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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

APRIL, MAY, JUNE, 1957

Prepared by Members of the

Chemical Effluents Technology Operation

Edited by: D. J. Brown

September 25, 1957

CHEMICAL RESEARCH AND DEVELOPMENT OPERATION
HANFORD LABORATORIES OPERATION

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

Operated for the Atomic Energy Commission by the
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PRELIMINARY REPORT

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

APRIL, MAY, JUNE, 1957

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
APRIL, MAY, JUNE, 1957

INTRODUCTION

The Chemical Effluents Technology Operation is assigned to investigate the radiological aspects of environmental contamination resulting from plant operations or from potential process disasters. This report is primarily concerned with plant assistance research in the field of waste disposal during the quarter April, May, and June, 1957.

The ground-water monitoring data utilized in this report were obtained from well water samples. These samples are collected by the Regional Monitoring Operation and analyzed by the Radiological Chemical Analysis Operation.

I. INTERPRETATION OF GROUND WATER MONITORING DATA

200-East Area

Cribbed radioactive wastes reaching the ground water underlying the 200-East area continue to move westward down the hydraulic gradient. Immediately west of the 200-East area fence the contaminated ground water intersects a more permeable zone and spreads to the north and south. The approximate extent and direction of this spreading is shown in Figure 1. This figure also shows the isolation of the A-8 wastes underlying the Purex area. The limit shown in Figure 1 is defined by the 1.5×10^{-7} µc/cc total beta concentration. The arrows indicating the general direction of movement are based on nitrate ion concentrations observed in the ground water ahead of the contamination front.

Fission product analyses showed no detectable concentration of radioactive Sr^{90} or Cs^{137} in test wells monitoring the cribs within the 200-East Area. However, water samples taken from wells located adjacent to the BY disposal site revealed the presence of Co^{60} in the ground water in concentrations up to 1.3×10^{-3} µc/cc. The maximum permissible concentration of this material in drinking water for non-occupational consumption is 4×10^{-5} µc/cc. These high Co^{60} values result from TBP scavenged wastes draining from the BY cribs into the ground water. The existence of significant amounts of Co^{60} in the form of an anion complex in these wastes was discovered early in 1956. In this complexed form cobalt ion is not removed by soil adsorption mechanisms. (12).

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

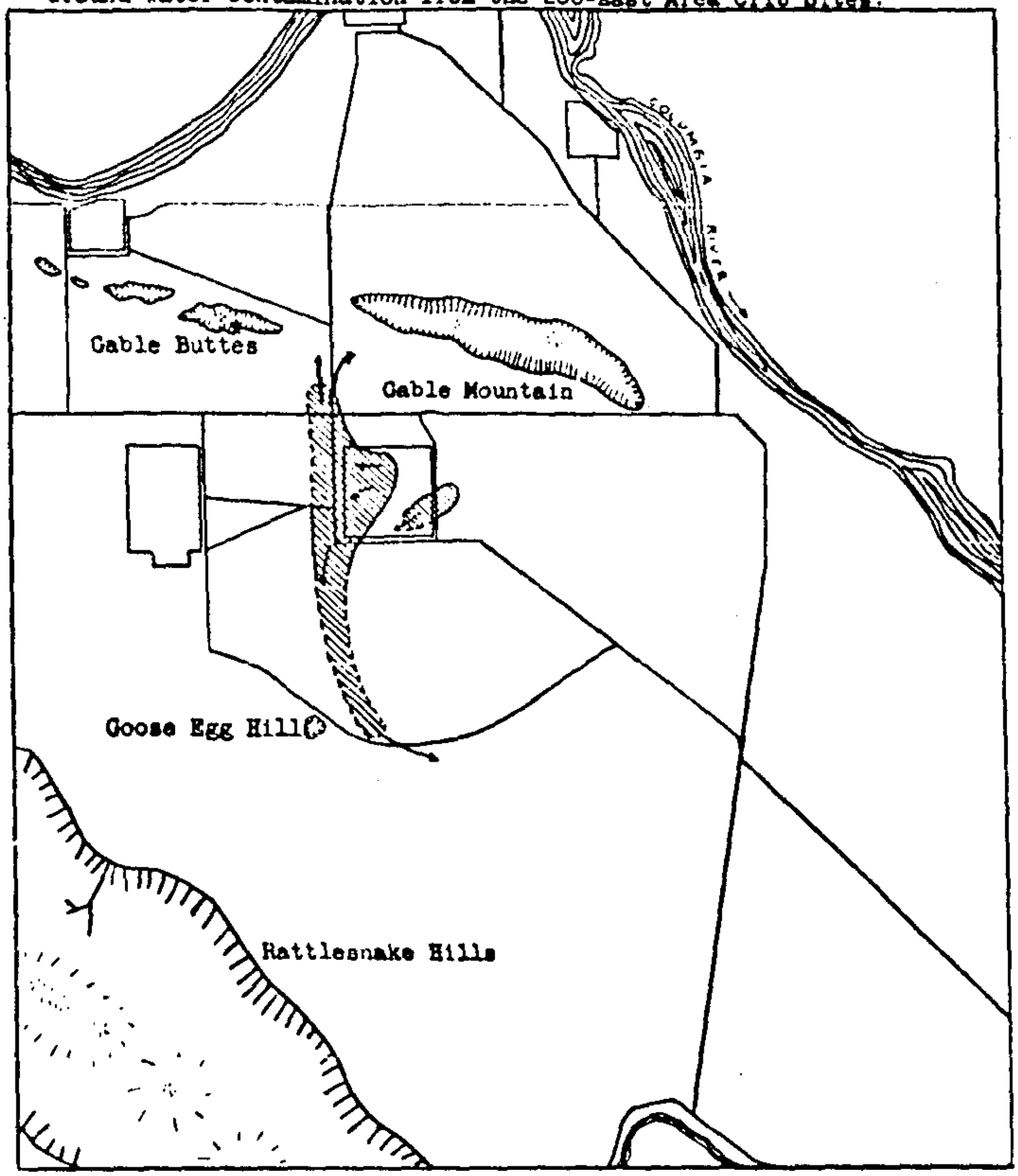

Figure 1.

Contamination pattern as of June 1957 depicted by outlining the 1.5 x 10^{-7} $\mu c/cc$ ground-water contamination limits.

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Wells drilled adjacent to and down-gradient from the 216-A-8 crib continue to show high gross beta concentrations (5×10^{-2} µc/cc) in the ground water. No breakthrough of long-lived isotopes into the ground water has been observed.

200-West Area

Results from test wells in the vicinity of the Redox area indicate contaminants, reaching the ground water from the 216-S-1 and 2 cribs, are probably moving southeastward rather than eastward as previously thought. This observation is based primarily upon results from wells 299-W22-8, 299-W22-9, 299-W22-19, and 699-35-70. (See Figure 2).

Wells 299-W22-8 and 299-W22-9 are located 1000 feet east of the 216-S-1 and 2 cribs and down the ground-water gradient. These wells have shown no detectable concentrations of beta-gamma emitters in the ground water for the past three months. However, the activity density in well 699-35-70, located 3000 feet east of well 299-W22-8, has been as much as 25 times higher than the detectable limit. Moreover, analyses from well 299-W22-19 show beta-gamma emitter concentrations as high as 1.7×10^{-5} µc/cc. The probable source of the radioactive material noted in well 699-35-70 is the 216-WR cribs located approximately 4,500 feet northwest of this well. The probable source of the activity in well 299-W22-19 is the 216-S-1 and 2 cribs or the 216-S-7 crib. These cribs are located approximately 3,000 feet to the northwest. The southeastward movement of these wastes in the ground water increases the distance that these contaminants must travel through fine material.

The ground-water contamination pattern in the vicinity of the T-Plant showed no significant change.

Well 299-W22-2, located adjacent to the 216-S-1 crib, showed positive Sr^{90} concentrations in the ground water during this quarter. The activity density of strontium-90 in this well is 1.1×10^{-6} µc/cc. It was predicted that Sr^{90} would precede Cs^{137} in the ground water at this site because of the low pH of wastes discharged to this site. However, in most cases Cs^{137} is the first long-lived isotope expected to appear in the ground water. No other samples from monitoring wells in 200-West area contained detectable concentrations of long-lived isotopes.

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Ground-water Contamination from the 200-West Area Crib Site

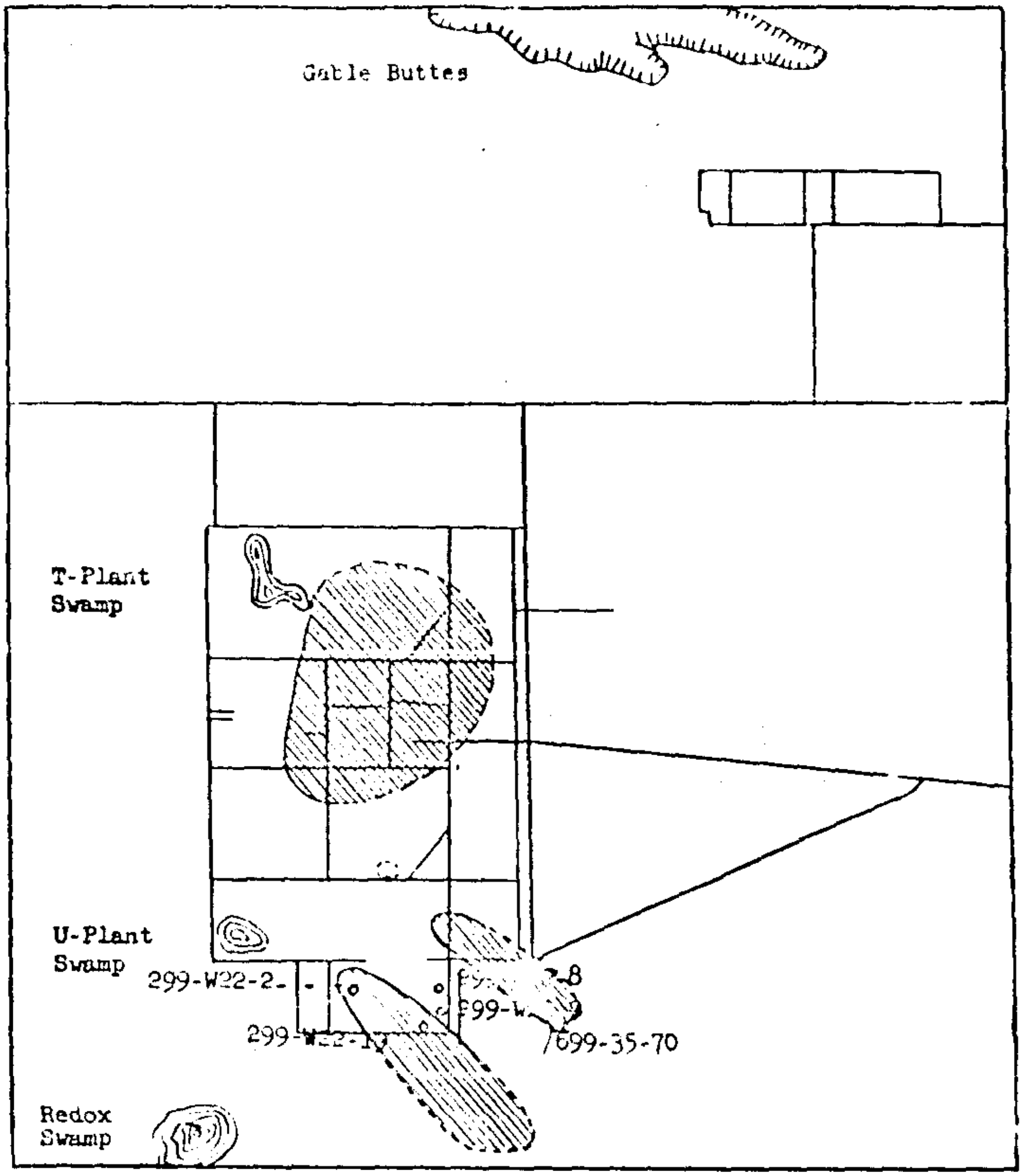

Figure 2.


Contamination pattern as of June 1957 depicted by outlining the 1.5×10^{-7} $\mu c/cc$ ground-water contamination limits.

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II PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department

In-farm scavenging operations at C-Farm started on March 31, 1957. The first three batches of scavenged supernates were found to be unsuitable for cribbing. Two of the batches contained Co^{60} in concentrations appreciably greater than the recommended cribbable test limit of 4×10^{-4} μc/cc. and the third batch demonstrated poor cesium adsorption in soil column tests.

A project proposal (10) issued by the Chemical Processing Department requests test wells at the 216-BC Area for use in monitoring test disposals of high Co^{60} scavenged wastes. These wells will probably not be available for sampling until early 1958. Chemical Processing Department has been requested to delay disposals to the 216-BC crib site as long as possible so that test wells can be drilled and hydrological testing performed before the wastes enter the regional ground-water table.

Document HW-50132, "Proposed Use of Test Wells to be Installed as Part of the High Co^{60} Scavenged Waste Disposal Test," was issued May 7, 1957. It outlines the proposed geological and hydrological tests, and specifies the monitoring and analytical requirements concerned with the test disposal of high Co^{60} scavenged wastes.

A six-inch diameter soil column capped with a one-foot layer of aluminosilicate gel is being studied to determine moisture loss from the gel to the soil. After thirty days, the soil was wetted to a depth of 47 inches. Examination of the gel, which now occupies only about 40% of its original volume, indicates that a considerable amount of free moisture is still available for removal by the soil.

Three hundred gallons of sodium silicate have been received, and two centrifugal pumps with motors have been ordered for use in field test disposals of aluminosilicate gel. Present plans are to conduct "cold" disposal tests east of the 300 Area to obtain mixing and moisture-loss data.

Document HW-50198, "Economics of Disposing of Coating Waste as a Gel -- Preliminary Estimates," was issued on May 14, 1957. It concluded that the cost of gelling and disposing of one gallon of coating waste would be about 9 to 14 cents.

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A sample of ground water from well 299-E33-4, located near the 216-BY scavenged waste crib site, was analyzed for free cyanide ion (CN^-) when it was suspected that ferrocyanide salts used in the waste scavenging operation might not be completely removed by the soil. Free cyanide concentration was less than 0.5 ppm. Previous samples from the same well were reported to contain as much as 230 ppm cyanide, but the analytical method then used would have converted ferrocyanide to cyanide. The current result, which is on the order of MPL for cyanide, is not believed to be of serious concern. However, the presence of cyanide ion, nitrate ion, and possibly other toxic chemicals in significant concentrations in ground water emphasizes the necessity for evaluating chemical toxicity of effluents as well as radiological toxicity.

Document HW-51026, "Leak Detection, Underground Storage Tanks," June 20, 1957, presents basic data for possible application in establishing leak detection systems for 200 Area radioactive waste storage tanks.

Irradiation Processing Department

The Irradiation Processing Department, because of potential production losses, had requested relaxation of the specification prohibiting summer purges. This restriction was based on the principle that no preventable river disposal of P^{32} should be allowed during the period of the year when the accumulation of the isotope in whitefish flesh was at a maximum. "Hot purge" effluents may have up to twenty-five times the normal effluent concentration of P^{32}. Document HW-50601, "The Effect of Purges When River Temperature Exceeds 15° C," was issued. This document supplied the bases for permitting a maximum of ten purges during the late summer and early fall. It also specified that purge effluents during this season be analyzed for P^{32} in order that a periodic appraisal can be made of the effect of purges. It is estimated the concentration of P^{32} in the river will increase less than three percent, during the critical period, as a result of the relaxation.

Study has continued on the disposal aspects of using Turco 4306-B as a decontaminating agent for internal cleaning of reactor rear face piping. The object of the decontamination is to reduce discharge area exposure rates. The Irradiation Processing Department is developing a method of injecting the cleaning solution into the rear crossheaders without sending the reagent through the process tubes. One disposal aspect investigated was the effect the passage of cleaning solution through the retention

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basin would have on the extraction of hazardous fission products from the basin sludge. Laboratory results indicate the release of strontium isotopes to the cleaning solution is about twenty times the amount released to normal effluent water. Since the experiments were designed to provide an indication of the maximum effect, it was concluded that the actual cleaning operation would not cause significant increase of fission products from the basin sludge being sent to the river. Plant scale tests for cleaning are planned for the next period. Sampling and analytical programs were developed to evaluate disposal consequences. The programs will include collecting data relative to toxicological effects on drinking water, to adverse effects on downstream water treatment processes, as well as the radiological effects.

III. LABORATORY EVALUATION OF WASTES

The relaxing of the cobalt specifications during the use test of cribs in 216-BC (5) from one-tenth MPC (4.0×10^{-5} µc/cc) to MPC (4.0×10^{-4} µc/cc) qualified three of the six scavenged wastes from the Uranium Recovery Plant examined by CET for further crib disposal consideration. The standard 40 cm soil column tests, however, indicated that two of the three could not be cribbed on the basis of the Cs breakthrough. These results are summarized in Table I. The volume capacity for strontium is also shown.

Table I

Soil Capacity for Uranium Recovery Plant Wastes With Less than MPC in Co^{60}

Batch No.	Co^{60} µc/cc	Estimated Capacity - Column Volumes	
		Cs	Sr
54-106-BY	3.8×10^{-4}	> 2 and < 3	3
9-112C-102C	1.2×10^{-4}	< 1	> 3
12-112C-106C	1.1×10^{-4}	< 1	> 3

Table II gives the same information for the batches which were too high in cobalt to recommend for crib disposal.

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Table II

Soil Capacity for Uranium Recovery Plant Wastes

Batch No.	Co^{60} µc/cc	Estimated Capacity - Column Volumes Cs	Sr
55-106-BY	8.3×10^{-4}	> 3	> 3
56-107-BY	5.2×10^{-5}	< 1	> 2 and < 3
57-110-BY	1.0×10^{-3}	> 3	> 3

The poor removal of Cs from this waste was not unexpected in view of the relatively high salt content which is evidenced by the magnitude of the specific gravities. Table III gives the distribution coefficients (K_d) for the "standard" 200 East soil, which was used in the column runs. The specific gravities of the batch is given when known.

Table III

Distribution Coefficient and Specific Gravities for Uranium Recovery Plant Waste

Batch No.	K_d for Cs	K_d for Sr	Sp. Gr.
54-106-BY	10.5	51.5	-----
9-112C-102-C	6.0	35.0	1.22
12-112C-106-C	10.7	53.0	1.33
55-106-BY	53	71	-----
56-107-BY	12.5	28.5	1.21
57-160-BY	73	>100	-----

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IV. REGIONAL HYDROLOGY

During the second quarter of 1957 the Purex operation disposed of an average of 9.8 mgd (millions of gallons per day) of liquid wastes to the B-swamp and to cribs. The average for the first half of 1957 of 8.7 mgd is an increase of 2.4 mgd over the average for 1956 of 6.3 mgd. Consequently, it is estimated that the 200-East ground-water mound, at the point of reference, will continue to rise during 1957 somewhat above the predicted altitude of 412 ft above mean sea level (1). This will increase slightly the hydraulic gradients from the mound and concurrently the ground-water velocities. Since December, 1956, the mound has risen 1.19 ft to an elevation of 412.14 ft.

Approximately 6 mgd of effluent is discharged to swamps and cribs at the 200-West Area. Whereas the underlying ground-water mound continues to fluctuate, it appears that the mound is approaching hydraulic equilibrium. For example, the water level beneath the northern part of area declined only 0.80 ft during the second quarter as compared to a 1.75 ft decline during the first quarter, and the peak of the mound beneath the southwestern part of the area continues to fluctuate between elevations 475 and 476 ft above sea level. Consequently, no significant changes are expected in directions or rate of ground-water movement through the remainder of 1957.

In order to further define the hydraulic characteristics of Hanford aquifers (11), four additional pumping tests were conducted. The drawdown-recovery data were interpreted graphically and the results are included in the following table which summarizes the results of all tests completed to date:

Aquifer Tested	Well No.	Transmissibility (gpd/ft)	Permeability (gpd/ft^2)
(A) Ringold formation			
Lower clay portion	699-40-33	1,600	10
Midile conglomerate	199-K-10	34,000	400
Upper silty portion	699-71-52	35,000	900
	699-40-24	210,000	1,400
(B) Glacio-fluviatile deposits	199-F7-1	59,000	3,900
	699-62-43	380,000	12,700
	699-65-50	480,000	13,700
	699-55-50	3,000,000	66,700

Obviously the hydraulic characteristics both within a given aquifer and between different aquifers differ widely, However, orders of magnitude

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are indicated which permit further correlations with other geologic and hydrologic techniques to delineate areas of rapidly moving ground water.

Leveling and taping of the wells in the BC crib and trench area show that a small but definite mound with a maximum known elevation of 2 ft underlies the area. If this is caused by the 1 million gallons per month of scavenged wastes discharging to the trenches, it indicates that the specific retention of the soil column is less than presently believed.

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V. WELL DRILLING SUMMARY

TABLE

WELL DRILLING SUMMARY

Second Quarter 1957

U. S. G. S.

Well	Ft. Drilled	Finished	Total Feet	To Water?
299-E13-19	68	4/2/57	363	Yes
299-E33-21	17	4/4/57	282	"
299-W15-5	159	4/11/57	599	"
199-D5-10	28	4/16/57	28	No
199-D5-11	27	4/16/57	27	"
299-W19-1	301	5/2/57	301	Yes
299-E24-8	282	5/22/57	282	"
299-W22-19	450	6/4/57	450	"
299-W23-4	300	6/17/57	300	"
299-W22-20	301	6/19/57	301	"
	1,933		2,933	

Hatch Drilling Co.

Well	Ft. Drilled	Finished	Total Feet	To Water?
699-77-36	150	4/12/57	150	Yes
699-71-30	150	4/15/57	150	"
699-83-47	150	4/23/57	150	"
699-77-44	150	5/3/57	150	"
699-78-62	150	5/16/57	150	"
699-77-54	150	5/24/57	150	"
699-35-66	450	6/12/57	450	"
699-38-70	413	6/13/57	413	"
	1,763		1,763	

Drilling crews of the U. S. G. S. completed six wells of the CA-700 drilling project during the second quarter of 1957. One additional well was drilled under project number CG-648-1 and two shallow test holes were drilled for Irradiation Processing Department in the 100-D area.

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The Hatch Drilling Company has completed eight wells on the Ca-700 Drilling Project. The total footage drilled to date is 2,400 feet. This represents approximately one-half the contracted footage drilled in one-third of the allotted time specified in the contract.

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