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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JANUARY, FEBRUARY, MARCH, 1958

Prepared by Members of the

Chemical Effluents Technology Operation

Edited by: W. H. Bierschenk

April 24, 1958

CHEMICAL [illegible] AND D[illegible] OPERATION
HANFORD [illegible] OPERATION

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

JANUARY, FEBRUARY, MARCH, 1958

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
JANUARY, FEBRUARY, MARCH, 1958

INTRODUCTION

The Chemical Effluents Technology Operation performs research to investigate the chemical and physical aspects of environmental contamination resulting from plant effluents or from potential process disasters. This report is primarily concerned with plant assistance research in the field of waste disposal during the quarter January-March, 1958.

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

I. INTERPRETATION OF GROUND-WATER MONITORING DATA (W. H. Bierschenk).

Figure 1 shows the probable limits of ground-water contamination based on gross beta activity > 1.5 x 10^{-7} μc/cc in well water samples. This detection level is approximately 0.1% of the Radiation Protection Standards MPC for Ru^{106}. Also shown on the figure are generalized contours on the water table as of December 1957. The general direction of ground-water movement is normal to the contour lines in the direction of the downward slope.

200-East Area

There are three zones of contaminated ground water beneath 200-East Area. (See Figure 1). The depth to water ranges from 200 feet in the northeast to 340 feet in the southwest. The principal sources of ground-water contamination are the waste effluents disposed to the following three general sites, which are discussed in order.

(1) 216-BY and 241-B cribs. - - During the period of use, ending in December 1955, roughly 430,000 curies of beta particle emitters were discharged to these cribs. Part of these wastes are percolating the 240 feet to the water table and entering the ground water. During the period covered by this report, the maximum concentration of gross beta activity detected was 5.1 x 10^{-2} μc/cc, reported 1-6-58. The contaminants move westward and southwestward down the hydraulic gradient imposed by the 200-East ground-water mound. See "A", Figure 1. West of 200-East Area the water table occurs in permeable glacio-fluvia[illegible] sands and gravels, and contaminants reaching these sediments [illegible] move chiefly southward and southeastward. Radioactive contaminati[illegible] [illegible]ed intermittently in three wells located about 11, 12 and 17 mi[illegible] [illegible]east of 200-East Area. The maximum concentration detected in th[illegible] [illegible] of 3.0 x 10^{-7} μc/cc (2-19-58) is far below that considered hazardous [illegible] [illegible]inking water.

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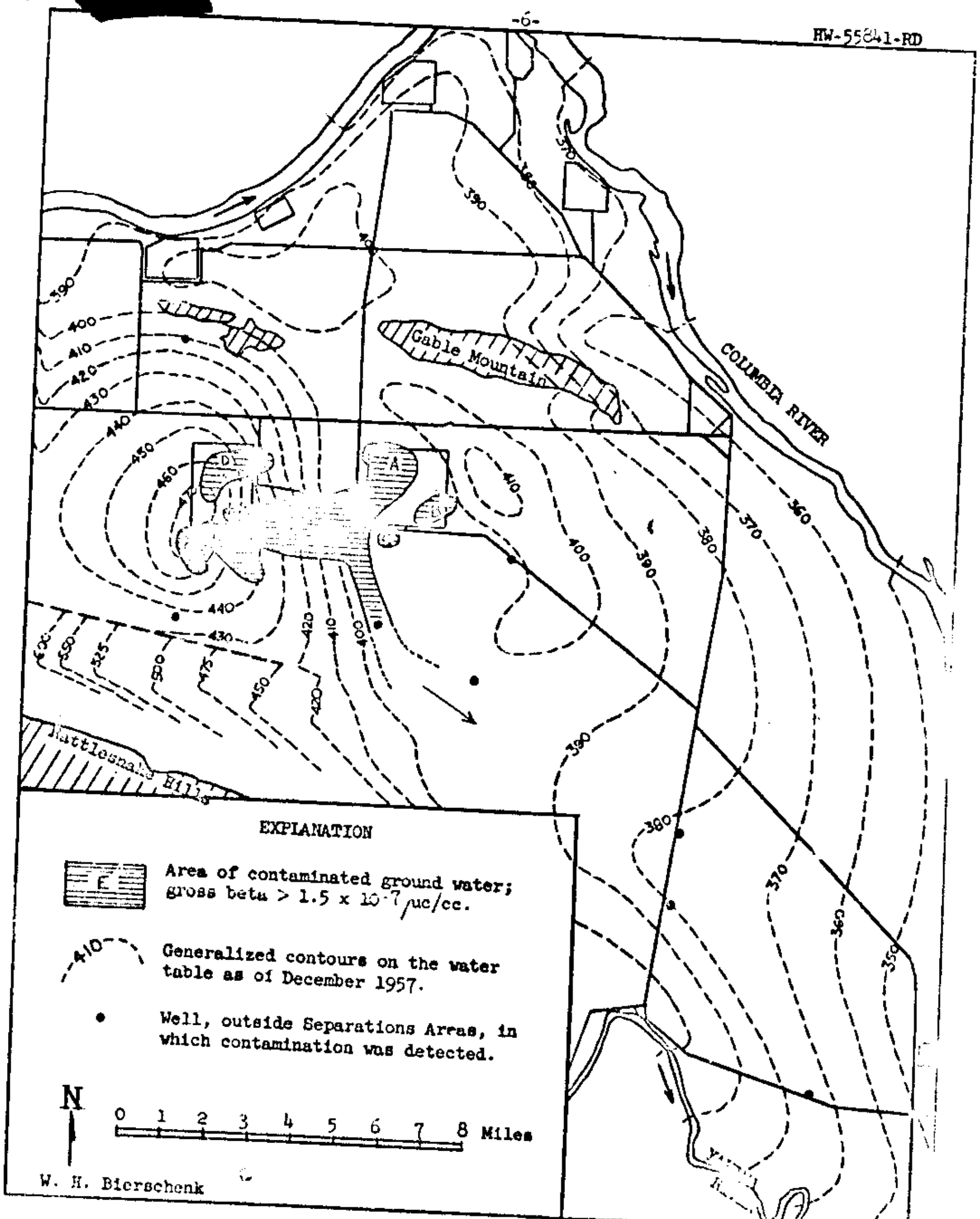

Fig. 1

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(2) 216-A cribs. - - Of the 10,700 beta curies discharged to the 216-A cribs, 85% or 9,000 curies has gone to the A-8 crib. Those Purex process wastes that percolate to the water table contribute to the ground-water contamination zone labeled "B" in Figure 1. The maximum detected gross beta concentration for the period was 5.8×10^{-3} $\mu c/cc$, reported 1-13-58. The contaminated ground water is moving southwestward.

Scintillation probe logs of the six monitoring wells at the A-8 site were prepared in a study of the distribution of radioactive material beneath the crib. The data obtained reveal significantly different penetration of wastes in different areas. For example, in one well the tests indicated that wastes had moved the entire 235 feet to the water table, whereas in an adjacent well gamma emitters were detected to a depth of only 125 feet. These data are correlative with the geologic stratigraphy.

(3) 216-BC cribs and trenches. - - Over 912,000 beta curies of TBP scavenged wastes have been discharged to the BC facilities. The intermittent appearance late in December 1957 and in January 1958 of radioactive contamination in the ground water (depth about 340 feet) beneath these sites is interpreted as a definite breakthrough from one or more of the disposal facilities. See "C", Figure 1. The maximum beta concentration detected to date in the ground water was 7 6 x 10^{-6} $\mu c/cc$, reported 12-26-57. This concentration was found at a depth of 10 feet below the water table; the maximum concentration found in samples from the surface of the water was 2.7×10^{-7} $\mu c/cc$, reported 1-2-58. The concentrations observed have been very low and the results of repeated sampling not completely consistent. These results may possibly indicate sinking of high-density [illegible] wastes in the ground water.

Isotopic and fission product [illegible] - - Results from isotopic analyses made on well water samples show detectable Co^{60} occurring in the ground water beneath the 216-BY cribs and the 216-A-8 crib. The maximum concentration detected beneath the BY cribs was 6.7×10^{-4} $\mu c/cc$, reported 2-10-58. This exceeds the Radiation Protection Standards MPC by a factor of about 2. However, the concentration in samples from this particular well has decreased from the known maximum of 1.3×10^{-3} $\mu c/cc$, reported 5-6-57. On 3-10-58 a Co^{60} concentration of 1.95×10^{-6} $\mu c/cc$ was detected in one well monitoring the A-8 crib. This value is not expected to go much higher because the influent waste to the crib contained only about 3×10^{-6} $\mu c/cc$.

200-West Area

There are currently four zones of contaminated ground water beneath the 200-West Area. See Figure 1. The depth to water ranges from about 200 feet in the west to 280 feet in the east. The principal sources of contamination are the wastes of the T-Plant and Redox disposal facilities.

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(1) T-Plant cribs and trenches. - - Disposal of wastes to the T-facilities terminated in mid-year, 1956. A total of 94,000 beta curies had been discharged, roughly 90% of which went to the 216-TY-1 crib, the 241-TX trenches, and the 361-T-1,2 cribs. Those radioactive wastes that have percolated to the water table contribute to zone "D" on Figure 1. For the period of this report, the maximum detected concentration of beta particle emitters in well water samples was 1.2×10^{-4} μc/cc, reported 3-4-58. The contaminated ground water moves generally northeastward in accordance with the prevailing hydraulic gradient.

The ground water underlying the 216-WR crib is contaminated to a detected level of 3.7×10^{-5} μc/cc (1-7-58), and wells to the east beyond 200-West Area have shown beta concentrations as high as 2.2×10^{-6} μc/cc. However, this contaminated zone, "E" (Figure 1), influenced by the prevailing eastward hydraulic gradient, was probably contaminated by wastes from the T-facilities. While the T-Plant was active, the prevailing gradient was southeastward, and wastes moved in that direction. Changes in rates, volumes, and sites of disposal (1) altered directions of ground-water movement, thus zone "E" is believed a remnant of former conditions. A scintillation probe log of the well monitoring the 216-WR crib shows practically no gamma activity at depth.

(2) Redox cribs. - - More than 850,000 beta curies have been discharged to the "S" disposal facilities, and almost all of this has gone to the 216-S-1,2 and S-7 cribs. The underlying ground water has been contaminated by some of these wastes, the maximum detected concentration for the period being 3.9×10^{-3} μc/cc (2-17-58). The contamination tends to move southeastward down gradient. See zone "F", (Figure 1).

Scintillation probe logs of the wells monitoring the Redox cribs show that immediately adjacent to the 216-S-1,2 and 7 cribs radioactive wastes have percolated down through the sediments 160 feet to the water table. However the horizontal movement of wastes in the sediments is generally limited to less than 200 feet.

The fourth zone in 200-West Area, "G", lies beneath the 216-S-5, 6 cribs. The maximum beta concentration detected in water samples from monitoring wells was 3.5×10^{-7} μc/cc, reported 1-7-58. This contamination can be expected to move generally southeastward. In the future, some ground water contamination in this zone may be contributed by beta particle emitters present in the Redox swamp waters. In February, unusually high activity was noted in process water discharged to the new Redox swamp. A sample was found to contain 1×10^{-2} μc/cc and investigation of past results indicated an increasing trend by a factor of 2 each month since the end of November 1957.

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Fission product analyses. - - Radiostrontium persisted in the ground water beneath the 216-S-1,2 cribs as indicated by samples from adjacent wells. On 1-14-58 the well water sample contained 1.4×10^{-6} µc/cc; this is an increase from the 8.8×10^{-7} µc/cc reported in the last quarter of 1957 (2). No radiostrontium or radiocesium was found in ground-water samples from any other site.

II. PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department

Co^{60} use test (W. A. Haney).

The waste scavenging program came to an end following the processing of batches 28 and 29 in January 1958. Although the Co^{60} concentrations in these batches were below the cribbable limit of 4×10^{-4} µc/cc, poor cesium adsorption characteristics made it advisable to discharge the wastes to the specific retention trenches.

The following table summarizes disposal data on wastes discharged to the three major scavenged waste disposal sites.

200 AREAS SCAVENGED WASTE DISPOSALS

Site	Volume (Gallons)	Beta Activity (Curies)	Sr^{90} Activity (Curies)	Cs^{137} Activity (Curies)
216-BY cribs	8,945,000	408,510	14,784	3,141
216-BC cribs	8,657,375	300,255	1,407	1,539
216-BC trenches	17,213,000	500,000	5,380	7,000
Totals	35,015,375	1,2[illegible]	21,571	11,680

The total beta activity in scavenged waste supernatant liquid discharged to ground represents about 55% of the beta activity sent to all ground disposal sites in the 200 Areas.

The second phase of this program, the study of the dispersion of liquids in ground water by means of a "Co^{60} use test" got underway in March with the beginning of the well drilling. All the wells are expected to be completed by the end of June.

Specific retention study (W. A. Haney).

HW-54599 - - "A History and Discussion of Specific Retention Disposal of Radioactive Liquid Wastes in the 200 Areas," was issued January 20, 1958 (3). This report reviews the history and presents tabulated data on specific retention disposals of 200 Areas radioactive liquid wastes. A discussion of the shortcomings and unevaluated features of this disposal method are also presented. Lowering of the capacity factor from 10% (volume basis) to 6% was recommended

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in view of the absence of reliable data defining the extent of underground spreading which occurs at the various disposal sites. An absence of data on long-term migration of radioisotopes in wetted soils also makes it advisable to use a more conservative capacity factor.

Disposal to cribs (W. A. Haney).

On the basis of conservative laboratory data, calculations show that Sr^{90} may enter the regional ground water beneath the 216-A-6 crib within the next few months. Consequently a recommendation was made to Purex Operation to abandon this crib and to activate the 216-A-24 replacement crib on or about May 1, 1958

Ninety percent of the Sr^{90} discharged to the abandoned 216-S-1 and 2 cribs was accounted for in a cylinder of soil about 120 to 140 feet in diameter and 30 feet deep. The audit of Sr^{90} was calculated using the radioanalysis of soil samples taken from wells located near the circumference of the cylinder. In nearly all these samples, Cs^{137} was not detectable, which prohibited making a Cs^{137} audit. The absence of this radioisotope is evidence that it was removed by the soil before the waste reached the wells. The material balance of long half-life isotopes or "positive" approach method of auditing wastes discharged to the ground appears to be a feasible reinforcement to the present "negative" monitoring method. However, it would be very expensive, requiring a large number of radioisotopic analyses of the effluent to a crib and possibly tripling the number of wells associated with the crib.

The presence of plutonium in the soil at the bottom of a 150-foot well adjacent to the 234-5 Building waste crib was confirmed by laboratory analysis. Six other shallow wells in the immediate vicinity are suspected of containing plutonium contamination. Plutonium contamination at this depth (50 feet above the regional ground water) has resulted in a recommendation to Finished Products Operations that a new crib, with attendant ground-water monitoring wells, be provided in the immediate future.

Coating waste disposal (W. A. Haney).

The moisture content of the aluminosilicate gel in the 300 Area test disposal pit has not changed significantly since the test started. This behavior is in sharp contrast with the data collected from the laboratory soil column test which showed 75% of the moisture was lost to the soil and atmosphere over a period of three months. This difference in experimental findings indicates that concern over loss of moisture from the gel to the soil may have been over-emphasized. Samples of the soil below the test pit are to be taken within a few months. Analysis of these samples will help to clarify the differences in experimental results.

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300 Area waste disposal (W. A. Haney)

A sampling traverse of the Columbia River conducted 1/2 mile below the 300 Area in January 1958 yielded samples which contained uranium in concentrations just slightly above background. This, combined with previous findings, establish that nearly complete dilution of 300 Area wastes is realized within a short distance downstream of the 300 Area at all times of the year.

Irradiation Processing Department

As^{76} and P^{32} in reactor effluent (W. N. Koop).

The river concentrations of As^{76} and P^{32}, resulting from disposal of reactor coolant, are of serious radiological concern during certain periods of each year. Restricting reactor production, either by limiting power level or operating time, is the only known way of maintaining or reducing the release rate of these two isotopes to the river. Three studies are planned to find alternate methods of inhibiting the formation of As^{76} and P^{32} in the coolant.

The first study was started in January at B-Area where samples and operating data were collected. The object is to determine relationships that may exist between seasonal operating conditions and the coolant concentrations of As^{76} and P^{32}. The correlation of operational data and analytical results will be attempted by graphical methods. This study will probably be completed in about one year.

The object of the second study is to determine the effect a lower pH coolant has on the effluent concentration of the two isotopes. The program of collecting effluent samples from each of six 105-KE experimental tubes was started in March and a comparison of the isotopic concentration of the streams will be made. These six tubes are being operated as part of a corrosion study program. Two of the tubes are cooled with pH 6.0 water, two at pH 6.5, and two at the standard pH level 7.0. This test will probably be completed before the end of the next quarter.

The third study is to be conducted at F-Area in May. The object is to determine whether the effluent concentration of As^{76} and P^{32} can be significantly decreased by avoiding the impurities associated with the use of commercial grade H_2SO_4 for treating coolant. It is planned to add reagent grade sulfuric acid to the water cooling one-half of the reactor, while using commercial grade acid to treat the water cooling the other half. Isotopic analyses of effluent samples of both halves of the reactor will be made and compared.

1957 purges

A review was made of the reactor purges conducted in 1957 to determine if the current limitations on purge effluent disposal are adequate without being unduly restrictive. (The disposal rules are based on estimates of river pollution resulting from the release of purge effluents in the spring of 1955). A comparison

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of the quantities of radioactive material found in 1955 with that found in 1957 purge effluents showed no significant difference. The isotopes of concern (Fe^{59}, P^{32}, and Np^{239}) were all increased by about the amount anticipated and can be traced directly to an increase in operating level. The 1957 effluents, from about 50 purges during reactor operation, were sent to the river and the total time that this material was being released was about 20 hours. The effluents from another 10 purges were sent to cribs. The conclusion was reached that the present disposal rules are needed for preventing undue river pollution from purges and yet permit effective use of this operation. The rules requiring sampling and analyses are still needed to permit periodic appraisal of river pollution from purges.

Retention basins (W. N. Koop).

Document HW-53249 - - "Effects of Direct Disposal of Reactor Effluent Water to the River" - - was issued on March 6, 1958 (4). This document reviews disposal aspects of discontinuing the detention of normal reactor coolant. The conclusions presented were made by the authors after cooperating with project engineers who were preparing plans for modifying the effluent disposal equipment.

Uranium oxidation and fission product volatilization experiments (R. K. Hilliard).

Base-line data were gathered for the uranium oxidation experiments. The slight amount of oxidation which occurred in argon atmospheres was found to be less than 1% of that expected in air and steam atmospheres. Therefore, the proposed technique of heating and cooling the uranium specimens in argon so as to maintain isothermal conditions during the oxidation period appears to be reasonable. The initial reaction in an inert atmosphere is believed to be caused by a combination of reactions with the residual air in the system after degassing and with the combustion boat material. All boats tested showed some degree of reaction with molten uranium.

Tests with air atmospheres were started at the quarter's end. The effect of time and temperature on oxidation rates in air and steam at temperatures up to 1400° C will be investigated during the coming quarter.

The experimental equipment operated satisfactorily and it is expected that only slight revisions will be required for the fission product volatilization experiments.

The literature survey, entitled "The Effect of Heating Irradiated Uranium - - A Literature Survey," HW-52735, was issued in January (5).

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III. LABORATORY EVALUATION OF WASTES (H. L. Brandt).

Redox Operation

241-SX tank farm waste evaluation.- - Multiple soil-column testing started on the 106 Tank and the 401 Building condensates for evaluation of the 216-SX-1 crib capacity. Since March 1958 the condensates were recycled to the boiling tanks in the Farm. Only the excess condensate from the 401 Building is currently pumped to the crib.

D-2 waste evaluation.- -More than 10 column volumes of Redox D-2 were put through standard soil columns (simulating the 216-S-7 crib) without exceeding 2×10^{-7} $\mu c/cc$ of Sr^{90} in the effluent liquid. This concentration is the current analytical sensitivity. In view of this high capacity special laboratory techniques including the addition of Sr^{90} to the waste samples will be used to calculate column capacities. It appears reasonable to assume, however, that a Sr^{90} breakthrough in the ground water is not imminent since the equivalent of only 4 column volumes was discharged to the 216-S-7 crib to date. An equipment cleanout rinse of 50,000 gallons was pumped to the crib in July 1957. The rinse had a concentration of Sr^{90} 100 times that of regular D-2 and this was equivalent to 0.7 column volumes of the waste stream. It did not, however, have a disproportionate effect on the crib capacity.

Purex Operation

A-8 waste evaluation and equipment test.- - Final soil-column laboratory evaluation tests for the 216-A-8 crib gave a capacity of 13.5 column volumes. This is considered reasonable confirmation of the initial column runs on this waste which indicated a crib capacity of 9-column volumes.

An analysis was made to determine the effect of a spray nozzle for increasing drop size and thus increasing the separation efficiency in the A-8 vapor header. Total strontium was decreased by about one order of magnitude. Of the components analyzed, only Nb^{95} increased. Table 1 summarizes the results.

Table 1

Activity Density of Condensed Purex A-8 Vapor ($\mu c/cc$)

Component	After Nozzle Installation	Before Nozzle Installation
Total Beta	5.1×10^{-1}	9.9×10^{-1}
Ru^{106}	1.8×10^{-1}	6.7×10^{-1}
Total Sr	2.7×10^{-4}	1.3×10^{-3}
Zr^{95}	1.1×10^{-2}	4.6×10^{-2}
Nb^{95}	1.1×10^{-2}	3.6×10^{-3}

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A-5 waste evaluation and special test. - - Experiments to date indicate that the 216-A-5 crib capacity may be as low as 2 column volumes for Sr^{90}. The crib has already received 89 column volumes. The calcium ion in the A-5 waste stream appears to be the major cause of the unusually low crib capacity. The calcium is added to the stream in the limestone bed which neutralizes the waste before disposal. Studies are underway to find a method for increasing the capacity of the soil for the Sr^{90} in this waste.

234-5 Recuplex Investigation

Recuplex waste (CAW). - - Experiments were initiated to determine the flow and the plutonium adsorption characteristics of the CAW waste in the Z-10 crib. These experiments have already shown that an acidified process water (up to 0.05M HNO_3) percolates through the soil at rates up to 0.4 gal/ft^2/hr. The crib soil contains about 4% carbonate. Thus the soil can be "conditioned" to a specified pH before it receives the waste. Tests on synthetic wastes show that the greater the acidity of a solution of high salt content, the slower the flow through the soil. In the case of the actual CAW waste, however, flow rates in preliminary tests have been as high as the equivalent of 8100 gallons per hour through a crib the size of Z-10.

TBP scavenged waste

The final soil column test on scavenged TBP waste (Batch No. 29-108C-109 BX) showed too high a Cs^{137} breakthrough to permit crib disposal. Table 2 summarizes the results.

Table II

Soil Column Test Breakthrough Ratios of TBP Waste No. 29-108C-109BX

Column Volumes	Cs^{137}	Sr^{90}
1	1.34×10^{-1}	6.45×10^{-4}
2	3.75×10^{-1}	3.76×10^{-3}
3	5.4×10^{-1}	2.45×10^{-3}
Limiting breakthrough	3.02×10^{-3}	1.0×10^{-2}

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IV. GROUND-WATER HYDROLOGY (W. H. Bierschenk)

A water-table contour map as of December 1957 revealed additional information regarding Hanford hydrology. The incorporation of data from several recently drilled wells was largely responsible for the development of the new information. It is evident from the map (see Figure 1) that the southern movement of water from the 200-West ground-water mound is restricted by the buried basalt ridge that separates it from Cold Creek valley. A low, flat mound north of Gable Butte is attributed to recharge from the Columbia River during the annual high river stage. This seasonal recharge contributes west-to-east flow of ground water north of Gable Mountain.

Detectable fluorescein has arrived in two wells 11,500 and 13,200 feet from the injection well. The movement of ground water through glacio-fluviatile sediments southeast of 200-East Area thus occurs at average rates of roughly 160 and 150 feet per day, respectively. The fluorescein concentration in observation wells continues to increase, indicating the possibility of estimates of diffusion rates in the ground water.

A research study of the specific retention capacities of Hanford sediments was initiated. Tests were performed and are continuing to evaluate a centrifuge technique for obtaining this data by attempting to establish a gravity-time-specific retention relationship. Touchet sediments averaged about 13% moisture by weight following a 1-hour test at 1,000 gravities. After 4 hours at 1,000 gravities the moisture content was about 9%. This is estimated to be roughly equivalent to 167 days drainage at 1 gravity. The moisture content of the "dry" sediments as obtained in the field averaged about 4% by weight. This is estimated to represent gravity drainage for a period in excess of 5,000 years. It also represents some unknown degree of evaporation, although the samples tested were obtained from buried formations in which evaporation would be minimized. It is hoped that a valid asymptotic curve can be constructed from such data which will give the appropriate specific retention-time relationship.

V. WELL DRILLING SUMMARY (D. J. Brown)

TABLE

First Quarter 1958

Hatch Drilling Company	Ft. Drilled	Finished	Total Feet	To Water?
699-27-54	261	1-13-58	350	Yes
699- 9-E4	342	1-17-58	454	"
699- 2-17	350	1-31-58	350	"
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The Hatch Drilling Company completed the AT (45-1) - 1178 drilling contract on schedule. Their completion date was January 31, 1958. Twenty-three wells with a total footage of approximately 7,300 feet were drilled in 299 calendar days; an average of 13 feet drilled per crew calendar day. This is the second highest footage drilled by a fixed-price contractor at Hanford.

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