REPORT ON THE WASTE TREATMENT AND DISPOSAL OPERATION AT THE 100 AND 300 AREAS, HANFORD PROJECT RICHLAND, WASHINGTON

United States Department of the Interior
Federal Water Pollution Control Administration
Northwest Region, Portland, Oregon

November 1969

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I. INTRODUCTION

The Hanford Project is a major facility of the Atomic Energy Commission (AEC) in south-central Washington extending over a 640-square mile area adjacent to the Columbia River. The primary function of the Hanford Project is the production of plutonium from fissionable uranium. After production in the reactor, the plutonium is separated from the uranium and fission products in chemical separation plants. At Hanford, the reactor area is designated the 100 Area, the chemical separation area the 200 Area, and the uranium fuel fabrication and laboratory area the 300 Area.

Purpose of Examination

Executive Order 11288 states that the departments, agencies and establishments of the Executive Branch of the Government shall provide leadership in the nationwide effort to improve water quality through prevention, control and abatement of water pollution from Federal Government facilities and activities. The Federal Water Pollution Control Administration has been directed to provide technical assistance and advice to the heads of other departments, agencies and establishments in connection with their duties and responsibilities under this Order.

In May 1969, a four-man team from the Federal Water Pollution Control Administration met with officials of the AEC and their

contractors at Richland, Washington to review chemical, radioactive, and thermal waste treatment and disposal operations. Officials from the Washington State Pollution Control Commission and the Washington State Health Department also attended this meeting. At the request of the AEC, discussions and tours were restricted to operations of the laboratories, fuel fabrication facility and reactor areas. The review and examination did not extend to the chemical processing plants in the 200 Area where the major part of the radioactive and chemical wastes from Hanford are generated. A list of those in attendance and the agenda for the May 13 and 14 meeting are given in Appendix A.

This was the second review and examination conducted at Hanford subsequent to the signing of Executive Order 11288 on July 2, 1966. The first examination, which was also restricted to the 100 and 300 Areas was conducted in November 1966.

One of the objectives of the 1969 examination was to evaluate the AEC responses to recommendations made following the November 1966 examination.

NATIONAL POLICY RELATING TO POLLUTION CAUSED BY THE OPERATION OF FEDERAL FACILITIES

The purpose of the Federal Water Pollution Control Act is to enhance the quality and value of our water resources and to establish a national policy for the prevention, control, and abatement of water pollution. The policy for all Federal departments, agencies, and establishments of the Executive Branch of Government was spelled out in Exectuve Order 11288 "Prevention, control and abatement of water pollution by Federal activities". This policy states that Federal establishments shall provide leadership in a nationwide effort to improve water quality through prevention control and abatement of water pollution.

In order to enhance or improve water quality, it is the responsibility of each Federal activity to establish programs for the improvement of each waste treatment operation that contributes waste to the Nations water resources. These programs should provide for the best possible treatment methods available so as to enhance and improve water quality. In no event should the operation of Federal Activities cause the further degradation of any of our water resources.

II. RECOMMENDATIONS

The recommendations of the FWPCA participants for the prevention and control of water pollution at the 100 and 300 Areas are summarized below. Supporting statements are given in the text of this report.

300-Area-Laboratory and Fuel Fabrication Area

1. The feasibility of constructing one or more shallow production wells in the 300 area where high level radioactive wastes are handled and processed should be considered as a safeguard for the retrieval of any radioactive waste that is accidentally spilled or leaked to the ground.

2. The piping for the 300-Area waste systems should be periodically pressure tested for early detection of leakage.

3. The source and extent of the ground-water pollution in the 300 Area should be investigated.

100-Area-Reactor Area

1. The AEC should initiate immediate plans for the design and construction of adequate cooling facilities for the waste streams from the KE, KW, and N reactors. An acceptable alternative would be to initiate an immediate program for waste heat utilization.

2. Settled sludge and filter backwash from the K-reactor water treatment plants should be discharged to a trench.

General

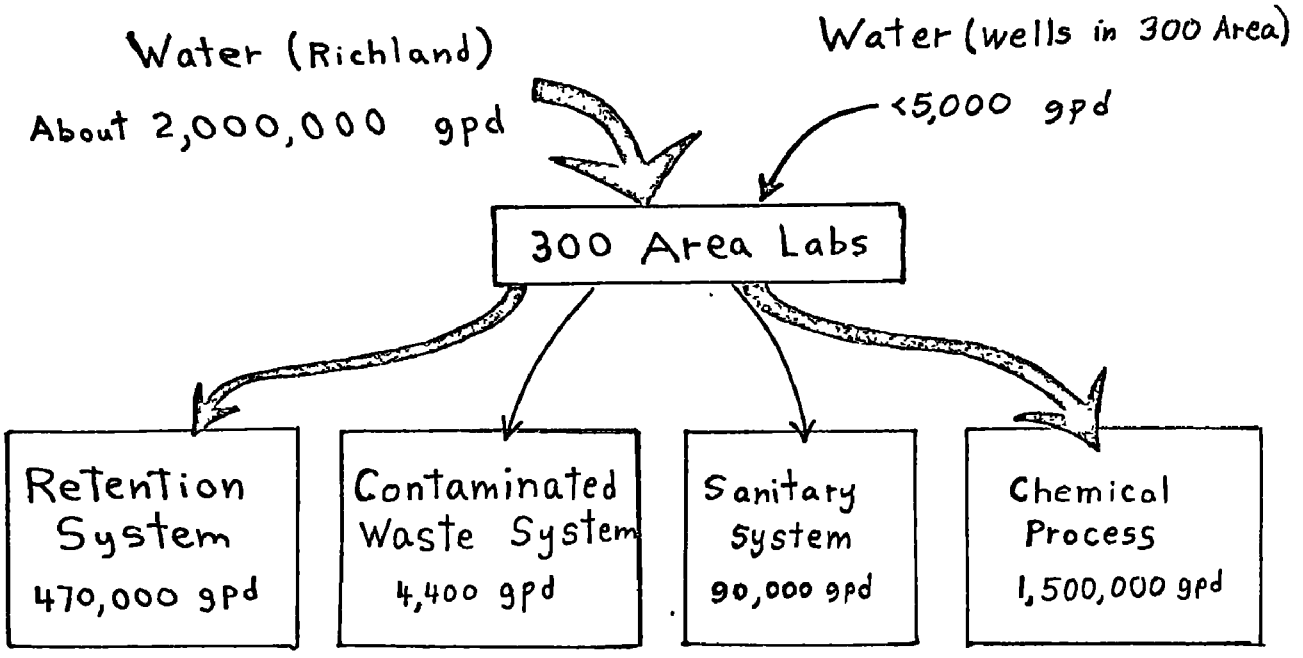
1. As part of the monitoring program, the source of the antimony-122 in the Columbia River at Hanford should be investigated.

III. 300 AREA OBSERVATIONS

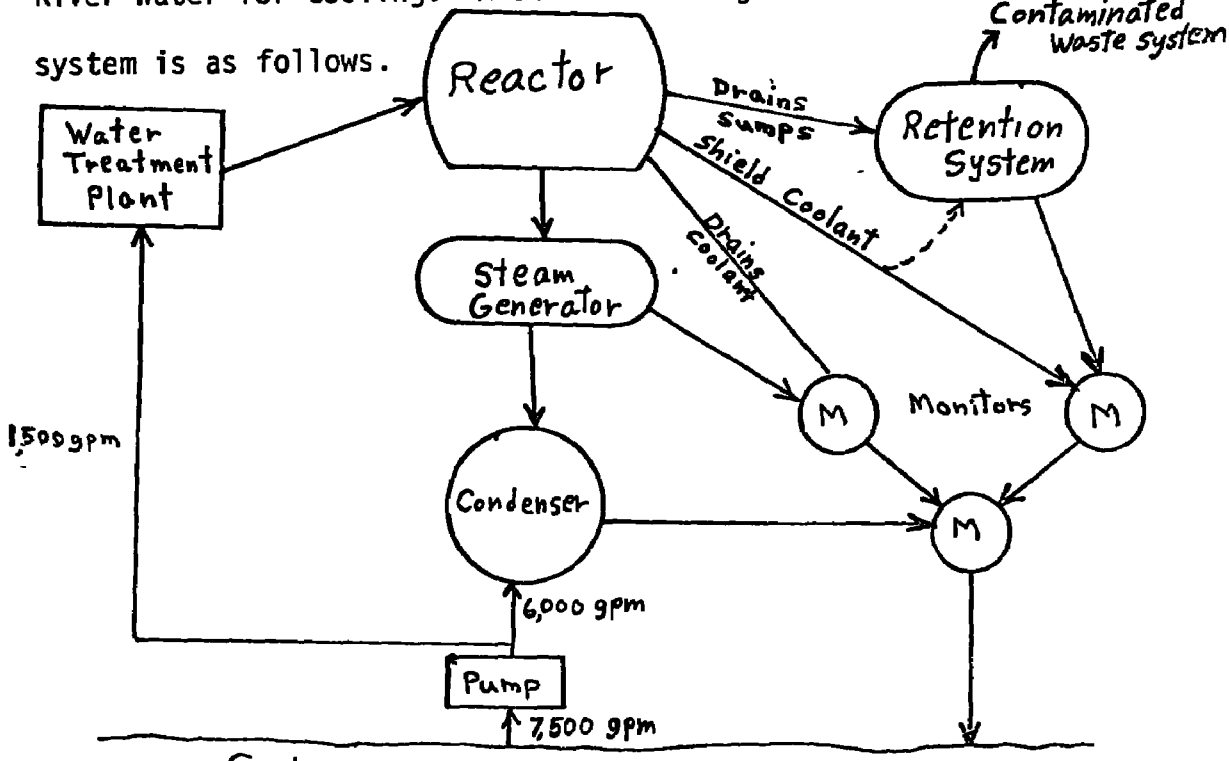
General

The 300-Area is the laboratory and fuel fabrication area located adjacent to the Columbia River approximately 5 miles north of Richland. This area also contains the Plutonium Recycle Test Reactor (PRTR). The facilities and laboratories have been constructed on a broad gravel plain that lies some 50 feet above the adjacent Columbia River.

The AEC and their contractors provided the following flow chart that depicts the water use and disposal in the 300-Area. This does not include the water requirements for the PRTR.



The PRTR has a separate water system that utilizes Columbia River water for cooling. A schematic diagram of the water and waste system is as follows.



AEC reports which were obtained subsequent to the May 1969, meeting on the status of ground water at Hanford (BNWL 984, 1047) contain the following statement relating to ground-water quality in the 300-Area: "If the Public Health Service drinking water limits are used as a base for comparison with the concentrations of non-radioactive contaminants, much of the ground water beneath the 300-Area is above the recommended limits, especially for nitrate ion."

No mention of ground-water pollution in the 300-Area was made during the May 1969, meetings. From the location of the 300-Area disposal ponds and influent quality data, these ponds are not the likely source of the ground-water pollution. Additional information

should be obtained as to the extent and source of the water pollution in the 300-Area.

Radioactive Waste Retention System and Disposal System

The retention system for radioactive wastes consists of four 50,000 gallon concrete basins. "Suspect" wastes are held in these tanks for monitoring. If the waste radioactivity is greater than 5×10^{-5} μc/ml, it is transferred to the 200-Area for disposal.

The percolation ponds for disposal of low level wastes are located at the north end of the 300 Area immediately adjacent to the Columbia River. They consist of two ponds, each having a capacity of about 25,000,000 gallons. These ponds are used alternately with operating periods of the order of 8 or 9 months for each pond. While dry, the pond bottom is scarified to increase percolation rates. Water from these ponds moves through the coarse alluvium to the Columbia River. Influent flow to the pond is on the order of 1½ mgd and it receives an average of approximately 15 to 20 days retention prior to percolation to the river. The 1968 average chemical concentrations of monthly samples collected at the percolation pond inlet and the Public Health Service Drinking Water Standards are as follows:

	Chemical Concentrations (mg/1)	
	1962 Drinking Water Standards	Pond Influent Average
Chloride (Cl)	250	2.04
Copper (Cu)	1.0	0.024
Iron (Fe)	0.3	0.025
Nitrate (NO_3)	45	136
Sulfate (SO_4)	250	30
Hexavalent Chromium	.05	0.047

Contaminated Waste System

Intermediate level radioactive waste is routed to the Contaminated Waste System. This waste is collected in a 15,000 gal. stainless steel tank and is subsequently transferred to six 8,000 gal. stainless steel storage tanks. The stored waste is chemically neutralized to reduce acidity and is transferred to the 200-Area in 20,000 gallon capacity railroad tank cars. The waste is ultimately processed in an evaporator. Long time storage is provided for the evaporator concentrate and the condensate is discharged to the surface pond.

Wastes going to the Contaminated Waste System originate from nine buildings in the 300-Area and are transferred in an underground pipe system to the various tanks and ultimately to the railroad car loading facility. It was reported that the piping system is not periodically pressure-checked for leakage and that if some leaks were to develop, contaminated waste could leak to the ground without being detected. Since dissolved materials can percolate to the underlying water table, the AEC should develop and adopt a system for periodically pressure checking the contaminated waste piping system for leakage.

High Level Waste System

Approximately 3,000 gallons of very high level radioactive liquid waste are transported to the 300-Area from the 200-Area each month. This material which is used in isotope separation and research in several of the laboratories, is transported by truck in 20 and 30

ton casks. After processing, the remaining high level waste is returned to the 200-Area for long-time storage. The transportation, handling and processing of this highly radioactive material in proximity to the Columbia River requires special safeguards to insure that none of this material can ever escape to the river. The travel time for ground water moving from the 300-Area to the River through the underlying gravel is a matter of days rather than years as it is from the 200-Area. Should any of this highly radioactive material escape to the ground in the 300-Area, it may be physically impossible to construct the necessary retrievel wells in time to prevent its movement to the river.

One safeguard that would prevent contaminated ground-water movement to the river in case of an accidental leak or spill would be the construction of a large capacity well or wells in the area where the high level radioactive material is processed. The pumping of such a well or wells would create a cone of depression which would serve as a large funnel beneath the area for retrieving any waste lost to the ground. The periodic testing of such safety wells would also provide water samples that would be representative of a large part of the ground-water body underlying the 300-Area. Testing of these samples would provide an early warning system to changes in ground-water quality and would indicate the occurrence of leaks.

IV. 100-AREA OBSERVATIONS

General

The 100-Area is located along the Columbia River some 30 miles northwest of Richland, Washington. Three reactors are currently in operation, KE, KW, and the dual-purpose N-Reactor.

Cooling water for all 3 reactors is pumped from the Columbia River. The relatively old, single-purpose K-reactors utilize a single, once-through cooling system. The cooling water makes one pass through the reactors and is returned to the river following a 20 minute retention period.

The N-reactor utilizes a recirculating, primary coolant system. Cooling water from the reactor passes through heat exchangers where steam is generated for transmission to the adjacent Washington Public Power Supply System power plant. Spent steam and excess steam is condensed in secondary heat exchangers and returned to the reactor. The heated secondary cooling water is returned to the Columbia River.

N-Reactor Area

Heated shield coolant and cooling water treatment wastes at the N-Reactor are discharged directly to the Columbia River. Adjacent to the reactor is a large crib that is used for the disposal of "primary coolant bleed-off", primary coolant spills, and other low level radioactive wastes. The crib is a large excavated disposal well, about ½ acre in area that has been partially filled

with boulders. The boulders tend to reduce the evaporation of the waste discharged to the crib. For periods of high flow, there is an overflow from the crib to a long open ditch. This ditch, like the crib, discharges waste to the surficial gravel deposits that are common to the area. It was reported that there are observation wells in the vicinity of the crib and trench but information on the degree of pollution of the ground water underlying the 100-Area was not available at the time of the visit.

There are two outfall systems for heated secondary cooling water, one from the excess steam "dump condensers" at the N-reactor and one from the WPPSS power plant spent steam condensers. Neither system provides for "waste heat treatment".

K-Reactor Area

The two K reactors are designated KW for the West reactor and KE for the East reactor. These are almost identical reactors located immediately adjacent to each other. Each has its own water intake, water treatment plant and river outfall but share a trench ground disposal system for contaminated wastes.

Reactor cooling water and minor waste streams flow through a circular detention basin prior to discharge to the river. There are three such basins; one for each reactor and one standby. The standby basin is kept empty to receive waste from either of the other two tanks in case of a fuel element rupture that leaks radioactive material to the cooling water. Detention time in these

basins is about 20 minutes. There is no other apparent use for these basins and it would appear desirable to maintain all three basins empty and on standby to receive contaminated waste. Such an operating system would provide about 1 hour's retention time in case of fuel element rupture.

Under current operating practices, contaminated waste detected in the first basin is diverted to the second basin and the overflow is discharged to a mile-long ditch excavated in the permeable gravels that border the river. The discharge of the contaminated waste to this trench provides a time delay for radioactive decay and some sorption of the waste prior to its inflow to the Columbia River.

Primary cooling water for the K-reactors is extensively treated before use. This is accomplished in large water treatment plants at each reactor. Additives include alum, sulfuric acid, polyacrylimide, and sodium chromate. The water is floculated and suspended materials are removed in a filter system. The filters are frequently backwashed at discharge rates up to 6,000 gpm. The backwashing waste and other waste from the water treatment plants are discharged to the river. It would appear desirable for the AEC to take advantage of their water treatment plants to enhance the quality of their effluent. This could be easily accomplished by discharging the treatment plant waste to a sump or trench in the gravels where all the solids would be removed prior to its subsurface discharge to the river.

V. REDUCTION IN EFFLUENT RADIOACTIVITY

The November 1966, examination resulted in three recommendations to reduce the amount of radioactivity, being discharged to the Columbia River. These recommendations included (1), the immediate modification of the reactor cooling water treatment process to include the addition of sodium silicate on all single-pass reactors, (2) a concentrated effort directed toward the refinement of a process modificaiton which will reduce the effluent concentration of zinc-65, (3) a full scale program to evaluate trench disposal as a means of reducing the quantities of radioactivity and thermal energy discharged to the Columbia River.

The purpose of this section is to discuss the AEC response to these recommendations and efforts towards reduction of radioactive and thermal wastes.

Since the 1966 examination of the Hanford Atomic Works, no significant changes have been made in the operation of the single-pass production reactors that would have reduced effluent radioactivity. Similarly, disposal procedures to partially dissipate the thermal energy of the cooling water discharges prior to mixing in the Columbia River have not been instituted. Thus, on the basis of effluent quality, the situation has remained "status quo". However, the total quantities of radionuclides and thermal energy discharged to the Columbia River have decreased as the result of reactor shutdowns. At the close of 1966, five single-pass production reactors

(B, C, D, KE, and KW), the closed-cycle N reactor, and the plutonium recycle test reactor (PRTR) were in operation. Since that time three of the single-pass reactors have been taken out of operation: D reactor in June 1967, B reactor in February 1968, and the C reactor early in 1969. Sufficient time has not yet elapsed to define the total impact of these shutdowns on environmental levels of radioactivity.

The Atomic Energy Commission has been responsive to the recommendations that followed the 1966 meeting, but not in a decidedly positive manner. As summarized below the recommendations have not been implemented "per se" although a 50% reduction in zinc-65 releases has probably been accomplished through the reduction in plutonium production.

(1) The use of sodium silicate treatment additive has not been put into practice because of increased rear-face radiation at the reactor. The increased dose-rate would require a longer down time before reactor maintenance operations could commence. Apparently, the increased down time would unduly hamper plant activities.

(2) No concentrated effort has been undertaken towards reduction of effluent zinc-65 concentrations through process modification. Tables I and II show the downward trend in zinc-65 transport rates and concentrations in the Columbia River due, to reductions in plutonium production.

Table I
MAXIMUM TRANSPORT RATE OF ZINC-65 IN THE COLUMBIA RIVER AT RICHLAND, WASHINGTON

Year	Maximum Transport Rate (curies/day)	Month Observed	Columbia River Peak Flow at Priest Rapids Dam (10^3 cfs)
1965	150	May	330 (June)
1966	300	May	320 (June)
1967	600	June	470 (June)
1968	50	June	320 (June)

Table II
MAXIMUM ZINC-65 CONCENTRATIONS IN THE COLUMBIA RIVER AT RICHLAND, WASHINGTON, AND IN RICHLAND DRINKING WATER

Year	Maximum Zinc-65 Concentration (pc/1)	
	Columbia River	Drinking Water
1965	300 (March)	650 (June)
1966	200 (February)	700 (May)
1967	200 (March)	1000 (May)
1968	80 (March)	Not reported

Note: The values were read from graphs and are to be taken as approximate values.

(3) Trench disposal was tested in the D Area in 1967 and in the C Area in 1967 and the first half of 1968. The D Area test involved the application of 25,000 gpm (55 cfs) to a trench located approximately 1,200 feet from the Columbia River with the following results:

a. Ground water levels were increased with the one foot contour (incremental increase) positioned at a radial distance of about 1.5 miles from the reactor and trench area.

b. Springs were opened along the river bank. Radiochemical analyses of seepage samples indicated concentration reduction factors of 100X for iodine-131, and the complete removal of zinc-65.

There does not appear to be any future plans for testing trench disposal and/or using it for at least a fraction of the effluent flows in the 100-K Area.

According to Dr. R. G. Geier, Douglas-United Nuclear, research activities intended to reduce effluent radioactivity will be continued in the 100-K Area insofar as budget constraints allow. The probable direction of this program in the immediate future and possible areas of interest and investigation were not discussed.

Recent monitoring by the AEC has detected the presence of antimony-122 in the Columbia River at Hanford. The source of this radioactive isotope is unknown at this time.

VI. CONCLUSIONS

The following conclusions are based on the information obtained during the meeting at Hanford, May 13 and 14, with consideration given to previous meetings and published documents.

1. Considering the probable radiation dose received by residents of the Tri-City area, the estimated levels of exposure - now and in the past - are well below the recommended radiation protection guides of the Federal Radiation Council. The FWPCA has never taken issue with the conclusion that exposure levels were below acceptable levels. However, the Federal Water Pollution Control Administration has urged the implementation of a positive action program to reduce the levels of radioactivity in the separate effluents from the single-pass production reactors. In other words, irrespective of doses to which population groups are exposed, the liquid waste management program should be geared to the best possible treatment methods and techniques consistent with technological feasibility and economic reason.

Although it is recognized that the ultimate goal in any situation involving the discharge of radioactive materials is the protection of the resident population from unnecessary or excessive radiation exposure, estimates of "dose to people" should not be the sole criterion for evaluating the adequacy and suitability of waste treatment and disposal procedures. Evaluation on the basis of dose is not entirely compatible with a policy calling for minimization,

particularly in those situations involving receiving waters which offer large dilution capacity or are not used for drinking water. To base treatment needs and discharge requirements on only maintaining the levels of human exposure below acceptable or tolerable limits would imply a policy of maximum use of the environment.

2. The practice of discharging untreated thermal wastes to the Columbia River at Hanford has caused a great deal of intense controversy over the severity and extent of adverse effects on the anadromous fishery. Also, the thermal discharges have violated at times, the temperature criteria of the Washington Interstate Water Qualtiy Standards. And, finally, the discharge of untreated thermal waste by the AEC contractors is in direct conflict with Sec. 11 of the Federal Water Pollution Control Act and Section 1(6) of Executive Order 11288.

3. Since 1966, plutonium production activities at Hanford Atomic Works have been significantly curtailed with resultant decreases in the annual quantities of radioactive materials discharged into the Columbia River. Quite possibly, the reductions in radioactivity releases that were sought in the recommendations of the 1966 meeting have occurred; albeit in an unexpected manner.

We would encourage Douglas-United Nuclear to continue their research program for developing process modifications and/or new methods to reduce the effluent activity of the single-pass reactors which are still in operation. This program should concentrate on changes which appear to have reasonable cost data from the outset.

4. Tritium and ruthenium-106 originating from the ground disposal of liquid wastes from the 200 Area are probably entering the Columbia River north of the 300 Area. However, the concentrations and ground-water flow are apparently such that there is no detectable change in Columbia River water quality attributable to this source. Dr. R. F. Foster stated that the average annual dose to a Richland resident would be increased by a factor of two (presumably for only one year) if the total activity discharged to the ground over the years was to enter the river as a concentrated "slug" injection. Apparently, little information is available on the disposal of chemical wastes in the 200 Area or the extent of chemical pollution of the underlying ground water.

5. As part of the routine monitoring program, effort should be made to determine whether the source of antimony-122 in the Columbia River is wastes from the 100 or 300 Areas or the ground-water regimen tributary to the river. Uncertainty as to the origin of any radionuclide is objectionable when there is the possibility that the ground-water route is involved. Radioactive materials contributed to a stream by ground-water effluent represents a pollution source that is no longer under man's control.

6. In those areas where the possibility of a spill of either intermediate or high level liquid radwastes exists, caution should be exercised to avoid the complete exhaustion of the ion-exchange capacity of the earth materials beneath such areas by the routine discharge of wastes directly to trenches and other earth-

surface structures. The ion-exchange capacity of the earth materials beneath these areas should be at least partially reserved as insurance to retard radionuclides from an accidental spill or retain them long enough for ultimate recovery to prevent disposal to the environment from becoming a reality.

REFERENCES

Essig, T. H. & Steele, F. B. Hanford Wells BNWL-928 Pacific Northwest Laboratory, Richland, Washington, October 1968.

Essig, T. H. Radiological Status of ground water beneath the Hanford Project, July-December 1967 BNWL-835 Pacific Northwest Laboratory, Richland, Washington, June 1968.

Essig, T. H. Radiological status of ground water beneath the Hanford Project, January-June, 1968 BNWL-984 Pacific Northwest Laboratory Richland, Washington, January 1969.

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Foster, R. F., Junkins R. L. And Linderoth C. E. Waste Control at the Hanford Plutonium production plant, Journ. Water Pollution Control Federation, Vol. 33 No. 5, May 1961.

APPENDIX A

ATTENDANCE AT THE MAY 13 AND 14 MEETING ON WATER POLLUTION, RICHLAND, WASHINGTON

ATTENDANCE MAY 13 & 14 MEETING-RICHLAND, WASHINGTON

Name	Agency or Company	Location
Art Brunstad	AEC	Richland
E.F. Greenleaf	AEC	Washington, D. C.
P.G. Rhoades	AEC	Richland
A.A. Schoen	AEC	Washington, D. C.
R.B. St. John	AEC	Richland
M.W. Tiernan	AEC	Richland
J.P. Corley	BNW	Richland
R.F. Foster	BNW	Richland
R.B. Hall	BNW	Richland
R.T. Jaske	BNW	Richland
E.E. Voiland	BNW	Richland
J.W. Ballowe	DUN	Richland
C.D. Corbit	DUN	Richland
R.G. Geier	DUN	Richland
Larry Reilly	DUN	Richland
Emil C. Jensen	Wash. St. Health	Olympia, Washington
Gene Asselstine	WWPCC	Olympia, Washington
George H. Hanson	WWPCC	Olympia, Washington
Roland E. Pine	WWPCC	Olympia, Washington
Milton W. Lammering	FWPCA	Cincinnati, Ohio
Jack E. Sceva	FWPCA	Portland, Oregon
Robert C. Scott	FWPCA	Cincinnati, Ohio
Robert W. Zeller	FWPCA	Portland, Oregon

1) AEC Atomic Energy Commission; BNW, Battelle Northwest; DUN, Douglas United Nuclear; WWPCC, Washington Water Pollution Control Commission; FWPCA, Federal Water Pollution Control Administration.

APPENDIX B
MEETING OF
AGENDA-MAY 13 AND 14, 1969

AGENDA
MEETING WITH FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, WASHINGTON WATER POLLUTION CONTROL COMMISSION AND WASHINGTON STATE DEPARTMENT OF HEALTH

May 13, 1969

8:15-8:30	Welcome and Introductions	R.B. St. John
8:30-9:15	300 Area Laboratory Liquid Waste Handling	E.E. Voiland
9:15-10:00	300 Area Fuel Fabrication Liquid Waste Handling	C.D. Corbit
10:00-10:15	Break	
10:15-11:30	Reactor Effluent and Liquid Waste Handling	Dr. R.G. Geier
11:30-12:00	Environmental Program	Dr. R.F. Foster
12:00-1:15	Lunch	
1:15-2:00	Dose Estimates for 1968 and Trends	J.P. Corley
2:00-2:45	Thermal Discharges	J.W. Ballowe
2:45-3:00	Break	
3:00-4:30	Impact of Heat on the River and Long Range Predictions	R.T. Jaske

May 14, 1969

7:40	Depart Bali Hi Motel for Area Tour	
8:00	Arrive 300 Area	
	Tour PRTR	Tour Guide-Voiland
	340 Waste Handling	
	313 Building	Tour Guide-Corbit
9:15	Depart 300 Area	
9:45	Arrive 100-N	Tour Guide-Geier
	Tour Waste Handling Facilities	

10:15	Depart 100-N	
10:30	Arrive 100-K Tour Reactor, Water Treatment Facilities and Effluent Facilities	Tour Guide-Geier
11:15	Depart 100-K	
12:00	Arrive Federal Building	
12:00-1:15	Lunch	
1:15-4:30	Open Discussion	Moderator- M.W. Tiernan