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CHEMICAL EFFLUENTS TECHNOLOGY

WASTE DISPOSAL INVESTIGATIONS

JULY, AUGUST, SEPTEMBER, 1956

Prepared by Members of the

Chemical Effluents Technology Operation

Edited by: D. J. Brown

April 12, 1957

CHEMICAL RESEARCH AND DEVELOPMENT OPERATION
HANFORD LABORATORIES OPERATION

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRELIMINARY REPORT

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CHEMICAL EFFLUENTS TECHNOLOGY

WASTE DISPOSAL INVESTIGATIONS

JULY, AUGUST, SEPTEMBER, 1956

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
JULY, AUGUST, SEPTEMBER, 1956

INTRODUCTION

The Chemical Effluents Technology Operation has among its functions the direct support of plant waste disposal activities and certain protection of plant and personnel activities. This report is the first of a series of new title but continues much of the reporting previously found in the Earth Sciences' monthly waste disposal monitoring activities summary report published by the Earth Sciences Biophysics Section personnel.

Portions of the material included in this document continue the reporting on topics previously covered by personnel of the Radiological Engineering Section, Radiological Sciences Department. Included is an interpretation of the ground water monitoring patterns revealed by well sampling activities. These well samples are routinely collected by the Regional Monitoring Operation, analyzed by the Radiological Chemical Analysis Operation, and the results reported by the former.

I. INTERPRETATION OF GROUND WATER MONITORING DATA

200-East Area

Throughout the third quarter of 1956 the extent of 200-East ground water contamination decreased. This was primarily due to the reconstruction of the ground-water mound east of the 200-East Area.

During July and August, as the 200-East water mound was rising, the southeastward movement of contaminated ground water was diverted southward. This change was indicated by analyses of the ground water from wells south and southeast of 200-East Area. During September the only wells which showed significant concentrations of beta-gamma emitters were located within the limits of the 200-East Area fence.

Figure 1 shows the approximate extent of contaminated ground water, originating from 200-East Area cribs, as of September 30, 1956. This may be an indication that the contaminated ground water is being contained by the 200-East ground water mound.

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Ground water contamination from the 200-East Area Crib Sites.

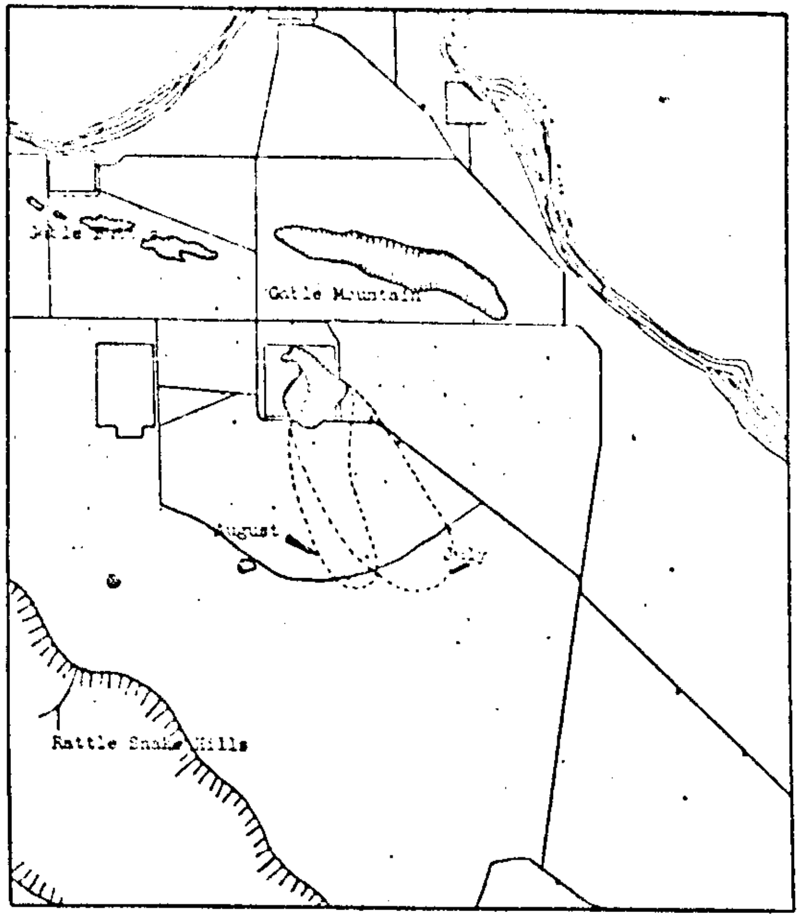

Figure 1.

Approximate extent of contaminated ground water, September 30, 195[illegible].

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200-West Area

Results from test wells monitoring the ground water in the vicinity of the Redox disposal sites, indicate no significant changes in the ground water contamination pattern during the past quarter. Estimated ground water velocities in this area are approximately 10-40 feet per day. This relatively slow velocity is probably the major factor attributing to the lack of change noted above.

The newly imposed northward ground water gradient, caused by the gradual lowering of the "T" swamp mound has not changed significantly the activity densities in wells monitoring the T-Plant 2nd. cycle disposal site. This may be due to the relatively slow rate of ground water movement in this region. Wells surrounding the T-Plant reverse well site indicate that beta-gamma emitter concentrations have gradually decreased in this site during the past quarter. The reverse well is located approximately 2,000 feet east of the T-Plant 2nd. cycle cribs.

Figure 2 illustrates the approximate extent of ground water contamination from cribs located within the 200-West Area.

A study was initiated during the third quarter of 1956 to investigate the influence of fluid density of radioactive wastes on the vertical distribution of contamination with movement in the ground water through various types of geological formations. The study incorporated the use of a delayed-action depth sampling device, which collected undisturbed water samples from different depths below the surface of the ground water. Data collected to date have shown the highest contamination concentration in wells southeast of 200-East Area occurring at the surface of the water table. Dilution velocity tests in these same wells show the highest ground-water velocities also occurring at the surface.

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Ground water contamination from the 200-West Area Crib Sites.

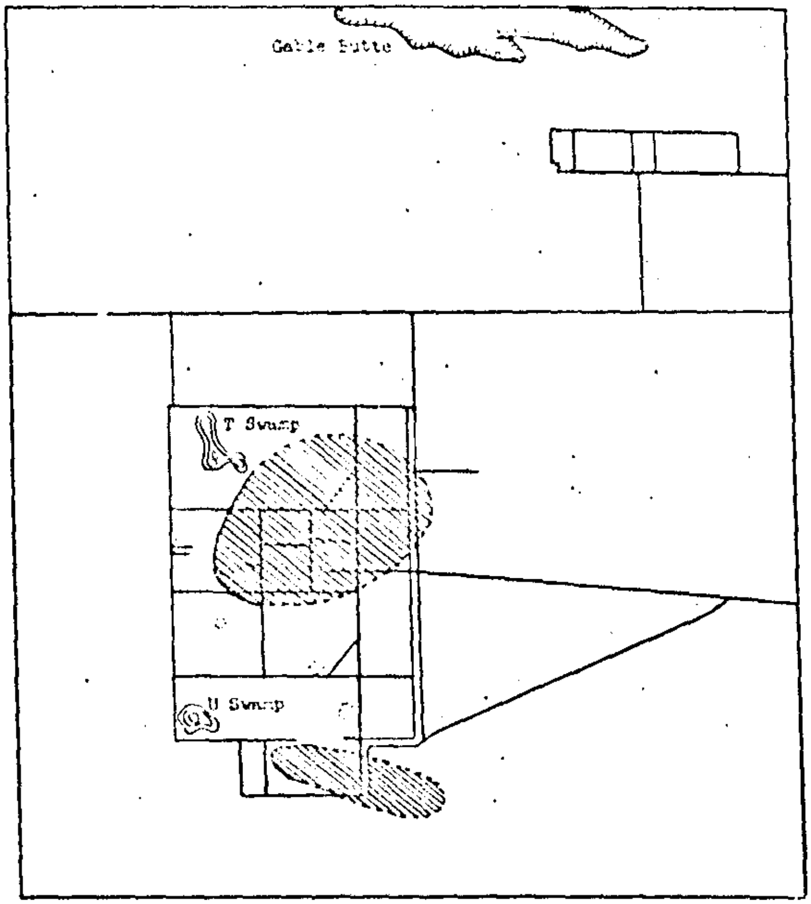

Figure 2.

Approximate extent of contaminated ground water.
September 30, 1956

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II. PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department

The discovery of significant concentrations of cobalt-60 in TBP scavenged waste supernates early in 1956, and the demonstrated poor removal of this chemically-complexed radioisotope by soil adsorption-mechanisms have effectively halted the crib disposal of TBP scavenged supernates. A maximum cribbable limit of 4×10^{-5} uc Co^{60}/cc, based on present allowable ground-water contamination limits, has been recommended. Laboratory and plant efforts to decontaminate TBP wastes to this level have so far been unsuccessful, and little hope is held that a satisfactory method can be developed and applied prior to termination of the metal recovery program.

Utilization of available tank space, including several tanks held in reserve for possible startup of B-Plant, for storage of non-cribbable TBP supernates would have permitted operation of the metal recovery plant to continue only until about August 1, 1956.

To permit uninterrupted operation of the metal recovery facility, it was decided to dispose of high cobalt-60 supernates into a series of trenches to be located west of the 216-BC crib site. This disposal was to be on the basis that specific retention of the liquid in the soil pore spaces would prevent any of the wastes from entering the regional ground water table. Fifteen trenches, with attendant monitoring wells are being provided to accommodate the 19,000,000 gallons of waste that will be produced prior to cessation of the metal recovery program.

Several of the trenches have already been made available and are now receiving waste. Delivery to the first trench began on July 28, 1956, and through September, 1956, the trenches have received 2.5 million gallons of high cobalt-60 scavenged supernate.

Document HW-45058, "Review of Radioactive Liquid Waste Disposal Practices for Hanford Separations Plants," issued August 24, 1956, presents a brief over-all review of fundamental factors governing ground disposal of Separations plants wastes and information on waste disposal controls and audits.

Eleven test wells were drilled or deepened in the vicinity of the 216-S-1 and 2 cribs in an effort to explore the extent and levels of contamination in the ground. The results of this exploration may reveal the geological factors which influence the spread of contamination in this general area.

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Irradiation Processing Department

A significant change in disposal procedure for "hot purge" effluents was approved and put into practice. A "hot purge" is an operation in which diatomaceous earth is injected into the cooling water of an operating reactor, to remove the flow-impeding film that accumulates on the aluminum surfaces of process tubes and fuel elements. Until September 1, 1956, the Radiation Protection Standard (RPS) required that this effluent be cribbed in order to filter most of the particulate contamination before the effluent reached the river. Deviation from this standard was permitted during six hot purges in the spring of 1955, as a test, to revaluate the hazards involved in allowing the purge effluent to be disposed in the same manner as the normal or non-purge effluent. The revaluation was completed in the issuance of Document HW-45125 on August 30, 1956, which recommended the policy change permitting the more direct river disposal procedure, if the following control measures were enforced:

1. The period of a purge be limited to maximum of one hour.

2. The concentration of diatomaceous earth in influent cooling water to be limited to 25 ppm.

3. No more than one purge be made in each 48-hour period.

4. Hot purges are prohibited when the river temperature exceeds 15°C.

   (The quantity of P^{32} sent to the river should be limited to a practicable minimum during the period when the accumulation rate of this isotope in whitefish flesh is at a maximum, i. e., when river temperatures exceed 15°C).

5. Maintain records of the contamination level of each hot purge effluent.

   (This control requires analyses of effluent for concentration of the total beta emitters on every purge and further analyses for pertinent isotopes on every fourth purge).

By purging as frequently as permitted under the recommended controls, the maximum increase in dosage rate to humans was estimated to be less than 5% over that resulting from discharge of routine effluent to the river. The current need for purges to remove film from process tubes is considerably less than the purging frequency permitted. By October 1, 1956, the changes in disposal policy had been approved and personnel of the Irradiation Processing Department (IPD) were incorporating the recommended control measures into

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their hot purge procedures. The economic incentives for IPD to make these procedural changes were based on costs of retention basin structural repair and of crib pump maintenance.

Retention basin analytical data from routine samples and other reactor operating data for the period 1951 through 1955 were placed on IBM cards. Converting this information to a form suitable for statistical correlation was started. The goal is to develop the relationship between the concentrations of radioisotopes in the reactor cooling water effluent with the variables of reactor operation which will permit more accurate predictions of the river pollution rate under future operating conditions.

III. LABORATORY EVALUATION OF WASTES

Laboratory soil column and batch (equilibrium) experiments were conducted for each tank of scavenged waste produced in the Uranium Recovery Plant. The concentration of cobalt-60 was greater than the present permissible limit for cobalt-60 in ground water (4.0×10^{-5} $\mu c/ml$ or 0.1 MPC) in all wastes received by the laboratory. The concentrations of cobalt-60 reported by the Analytical Control Operation, together with disposal volumes which were estimated by Earth Sciences laboratory on the basis of the adsorption of cesium-137 and strontium-90 by soil, are shown in Table 1.

Table 1. Concentrations of Cobalt-60 and Estimated Disposal Volumes Based on the Adsorption Characteristics of Cesium-137 and Strontium-90.

Waste Batch	Cobalt-60 $\mu c/ml$	Estimated Disposal Volumes: Cesium-137 Column Volumes	Estimated Disposal Volumes: Strontium-90 Column Volumes
37-110-BY	2.1×10^{-3}	3	3
38-106-BY	1.4×10^{-3}	3	3
39-107-BY	9.8×10^{-4}	1	3
40-108-BY	4.1×10^{-4}	<1	1
41-110-BY	6.4×10^{-4}	3	3
42-106-BY	1.3×10^{-3}	<1	3
43-107-BY	8.8×10^{-4}	3	3
44-108-BY	1.3×10^{-4}	1	3

The results of laboratory soil column experiments with three different batches of waste to test the ability of soil to remove cobalt-60 from solution are shown in Tables 2 and 3.

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Table 2. Breakthrough of Co^{60} in Soil Columns.

No. of Column Volumes of Effluent	Waste 33-110-BY Co^{60} ($\mu c/ml$)	Waste 34-106-BY Co^{60} ($\mu c/ml$)
1	1.1×10^{-3}	4.5×10^{-4}
2	1.5×10^{-3}	
3	1.0×10^{-3}	
Influent concentration	9.3×10^{-4}	4.3×10^{-4}

- -

Table 3. Breakthrough of Co^{60} in a Soil Column.

Waste 36-108-BY

No. of Column Volumes of Effluent	I: Na_2S added to 0.00125 M — Co^{60} ($\mu c/ml$)	II: Na_2S added to 0.00125 M, $Co(NO_3)_2 \cdot 6H_2O$ added to 0.002 M — Co^{60} ($\mu c/ml$)
1	1.0×10^{-3}	1.0×10^{-3}
2	1.1×10^{-3}	8.4×10^{-4}
3	1.0×10^{-3}	1.1×10^{-3}
Influent concentration	1.0×10^{-3}	7.5×10^{-4}

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The soil column data clearly show that cobalt-60 was not removed by soil from the nickel ferrocyanide scavenged solutions. Even additional treatments with sodium sulfide and cobalt carrier treatments that were suggested by Process Chemistry Operation personnel had no apparent effect on the complexed cobalt ion. The concentration of cesium and strontium ions in the effluents from these same columns, on the other hand, were 1/30 to <1/1000 of the concentration of the cesium and strontium in the influent indicating excellent removal by soil of cesium and strontium from these solutions. The inability of the soil to remove complexed cobalt ions from solution points out the importance of reducing the concentration of cobalt-60 during the waste treatment step to the permissible limits for ground water contamination.

Batch experiments were performed to determine the effect of Al(III) on the removal by soil of strontium-90 from Uranium Recovery Plant scavenged waste solutions. Waste 3-112C-111C, containing 1.6×10^{-3} moles/liter of Al(III), was mixed with synthetic waste, which contained no Al(III), and the mixtures were equilibrated with soil samples for one hour. The distribution coefficients were then determined for both cesium-137 and strontium-90 in the mixtures. The results are shown in Table 4.

Table 4. Measured distribution coefficients for Cs^{137} and Sr^{90} as a function of concentration of Al(III).

Al(III) concentration moles/liter	Distribution Coefficients, K_d Cs^{137}	Sr^{90}
1.6×10^{-3}	3.1	1.8
1.3×10^{-3}	2.8	2.5
9.6×10^{-4}	3.1	3.4
6.4×10^{-4}	3.9	6.4
3.2×10^{-4}	2.5	16.7

The distribution coefficient for cesium-137 was essentially constant throughout the range of the Al(III) concentrations investigated, indicating that the Al(III) had no effect on the removal by soil of cesium-137. The distribution coefficients for strontium-90 indicate that a decrease in the concentration of Al(III) resulted in a definite increase in the amount of strontium-90 removed from solution by soil. Thus, the experimental evidence suggests very strongly that Al(III) was the constituent of the 3-112C-111C waste that inhibited the adsorption of strontium-90 by soil, however additional tests will be required to confirm this conclusion.

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IV. REGIONAL HYDROLOGY

Quantitative measurements of the hydraulic characteristics of the sediments beneath the 100-K Area and qualitative information deduced from ground-water contours as of October, 1955, indicate the water-bearing formations adjacent to the Columbia River between 100-K Area and 100-F Area to be relatively impermeable (transmit water poorly). In contrast to this, those adjacent to the river between 100-F Area and 300 Area are quite permeable and transmit water readily. This information helps to direct the emphasis of future ground water monitoring effort.

The ground water in the vicinity of the 200-East Area shows a rapid buildup of the Purex ground-water mound from the discharge to ground of a three-month total of 592 million gallons of non-radioactive cooling water. The water table during this period rose as much as 5.7 ft. to a maximum level of 408.65 ft. Elsewhere, the water level in wells within the area rose above an altitude of 395 ft., indicating that the water table between 200-East and 200-West Areas is building up to levels not previously attained.

The ground-water mound beneath 200-West Area was considerably altered during the period from substantial changes in disposal practices. The amount of cooling water discharged to the T-Swamp has been reduced from an approximate average of 3 mg/d to only 0.1 mg/d, whereas water to the U-swamp and Redox caverns continued at a combined rate averaging about 6 mg/d. As a result, water levels in the northwest part of the area (beneath T-swamp) dropped as much as 6.4 ft. to an altitude of 471.89 ft. while levels beneath the southwestern part rose as much as 0.3 ft. to an altitude of 475.60 ft. Thus, the previously predominant southeastward gradient within 200-W Area has been changed so that now a northeastward gradient prevails, tending to route T-Plant second-cycle contaminants toward more permeable zones in the Gable Butte-Gable Mountain Area.

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V. WELL DRILLING SUMMARY

TABLE

WELL DRILLING SUMMARY

Third Quarter, 1956

U. S. G. S.

Well	Ft. Drilled	Finished	Total Feet	To Water?
241-S-23	261	8/23/56	261	Yes
49-57	168	7/27/56	168	"
55-50-B	95	8/ 6/56	95	"
42-39	314	8/21/56	314	"
48-71	305	9/25/56	305	"
	1143			

Strasser Drilling Co.

Well				
241-BC-8	364	7/30/56	364	Yes
241-BC-9	364	8/ 2/56	364	"
241-BC-10	347	8/31/56	347	"
241-BC-11	366	9/21/56	366	"
199-F5-6	191	8/10/56	191	"
199-F7-1	150	8/14/56	150	"
	1782			

Wells Reperforated and Developed by U. S. G. S.

50-42	47-60	35-70	39-79	361-T-14
45-42	60-60	45-69	35-79	361-T-15
50-53	24-33	34-51	231-2	361-T-22
54-57	20-20	38-43	361-B-5	361-T-23
39-43	8-17	43-35	361-B-7	241-T-16
44-43	32-77	49-79	361-T-12	241-T-18
				224-T-4

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U. S. G. S. drilling crews have completed 5,464 feet of the 5,550 feet budgeted for FY 1956. This work was scheduled for completion on July 1, 1956.

A program for reconditioning and reperforating 31 wells in the proximity of the 200 Areas was carried out by drilling crews of the U. S. G. S.

The Strasser Drilling Co. has completed 6,991 feet of drilling. Their original contract called for an estimated 5,000 feet, but was extended to include the emergency drilling of 216-BC - PHASE I and II - Specific retention disposal monitoring wells. There is approximately 1,000 feet remaining to be drilled to complete this extended contract.

Document HW-44355, titled "Hanford Wells" was published by Geochemical and Geophysical Research during the quarter ending September, 1956. This report is intended to provide a compilation of wells in and adjacent to the Hanford Controlled Area and a consistent numbering system for these wells. This system is applicable to all future wells drilled in the area, and is administered by Engineering Files.

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