several acres of surface at any given stations. In July, 1932 these incrustations amounted to 26 tons per acre on Thompson Flat.

"21. The incrustations were composed of a soluble fraction (3 to 40 percent) which was largely zinc sulphate and an insoluble fraction carrying zinc, and lead compounds.

"22. The soluble fraction of these incrustations was highly toxic to fish, frogs, turtles, fresh-water mussels and plankton crustacea.

"23. Exposures of 12 to 31 days to high dilutions of these incrustations were fatal to fish, the animals showing among other symptoms black deposits of lead in the fins and elsewhere about the body, indicative of cumulative lead poisoning.

"24. The acute pollution conditions existing in the Coeur d'Alene River as resulting from the enormous de-

posits of rock powder and from the toxic substances produced by the weathering of the exposed mine slimes on the flats, are threatening the small lakes along the Coeur d'Alene River, and also Coeur d'Alene Lake.

"25. There is but one solution for this pollution problem as far as fisheries are concerned, namely, the exclusion of all mine wastes from the Coeur d'Alene River.

"26. A practical system for the disposal of mine wastes without river pollution, now in operation in British Columbia is discussed."

Pages 125 to 130, Inclusive, or Dr. Ellis' Report.

SUMMARY OF INVESTIGATIONS

By W. V. Leonard, State Chemist and
Sanitary Engineer, Department of Public Welfare
Boise, Idaho

"Discussion of Analytical Data

"In the review of the results of Stations 1 to 9, inclusive, the analytical data checks very closely with the original thought. A dimunition of the lead content in keeping with the distance from the mouth of the Coeur d'Alene River was noted. No erratic samples were found in those submitted to the State Department, and only the variations due to the lake level and river flow were shown.

"Toxicity of Lead Salts

"There is such a discrepancy in the literature relating to chronic lead poisoning that this report will not attempt to give the maximum amount of water that could be ingested before the allowable limit of poisoning would be reached. It is generally conceded that lead in drinking water where it reaches one part per million or more, is a direct health hazard. None of the stations sampled by the Department of Public Welfare reached more than

.26 p.p.m. This maximum was at the Harrison Intake, Sample No. 1. At the intake to the Coeur d'Alene River supply, the average lead content over the period of this examination was .15 p.p.m.

"While this exceeds the Treasury Department's ruling on waters in inter-state traffic, it is my opinion that there is no great health hazard due to chronic lead poisoning for the public using water at Coeur d'Alene."

Page 26 of Mr. Leonard's Report.