68A1096 #280 MHS Clinch River

OBJECTIVES OF CLINCH RIVER STUDY

The purpose of the study of the Clinch River below Oak Ridge National Laboratory is to obtain fundamental information on the physical, chemical, and biological dynamics of a flowing, fresh water ecosystem which is receiving large volumes of low-level radioactive wastes. Information from a broadly conceived fundamental and applied program will have important implications for two major world-wide problems resulting from large-scale environmental contamination. These are:

1. What is the over-all diluent capacity of fresh water environments for an increasing continuous input of large volumes of low-level radioactive wastes?

2. What is the long-term indirect impact of radioactive contamination of such environments?

Objectives

This program has four general objectives, namely:

1. to determine the fate of radioactive materials currently being discharged to the river,

2. to determine and understand the mechanisms of dispersion of radionuclides released to the river,

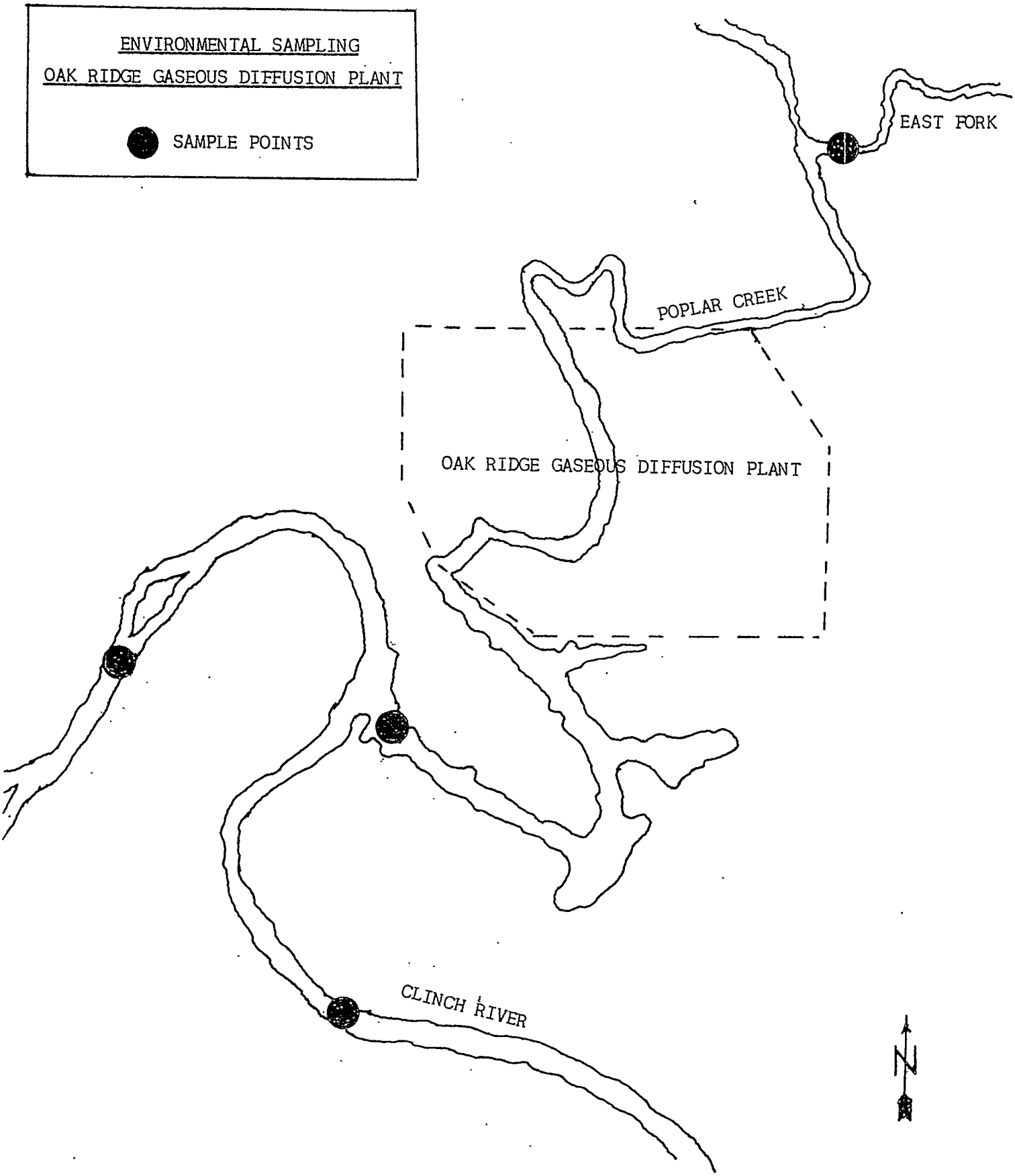
3. to evaluate the direct and indirect health and hazard aspects of the current disposal practices in the river,

4. to evaluate the over-all usefulness of this and similar rivers for radioactive waste disposal purposes.

ChemRisk Document No. 2110

News Release

April 18, 1960



ENVIRONMENTAL SAMPLING
OAK RIDGE GASEOUS DIFFUSION PLANT

Period 1959

Location of Point	Type of Analysis Made	No. of Samples	Concentration ($\mu c/cc \times 10^{-8}$) Plant Experience Low	High	Av.	Max. Permissible (MPC)	Av. Pl. Exp./MPC
Local Streams (Water)							
Poplar Creek	Uranium Concentration						
Upstream		52	3.7	8.7	6.2	2000	0.31%
Downstream	"	52	0.5	1.0	0.6	2000	0.03%
Clinch River							
Upstream	"	52	0.08	0.2	0.1	2000	0.005%
Downstream	"	52	0.1	0.3	0.3	2000	0.015%
Poplar Creek	Total Beta Activity						
Upstream		52	14.0	22.0	18.0	2000	0.9%
Downstream	"	52	11.0	32.0	22.0	2000	1.1%
Clinch River							
Upstream	"	52	13.0	96.0	39.0	105*	37%
Downstream	"	52	10.0	136.0	50.0	105*	48%

Normal Sampling Frequency: Continuous sampling; composited over one week.

* Measured mixture of radionuclides.

ENVIRONMENTAL SAMPLING
OAK RIDGE GASEOUS DIFFUSION PLANT

Period 1959

Location of Point	Type of Analysis Made	No. of Samples	Concentration ($\mu c/g \times 10^{-8}$) Plant Experience Low	High	Av.	Max. Permissible (MPC)
Stream Bottom (Mud)						
Poplar Creek	Uranium Concentration					
Upstream		4	400	6,900	3,200	None Specified
Downstream	"	4	1,300	4,500	2,500	
Clinch River						
Downstream	"	4	300	1,300	700	
Poplar Creek	Total Beta Activity					
Upstream		4	7,200	28,600	18,000	None Specified
Downstream	"	4	12,900	21,200	18,500	
Clinch River						
Downstream	"	4	15,800	79,200	45,500	

Normal Sampling Frequency: Grab sample, once each quarter at each location.

68A1096 #280 . MHL Clinch River

MINUTES

MEETING ON "PLAN FOR CLINCH RIVER STUDY"

OAK RIDGE NATIONAL LABORATORY
Building 2001-Conference Room
December 18, 1959 - 9:30 AM

INTRODUCTION

E. G. Struxness, acting as chairman, called the meeting to order. He welcomed and introduced those present (see attendance list, page 13) and outlined the purpose of the meeting as follows:

1. Acceptance of plan for proposed Clinch River Study.

2. To determine the interest of agencies represented in the study and their possible participation in the work program.

3. To consider need of and organize a Steering Committee to guide and implement the study program.

STATEMENTS BY ATOMIC ENERGY COMMISSION REPRESENTATION

W. G. Belter conveyed regrets from J. A. Lieberman of the Environmental and Sanitary Engineering Section of the AEC in Washington for not being able to attend the meeting. With regard to the proposed program, he said the Sanitary Engineering group of AEC is much concerned with the effects of waste disposal on our environment and that about 40% of the budget of this group is for environmental studies, of which 30% is in the program at Oak Ridge. He said this should be a cooperative and joint undertaking for a comprehensive study of the Clinch and Tennessee Rivers, and that he hoped all agencies represented in the meeting would be able to take part in the estimate of manpower and financial limitations involved. The fate of radioactivity in both the Clinch and Tennessee Rivers must be determined in order to guide control measures and future releases to the Clinch River.

The Laboratory has conducted an extensive monitoring program exemplified in the recent report by the Applied Health Physics Section on radioactivity in the Clinch and Tennessee Rivers. He said the proposed study is not a monitoring program but the basic information and data from monitoring will aid in determining the capacity of these streams to assimilate wastes and in improving control procedures.

All groups here have relatively different but complementary interests. For this reason it will be desirable to organize a Steering Committee; a small group for guidance of the program. There should be one technical representative from each agency who will have the authority to act for his agency in planning the program. He said that it will be helpful if each agency can decide how it will participate and to what extent it will be able to make its facilities available for the study as a preliminary basis for allocation of work. He said the AEC in Washington has allocated a certain amount of funds for work on this project this year and the Public Health Service has personnel available to do planning and field work of this program. After the committee is selected perhaps we can have discussion on uniformity of preparation and collection of samples. This no doubt will be a problem and will require more definite ideas as to how the preliminary work will be done.

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C. S. Shoup emphasized the mutual nature of the proposed program. He said the study should include participation by several agencies through contributions of data they now have on special aspects of the program and also by active help in obtaining new data. When agencies or groups participate actively and make a definite contribution they have greater interest and the program is more successful. It is important to collect information now in files and perhaps prepare an overall report of what we now know of the Clinch.

As to assignment of personnel, he said that AEC ORO can arrange for people from other agencies and commissions to work in the Laboratory.

For reporting results of the study he said they had found that it is best to issue reports through the regular reporting system of ORNL. This has advantage in that the reports get the TID 4500 distribution to all atomic energy sites and can be purchased by others who have an interest in the information. The issuance of reports as ORNL publications does not preclude the opportunity for a particular agency to publish details of the work in its special area with approval as separate releases.

RADIOACTIVITY IN SILT OF THE CLINCH AND TENNESSEE RIVERS

H. H. Abee summarized the area monitoring program of the Health Physics Division and the data collected concerning releases of radioactivity to the river. He pointed out that in the Clinch River study we are concerned primarily with contamination by low-level radioactive waste water and potential seepage from disposal of solid and intermediate liquid waste to the ground. He referred to available health physics reports and described the system of sample collection and analyses for control purposes and showed slides to illustrate these data. (Discussion followed)

Q. Wallen: What kind of analyses are made on samples collected at White Oak Dam?

A. Abee: Three composites are made:

1. Daily composite on which gross beta and gamma is determined;

2. Weekly composite on which alpha determinations are made; and,

3. Monthly composites on which radiochemical analyses are made for some 5 or 6 of the most important radionuclides.

Q. Wallen: How do you determine the effect of discharges from White Oak Creek upon radioactivity in the Clinch River?

A. Abee: It is assumed that discharges from the creek are completely dispersed in the river water and the calculated concentration is considered in relation to the MPC_W value. This is the concentration for drinking water which will allow an individual to drink the water for 50 years without any detectable damage to the person.

Q. Schultz: Is the concentration checked by sampling in the river?

A. Abee: No, it is not. Concentrations in the river are so low and analyses so complicated that control is based on a straight mathematical calculation using

a dilution factor.

Q. Schultz: Is any allowance made for biological concentration in the river?

A. Abee: No, because our knowledge is not sufficient. We do make one check by river sampling at a ferry near the mouth of the Clinch River. By contract with the ferry operator a daily grab sample is composited to about 20 gallon in three months and analyzed quarterly to determine the average of the important nuclides: For example: 1956 through 1958; the average was about 7.5 x 10^{-7} micro-curies per ml at the sampling point.

T. J. Burnett commented that based on the radiochemical analyses this value is about 30% of the MPC_w.

H. H. Abee said the river monitoring surveys have been confined primarily to concentration of radioactive materials in the suspended matter which settle and form bottom sediments. Since early 1951 sediment surveys have been made down the Clinch and Tennessee Rivers to Chattanooga and beyond. Results have been reported by Garner and Kochtitzky and recently by Cottrell. The surveys include bottom scanning with "Flounder" instrument and also by collecting sediment samples.

Q. Schultz: Do you have alpha and beta counts?

A. Abee: No. The underwater instrument can detect primarily gamma radiation.

In discussion of results of analyses Abee referred to his slides showing data at the various cross sections downstream. In response to a number of questions about methods of analysis and levels of activity found, E. G. Struxness commented that much description and summaries of this information are contained in the record of the Congressional Hearings held by the Joint Committee on Atomic Energy in Washington, January 28 to February 3, 1959.

PROPOSED CLINCH RIVER STUDY PROGRAM

F. L. Parker reviewed the Plan for Clinch River Study, copies of which were distributed before the meeting began. He said it is necessary that we determine the exact fate of radioactive materials. The plan represents the Health Physics Division rather than a single section in the Health Physics Division. Most studies are concerned with meeting MPC standards for a flowing stream. This may not be the best approach but we do know there is contamination by potentially hazardous nuclides. We need to arrive at a more rational MPC figure. The primary need is to get a budget of radioactive material in the river. To do this we must take more water and sediment samples, particularly downstream, and make alpha as well as beta gamma determinations. We want to correlate levels in the sediment with distribution in the water.

Q. Wallen: How far down in sediment do you go?

A. Auerbach: No sediments have been taken.

Parker: Sediment sampling is planned probably at depths to 6".

Nelson: It is planned to go downstream and determine the movement of sediment through the stream to see how suspended matter moves downstream.

Q. Wallen: What will be used for tracer?

A. Parker: For sediment, a radioactive material, possibly Sc-46. Two tracer tests were run this past summer. (Discussion of tests followed)

Q. Wallen: Will there be models used?

A. Parker: Not this year. Models cannot reproduce completely the conditions in the field. For example, with models we could obtain hydrologic data and measure dispersion and sediment transport but models would not provide biological data. (Suggested that Rex Elder of TVA comment from his experiments with hydrologic models)

Elder: My primary work is in the model field. I have had only two discussions with Frank about models. Cannot do a good job with models in the situation here. Dollars in 7 figure amounts probably would be necessary to simulate the extremely complex flow pattern in the lower 20 miles of Clinch River. The stream below ORNL could not be located in a more complex river situation than this. It is at a point where the flows run into the backwater from Watts Bar Dam. The prediction of flows then becomes highly complex during summer months because of stratification. Releases come down the Tennessee River and will be reflected in the movement of water in the Clinch River. It is complicated by the fact that from 5 to 30 days in a row we may have 4, 6, or 7,000 cfs during day time, power plants of TVA may shut down almost completely at night, then start to pick up at 5 or 6 in the morning, increase to capacity, then drop off toward evening and back to light load again. With these things going at about 4 plants affecting flow in this area, it is not uncommon to have negative water slopes and still have good discharges going downstream.

Q. Wallen: Is there any need to use models to define the water slopes?

A. Elder: No, unless your budget is ample and there is need to elucidate a particular facet which proves too difficult to work out in the field. (Elder commented that models would be suitable for working on restricted facets of the hydrology of the stream, as Parker suggested.)

S. I. Auerbach: The ecological problem in the Clinch River can be epitomized as follows: 1) As ecologists we are interested in obtaining basic biological knowledge from streams such as the Clinch River. 2) As Health Physicists we are interested in improving the status of operational monitoring in the Laboratory environs, including the Clinch River. 3) We believe we can contribute information necessary to understanding the fate of radionuclides released to the river.

The basis for programs of ecology and biology in radiological river studies is meager. Less than 1/2 dozen atomic energy installations have had good biological sampling programs of which Hanford and Chalk River are outstanding.

The status of work in biology on the Clinch River has been extremely meager. A survey was made with the aid of TVA and the Fish and Game Commission of the State of Tennessee. They collected a total of 700 fish from White Oak Lake and the Clinch River. The radioanalyses done at that time was gross beta. Based on Sr content found in the White Oak Creek fish, and using the MPCs at that time, they calculated that of the fish from White Oak Lake a person would have to eat 14 pounds of fish per day to get the maximum permissible dose and at river mile 13.3, 36 pounds per day. This survey was done about

12 years ago. Since that time, MPCs have changed and more activity has been deposited in the river. The only other study at this Laboratory was done by Professor James Lackey, which was collection and examination of plankton in the river below White Oak Creek. Dr. Lackey found the Clinch River water above White Oak Creek to contain negligible plankton. The water from Norris Dam is discharged at the bottom and the flows to mile 28 or 29 are cool and free running. We add nutrient materials in addition to radioactive materials which supports increased biological activity below White Oak Creek outfall.

There is another complicating factor--the proposed Melton Hill Dam. This installation will be both a hydroelectric and navigation dam. Its construction and subsequent operation will alter conditions in the river below the dam. We have a number of years before this dam is in operation.

To develop an understanding of the role of the flora and fauna in determining and affecting the fate of radionuclides in the river we should get started on the proposed program at the earliest possible time. There are four major steps in our program: 1) Characterization of the biota some distance above and below White Oak Creek outfall; 2) information regarding the biological productivity; 3) information on the specific radionuclides present, and, 4) synthesis of total system relationships as we can put them together--chemical, physical and biological. More detailed discussion on the phases of the ecology program will be given by D. J. Nelson.

D. J. Nelson: Initial work will be concerned with a characterization of the environment from the biological and chemical standpoint. Physical information will become available from the engineering studies. One of the first questions concerns the source of photosynthetically produced organic matter found within the stream. There are two sources. 1) That which originates within the stream. This primary production will be estimated by the diurnal oxygen curve method.

Q. Schultz: How often do you propose to sample?

A. Nelson: Once a week and twice a week during summer time.

Q. Wallen: What hours of the day and what will you measure?

A. Nelson: 24 hours per day or before sunup till after sundown. Since we are going to be on the stream we anticipate making measurements of other environmental parameters such as PO_4, chlorophyll, temperature, light intensity, etc.

Q. Wallen: How are measurements made?

A. Nelson: When sufficient data are accumulated a multiple regression analysis will be attempted to evaluate the effect of each factor and combination of factors on the primary production within the stream.

PO_4 and NO_3 frequently are limiting factors for photosynthesis in aquatic communities. Since the Laboratory wastes include large amounts of NO_3, one could add PO_4 as fertilizer to the stream and determine what effect it has on photosynthesis. A technique such as this might present a method for treatment of large volumes of waste which might occur as the result of an accident. In streams you find large amounts of organic matter such as leaves which are derived from the watershed. It is possible that half of the organic matter at the photosynthetic level in the stream is derived from the

watershed. (Discussion) We should determine the quantity of organic matter originating on the watershed and what its role is in the food chain. In effect we would have the budget of photosynthetically produced organic matter in the Clinch River. The allochthonous organic matter is known to concentrate radionuclides. Whether the concentration is due to physical sorption or the metabolism of heterotrophic microorganisms such as bacteria is not known. Some laboratory experiments are being conducted with sterile and non-sterile mixtures of river water and leaf material to separate the physical and biological factors which concentrate radionuclides on the non-living organic matter. There is a great deal of organic matter in the bottom sediments and radionuclides associated with it may enter the food chain through the feeding activities of the bottom-dwelling organisms.

Another phase of the Clinch River studies will deal with biogeochemistry and with particular reference to those elements which are released in the radioactive effluent from the Laboratory. A recent paper in Limnology and Oceanography by Nicholls, Curl, and Bowen from Woods Hole and MIT emphasizes that some elements are actively concentrated or excluded by different organisms. They concluded that each element will be found concentrated by some organism in the spectrum of life. The work will include stable and radiochemistry, the determination of body burdens and eventually uptake and excretion rates. The studies will be associated with work on the food chain. We will be able to find the quantity of the various radionuclides in the biota, which elements are mobile and which are conserved.

Q. Wallen: What exactly do you plan to do?

A. Nelson: Plan to start on photosynthesis this spring and carry it a full year and pick up information on the organic matter coming into the stream and also on chemical nature.

Chairman Struxness said that the previous discussion of past work on the river and the plan for the proposed study leads logically to comments by others as an extra order of business. He called for a discussion of the hydrologic parameters.

Godfrey stated that these had been pretty well covered. He indicated that the level of the program almost rules out any extensive model studies.

Elder said that a statement previously made that there are no drinking water supplies taken from this reservoir is not entirely correct. During low flows in the river the cold Clinch River water will flow along the bottom up the Emory River and find its way into the Harriman water supply intake and after warming up will flow back along the surface to the Clinch River.

Parker: The water is monitored at the K-25 plant which has the first downstream water supply taken from Clinch River below ORNL.

Jones: The Kingston water supply which is usually from springs may be affected when water shortage causes intake from the Tennessee River. The Kingston water intake is located a short distance upstream from the mouth of the Clinch and under some conditions there may be an upstream of Clinch River water to the Kingston intake.

Kochtitzky substantiated the fact that under these conditions of up stream flow of the Tennessee River, Kingston might use Clinch River water.

Burnett: A possible concern of the agencies represented here is stream pollution control and we have provided that. The amounts released from White Oak Lake bed area are monitored for protection of the public and can be controlled temporarily by closing White Oak Dam.

(The TVA representatives emphasized that reservoir operations do affect river conditions although information may not be quantitative.)

Elder: There are figures on the effect of Melton Hill Dam. The Melton Hill project will affect the releases in this area to some extent. The fluctuations will be larger and of shorter duration.

Belter proposed that Parker summarize what is to be done in the next six months.

Parker recalled meetings two years ago. Summary of work to be done: investigation of literature, determine the most important hydrologic features to be studied, try to determine what would be the most effective way of studying hydrologic effects.

Q. Belter: Do you anticipate compiling this data? What time would be involved?

A. Parker: The program will progress as data is obtained.

Friend asked if TVA data on mixing were adequate and what would be expected of the PHS.

Struxness: As to what ORNL can do for the next six months: We are negotiating for a man to do hydrologic studies which makes it difficult for us to know what we will do on hydrologic aspects, except tie together what we have in our files on the tracer tests.

Auerbach: On biological aspects for next 6 months: Cottrell's report: Applied Health Physics people have measured the activity in the sediment at specified TVA silt ranges. These provide us a useful guide-line in which to start a biological characterization of the river. We have requested our Laboratory management to purchase a large type of laboratory boat, a pontoon type houseboat, in which we can maintain a crew and sampling facilities. We propose, together with Mr. Abee, to start out at these silt ranges and do one silt range a week on three or four ranges or once a month at each silt range. We think by March we could go into the river and start the silt range samples.

Q. Wallen: What do you mean by characterization of the river?

A. Auerbach: Start work to determine the specific radionuclides in the organisms. Abee's group will be collecting samples at various cross sections, which will be additional.

Wallen commented that this omits two important aspects; namely, fish and plankton.

Auerbach said the aid of Tennessee Fish and Game Commission would be enlisted for sampling the fish and the water samples will be collected by Abee's group which will aid in plankton studies.

Abee: Proposal for next six months: Applied Health Physics program will not have facilities for the next 6 months but hope to integrate the two programs in order to make cross section measurements the year round to see how seasonal variations affect bottom sediments.

Struxness: Asked Wallen to comment on the proposal since he seems to feel that it is too ambitious.

Wallen: I have strong objection to the ecology program as written. I do think the objectives are very broad. At Hanford, with ten people, they have been unable to do in five or ten years what is planned here. It will take a lot of people we do not have and it seems the two parts of the program are contradictory. The objectives are too general. We need to rewrite the proposal, be more specific and make it more of a job description. As now written, it would mean that you either hire 5 people or reduce the program to include one person.

Struxness: We recognize the proposal is very broad and very general. In February and March of each year we have to describe the proposed investigation for AEC Form 189 budget submission to be done in the first year and also in the second year. We are not in position at the moment but hope to be in February. I agree it is an idealistic proposal and difficult at the moment for a Steering Committee to have anything to go on. This is one of the most important studies that the Laboratory has ever undertaken. We would like for it to be as thorough and comprehensive as we can make it. We want you to have interest and responsibility to come in and help. I think the agencies represented here should come in, as well as other agencies. With the AEC alone it would flop. We can make adjustments with the money from the AEC. No increases expected in the next two fiscal years. We are not expecting to come to the agencies with too large a proposal. There may be need for additional funds but we will do our level best to justify it.

Belter: There have been certain funds allotted for fiscal year 1960. Going back to Steering Committee. It is needed to try to find out where to get started.

Schultz: To get the proposal better lined up, you should bring in the best limnologists and discuss this thing. Six months is not much time if you can get people together and really work together. It is early to start with samples.

Struxness: I agree that we should lay plans before starting on the river. More fission products up to now have been released to this stream than at any other place and less has been done to understand it. We have a situation that is changing. We who are interested in health protection are very much interested in the river program and we must get it underway.

Friend: I think the Steering Committee should be set up in order to set up the program.

Kochtitzky: A detailed work plan is needed to show respective agencies what time, personnel and money will be required before they are willing to commit their agencies.

Schoen: I think it should be left to the Steering Committee as to work plan and how we would be involved in it.

LUNCH

STATEMENT ON THE HISTORY AND PHILOSOPHY OF LABORATORY OPERATIONS WITH RESPECT TO THE CLINCH RIVER

K. Z. Morgan commented on the recent serious accidents and meetings on the subject. He stated that the field of Health Physics is relatively new. He briefly reviewed the

history of Health Physics and the development of the radiation protection committees, specifically the National Committee on Radiation Protection and the International Commission on Radiological Protection. In discussing the history of the White Oak Lake and Clinch River usage by ORNL, Morgan showed how the maximum permissible exposures have been successively reduced over the last 17 years. He emphasized that there is little liklihood that the present maximum permissible concentrations will be increased; rather, the chances are that they will be decreased in the future.

Struxness commented that Morgan's discussion exemplifies why we are concerned about the Clinch River. He suggested that each representative make a statement of the interest and possible participation of his agency. He stated that it would not be a firm committment.

STATEMENTS ON THE INTEREST AND/OR ACTIVE PARTICIPATION OF OTHER AGENCIES IN CLINCH RIVER STUDY PROGRAM

S. Leary Jones: The State of Tennessee is interested and I feel that the study must be made. It is possible in the state program to shift emphasis from what is now being done; for example, from bacterial studies to studies on this objective. Details will come out after the Steering Committee gets underway. Apparently monitoring is being done. I would like to see a certain amount of monitoring start now at Chattanooga. The people are quite concerned about the Strontium 90 that is in the water supply. We have had a number of letters about this problem because there is no solid basis for assurance that it is perfectly safe. He illustrated how much trouble public concern may cause by reference to a relatively minor incident of pollution by a paper mill which almost forced the company to leave the state. He said he would like to see this program tied in with TVA reservoir operation studies. It is hard to say how this should be set up. This should be correlated with plans developed by the Steering Committee. We have eight people in our group who will be very much interested in this work. We have three biologists and I would like to send one of them (Mulligan) to ORNL to work on this problem.

Struxness: We do not have proof but strongly suspect that the Strontium 90 at Chattanooga does not come from Oak Ridge, but we cannot prove it. Our Laboratory management and the AEC are quite aware of the public relations problem that we may have to face. This is another reason why we must do the best we can and answer the questions that we are sure might be asked.

F. E. Gartrell: We are interested to see that the hydrologic and chemical data accumulated through the years by TVA is used both in planning and carrying out this study. We have not given any attention to the matter of radioactive material. We have felt the need to accumulate radiologic data and have some plans to do so, and I feel that with a study of this kind getting underway it would be a good time for us to initiate some studies of our own. Participation proposed, in addition to developing staff competency, would provide guide-lines as to the kind of sampling needed to be done by TVA on a long-term basis. The question of the best way to operate TVA reservoirs in the event of an accidental spill has been given a lot of attention. But we have not gotten down to specific cases or worked out details. We are concerned about radioactive wastes in TVA water supplies which we have responsibility for operating. We are concerned with effect on fish and game as well as the effect on water quality.

As far as being in a position to participate in a program of this kind, we have lots of competence and skills but to what extent we can make them available is something

we would have to work out with personnel in our organization. We have a small staff but the details of studies that have been made in the past 2 1/2 years may have applications and some of the basic data would be useful. We have extensive survey facilities but these facilities are costly. The amount of dollar contribution that we could make might not be very encouraging in undertaking a study of this magnitude. I feel that I certainly would recommend to TVA management that TVA participate in this study. The details of our contribution would have to be worked out later when your work program has been defined.

A. G. Friend: We are very much interested in the project. We have at the present time the funds and the personnel. The budget next year we do not have and what we can do next year I do not know. We are in pretty good shape for the remainder of this fiscal year.

Struxness: Would your participation be on the biological side or equally on the hydrological side?

Friend: outlined what was done on the Mohawk River Study. He stated that something of that nature could be contributed.

E. G. Godfrey: I cannot speak for the USGS and I am going to ask Mr. Cragwall to make the statement. First, however, I would like to speak of our interest in this program. The USGS has been working with AEC on waste disposal problems. They have been actively participating in a number of programs with various local groups such as KAPL and Savannah River. We have in the past participated in studies here in Tennessee. As far as participating in this study it would have to be worked out with Mr. Cragwall.

J. S. Cragwall: We are very interested in the project and feel we have skills to be of assistance to you and we can always participate to the extent that funds may be made available. If these are not available, we will cooperate in furnishing technical skills to the best extent we can.

J. E. Munzer: We are definitely interested in all types of field work which we can do on a contract basis. The contracts will run from a week or two to 3 months. We are definitely interested in this operation.

Struxness: TVA and USGS already have information on the hydrological aspects and are definitely interested in this study, especially the USGS. We will look more or less to them for the guidance and actual performance of measurements made on the river. The PHS, plus the Stream Pollution Control Board, as well as the group represented by Mr. Munzer, have almost the same interests as the Health Physics Division. These groups would in some ways enter into the study of biological and radiological determinations. One of the big parts of this study will be analyses. We all agree we need hands and need to get out on the river. We have large and well equipped laboratory and analytical facilities at ORNL.

Morgan: Are you planning to get enough money for this?

Struxness: We must consider this in looking at reality in collection of samples and analyses of samples. We are fooling ourselves if we say we can do this study over a period of 5 years. Someone will have to put out a good sum of money for these analyses.

Friend: PHS has two methods; 1) refined, and, 2) a quick and dirty method, which is cheaper.

Struxness: Another thing that complicates organization in carrying out this cooperative program is that some of us are interested in the practical and some in the scientific aspects. As to responsibilities for source of support, one group might support the biological phases and another support the engineering-hydrologic portion.

Some of you are more concerned about the TVA system from K-25 to some point on downstream. Some of us are more concerned with the stretch immediately below the outfall of White Oak Creek. Over all of us hangs the public relations problem associated with this program. The AEC will have to begin educating the public.

Shoup: Our public information people are aware of this meeting and the plans for a cooperative effort. They are prepared to issue a press release when the program gets into operation.

Struxness: You fellows who are interested hold an important part in orienting and informing your colleagues back home. It is unfortunate that this meeting could not have been held 16 years ago. (Mr. Struxness asked for comments from the attendance concerning the proposal that a Steering Committee composed of representatives from the various participating agencies be appointed to coordinate the overall direction of the river studies. He said that this involved the type of committee, its functions, and procedures of reporting results.)

ORGANIZATION OF CLINCH RIVER RESEARCH STEERING COMMITTEE

Gartrell: The release of all information should be formal, through the Steering Committee and should be cleared through this group. We should think about who will be the representatives in the committee. Since ORNL has the biggest stake in this program it would seem to me that Struxness would be a logical choice to head up the committee in view of the fact that he heads the ORNL waste disposal and engineering group.

Shoup: It seems that all the agencies participating would be the ones who would be represented on the committee and would have one member from each agency on the committee.

Struxness: I am interested in knowing whether this Steering Committee is an advisory committee or is it a working committee.

Gartrell: I think it should be a working committee not just advisory. The representative from each agency would clear with his own group. The committee should make the decisions as to the direction of the program. It is different from a typical river advisory board.

Struxness: It should be a working committee which would see that the work is done. The chairman of the Steering Committee should be at Oak Ridge and would be really the local coordinator of the program.

Gartrell: Due to the fact that you have these various groups under your jurisdiction, it would seem logical that you should be chairman.

Steering Committee members were elected as follows:

E. G. Struxness, Chairman
S. Leary Jones
A. G. Friend
E. G. Godfrey
F. E. Gartrell

J. A. Lieberman - ex officio
I. E. Wallen " "
A. A. Schoen " "

Burnett: If this is to be both an advisory and working committee would you need a larger committee?

Struxness: I believe we agree the Steering Committee is large enough to represent the group here. We can start on this basis and may see fit to change it later.

Shoup: Does this mean that alternates may be on the committee for particular problems?

Struxness: On behalf of the AEC and ORNL, we are anxious to have representatives on the Steering Committee who have something to say about this program.

Morton: There should not be alternate members on the committee. If this committee is going to have definite responsibilities, the members must accept their responsibilities for decisions. They can bring their staff support to committee meetings, or accept assignments and work them out themselves in their own group and with their own agency.

Shoup: I think you are right. I used the wrong terminology. Your suggested staff support will be the correct means to operate as need.

The meeting was adjourned at 3:50 PM.

After the meeting was adjourned the first meeting of the Steering Committee was set up for Thursday and Friday, January 21 and 22, 1960.

ATTENDANCE LIST

USAEC

I. E. Wallen (DBM-ESB - Washington)
Vincent Schultz (DBM-ESB - Washington)
W. G. Belter (DRD - Washington)
C. S. Shoup (ORO- Oak Ridge)
A. A. Schoen (ORO- Oak Ridge)

USGS

E. P. Mathews (Surface Water Branch - Knoxville)
J. S. Cragwall, Jr. (Surface Water Branch - Chattanooga)
E. G. Godfrey (" " " ")
B. J. Frederick (" " " ")
R. M. Richardson (Ground Water Branch - ORNL)

USPHS

A. G. Friend (Taft Sanitary Eng. Center - Cincinnati)
J. E. Munzer (Regional Office - Atlanta)

TVA

F. E. Gartrell (Health and Safety Div. - Chattanooga)
O. W. Kochtitzky " " " " ")
Rex A. Elder (Norris Lab. - Hydrologic Data Div. - Norris)

State Stream Pollution Control Board

S. Leary Jones (Nashville) EXEC. SEC. STREAM POLLUTION CONTROL BOARD, TENN. DEPT. OF HEALTH
W. H. Martin (") DIRECTOR STREAM POLLUTION CONTROL, " " " "
ASS'T " " " " " " " "

ORNL

K. Z. Morgan (Division)
E. G. Struxness (Division)
R. J. Morton (Waste Disposal)
F. L. Parker (" ")
R. L. Bradshaw " ")
S. I. Auerbach (Ecology)
D. J. Nelson (")
H. H. Abee (Applied Health Physics)
T. J. Burnett " " ")

68A.1096 #280 MHS Clinch River

MINUTES

MEETING ON "PLAN FOR CLINCH RIVER STUDY"

OAK RIDGE NATIONAL LABORATORY
Building 2001-Conference Room
December 18, 1959 - 9:30 AM

INTRODUCTION

E. G. Struxness, acting as chairman, called the meeting to order. He welcomed and introduced those present (see attendance list, page 13) and outlined the purpose of the meeting as follows:

1. To discuss the plan for proposed Clinch River Study.

2. To determine the interest of agencies represented in the meeting and their possible participation in the work program.

3. To consider need of and organize a Steering Committee to guide and implement the study program.

STATEMENTS BY ATOMIC ENERGY COMMISSION REPRESENTATION

W. G. Belter conveyed regrets from J. A. Lieberman of the Environmental and Sanitary Engineering Section of the AEC in Washington for not being able to attend the meeting. With regard to the proposed program, he said the Sanitary Engineering group of AEC is much concerned with the effects of waste disposal on our environment and that about 40% of the budget of this group is for environmental studies. It is hoped that the proposed comprehensive study of the Clinch and Tennessee Rivers will be a cooperative undertaking with all of the agencies represented at the meeting being able to participate to the extent of manpower and financial limitations. The fate of radioactivity in both the Clinch and Tennessee Rivers must be determined in order to guide waste disposal control measures and future releases to the Clinch River.

The Laboratory has conducted an extensive monitoring program as exemplified in the recent report by the Applied Health Physics Section on radioactivity in the Clinch and Tennessee Rivers. He said the proposed study is not a monitoring program or a stream pollution survey, but the basic information and data developed will aid in determining the capacity of these streams to assimilate large-volume, low-level wastes and thereby improve waste management procedures.

All groups here have relatively different but complementary interests. For this reason it will be desirable to organize a Steering Committee; a small group for guidance of the program. There should be one technical representative from each agency who will have the authority to act for his agency in planning the program. He said that it would be helpful if each agency could decide how it will participate and to what extent it will be able to make its facilities available for the study as a preliminary basis for allocation of work. He said the AEC in Washington has allocated a certain amount of funds for work on this project this year and the Public Health Service, under an interagency agreement with the Commission, has personnel available to do planning and field work in this program. After the committee is selected, it would be desirable to begin discussions on the establishment of representative stream sampling stations, uniform sample collection, analytical procedures to be used, etc. In this manner, it is hoped that exploratory field work can be initiated as soon as possible.

C. S. Shoup emphasized the mutual interest of the various agencies in the proposed program and said the study should include participation by several agencies through contributions of data they now have on special aspects of the program and also by active help in obtaining new data. When agencies or groups participate actively and make a definite contribution they have greater interest and the program is more successful. It is important to collect information now in files and perhaps prepare an overall report of what we now know of the Clinch.

As to assignment of personnel, he said that AEC ORO can arrange for people from other agencies and commissions to work in the Laboratory.

For reporting results of the study he said they had found that it is best to issue reports through the regular reporting system of ORNL. This has advantage in that the reports get the TID 4500 distribution to all atomic energy sites and can be purchased by others who have an interest in the information. The issuance of reports as ORNL publications does not preclude the opportunity for a particular agency to publish details of the work in its special area with approval as separate releases.

RADIOACTIVITY IN SILT OF THE CLINCH AND TENNESSEE RIVERS

H. H. Abee summarized the area monitoring program of the Health Physics Division and the data collected concerning releases of radioactivity to the river. He pointed out that in the Clinch River study we are concerned primarily with contamination by low-level radioactive waste water and potential seepage from disposal of solid and intermediate liquid waste to the ground. He referred to available health physics reports and describe the system of sample collection and analyses for control purposes and showed slides to illustrate these data. (Discussion followed)

Q. Wallen: What kind of analyses are made on samples collected at White Oak Dam?

A. Abee: Three composites are made:

1. Daily composite on which gross beta and gamma is determined;

2. Weekly composite on which alpha determinations are made; and,

3. Monthly composites on which radiochemical analyses are made for some 5 or 6 of the most important radionuclides.

Q. Wallen: How do you determine the effect of discharges from White Oak Creek upon radioactivity in the Clinch River?

A. Abee: The probable concentrations are calculated values, based on dilution factors. It is assumed that discharges from the creek are completely dispersed in the river water and the calculated concentration is considered in relation to the MPC_w value. This is the concentration for drinking water which will allow an individual to drink the water for 50 years without any detectable damage to the person.

Q. Schultz: Is the concentration checked by sampling in the river?

A. Abee: No, it is not. Concentrations in the river are so low and analyses so complicated that control is based on a straight mathematical calculation using

a dilution factor which represents the ratio of river flow and creek discharges for the particular period of time.

Q. Schultz: Is any allowance made for biological concentration in the river?

A. Abee: No, because our knowledge is not sufficient. We do make one check by river sampling at a ferry near the mouth of the Clinch River, some 16 miles downstream. By contract with the ferry operator, a daily grab sample is composited to about 20 gallon in three months and analyzed quarterly to determine the average of the important nuclides: For example: 1956 through 1958; the average was about 7.5×10^{-7} micro-curies per ml at the sampling point.

T. J. Burnett commented that based on the radiochemical analyses this value is about 30% of the MPC_w.

H. H. Abee said the river monitoring surveys have been confined primarily to concentration of radioactive materials in the suspended matter which settle and form bottom sediments. Since early 1951 sediment surveys have been made down the Clinch and Tennessee Rivers to Chattanooga and beyond. Results have been reported by Garner and Kochtitzky and recently by Cottrell (ORNL-2847). The surveys include bottom scanning with the "Flounder" instrument and also by collecting sediment samples.

Q. Schultz: Do you have alpha and beta counts?

A. Abee: No. The underwater instrument can detect primarily gamma radiation.

In discussion of results of analyses Abee referred to his slides showing data at the various cross sections downstream. In response to a number of questions about methods of analysis and levels of activity found, E. G. Struxness commented that much description and summaries of this information are contained in the record of the Congressional Hearings held by the Joint Committee on Atomic Energy in Washington, January 28 to February 3, 1959.

PROPOSED CLINCH RIVER STUDY PROGRAM

F. L. Parker reviewed the Plan for Clinch River Study, copies of which were distributed before the meeting began. He said it is necessary that we determine the exact fate of radioactive materials. The plan represents the Health Physics Division rather than a single section in the Health Physics Division. Most studies are concerned with meeting MPC standards for a flowing stream. This may not be the best approach but we do know there is contamination by potentially hazardous nuclides. We need to arrive at a more rational MPC figure. The primary need is to get a materials balance of radioactive materials in the river. To do this we must take more water and sediment samples, particularly downstream, and make alpha as well as beta gamma determinations. We want to correlate levels in the sediment with distribution in the water.

Q. Wallen: How far down in sediment do you go?

A. Auerbach: No sediments have been taken.

Parker: Sediment sampling is planned probably at depths to 6".

Nelson: It is planned to go downstream and determine the movement of sediment through the stream to see how suspended matter moves downstream.

Q. Wallen: What will be used for tracer?

A. Parker: For sediment, a radioactive material, possibly Sc-46. Two tracer tests were run this past summer. (Discussion of tests followed)

Q. Wallen: Will there be models used?

A. Parker: Not this year. Models cannot reproduce completely the conditions in the field. For example, with models we could obtain hydrologic data and measure dispersion and sediment transport but models would not provide biological data. (Suggested that Rex Elder of TVA comment from his experiments with hydrologic models)

Elder: My primary work is in the model field. I have had only two discussions with Frank about models. Cannot do a good job with models in the situation here. Dollars in 7 figure amounts probably would be necessary to simulate the extremely complex flow pattern in the lower 20 miles of Clinch River. The stream below ORNL could not be located in a more complex river situation than this. It is at a point where the flows run into the backwater from Watts Bar Dam. The prediction of flows then becomes highly complex during summer months because of stratification. Releases come down the Tennessee River and will be reflected in the movement of water in the Clinch River. It is complicated by the fact that from 5 to 30 days in a row we may have 4, 6, or 7,000 cfs during day time, power plants of TVA may shut down almost completely at night, then start to pick up at 5 or 6 in the morning, increase to capacity, then drop off toward evening and back to light load again. With these things going at about 4 plants affecting flow in this area, it is not uncommon to have negative water slopes and still have good discharges going downstream.

Q. Wallen: Is there any need to use models to define the water slopes?

A. Elder: No, unless your budget is ample and there is need to elucidate a particular facet which proves too difficult to work out in the field. (Elder commented that models would be suitable for working on restricted facets of the hydrology of the stream, as Parker suggested.)

S. I. Auerbach: The ecological problem in the Clinch River can be epitomized as follows: 1) As ecologists we are interested in obtaining basic biological knowledge from streams such as the Clinch River. 2) As Health Physicists we are interested in improving the status of operational monitoring in the Laboratory environs, including the Clinch River. 3) We believe we can contribute information necessary to understanding the fate of radionuclides released to the river.

The basis for programs of ecology and biology in radiological river studies is meager. Less than 1/2 dozen atomic energy installations have had good biological sampling programs of which Hanford and Chalk River are outstanding.

The extent of work in biology on the Clinch River has been extremely meager. A survey was made with the aid of TVA and the Fish and Game Commission of the State of Tennessee. They collected a total of 700 fish from White Oak Lake and the Clinch River. The radioanalyses done at that time were for gross beta. Based on Sr content found in the White Oak Creek fish, and using the MPCs at that time, they calculated that of the fish from White Oak Lake a person would have to eat 14 pounds of fish per day to get the maximum permissible dose and at river mile 13.3, 36 pounds per day. This survey was

done about 12 years ago. Since that time, MPCs have changed and more activity has been deposited in the river. The only other study at this Laboratory was done by Professor James Lackey, which was collection and examination of plankton in the river below White Oak Creek. Dr. Lackey found the Clinch River water above White Oak Creek to contain negligible plankton. The water from Norris Dam is discharged at the bottom and the flows to mile 28 or 29 are cool and free running. In addition to radioactive materials, we add nutrient materials which support increased biological activity below White Oak Creek outfall.

There is another complicating factor--the proposed Melton Hill Dam. This installation will be both a hydroelectric and navigation dam. Its construction and subsequent operation will alter conditions in the river below the dam. We have a number of years before this dam is in operation.

To develop an understanding of the role of the flora and fauna in determining and affecting the fate of radionuclides in the river we should get started on the proposed program at the earliest possible time. There are four major steps in our program: 1) Characterization of the biota some distance above and below White Oak Creek outfall; 2) obtaining information regarding the biological productivity; 3) obtaining information on the specific radionuclides present, and, 4) synthesis of total system relationships as we can put them together--chemical, physical and biological. More detailed discussion on the phases of the ecology program will be given by D. J. Nelson.

D. J. Nelson: Initial work will be concerned with a characterization of the environment from the biological and chemical standpoint. Physical information will become available from the engineering studies. One of the first questions concerns the source of photosynthetically produced organic matter found within the stream. There are two sources: 1) That which originates within the stream. This primary production will be estimated by the diurnal ozygen curve method.

Q. Schultz: How often do you propose to sample?

A. Nelson: Once a week and twice a week during summer time.

Q. Wallen: What hours of the day and what will you measure?

A. Nelson: 24 hours per day or before sunup till after sundown. Since we are going to be on the stream we anticipate making measurements of other environmental parameters such as PO_4, chlorophyll, temperature, light intensity, etc.

Q. Wallen: How are measurements made?

A. Nelson: When sufficient data are accumulated a multiple regression analysis will be attempted to evaluate the effect of each factor and combination of factors on the primary production within the stream.

PO_4 and NO_3 frequently are limiting factors for photosynthesis in aquatic communities. Since the Laboratory wastes include large amounts of NO_3, one could add PO_4 as fertilizer to the stream and determine what effect it has on photosynthesis. A technique such as this might present a method for treatment of large volumes of waste which might occur as the result of an accident. In streams you find large amounts of organic matter such as leaves which are derived from the watershed. It is possible that half of the organic matter at the photosynthetic level in the stream is derived from the watershed. (Dis-

cussion) We should determine the quantity of organic matter originating on the watershed and what its role is in the food chain. In effect we would have the budget of photosynthetically produced organic matter in the Clinch River. The allochthonous organic matter is known to concentrate radionuclides. Whether the concentration is due to physical sorption or the metabolism of heterotrophic microorganisms such as bacteria is not known. Some laboratory experiments are being conducted with sterile and non-sterile mixtures of river water and leaf material to separate the physical and biological factors which concentrate radionuclides on the non-living organic matter. There is a great deal of organic matter in the bottom sediments and radionuclides associated with it may enter the food chain through the feeding activities of the bottom-dwelling organisms.

Another phase of the Clinch River studies will deal with biogeochemistry and with particular reference to those elements which are released in the radioactive effluent from the Laboratory. A recent paper in Limnology and Oceanography by Nicholls, Curl, and Bowen from Woods Hole and MIT emphasizes that some elements are actively concentrated or excreted by different organisms. They concluded that each element will be found concentrated by some organism in the spectrum of life. The work will include stable and radiochemistry, the determination of body burdens and eventually uptake and excretion rates. The studies will be associated with work on the food chain. We will be able to find the quantity of the various radionuclides in the biota, which elements are mobile and which are conserved.

Q. Wallen: What exactly do you plan to do?

A. Nelson: Plan to start on photosynthesis this spring and carry it a full year and pick up information on the organic matter coming into the stream and also on chemical nature.

Chairman Struxness said that the previous discussion of past work on the river and the plan for the proposed study leads logically to comments by others as an extra order of business. He called for a discussion of the hydrologic parameters.

Godfrey stated that these had been pretty well covered. He indicated that the level of the program almost rules out any extensive model studies.

Elder said that a statement previously made that there are no drinking water supplies taken from this reservoir is not entirely correct. During low flows in the river the cold Clinch River water will flow upstream along the bottom of the Emory River about 12 miles and find its way into the Harriman water supply intake and, after warming up, will flow back along the surface to the Clinch River.

Parker: The water is monitored at the K-25 plant which has the first downstream water supply taken from Clinch River below ORNL.

Jones: The Kingston water supply is usually from springs, but when the spring flow is inadequate a filter plant with intake on the Tennessee River, a short distance upstream from the mouth of Clinch River, is used to supplement the municipal supply. The Kingston system may be affected when water shortage causes intake from the Tennessee River, because under some conditions there may be an upstream flow of Clinch River water to the Kingston intake.

Kochtitzky substantiated the fact that under these conditions of upstream flow of the Tennessee River, Kingston might use Clinch River water. Furthermore, the Kingston Steam

Plant of TVA has special diversionary facilities to deliver Clinch River water to the plant intake on the Emory River.

Burnett: A possible concern of the agencies represented here is stream pollution control and we have provided that. The amounts released from White Oak Lake bed area are monitored for protection of the public and can be controlled temporarily by closing White Oak Dam.

(The TVA representatives emphasized that reservoir operations do affect river conditions although information may not be quantitative.)

Elder: There are figures available on the effect of Melton Hill Dam. It is proposed to construct Melton Hill Dam on the Clinch River a short distance above the mouth of White Oak Creek. Water released from Norris Dam some 55 miles farther up the river will be reused to generate power at Melton Hill. The starting and stopping of turbines at Melton Hill will be reflected in the flow at White Oak Creek much more quickly than similar operations at Norris in the past. Furthermore, because of the short distance to White Oak Creek the peaks of high and low release will not be flattened as much as flows from Norris were before the construction of this intervening dam.

Belter proposed that Parker summarize what is to be done in the next six months.

Parker recalled meetings two years ago. Summary of work to be done: investigation of literature, determine the most important hydrologic features to be studied, try to determine what would be the most effective way of studying hydrologic effects.

Q. Belter: Do you anticipate compiling this data? What time would be involved?

A. Parker: The program will progress as data is obtained.

Friend asked if TVA data on mixing were adequate and what would be expected of the PHS.

Struxness: As to what ORNL can do for the next six months: We are negotiating for a man to do hydrologic studies which makes it difficult for us to know what we will do on hydrologic aspects, except tie together what we have in our files on the tracer tests.

Auerbach: On biological aspects for next 6 months: Cottrell's report: Applied Health Physics people have measured the activity in the sediment at specified TVA silt ranges. These provide us a useful guide-line in which to start a biological characterization of the river. We have requested our Laboratory management to purchase a large type of laboratory boat, a pontoon type houseboat, in which we can maintain a crew and sampling facilities. We propose, together with Mr. Abee, to start out at these silt ranges and do one silt range a week on three or four ranges or once a month at each silt range. We think by March we could go into the river and start the silt range samples.

Q. Wallen: What do you mean by characterization of the river?

A. Auerbach: Start work to determine the specific radionuclides in the organisms. Abee's group will be collecting samples at various cross sections, which will be additional.

Wallen commented that this omits two important aspects; namely, fish and plankton.

Auerbach said the aid of Tennessee Fish and Game Commission would be enlisted for sampling the fish and the water samples will be collected by Abee's group which will aid in plankton studies.

Abee: Proposal for next six months: Applied Health Physics program will not have facilities for the next 6 months but hope to integrate the two programs in order to make cross section measurements the year round to see how seasonal variations affect bottom sediments.

Struxness: Asked Wallen to comment on the proposal since he seems to feel that it is too ambitious.

Wallen: I have strong objection to the ecology program as written. I do think the objectives are very broad. At Hanford, with ten people, they have been unable to do in five or ten years what is planned here. It will take a lot of people we do not have and it seems the two parts of the program are contradictory. The objectives are too general. We need to rewrite the proposal, be more specific and make it more of a job description. As now written, it would mean that you either hire 5 people or reduce the program to include one person.

Struxness: We recognize the proposal is very broad and very general. In February and March of each year we have to describe the proposed investigation for AEC Form 189 budget submission to be done in the first year and also in the second year. We are not in position at the moment but hope to be in February. I agree it is an idealistic proposal and difficult at the moment for a Steering Committee to have anything to go on. This is one of the most important studies that the Laboratory has ever undertaken. We would like for it to be as thorough and comprehensive as we can make it. We want you to have interest and responsibility to come in and help. I think the agencies represented here should come in, as well as other agencies. With the AEC alone it would flop. We can make adjustments with the money from the AEC. No increases expected in the next two fiscal years. We are not expecting to come to the agencies with too large a proposal. There may be need for additional funds but we will do our level best to justify it.

Belter: There have been certain funds allotted for fiscal year 1960. Referring back to a Steering Committee, we believe it is desirable to select this group now in order that detailed plans for the study can be developed as soon as possible.

Schultz: To get the proposal better lined up, you should bring in the best limnologists and discuss this thing. Six months is not much time if you can get people together and really work together. It is too early to start with samples.

Struxness: I agree that we should lay plans before starting on the river. More fission products have been released to this stream than to any other and less has been done to understand it. We have a situation that is changing. We who are interested in health protection are very much interested in the river program and we must get it underway. As mentioned previously by others, there is need to improve and expand the river monitoring program. The proposed river study will help by providing information and justification for more definitive monitoring.

Friend: I think the Steering Committee should be set up in order to set up the program.

Kochtitzky: A detailed work plan is needed to show respective agencies what time, per-

sonnel and money will be required before they are willing to commit their agencies.

Schoen: I think it should be left to the Steering Committee to draft a work plan and to determine how we would be involved in it.

LUNCH

STATEMENT ON THE HISTORY AND PHILOSOPHY OF LABORATORY OPERATIONS WITH RESPECT TO THE CLINCH RIVER

K. Z. Morgan commented on the recent serious accidents and meetings on the subject. He stated that the field of Health Physics is relatively new. He briefly reviewed the history of Health Physics and the development of the radiation protection committees, specifically the National Committee on Radiation Protection and the International Commission on Radiological Protection. In discussing the history of the White Oak Lake and Clinch River usage by ORNL, Morgan showed how the maximum permissible exposures have been successively reduced over the last 17 years. He emphasized that there is little liklihood that the present maximum permissible concentrations will be increased; rather, the chances are that they will be decreased in the future.

Struxness commented that Morgan's discussion exemplifies why we are concerned about the Clinch River. He suggested that each representative make a statement of the interest and possible participation of his agency. He stated that it would not be a firm committment.

STATEMENTS ON THE INTEREST AND/OR ACTIVE PARTICIPATION OF OTHER AGENCIES IN CLINCH RIVER STUDY PROGRAM

S. Leary Jones: The State of Tennessee is interested and I feel that the study must be made. It is possible in the state program to shift emphasis from what is now being done; for example, from bacterial studies to studies on this objective. Details will come out after the Steering Committee gets underway. Apparently monitoring is being done. I would like to see a certain amount of monitoring start now at Chattanooga. The people are quite concerned about the Strontium 90 that is in the water supply. We have had a number of letters about this problem. They have been difficult to answer because there is no solid basis for assurance that it is perfectly safe. He illustrated how much trouble public concern may cause by reference to a relatively minor incident of pollution by a paper mill which almost forced the company to leave the state. He said he would like to see this program tied in with TVA reservoir operation studies. It is hard to say how this should be set up. This should be correlated with plans developed by the Steering Committee. We have eight people in our group who will be very much interested in this work. We have three biologists and I would like to send one of them (Mulligan) to ORNL to work on this problem.

Struxness: We strongly suspect that the Strontium 90 at Chattanooga does not come from Oak Ridge, but we cannot prove it. Our Laboratory management and the AEC are quite aware of the public relations problem that we may have to face. This is another reason why we must do the best we can to answer the questions that we are sure might be asked.

F. E. Gartrell: We are interested in participating in the proposed study. We would expect that the vast amount of the hydrologic and water quality data accumulated through the years by TVA would be useful both in planning and in carrying out this study. In our studies to date we have not given any attention to the matter of radioactive material.

However, we have felt the need to accumulate radiological data and have some plans to do so. I feel that with a study of this kind getting underway it would be a good time for us to initiate some activities in this field. Participation in the proposed study, in addition to developing staff competency, would provide guide-lines as to the kind of sampling that might need to be done by TVA on a long-term basis and would provide preimpoundage baseline data for the Melton Hill project. The question of the best way to operate TVA reservoirs in the event of an accidental spill has been given a lot of attention, but so far we have not gotten down to specific cases nor have we worked out administrative details that would be involved. We are concerned about radioactive wastes in TVA drinking water supplies which we have responsibility for operating, such as the ones at the Kingston power plant and Watts Bar Dam. We are concerned with effects on fish and game as well as the effects on water quality which might adversely influence future developments in the Valley.

As for participating in a program of this kind, TVA has lots of competence and skills but to what extent we can make them available is something we would have to work out with the various TVA organizations that might be involved. We have a small stream pollution control staff which devotes some time to research. Studies that have been made in the past 2-1/2 years may have applications in the Clinch River study and some of the basic data might be useful. TVA has extensive survey and mapping facilities and hydraulic laboratories. I feel that I certainly would recommend to TVA management that TVA participate in this study. The details of our contribution would have to be worked out later when your work program has been defined. The size of the contribution that we possibly could make might not be very encouraging in undertaking a study of this magnitude.

A. G. Friend: We are very much interested in the project. We have at the present time the funds and the personnel. The budget next year we do not have and what we can do next year I do not know. We are in pretty good shape for the remainder of this fiscal year.

Struxness: Would your participation be on the biological side or equally on the hydrological side?

Friend outlined what was done on the Mohawk River study. He stated that something of that nature could be contributed.

R. G. Godfrey: I cannot speak for the USGS and I am going to ask Mr. Cragwall to make the statement. First, however, I would like to speak of our interest in this program. The USGS has been working with AEC on waste disposal problems. They have been actively participating in a number of programs with various local groups such as KAPL and Savannah River. We have in the past participated in studies here in Tennessee. As far as participating in this study it would have to be worked out with Mr. Cragwall.

J. S. Cragwall: We are very interested in the project and feel we have the skills that will be of assistance to you. We can participate to the extent that funds and manpower are made available. Within these limitations we will cooperate in furnishing hydrologic information and technical skills to the greatest extent possible.

J. E. Munzer: (Regional Radiological Health Consultant, Region IV, speaking for Division of Water Supply and Pollution Control, U.S.P.H.S.) The Division is definitely interested in all types of field work relating to water pollution, and has done many of these in cooperation with State and other Federal agencies, usually in the case of the latter, on

a contract basis. Such surveys have been for a few days duration to several years. With reference to the Water Quality Network stations, one of which is located at Chattanooga, Tennessee, five groups of tests are performed: 1. General Chemical Analysis, 2. Carbon Filter Analysis, 3. Bacteriological Analysis, 4. Plankton Count, 5. Radioactivity. (Results of the first year of operation will be found in Public Health Service Publication No. 663, National Water Quality Network.)

Struxness: TVA and USGS already have information on the hydrological aspects and are definitely interested in this study, especially the USGS. We will look more or less to them for the guidance and actual performance of measurements made on the river. The PHS, plus the Stream Pollution Control Board, as well as the group represented by Mr. Munzer, have almost the same interests as the Health Physics Division. These groups would in some ways enter into the study of biological and radiological determinations. One of the big parts of this study will be analyses. We all agree we need hands and need to get out on the river. We have large and well equipped laboratory and analytical facilities at ORNL.

Morgan: Are you planning to get enough money for this?

Struxness: We must consider this in looking at reality in collection of samples and analyses of samples. We are fooling ourselves if we say we can do this study over a period of 5 years. Someone will have to put out a good sum of money for these analyses.

Friend: PHS has two methods; 1) refined, and, 2) a quick and dirty method, which is cheaper.

Struxness: Another thing that complicates organization in carrying out this cooperative program is that some of us are interested in the practical and some in the scientific aspects. As to responsibilities for source of support, one group might support the biological phases and another support the engineering-hydrologic portion.

Some of you are more concerned about the TVA system from K-25 to some point on downstream. Some of us are more concerned with the stretch immediately below the outfall of White Oak Creek. Over all of us hangs the public relations problem associated with this program. The AEC will have to begin educating the public.

Shoup: Our public information people are aware of this meeting and the plans for a cooperative effort. They are prepared to issue a press release when the program gets into operation.

Struxness: You fellows who are interested hold an important part in orienting and informing your colleagues back home. It is unfortunate that this meeting could not have been held 16 years ago. (Mr. Struxness asked for comments from the attendance concerning the proposal that a Steering Committee composed of representatives from the various participating agencies be appointed to coordinate the overall direction of the river studies. He said that this involved the type of committee, its functions, and procedures of reporting results.)

ORGANIZATION OF CLINCH RIVER RESEARCH STEERING COMMITTEE

Belter: The release of all information should be formal, through the Steering Committee and should be cleared through this group. We should think about who will be the representatives on the committee. Since ORNL has the biggest stake in this program it would seem to me that Struxness would be a logical choice to head up the committee in view of the fact that he heads the ORNL waste disposal and engineering group.

Shoup: It seems that all the agencies participating would be the ones who would be represented on the committee and would have one member from each agency on the committee.

Struxness: I am interested in knowing whether this Steering Committee is an advisory committee or a working committee.

Belter: I think it should be a working committee not just advisory. The representative from each agency would clear with his own group. The committee should make the decisions as to the direction of the program. It is different from a typical river advisory board.

Struxness: It should be a working committee which would see that the work is done. The chairman of the Steering Committee should be at Oak Ridge and would be really the local coordinator of the program.

Gartrell: Due to the fact that you have these various groups under your jurisdiction, it would seem logical that you should be chairman.

Steering Committee members were elected as follows:

E. G. Struxness, Chairman	J. A. Lieberman - ex officio
S. Leary Jones	I. E. Wallen " "
A. G. Friend	A. A. Schoen " "
R. G. Godfrey	
F. E. Gartrell	

Burnett: If this is to be both an advisory and working committee would you need a larger committee?

Struxness: I believe we agree the Steering Committee is large enough to represent the group here. We can start on this basis and may see fit to change it later.

Shoup: Does this mean that alternates may be on the committee for particular problems?

Struxness: On behalf of the AEC and ORNL, we are anxious to have representatives on the Steering Committee who have something to say about this program.

Morton: There should not be alternate members on the committee. If this committee is going to have definite responsibilities, the members must accept their responsibilities for decisions. They can bring their staff support to committee meetings, or accept assignments and work them out themselves in their own group and with their own agency.

Shoup: I think you are right. I used the wrong terminology. Staff support as needed will be the correct means to lend strength to the Committee's work.

The meeting was adjourned at 3:50 PM.

After the meeting was adjourned, the first meeting of the Steering Committee was set up for Thursday and Friday, January 21 and 22, 1960.

ATTENDANCE LIST

USAEC

I. E. Wallen (DBM-ESB - Washington)
Vincent Schultz (DBM-ESB - Washington)
W. G. Belter (DRD - Washington)
C. S. Shoup (ORO - Oak Ridge)
A. A. Schoen (ORO - Oak Ridge)

USGS

R. G. Godfrey (Surface Water Branch - Washington)
E. P. Mathews (" " " Knoxville)
J. S. Cragwall, Jr. (Surface Water Branch - Chattanooga)
B. J. Frederick (Surface Water Branch - Chattanooga)
R. M. Richardson (Ground Water Branch - ORNL)

USPHS

A. G. Friend (Taft Sanitary Eng. Center - Cincinnati)
J. E. Munzer (Regional Office - Atlanta)

TVA

F. E. Gartrell (Health and Safety Div. - Chattanooga)
O. W. Kochtitzky " " " " ")
Rex A. Elder (Norris Lab. - Hydraulic Data Div. - Norris)

Tennessee Stream Pollution Control Board

S. Leary Jones (Nashville)
W. H. Martin (")

ORNL

K. Z. Morgan (Division)
E. G. Struxness (Division)
R. J. Morton (Waste Disposal)
F. L. Parker (" ")
R. L. Bradshaw " ")
S. I. Auerbach (Ecology)
D. J. Nelson (")
H. H. Abee (Applied Health Physics)
T. J. Burnett " " ")

68A 1096 #280 MHS Clinch River

MINUTES

MEETING ON "PLAN FOR CLINCH RIVER STUDY"

OAK RIDGE NATIONAL LABORATORY
Building 2001-Conference Room
December 18, 1959 - 9:30 AM

INTRODUCTION

E. G. Struxness, acting as chairman, called the meeting to order. He welcomed and introduced those present (see attendance list, page 13) and outlined the purpose of the meeting as follows:

1. Acceptance of plan for proposed Clinch River Study.

2. To determine the interest of agencies represented in the study and their possible participation in the work program.

3. To consider need of and organize a Steering Committee to guide and implement the study program.

STATEMENTS BY ATOMIC ENERGY COMMISSION REPRESENTATION

W. G. Belter conveyed regrets from J. A. Lieberman of the Environmental and Sanitary Engineering Section of the AEC in Washington for not being able to attend the meeting. With regard to the proposed program, he said the Sanitary Engineering group of AEC is much concerned with the effects of waste disposal on our environment and that about 40% of the budget of this group is for environmental studies, of which 30% is in the program at Oak Ridge. He said this should be a cooperative and joint undertaking for a comprehensive study of the Clinch and Tennessee Rivers, and that he hoped all agencies represented in the meeting would be able to take part in the estimate of manpower and financial limitations involved. The fate of radioactivity in both the Clinch and Tennessee Rivers must be determined in order to guide control measures and future releases to the Clinch River.

The Laboratory has conducted an extensive monitoring program exemplified in the recent report by the Applied Health Physics Section on radioactivity in the Clinch and Tennessee Rivers. He said the proposed study is not a monitoring program but the basic information and data from monitoring will aid in determining the capacity of these streams to assimilate wastes and in improving control procedures.

All groups here have relatively different but complementary interests. For this reason it will be desirable to organize a Steering Committee; a small group for guidance of the program. There should be one technical representative from each agency who will have the authority to act for his agency in planning the program. He said that it will be helpful if each agency can decide how it will participate and to what extent it will be able to make its facilities available for the study as a preliminary basis for allocation of work. He said the AEC in Washington has allocated a certain amount of funds for work on this project this year and the Public Health Service has personnel available to do planning and field work of this program. After the committee is selected perhaps we can have discussion on uniformity of preparation and collection of samples. This no doubt will be a problem and will require more definite ideas as to how the preliminary work will be done.

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C. S. Shoup emphasized the mutual nature of the proposed program. He said the study should include participation by several agencies through contributions of data they now have on special aspects of the program and also by active help in obtaining new data. When agencies or groups participate actively and make a definite contribution they have greater interest and the program is more successful. It is important to collect information now in files and perhaps prepare an overall report of what we now know of the Clinch.

As to assignment of personnel, he said that AEC ORO can arrange for people from other agencies and commissions to work in the Laboratory.

For reporting results of the study he said they had found that it is best to issue reports through the regular reporting system of ORNL. This has advantage in that the reports get the TID 4500 distribution to all atomic energy sites and can be purchased by others who have an interest in the information. The issuance of reports as ORNL publications does not preclude the opportunity for a particular agency to publish details of the work in its special area with approval as separate releases.

RADIOACTIVITY IN SILT OF THE CLINCH AND TENNESSEE RIVERS

H. H. Abee summarized the area monitoring program of the Health Physics Division and the data collected concerning releases of radioactivity to the river. He pointed out that in the Clinch River study we are concerned primarily with contamination by low-level radioactive waste water and potential seepage from disposal of solid and intermediate liquid waste to the ground. He referred to available health physics reports and described the system of sample collection and analyses for control purposes and showed slides to illustrate these data. (Discussion followed)

Q. Wallen: What kind of analyses are made on samples collected at White Oak Dam?

A. Abee: Three composites are made:

1. Daily composite on which gross beta and gamma is determined;

2. Weekly composite on which alpha determinations are made; and,

3. Monthly composites on which radiochemical analyses are made for some 5 or 6 of the most important radionuclides.

Q. Wallen: How do you determine the effect of discharges from White Oak Creek upon radioactivity in the Clinch River?

A. Abee: It is assumed that discharges from the creek are completely dispersed in the river water and the calculated concentration is considered in relation to the MPC_W value. This is the concentration for drinking water which will allow an individual to drink the water for 50 years without any detectable damage to the person.

Q. Schultz: Is the concentration checked by sampling in the river?

A. Abee: No, it is not. Concentrations in the river are so low and analyses so complicated that control is based on a straight mathematical calculation using

a dilution factor.

Q. Schultz: Is any allowance made for biological concentration in the river?

A. Abee: No, because our knowledge is not sufficient. We do make one check by river sampling at a ferry near the mouth of the Clinch River. By contract with the ferry operator a daily grab sample is composited to about 20 gallon in three months and analyzed quarterly to determine the average of the important nuclides: For example: 1956 through 1958; the average was about 7.5 x 10^{-7} micro-curies per ml at the sampling point.

T. J. Burnett commented that based on the radiochemical analyses this value is about 30% of the MPC_W.

H. H. Abee said the river monitoring surveys have been confined primarily to concentration of radioactive materials in the suspended matter which settle and form bottom sediments. Since early 1951 sediment surveys have been made down the Clinch and Tennessee Rivers to Chattanooga and beyond. Results have been reported by Garner and Kochtitzky and recently by Cottrell. The surveys include bottom scanning with "Flounder" instrument and also by collecting sediment samples.

Q. Schultz: Do you have alpha and beta counts?

A. Abee: No. The underwater instrument can detect primarily gamma radiation.

In discussion of results of analyses Abee referred to his slides showing data at the various cross sections downstream. In response to a number of questions about methods of analysis and levels of activity found, E. G. Struxness commented that much description and summaries of this information are contained in the record of the Congressional Hearings held by the Joint Committee on Atomic Energy in Washington, January 28 to February 3, 1959.

PROPOSED CLINCH RIVER STUDY PROGRAM

F. L. Parker reviewed the Plan for Clinch River Study, copies of which were distributed before the meeting began. He said it is necessary that we determine the exact fate of radioactive materials. The plan represents the Health Physics Division rather than a single section in the Health Physics Division. Most studies are concerned with meeting MPC standards for a flowing stream. This may not be the best approach but we do know there is contamination by potentially hazardous nuclides. We need to arrive at a more rational MPC figure. The primary need is to get a budget of radioactive material in the river. To do this we must take more water and sediment samples, particularly downstream, and make alpha as well as beta gamma determinations. We want to correlate levels in the sediment with distribution in the water.

Q. Wallen: How far down in sediment do you go?

A. Auerbach: No sediments have been taken.

Parker: Sediment sampling is planned probably at depths to 6".

Nelson: It is planned to go downstream and determine the movement of sediment through the stream to see how suspended matter moves downstream.

Q. Wallen: What will be used for tracer?

A. Parker: For sediment, a radioactive material, possibly Sc-46. Two tracer tests were run this past summer. (Discussion of tests followed)

Q. Wallen: Will there be models used?

A. Parker: Not this year. Models cannot reproduce completely the conditions in the field. For example, with models we could obtain hydrologic data and measure dispersion and sediment transport but models would not provide biological data. (Suggested that Rex Elder of TVA comment from his experiments with hydrologic models)

Elder: My primary work is in the model field. I have had only two discussions with Frank about models. Cannot do a good job with models in the situation here. Dollars in 7 figure amounts probably would be necessary to simulate the extremely complex flow pattern in the lower 20 miles of Clinch River. The stream below ORNL could not be located in a more complex river situation than this. It is at a point where the flows run into the backwater from Watts Bar Dam. The prediction of flows then becomes highly complex during summer months because of stratification. Releases come down the Tennessee River and will be reflected in the movement of water in the Clinch River. It is complicated by the fact that from 5 to 30 days in a row we may have 4, 6, or 7,000 cfs during day time, power plants of TVA may shut down almost completely at night, then start to pick up at 5 or 6 in the morning, increase to capacity, then drop off toward evening and back to light load again. With these things going at about 4 plants affecting flow in this area, it is not uncommon to have negative water slopes and still have good discharges going downstream.

Q. Wallen: Is there any need to use models to define the water slopes?

A. Elder: No, unless your budget is ample and there is need to elucidate a particular facet which proves too difficult to work out in the field. (Elder commented that models would be suitable for working on restricted facets of the hydrology of the stream, as Parker suggested.)

S. I. Auerbach: The ecological problem in the Clinch River can be epitomized as follows: 1) As ecologists we are interested in obtaining basic biological knowledge from streams such as the Clinch River. 2) As Health Physicists we are interested in improving the status of operational monitoring in the Laboratory environs, including the Clinch River. 3) We believe we can contribute information necessary to understanding the fate of radionuclides released to the river.

The basis for programs of ecology and biology in radiological river studies is meager. Less than 1/2 dozen atomic energy installations have had good biological sampling programs of which Hanford and Chalk River are outstanding.

The status of work in biology on the Clinch River has been extremely meager. A survey was made with the aid of TVA and the Fish and Game Commission of the State of Tennessee. They collected a total of 700 fish from White Oak Lake and the Clinch River. The radioanalyses done at that time was gross beta. Based on Sr content found in the White Oak Creek fish, and using the MPCs at that time, they calculated that of the fish from White Oak Lake a person would have to eat 14 pounds of fish per day to get the maximum permissible dose and at river mile 13.3, 36 pounds per day. This survey was done about

12 years ago. Since that time, MPCs have changed and more activity has been deposited in the river. The only other study at this Laboratory was done by Professor James Lackey, which was collection and examination of plankton in the river below White Oak Creek. Dr. Lackey found the Clinch River water above White Oak Creek to contain negligible plankton. The water from Norris Dam is discharged at the bottom and the flows to mile 28 or 29 are cool and free running. We add nutrient materials in addition to radioactive materials which supports increased biological activity below White Oak Creek outfall.

There is another complicating factor--the proposed Melton Hill Dam. This installation will be both a hydroelectric and navigation dam. Its construction and subsequent operation will alter conditions in the river below the dam. We have a number of years before this dam is in operation.

To develop an understanding of the role of the flora and fauna in determining and affecting the fate of radionuclides in the river we should get started on the proposed program at the earliest possible time. There are four major steps in our program: 1) Characterization of the biota some distance above and below White Oak Creek outfall; 2) information regarding the biological productivity; 3) information on the specific radionuclides present, and, 4) synthesis of total system relationships as we can put them together--chemical, physical and biological. More detailed discussion on the phases of the ecology program will be given by D. J. Nelson.

D. J. Nelson: Initial work will be concerned with a characterization of the environment from the biological and chemical standpoint. Physical information will become available from the engineering studies. One of the first questions concerns the source of photosynthetically produced organic matter found within the stream. There are two sources. 1) That which originates within the stream. This primary production will be estimated by the diurnal oxygen curve method.

Q. Schultz: How often do you propose to sample?

A. Nelson: Once a week and twice a week during summer time.

Q. Wallen: What hours of the day and what will you measure?

A. Nelson: 24 hours per day or before sunup till after sundown. Since we are going to be on the stream we anticipate making measurements of other environmental parameters such as PO_4, chlorophyll, temperature, light intensity, etc.

Q. Wallen: How are measurements made?

A. Nelson: When sufficient data are accumulated a multiple regression analysis will be attempted to evaluate the effect of each factor and combination of factors on the primary production within the stream.

PO_4 and NO_3 frequently are limiting factors for photosynthesis in aquatic communities. Since the laboratory wastes include large amounts of NO_3, one could add PO_4 as fertilizer to the stream and determine what effect it has on photosynthesis. A technique such as this might present a method for treatment of large volumes of waste which might occur as the result of an accident. In streams you find large amounts of organic matter such as leaves which are derived from the watershed. It is possible that half of the organic matter at the photosynthetic level in the stream is derived from the

watershed. (Discussion) We should determine the quantity of organic matter originating on the watershed and what its role is in the food chain. In effect we would have the budget of photosynthetically produced organic matter in the Clinch River. The allochthonous organic matter is known to concentrate radionuclides. Whether the concentration is due to physical sorption or the metabolism of heterotrophic microorganisms such as bacteria is not known. Some laboratory experiments are being conducted with sterile and non-sterile mixtures of river water and leaf material to separate the physical and biological factors which concentrate radionuclides on the non-living organic matter. There is a great deal of organic matter in the bottom sediments and radionuclides associated with it may enter the food chain through the feeding activities of the bottom-dwelling organisms.

Another phase of the Clinch River studies will deal with biogeochemistry and with particular reference to those elements which are released in the radioactive effluent from the Laboratory. A recent paper in Limnology and Oceanography by Nicholls, Curl, and Bowen from Woods Hole and MIT emphasizes that some elements are actively concentrated or excluded by different organisms. They concluded that each element will be found concentrated by some organism in the spectrum of life. The work will include stable and radiochemistry, the determination of body burdens and eventually uptake and excretion rates. The studies will be associated with work on the food chain. We will be able to find the quantity of the various radionuclides in the biota, which elements are mobile and which are conserved.

Q. Wallen: What exactly do you plan to do?

A. Nelson: Plan to start on photosynthesis this spring and carry it a full year and pick up information on the organic matter coming into the stream and also on chemical nature.

Chairman Struxness said that the previous discussion of past work on the river and the plan for the proposed study leads logically to comments by others as an extra order of business. He called for a discussion of the hydrologic parameters.

Godfrey stated that these had been pretty well covered. He indicated that the level of the program almost rules out any extensive model studies.

Elder said that a statement previously made that there are no drinking water supplies taken from this reservoir is not entirely correct. During low flows in the river the cold Clinch River water will flow along the bottom up the Emory River and find its way into the Harriman water supply intake and after warming up will flow back along the surface to the Clinch River.

Parker: The water is monitored at the K-25 plant which has the first downstream water supply taken from Clinch River below ORNL.

Jones: The Kingston water supply which is usually from springs may be affected when water shortage causes intake from the Tennessee River. The Kingston water intake is located a short distance upstream from the mouth of the Clinch and under some conditions there may be an upstream of Clinch River water to the Kingston intake.

Kochtitzky substantiated the fact that under these conditions of up stream flow of the Tennessee River, Kingston might use Clinch River water.

Burnett: A possible concern of the agencies represented here is stream pollution control and we have provided that. The amounts released from White Oak Lake bed area are monitored for protection of the public and can be controlled temporarily by closing White Oak Dam.

(The TVA representatives emphasized that reservoir operations do affect river conditions although information may not be quantitative.)

Elder: There are figures on the effect of Melton Hill Dam. The Melton Hill project will affect the releases in this area to some extent. The fluctuations will be larger and of shorter duration.

Belter proposed that Parker summarize what is to be done in the next six months.

Parker recalled meetings two years ago. Summary of work to be done: investigation of literature, determine the most important hydrologic features to be studied, try to determine what would be the most effective way of studying hydrologic effects.

Q. Belter: Do you anticipate compiling this data? What time would be involved?

A. Parker: The program will progress as data is obtained.

Friend asked if TVA data on mixing were adequate and what would be expected of the PHS.

Struxness: As to what ORNL can do for the next six months: We are negotiating for a man to do hydrologic studies which makes it difficult for us to know what we will do on hydrologic aspects, except tie together what we have in our files on the tracer tests.

Auerbach: On biological aspects for next 6 months: Cottrell's report: Applied Health Physics people have measured the activity in the sediment at specified TVA silt ranges. These provide us a useful guide-line in which to start a biological characterization of the river. We have requested our Laboratory management to purchase a large type of laboratory boat, a pontoon type houseboat, in which we can maintain a crew and sampling facilities. We propose, together with Mr. Abee, to start out at these silt ranges and do one silt range a week on three or four ranges or once a month at each silt range. We think by March we could go into the river and start the silt range samples.

Q. Wallen: What do you mean by characterization of the river?

A. Auerbach: Start work to determine the specific radionuclides in the organisms. Abee's group will be collecting samples at various cross sections, which will be additional.

Wallen commented that this omits two important aspects; namely, fish and plankton.

Auerbach said the aid of Tennessee Fish and Game Commission would be enlisted for sampling the fish and the water samples will be collected by Abee's group which will aid in plankton studies.

Abee: Proposal for next six months: Applied Health Physics program will not have facilities for the next 6 months but hope to integrate the two programs in order to make cross section measurements the year round to see how seasonal variations affect bottom sediments.

Struxness: Asked Wallen to comment on the proposal since he seems to feel that it is too ambitious.

Wallen: I have strong objection to the ecology program as written. I do think the objectives are very broad. At Hanford, with ten people, they have been unable to do in five or ten years what is planned here. It will take a lot of people we do not have and it seems the two parts of the program are contradictory. The objectives are too general. We need to rewrite the proposal, be more specific and make it more of a job description. As now written, it would mean that you either hire 5 people or reduce the program to include one person.

Struxness: We recognize the proposal is very broad and very general. In February and March of each year we have to describe the proposed investigation for AEC Form 189 budget submission to be done in the first year and also in the second year. We are not in position at the moment but hope to be in February. I agree it is an idealistic proposal and difficult at the moment for a Steering Committee to have anything to go on. This is one of the most important studies that the Laboratory has ever undertaken. We would like for it to be as thorough and comprehensive as we can make it. We want you to have interest and responsibility to come in and help. I think the agencies represented here should come in, as well as other agencies. With the AEC alone it would flop. We can make adjustments with the money from the AEC. No increases expected in the next two fiscal years. We are not expecting to come to the agencies with too large a proposal. There may be need for additional funds but we will do our level best to justify it.

Belter: There have been certain funds allotted for fiscal year 1960. Going back to Steering Committee. It is needed to try to find out where to get started.

Schultz: To get the proposal better lined up, you should bring in the best limnologists and discuss this thing. Six months is not much time if you can get people together and really work together. It is early to start with samples.

Struxness: I agree that we should lay plans before starting on the river. More fission products up to now have been released to this stream than at any other place and less has been done to understand it. We have a situation that is changing. We who are interested in health protection are very much interested in the river program and we must get it underway.

Friend: I think the Steering Committee should be set up in order to set up the program.

Kochtitzky: A detailed work plan is needed to show respective agencies what time, personnel and money will be required before they are willing to commit their agencies.

Schoen: I think it should be left to the Steering Committee ~~as~~ to develop a work plan and determine how each agency would be involved in it.

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STATEMENT ON THE HISTORY AND PHILOSOPHY OF LABORATORY OPERATIONS WITH RESPECT TO THE CLINCH RIVER

K. Z. Morgan commented on the recent serious accidents and meetings on the subject. He stated that the field of Health Physics is relatively new. He briefly reviewed the

history of Health Physics and the development of the radiation protection committees, specifically the National Committee on Radiation Protection and the International Commission on Radiological Protection. In discussing the history of the White Oak Lake and Clinch River usage by ORNL, Morgan showed how the maximum permissible exposures have been successively reduced over the last 17 years. He emphasized that there is little liklihood that the present maximum permissible concentrations will be increased; rather, the chances are that they will be decreased in the future.

Struxness commented that Morgan's discussion exemplifies why we are concerned about the Clinch River. He suggested that each representative make a statement of the interest and possible participation of his agency. He stated that it would not be a firm committment.

STATEMENTS ON THE INTEREST AND/OR ACTIVE PARTICIPATION OF OTHER AGENCIES IN CLINCH RIVER STUDY PROGRAM

S. Leary Jones: The State of Tennessee is interested and I feel that the study must be made. It is possible in the state program to shift emphasis from what is now being done; for example, from bacterial studies to studies on this objective. Details will come out after the Steering Committee gets underway. Apparently monitoring is being done. I would like to see a certain amount of monitoring start now at Chattanooga. The people are quite concerned about the Strontium 90 that is in the water supply. We have had a number of letters about this problem because there is no solid basis for assurance that it is perfectly safe. He illustrated how much trouble public concern may cause by reference to a relatively minor incident of pollution by a paper mill which almost forced the company to leave the state. He said he would like to see this program tied in with TVA reservoir operation studies. It is hard to say how this should be set up. This should be correlated with plans developed by the Steering Committee. We have eight people in our group who will be very much interested in this work. We have three biologists and I would like to send one of them (Mulligan) to ORNL to work on this problem.

Struxness: We do not have proof but strongly suspect that the Strontium 90 at Chattanooga does not come from Oak Ridge, but we cannot prove it. Our Laboratory management and the AEC are quite aware of the public relations problem that we may have to face. This is another reason why we must do the best we can and answer the questions that we are sure might be asked.

F. E. Gartrell: We are interested to see that the hydrologic and chemical data accumulated through the years by TVA is used both in planning and carrying out this study. We have not given any attention to the matter of radioactive material. We have felt the need to accumulate radiologic data and have some plans to do so, and I feel that with a study of this kind getting underway it would be a good time for us to initiate some studies of our own. Participation proposed, in addition to developing staff competency, would provide guide-lines as to the kind of sampling needed to be done by TVA on a long-term basis. The question of the best way to operate TVA reservoirs in the event of an accidental spill has been given a lot of attention. But we have not gotten down to specific cases or worked out details. We are concerned about radioactive wastes in TVA water supplies which we have responsibility for operating. We are concerned with effect on fish and game as well as the effect on water quality.

As far as being in a position to participate in a program of this kind, we have lots of competence and skills but to what extent we can make them available is something

we would have to work out with personnel in our organization. We have a small staff but the details of studies that have been made in the past 2 1/2 years may have applications and some of the basic data would be useful. We have extensive survey facilities but these facilities are costly. The amount of dollar contribution that we could make might not be very encouraging in undertaking a study of this magnitude. I feel that I certainly would recommend to TVA management that TVA participate in this study. The details of our contribution would have to be worked out later when your work program has been defined.

A. G. Friend: We are very much interested in the project. We have at the present time the funds and the personnel. The budget next year we do not have and what we can do next year I do not know. We are in pretty good shape for the remainder of this fiscal year.

Struxness: Would your participation be on the biological side or equally on the hydrological side?

Friend: outlined what was done on the Mohawk River Study. He stated that something of that nature could be contributed.

E. G. Godfrey: I cannot speak for the USGS and I am going to ask Mr. Cragwall to make the statement. First, however, I would like to speak of our interest in this program. The USGS has been working with AEC on waste disposal problems. They have been actively participating in a number of programs with various local groups such as KAPL and Savannah River. We have in the past participated in studies here in Tennessee. As far as participating in this study it would have to be worked out with Mr. Cragwall.

J. S. Cragwall: We are very interested in the project and feel we have skills to be of assistance to you and we can always participate to the extent that funds may be made available. If these are not available, we will cooperate in furnishing technical skills to the best extent we can.

J. E. Munzer: We are definitely interested in all types of field work which we can do on a contract basis. The contracts will run from a week or two to 3 months. We are definitely interested in this operation.

Struxness: TVA and USGS already have information on the hydrological aspects and are definitely interested in this study, especially the USGS. We will look more or less to them for the guidance and actual performance of measurements made on the river. The PHS, plus the Stream Pollution Control Board, as well as the group represented by Mr. Munzer, have almost the same interests as the Health Physics Division. These groups would in some ways enter into the study of biological and radiological determinations. One of the big parts of this study will be analyses. We all agree we need hands and need to get out on the river. We have large and well equipped laboratory and analytical facilities at ORNL.

Morgan: Are you planning to get enough money for this?

Struxness: We must consider this in looking at reality in collection of samples and analyses of samples. We are fooling ourselves if we say we can do this study over a period of 5 years. Someone will have to put out a good sum of money for these analyses.

Friend: PHS has two methods; 1) refined, and, 2) a quick and dirty method, which is cheaper.

Struxness: Another thing that complicates organization in carrying out this cooperative program is that some of us are interested in the practical and some in the scientific aspects. As to responsibilities for source of support, one group might support the biological phases and another support the engineering-hydrologic portion.

Some of you are more concerned about the TVA system from K-25 to some point on downstream. Some of us are more concerned with the stretch immediately below the outfall of White Oak Creek. Over all of us hangs the public relations problem associated with this program. The AEC will have to begin educating the public.

Shoup: Our public information people are aware of this meeting and the plans for a cooperative effort. They are prepared to issue a press release when the program gets into operation.

Struxness: You fellows who are interested hold an important part in orienting and informing your colleagues back home. It is unfortunate that this meeting could not have been held 16 years ago. (Mr. Struxness asked for comments from the attendance concerning the proposal that a Steering Committee composed of representatives from the various participating agencies be appointed to coordinate the overall direction of the river studies. He said that this involved the type of committee, its functions, and procedures of reporting results.)

ORGANIZATION OF CLINCH RIVER RESEARCH STEERING COMMITTEE

Gartrell: The release of all information should be formal, through the Steering Committee and should be cleared through this group. We should think about who will be the representatives in the committee. Since ORNL has the biggest stake in this program it would seem to me that Struxness would be a logical choice to head up the committee in view of the fact that he heads the ORNL waste disposal and engineering group.

Shoup: It seems that all the agencies participating would be the ones who would be represented on the committee and would have one member from each agency on the committee.

Struxness: I am interested in knowing whether this Steering Committee is an advisory committee or is it a working committee.

Gartrell: I think it should be a working committee not just advisory. The representative from each agency would clear with his own group. The committee should make the decisions as to the direction of the program. It is different from a typical river advisory board.

Struxness: It should be a working committee which would see that the work is done. The chairman of the Steering Committee should be at Oak Ridge and would be really the local coordinator of the program.

Gartrell: Due to the fact that you have these various groups under your jurisdiction, it would seem logical that you should be chairman.

Steering Committee members were elected as follows:

E. G. Struxness, Chairman
S. Leary Jones
A. G. Friend
E. G. Godfrey
F. E. Gartrell

J. A. Lieberman - ex officio
I. E. Wallen " "
A. A. Schoen " "

Burnett: If this is to be both an advisory and working committee would you need a larger committee?

Struxness: I believe we agree the Steering Committee is large enough to represent the group here. We can start on this basis and may see fit to change it later.

Shoup: Does this mean that alternates may be on the committee for particular problems?

Struxness: On behalf of the AEC and ORNL, we are anxious to have representatives on the Steering Committee who have something to say about this program.

Morton: There should not be alternate members on the committee. If this committee is going to have definite responsibilities, the members must accept their responsibilities for decisions. They can bring their staff support to committee meetings, or accept assignments and work them out themselves in their own group and with their own agency.

Shoup: I think you are right. I used the wrong terminology.

The meeting was adjourned at 3:50 PM.

After the meeting was adjourned the first meeting of the Steering Committee was set up for Thursday and Friday, January 21 and 22, 1960.

ATTENDANCE LIST

USAEC

I. E. Wallen (DBM-ESB - Washington)
Vincent Schultz (DBM-ESB - Washington)
W. G. Belter (DRD - Washington)
C. S. Shoup (ORO- Oak Ridge)
A. A. Schoen (ORO- Oak Ridge)

USGS

E. P. Mathews (Surface Water Branch - Knoxville)
J. S. Cragwall, Jr. (Surface Water Branch - Chattanooga)
E. G. Godfrey (" " " ")
B. J. Frederick (" " " ")
R. M. Richardson (Ground Water Branch - ORNL)

USPHS

A. G. Friend (Taft Sanitary Eng. Center - Cincinnati)
J. E. Munzer (Regional Office - Atlanta)

TVA

F. E. Gartrell (Health and Safety Div. - Chattanooga)
O. W. Kochtitzky " " " " ")
Rex A. Elder (Norris Lab. - Hydrologic Data Div. - Norris)

State Stream Pollution Control Board

S. Leary Jones (Nashville)
W. H. Martin (")

ORNL

K. Z. Morgan (Division)
E. G. Struxness (Division)
R. J. Morton (Waste Disposal)
F. L. Parker (" ")
R. L. Bradshaw " ")
S. I. Auerbach (Ecology)
D. J. Nelson (")
H. H. Abee (Applied Health Physics)
T. J. Burnett " " ")

68A1596 #280 MHJ Clinch River

MINUTES

OPEN MEETING - "CLINCH RIVER STUDY" STEERING COMMITTEE

OAK RIDGE NATIONAL LABORATORY
Building 3504-Conference Room
January 21, 1960 - 10:00 AM

ATTENDANCE LIST

I. E. Wallen - USAEC - DBM-ESB - Washington
W. G. Belter - USAEC - DRD - Washington
A. A. Schoen - USAEC - ORO - Oak Ridge
R. G. Godfrey - USGS - Surface Water Branch - Washington
F. E. Gartrell - TVA - Health and Safety Division - Chattanooga
S. Leary Jones - Tennessee Stream Pollution Control Board - Nashville
Price Wilkins - Tennessee State Fish and Game Commission - Nashville
E. G. Struxness - ORNL - Health Physics Division
R. J. Morton - ORNL - Waste Disposal
Frank Parker - ORNL - Waste Disposal
S. I. Auerbach - ORNL - Ecology
D. J. Nelson - ORNL - Ecology

Chairman Struxness: I passed out to you some material that could be used as a basis for discussing our business along the lines suggested in my letter to you. I characterize this material as the best thoughts we have here at this site, at this time, on; 1) the objectives of the study, and, 2) the work that we should get underway immediately. Where we were uncertain regarding the participation of certain agencies, we ask questions or make suggestions. I would like to open for discussion the material covered on the first sheet--the overall objectives. The subject of overall objectives of this study is now under consideration.

Belter: I want to express the regrets of Al Friend of the Public Health Service for not being able to be here this morning. An allergic reaction to an inoculation necessitated his taking a plane back to Cincinnati. Friend mentioned that his group at Cincinnati is ready to do field work on the Clinch River or the Tennessee River at the direction of the committee and they are ready to start field work within a period of a week, two weeks, or so, depending on just what aspects the committee decides the PHS should do. He would be willing to come down next week with his aquatic biologist, Henderson, and work out details with the Laboratory. We are actually going ahead with the survey program. So whatever phases or aspects the committee decides the PHS should do, they are willing to go to work in the field almost immediately. This is for the record.

Struxness: As you will recognize from these objectives, this study is not a stream pollution survey. I think the committee should recognize this and if there are any questions about this aspect of the study we should discuss them now.

Belter: Much of the information that will be obtained in this survey will be of direct interest to, and bearing on, stream pollution, but it is primarily a research and development project. You will be determining the fate of radioactivity and this information will have interest from a stream pollution standpoint. But the study is not the typical stream pollution survey. It will be much more detailed than that type of a survey.

Struxness: I would like to start the discussion by posing this question to the group. Is there any uncertainty or lack of knowledge regarding the radioactive material in which we are primarily interested? In Item 1 under chemical and physical objectives we refer to the chemical and physical fate of radioactive materials.

Godfrey: Are you referring to specific nuclides or gross radioactivity?

Struxness: We are speaking of gross radioactivity but we are thinking of specific nuclides. We are primarily interested in Strontium-90, Cesium-137, Ruthenium-106, Cobalt-60, and the transuranic alpha-emitting isotopes. However, in relative importance, we think that the transuranics do assume some lower order of priority than the fission products.

Belter: Al Friend of PHS has always mentioned in discussions that the survey should deal with specific nuclides, primarily. In other words, we are interested in the fate of Strontium-90, Cesium-137, Ruthenium-106, in this river system.

Struxness: There is one other element or isotope that we might discuss briefly because of the visits of Gene Wallen and Sam Shoup to Y-12 and K-25. Did you detect any need for concentrating specifically on uranium?

Wallen: I think we could not ignore uranium.

Struxness: I asked the question for another reason. Since our last meeting the people in Y-12 have learned of this proposed study in the Clinch River. Quite independently they have been looking at the industrial wastes released from Y-12, and they were wondering if there should be some coordination or some broadening of our objectives possibly to include in this overall study the problem of chemical wastes released to the east fork of Poplar Creek. This waste includes uranium.

Godfrey: I understand from Phil Mathews that they are also considering coming across the ridge into Bear Creek with some of their waste and that it does contain only chemical waste.

Struxness: Yes. For those of you who are not familiar; Bear Creek drains from this direction back into Poplar Creek and for years they had been releasing, primarily in the east fork of Poplar Creek, these chemical wastes; however, also for years they have located, at the west end of the Y-12 area, storage pits or seepage pits into which they have released chemical wastes containing small concentrations of uranium. I am not familiar with the operation at the present time but I was quite familiar with it a few years back and the type of wastes released to these seepage pits were such that you would expect almost anything to end up in the seepage pits including a good amount of organic solvents, also the concentration of uranium running on the order of 5 ppm. The reason for that is that back in the early days, and even to date, uranium has been considered a very valuable product. The operation in Y-12 is geared to very high recoveries of the material going into the plant and the minimization of material coming out.

Schoen: This is true also at K-25 in that the economics involved in uranium recovery keep uranium releases to a minimum. In most cases, the factors of safety added on by the dictates of the economics are more than adequate to protect against uranium

pollution of streams.

Struxness: The Y-12 production plant was started during the war years under pressure to get into production rapidly, and at one time during the war there were 27,000 employees in the Y-12 plant. Because of routine analyses of the water in this plant as well as analyses of effluents leaving the plant, we found concentrations of the order of 100 ppm of uranium in the sewage treatment plant. We found similar concentrations in the east fork of Poplar Creek. They quickly did a survey of the plant and corrected some of the cross connections and I am sure that since that time they have been alert to such possibilities.

Belter: Under No. 2 of the chemical and physical objectives, would it be possible to make measurements on Poplar Creek, and maybe below K-25, to determine the quantities of waste flows that are being discharged to the Clinch in the same way as curie content will be measured at the outflow of White Oak Creek? Would it be possible perhaps to revise the objectives here to include the measurement of these two potential sources of pollution?

Struxness: In answering that question there are some practical facts that we must consider. The compartmentalization within the Y-12 plant, and similar compartmentalization at K-25, will make coordination with those plants difficult.

Belter: Does the Applied Health Physics group take into consideration these other possible sources of pollution or is their responsibility limited to ORNL wastes?

Parker: They measure total influence upon the main stream. They do not measure outflow from each individual stream itself.

Belter: Would it be desirable for this survey to actually measure the outflow of these creeks?

Struxness: As to whether it is possible to include within the scope of this study a study of the east fork of Poplar Creek, Bear Creek, and so on, the answer is "yes". However, the work would have to be coordinated with another complex organization from which it is difficult to get information because of the security compartmentalization.

Belter: Do you envision any real difficulty in trying to do this Bear Creek and Poplar Creek work as a part of the overall study?

Struxness: There is no difficulty--it is a matter of taking time to brief and confer with the Y-12 and K-25 people.

Godfrey: Frank, you I believe made the statement to the effect that Y-12 does not monitor the east fork of Poplar Creek itself.

Parker: The Laboratory does not.

Godfrey: Does Y-12 monitor east fork?

Struxness: I am quite certain there is a minimum amount of sampling and analysis of the effluent from the Y-12 plant in Poplar Creek. Furthermore, there is some

selective sampling at points upstream from the gaging station within the Y-12 area.

Belter: Would the committee feel it desirable to invite a representative of Y-12 to come to one of these sessions in order to determine their feelings or interest in this program? I feel that the study would be relatively incomplete if such work is not included. I think we ought to have this information on a detailed basis otherwise what we have is strictly White Oak Creek discharge and we leave ourselves open to the question, "what about the other plants in the Oak Ridge area?"

Morton: Mr. Chairman, I happen to know there were seven or eight sampling stations in and around K-25; they have good analytical chemistry labs, and I suspect they still have a sampling program. We never see the data but we probably could obtain and use it if we could show need.

Schoen: They are definitely sampling. The question is whether they are doing this in accordance or in sufficient detail to give us the information we would need to make a thorough evaluation of what contribution the Oak Ridge facilities are making to the river system.

Belter: Are they doing any type of biological sampling?

Struxness: They are not to my knowledge doing any biological sampling. It is primarily water analysis.

Belter: I would be interested in the views of other members of the committee regarding the bringing of some of the other Oak Ridge facility people into these discussions.

Struxness: I would suggest that if we invite Y-12 people we should include in the invitation K-25 staff also. Furthermore, I suspect that these people would want some time to prepare. Therefore, it might be the subject of a later meeting of the committee. Pass it this time and consider taking it up at the next meeting.

Belter: I think we should get the quantitative data and I am wondering how the committee reacts to the suggestion that the chairman should contact both the Y-12 and K-25 people and invite them to present this data in the next quarterly meeting. We could give them time to prepare and also give them the background on this study. The committee could then decide on the application of the program to these plants.

Struxness: From my conversations with the Sanitary Engineer in Y-12, I know now that he would be quite pleased to be invited and present this information. I am quite sure that K-25 would be too.

Belter: Would he represent the feeling of the Y-12 management?

Struxness: Yes. I would like to dismiss further discussion on this particular aspect at this time and say that I will get in touch with both installations and extend this invitation and ask them to give us a prepared statement at the next steering committee meeting.

Struxness: Any other comments now on the objectives, or discussion. Frank, do you have any question about Item No. 4 under chemical and physical?

Gartrell: No, I don't have any question about it. I would just have put that No. 1 if I had been listing.

Belter: The question which concerns you, Dick, is this in cooperation and conjunction with USGS?

Godfrey: Well, the objectives that are listed here under chemical and physical are the same objectives that we are working towards in other studies in other places.

Belter: Do you have any studies right now going on on these objectives on the Clinch or the Tennessee?

Godfrey: Yes, in fact last week we ran some tests on a small tributary to the Clinch in Virginia. It was a rerun of a test we ran last June but the stream had base flow four times as great as we had last June. We were not successful in attempting to rerun the test on the Clinch but the Poplar Creek one was a real good set of data.

Belter: This work that you have done upstream--this wouldn't have any direct relationship or bearing on these studies?

Godfrey: Only in the basic understanding of the mechanisms.

Gartrell: With regard to point 4--the objective is stated, but it seems to me equally important to identify the limitations of this particular stream. There may be some serious limitations on an overall basis that you may have to handle in many ways before you can take into account the detailed way in which this hydrologic system operates. You may identify some limitations and, of course, with most stream pollution control problems of this kind you have to deal with different stream situations--periods of low flow and periods of high temperature in the water; consequently it may be necessary that we concern ourselves with identifying those limitations too.

Struxness: That is of prime interest to ORNL. In management's view this is No. 1.

Gartrell: Then the Melton Hill Dam will regulate the flow of the Clinch at White Oak Creek. The type of operation that you will have at that dam will change what you have now. There would be periods of time when there would be no flow at all at White Oak Creek whereas when you cut Norris off it is a matter of hours before it flows out at the mouth of White Oak Creek. Melton Hill project, however, when you cut it off the flow will be cut off and that's it. When they cut it back on, any waste accumulated in the Clinch River from White Oak Creek will travel as a slug of waste whereas now anything that is carried into the stream is averaged out over a period of 24 hours or so. You may find yourself getting 10, 12, 15 hour accumulation of waste from White Oak Creek and in an operation of 3 or 4 hours at the Melton Hill project you would get this slug of waste moving down rather than having dilution during a period of 24 hours.

Belter: Actually if it was authorized this year it would be at least two years

before operation of this facility and by that time we should have considerable field data on the Clinch, at least the present survey.

Gartrell: These dam constructions begin when they start putting in roads and excavating and then the conditions of the river are going to be disturbed tremendously.

Belter: What is the earliest possible construction date of this project?

Gartrell: It will start this fall.

Belter: This fall. Six months time!

Parker: Representative Baker said ten days after authorization, which could be the tenth of July possibly. Actually that is the reason why we took the general survey as No. 1 on our list--because when they are moving dirt it will be difficult to get a background basis on which to operate in the future.

Belter: A question on the chemical and physical objectives under No. 1, general survey. There is allotted 15 man months in the field. Would all of this be from ORNL or would ORNL provide just the laboratory work? How about the field work?

Parker: The field work also would be ORNL. This would be a combination of the work now being carried out by the Applied Health Physics group, as well as our own group.

Struxness: Walt, you are getting into the second part. I wonder if we now have reached the point where we can pass on the general objectives. I, too, agree with Frank Gartrell's comment on No. 4 and I would like to include that in restating objective No. 4 under chemical and physical for clarifying the report. Can we pass on to the next subject of our discussion?

Gartrell: I would like to make one additional comment. In the earlier discussion there was some mention of possibilities of extrapolating the data to give information that would be of value for estimating the capacity of a stream to a universal basis. I notice there is no reference to that and I think that is good. I would like to see this as a good practical study for achieving the objective, but if you had the other objective in mind--why I think you would be doing quite a different study. I hope the universal facet of it was omitted intentionally, not just through oversight, so it will not come back into the picture later on.

Struxness: We directed our attention to that very specific point, Frank, and this is omitted not by accident. We are now thinking strictly in terms of this stretch of the river.

Gartrell: That's fine. I wanted to be sure of that.

Struxness: The second order of business is to discuss the specific work project and the amount of effort that we will apply in each of these, and consider when such work might begin. As listed in the proposal, we would cover the biological work first. I would now entertain statements or comments from Stanley and Dan in regard to these proposals.

Nelson: This proposal is designed to give us some information on the river as quickly as possible with particular regard to the kinds of organisms present. The proposal is quite general and we will measure only gross gamma activity at this stage. In a specific survey we would measure activity of specific isotopes and do exact radiochemical work. We have had Dr. Morgan list the isotopes that he considered to be of primary importance and they are the ones mentioned a few minutes ago; namely, strontium, cesium, ruthenium, and transuranics. We will have to do a good bit of exploratory work on the detection of transuranics in our biological samples. About the only way we can measure these is by alpha analysis and this is a problem in itself. The advent of Melton Hill Dam is another problem because this is very definitely going to change the characteristics of the river; particularly in the vicinity of the mouth of White Oak Creek. If the dam is approved we might find that we would have to alter Part B on the more specific survey but, in the meantime, I think we could go ahead with Part A and get as much information as we could over the broad stretch of the river and see what developments occur in connection with the dam.

Belter: Question, Dan. Would it be possible to determine radionuclide content of the organisms by gamma analysis?

Nelson: This could be done.

Auerbach: I will just clarify that. Our reason for putting it the way we did was because the gross gamma measurement would give us the quickest and easiest way of locating the radioactive organisms. If we have assistance we could push B-2 up to Part A.

Belter: The reason I mention this is that with respect to assistance, this is an area in which perhaps the USPHS could assist manpowerwise and perform some necessary field work and also, perhaps, some of the laboratory work since they are set up to do multichannel analyses, etc. This is one thing that Friend mentioned before leaving. He made the suggestion that he come down with his aquatic biologist, Henderson, to think in terms of what areas they could serve. Then you can arrive at a decision as to what stations ought to be sampled and they can work very closely with your group and with the Applied Health Physics group to accomplish the field work.

Nelson: Walt, we have a fish survey outlined on the next page. I think it is unfortunate that Al Friend isn't here so we could discuss these specifically, but in any case on this general survey the samples would not be discarded and would be available for future analysis.

Belter: I am just thinking of making more manpower available. In the case of the PHS, perhaps 4 members of a survey team might be assigned to do a fair amount of field work within the next few weeks and to utilize this available manpower under the direction of the Survey staff. I think this is something that the committee might consider as a means of getting the field work started.

Schoen: Are you saying that this 4-man team is ready to get started within two weeks?

Belter: That is what Friend has said. One week is what he indicated at the time

of the last meeting. If the committee decides what should be done, Friend's team is ready to start within one week. They recently completed the field work they were doing at KAPL on the Mohawk River. Since that time they are doing the analytical work in Cincinnati but have reached the stage now where they are ready to go out and do more field work.

Auerbach: Do you, taking your words literally, feel that the PHS group would be amenable to following a pattern of sampling that has biological research implications?

Belter: Very, very much so. Much of the work they did on the Mohawk was biological.

Struxness: My impression of what you say, Walt, is that here immediately we can integrate 4 men into the program.

Belter: Right.

Struxness: They are looking for a good study project?

Belter: That is exactly correct.

Would it be desirable, Ed, to have Stan go up to the map and show where these sampling stations are envisioned at the present time and maybe initiate some discussion on these?

Nelson: As you can see from that outline, I have roughly indicated areas to be sampled. Mile 23 on this map would be at this point and we would want to get one sampling station above here. I have indicated a minimum of one sampling station between Poplar Creek and White Oak Creek. Another sampling site would be between Poplar Creek and the mouth of Emory River. I think it would be advisable to go down the Tennessee River and pick up one station.

Belter: Any thoughts on where this station would be in the Tennessee?

Nelson: Well, I would say as short a distance downstream as conveniently possible to eliminate excessive traveling time. If we had the personnel available, and this is where PHS could assist, I think it would be advisable to go up the Tennessee River and locate one station to get effects of the effluent upon the Tennessee River itself. In addition, another sampling site between Emory River and Poplar Creek and another one between Poplar Creek and White Oak Creek would be useful. This would give us a total of 7 sampling sites. I think these sampling sites should be sampled frequently. I have indicated twice each month. This is on the basis of experience at Hanford where they have found that samples which are not taken regularly are of little value. All you get is an odd reading here or there which is impossible to interpret.

Godfrey: Amen.

Belter: I am wondering, does Leary Jones have anything to suggest at this time on the sampling frequency of twice a month? Would there be any way, Leary, where the Stream Pollution Control Board could help in this sampling program?

Jones: I don't know how much on the actual sampling we are going to help. We've got a small staff and there is no more money for the next year and a half, and there will not be any increase for three and a half years. We will help what we can.

Belter: Is there any possibility, Leary, of integrating into their normal program when they would be in the vicinity perhaps of some of these stations that are on the Tennessee, or of using them for sampling in connection with their regular duties?

Jones: Their regular duties wouldn't cover that area. On the biological work, your problem is not sampling. The major problem is identification of your material. You can sample enough in one day to keep you busy in the lab a month.

Schoen: In that regard you indicated at the last meeting you had some interest in perhaps sending a biologist to ORNL to more or less familiarize himself with the techniques involved and it sounds now like you've got your men all committed to other work.

Jones: Yes, I talked too much last time. As for putting him here full time, we could not. All these new industries are coming in and we are so far behind on those that it would be embarrassing if we published information as to how far behind we are. We will squeeze in all the time we can on the Clinch River Study.

Struxness: I would question about integrating now--Leary's man and the Public Health Service men and others--into the effort here on site. Question directed to you, Stanley. I assume if the PHS group comes down here they have to settle in some locale in the Laboratory or in our facilities. Do you have room, for instance, for four people and the equipment they would bring with them?

Auerbach: Yes, providing they have transportation. We can provide some freezer capacity with the possibility of some increased freezer capacities for storing. One other point pertinent to Mr. Jones' discussion is the fact that our laboratories at Y-12 are in a restricted zone and if there is a possibility that even one of your men will come at infrequent times for periods of a week or so we might consider getting a man under clearance.

Jones: We don't have our biologist cleared.

Struxness: The problem there, Leary, is because that is a different plant. For such a man to plan to spend any time he should be cleared and that takes a minimum of 90 days.

Auerbach: The PHS people have clearance?

Belter: They are all cleared.

Struxness: If these 4 people come next week, I don't know where we would put them.

Auerbach: Some of them would be out in the field.

Belter: They would be out in the field and perhaps staying at the hotel. That has

never been a problem.

Auerbach: We can accommodate them in our place, certainly until summer.

Struxness: Frank, do you have any biologists?

Gartrell: No, but I'll ask whether or not summer biologists could be worked into a program of this kind. We had a young college professor for the past two summers on some other assignments and we might make some arrangements to get him for summer months, providing we can get some money and if he hasn't signed up somewhere else. However, he wouldn't get here until sometime after the first of June and would be due to leave Labor Day. He is a very competent person and he has worked on plankton studies with us. We think quite highly of him and I think he would fit in very well.

Belter: Is he coming in this summer again?

Gartrell: That's right.

Nelson: Could we get some information from some of the routine operations your fish and game people are planning this summer and this winter. We need background information and this would have to come from above Norris Dam in the reservoir. TVA is planning a fish survey on the Clinch River above the Melton Hill Dam site and this would also provide us with some information and specimens of value.

Gartrell: I have talked to our Fish and Game Branch about fish population studies. Their practice is to work with the State fish and game people. They would cooperate on any work that the State fish and game people did. I am sure if you needed some collections in Norris Lake you could probably arrange to get help from our people.

Nelson: One item is that they have this rough fish removal program up there.

Wilkins: Along that line, will one set of fish samples serve for your background material?

Nelson: This would help.

Wilkins: Or do you need to get them monthly also?

Nelson: Ideally it would be nice to get them monthly. I think analysis of a large number of specimens from Norris plus a large number from the Clinch River would be a tremendous job. Statistically this fish problem is going to be very difficult.

Belter: I have a question for Price Wilkins. Is there any possibility of obtaining, shall we say, a biologist from the Game and Fish Commission, for limited service who could actively participate in this program either during the summer or during any other time?

Wilkins: There is always a possibility but we are in much the same position as Leary. We only have two men in all of East Tennessee. One is assigned to this district. He would be able to come in at times to help with a fishery survey, especially if it were extensive enough to require extra men, extra gear, extra boats.

I am sure we could work that out.

Jones: Price, how about your conservation officers. Could they help with fish collection? I know they are tied up day and night on law enforcement but heretofore you have been able to pull them off for a day at a time and they usually have the boat equipment and usually know where the fish are.

Wilkins: That would be especially true in low backwater on Watts Bar. They could provide at least boats in that area.

Jones: One of our troubles in the State is that we are up to our ears in routine enforcement. We have no research program although the law says we can set up research studies.

Auerbach: I think the committee should consider postponing the fish survey until later because it will be the major biological engineering operation of this survey. Several hundred fish would have to be butchered, filleted, and digested in hot acid. It is an operation of considerable magnitude.

Struxness: Should the committee consider asking the PHS and the Fish and Game Commission to take this on as a package? They organize it, they conduct it, and we will concentrate our efforts on the bottom fauna survey?

Belter: This would be for all stretches of the river--upstream, downstream--the Tennessee, the Clinch?

Wilkins: I don't think you can count on that much Game and Fish participation, on a routine monthly basis. If you have something big coming up, such that you need one extensive set of samples, I am sure we can pull enough men in to help to get those, but to have this thing recurring monthly would just take more time than we are prepared to give.

Schoen: It would seem to me that what might be done is to use the Public Health Service in the fish study and to plan the sort of sampling that is necessary to elicit the information needed for the study, particularly with 4 people from PHS being available now to start work. Since these people are available now it would be a shame to forego this opportunity to get started even on a limited basis.

Auerbach: I suggest that the PHS come on down. We would work out a bottom sampling program while they were here getting fish samples.

Wilkins: Are you thinking in terms of specimens of all Tennessee River species or two or three representative species?

Struxness: Of course, Nelson never did get a chance to answer that question.

Nelson: I think we should investigate all species and perhaps give particular attention to game fish.....

Wilkins: In other words we should begin with the more representative animals.

Nelson: That is true. We should know the species of fish in the stretches of the

Clinch River.

Auerbach: I am concerned that the number of fish samples being discussed is getting beyond our capacity for radioanalysis. In bringing up the fish survey in the first place, from our own biological point of view, we have mentioned it not because we feel in a position to do any biological work with fish populations--it is a tremendous job and Fish and Game and fishery research groups have been working on the biological aspects of fish populations for many years. The importance of the fish survey is related to the immediate radiation hazard. For this reason we put it in the program as a separate but related study, not necessarily a part of the biological program that we have proposed for the next year.

NOTE: Following this statement there was considerable discussion on the various technical aspects of the frequency of fish sampling, sample preparation, methods of radioanalysis, and time required to obtain significant radioactivity measurements.

Struxness: Well, I think we have a pretty good idea of at least the scope of the proposed biological work.

Belter: Before you leave this subject on the fish survey maybe we should get in contact with Friend and relate to him our discussion and also the suggestions on the frequency of sampling and have Friend come down here next week and discuss it in detail with Auerbach and Nelson. See what Friend and his biologists think about this and how they can fit this work into their program.

Struxness: Maybe they could get started on this study this first quarter of 1960.

Auerbach: Walt, I gather from what you say that the PHS is going to be in a position to work this team in FY 1961.

Belter: Right now they are primarily concerned about the last of fiscal '60. What we want to make sure of now is that they are utilized in the last five months or so of this fiscal year. We are hopeful, as far as the next fiscal year is concerned, that they will continue but this is not finalized at all at this stage. In the last five months they are definitely available and might think in terms of getting two quarters of data, if that meets with the committee's approval. I would suggest that the PHS fellows get together with Stan and Dan of Health Physics, State Fish and Game Department, and TVA Fish and Game. It is desirable to get a program that can be outlined, at least on the fish survey.

Struxness: Now in view of the passing time, I think we should get on to the discussion of the chemical and physical part of this study. The proposed scope is included on the last sheet of this proposal.

Belter: Before you leave the general survey of bottom organisms, is there any part of this work here that perhaps either the Public Health Service or the Stream Pollution Control Board could assist in?

Auerbach: Certainly, in the general survey.

Belter: This is the other item I want us to mention to them. They can also assist

in this area.

Auerbach: The bottom survey is planned to be done the rest of this fiscal year and will be our main effort the rest of the year.

Struxness: This is the main effort of the ORNL staff. Any work that these folks do should be more or less under the direction of and coordinated with the ORNL effort.

Belter: My point and idea is that perhaps the ORNL effort could only just cover a certain part of the Clinch and maybe is not going to go further downstream than the Tennessee. Perhaps the PHS could do work at the same time that ORNL is working in the Clinch. I think this is another item that could be decided in a discussion with Stan and Dan. I want to make sure that Friend is apprised of this work listed under Roman numeral I. There might be some possibilities here for them in addition to the fish survey.

Nelson: They could help and also do some gamma analyses for us.

Belter: Friend is primarily interested in gamma analyses.

Auerbach: Would this also be in the next fiscal year?

Belter: Yes. This is fine, Stan. There are two good general research areas here. The general survey part and the fish survey part where the PHS can be started.

Nelson: I should mention there is nothing in the proposal on plankton.

Belter: I have a question on that, too. This plankton work may be another area where they (PHS) can assist. They actually collect samples of sediments and plankton. They could be working for Frank in addition to your group.

Struxness: Shall we then get on to the discussion of the proposal on the last page--the chemical and physical work of the study?

Parker: There are two reasons for doing the general survey. First, we need a background measurement of what is actually in the Clinch now if we want to develop a materials balance. We are interested in the contamination that goes into the river and what happens to it once it gets there and how it passes on downstream. Second, if Melton Hill Dam does go in then it is likely it will upset the whole system and will cover a good deal of the bottom sediment with new sediment. If we do not complete this general survey before that happens--once that does occur we will have, essentially, a fresh, new stream at the bottom to start out with. There will not be very much to start working on in the river, as there will be so much sediment going down the stream. Before the actual general survey starts we might want to get out and make measurements of some of the more active river cross-sections to establish a statistical analysis and determine how many stations will be required to distinguish between sediments at the surface and below the surface. This should all be done before the general survey, so that at the time of the general survey we will be able to proceed directly down the stream. Having the general survey, if we then can determine what goes out of White Oak Creek (discharges from K-25 in the past have been very low) we will be able to start the

preparation of a materials balance. The general survey will enable us to set up a number of cross-sections downstream to measure the movement of the radioactivity out of this reach of the river. It may be possible to just have one at the end of the reach. I think from our point of view we will look primarily at the Clinch and Emory River. A good place for the Public Health Service men would be on the Tennessee River as the public health significance would be there. To make the most of all this data and the data that is already available, we of course would need to have velocity and temperature profiles of the river system. This is one of the things that we measured last summer with the Health Physics fellows and the assistance of the USGS. They helped train these fellows and gave them experience on what it is like to run a river survey--experience in running the temperature probes and the velocity gages at the same time that we ran the radiation probes with the result that we have good background information a short distance downstream from White Oak Creek. We would like to extend this, of course, to the whole river and we hope that this would then allow us to make full use of the data that is already in the files on the activity from the bottom sediments. A good deal more analysis could be done on the information in the files of the Applied Health Physics group, but we need this sort of information to do it. We hope the USGS will be able to cooperate in that effort. Then finally we want to get on to a research type program to determine where and how the material is taken up by the sediments. To do that we propose to go upstream and take some bottom sediment and suspended sediment samples and run a series of trial tests with actual wastes and with some of the pure isotopes and eventually run those in a flume and determine the rates of uptake as well. We hope that we can get some assistance from the USGS on the determination of the type of clay minerals, ion exchange capacity, and that sort of thing.

Godfrey: Which group are you thinking of?

Parker: The Petrography and Geochemistry Branch. The other part would be Surface Water Branch for temperature and velocity measurements. That in a nutshell is about what we hope we can accomplish in the next year and a half; providing we have assistance, primarily from USGS. I think that the work that the PHS could do on the Tennessee River would tie in very neatly with the materials balance work that we could do on the Clinch and the Emory. I think it would also relieve the minds of the people down in Chattanooga, too, if they were working down there as well.

Belter: When you say on the Tennessee, Frank, do you mean strictly on the sediments and biota or also the water?

Parker: Water as well. We'll be doing water samples during the general survey. When coming to Part III, preparing the materials balance of the activity, I think we will find that the major amounts of activity do move in the sediments and we can cut down on the water samples and depend a good deal on the sediment samples. That is prejudging what we hope to find out in the general survey. There is not very much more we can do about the water except measure it. This will tie in with the Applied Physics program. We will use, at least at the start, the same cross-sections that Applied Health Physics people have been using up to now, so we shall be able to have some correlation with all the data that is in the files. After an analysis of the general survey has been completed, we may want to change some of our stations. In that case they may want to change some of theirs, too.

Belter: Have you thought, Frank, about the frequency of the sampling program? Much of what Applied Health Physics has done especially on silt has been done on an annual basis. What are you thinking of here--on a quarterly basis or monthly to begin with?

Parker: To begin with it will most likely be summertime before we can do the general survey. That will take, say, all summer just getting the general survey completed. To determine a materials balance, I would say monthly would be about the minimum for taking the suspended and bottom sediment samples. If the general survey should work out well then we could reduce the number of samples we would have to take and might only have to take one cross section.

Belter: Did I understand you right, Frank, that as far as the general survey is concerned it wouldn't start until this coming summer?

Parker: Well, preparations for this have already started but preliminary work must be done to decide the type of samples that must be taken in the general survey.

Belter: What I was wondering about was samples for this quarter. Might we not attempt to suggest any frequency but try to take so many during this next three months in conjunction with the Applied Health Physics routine sampling program.

Parker: There is no routine sampling program on the river now except water samples taken at Center's Ferry. I think it is really a question of equipment and manpower. I can't see going up there and taking samples just to be taking samples.

Belter: That is right. I agree with you on that.

Parker: Whereas, if we do this preliminary study for the general survey we will have some idea where the places are and the type of samples that are to be taken. Until we do that I don't know how valuable samples would be.

Godfrey: We've got whole buildings full of meaningless samples.

Parker: That's right.

Belter: Well, Frank, how about the number II item as far as taking samples from White Oak Creek?

Parker: I would say a minimum of once a week, compositing daily samples and measuring once a week. This is very dependent at the present time on the reconstruction of the White Oak Dam which is in progress. Because of the accidents here it has not been completed though it was scheduled for completion by this time. Until that is done there isn't any point in trying to get the materials balance because we're not sure of the flow.

Belter: When do you anticipate, hope, or expect to get this started?

Parker: Which one?

Belter: This number II part. Will that be next summer, too?

Parker: Why, as soon as the dam is completed which should be rather soon I should think. We can start that right away.

Godfrey: I have a couple of questions for Parker or Gartrell, I'm not sure at this point. I have never seen any data about how the suspended silt load varies with discharge in the Clinch. I'm sure that there is a hydrograph which says when the water discharge is increased somewhere in the neighborhood of ten-fold. The sediment at the same time will go up perhaps one hundred-fold. Are you going to try and do sampling over a range of discharge?

Parker: Well, we hope to do at least quarterly the bottom sediments on this materials balance and, because of the way TVA operates their reservoirs, in a sense we will be at different stages during these periods of time.

Gartrell: I think this will vary with the season. Some of the things will vary slowly and there will be very little change when we're using water that will have been stored for several months in Norris. In the wintertime with Norris low and when between floods, then you have an increased silt load. I don't know specifically what kind of data we have, but I'm sure (I'm like you--I've got a building full of samples) we could find out quite easily what is available along that line.

Godfrey: I know it is a complicated situation with Norris and its seasonal pattern and of course this is trapping a good portion of the sediment. It looks to me like there would be more in wintertime when Norris is pulled down. There will be more suspended sediment available.

Gartrell: Well, Norris gets muddy in the wintertime. It freezes up there in Norris Lake just like any river lake in the wintertime, but in the summertime it is nearly always clear. I'm sure that Dan ought to be able to get enough information of that kind and we can probably add some, too.

Jones: We should have an indication of that at the Clinton water plant. They ought to be running daily turbidities.. I say "ought" because I'm not sure. A turbidity would not necessarily be sediment, but it should be an indication and there is a gage somewhere near there which could be tied in with the silt load.

Parker: I think, of course, we'll want to get together with the TVA people that have had lots of experience on measuring sediment before we get very far along. I think the USGS has also contributed a great deal on the movement of sediments and silt.

Gartrell: On this item IV, I asked Rex Elder for any information we might have on temperature and velocity distribution in the channel and in this same section of the river that I referred to, from the mouth up to K-25. He says that they have velocities and temperature distribution data for wide means of flow conditions for different seasons of the year and the data hasn't been worked up in final reports in forms to be distributed, but you would be welcome to use all the data but to actually work it up would take several man-months. I imagine it would take about the number of man-months you have here to do the total job but he does have lots of information of that type. It might be that he has already done field work for this phase.

Godfrey: Frank, did you say that was just up to K-25?

Gartrell: That is as far as we may have to cover because all the data we could possibly use is from K-25 on down.

Belter: Maybe, Dick, you could check with your Geochemistry and Petrography Branch. Seems to me they are doing some sediment studies but I don't know where it is.

Godfrey: At Colorado State University. There are two programs that are concerned with what Frank is driving at here. I'm sure that the Geochemistry people in Washington and also perhaps Parker and John Heim and his crew in Denver would be interested. They have been working in this area. Whether they have touched upon exactly what Frank is interested in or not is something I'll have to find out.

Belter: I do think this would be worth following up on, Dick.

Well, Frank, what do you think you will be doing in the next two or so months?

Parker: Two things. One would be preparing the equipment for the general survey and the second, getting out on the river and taking enough samples to determine exactly what samples we will take on this general survey. For instance the question of whether we can composite mud samples all the way across the river, which is what is being done now. They take several samples at each cross-section and make a composite and measure only the composite. I think this should be tested to see whether this is actually a legitimate operation. I'm sure it is good enough for the monitoring information they need, but for the materials balance we might want to make sure that it is actually the preferred way to do it. We would also want to check to see whether we should weight the channel samples more than we should weight the ones at the edges along the same cross-section. I also question where the samples should be taken. Right now they are taken by an Eckman mud sampler. We might actually want to use a coring device to see whether better samples can be obtained in that manner and perhaps shear them off at different levels and measure the activity. I think this is the sort of information we should develop in the next couple of months at the same time we are working to get equipment. Stan and Dan are hoping to buy a boat and we hope that we can get that equipped and any other equipment needed for work during the summer. I think all we can expect to do in the next couple of months is to find that information and get the lab set up to handle some samples when we get them.

Godfrey: I might say that Phil Mathews and Joe Cragwall would be very happy to work with you in helping to get whatever equipment you need.

Parker: Actually most of the stuff that the USGS uses seems to be homemade.

Godfrey: Yes, nobody else wants it.

Parker: Phil also mentioned his department has a fancy, new temperature measuring device.

Godfrey: We could round up some more of those if needed on a short term loan basis.

Belter: I have one more question for Frank Gartrell. What do you think, Frank, about your agency's participation in the study? You will be supplying Parker with

all the available velocity and temperature profile data that you have up to K-25, and possibly a biology professor for the summer who may come to work on this program?

Gartrell: That is a possibility. And if you get the sampling program refined, possibly the sanitary engineering staff would be able to assist in the sampling program. But until we know exactly what the sampling program is going to be, I'm not in much of a position to promise any further.

Belter: When you say sampling program are you thinking about Leary's suggestion of once a quarter fish survey or would there be any possibility of manpower?

Gartrell: I think that possibly TVA Fish and Game would help with that, but I had in mind either the sampling program that Frank was talking about which would interest the Stream Pollution Control staff, or the transport of radioactive materials through the river system. We're interested in the portion that is transported in solution in the water and also that which is transported in silt. Having that interest I think that the Stream Pollution Control staff will perhaps be interested with that stage of the sampling. It might be that they would want to include some sampling even on beyond Watt's Bar further downstream, but I'm sure that they would be interested in the early stages of the sampling up in the Clinch and getting the sampling procedures worked out and deciding what is the best way to do the sampling. They might later on extend the sampling on their streams.

Parker: They certainly have had much experience in this field which we haven't. Of course we would like to work closely with them to establish our program.

Belter: Well, that is three potential areas where TVA could participate or cooperate in the study.

Gartrell: I think there is another way they could be helpful and that is in getting the long term forecasts as to what the flow conditions are likely to be within the next weeks or months, and you might be guided in the rates of sampling by the forecast of the operating conditions. The sampling might be in a period when they are having little or no flow from Norris Dam. (Laughter) You need to have some idea of what flow conditions are likely to be if you want to get some different samples, because you certainly don't want to sample in identical conditions several times. That would just be a matter of providing you forecast information.

Belter: One other question we could ask Price Wilkins; is there any other area, after all these discussions we have had so far, where the Game and Fish Commission could enter into this program aside from perhaps supplying some manpower on a one- or two-day basis per quarter? Is this suggestion favorable to your group or do you see any other areas where you might perhaps enter into this program?

Wilkins: It would be better if someone with more authority than I have were here to answer that question, but in general I would say that once you have established your work routine and know what day you want to collect, you know what your minimum standards are, then, if you want to come back and ask that question again, it may very well be that we can help. But right now you may be putting me in a position of asking me how I would run your project. After you have started then come back to us and see where we can be of some help.

Belter: I'm sure you realize at this stage that it is too much of a general run into this thing. Much of this initial work is more of a probing nature, general survey type. Frank Parker has mentioned here and Stan, too, much of the beginning work is really a general survey in nature and you have to do this first before you can think in terms of what specific directions you want to go in the program.

Godfrey: I have a question, Frank. On your data necessary for your materials balance on the Clinch, do you have any idea as yet what frequency of operation you will need to have?

Parker: I would think it would turn out to be mostly sediment carrying most of the activity downstream, which information we hope to develop during the general survey. If this is the case, I think that perhaps once a month--or once a week would be actually what would be required. I believe this would be another thing to be considered. We will try it in the field and see what works out best.

Godfrey: I have some reservations about the sediment carrying all the activity.

Gartrell: I have been thinking the same thing.

Parker: For one thing, the volume of water is a factor.

Godfrey: Actually there is very little sediment in the Clinch, particularly upstream.

Gartrell: Very limited. If you want to put it on a pound per pound basis it is a very small proportion of the mass going down the river.

Parker: The uptake qualities of silt is phenomenal, and if you try jar tests or even if you make it in the field you find that the amount taken up is just enormous.

Godfrey: This is true. This is why I'm not going to make any bald statements. I'll just keep my little reservations right over here in the corner.

Parker: As I said previously, I am prejudging this. It all depends upon the general survey to help us find this information.

Belter: One other general question I have. About two or three months ago when discussion was being initiated there was some mention made of the existing reports that were either in the process of preparation or some which were coming out like Gartrell's silt study report and the question then was whether there were any actual Applied Health Physics reports coming out from this routine monitoring data. I understand much of it has been filed. I believe there was some indication that some of these reports might actually be published. I was going to raise the question--have any things developed in the last month or so which would indicate whether some of these reports are about ready to come out? I think we asked Frank Parker the same thing, if some of these tracer study reports, which I guess you have two in various stages of production right now, how do those stand, Frank? Maybe Stan or Ed can answer the other question.

Parker: The data from the tracer tests is all worked up. The question now is interpreting and writing it up. I think we can include this in one report because

these summer tests were qualitative and not quantitative. Actually it lends some additional bearing to the tracer test--I think they should put in this report.

Struxness: I can answer the second part of your question. The Applied Health Physics Section has been requested by AEC to prepare for distribution on the standard distribution lists an annual Applied Health Physics report. The report for 1958 is about ready and may even now be in Reproduction. The report for 1959 is also well along toward completion but I checked on it a day or two ago and because of the recent accidents they haven't been able to do a thing recently.

Belter: The reason for my question on this is perhaps utilization by the committee members and their various agencies of the reports planning.

Schoen: Much of the environmental monitoring data is published in an unclassified form. In many cases, of course, in production plants the environmental monitoring data was included in the operational monthly report. Much of this operational information is classified.

Belter: McCone's presentation last spring to the National Press Club Association in Washington D.C., where he made the statement that all the environmental data as far as AEC installations were concerned, should be disseminated to the public--this is more or less one of the follow-ups of scientific information. It has been initiated more or less, at least the fallout data has been issued in three quarterly reports up till now. And now Dr. Western is coming out with one in which is summarized all environmental data and fallout data. Environmental monitoring data is published more or less on a routine quarterly basis. This is disseminated locally. Leary Jones indicated the possibility of participating in this fish survey thing--one or two days once a quarter or something like that. Another thing I was thinking of--the possibility of one of your biologists or so working into this program somehow or another, again depending on whether you can spare a man to work with Dan Nelson. Seems to me he would be very useful. How long a period? What time--summertime or what?

Jones: It is hard to comment on something that occurs once a quarter. We can afford enough personnel to handle that as long as we know as much as a month ahead. It is this routine week-in and week-out business that is complicated, and I will do some figuring. We want to be in on it. We want to help as much as we can on this. Tying one up for six months, we can't do it.

Belter: What I'm wondering about is the possibility like Frank Parker mentioned a moment ago--maybe the work will be intensified this summer. There might be a place here where one or two people from the State Health Department or from the Stream Pollution group could work with Frank's group on some of this general survey work.

Jones: Summer is our worst time.

Struxness: We have a problem in summer, too, of providing space and facilities for the summer research participants. Also the activity of the ecological section is intensified. It could be a real problem for Auerbach, too. Our problem is just to find a place to put them if they get here. In September they return to their home stations and we do have room.

Wilkins: If you decide that quarterly fish samples are enough and will be what you need, we will tentatively schedule a man. I'm sure we can and Fish and Game in TVA can--that will give you at least four, probably over a two day period.

Godfrey: I want to ask Frank another question about this. As you well know, Frank, there is quite a little effort involved in getting a number of temperature and velocity profiles. You were thinking of about how many sections and were you thinking over a range of conditions to fill in what TVA might not have?

Parker: I was thinking particularly of our quarters at a number of representative stations taking the profiles--and there you would have high and low condition for the year every time we got the samples. This would be information we would have to use to fill in with information we have on file.

Godfrey: Were you thinking of the areas--have you given any thought to the areas of species that are not affected by the density current from Norris Dam that Rex Elder was talking about last time, and installing these temperature gages?

Jones: I want to refer again to this general survey. The reason I'm asking specific questions is that I have to go back and explain the program to our biologist. You need manpower on that?

Nelson: Yes.

Jones: When you collect your bottom samples will you identify each of the bottom organisms? Separate those and then take them in and measure radioactivity?

Nelson: This would be the idea.

Jones: Could that material be sorted away from here and then be sent back?

Nelson: There is no reason why it couldn't be handled in that fashion.

Jones: How important is shipping time?

Nelson: I am concerned about sorting and handling organisms. We will be dealing with species which ingest mud and silt. This being the case the silt in the digestive tract will tend to be radioactive. I think it would be desirable to allow these organisms to clear their guts of anything of this nature, otherwise we will not know whether we are measuring the radioactivity of tissue and organs or gut contents. Consequently we would take the samples, sort the organisms as quickly as possible, let them clear their digestive tract, kill and preserve the bodies, and preserve the liquid and the organisms for radioanalysis.

Jones: Samples collected will arrive in Nashville by next morning by bus. You are going to have to keep the animals alive until then. Will we run into a problem on shipping that you wouldn't have in a lab?

Nelson: I am not sure but I believe we could hold them in the refrigerator until the next day and sort them. This is a problem.

Jones: At this stage you have to take it point by point. We will explore this

aspect when I get back. We could do the sorting more cheaply in Nashville.

TVA, during this period, will hold a constant flow of water.

Wilkins: You mean it is constantly fluctuating? (Laughter)

Belter: Well, I think, Ed, that pretty well summarizes most of the agencies' comments and suggestions where they might be able to aid in the program. I guess, Dick, you probably want to check with the G and P people on number V.

Godfrey: And see what possible help we could get from the members. Joe and Phil have indicated their willingness to cooperate trying to get this on paper. That will be on number IV.

Belter: I think that about covers all the groups. I think it extremely unfortunate that Friend couldn't be here.

Jones: But they contributed.

Gartrell: Yes. They contribute the river and we the manpower. (Laughter)

Belter: Well, we've already discussed everything two or three times mostly trying to get this manpower operating out in the field. He said again today just before he left for the airport that from that standpoint I should just pass a little information on so that they can see results as far as next week is concerned.

Jones: Maybe what we ought to do is get this map out, work up an outline and say this is what we decided you are supposed to do. He might be able to do it. (Laughter)

Struxness: I suggest that we have sat long enough for one day. We seem to have all of the ideas pertinent to the proposal. I suggest that we break up and you can go back to the hotel and recover some of your energy for the evening.

Belter: Unless Stan, Dan, or Gene--do you have anything else?

Struxness: We'll be back here at nine o'clock in the morning and we can leave everything here as is.

Meeting adjourned at 3:30 PM

PLAN FOR CLINCH RIVER STUDY

PURPOSE

1. The purpose of the study of the Clinch River below Oak Ridge National Laboratory is to obtain fundamental information on the physical, chemical, and biological dynamics of a flowing, fresh water ecosystem which is receiving large volumes of low-level radioactive wastes. Information from a broadly conceived fundamental and applied program will have important implications for two major world-wide problems resulting from large scale environmental contamination. These are:
   1. What is the overall diluent capacity of fresh water environments for an increasing continuous input of large volumes of low level radioactive wastes?
   2. What is the long term indirect impact of radioactive contamination of such environments?

OBJECTIVES

This program has four general objectives, namely:

1. To determine the fate of radioactive materials currently being discharged to the river.
2. To determine and understand the mechanisms of dispersion of radionuclides released to the river.
3. To evaluate the direct and indirect health and hazard aspects of the current disposal practices in the river.
4. To evaluate the overall usefulness of this and similar rivers for radioactive waste disposal purposes.

HYDROLOGY

The Clinch River, a component of the Tennessee River Valley System, rises near Tazewell, Virginia and flows southwest to join the Tennessee River near Kingston, Tennessee. The Clinch River is over 300 miles long and drains an area of approximately 4,000 square miles. Below Norris Dam, at Clinch River Mile (CRM) 79.8, the

river is highly regulated by the flow from the dam and by the flow from and the elevation of the water at Watts Bar Dam, located 46 miles downstream from the confluence of the Clinch and Tennessee Rivers. White Oak Creek, which drains the site of the Oak Ridge National Laboratory, joins the Clinch River at Mile 20.8. The backwater pool from Watts Bar Dam extends upstream past White Oak Creek to CRM 28 during the non-flooding season, May to September, and to White Oak Creek during minimum pool elevation. The average flow in the river above White Oak Creek is 4500 cfs with a maximum of 44,900 cfs and a minimum of 130 cfs.

The time for water or a wave to move from Norris Dam to CRM 20.8 is variable, depending upon conditions in the river. A flow of 3000 cfs corresponds to one turbine operating at Norris Dam, and 5600 cfs corresponds to two turbines operating. The electrical output is tied into the TVA power system, and because of the integrated use of water and steam the flow at Norris Dam through the turbines might be zero, 3000, or 5600 cfs. If the flow were zero prior to startup, then a solitary wave would be generated when the turbine gates were opened. This would also be true if two turbines were operating prior to shutting down one. The velocity of the wave depends in part upon the depth of water in the river and so would vary depending upon the water elevation at Watts Bar Dam.

The time of travel of water from Norris Dam to CRM 20.8 is about twice the time for the wave to travel. This assumes unstratified flow in the river which is not always the case. In the summer backwaters from Watts Bar Dam are warmer than the Clinch River water released from Norris Dam and which cause the Norris water to flow under the pooled water, a stratified flow. The "duck under point" varies depending upon conditions in the river, but commonly occurs at about CRM 12.0. It is evident that the Clinch River is a highly complex hydraulic system.

The Clinch River is used for fishing, swimming, water skiing, irrigation, drinking water, and industrial cooling. The river is also used for navigation, primarily coal barges, up to the K-25 steam plant at CRM 13. The use of the river

will be materially increased if the proposed Melton Hill Dam at CRM 23.1 is constructed. This would entail important channel changes and increased velocities and lower temperatures in the river.

RADIOACTIVE RELEASES TO THE RIVER

The Oak Ridge National Laboratory releases some radioactive material to White Oak Creek from the waste water treatment plant, earthen seepage pits, drainage of various reactor facilities, cooling water from the reactors, and storage from the bed of White Oak Lake.

White Oak Lake from 1943 to 1955 had been used as an impoundment for the wastes released from the Laboratory. This lake covered an area of 35 to 44 acres and had an average depth of 6 feet. Some of the wastes flowing from the Laboratory settled in White Oak Lake and were sorbed on the muds and silts. Eventually equilibrium was reached in the lake between inflow and outflow of radioactive materials and the lake was drained. Now the wastes flow in White Oak Creek through the bed of White Oak Lake. The gates at the dam are still operative and will be used to form a lake for temporary storage if high-level wastes should accidentally be discharged.

During the 10 years, 1948-1957, a total of 3600 curies have been discharged from White Oak Creek into the Clinch River. The major radioactive constituents have been the rare earths, strontium 89, strontium 90, cesium 137 and ruthenium 106. In addition, White Oak Creek discharges substantial quantities of nonradioactive chemicals, particularly nitrates. This chemical discharge and the slowing down and warming up of the Clinch River waters below White Oak Creek results in luxurious algal blooms in the nutrient rich waters.

The Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant also discharge wastes to the Clinch River. The wastes from the uranium processing at these plants, though of low activity, does increase the contaminant load of the river.

MPC STANDARDS FOR RELEASES TO THE RIVER

The present NCRP standards for drinking water used by the population at large

do not necessarily apply to concentrations in the Clinch River because the river is not used as a source for community drinking water supplies. It is also possible that fission products in the river in concentrations lower than these MPC standards could be reconcentrated in the bottom sediments and the biota to such an extent that hazardous conditions might develop. Studies of the continuous discharge of radioactive materials will lead to an understanding of the proper use of the river to assimilate radioactive wastes without detriment to man or to the environment.

CONTINUOUS RELEASE

The continuous discharge of radioactive material, by definition, will allow the physical, chemical, and biological environments to approach steady state conditions. The absorption and adsorption of the radioactive material by the suspended solids and biota will tend to decrease the concentration of radioactive material in the water. The physical processes of dispersal need not be considered because they apply only to the beginning and end of the flows. The rest of the time simple dilution is all that occurs, provided the contaminant is uniformly mixed by the time it reaches the cross sections of interest. The monitoring of continuous discharges must include measurements of concentration in the biota, mud, and water. Water used for drinking, irrigation, and recreation should not exceed acceptable dosages to downstream users. From the public health viewpoint, the most important elements of the environment to be monitored are those which are directly involved in human food chains, namely, water, fish, and irrigated agricultural crops. It would be desirable, of course, to monitor the entire food-web in order to determine concentrations and ecological effects in the environment as a whole.

Present Program

The primary emphasis of the study of releases to the environment to date has been to ensure that the concentrations are below the maximum permissible concentrations for drinking water recommended by the National Committee on Radiation Protection. By

insure this, the liquid wastes from ORNL are continuously sampled in White Oak Creek at the White Wing Dam and on the Clinch River at K-25, the Gaseous Diffusion Plant. The U. S. Geological Survey measures the amount of flow in White Oak Creek and in the Clinch River so that the concentration of wastes in the River, assuming complete dilution, is obtained. The daily samples at White Wing Dam are composited and counted for gross beta and gamma. A portion of the flow is brought past a G-M tube and the count rate telemetered back to the area control laboratory. If the count should be high, White Wing Dam would be closed until such time as the activity had decayed or some remedial action had been taken.

Weekly composite samples are analyzed radiochemically for plutonium. Monthly composite samples are analyzed radiochemically for strontium, cesium, ruthenium, iodine, zirconium, trivalent rare earths, niobium, barium, and cobalt. Once the radioactive materials pass out of White Oak Creek, they then flow into the Clinch River and eventually into the Tennessee River. Each year the Laboratory has conducted a survey of the amount of radioactive materials in the Clinch and Tennessee River sediments. Water samples are also taken. The River bottom is sampled every 2 miles in the Clinch River and approximately every 10 miles in the Tennessee River and in its reservoirs. Fifty-foot intervals are used in the Clinch River cross sections. An average of ten readings and samples are taken per cross section in the Tennessee River and at Watts Bar and Chickamauga reservoirs. The gamma radiation of the bottom sediments in place is measured by 12 battery-operated G-M tubes connected in parallel. Bottom sediments are also analyzed for their radiochemical constituents. A water sample is collected daily at Center's Ferry near Kingston, Tennessee, and composited for a three-month period. The composite is filtered and concentrated. The residue of suspended solids and the concentrate are analyzed for fission products to determine the level and composition of the radionuclides existing in the Clinch River waters.

The highest concentration of radioactivity in the river bottom sediments is about eighteen times background and is located about 10 [illegible]

of White Oak Creek and the Clinch River where the velocities are slowed. The concentration of radioactive materials in the River falls off very quickly after the first 20 miles and is only about twice background at 100 miles and approaches background at 150 miles downstream, though fission products are still detectable by sediment analysis. At this level it is difficult, if not impossible, to distinguish between fall-out and waste disposal contaminants. The level of radioactive contamination in the bottom sediments drops off rapidly below each dam in the Tennessee River, and increases again as the next dam is approached. This, of course, is because the water velocity decreases at the dam, and particles settle out.

Proposed Program

We plan to increase this program to such an extent that a budget of the radioactive material in the river can be established. It is necessary to determine what is already in the river, what we are adding to the river, and what is leaving the river. This budget will require a more detailed analysis of the wastes leaving the Laboratory and a more detailed determination of the radioactive material in the water, mud, and biota. Additional sampling stations will be established on the river both upstream and downstream from White Oak Creek. These stations will be located with respect to the TVA silt ranges.

The main sampling stations will be located upstream as far as the site of the proposed Melton Hill Dam and downstream as far as the entry of the Emory River, Clinch River Mile 4.4.

The construction of Melton Hill Dam will have an important effect on the velocities, temperatures, and sediment transport of the Clinch River. It is estimated that the Clinch River waters at White Oak Creek will be 5 degrees F lower than at present. This could mean that the nutrient-rich White Oak Creek waters would float on the surface of the Clinch River a good deal of the time.

The changes in the channel of the river to accompany the discharge from Melton

deposition. An immediate start in the river program will also make it possible to watch the build-up of sediments in new areas and to determine the means and mechanism thereof.

Water samples will be taken to determine the radioactive and chemical constituents. The cross sectional distribution of the radioactive materials in the water phase will be determined.

The bed load movements will be investigated to determine the amount of deposited silts that are being resuspended and to evaluate the effect of high velocities upon resuspension of silts. Silt samples will be examined to correlate radionuclide uptake with mineral species. It is planned that the USGS Geochemistry and Petrology Branch will determine the mineral species.

The last survey of contamination of game fish in the Clinch River, made in 1948, sampled fish at two locations - one just below the White Oak Creek outfall and the second at Clinch River Mile 18 to 19 (about 6 -1/2 miles below the outfall). No collections were made above the outfall. Of the radioactive fish collected in the river proper all were well within MPC standards in operation at that time. It would be desirable to survey for radioactive contamination the game fish species above and below White Oak Creek. The extent of a fish survey would be governed

by the information obtained on water and silt contamination and by the ecologic data.

The general objective of the ecological research on the Clinch River is to obtain an understanding of the steady-state chemical and biological composition of the Clinch River ecosystem. To obtain an understanding of the system:

1. The population densities, distributions, biomass and radionuclide concentrations in the major bottom-dwelling organisms such as shellfish (clams), crustacea, and insects will be determined.

2. The seasonal and annual composition and variation of the Clinch River above and below the White Oak Creek outfall will be characterized. This objective will involve selecting suitable segments of the river for detailed study and analyses. Measurements will include the chemical and radiochemical composition of both organic and inorganic phases of the river water. For example, nitrogen, phosphorus, carbonates, stable isotopes as well as radioactive ones, temperature and turbidity will be measured. Total oxygen and carbon dioxide will be measured to determine the gross primary productivity which is the total rate of photosynthesis in the flowing water mass.

3. The movement and rates of biological and chemical cycling of strontium 90, cesium-137 and other isotopes in the Clinch River will be measured. This work would include field and laboratory studies on rates of uptake and turnover of isotopes by characteristic river organisms under steady and non-steady state conditions and varying substrate conditions.

INTERMITTENT RELEASE

An intermittent release may be characterized as one in which physical processes in the stream play the primary role, while the biological and chemical processes are subordinate. In other words, the "slug" of radioactive material will pass through each cross section of the stream so rapidly that it will not come to

chemical or biological equilibrium with the biota and sediments. For the sake of simplification, therefore, we may ignore the uptake and deposition due to chemical and biological processes and determine the dispersion of radioactive materials due only to physical processes. It is possible to determine dispersal patterns of intermittent releases by three methods.

Present Program:

A series of small scale tracer tests are being run this summer as part of the training program for the AEC Radiological Physics fellows. The tests are particularly concerned with hydraulic conditions at the mouth of White Oak Creek and background radiation measurements above White Oak Creek. Through the cooperation of the USGS, velocity and temperature profiles are obtained at the same time.

Two years ago tracer studies were run when TVA maintained steady flow in the river for determining the degree of reaeration of the Clinch River below Norris Dam.

Tracer-level tests were run on July 4-7 and July 9-13. The TVA maintained a steady flow in the Clinch River of 3000 cfs for the first test and 6000 cfs for the second test. On each test, 5 curies of I^{131} was injected into White Oak Creek at its confluence with the Clinch River. Liquid samples were taken periodically during the course of the test at Clinch River miles 19.6, 17.8, 15.5, 14.0, and 13.1 (stations A, B, C, D, and E, respectively) (Fig. 1). Scintillation counters were used for measuring the concentration of radioiodine flowing past the sampling stations. Through a cooperative arrangement with the U.S. Geological Survey, the flow through this reach of the river was measured during the test. The velocity and temperature profiles at the sampling stations were also determined by the U.S. Geological Survey.

Additional liquid samples were collected downstream at Centers Ferry (CRM 4.4) and at the Kingston Steam Plant (Emory River intake). While the results have not been completely evaluated, preliminary studies of the first test at CRM 19.6

(station A) show clearly that complete dilution was not attained, under the river conditions existing during the time of the test. A definite temperature gradient exists (Fig. 2) causing the concentration profile shown in Fig. 3. The contaminated White Oak Creek water flows below the surface waters of the Clinch River and remains close to the right bank, only gradually spreading across the river. Further downstream at station C, CRM 15.5, complete dilution was obtained.

Proposed Program: 1. Analytical

First is the purely analytical approach based on the theories of fluid mechanics. Because of the inhomogeneities in cross section, gradient and level of the stream, and the variablenes in flow and temperature, simplifying assumptions must be made. The simplified equation and its solution is

$$\frac{\partial^2 c}{\partial x^2} - \frac{v}{a^2}\frac{\partial c}{\partial x} - \frac{(\lambda + N)c}{a^2} = \frac{1}{a^2}\frac{\partial c}{\partial t} \qquad (1)$$

$$c = \frac{M}{\sqrt{4\pi\alpha^2 t}} \text{ exponent } \left(-\frac{(x - vt)^2}{4\alpha^2 t} - (N + \lambda)t \right) \qquad (2)$$

where C and M are the concentration and mass of the contaminant, A the cross sectional area of the stream, α^2 the eddy diffusion coefficient, t the time after release of activity, x the distance downstream from the dosing point, v the mean velocity of the stream, N the gross river uptake coefficient, and λ the nuclear decay coefficient.

It is obvious that all the unknowns and uncertainties of the biological and chemical processes are lumped together in the river uptake coefficient.

Proposed Program: 2. Field Testing

It is necessary to run a series of field tests, which is the second method of studying intermittent releases, with various isotopes to determine the river uptake

cofficient and the eddy diffusion coefficient for the particular conditions under which the tests were run. The coefficients are obtained from the field test data by plotting the per cent of the contaminant passing each station on semi-log paper versus time and from the slope determining the combined nuclear decay and river absorption coefficient. The eddy diffusion coefficient can be determined by multiplying the flow-through curves by the combined nuclear decay and river uptake coefficient to make the normalized area under the curve equal to 1. Then taking advantage of the fact that the flow through curve is a skewed Gaussian curve, the eddy diffusion coefficient is found by use of the properties of the moment generating function to be equal to

$$\alpha^2 = \frac{x^2}{2} \frac{m_2}{(m_1)^3} \qquad (3)$$

where x = distance downstream from the dosing station, m_2 = second moment generating function about the origin, m_1 = first moment generating function about the origin. When average values for eddy diffusion and river uptake coefficients have been determined for a wide variety of conditions, then it should be possible using equation 2 to determine the contaminant flow through curves. Without these experimentally determined values, the utility of the first method is relatively limited.

The problems of field testing, such as irregular flows, temperature changes, large man power and equipment requirements, and the necessity of many tests to obtain results under representative conditions, are manifold; however, it is the only exact method possible.

Proposed Program: 3. Model Testing

A third possible method is model testing where flow, temperature, and elevation can be varied easily over wide ranges and can be related to prototype once the

model has been verified. A model is verified hydraulically to insure that the velocities and direction of flow are in proper agreement with the prototype. The model would also need to be verified in these tests for temperature distribution, as the density currents resulting from the variations in temperature play an important role in the dispersion of the radiocontaminants. The model would be scaled by the Froude number $\frac{v}{\sqrt{gl}}$ where v is velocity, g is gravitational acceleration, and l is distance, as the gravitational effects are more dominant than the viscous effects. The surface tension and elastic compression of the water can be safely ignored in open channel tests. No model can, of course, reproduce the effects in the prototype, since the viscous forces, surface tension, and elastic compression [illegible] in the flow regime. However, [illegible] changes in concentration due to changes in flow, weights, etc., can be measured with sufficient accuracy for engineering works.

The model is planned to cover the stretch of the river between White Wing Bridge, CRM 23.7 and Brashear Creek CRM [illegible] The maximum depth of water [illegible] is necessary to use a vertically distorted model. Otherwise, if the model-prototype ratio were 1 to 1000, the depth in model would only be three hundredths of a foot. At that maximum depth and a lower average depth, viscous effects and surface tension would become important in the model though not in the prototype.

At present it is planned to build a simplified model to determine the entrance conditions from White Oak Creek into the Clinch River. A series of small scale tracer tests, including velocity and temperature measurements, are being made this summer to provide the data necessary to verify this simplified model. The large model will be built in sections with the first section covering river miles [illegible] to 19.6. If dispersion is complete by that station, then the rest of the model can be neglected. If testing shows that dispersion is not complete at Mile 19.6, then another section of the model will be built. If the horizontal scale were [illegible] than the [illegible]

CONCLUSION

The best solution to the intermittent test, and the continuous test as well, is a synthesis of all three methods, combined with the information developed by the study on the rates of uptake of the various isotopes by individual organisms, muds, and flora. Then it should be possible to use the model data, the field test data, and the ecological information to obtain the constants necessary for the mathematical model of the system and to calculate the flow-through curves of the contaminant for a wide variety of conditions. This is essentially the approach that we are using at present to evaluate the water-borne hazards of the startup of the N. S. Savannah at Camden, New Jersey.

Program Fiscal Years 1960-1961

During the next two years we propose to implement the above over-all plans by:

(1) Year-round survey above and below the confluence of White Oak Creek with the Clinch River for radionuclide composition and concentrations in: (a) sediment samples which will be correlated with TVA silt ranges to determine the total radionuclide load in the sediments. Continuing surveys will check the build-up in these sediments and if equilibrium is being reached. In particular, surveys will be made during periods of low and high flows to determine the effect of such flows on the total contaminant load. (b) water samples which will be taken as part of the limnological study to determine the activity and chemical distribution across the stream and downstream for the various river regimes. The temperature profile, turbidity, and diurnal curve oxygen will also be measured.

(2) Fish collection at various points above and below White Oak Creek and analyses for radioactive content.

(3) Quantitative plankton and bottom invertebrate analyses.

(4) Tracer studies with releases occurring under a variety of river regimes.

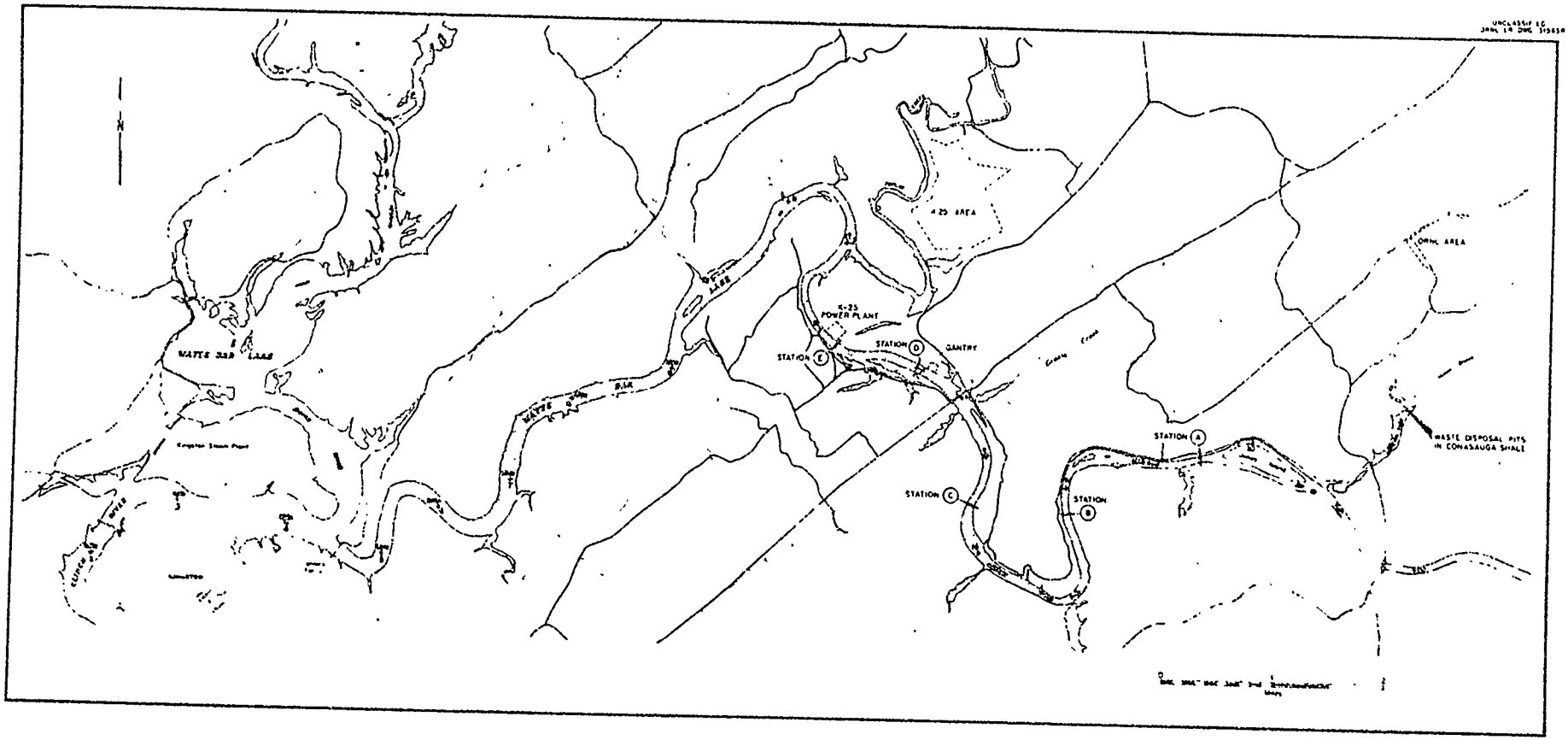
(5) Model testing of the reach of the river immediately downstream of White Oak Creek.

The above studies will be co-ordinated with the U. S. Geological Survey, TVA, Tennessee Stream Pollution Control Board, and the U. S. Public Health Service.

The estimated man power and dollar costs will be:

Year	Man Power	Costs
1960	3.3	$100,000
1961	3.8	150,000

These estimates include the man power and dollars supplied by the Ecology Section and the Applied Health Physics Section to carry out their respective shares of the program.


N
WATTS BAR LAKE
K-25 POWER PLANT
STATION F
STATION D
GANTRY
K-25 AREA
STATION A
STATION B
STATION C
WASTE DISPOSAL PITS IN CONASAUGA SHALE

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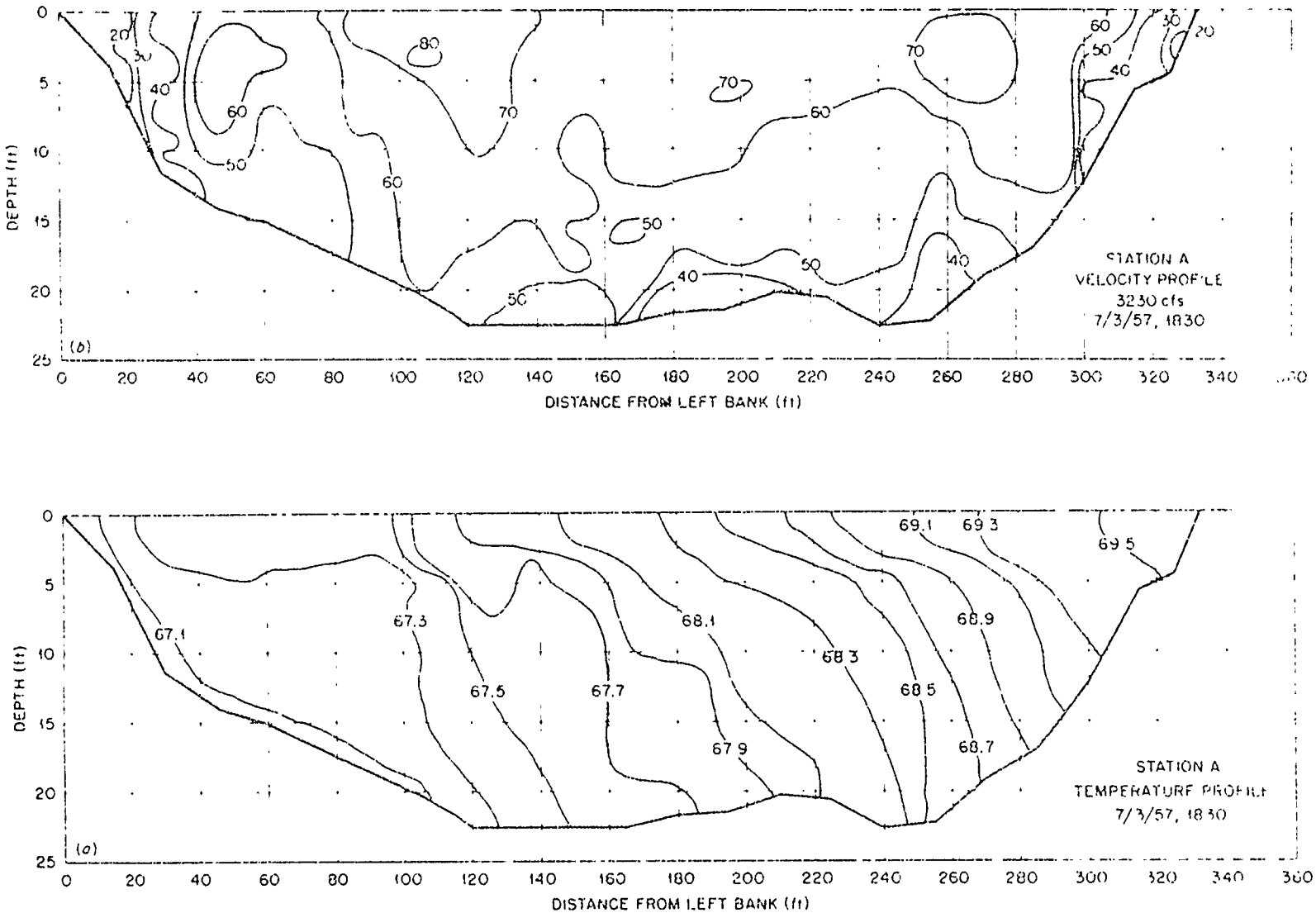

Fig. 2. Temperature (a) and Velocity (b) Profiles at Clinch River Mile 19.6, Test 1.

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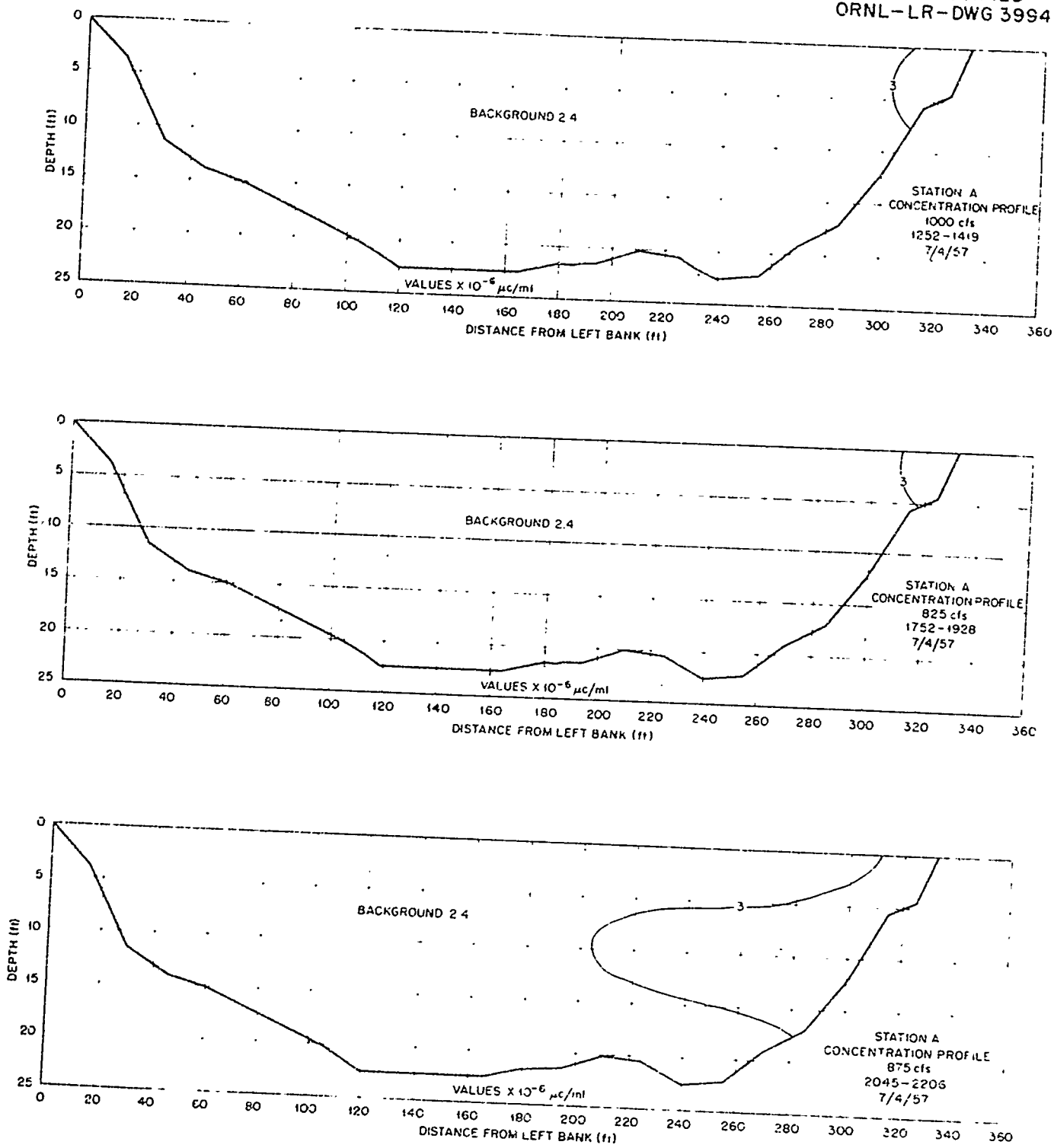

Fig. 3. Concentration Profiles at Clinch River Station A.

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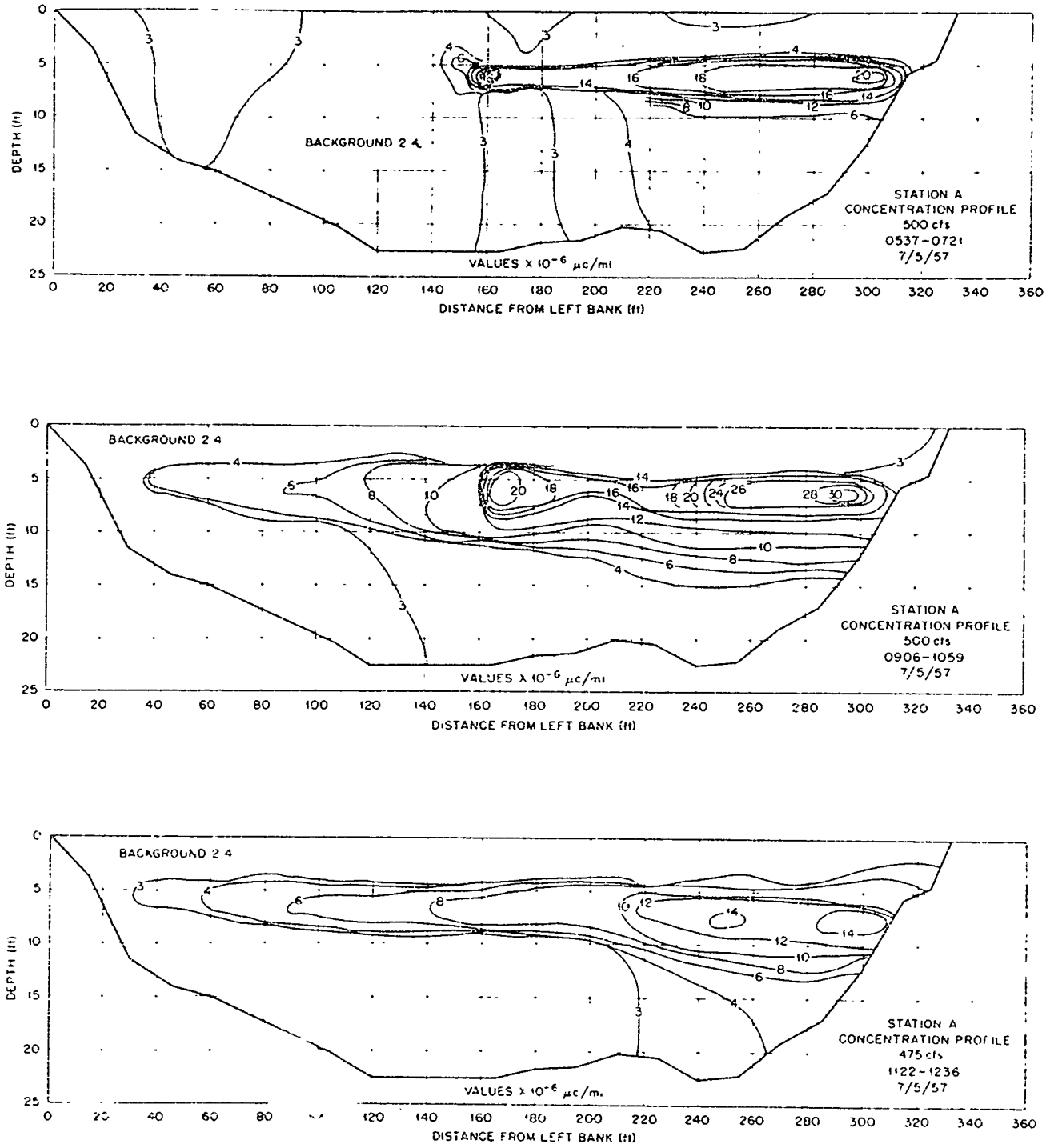

Fig. 3 (continued). Concentration Profiles at Clinch River Station A.

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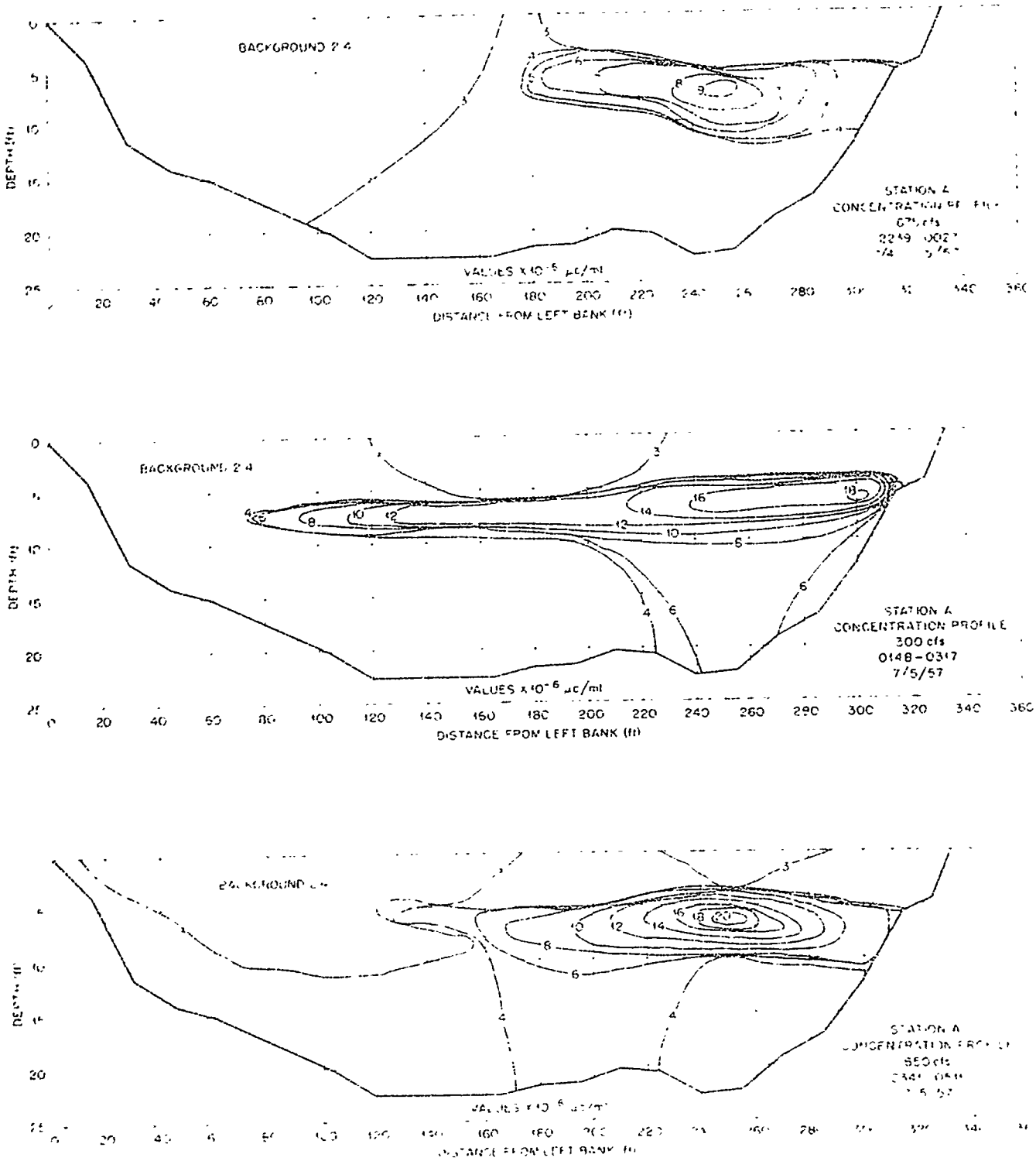

Fig. 3 (continued). Concentration Profiles at Clinch River Station A.

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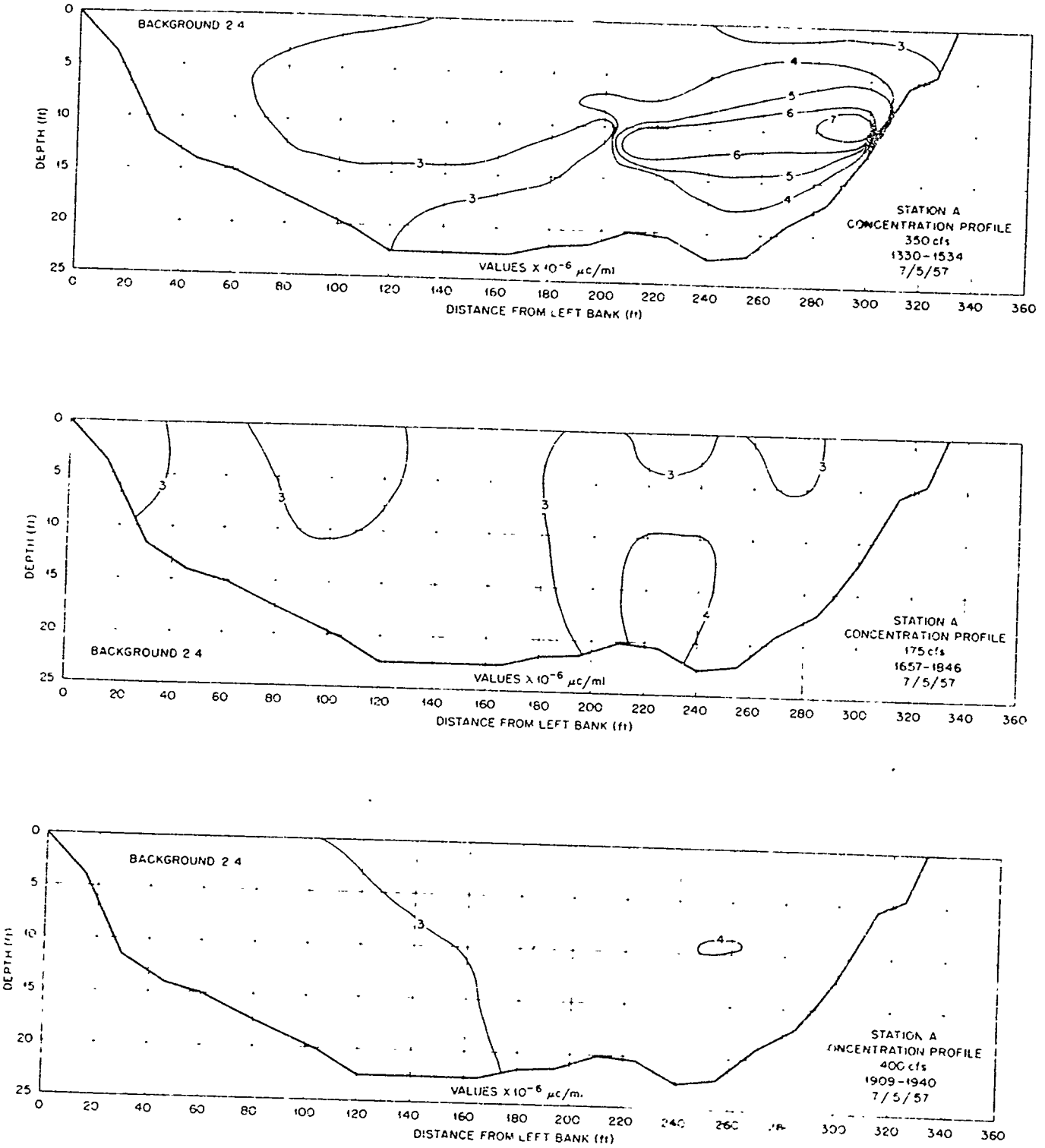

Fig. 3 (continued). Concentration Profiles at Clinch River Station A.

68A1096 #280 TMS Clinch River

PRELIMINARY REPORT ON CLINCH RIVER SAMPLES COLLECTED FEBRUARY 9-15, 1960 BY PERSONNEL OF THE U. S. PUBLIC HEALTH SERVICE

I. General

Samples of biota, mud, and water from the Clinch River were collected by personnel of the Cooperative Studies Unit, Radiological Health Research Activities, Division of Radiological Health, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio during the period February 9-15, 1960. Personnel from the Center who participated in this sampling were Dr. A. G. Friend, Mr. A. H. Story, Mr. M. Howell, and Mr. C. Henderson. The first three of these participants named are Sanitary Engineers attached to the Radiological Health Research Activities at the Center and the latter is an Aquatic Biologist with the Research Section of Water Supply & Water Pollution Control also at the Center.

Persons contacted during this trip were: Mr. Larry Miller, Chief of the Fish & Game Department, and Mr. Jack Chance, Fish Biologist, both of TVA at Norris, Tennessee; Mr. Wilbur Kochtitzky, Mr. Milo Churchill, Mr. Ward Filgo, and Mr. Buckingham of TVA in Chattanooga, Tennessee; Mr. Swearingen, Plant Superintendent of the Chattanooga Water Treatment Plant; Mr. Ralph Sinclair, and Mr. Harold Mulligan of the Tennessee Water Pollution Control Board; Mr. Price Wilkins and Mr. Ed Manges of the Tennessee Fish & Game Department; Dr. Frank Parker, Dr. Dan Nelson, Mr. Roy Morton, Mr. Ray Richardson, and Mr. Ken Cowser of the Health Physics Section, ORNL; and Mr. John Latendresse, Mr. Cecil (Meatball) Morse, and Mr. J. P. Lyons, all the latter being commercial fishermen in this area.

II. Location of Sampling Stations and Samples Collected

A. Station 1

Station 1 was the area above Norris Dam. The water sample from Station 1 was collected from the concession stand approximately 1/4 mile north of Norris Dam. The mud sample was collected in the vicinity of Pellissippi boat dock, approximately six miles above the dam on the Clinch River arm of the reservoir. One large fish sample was collected from the mouth of the cove at the boat dock and the other two fish samples were furnished by Mr. John Latendresse. These latter fish were collected from the upper reaches of Norris Reservoir where commercial fishing was going on at the time of this trip. The minnows from Station 1 were collected from a small stream flowing into the reservoir about three miles above Norris Dam by Mr. Mulligan and Mr. Sinclair of the Water Pollution Control Board.

NOTICE

This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and does not represent a final report.

In the stretch of the river between Norris Dam and White Oak Creek (I would estimate about half way) a sample of filamentous algae and one live clam were collected.

B. Station 2

The water sample from Station 2 was collected from White Oak Creek about 50 feet above its point of entry into the Clinch River. Fish samples were collected from the mouth of White Oak Creek and at a point about 150 yards downstream from the mouth. Bottom mud samples were collected in the vicinity of the dam on White Oak Creek, at the mouth of White Oak Creek and from the Clinch River about 150 yards downstream from the mouth. A sample of soil was also taken from the creek bank near the mouth of White Oak Creek.

C. Station 3

The water sample collected at Station 3 was taken from the center pier of the Gallaher Bridge located near the mouth of Grassy Creek. Bottom mud samples were collected about one mile below the mouth of Poplar Creek at buoy 10.9 and about 200 yards below the point of entry of Poplar Creek into the Clinch River. Fish samples were collected just above and just below Gallaher Bridge. A medium-size eastern painted turtle was collected in the gill net just below Gallaher Bridge. We are indebted to Mr. Ed Manges of the Tennessee Fish & Game Commission for his aid in collecting the fish samples at Station 3.

D. Station 4

The water sample from Station 4 was collected on the south bank of the Clinch River at Anderson Ferry almost opposite the point where the Emory River enters the Clinch. Mud samples were collected at the mouth of the Emory River and about 1/4 mile above Anderson's Ferry in the Clinch River. Large fish from Station 4 were collected about 1/2 mile below highway 70 bridge west of Kingston. The small fish sample at Station 4 was collected at the same point as the mud samples about 1/4 mile above Anderson's Ferry.

E. Station 5

The water sample at Station 5 was collected immediately above the face of the Fort Loudon Dam. We are indebted to the Security Officers at the Dam for changing sample bottles every day, thus relieving us of the necessity of visiting this sampler daily. The mud samples from Fort Loudon Reservoir was collected about eight miles above the dam at a public picnic area. The fish samples were collected from the same

Sample Type
Algae bags
Clam (shells)
Crayfish
Fil. algae
Filter sand
Fish
Mud
Plankton tow
Rock
Sand wash H_2O
Sludge
Spinach bags
Snails
Tea bags
Turtle
Water

Station Totals

1 - Clinch Rive
2 - " "
3 - " "
4 - " "
5 - Tennessee R
6 - "
7 - "
X - Three diffe

area. For these fish collections we are indebted to Principal Trout Biologist of the Tennessee Fish & Ga accompanied us to this area and furnished the boat a the collections were made.

F. Station 6

The water sample from Station 6 was collec race below Watts Bar Dam. The mud sample (sand) was 1/2 mile below the Dam. A sample of clam shell from also collected for analysis.

G. Station 7

The water samples from Station 7 were coll Swearingen, Plant Superintendent of the Chattanooga W Plant. These daily samples consisted of hourly compo raw intake water and the treated water. Mr. Swearing for us a sample of settled filter sludge approximatel a sample of back-wash water, and a sample of used fil Chattanooga Water Treatment Works. Mud samples were upstream face of the Chickamauga Dam and from South C about 1/4 mile from its mouth and below the heavy met effluent of which was discharged into this creek. Fi Station 7 consisted of four catfish from the vicinity nessee in the Chickamauga Reservoir. One medium size collected immediately below the Chickamauga Dam and a was collected from Hales Bar Dam near Shellmound, Ten

In addition to the above samples three bot were collected from Bear Creek on the Oak Ridge Reser listing of all samples analyzed is shown in Table 1. however, the numbers do not indicate individual sampl the trip but samples analyzed, e.g. an individual fis one to seven samples when separated into component pa purposes.

III. Discussion of Results

A. Water

Gamma spectra of water samples collected at tions on the Clinch and Tennessee Rivers are shown in nuclide concentrations for these various samples are s The predominant radioisotopes found were Ce^{144}-Pr^{144},

Cs^{137}-Ba^{137m}, Co^{60}, and Sr^{90}. Traces of Zr^{95}-Nb^{95} and Zn^{65} were indicated by these spectra. Plots of the activities of the various isotopes at the various stations are shown in Figure 2. From this plot it will be noted that the Ce^{144}-Pr^{144} and Co^{60} disappear from the water phase quite rapidly -- little activity from either of these nuclides being noted beyond Station 3. Cs^{137} also seems to disappear from the water phase quite rapidly -- no activity from this isotope being indicated below Station 4. The ruthenium and strontium, however, appear to remain in the water phase for appreciable lengths of time as indicated by the plots on Figure 2 for these elements. It is probable that this rapid reduction in concentration in the water phase is due to the uptake of Ce^{144}-Pr^{144}, Co^{60}, and Cs^{137}-Ba^{137m} by the bottom muds either due to ion exchange, to adsorption, or to precipitation.

B. Bottom Muds

Gamma spectra of bottom mud samples collected at the various stations on the Clinch and Tennessee Rivers are shown in Figure 3. Station 1 and 5 are to be considered as background. It will be seen that the same isotopes found in the water also appear in the spectra of the bottom muds with much higher concentrations. Radionuclide concentrations for these various samples are shown in Table 3. A plot showing the concentrations of the various radionuclides in the bottom muds is shown in Figure 4. The low values shown at Station 6 which were collected at Watts Bar Dam are probably due to scour in this area and also to the fact that the mud sample from this station showed very little clay content from visual inspection, the main component being sand which has very low ion exchange capacity. The high concentrations further down the river at the face of Chickamauga Dam were consequently due to the deposition of materials transported by the river or may be due to ion exchange <u>in situ</u>. Figure 5 shows gamma spectra of bottom mud samples collected from some of the tributaries flowing into the Clinch and Tennessee Rivers in the reaches under study. These streams include White Oak Creek, Bear Creek, Poplar Creek, and South Chickamauga Creek. Also shown is a spectrum of the mud samples collected from Loudon Reservoir. Corresponding nuclide concentration in the bottom muds as determined from these samples are shown in Table 4. As might be expected the nuclide concentration values reported for the sample collected from White Oak Creek are quite high with the presence of Ce^{144}-Pr^{144}, Ru^{106}-Rh^{106}, Cs^{137}-Ba^{137m}, Zr^{95}-Nb^{95}, and Co^{60} indicated. The spectra of mud samples collected from Poplar Creek also show the presence of the same nuclides as those found in the White Oak Creek samples, although the concentrations are lower by a factor of one or two orders of magnitude. Whether these isotopes found in the mud at Poplar Creek originated from White Oak Creek or whether it reflects discharge practices in the K-25 was

TABLE 2

RADIONUCLIDE CONCENTRATION IN WATER AT VARIOUS STATIONS AT CLINCH AND TENNESSEE RIVERS

Feb. 9 - 15, 1960

STATION	$Ce\text{-}Pr^{141-144}$ uuc/l	$Ru\text{-}Rh^{106}$ uuc/l	$Cs\text{-}Ba^{137}$ uuc/l	$Zr^{95}\text{-}Nb^{95}$ uuc/l	Zn^{65} uuc/l	Co^{60} uuc/l	Sr^{90}* uuc/l
1 (430)	---	---	---	---	---	---	0.5
2 (432)	985	14,300	1900	T	---	321	2825
3 (373)	625	870	115	---	---	17	19.7
4 (431)	---	890	96	T	---	T	5.8
5 (228)	---	---	---	---	---	---	0.4
6 (429)	---	110	---	T	---	T	1.5
7 (Raw) (427)	---	525	---	---	T	T	4.4
7 (Treated) (428)	---	230	---	---	---	T	3.6

* Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 3

RADIONUCLIDE CONCENTRATIONS IN BOTTOM MUD SAMPLES FROM THE CLINCH AND TENNESSEE RIVERS

Feb. 9 - 15, 1960

SAMPLES Location	Ce^{144} uuc/kg*	Ru^{106} uuc/kg*	Cs^{137} uuc/kg*	Zr^{95} uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Ft. Loudoun Resevoir (213)	1160	---	T	70	---	---	283
Norris Dam Resevoir (202)	940	350	T	70	---	---	74
Clinch River at mouth of White Oak Creek (204)	2.32×10^6	2.44×10^6	8.75×10^6	7.6×10^4	---	5.1×10^5	9.7×10^4
Clinch River 150' below mouth of White Oak Creek (206)	5.7×10^4	1.0×10^5	3.64×10^5	4.12×10^3	---	2.1×10^4	8.6×10^3
Clinch River 300' above Gallaher Bridge (207)	2.75×10^6	3.98×10^6	3.16×10^5	2.36×10^5	---	2.5×10^5	5.0×10^3
Clinch River at mouth of Emory River (212)	1900	4450	11,000	T	---	600	900
Clinch River 1200" above Anderson Ferry (211)	1.77×10^4	4.2×10^4	8.85×10^4	1.17×10^3	---	880	260
Tennessee River below Watts Bar Dam (214)	---	T	790	T	---	---	170
Tennessee River at face of Chickamauga Dam (215)	2900	3200	6100	210	---	690	535

* Dry weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 4

RADIONUCLIDE CONCENTRATIONS IN BOTTOM MUDS OF CLINCH AND TENNESSEE RIVER TRIBUTARIES

Feb. 9 - 15, 1960

SAMPLING Location	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr^{95}\text{-}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
White Oak Creek Dam (203)	5.02×10^6	6.64×10^7	3.79×10^7	7.32×10^6	---	2.85×10^6	1.03×10^6
Mouth of White Oak Creek E (205)	1.12×10^6	2.45×10^6	9.25×10^6	1.53×10^6	---	7.65×10^5	3.59×10^5
Bear Creek at White Wing Rd. (217)	---	---	---	---	---	---	21
Ft. Loudoun (213)	---	---	T	---	---	---	295
Bear Creek (Rock) at White Wing Rd. (220)	---	---	T	---	---	---	63
Bear Creek, White Wing Rd. and Turnpike (221)	---	---	T	---	---	---	
Bear Creek (Gravel) (219)	---	---	T	T	---	---	32
Poplar Creek E (208)	5.86×10^5	1.2×10^6	5.0×10^6	2.96×10^4	---	3.36×10^5	802
Poplar Creek 200 yds. up from mouth (210)	1.23×10^5	3.82×10^5	4.29×10^5	2.05×10^4	---	3.97×10^4	770
Poplar Creek 200' below K-25 fence (209)	---	---	1.2×10^5	---	---	2.5×10^5	532
S. Chickamauga Creek (216)	3700	---	---	455	---	---	331

* Dry weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

not determined at this time. From the data, however, it appears that the former premise is more dependable since activity levels are lower upstream in Poplar Creek than at the mouth. From the sample collected at Bear Creek little activity due to man-made nuclides appeared although peaks are present which indicate some activity due to decay products of both Th^{232} and U^{238}. The same may be said of the sample collected at Fort Loudon Reservoir.

It has been reported that a heavy-metals industry located on South Chickamauga Creek just above Chattanooga might be responsible for the high activity levels of Sr^{90} reported by the Basic Water Quality Network for Tennessee River water at Chattanooga. While in Chattanooga we inquired as to the activity of this industry and were told that it had discontinued operation about eight months prior to this visit. However, in order to determine if there was a reservoir of activity in the bottom muds of the South Chickamauga Creek which might be slowly released into the water, a bottom mud sample was collected about 1/4 mile from its point of confluence with the Tennessee River. The gamma spectrum of this mud sample shows little activity due to man-made nuclides; however, peaks do indicate the presence of decay products of U^{238} and Th^{232}.

C. Fish

In general when the samples were large enough they were divided into component parts consisting of flesh; bone; scales; liver; gill, heart, and thyroid; stomach, intestines, and contents; and the remaining viscera. Each of these samples was analyzed separately in order to determine the location of specific radionuclides in the body.

1. Stations 1 and 5

Gamma spectra of fish samples collected from Station 1 (Norris Reservoir) and Station 5 (Fort Loudon Reservoir) are shown in Figures 6, 7, 8, and 9. Nuclide concentrations are shown in Tables 5, 6, 7, and 8. For relative values these samples were taken as background, i.e. do not reflect any influences from the discharge of White Oak Creek to the Clinch River. It will be noted that in general slight concentrations in nuclides are reported, this activity probably being due to fallout on the water shed from weapons test.

2. Station 2

The fish collected from White Oak Creek were small and consequently it did not seem advisable to divide them into seven samples as we did for larger fish. These small fish were divided into two samples. They were gutted and the insides counted as one sample, the remainder of the fish counted as another.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN CARP FROM STATION 1, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce-Pr^{141-144}$ uuc/kg*	$Ru-Rh^{106}$ uuc/kg*	$Cs-Ba^{137}$ uuc/kg*	$Zr^{95}-Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Scales (400)	---	213	T	256	385	---	21
Flesh (401)	---	---	36	14	---	---	
Bone (406)	---	545	372	---	---	---	22
Liver (403)	---	T	---	---	---	---	
Intestines and Contents (404)	---	---	---	---	---	---	
Viscera (405)	---	390	T	---	---	---	
Ovaries (406)	---	167	T	---	---	---	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 6

RADIONUCLIDE CONCENTRATION IN CARP-SUCKER (QUILLBACK) FROM NORRIS RESERVOIR, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce-Pr^{141-144}$ uuc/kg*	$Ru-Rh^{106}$ uuc/kg*	$Cs-Ba^{137}$ uuc/kg*	$Zr^{95}-Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Scales (386)	---	480	110	T	---	---	
Flesh (387)	---	320	T	---	---	---	
Bone (388)	---	440	---	70	300	---	28.5
Intestine and Contents (389)	---	T	T	---	---	---	
Liver (390)	---	T	T	---	---	---	
Viscera (391)	---	220	T	---	---	---	
Gills (392)	---	460	---	80	---	---	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 7

RADIONUCLIDE CONCENTRATIONS IN CARP FROM THE TENNESSEE RIVER AT STATION 5

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr^{95}\text{-}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Scales (393)	---	---	200	T	200	T	7.8
Flesh (394)	---	260	---	---	145	---	
Bones (395)	---	750	T	770	3320	T	5.5
Gills (396)	1320	440	---	70	280	T	
Liver (397)	---	950	220	100	---	---	
Intestine and Content (398)	---	720	290	---	---	T	
Viscera (399)	---	---	130	70	---	T	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

The samples collected from White Oak Creek represent three species, gizzard shad, white bass, and sauger. The gamma spectra obtained from the analyses of these fishes are found in Figure 10. Radionuclide concentrations found in these species are shown in Table 9. It is interesting to note that the activities of the gizzard shad were significantly higher than those of the white bass and sauger on a per kilogram basis. This is probably due to the fact that the gizzard shad are lower in the food chain than the game species represented by the bass and sauger; and consequently,due to their feeding habits, accumulated greater quantities of all the nuclides than did the latter.

3. Station 3

Gamma spectra of the component parts of two game species of fish, white bass and sauger, are shown in Figures 11 and 12, respectively. Corresponding nuclide concentrations are shown in Tables 10 and 11. Since these are game species of fish the nuclide concentrations are smaller than would be the case with filter and bottom feeding fish. The concentration of nuclides from the component parts of the latter type fish are shown in Tables 12, 13, and 14. Gamma spectra for these samples are shown in Figures 13, 14, and 15.

The nuclides present in the fish collected at Station 3 are identical with those found in White Oak Creek and with the water collected from White Oak Creek; however, the corresponding levels of activity are appreciably lower. The nuclides found were Ce^{144}-Pr^{144}, Ru^{106}-Rh^{106}, Cs^{137}-Ba^{137m}, Zr^{95}-Nb^{95}, Zn^{65}, Co^{60}, and Sr^{90}.

The nuclide concentrations in the carp from Station 3 presents an interesting picture. A perusal of the values shown in the Figure indicate that practically all the activity is tied up with the stomach, intestines, and content. One might speculate that this fish had probably spent most of its time in the Clinch River upstream of White Oak Creek or in one of the tributaries flowing into this area and that it had only recently moved into the area where it was caught. If this were true, then the high nuclide concentrations of ruthenium and cesium in the intestinal samples would indicate that this was taken up with the food and that the fish had not been able to assimilate and fix this in his body organs to any extent. Conversely one might say that the gizzard shad from this station had spent an appreciable length of his time in waters with relatively high nuclide concentrations.

4. Station 4

Three samples of game fish representing two species, sauger and smallmouth bass, were collected at Station 4. Gamma spectra of these samples are shown in Figures 16, 17, and 18, respectively. Nuclide concentrations are shown in Tables 15, 16, and 17.

TABLE 9

RADIONUCLIDE CONCENTRATIONS IN FISH FROM WHITE OAK CREEK

Feb. 9 - 15, 1960

SAMPLE	$Ce-Pr^{141-144}$ uuc/kg*	$Ru-Rh^{106}$ uuc/kg*	$Cs-Ba^{137}$ uuc/kg*	$Zr^{95}-Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Gizzard Shad Structure (298)	---	43,000	15,300	T	---	3000	
Gizzard Shad Viscera (299)	---	232,000	74,000	4,500	T	10,400	
White Bass Structure (303)	---	8,900	2,900	60	710	---	56
White Bass Viscera (302)	---	20,600	3,300	140	T	640	
Sauger Structure (301)	---	3,600	1,400	---	T	---	16
Sauger Viscera (300)	---	4,150	1,700	140	---	---	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 10

RADIONUCLIDE CONCENTRATION IN WHITE BASS, STATION 3, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce-Pr^{141-144}$ uuc/kg*	$Ru-Rh^{106}$ uuc/kg*	$Cs-Ba^{137}$ uuc/kg*	$Zr-Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Flesh (317)	---	345	700	30	T	T	
Bone (318)	710	1000	T	T	---	---	665
Viscera (319)	---	T	---	---	---	---	
Liver (320)	?	?	?	T	---	---	
Intestine and Content (321)	---	2300	700				
Scales (323)	---	T	T	150	---	---	635

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 11

RADIONUCLIDE CONCENTRATION IN SAUGER FROM STATION 3, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr^{95}\text{-}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Bones (284)	---	---	T	---	---	---	56
Flesh (285)	---	---	750	---	---	---	
Scales (286)	---	3300	900	---	---	---	430
GHT (287)	---	3300	950	---	---	---	
Liver (288)	---	---	T	---	T	---	
Viscera (289)	---	---	520	---	---	---	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 12

RADIONUCLIDE CONCENTRATION IN GIZZARD SHAD FROM CLINCH RIVER, STATION 3

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr^{95}\text{-}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Intestine and Contents (310)	8400	28,500	16,200	200	---	180	
Liver (311)	---	4,200	1,780	140	450	---	
Flesh (312)	---	---	1,100	---	900	---	
GHT (313)	---	2,200	2,600	T	250	---	
Viscera (314)	4400	13,700	74,000	230	660	970	
Bone (315)	720	1,760	1,550	60	710	---	850
Scales (316)	---	740	470	50	110	170	1080

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 13

RADIONUCLIDE CONCENTRATIONS IN SHIPJACK HERRING FROM STATION 3, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr^{95}\text{-}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Scales (229)	---	210	390	---	---	---	162
Gills (230)	---	2280	1050	---	180	---	
Ovaries and Testes (231)	---	T	1200	T	---	---	
Intestine and Contents (232)	---	800	660	---	---	---	
Liver (233)	---	---	800	---	---	---	
Viscera (234)	---	820	720	---	---	---	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 14

RADIONUCLIDE CONCENTRATIONS IN CARP FROM STATION 3, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce-Pr^{141-144}$ uuc/kg*	$Ru-Rh^{106}$ uuc/kg*	$Cs-Ba^{137}$ uuc/kg*	$Zr^{95}-Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Intestine and Contents (291)	---	9400	12,800	T	---	---	
GHT (292)	---	---	T	---	---	---	
Liver (293)	---	---	---	T	---	---	
Viscera (294)	---	---	T	---	580	---	
Scales (295)	---	---	T	---	530	---	290
Bone (296)	---	T	T	---	280	---	223
Flesh (297)	---	---	432	---	270	---	51

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

Gamma spectra of carp and carp sucker from this same station are shown in Figures 19 and 20. Nuclide concentrations found on analyses from their component parts are shown in Tables 18 and 19. The same error in drawing conclusions concerning uptake by fish which has been stated for the smallmouth bass are more vividly pointed up by comparing these two samples of fish which have similar feeding habits. Here the nuclide concentrations are significantly different.

Gamma spectra of small fish samples collected at Station 4 are shown in Figure 9.

5. Station 7

A fish sample consisting of four catfish, collected from the Chickamauga Reservoir at Hixson, Tennessee, was obtained from a commercial fisherman. The gamma spectra obtained from composited component samples obtained from all these fish are shown in Figure 21 and nuclide concentrations are shown in Table 20. The results of the analyses of these fish for radioactivity are surprising since none of the man-made isotopes appear in concentrations large enough for determination by gamma spectroscopy, although the gamma spectra do indicate the presence of the decay products of Th^{232} and U^{238} in measureable quantities. Strontium-90 concentrations were determined by radiochemical means. Here again one might speculate that these fish had spent all of their life in one of the tributaries which is not effected by discharge practices of ORNL and had only recently migrated into the Tennessee River proper. Such an explanation would appear feasible provided the information we obtained from the commercial fisherman was true and these fish had been caught from the Chickamauga Reservoir on the preceding day.

Gamma spectra of a buffalo taken from Hales Bar Reservoir below Chattanooga are shown in Figure 22 and nuclide concentrations determined for these samples are shown in Table 21. With the exception of Ce^{144}-Pr^{144} and Co^{60}, all the other expected isotopes are present, some at surprisingly relative high levels.

D. Miscellaneous Aquatic Fauna

Gamma spectra of miscellaneous aquatic fauna consisting of snails, crayfish, clams, and a turtle are shown in Figure 23. Nuclide concentrations where they could be calculated are shown in Table 22. In some instances the counting geometry was not determined and consequently nuclide concentrations based on these gamma scans are not possible. However, all the samples, except the turtle, were submitted for radiochemical analyses and the results obtained for Sr^{90} are shown. It is significant to note the level of Zn^{65} found in the snail sample which was collected from a small stream flowing into Norris Reservoir, while only traces were found in those samples collected at other places.

TABLE 15

RADIONUCLIDE CONCENTRATION IN SAUGER FROM STATION 4, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr^{95}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Flesh (362)	---	840	490	T	---	---	
Bones (363)	---	1000	---	T	---	---	31
Intestine and Content (364)	---	2600	---	T	---	---	
Viscera (365)	300	370	T	---	185	---	

* Live weight

**Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 16

RADIONUCLIDE CONCENTRATIONS IN SMALLMOUTH BASS FROM STATION 4, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce-Pr^{141-144}$ uuc/kg*	$Ru-Rh^{106}$ uuc/kg*	$Cs-Ba^{137}$ uuc/kg*	$Zr^{95}-Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Scales (324)	2750	950	500	17	95	180	198
Flesh (325)	---	440	600	30	63	60	
Bones (326)	---	690	190	30	63	---	33.4
Liver (327)	---	490	370	54	390	---	
Viscera (328)	---	235	270	---	T	---	
Intestine and Content (329)	---	1050	485	25	85	T	
GHT (330)	---	2150	530	30	T	120	
Ovaries (331)	---	850	410	32	---	---	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 17

RADIONUCLIDE CONCENTRATION IN SMALLMOUTH BASS, STATION 4, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce-Pr^{141-144}$ uuc/kg*	$Ru-Rh^{106}$ uuc/kg*	$Cs-Ba^{137}$ uuc/kg*	$Zr-Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Intestine and Content (338)	---	T	T	---	---	T	
GHT (339)	---	T	T	T	T	T	
Scales (340)	---	490	380	---	T	---	109
Flesh (341)	T	450	570	---	---	---	
Bone (342)	T	---	650	T	150	T	
Liver (343)	---	---	---	---	---	---	
Ovaries (344)	---	T	T	---	---	---	
Viscera (345)	---	---	---	---	---	---	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 18

RADIONUCLIDE CONCENTRATION IN CARP FROM THE TENNESSEE RIVER AT STATION 4

Feb. 9 - 15, 1960

SAMPLE	$Ce-Pr^{141-144}$ uuc/kg*	$Ru-Rh^{106}$ uuc/kg*	$Cs-Ba^{137}$ uuc/kg*	$Zr^{95}-Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Scales (354)	---	---	---	---	---	---	60
Flesh (355)	---	440	460	T	---	---	
Bones (356)	---	310	T	---	---	---	41
Liver (357)	---	2600	T	41	---	---	
GHT (358)	---	700	120	20	140	---	
Intestine and Contents (359)	---	---	1000	77	145	---	
Viscera (360)	---	---	450	73	---	---	
Ovaries (361)	---	375	660	16	92	100	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 19

RADIONUCLIDE CONCENTRATIONS IN CARP SUCKER FROM STATION 4, CLINCH RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr^{95}\text{-}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Scales (346)	---	800	80	40	---	---	63
Flesh (347)	---	430	325	15	---	---	
Bones (348)	---	192	345	15	---	---	74
Liver (349)	---	42,000	2700	1600	7600	---	
Ovaries (350)	---	36,000	53,000	2900	8900	---	
GHT (351)	---	935	150	36	---	---	
Intestines and Content (352)	5100	30,000	17,000	146	390	770	
Viscera (353)	430	1600	435	---	90	140	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 20

RADIONUCLIDE CONCENTRATION* IN CATFISH, STATION 7, TENNESSEE RIVER

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg**	$Ru\text{-}Rh^{106}$ uuc/kg**	$Cs\text{-}Ba^{137}$ uuc/kg**	$Zr^{95}\text{-}Nb^{95}$ uuc/kg**	Zn^{65} uuc/kg**	Co^{60} uuc/kg**	Sr^{90}*** uuc/kg**
Flesh (366)	---	---	---	---	---	---	
Ovaries (367)	---	---	---	---	---	---	
Bone (368)	---	---	---	---	---	---	665
Intestine and Content (369)	---	---	---	---	---	---	
Viscera (370)	---	---	---	---	---	---	
GHT (371)	---	---	---	---	---	---	
Liver (372)	---	---	---	---	---	---	

* All gamma activity appears to be associated with natural activity.

** Live weight

*** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

E. Plankton

Plankton tows were obtained at four stations, 1, 5, 3, and 4. Gamma spectra of these samples are shown in Figure 24. These samples were quite small indicating a practical absence of plankton from the river system at this time of the year and consequently the nuclide concentrations on these small samples were so minute that their spectra appear as practically normal background.

F. Filter Sand from Chattanooga

Gamma spectra of filter sand as collected, after washing, and of two wash waters, are shown in Figure 25. Corresponding nuclide concentrations for these samples are shown in Table 23. The filter of the unwashed sand showed activity due to Ce^{144}-Pr^{144}, Ru^{106}-Rh^{106}, Cs^{137}-Ba^{137m}, and Co^{60}, with a trace of Zr^{95}-Nb^{95}. In order to determine if this activity could be removed from the sand by a simple backwash procedure, the sand sample was placed in an approximately equal volume of water and stirred for about five minutes. The result of the gamma analysis of the wash water, obtained from this washing, is shown as the third spectrum in Figure 25. After this preliminary washing the sand was again resuspended in about an equal volume of water and stirred quite rapidly for approximately 20 minutes to see if attrition between sand grains would remove any activity left on the sand after the first washing. A gamma spectrum of the second wash water is shown as the last curve on Figure 25, and a final gamma spectrum of the filter sand after the two washings is shown as the second spectrum of Figure 25. A glance at this latter spectrum indicates that the activity due to ruthenium, cesium, cerium, and cobalt are very firmly attached to the sand particles and would be difficult to remove by mechanical means. The type of fixation, however, is not determined.

TABLE 21

RADIONUCLIDE CONCENTRATIONS IN BUFFALO FROM STATION 7, TENNESSEE RIVER

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr\text{-}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*	Sr^{90}** uuc/kg*
Scales (408)	---	66	T	---	---	---	95.1
Flesh (409)	---	2600	185	---	---	---	
Bones (410)	---	1380	157	---	69	---	307.
Intestines and Content (411)	---	4400	207	---	---	---	
Liver (412)	---	1860	230	99	150	---	
Viscera (413)	---	142	T	55	110	---	
Gills (414)	---	---	T	---	---	---	

* Live weight

** Sr^{90} values shown only for samples analysed. Values obtained by radiochemical analyses.

TABLE 22

RADIONUCLIDE CONCENTRATIONS OF MISCELLANEOUS AQUATIC FAUNA FROM CLINCH AND TENNESSEE RIVERS

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg**	$Ru\text{-}Rh^{106}$ uuc/kg**	$Cs\text{-}Ba^{137}$ uuc/kg**	$Zr^{95}Nb^{95}$ uuc/kg**	Zn^{65} uuc/kg**	Co^{60} uuc/kg**	Sr^{90}*** uuc/kg**
Snails from Norris Resevoir (407)	---	T	---	---	2170	---	145.
Crayfish from Norris Resevoir (421)	---	---	---	---	---	---	118.
Clam from Clinch River above White Oak Creek (222)	---	T	---	---	T	---	35.8
Turtle from Clinch River, Station 3 (227)	+*	---	+*	+*	T	---	
Clam shells from below Watts Bar Dam (224)	T	T	T	T	T	---	1070

* (+) values indicate presence of nuclides, but counting efficiency not determined.

** Live weight

*** Sr^{90} values shown only for sample analysed. Values obtained by radiochemical analyses.

TABLE 23

RADIONUCLIDE CONCENTRATIONS OF FILTER SAND AND FILTER SAND WASH WATERS

FROM THE CHATTANOOGA WATER TREATMENT PLANT

Feb. 9 - 15, 1960

SAMPLE	$Ce\text{-}Pr^{141-144}$ uuc/kg*	$Ru\text{-}Rh^{106}$ uuc/kg*	$Cs\text{-}Ba^{137}$ uuc/kg*	$Zr\text{-}^{95}Nb^{95}$ uuc/kg*	Zn^{65} uuc/kg*	Co^{60} uuc/kg*
Unwashed Filter Sand (226)	330*	5700*	730*	T	---	100*
Twice Washed Filter Sand (384)	197*	2200*	370*	6*	32*	88*
First Wash Water residue (385)	14,400**	125**	34**	0.8**	---	---
Second Wash Water residue (426)	26**	653**	79**	---	4.**	T

* Dry weight

** uuc/liter

68A1096 #280 MHS Clinch River

OAK RIDGE NATIONAL LABORATORY

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UNION CARBIDE NUCLEAR COMPANY

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POST OFFICE BOX X
OAK RIDGE, TENNESSEE

March 3, 1960

MEMORANDUM REPORT NO. 1

to

The Clinch River Study Steering Committee

F. V. Durand, Director
State Game and Fish Commission
Cordell Hull Building
Nashville, Tennessee

A. G. Friend
U. S. Public Health Service
Robert A. Taft Sanitary Engineering Center
4676 Columbia Parkway
Cincinnati 26, Ohio

F. E. Gartrell
Health and Safety Division
Tennessee Valley Authority
Edney Building
Chattanooga, Tennessee

E. G. Godfrey
Surface Water Branch
U. S. Geological Survey
Washington 25, D. C.

S. Leary Jones
Tennessee Department of
Public Health
Cordell Hull Building
Nashville, Tennessee

Ex Officio

J. A. Lieberman
Environmental and Sanitary Engineering Section
Division of Reactor Development
U. S. Atomic Energy Commission
Washington 25, D. C.

MEDICAL, HEALTH & SAFETY 20-3 (Clinch R.)

A. A. Schoen
Biology Division
U. S. Atomic Energy Commission
Oak Ridge, Tennessee

I. E. Wallen
Environmental Sciences Branch
Division of Biology and Medicine
U. S. Atomic Energy Commission
Washington 25, D. C.

Subject: Progress Since Committee Meeting of January 21, 1960

I. Meeting of USPHS and ORNL Groups

Due to Al Friend's sudden illness on January 21, which prevented his attendance at the January 21 meeting, discussions pertaining to the participation of USPHS in the Clinch River Study were postponed until January 26th. On that day, Al Friend and C. Henderson of USPHS met with S. I. Auerbach, D. J. Nelson F. L. Parker and the writer at Oak Ridge.

The decisions of the Steering Committee made at the January 21 meeting, were relayed to Friend and Henderson as follows:

1. That the exploratory phase of this study, requiring a period of approximately 6 to 9 months, would deal with the sampling and analysis of river water, suspended solids, bottom sediments, bottom fauna and fish populations at mutually agreed upon collecting stations.

2. That the ORNL Ecology Section (Auerbach) would assume primary responsibility for the bottom fauna.

3. That the ORNL Waste Research Section (Parker) would assume primary responsibility for river water, suspended solids and bottom sediments.

4. That the USPHS Group (Friend) would assume primary responsibility for fish populations.

Friend pointed out that any activities carried out by USPHS would require justification from the point of view of public health interest, or they could not participate. The USPHS laboratories at

Cincinnati are equipped to handle work of public health interest and this determines the types of samples taken and analysis made. The USPHS Group preferred to take samples of everything, and to take them back to Cincinnati for preparation and analysis. This restrictive approach was not stipulated at the Steering Committee Meeting January 21st, and it introduces some complications that will have to be clarified. While there were some conflicting viewpoints on sampling techniques and respective responsibilities, there seemed to be general agreement between the two groups as to the over-all objectives.

II. Activities at ORNL

Bottom Sediments. Two foreign scientists, on detached ICA assignment to ORNL for training purposes, have started a study of the sorption and retention of fission products by clay minerals under the supervision of Dr. Tamura. Once they have mastered the necessary techniques involved, they will study the sorption and retention of fission products by uncontaminated bottom sediments taken from the Clinch River above White Oak Creek outfall.

Bottom Fauna. Dr. Nelson has collected and identified the bottom organisms taken from the river two miles above, and one mile below the White Oak Creek outfall.

III. Activities of the USPHS Group

A team of investigators, consisting of Friend, Henderson, Howell and Storey, were in Oak Ridge from February 8 to February 16. They collected samples from the river at six stations (Norris Dam, Loudon Dam, White Oak Creek, K-25, Kingston and Chickamauga Dam).

While it is recognized that this collection trip was of a preliminary nature, it is believed that an effective total research effort can only be maintained if there is close liaison between the Steering Committee and all agency personnel.

It is assumed that all of the data obtained by the USPHS Group will be submitted to the Steering Committee for consideration at the next meeting.

IV. Meeting of ORNL and TVA Groups

Several meetings have been held in an effort to determine the nature and extent of TVA's participation. TVA is proposing to furnish file data and man-power in various phases of the study.

V. Next Steering Committee Meeting

The next meeting will be held in Oak Ridge on April 7 and April 8, 1960. Detailed progress reports will be reviewed and radioactive discharges from Y-12 and K-25 will be discussed.

Sincerely,

Edw. G. Struxness

E. G. Struxness
Chairman
Clinch River Study Steering Committee

EGS:ms

cc: W. H. Jordan
K. Z. Morgan
W. S. Snyder
C. S. Shoup
J. N. Wolfe

X-821

ORNL

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ORNL
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60-3-13

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ORNL-RC

DATE: March 3, 1960

SUBJECT: Memorandum Report No. 1 to The Clinch River Study Steering Committee

TO:

FROM: E. G. Struxness

This document has been approved for release to the public by:

David R Hamrin 5/21/96
Technical Information Officer Date
ORNL Site

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POST OFFICE BOX X
OAK RIDGE, TENNESSEE

March 3, 1960

MEMORANDUM REPORT NO. 1

to

The Clinch River Study Steering Committee

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Edw. G. Struxness

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Chairman
Clinch River Study Steering Committee

EGS:ms

cc: W. H. Jordan
K. Z. Morgan
W. S. Snyder
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J. N. Wolfe

68A1096 #280 MHS Clinch River

MINUTES
EXECUTIVE MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Building 2001 - Conference Room
April 21, 1960

The Executive Session was convened by the chairman, E. G. Struxness, at 2:45 p.m., with the following members present: W. G. Belter (ex officio), A. G. Friend, F. E. Gartrell, R. G. Godfrey, S. Leary Jones, J. A. Lieberman (ex officio), Vincent Schultz (ex officio, vice I. E. Wallen), and A. A. Schoen (ex officio). Member F. C. Durand was absent. Roy J. Morton attended to serve as secretary.

The Chairman raised the question of what should be done with the preliminary reports presented in the open meeting earlier today. After discussion it was agreed that copies of the preliminary reports should be attached to the minutes of the open meeting with the notation that they were of a preliminary nature, distributed for the use of the Committee with the understanding that the material is not to be released or quoted openly without approval from the agency that prepared the report. Schultz commended the several individuals who did the preliminary work and those who presented the reports at the open meeting.

Several members of the Committee requested extra copies of the minutes for use by members of their staff. It was agreed that these should be provided, and the secretary made note of the extra copies requested.

Struxness inquired as to the status of the press release on the Clinch River Study which was submitted sometime ago. Lieberman stated that this release had been reviewed and some revisions made by the AEC in Washington and that the final version should now be enroute from the Washington office to AEC-ORO. There were comments from members of the Committee who had received the original draft of the release. Gartrell received a copy. Friend said that PHS in Cincinnati and Washington received copies; some individuals of PHS in Washington thought that public health was not emphasized sufficiently. Lieberman said that some in the AEC felt that the release as drafted left the implication that this was the first time anything has been done on the Clinch River. The AEC Public Information people in revising the draft wanted to make it clear that this is a research study; monitoring already is being done.

Jones said he had heard that a writer in Washington is anxious to write an article on releases of radioactivity at Oak Ridge. After discussion, it was the consensus of the Committee that it is desirable to get out the release on the Clinch River Study to forestall irresponsible releases about the river.

Struxness asked for discussion of something that may be a problem; namely, some biologists feel that this is just another stream pollution survey. Schultz said he saw no objection to the type of data being collected. He has talked with Friend and Auerbach about it. Different groups have different interests, and their

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work will not be of identical character. With respect to monitoring functions, Lieberman emphasized that this Committee should not approve or disapprove conditions in the river. Other members of the Committee appeared to agree. Lieberman commented further, restating the purposes of the study and that we must have the biologists' help. If they are able at the same time to exploit their own interests, there is no objection. We must aim to be practical to the end that answers will come out of this study, even though this is achieved by survey rather than intensive study techniques. Friend said that PHS is not set up to study particular organisms intensively - must use survey techniques. Jones suggested that the objectives of the study should be restated in or attached to these minutes. This was agreed.

Struxness mentioned a letter of which he had knowledge that tended to discourage support for work on the biological aspects of the study by the Biology and Medicine Division of AEC. Schultz said that he was interested in this comment and that he will inquire into it further.

Lieberman emphasized again that we must get help from other agencies, for example, TVA. Gartrell said that if the Committee will state a particular thing to be done, TVA can probably manage to get it done.

Struxness commented that hydraulics and hydrology were not discussed much in the open meeting. There were a number of suggestions aimed to improve coverage of these aspects. Lieberman asked whether "hydraulic data" is an area in which TVA can co-operate with USGS. At least "could the TVA and the USGS collaborate on: (1) what to be done, and (2) who to do it?" Gartrell said that sampling should be fitted into the hydraulic pattern of the streams. Lieberman asked what do we have to do to establish a working mechanism for co-ordinating sampling and hydraulics? Gartrell suggested detailed discussions between the USGS and the TVA Hydraulic Data Division of which A. S. Fry is head. Gartrell said that he can and will arrange for these discussions. Examples of questions suggested to be discussed were:

(1) Based on the knowledge now available, is it reasonable to set up times when it would be simpler to do various parts of the study?

(2) What is necessary to set up a system of recorded hydraulic data that will aid in guiding other parts of the study?

Struxness suggested that the question of how many gages are needed is a part of this problem. Lieberman made a Motion that by the time of the next meeting Gartrell and Godfrey be asked to study the need for gaging and submit recommendations as to what gages are needed and how the information from them is to be made available. The motion was amended to ask Gartrell and Godfrey to do this within a month, if possible, and report to the chairman of this Committee. The motion was approved.

Schultz cautioned that the sampling program must not be biased by selecting low flows only; it is essential that all conditions be represented. Gartrell said

that the "wave" and "slug" behavior is quite complicated as flow is cut on and off at the dams. Lieberman said that he would like to hear this discussed in detail at some meeting of this Committee. There was general discussion, and it was the consensus that we need for TVA not only to provide the flow data but also to help interpret its meaning in terms of this study.

Schultz commented that this type of information (hydraulic) is not so important in sampling of the kind the PHS did in February (mainly survey), but is more important for studies such as Auerbach and Nelson are doing; they are trying to explain "why." There was general discussion of the difficulty of getting definitive ecological knowledge in a highly variable situation. Schultz said that this is true, but we should do the best we can, taking advantage of related information, such as hydraulic data, discussed earlier.

Lieberman mentioned the problem from use of various units and suggested that a small committee be formed to consider what units should be used. Schultz thought that this is too much of a problem to undertake as a part of this study. Struxness suggested that each agency should select and state what units they prefer to use, and these can be converted by other agencies to their own units if necessary.

Friend said that the PHS would like to make another survey sometime in the early summer, for example, June. Struxness said that this is desirable to show seasonal differences. He requested that in the next survey efforts be made to: (1) notify ORNL people in advance and have more discussions, and (2) consider the possibility of splitting samples more systematically than was done in the last survey.

Next Meeting

Thursday and Friday, August 18-19, 1960, were selected as the dates for the next meeting.

The Committee was adjourned at 4:15 p.m.

Minutes prepared by Roy J. Morton.

MINUTES
OPEN MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Building 2001 - Conference Room
April 21, 1960

ATTENDANCE

COMMITTEE MEMBERS

Present:

E. G. Struxness, Chairman (ORNL)
A. G. Friend (USPHS)
F. E. Gartrell (TVA)*
R. G. Godfrey (USGS)
S. Leary Jones (Tenn. SDPH & Str. Pol. Control Bd.)
J. A. Lieberman (USAEC - Wash., ex officio)
Vincent Schultz (USAEC - Wash., ex officio, vice I. E. Wallen)
A. A. Schoen (USAEC - ORO, ex officio)

Absent:

F. C. Durand (Tenn. Game & Fish Commission)

VISITORS AND STAFF PRESENT

S. I. Auerbach (ORNL)
W. G. Belter (USAEC - Wash.)
G. Bruscia (ORNL - temporary, Italy)*
Milo A. Churchill (TVA)
C. Henderson (USPHS)
Hugh F. Henry (ORGDP)
M. Howell (USPHS)
W. H. Jordan (ORNL)*
W. H. Martin (Tenn. SDPH)
Roy J. Morton (ORNL)
D. J. Nelson (ORNL)
F. L. Parker (ORNL)
R. M. Richardson (USGS - ORNL)
N. B. Schultz (ORGDP)
C. S. Shoup (USAEC - ORO)*
A. Sorathesn (ORNL - temporary, Thailand)*
A. H. Story (USPHS)
T. Tamura (ORNL)*

---

*Attended afternoon session only.

A 5876

The meeting was called to order at 9:30 a.m. by the chairman, E. G. Struxness. The Chairman welcomed members of the group and expressed appreciation to those who had traveled to the Laboratory to attend the meeting. After announcements regarding certain details of arrangements, he called attention to the agenda which was to be followed (see attached). He said it was expected that both the open session and the executive meeting of the Committee could be completed today, but that in any event business of the Committee would be concluded by noon, April 22.

Dr. Hugh F. Henry of the Oak Ridge Gaseous Diffusion Plant (ORGDP) had been invited to meet with the Committee and discuss radioactive releases from ORGDP.

Dr. Henry distributed a sketch map of the general ORGDP Area (see News Release, 4/18/60, attached), and pointed out the sampling stations on Poplar Creek and the Clinch River. The principal radioactive material handled at this plant is uranium, which is primarily an alpha emitter with beta-gamma-emitting daughters. In general, the equilibrium beta-gamma fields are the maxima attained. However, the daughters of uranium are not volatile and remain behind in the process after uranium is volatilized as UF_6, with higher resultant fields. Small amounts of fission products come from handling of spent fuel from reactors which has been decontaminated in fuel reprocessing but contains some fission products. It was noted that from the nature of the operation, discharges of radioactive materials at this plant are not comparable with those from operations dealing primarily with irradiated reactor fuels and fission product materials. Losses of uranium are kept to a minimum, the standard limit being less than 1 ppm uranium in waste water.

The principal discharge of waste water is through a storm sewer, the location of which was pointed out. Some waste water is accumulated in a holding pond from which it flows to Poplar Creek. Asked about release of U^{235}, Dr. Henry said that the specific activity of enriched uranium is higher than normal uranium which enables checking of the waste water. Essentially no U^{235} is released, and the counts from uranium in the waste are due to U^{238}. Asked about Ra^{226}, Dr. Henry replied there was no indication that this was above background. A control concept used is to control the uranium and maintain the low specified limits with the result that the daughter products will also be taken care of.

With regard to sampling, continuous composite liquid samples are taken in Poplar Creek and the Clinch River as indicated on the attached map (see News Release, 4/18/60); in addition at the water plant (potable) there is a continuous sampler for analysis of the raw water from the Clinch River, this location being about 8 miles below the mouth of the White Oak Creek. Water samples at other points in Poplar Creek and in Clinch River above and below ORGDP are taken periodically as checks. Mud samples are taken periodically; for example, at each of the water sampling sites and at the point of waste discharge a grab sample is taken once per quarter. In the streams no mud sampling dredge or other sampler is used, and mud is taken by dip-sampling, avoiding debris. It was brought out that the continuous water samples are not proportional to stream flow; they are taken at a constant rate continuously.

The results of analyses of water and mud samples during 1959 were reviewed, as tabulated in the attached News Release. Records of the monitoring program go

back to about 1949. It was noted that for mud no MPC value is specified. A chart was shown comparing gross beta activity in the raw water at the water plant with the nonoccupational MPC value for Sr^{90} in water for the past several years. Experience, in general, has been that the gross-beta level is around 10% of the MPC based on Sr^{90} alone and much less than that based on the mixture of radioisotopes actually present. Asked about build-up of activity in the mud in a waste holding pond, it was stated that this is checked once a year and that little, if any, activity is released to it now. No data on the results were at hand at this meeting.

The Chairman thanked Dr. Henry and Mr. N. B. Schultz of ORGDP for making this information available to the Committee. There was comment that, in connection with actual work on the river study, there will probably be need to consider specific data or to make field observations concerning conditions in the ORGDP Area or in Poplar Creek above.

The Chairman said that people at the Y-12 area were invited to discuss discharges from that plant, but they requested more time and will discuss this subject at a later meeting.

In the next discussion, A. G. Friend described the work done in February 1960 by personnel of PHS sanitary Engineering Center in Cincinnati. A preliminary report on this work was distributed (copy of report attached to these minutes).

This preliminary survey, made February 9-15, 1960, included collection of samples of water, bottom muds, fish, miscellaneous aquatic fauna, plankton, and filter sand from the Chattanooga Water Treatment Plant. These were taken from seven sampling stations at selected points from above Norris Dam on the Clinch River and at Fort Loudoun Dam on the Tennessee River to Chattanooga. In addition, samples were taken from three different locations on Bear Creek in the Oak Ridge area. A total of 230 analyses of samples or components of the same field sample were made. It was explained that the report has not been finally checked and is in preliminary form in other respects. It is made available for the use of the Committee, but releases or quotations from it should be reserved until it is in more nearly final form.

Friend summarized the survey briefly and, with assistance from Henderson, Howell, and Story, answered questions about it.

In discussing Table 2, Radionuclide Concentration in Water etc., Friend commented that 33 μμc/liter is used as the MPC value for drinking water. White Oak Creek samples showed 2800 + μμc/liter of Sr^{90}; and the trend of concentration was found to decrease downstream, except that it increased from a minimum of 0.4 μμc/liter (background at Fort Loudoun Dam), and 1.5 μμc/liter at Watts Bar Dam, to 4.4 μμc/liter in the raw water at Chattanooga. Jones explained that the Chattanooga figures are based on quarterly composites of weekly samples. He said that the last quarter-year of data for Chattanooga showed in the neighborhood of 1.4 μμc/liter. Schultz (AEC) asked about analytical and counting errors. Friend replied that the concentration of radionuclides is low, but with present methods they can be detected and measured. He commented that the Chattanooga Water Treatment Plant is estimated to

remove about 18% of the Sr^{90}. Lieberman asked why the increase as you go downstream; for example, is activity desorbed from the mud back into solution? Friend said he did not know. Struxness said there are indications that the Sr^{90} is in solution - only 18% removal at Chattanooga Water Plant. Also, a recent review at ORNL of data on White Oak Lake Bed indicates transport of strontium in solution, while cesium is transported on the sediments. Schultz asked whether the PHS will assign confidence limits to the data? Friend said, yes. Parker commented that the results of sampling in White Oak Creek and downstream should be correlated as to relative times of sampling and time of water flow - "may be sampling different water" than that analyzed from White Oak Creek.

Friend summarized the data on analyses of mud samples. These also showed higher concentrations at Chattanooga. Those below Watts Bar Dam were low - samples may not have been very good because of scouring below the dam.

Friend showed a series of charts of results of analyses of fish taken at seven locations. Henderson commented on the data in Table 5, Table 6, Table 7, etc. Friend said that in most cases the activity was from natural sources. He said some small fish were taken from Norris Reservoir, but there is no table in the report showing these data. Fish from White Oak Lake, about 6 inches long, 51 in number, are covered in Table 9. Schultz asked whether the intestinal contents were separated. Henderson replied that the whole alimentary tract was removed (separated). All other viscera were left to be assayed with the flesh, bones, and scales. Lieberman asked what the trend of activity in fish was as collection was farther downstream. Henderson replied that the picture is not very clear, but bottom feeders are picking up radioactive materials, as shown, for example, in Table 19. He emphasized, however, that we cannot attach too much importance to one series of fish samples.

Friend commented on the tests of filter sand from the Chattanooga Water Plant, shown in Table 23.

Struxness reminded the group that this first round of sampling was expected to serve as a basis for more definite planning; that is, develop a better pattern of sampling. He asked what conclusions had been reached regarding this. Friend and Henderson pointed out that the data had not been analyzed and studied fully. Lieberman pressed the point that opinions and observations should be recorded, and purposely we should add to or change plans for both sampling and analyses.

After a short intermission, the Chairman called upon D. J. Nelson to discuss "Studies on Clinch River Fish, Mollusks, Bottom Organisms, and Detritus." He distributed a brief report, "Cooperative Fish Studies by ORNL and TVA - March 23 to April 1, 1960," (see report attached) and a one-page attachment, dated April 13, 1960.

Nelson reviewed the results of the fish study shown in the tables. He said the data do suggest that activity in fish from the Clinch River is slightly higher than in those from Douglas Reservoir. Schultz (AEC) discussed sampling errors, especially sampling variations, and commented that variations may be one to three orders of magnitude. Nelson thought this too much and that one order of magnitude more reasonable if care is used in sampling. There was general discussion of sampling errors. It

was asked whether controlled exposures of fish, for example, in a cage, might be feasible. Nelson said that controlled laboratory experiments would be more reliable, but we are not set up to do this here. Such work is being done at Hanford and by the PHS. Lieberman thought we must get (as a frame of reference) data on certain questions; for example, rate of uptake, differences in species, size, etc., and fish movement. It was agreed that studies of this kind should be made for the Clinch-Tennessee River system. Also, a review of literature on fish movement and the reports of TVA studies on these rivers should be done.

Nelson indicated on a map the extent of studies of bottom organisms made and planned. He commented, "In the river bottom we have a tremendous reservoir of organic matter" - much leaf material provides organic matter; also, leaves with relatively high radioactivity have been found. Schultz (AEC) inquired whether there will be enough radioactivity in aquatic organisms for radiochemical analysis. Nelson thought there will be no trouble except for the laborious job of separating the organisms. Auerbach commented that from ORNL operations leaves are contaminated and get into the river. Therefore, sampling of water alone misses leaf transport to the stream and suggests that we must look at leaves and leaf material on the bottom of the stream. Nelson said that some clam and mussel shells from Indian mounds of the same species as in the river now have been obtained; and that Ca-Sr ratios are being determined in these shells, those from the river, and human bones.

Nelson mentioned a planned study to determine movement of radionuclides by bottom organisms. Lieberman raised the question of the importance of biological transport as compared with direct transport by the water in solution. There was no answer to this question. Henderson asked whether the river inventory is a continuing study. The answer was that it is the initial inventory of the Clinch River system and after this we will be concerned with the income and outgo of radioactive materials and their route in the River.

Struxness asked what is now indicated for a plan of future work. In his reply Nelson outlined what we would like to study: (1) fish movements in the river, (2) bottom organisms, and (3) molluscan data that are of interest (at least to us in this survey).

The meeting was recessed for lunch at 12:25 p.m.

Afternoon Session

Reconvening the meeting at 1:30 p.m. the Chairman called on F. L. Parker who discussed "Sediment Transport in the Clinch River and Discrimination Factors."

Parker summarized on the blackboard data regarding sediment in parts per million moving past the mouth of White Oak Creek and also an estimate of pounds per year for the 5-year period, 1955-59. He also listed the percentages of radioactivity on the silt in the composite samples collected at Center's Ferry, which were analyzed for Co^{60}, $Zr\text{-}Nb^{95}$, Cs^{137}, Ru^{106}, Ce^{144}, and Sr^{90}. These percentages varied from 5%

for strontium to 67% for cesium. The percentage distribution of the radionuclides from Center's Ferry analyses were listed and also the activity in curies. The distribution of activity according to season for 2 years of the period was shown.

Note: Further details of the data presented by Parker are given in the tables attached at the back of these minutes, "Sediment Transport and Related Data."

The bed load was discussed by Churchill, Lieberman, and others. Although determinations of transport are not adequate, it appeared to be the consensus that the bed load is not an important factor. Churchill said that in his opinion bed-load measurements should not be done because: (1) bed load is not very significant in transport of radioactivity, and (2) such determinations are very complex and difficult to make.

T. Tamura of ORNL discussed "Affinity of Clinch River Sediments for Radioactive Nuclides." He acknowledged that the work reported was done at ORNL by Aroon Sorathesn of Thailand and Guiseppe Bruscia of Italy, whom he introduced to the Committee.

Tamura distributed Table IV, V, VI, and VII (see tables attached). He explained that the studies were made using the jar-test technique and that the four tables being discussed were from the report on the entire study submitted by Sorathesn and Bruscia.

This was primarily a study of the characteristics and sorptive properties of uncontaminated sediments collected from the bottom of Clinch River. For comparison tests were run concurrently on the standard clays - illite, kaolinite, montmorillonite, and vermiculite, as shown in the tables. The process isotopes were Cs^{137}, Co^{60}, Sr^{85}, and $Zr\text{-}Nb^{95}$. Schultz asked about the mechanism of sorption to explain time dependency shown by data in the tables. Tamura discussed at some length the structural properties of the clays and the mechanism of sorption that predominates. Friend asked about chemical conditions, techniques, etc. Tamura explained these and commented that further details would be available in the report when it is completed and released.

Lieberman inquired what differences would be expected if river water had been used in the experiments instead of distilled water. Tamura said very little except slight reduction in the sorption of strontium because calcium in the river water would make the K_d lower.

Struxness asked Parker and Tamura what the preliminary study has shown. In reply they noted: (1) variability in sediment and concentration after heavy rains suggest that in the Clinch River Study we must be sure to sample after rains rather than strictly on a time basis; and (2) a smaller percentage of activity than was expected was found to be associated with the sediments which suggest the need for more sampling and analysis for dissolved activity in the water.

The Chairman invited reports by anyone present of changes in situation with respect to money, manpower, etc., but there were no reports. Lieberman commented that budget hearings are in progress.

There being no further business the open meeting was adjourned at 2:30 p.m. Members of the Committee were requested to be available for the executive session at 2:45 p.m.

ATTACHMENTS

1. Agenda, Steering Committee Meeting, 4/21/60
2. Objectives of Clinch River Study
3. News Release - Environmental Sampling, ORGDP, 4/18/60
4. Preliminary Report - Samples by PHS, February 1960
5. Fish Studies, ORNL and TVA, 3/23-4/1/60
6. Sediment Transport and Related Data by F. L. Parker
7. Percentages of cesium, cobalt, strontium, and zirconium-niobium sorbed by clays - 4 tables

Minutes prepared by Roy J. Morton

AGENDA

CLINCH RIVER STUDY STEERING COMMITTEE MEETING

April 21-22, 1960

Time	Title and Speaker
Thursday, April 21 - Building 2001	
9:00	"Radioactive Releases from ORGDP" -- H. F. Henry, Oak Ridge Gaseous Diffusion Plant
10:00	"Clinch River Studies" -- A. G. Friend, USPHS
11:30	"Studies on Clinch River Fish, Mollusks, Bottom Organisms, and Detritus" -- D. J. Nelson, ORNL
12:30	LUNCH
2:00	"Sediment Transport in the Clinch River and Discrimination Factors" -- F. L. Parker, ORNL
2:30	"Affinity of Clinch River Sediments for Radioactive Nuclides" -- T. Tamura, ORNL
3:00	Executive Session
Friday, April 22 - Building 3504	
9:00	Executive Session (if necessary)
12:00	LUNCH
	Optional -- 4500 Auditorium
1:00	"Public Reaction to Houston's Kellogg Incident and Atomic Waste Fears" -- R. S. O'Leary, Houston Post

68A1046#280- MNS Clinch River

MINUTES

OPEN MEETING - CLINCH RIVER STUDY STEERING COMMITTEE

OAK RIDGE NATIONAL LABORATORY
Conference Room - Building 2001
September 22, 1960

The meeting was called to order at 9:30 a.m., September 22, 1960, by Chairman E. G. Struxness with attendance as listed on page 8 of these minutes. W. J. Boegly, Jr. acted as secretary at this session. Minutes of the previous meeting were approved as written. The Chairman raised the question of whether previous minutes should be approved at each meeting or whether we should dispense with formal approval. It was agreed that minutes of each meeting be approved at the succeeding meeting.

The first item for discussion was a clarification of the aims and objectives of the Clinch River Study. The representative of the Biology and Medicine Division, AEC, Washington, D. C., raised a question relative to the scope and objectives of biological research in the Clinch River program. Struxness said that he felt the objectives of the Clinch River Study include location of the activity released to the river, determination of how the activity is moving, and an understanding of how the ecosystem in the river operates. In the final analysis we hope to achieve knowledge related to the possible hazard of material released to the river. For example, in this country nuclear facilities (research, production, reactors, fuel materials, etc.) have been approved on the basis of detailed analyses of possible hazards (hazard summaries). The hazard summary described the area and the facility and predicted the "maximum credible accident". This is the maximum release, due to the worst accident, with a prediction of what hazards would result. Generally, these may be written before, or after, the site has been selected. No doubt it would be best if the hazard summary was prepared prior to selection of the site. Past experience has shown that the significant hazards at these installations have been due mainly to smaller but more probable accidents, not to the "maximum credible accident". Furthermore, hazard summaries do not take into account the long-term importance of routine waste releases. By and large sites are not selected primarily to meet waste-disposal requirements.

According to Struxness, hazard summaries should include an analysis of the effect the installation will have on the site, the effect the site will have on the installation, and what is involved

in assuring the local population that the site is well chosen. In this light, the Clinch River Study will provide information that will be useful in further site selection studies. It also will give confirmatory information from actual experience.

In general, the three basic aims of the Clinch River Study are (1) to provide a detailed inventory of the activity in the River - how much, where it is and how it is moving; (2) to determine whether the activity constitutes a hazard; and (3) to study the biological parameters and interrelationships that influence the conditions of radioactivity in the River. As yet, we do not have a co-ordinated program. In general discussion following these comments, it was pointed out that possibly the program has not progressed far enough to be able to say whether we are going in different directions or not. Later, as we gain more information, we may be better able to decide what co-ordination will be necessary.

The Chairman suggested that if there were no objections to the above outlined plan of attack the Clinch River Study will continue according to this plan. No objections were made.

As agenda for the meeting, the Chairman suggested that progress reports be made by A. G. Friend, P. H. Carrigan, M. A. Churchill, D. J. Nelson, T. Tamura, and H. H. Abee.

Friend commented on his "Report on Clinch River Samples Collected February 9-15, 1960, by Personnel of the U. S. Public Health Service," which had been distributed. He pointed out that all information collected thus far is in this report. Attention was called to page 19 of the report in which it is indicated that cobalt, cerium, and cesium seem to pass out of the water phase rapidly; whereas ruthenium and strontium stay in the water phase for long travel times down the river. Also, on page 39 of the report the last two sentences in the last paragraph should be deleted. Struxness pointed out that the data on page 19 will be correlated with the data to be presented later by Tamura. A question was raised as to whether sampling is being done at proper points, in view of the apparent decrease in activity at Watts Bar Dam and the subsequent increase downstream. Before replying, Churchill asked where the samples were taken, and Friend reported that they were taken below the dam, in the winter, when the water was quite turbid. Churchill pointed out that there are, actually two basic systems of sampling. The first is to sample continuously and get data for a whole period. The second system is to follow a mass of water and sample this mass at various times and locations. He commented that the present sampling scheme assumes a constant waste source and constant dilution so that we only obtain a measure of what is at the sampling point at the sampling time, and not necessarily the same material at each station. It was asked whether TVA data on the time of flow should

be used in determining sampling time and station. Friend noted that this was an 18-day composited sample; however, Churchill pointed out that this was still not a long enough period. Until time-of-flow data is used and the same mass of water is being sampled, samples will not represent the true fate of the fission products. Struxness reported that in a meeting yesterday it was agreed that the USGS and TVA would select sampling points and times. Schultz pointed out that even though the analyses should not be compared from station-to-station, the samples from the station are correct in the relative nuclide concentration. Henderson commented that the USPHS did sample silt in the TVA silt ranges as was suggested at the last meeting.

A general discussion on the question of water sampling and analysis followed. Some of the more pertinent comments are summarized below.

Churchill: Sampling the Clinch River above Watts Bar Dam is a highly complicated process if we are to be sure that only Clinch River Water is being sampled. In the summer Norris Dam releases cold water into the Clinch, and this cold layer dips down below the warmer Emory River water and forms a layer nearer the bottom. Thus, to be sure that samples represent the Clinch River we must make temperature measurements and certain chemical tests. Actually the sampling point is not important; the sampling depth is. During the winter months the temperature of the water in both rivers is about the same, and a condition of uniform flow exists. In reply to a question, Churchill stated that the change from one condition to the other is not abrupt but occurs over a period of months. In general the mixed layers will occur from middle March to fall.

Jones: If it is necessary to continually make temperature measurements and calculations to determine sampling depth and sampling times, doesn't this restrict the sampling?

Churchill: It will be necessary to have someone near the sampling stations more or less continuously if we are to sample on the basis of time-of-flow calculations.

Struxness: Is data recorded so that we can go back and compute flows for samples already taken?

Churchill: We do not have temperature records; therefore, exact information cannot be given. If the Committee thinks this is essential, we must set up temperature measuring stations now.

Friend: If samples were taken below Watts Bar Dam, could TVA calculate the percentage of Clinch River water and Tennessee River water in the samples?

Churchill: This could be done, but it would be a complicated calculation.

Struxness: It is essential that we immediately find out what is happening to the strontium-90 in the river. How are we going to trace it downstream? Shouldn't we give first priority to continuous sampling and later consider slug sampling? We are doing continuous sampling at ORNL primarily to be sure we keep track of Sr^{90}.

Belter: How about Ru^{106} since the MPC value has been decreased?

Struxness: Ruthenium is not a critical nuclide. When we weight the relative hazard of Sr and Ru in the ORNL situation we find that Sr^{90} has more weight in the MPC than Ru and all the other nuclides put together.

Cragwall: Has the USPHS collected continuous samples at Chattanooga?

Friend: Only for the past few days.

Churchill: Previous data available is apparently based on composite samples. TVA probably would be willing to collect samples in the tailrace of Chickamauga Dam and adjust the sample volume to give a composite that is proportional to flow. (Tailrace is best for sampling as shown by previous TVA sampling studies).

Friend: What about samples at Watts Bar Dam? How much volume could you collect?

Churchill: Sampling could be done at Watts Bar also. The volume collected could be any amount desired. Would the USPHS or someone be able to analyze these samples?

Friend: We could analyze these samples if they were taken.

Churchill: Could USPHS supply the sample containers and take care of the shipping?

Friend: USPHS can furnish the containers.

Cragwall: How long will the continuous samplers operate without maintenance?

Friend: Approximately 24 hours (2 gallons) before the sampler shuts off automatically.

Cragwall: If maintenance of sampling stations could be done weekly, the USGS could probably help.

Friend: Instead of sampling the mud for radioactivity, wouldn't it be easier to sample the water and determine the difference in activity and assume that it is in the mud?

Churchill: We will need silt surveys to determine the amount of silt at various points even if we know what is in the silt.

Cragwall: Isn't the last 15 years a sediment problem? All the water has now gone past Chattanooga, and the only activity remaining is in the silt.

This ended the discussion of Friend's report. The Chairman announced that the next report would be made by P. H. Carrigan and would be a summary of the ORNL program of water and silt sampling. A summary statement was distributed.

The following items not in the printed statement were covered by Carrigan:

1. An additional continuous sampler was installed on the discharge at White Oak Dam. Sampling commenced in June, 1960, but no detailed compilation has been made of the data to date.

2. Cores taken were 1-inch in diameter, six to ten cores per cross-section, and cross-sections approximately 1 1/2 miles apart, depending on the river cross-section. Actually there is not very much silt to sample. Radioactivity has been found to a depth of 8-inches in some locations.

3. A continuous discharge gaging station at White Oak Dam was installed July 1, 1960; a continuous recorder station at CRM 19.1 is not yet in operation. Also we hope to install an electromagnetic current meter at CRM 19.1.

Churchill: inquired whether the core samples actually go to the bottom of the river bed, since frictional drag could plug the sampling tool and even though the sampler may have penetrated 3 feet the core inside might represent only the upper 1 foot of sediment. Carrigan pointed out that he was not at ORNL when the samples were taken; however, he understood that no trouble of this sort was observed. Cragwall questioned whether we could get a sediment budget by taking samples at stations 1 1/2 miles apart. Carrigan commented that we probably cannot obtain detailed information in this fashion. Cragwall agreed, and pointed out that considerable sediment could be in the meanders and bends, and this must be measured to get total sediment volume. Carrigan hoped to have a sonic-depth device in the future to measure silt depths.

The next topic for discussion was the work of the Ecology group at ORNL (presented by D. J. Nelson). Churchill commented that W. T. Lammers was loaned to the Ecology Group this summer to make flowing-material studies and will work on plankton next summer.

The following items covered by Nelson were not in his printed statement which was distributed:

1. Item I, No. 5 of the Objectives set forth in the April 21, 1960 Steering Committee Meeting (Cobalt-60 Uptake by Crayfish) has been completed by C. W. Wiser, but this information has not yet been reviewed.

2. Item I, No. 6 (Organisms and Detritus in Bottom Sediments and Radioactivity Content) has not been started.

3. Nelson said that he felt clams (fresh-water mussels) might be a good indicator for the strontium-90 content in water due to the passage of rather large quantities of water through the clam and the filtering action of the clam.

4. In describing the live fish boxes, Nelson pointed out that no initial counts were made on the fish before the test. It was also pointed out that on page 13 of the summary, Table 5, numbers listed under the title, "Fish in Upper and Lower Boxes", represent the number assigned to each fish and not the number of fish in the boxes.

After general discussion of the Ecology report, the Chairman introduced T. Tamura, who discussed sediment studies and handed out a short summary of this work. In addition to the summary, Tamura presented the following information:

1. In Table 3, the numbers under the column "River Sediments" represent mile 6.0 and 7.0; and the 150 or 450 are feet measured from the left bank.

2. He pointed out that the pH of the samples containing river sediments fall in the optimum range for cobalt removal, resulting in excellent removals.

3. After all analytical work is completed, a particle-size separation and mineralogical analysis of the sediment fractions should be performed. Also, a peroxide digestion of the samples should be performed, if and when we know the effect of the digestion process on the inorganic phase of the sediment.

The Chairman then introduced H. H. Abee of the Applied Health Physics Section of ORNL to discuss the surveys made this summer by his group.

In summary he pointed out that mud samples were collected every mile downstream of the Tennessee River to Guntersville, Alabama and on the Clinch River. The results were 15% to 30% higher than last year. This is based on a preliminary analysis of the data and is subject to revision. He felt this increase might be due to the releases occurring in the past year. In general, the ruthenium concentration below White Oak Creek has increased by some 10 to 100 times as compared with last year. This is probably due to a leak in one of the ORNL waste pits which is releasing ruthenium to White Oak Creek.

Struxness pointed out that the words, "Official Use Only - Not for Release", should be put on all material that was handed out at this session. He requested all members present to add these words to their material.

There being no further discussion, the Chairman adjourned the meeting at 1:00 p.m.; and thanked those in attendance for their time and interest.

RJM:WJB:ms

ATTENDANCE LIST

H. H. Abee (ORNL
W. G. Belter (Reactor Development-AEC)
W. J. Boegly, Jr. (ORNL)
P. H. Carrigan (USGS-ORNL)
M. A. Churchill (TVA)
J. S. Cragwall, Jr. (USGS)
D. M. Davis (ORNL)
A. G. Friend (USPHS
Glenn Gentry (Tenn. Game & Fish Commission)
L. Hemphill (ORNL)
C. Henderson (USPHS)
S. Leary Jones (Tenn. State Dept. of Public Health & Stream Pollution Control Board)
W. H. Martin (Tennessee Stream Pollution Control Board)
J. E. Munzer (USPHS)
D. J. Nelson (ORNL)
R. M. Richardson (USGS-ORNL)
A. A. Schoen (ORO-AEC)
Vincent Schultz (Biology & Medicine-AEC)
E. G. Struxness (ORNL)
T. Tamura (ORNL)
L. P. Wilkins (Tenn. Game & Fish Commission)

MINUTES
EXECUTIVE MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Building 2001 - Conference Room
September 22, 1960

The Executive Session was convened by the Chairman, E. G. Struxness, at 2 p.m., with the following members present: M. A. Churchill (vice F. E. Gartrell), J. S. Cragwall, A. G. Friend, Glenn Gentry, S. Leary Jones, W. G. Belter (ex officio, vice J. A. Lieberman), Vincent Schultz (ex officio), and A. A. Schoen (ex officio). Messrs. C. Henderson and L. P. Wilkins also attended the session; and W. J. Boegly, Jr., attended to serve as secretary.

The Chairman raised the question of what should be done with the reports presented to the Committee to date. Should these reports be made into a status report on the Clinch River Study? After discussion, it was agreed that, although the existing data is preliminary and of a scouting nature, a status report based on this information is needed. It was further agreed that E. G. Struxness should prepare a draft of the proposed report and send it to members of the Steering Committee for review and comments. A final draft will then be prepared and submitted to the ORNL Review Committee for publication as an ORNL report.

Jones commented on a telephone call he had received from a reporter inquiring about the Clinch River Study. This reporter had heard that the reason for this study was a complaint from the Tennessee Stream Pollution Control Board. Jones pointed out that this was not the case and felt that the reporter had been misinformed. The general point made was that the Steering Committee must let the public know what is being done as soon as

possible. A general discussion of the original press release and why the delay in its release followed. Struxness pointed out that this Committee has little control over press releases and suggested that AEC people in Washington might assist us by seeing that members have a chance to comment on press releases and are informed as to when such releases will be made. Schultz commented that this discussion emphasized the need for a status report on the Clinch River Study. The Committee agreed. Belter pointed out that as soon as the people at any installation start a study of the environment it seems that everyone assumes they have done something wrong and are trying to find out what the situation is. This is not a problem at AEC installations only but is common to all industry.

Jones raised the question of additional water sampling stations on the Clinch River system. About 3 years ago, after the water quality station was established at Chattanooga and the resulting data showed comparatively high activity, the possibility of other stations at various points on the river was discussed by the Tennessee Department of Public Health. The idea was tabled at that time. However, the subject has come up again, and stations at the Clinton River Intake, the Clinch River at Roane Ferry, and the Clinch River at Kingston have been suggested as locations for water quality stations. Jones felt that these stations might be useful in determining the river budget. He pointed out, however, that this would cause an overlapping with work of USPHS groups, since these samples would be analyzed for radioactivity only. Jones also commented that the Tennessee Stream Pollution Control Board has set up about seven sampling stations on various rivers, not including the Clinch River, and will be glad to submit data for comparison of the Clinch River and other Tennessee

rivers. Belter inquired as to how much water quality data is currently available for past periods in TVA and Tennessee Stream Pollution Control Board files. Jones said some data is available; mainly, pH, alkalinity, turbidity, and color. Churchill commented that TVA has made some mineral analyses on reservoirs, based on monthly grab samples.

It was pointed out by Struxness that in addition to fission-product analysis we will also need mineral analyses; and since ORNL will soon release phosphates, and are currently releasing nitrates, analyses for these minerals should be undertaken. He also pointed out that additional water quality work should be done by agencies involved in the Study if possible, instead of bringing in new groups.

Jones suggested that the Clinch River Study Committee select sampling stations and then see if we have facilities for analyses available among the groups involved. Furthermore, if we find that we have enough stations available to determine the budget, no additional stations will be required. However, if we need more stations, Struxness or the Tennessee Stream Pollution Control Board can request other help in maintaining sampling stations and doing analytical work. Churchill suggested sampling at TVA dams on the Clinch River system since personnel are available at all times of the day. He pointed out, however, that still more sampling might be needed to define the budget. Cragwall inquired whether we are thinking of mineral, radiochemical, suspended solid, or other analyses; if so, could all of this be done by one group? Churchill suggested that sampling stations at Norris Dam, Center's Ferry, Fort Loudoun Dam (or the Visking Corporation Plant), Watts Bar Dam, and Chickamauga Dam might be considered. He further felt that it would be possible to obtain proportional samples of

the type discussed in the Open Meeting at all of the sampling stations at TVA dams. These samples would be grab samples with the volume made proportional to flow. It was pointed out that at Center's Ferry the sample should be taken as near the bottom as possible, since this is the portion of the stream which can be considered as Clinch River water. Friend would handle the analysis of weekly composite samples. The sample size would be approximately 2 gallons per day. The upstream station to be used will be decided by Churchill and Friend.

Struxness pointed out that these samples will be overlapped by four samples being taken by ORNL. These are at the Oak Ridge Water Plant Intake, White Oak Creek at the Dam, K-25 Cooling Water Intake, and the sampling station above Kingston Steam Plant (Center's Ferry, CRM 4.5). Belter inquired as to what analyses will be run on these samples. A strontium-90 determination, gamma scan, and complete nuclide analysis will be run by Friend. Jones will provide mineral analyses. The frequency of analysis for each mineral will be determined by the variation found in each mineral. If the concentration of a mineral is fairly constant, this mineral will be run less frequently. Jones requires about one gallon for analysis,

The Chairman appointed a committee, composed of Friend, Churchill, Jones, and Cragwall, to design and implement the water sampling and analysis program for the Clinch River Study. They will also work out arrangements for shipping and analysis.

Gentry commented that when collecting fish and game samples, collectors must have a permit. These have been supplied to interested persons in the Clinch River Study. It is also desirable that the personnel doing the sampling contact local Fish and Game officers when working in any area.

Struxness requested a list of the officers to be contacted. Gentry also commented that fish are available from Cherokee Lake if anyone desired live fish. The Chairman was requested to contact Gentry if anyone wishes live fish, and he will see that fish are made available. In general discussion of the Fish Tagging Program, Churchill pointed out that for intermittent studies TVA and state officials could probably help. However, when we propose continuous studies of fish population, it becomes impossible for these agencies to provide personnel for long periods of time. Gentry agreed and commented that for a number of days he could supply personnel for assistance in a fish program. He also commented that this work should be scheduled well in advance so that personnel can be made available. Struxness will request from Dan Nelson (Ecology) a statement on what he plans to do and when, and Struxness will contact Gentry and Churchill for assistance.

Churchill raised the question of what is to be done about sediments and sediment analyses. Struxness suggested that since we have not decided what to do with the Clinch River cores at this time, it might be best to leave the sediment analyses for later. Churchill inquired as to whether coring was being done below Watts Bar Dam. Struxness said that nothing as yet was being done by ORNL below Watts Bar. Cragwall asked whether suspended sediments were important at this time. If not, the subject should be left for later discussion. Struxness commented that studies indicate that cesium-137 will be contained in the silt; however, since first order of priority should go to determining strontium-90 concentrations, sediment analysis should be left until later. Furthermore, preliminary analyses have indicated that little activity is present in suspended solids. After discussion, it was decided that suspended solids and sediment analysis should be left for further discussion at a later Committee meeting.

Jones suggested that Struxness prepare a list to show who is taking samples, where they are being taken, who is analyzing, and what type of analysis is being done. Also, this list should show how the samples are being taken and the volume per sample. This information could be made into a type of flow sheet, showing responsibilities for sampling and analysis. If this were then reproduced and sent out to the Committee, with revisions when necessary, this list would help prevent duplication of sampling and analyses.

Struxness mentioned the Health Physics Division Information Meeting to be held in October. All members of the Clinch River Study Steering Committee should have received invitations. If not, he extended a special invitation to all present to attend this meeting. He has been asked to present a 10-minute discussion of the Clinch River Study if this is satisfactory with the Committee. The Committee saw no objection.

The minutes of the last meeting were approved. No date was set for the next meeting of the Steering Committee. The meeting was adjourned at 4:30 p.m.

Minutes prepared by W. J. Boegly, Jr.