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# EARTH SCIENCES' WASTE DISPOSAL MONITORING ACTIVITIES SUMMARY, JANUARY, 1956

BY

EARTH SCIENCES PERSONNEL

Earth Sciences Unit
RADIOLOGICAL SCIENCES DEPARTMENT

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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EARTH SCIENCES' WASTE DISPOSAL MONITORING

ACTIVITIES SUMMARY, JANUARY, 1956

INTRODUCTION

Maps showing the approximate areas of contamination of the ground water by cribbed wastes will be included in these reports on a quarterly frequency, beginning with this issue. The extent of contamination will sometimes be based upon very limited data and necessarily upon the interpretation based upon that limited data and on past observations, thus the limits of contamination may be highly tentative. Data obtained from new wells being drilled to monitor the spread of such contamination will at least moderately alter the picture. The increasing complexity, as well as the importance of the waste disposal program, makes the issuance of such maps of considerable value, however, provided the limited data upon which the tentative conclusions are based is realized.

SUMMARY

Ground water contamination movement and trends continued about as before. Contamination in the ground waters external to the Separations areas was confirmed for the first time in ten years of disposal operations. The extent of contamination was still being evaluated at the month's end (see Plate 1). A practicable means for minimizing or halting such movement was indicated, which involves reproducing past events that minimized this flow. Cesium was detected in the ground water in three wells adjacent to cribs; the maximum detected was four times the current detection limit, and 0.2% of the Handbook 52 MPC for $Cs^{137}$ in drinking water, thus below the locally permissible levels of 10% of the Handbook 52 levels. The affected cribs, moreover, are no longer receiving wastes.

Awarding of a drilling contract to the Strasser Drilling Company of Portland, Oregon, is expected to quickly improve the currently unsatisfactory progress of well drilling.

Laboratory studies continued on the factors affecting infiltration rates of water into soils. Attempts to reduce the infiltration rate by the flocculation of 0.5% added bentonite were not successful.

Experiments with various solvents disclosed that Soltrol and Shell Spray Base do not significantly extract $Cs^{137}$ and $Sr^{90}$ from $NaNO_3$ solutions within the concentrations tested, but that hexone removes up to 4% $Cs^{137}$ and up to 28% of the Pu from similar solutions. Organic solvents accordingly pose some special problems in disposal to ground.

Preliminary experiments with tritium oxide in soil columns indicate a preferential retention of the tritium in soils, apparently correlated with the clay content. Use of natural tritium oxide in ground waters as a measure of their age is thus considerably more difficult than anticipated.

The adsorption of Sr from samples of D-1 and D-2 (Redox) wastes was markedly improved by raising the pH of the waste solutions to 8 or higher. The addition of phosphate to a sample of D-1 waste also markedly improved the Sr adsorption from that solution.

The wastes from two additional tanks of uranium recovery plant scavenged wastes were found within the limits prescribed for disposal to ground. Twenty-two tanks have been thus so studied. Wastes from two tanks of tank-farm scavenged wastes were also found to be within the limits prescribed for disposal to ground.

Well Monitoring Results and Evaluation

One hundred forty-eight samples of ground water were obtained from 37 wells by Earth Sciences personnel in January, and transmitted to the Radio-Analysis Laboratory. Thirty-seven were analyzed for fission products. The total beta-gamma activity in all samples was measured by means of standard radio-chemical procedures. The concentration of alpha emitters (uranium) was measured by means of a fluorophotometer. Specific determinations for plutonium were made on the water from those wells in which some possibility exists that plutonium might be present. Activity densities were calculated by Radio Analysis Laboratory. A total of 20 water samples were analyzed by the 222-U laboratory for non-radioactive salts. Thirty-two additional samples of ground water were obtained by Regional Monitoring personnel, including samples from the 321 crib site and the 361-B reverse well site.

TABLE I

*321 CRIB SITE ACTIVITY DENSITIES
FOR MONTH OF JANUARY

| Well Number | Beta-Gamma Emitters Units of $10^{-8}$ μc/cc | Alpha-Emitters Units of $10^{-9}$ μc/cc |
|---|---|---|
| 321-2 | 1.2 | 8.0 |
| 321-4 | 3.3 | 3.1 |
| 321-5 | 1.3 | 8.9 |
| 321-6 | 1.9 | 23.3 |
| 321-7 | 1.0 | 1.7 |
| 321-8 | 1.1 | 13.5 |
| 321-9 | 2.7 | 1.8 |

*This site sampled monthly by Regional Monitoring

No significant changes from December were apparent in the activity densities within the 321 crib wells.

TABLE II

*361-B REVERSE WELL AND 5-6 CRIB SITE ACTIVITY DENSITIES FOR THE MONTH OF JANUARY

| Well Number | Beta-Gamma Emitters Units of $10^{-8}$ uc/cc | Alpha-Emitters Units of $10^{-9}$ uc/cc |
|---|---|---|
| 361-B-1 | 1.4 | 4.8 |
| 361-B-2 | 1.6 | 1.8 |
| 361-B-3 | 1.4 | 1.8 |
| 361-B-4 | 0.8 | 0.7 |
| 361-B-5 | 3.6 | 0.9 |
| 361-B-6 | 1.8 | 0.9 |
| 361-B-7 | 4.1 | 0.5 |
| 361-B-8 | --- | --- |
| 361-B-9 | 1.7 | 4.7 |
| 361-B-11 | 1.8 | 0.5 |

*This site sampled monthly by Regional Monitoring

The activity densities within the 361-B wells remained about as previously reported. Wells 361-B-5 and 7 continue to show evidence of low level contamination that indicates the westward extent of the zone contamination noted on Plate 2.

TABLE III

241-B 2nd CYCLE AND 241-BY CRIB SITE ACTIVITY DENSITIES AND NON-RADIOACTIVE SALT CONCENTRATIONS FOR MONTH OF JANUARY

| Well Number | Beta-Gamma Emitters Units of $10^{-8}$ μc/cc | | | | | Alpha Emitters $10^{-9}$ μc/cc | Non-Radioactive Salts | |
|---|---|---|---|---|---|---|---|---|
| | 1st week | 2nd week | 3rd week | 4th week | 5th week | | NA ppm | $NO_3$ ppm |
| 224-B-4 | 40.3 | 152 | | 32.8 | | | | |
| 241-B-5 | 2,630 | 69,600 | | 115,000 | | | | |
| 241-B-11 | 396,000 | 670,000 | | 89,600 | | | | |
| 241-B-15 | 111,000 | 241,000 | 103,000 | 167,000 | | 3.16 | | |
| 241-B-16 | 49,900 | 126,000 | 180,000 | 174,000 | | 3.70 | | |
| 241-B-17 | 34,200 | 90,000 | 124,000 | 158,000 | | 2.38 | | |
| 241-B-18 | 285 | 908 | 966 | 551 | | 0.07 | | |
| 241-B-19 | 5,910 | 11,800 | 11,400 | 55,200 | | 2.07 | | |
| 241-BY-2 | 11.6 | | | | | 1.21 | | |
| 241-BY-8 | 120 | | 26.7 | 616 | | -0.14 | | |
| 241-BY-9 | 100,000 | 240,000 | 1,100,000 | 7,000,000 | | | | |
| 241-BY-10 | 1,100 | 12,000 | 11,000 | 36,000 | | | | |
| 241-BY-11 | 490,000 | 3,200,000 | 21,000,000 | 34,000,000 | | | | |
| 241-BY-12 | 4,400 | 8,400 | 47,000 | 67,000 | | | | |
| 241-BY-13 | <75 | 260 | 180 | 90 | | | | |
| 241-BY-14 | 36.2 | | 16.6 | 437 | | 1.19 | | |
| 241-BY-15 | <75 | <75 | 210 | <75 | | | | |
| 241-BY-16 | <75 | 120 | <75 | <75 | | | | |

Water from wells 241-BY-9, 10, 11 and 12, continued to show significant and appreciable increases in activity density, owing to the continued drainage from the soil columns beneath the now out-of-use cribs, and southeastward direction of ground water flow in the region. Specific determinations for plutonium in water from wells 241-BY-9, 10, 11, 12, 13, 15, and 16 disclosed no evidence of concentrations above the detectable limits of $1.8 \times 10^{-7}$ μc/cc, or about one-tenth of the Handbook 52 MPC for Pu in drinking water.

TABLE IV

361-T REVERSE WELL SITE ACTIVITY DENSITIES AND NON-RADIOACTIVE SALT CONCENTRATIONS FOR MONTH OF JANUARY

| Well Number | Beta-Gamma Emitters Units of $10^{-6}$ μc/cc | | | | | Alpha Emitters $10^{-9}$ μc/cc | Non-Radioactive Salts | |
|---|---|---|---|---|---|---|---|---|
| | 1st week | 2nd week | 3rd week | 4th week | 5th week | | $NA$ ppm | $NO_3$ ppm |
| 241-T-361 | 37.4 | 353 | | 303 | | 0.89 | | |
| 361-T-12 | 364 | 116 | | 341 | | 0.10 | | |
| 361-T-14 | 76.0 | 286 | | 466 | | -0.07 | | |
| 361-T-15 | 443 | 1,330 | | 355 | | -0.20 | | |
| 361-T-16 | 23.3 | | | 333 | | | | |
| 361-T-17 | 35.9 | 84.9 | | 269 | | 2.45 | | |
| 361-T-18 | 30.8 | 47.1 | | 432 | | 1.97 | | |
| 361-T-19 | 32.9 | 799 | | 1,000 | | 0.61 | | |
| 361-T-22 | 18.9 | 53.8 | | 369 | | 0.58 | | |

Wells 361-T-14, 15 and 22 show tenfold, thirteenfold, and elevenfold rises respectively in beta-gamma emitter activity densities over the average for December. A continued eastward movement of the ground water and contaminants from the 241-T 2nd. cycle crib site is indicated; the rate of movement is estimated to be about one foot per day, on the basis of dilution-velocity tests in the area, and on the apparent rate of travel of nitrate in contaminants at the site. Additional exploration to the northeast is planned for the immediate future to follow the trace amounts of contaminants.

TABLE V

241-T and TX 2ND CYCLE AND 216-TY CRIB SITES ACTIVITY DENSITIES FOR MONTH OF JANUARY

| Well Number | Beta-Gamma Emitters Units of $10^{-6}$ μc/cc | | | | | Alpha Emitters $10^{-9}$ μc/cc | Non-Radioactive Salts | |
|---|---|---|---|---|---|---|---|---|
| | 1st week | 2nd week | 3rd week | 4th week | 5th week | | NA ppm | $NO_3$ ppm |
| 224-T-4 | 70.0 | 76.3 | | 303 | | 0.5 | | |
| 224-T-10 | SEE TABLE VIII | | | | | | | |
| 241-T-15 | 2,470 | 1,430 | | 2,120 | | 61.7 | | |
| 241-T-16 | 2,200 | 2,560 | | 2,490 | | 62.89 | | |
| 241-T-17 | 3,650 | 3,850 | | 3,930 | | 16.18 | | |
| 241-T-18 | 32.5 | 78.5 | | 238 | | -0.34 | | |
| 241-T-19 | 19.2 | 225 | | 324 | | 0.78 | | |
| 241-T-20 | 11.3 | 23.3 | | 209 | | 0.75 | | |
| 241-T-21 | 23.7 | 62.4 | | 336 | | 0.17 | | |
| 231-? | 4.1 | 19.6 | | 218 | | 0.10 | | |
| 241-TY-? | 16,800 | 20,400 | | 19,000 | | 15.26 | | |
| 241-TY-5 | 690 | 480 | 630 | 1,400 | | | | |

Movement of the ground waters from these sites eastward was previously noted; some westward movement down the western side of the ground water mound is also evident from contamination in well 241-T-21. Well 241-TX-12 at the TX 154, or 2nd. cycle replacement crib, was incomplete but water samples taken during drilling showed 29.5 ppm Na and 260 ppm $NO_3$, further indicating the southward extent of the area of ground water contamination by 2nd cycle wastes (See Plate 2).

TABLE VI

REDOX, 216-S CRIB SITES ACTIVITY DENSITIES AND NON-RADIOACTIVE SALT CONCENTRATIONS FOR MONTH OF JANUARY

| Well Number | Beta-Gamma Emitters Units of $10^{-8}$ μc/cc | | | | | Alpha Emitters $10^{-9}$ μc/cc | Non-Radioactive Salts | |
|---|---|---|---|---|---|---|---|---|
| | 1st week | 2nd week | 3rd week | 4th week | 5th week | | NA ppm | $NO_3$ ppm |
| 241-S-6 | 30.7 | 210 | 55.0 | | | 1.61 | | |
| 241-SX-5 | 75 | 1,600 | 710 | | | | | |
| Redox Crib #2 | 35.6 | 128 | 30.0 | 1.5 | | <0.20 | | |
| Redox Crib #3 | 21.6 | 110 | 14.0 | 8.2 | | 2.68 | | |
| 207-S-12 | 6,300 | 15,000 | 13,000 | 3,800 | | | | |
| 207-S-14 | 180,000 | 190,000 | 200,000 | 190,000 | | | | |
| 216-S-7-#1 | | 53,000 | 21,000 | | | 2.64 | 20.5 | <1 |

Determination of plutonium in the water from wells 207-S-12 and 14, also called 241-S-12 and 14 at the 216-S-1 and 2 crib site, and from 241-SX-5 disclosed no evidence of concentrations above the detectible limits of $1.6 \times 10^{-7}$ μc/cc.

A sixfold increase in the beta gamma emitter activity density in well 241-S-6 suggests a contamination source in the tank farm condensate crib, however concrete data on the specific directions of movement of the ground water are yet lacking. Well #1 at the 216-S-7 crib (replacement of the 216-S-1 and 2 cribs) encountered high activity in the ground water there, undoubtedly from the 216-S-1 and 2 cribs, and suggests either a slightly south of east flow direction or a significant fanning out of the contaminants.

TABLE VII

PUREX CRIBS ACTIVITY DENSITIES AND NON-RADIOACTIVE SALT CONCENTRATIONS FOR MONTH OF JANUARY

| Well Number | Beta Gamma Emitters Units of $10^{-8}$ μc/cc | | | | | Alpha Emitters $10^{-9}$ μc/cc | Non-Radioactive Salts | |
|---|---|---|---|---|---|---|---|---|
| | 1st week | 2nd week | 3rd week | 4th week | 5th week | | NA ppm | $NO_3$ ppm |
| 241-A-1 | | 104 | | 7,640 | | | | |
| 216-A-1 #6 | 75.8 | 48.8 | | 3,880 | | | | |
| 216-A-8 #2 | 2,180 | 153 | | 110,000 | | | | |
| 216-A-6 #1 | 106 | 25.1 | | 712 | | | | |
| 38-43 | | 1,220 | | | | | | |

Beta-gamma emitter contamination in wells 241-A-1, 216-A-1 #6 and 216-A-5 #12 about 8000 to 9000 feet southeast of the 241-BY crib site, continued to rise. Rises of 15-fold, 10-fold, and 210-fold, respectively, were noted. Continued movement of the ground waters from the 241-BY crib site is thus confirmed. Contamination detected in well 30-43, about one mile east of the southeast corner of 200 East Area, shortly following completion of the well, confirmed the presence of contamination in the ground waters external to the Separations areas for the first time in ten years of disposal operations there.

Drilling began on well 31-38, about 4 miles southeast of the area to more adequately monitor the region.

The appreciable southeastward flow rates of the ground waters estimated to be 35 feet per day within 200 East Areas, evidently are in response to the lowering 200 East Area ground water mound, occasioned by the shutdown of B-Plant and to the rising and spreading 200 West Area mound. Similar conditions were noted in 1947 and 1948, when the first known contamination of the ground water in the Separations areas was detected in the 361-B reverse well site, about 2500 feet southeast of the reverse well, the source of the contamination (See HW-17088). Movement of the ground water and contained contaminants was halted by the rising 200 East Area ground water mound, and held nearly immobile for about eight years. Recurrence of the movement suggests that control is feasible by a recreated mound, not only to contain the present contaminants beneath the 200 East Area but to still further reduce the hazards in disposal to Purex sites. The recurrence of events further validates the observations and conclusions noted in the referenced document.

TABLE VIII

CRITICAL MONITORING WELLS - FISSION PRODUCT ANALYSES
FOR MONTH OF JANUARY

| Well Number | CESIUM ACTIVITY DENSITY Units of $10^{-7}$ μc/cc | | | | | STRONTIUM ACTIVITY DENSITY Units of $10^{-7}$ μc/cc | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st week | 2nd week | 3rd week | 4th week | 5th week | 1st week | 2nd week | 3rd week | 4th week | 5th week |
| 241-BY-9 | | <7.4 | | 9.4 | | | <2.0 | | <2.0 | |
| 241-BY-10 | | <7.4 | | <7.4 | | | <2.0 | | <2.0 | |
| 241-BY-11 | | <7.4 | 25 | 30 | | | <2.0 | <2.0 | <2.0 | |
| 241-BY-12 | | | | | | | <2.0 | | <2.0 | |
| 241-BY-13 | | | | | | | <2.0 | | <2.0 | |
| 241-BY-15 | | | | | | | <2.0 | | <2.0 | |
| 241-BY-16 | | | | | | | <2.0 | | <2.0 | |
| 241-S-12 | | <7.4 | | <7.4 | | | <2.0 | | <2.0 | |
| 241-S-14 | | <7.4 | | <7.4 | | | <2.0 | | <2.0 | |
| 241-TY-5 | | | | | | | <2.0 | | <2.0 | |
| 241-SX-5 | | | | | | | <2.0 | | | |
| 224-T-10 | | | 11 | <7.4 | | | | | | |
| 216-S-7 #1 | | | <7.4 | | | | | <2.0 | | |

Fission product analyses on well waters from well 241-BY-11 showed the presence of $Cs^{137}$ for the first time, in amounts 4 times the current detection limit and 0.2% of the Handbook 52 MPC for $Cs^{137}$ in drinking water.

Well Drilling

The Strasser Drilling Company of Portland, Oregon, was awarded the contract for the drilling of 27 construction wells to permit the U. S. Geological Survey to concentrate on the Earth Sciences' drilling program, currently a full year behind schedule in spite of efforts during the past year to accelerate that work. The contract will bring the lagging drilling program up to date and supply needed geological and hydrological data to help evaluate rapidly accumulating problems.

The Earth Sciences' program was advanced 409 feet in January. A total of 4,215 feet of the FY 1955 program has been drilled. A rate of 1157 feet/month must be met to complete the remaining 5,800 feet of the FY 1955 and 1956 programs by July of 1956. A total of 343 feet was drilled on construction.

LABORATORY WORK

Laboratory soil column studies continued to evaluate the factors affecting percolation rates in soils. Tap water, and well water containing a significantly higher salt content than the tap water, produced no demonstrably different percolation rates. The addition of 0.5% bentonite to a third column reduced the percolation rate, but no flocculation resulted. Mixtures containing up to 10% bentonite were tried, but at that concentration no significant percolation was evident.

Experiments were performed with organic solvent - $NaNO_3$ solutions to which $Sr^{90}$ and $Cs^{137}$ -Pu solutions were added, to determine what percentage of the respective radioisotopes were carried by the aqueous and organic solvent phases. The solutions used were 25% solvent (Shell-Spray Base, Soltrol and hexone), and 75% $NaNO_3$ solutions in 10%, 20% and 40% concentrations. The solutions following introduction of the radioisotopes, were shaken, allowed to settle, and were reshaken. Results are as follows:

TABLE IX

| Solvent used. | Conc. $NaNO_3$ | Beta c/m/ml | | | | Alpha c/m/ml. | |
|---|---|---|---|---|---|---|---|
| | | Sr | | Cs | | Pu | |
| | | Aq. layer | Solvent | Aq. layer | Solvent | Aq. layer | Solvent |
| Shell | 40% | 822.7 | 5.1 | 177.5 | -6.5 | 76.0 | 0 |
| Spray | 20% | 943.5 | 6.9 | 238.9 | -4.5 | 93 | 0.2 |
| Base | 10% | 1113.9 | 2.5 | 291.1 | -1.7 | 96.7 | 2.0 |
| | 40% | 1115.1 | -1.1 | 122.8 | 1.0 | 44.3 | 0.29 |
| Soltrol | 20% | 898.9 | -2.5 | 117.4 | 0.6 | 49.9 | 1.09 |
| | 10% | 1031.1 | -2.1 | 204.0 | 2.4 | 63.2 | 0.29 |
| | 40% | 1033.6 | 0.2 | 116.1 | 6.5 | 101.9 | 21.31 |
| Hexone | 20% | 965.4 | 2.0 | 141.3 | 2.7 | 105.1 | 27.51 |
| | 10% | 1037.6 | -1.6 | 138.1 | 12.6 | 117.3 | 46.05 |

Shell Spray Base and Soltrol do not extract significant amounts of the isotopes from the aqueous solutions at the concentrations tested, Hexone extracts 1 to 4% of the $Cs^{137}$ and 17 to 29% of the Pu from the $NaNO_3$ aqueous solution with the greatest extraction from the least concentrated $NaNO_3$ solutions tested. A measure of the relative magnitude of problems posed by disposal to ground of the three organic solvents is thus provided.

Preliminary soil column tests were made to determine the feasibility of the use of tritium oxide as a tracer for ground water movement. A retention of tritium was noted in all cases, since initial effluent was significantly lower in tritium content than the influent. The effluent attained the influent concentration within one-half column volume in all instances but one. The initial $C/C_o$ values generally decreased with an increase in clay content.

Results of soil column studies with D-1 and D-2 waste samples from which poor adsorption of Sr was noted, led to experiments to determine the feasibility of pre-treatment of those wastes to improve the adsorption of Sr from the wastes. Single samples were subjected to equilibrium adsorption studies, in which the pH was adjusted with NaOH. These studies showed the desirability of increasing the pH. Additional data collected on these wastes is shown in Table X.

TABLE X

ADSORPTION OF STRONTIUM BY SOIL FROM A MIXTURE OF D-1 AND D-2 WASTES

| D-1 and D-2 (1:60 Mixture) | | D-1 and D-2 (1:60 Mixture) 5 g/L of $Na_2HPO_4 \cdot 7H_2O$ added | |
|---|---|---|---|
| pH | Sr removed % | pH | Sr removed % |
| 6.9 | 41.4 | 7.5 | 84.6 |
| 7.5 | 51.8 | 8.8 | 97.6 |
| 8.6 | 91.6 | 10.9 | 96.3 |
| 11.6 | 95.1 | 11.5 | 95.2 |
| 12.4 | 91.4 | | |
| 12.7 | 87.3 | | |

The adsorption of strontium from the D-1 waste, which contained 4.14 g/L of dissolved salts, was improved markedly by the addition of phosphate as shown in Table XI.

TABLE XI

ADSORPTION OF STRONTIUM FROM D-1 WASTE

| D-1 | | D-1 (5 g/L of $Na_2HPO_4 \cdot 7H_2O$ added) | |
|---|---|---|---|
| pH | Sr removed % | pH | Sr removed % |
| 5.2 | 1.9 | 7.4 | 97.3 |
| 6.0 | 3.7 | 9.0 | 99.7 |
| 7.7 | 7.6 | 11.5 | 99.8 |
| 11.9 | 39.9 | | |
| 12.4 | 46.8 | | |

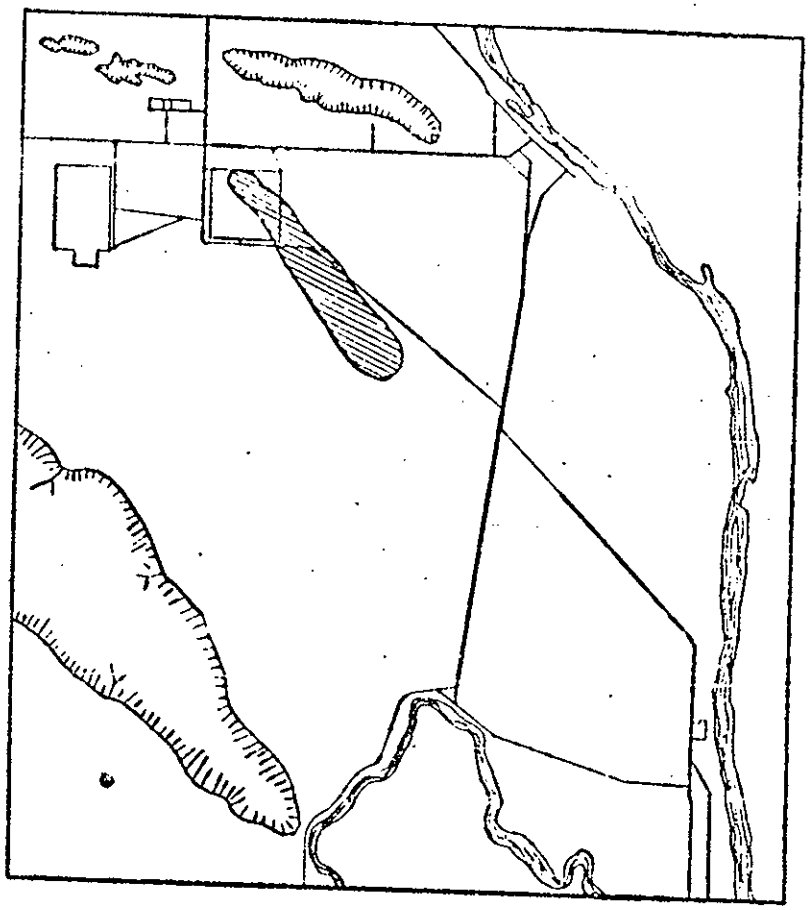
Apparently the 4 g/L of dissolved salts in the D-1 waste was sufficient to inhibit the adsorption of strontium seriously when no phosphate was present in the waste solution.

An increase in pH of the D-1 waste and an increase in pH and phosphate content of the D-2 waste provides the maximum adsorption of Cr, as determined from this one set of experiments.

Routine soil column tests were performed using samples from two uranium recovery plant scavenged wastes and two tank farm scavenged wastes. These tests were performed as a part of the present waste disposal study, which requires that each tank of waste be tested prior to disposal to the ground.

The results of these tests evaluated by the empirical method used in the past indicate that waste 21-106-BY, 22-110-BY, 1-109C-112C, and 2-109C-101C were within the limits prescribed for ground disposal.

# GROUND WATER CONTAMINATION FROM 200 EAST AREA CRIB SITES.

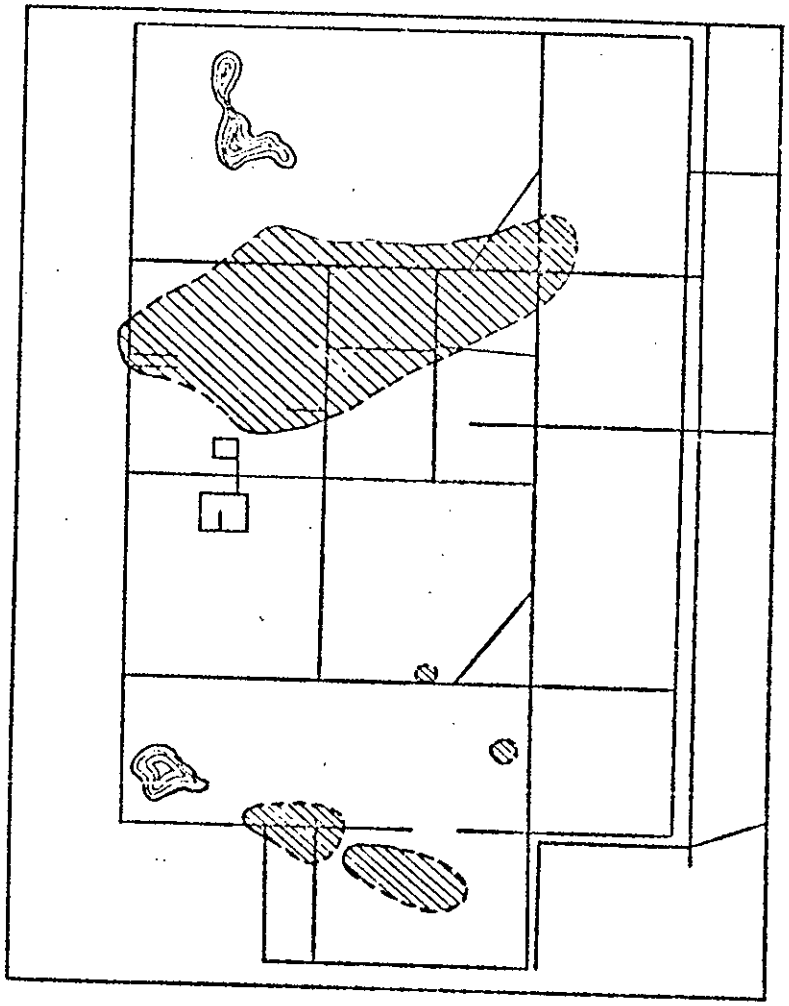


EXPLANATION

APPROXIMATE AREA OF KNOWN GROUND WATER CONTAMINATION AS OF JANUARY 31ST.

PLATE 1

ROUND WATER CONTAMINATION FROM
200 WEST CRIB SITES.



EXPLANATION

APPROXIMATE AREA OF KNOWN GROUND WATER CONTAMINATION AS OF JANUARY 31ST.

PLATE 2