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# CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS JANUARY - DECEMBER 1964

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by

D. J. Brown

Geochemical and Geophysical Research
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# CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS JANUARY - DECEMBER, 1964

## I. INTRODUCTION

The continual surveillance of radioactive nuclides in the ground beneath the Hanford Project is carried out under a radiological monitoring program established by the Chemical Effluents Technology operation. A network of over 500 cased wells exists on the Project for monitoring underground waste disposal sites and for tracing the movement of radionuclides released to the surface and subsurface environs.

A report is prepared semiannually to present information on the status of ground water contamination. Maps, which are included in the reports, define contaminated ground water zones with respect to the disposal areas and the Project in general. Because of a planned change in the ground water monitoring program, which took place in May, 1964, the normal six-month report period was extended to the end of the calendar year to take advantage of the results from the new sampling and analytical schedule.

In the Appendix attached those wells are shown in which concentrations of radionuclides were detected in the ground water above the routine detection limit of 0.08 pcβ/cc. In addition to these data, the 1963 average concentration of radioisotopes in well water samples, for the wells listed in the Appendix, are also given for the purpose of indicating the general trend in ground water contamination. Analytical results (gross beta) of water samples collected from confined aquifers and the results of special tritium analyses are also presented in tables in the Appendix.

All ground water samples were collected by the Environmental Monitoring Unit and analyzed by the Radiological Chemical Analysis Unit.

Well structures at Hanford are identified according to their location on the plant. The first group of numbers (199-, 299-, 699-) identifies the general area (100, 200, 600) in which the well is located. In the 100 and 200 Areas the second group of numbers (B3, E24, W22) identifies the particular area and the sheet map encompassing that portion of the area in which the well is located. In the 600 Area (the land within the Hanford fenced area, but outside the plant restricted areas) the second and third groups of numbers signify in thousands of feet the nearest plant coordinates; the north coordinate is the second group of numbers and the west coordinate is the third group. The exact location of any well mentioned in this report can be determined by referring to the well location maps published in the latest Hanford Wells document[1].

## II. INTERPRETATION OF GROUND WATER MONITORING DATA

Analytical results of ground water samples are studied to determine which wells have concentrations of radioisotopes above the routine detection limit of 0.08 pcβ/cc. The positive results are then checked for mathematical errors and the possibility of cross contamination during sampling and/or during the analysis. After this preliminary examination, the results are plotted on a contour map of the water table. Isoconcentration lines are then drawn to show the extent and direction of contamination spread. Figure 1 is a map showing the distribution of gross beta emitters in the ground water as of December 31, 1964. A comparison of the ground water contamination pattern in Figure 1 with that determined for the previous report period[2] showed several areas

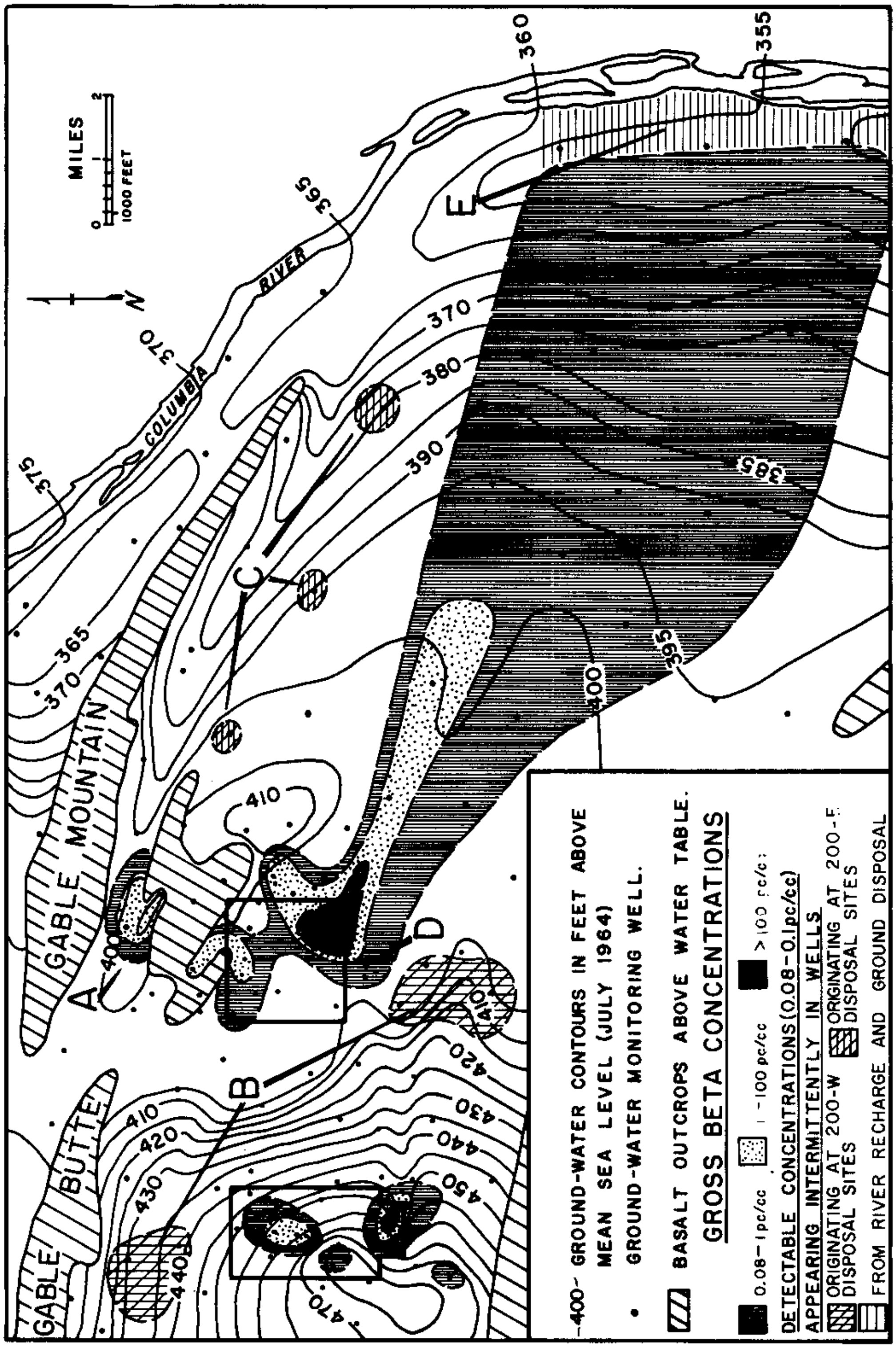


FIGURE 1

Extent of Ground Water Gross Beta Contamination January - December, 1964 where the zones of contamination had changed. These changes are discussed below.

200-East Area

Total beta concentrations in the ground water beneath the disposal areas in and adjacent to the 200-East Area are given in Table I of the Appendix. The data show only insignificant trends in total beta concentration changes during the year.

Ground water samples from beneath all active and some inactive disposal sites in 200-East Area were analyzed for specific long-lived isotopes during this report period. The results show $Co^{60}$ present in the ground water beneath several disposal sites in concentrations ranging up to 3 pc/cc. Somewhat higher $Co^{60}$ concentrations (up to 35 pc/cc) were detected beneath the abandoned 216-BY disposal site. Cobalt-60 has been detected in the ground water beneath this site in gradually decreasing concentrations for a number of years. $Sr^{90}$ was detected intermittently in the ground water beneath two abandoned cribs, 216-A6 and 216-A8, and beneath two active cribs, 216-A10 and 216-A24. In each instance, however, the concentration was well below the ground water limit of 0.1 pc/cc.

200-West Area

Beta concentrations in the ground water beneath 200-West Area are listed in Table I. These results show no appreciable changes in the concentration levels during the year. Wells in the west-central part of the area which heretofore showed no detectable contamination, are now included in the lowest zone of contamination. These wells monitor cribs which receive wastes from Z-Plant.

Isotopic analyses of the ground water underlying several disposal sites in 200-West Area showed the presence of two long-lived radionuclides. Beneath the abandoned 216-S1 and S2 cribs, $Sr^{90}$ is still detectable in concentrations averaging 42 pc/cc. A maximum concentration of 48 pc/cc was reported in the ground water underlying this disposal site on the 19th of June. Low concentrations of $Sr^{90}$ are also present in the ground water beneath the 216-S7 crib, 0.003 pc/cc. This crib is still in service due to the low $Sr^{90}$ concentrations in the samples analyzed. A replacement crib for the 216-S7 crib, the 216-S9, was recently constructed and is now ready for use in the event that the $Sr^{90}$ concentration should increase to 0.1 pc/cc. Plutonium was detected in the ground water and in sediments at the level of the water table beneath the 216-Z12 crib. The ground water limit for plutonium is 5 pc/cc. The concentration observed in the ground water was 0.04 pc/cc. The plutonium concentration on the sediments ranged up to 200 pc/gram, indicating appreciable Pu sorption in the saturated zone. Additional monitoring of this site is in progress to substantiate the breakthrough of plutonium into the ground water.

600 Area

Analytical results for all 600 Area wells showing detectable concentrations of beta emitters in the ground water are listed in Table I of the Appendix. On the basis of these data, several significant changes were noted in the contaminated ground water pattern in this region. These changes are shown in Figure 1 by letter designations A through E.

Location A designates a zone of contaminated ground water just south and adjacent to the west end of Gable Mountain. This zone underlies the approximate position of the Gable Mountain swamp, and reflects the midyear release of radiocontaminants to that disposal site. Ground water contamination, which consists primarily of $Ru^{103-106}$ with lesser amounts of $Zr^{95}$-$Nb^{95}$, is expected to decrease gradually in this region. Other general areas where changes occurred in the contamination pattern are north and southeast of the 200-West Area, Position B, and east of the 200-East Area, Position C. At these localities the concentrations of radioisotopes appear above the routine detection limit intermittently. Analytical results from wells located within the zones of contamination occasionally show detectable concentrations of radionuclides present every few days for a few weeks, and at other times detectable concentrations may appear in a well water sample only every other week. Usually when contamination appears in a well for a period of several weeks it can be detected thereafter as long as the source conditions remain the same. The source for the three small zones east of the 200-East Area is either the Gable Mountain swamp or the B-swamp east of the 200-East Area. These two swamps receive contaminants infrequently and this may account for the intermittent appearance in the well water. The source of the contamination appearing in the two zones at position B is believed to be residual activity from past disposals in 200-West Area.

The two remaining contamination-pattern changes are associated with the large contaminated ground water zone (Figure 1) between the 200-East Area and the Columbia River. At position D, the contamination pattern was extended to the southwest to include the wells at the abandoned BC crib site. The wells in this area have shown a low but increasing trend in concentrations of radionuclides in the ground water during the past year (see results in Appendix). The other zone, Position E, is along the Columbia River east of the 200-East Area. In the late spring and early summer the Columbia River recharges the unconfined aquifers hydraulically connected to its right and left banks. The effect of this recharge on the water table can be seen by referring to the ground water contours in Figure 1. The contours indicate a gradient from the river inland and a gradient from the 200 areas toward the river. The result of these two gradients, which exist during the high river stage, is the formation of a low trough in the water table approximately one mile inland from the river in which the ground water flows parallel to the Columbia River and in the same direction. This condition is known as a thalweg. Isotopic analyses of ground water samples obtained from the wells located in this thalweg show detectable concentrations of both $Ru^{106}$ and $Cr^{51}$, indicating a mixing of river water and ground water. During low river stage the thalweg disappears and the ground water moves directly into the Columbia River.

## III. FISSION PRODUCT TRITIUM IN THE GROUND WATER

Figure 2 is a map showing the latest two-dimensional distribution of tritium in the ground water beneath Hanford. The zones of contaminated ground water shown on this map are defined by ranges of selected average concentration values. The pattern of tritium concentrations is quite similar to that shown in Figure 1 for beta emitters in the ground water. The two significant differences between the maps are the extent of tritium contamination eastward from the 200-West Area and the tritium contamination of the B-swamp east of the 200-East Area. The results of all tritium analyses completed during this report period are given in

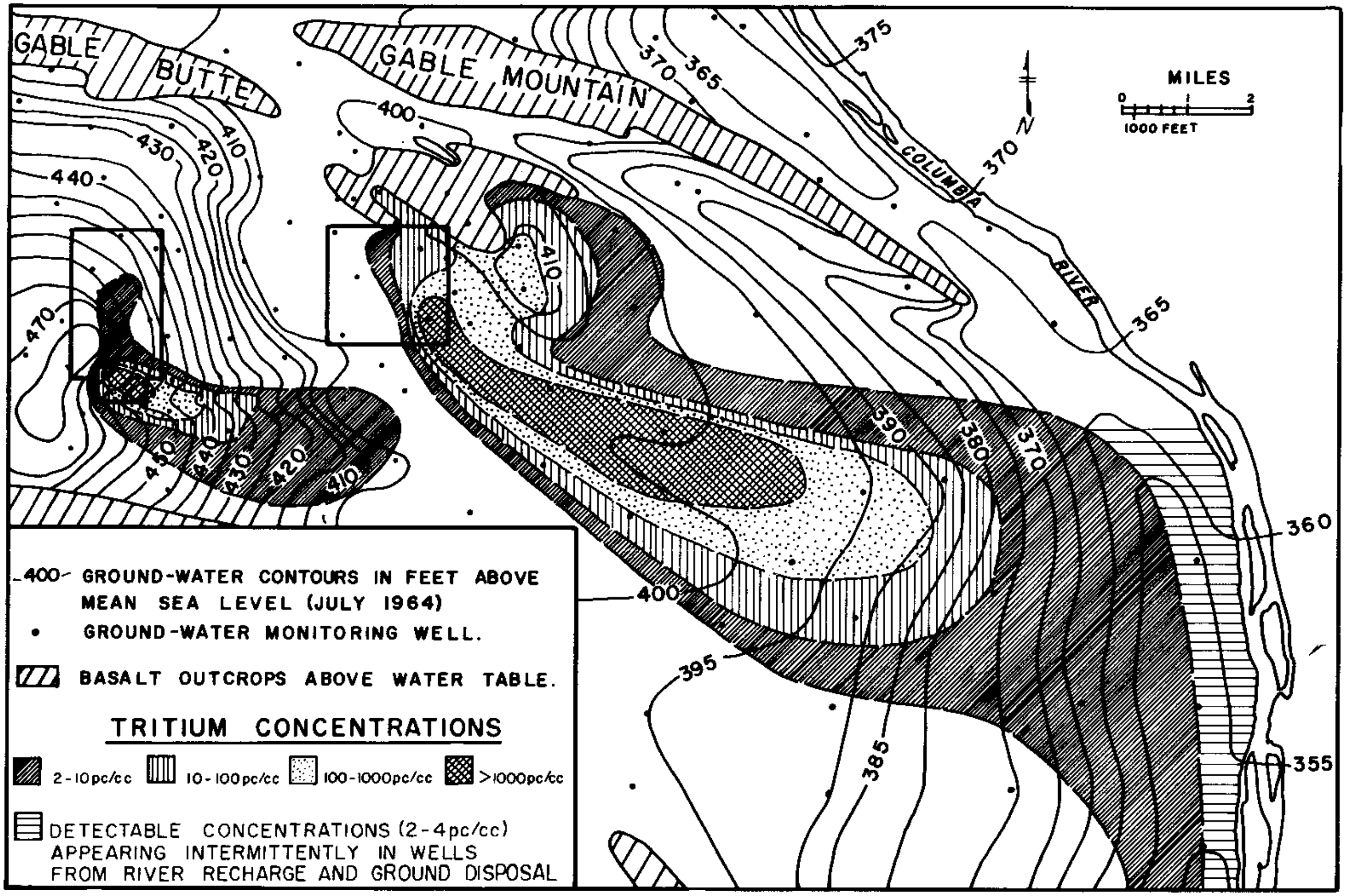


FIGURE 2

Extent of Ground Water Tritium Contamination January - December, 1964

Table III of the Appendix.

No significant changes were observed in the ground water tritium contamination pattern over that presented in the last semiannual report. The tritium map presented in the previous Waste Disposal Investigations report (HW-80909) showed detectable concentrations extending from disposal sites in the northern part of the 200-West Area, one-half mile beyond the perimeter fence to the north. Better analytical techniques and additional sampling resulted in a more precise interpretation of the tritium contamination pattern in this region, as can be seen in Figure 2.

Ground water samples from confined aquifers at depth show that tritium concentrations are detectable up to values of 200 pc/cc. The maximum result, 200 pc/cc, was observed in a well located over four miles from the Columbia River at a depth of approximately 500 feet below the regional water table.

## IV. WELL DRILLING

Recent analyses of ground water samples show that several confined aquifers contain low but detectable concentrations of radioisotopes emanating from disposal facilities in the 200 Areas. These data also indicate that contaminated ground water is moving in a direction which may ultimately carry it from beneath Hanford into off-project aquifers. To provide better monitoring of the confined aquifers and a more accurate definition of the flow system, additional monitoring wells have been proposed for construction during the current fiscal year. The well drilling proposal (CAH-159) calls for fifteen wells to be drilled within the broad contaminated ground-water front near the Columbia River north of the 300 Area. These wells will provide monitoring access to all of the confined aquifers believed to be potentially contaminated. The wells in this region will be divided into three groups of five wells. The five wells in each group will be closely spaced at one of three selected sites. Each well in a group will be drilled to sufficient depth to tap one of the major aquifers underlying the region. Two of the wells at each site will be drilled into aquifers within the basalt bedrock. Four additional monitoring wells are proposed for a site near the southeast corner of the 200-East Area in the zone of maximum beta emitter contamination, see Figure 1. These four wells will also be closely spaced at one site, and each will tap a major ground water aquifer. One of the four wells will be drilled to the underlying bedrock. It is anticipated that these wells will assist in defining the flow pattern of contaminated ground water into the various confined aquifers.

## V. REFERENCES

1. D. J. Brown and V. L. McGhan. Hanford Wells, HW-44355 REV2. January, 1963.

2. D. J. Brown and W. A. Haney. Chemical Effluents Technology Waste Disposal Investigations, July-December, 1963, HW-80909. February 18, 1964.

## VI. APPENDIX

### TABLE I

### RADIOLOGICAL MONITORING DATA FROM GROUND WATER SAMPLES, JANUARY-DECEMBER, 1964
### GROSS BETA ACTIVITY

| | Unconfined Ground Water Aquifer | | | |
|---|---|---|---|---|
| Well Designation | Avg. Conc. pcβ/cc | Max. Conc. pcβ/cc | Conc. In Latest Sample pcβ/cc | Avg. Conc. 1963 pcβ/cc |
| 200-East Area | | | | |
| Wells Monitoring 216-A Disposal Facilities | | | | |
| 299-E16-1 | .96 | 2.1 | 2.1 | 1.2 |
| 299-E16-2 | .37 | .71 | .48 | 1.6 |
| 299-E17-1 | 1500 | 2800 | 830 | 2700 |
| 299-E17-2 | 420 | 1300 | 260 | 290 |
| 299-E17-3 | 460 | 950 | 230 | 770 |
| 299-E24-1 | 560 | 1300 | 300 | 6100 |
| 299-E24-2 | 1800 | 2900 | 1200 | 2700 |
| 299-E24-3 | .18 | .25 | .25 | .15 |
| 299-E24-4 | .39 | .50 | .32 | .95 |
| 299-E24-5 | .71 | .98 | .41 | 3.5 |
| 299-E24-7 | .51 | 1.2 | .72 | .14 |
| 299-E24-9 | 950 | 1600 | 390 | 12 |
| 299-E25-2 | 1.2 | 3.0 | .71 | 2.5 |
| 299-E25-3 | 4.0 | 8.0 | 2.6 | 5.5 |
| 299-E25-4 | .68 | 2.0 | .13 | 1.5 |
| 299-E25-5 | .71 | 1.1 | .94 | .55 |
| 299-E25-6 | 2.6 | 7.3 | 7.3 | 3.1 |
| 299-E25-7 | 7.5 | 12 | 12 | 11 |
| 299-E25-8 | 5.1 | 8.0 | 3.6 | 10 |
| 299-E25-9 | .90 | 1.3 | .84 | .76 |
| 299-E25-10 | 2.1 | 2.3 | 2.3 | 4.0 |
| 299-E25-11 | .86 | 7.8 | 1.3 | 3.1 |
| 299-E25-12 | 1.2 | 1.9 | .77 | 5.6 |
| 299-E26-1 | < .08 | < .08 | < .08 | .09 |
| 299-E26-2 | 3.7 | 7.4 | 2.3 | .13 |
| 299-E26-3 | 9.2 | 13 | 5.3 | .67 |
| 299-E26-4 | 4.5 | 8.7 | 8.7 | 1.3 |
| 299-E26-5 | 1.1 | 1.6 | 1.6 | 1.0 |
| 299-E26-6 | .12 | 1.7 | .15 | 18 |
| 299-E27-3 | .65 | .98 | .90 | .54 |
| 299-E27-4 | .12 | .17 | .15 | -- |

APPENDIX

TABLE I (contd.)

| Well Designation | Unconfined Ground Water Aquifer Avg. Conc. pcβ/cc | Max. Conc. pcβ/cc | Conc. In Latest Sample pcβ/cc | Avg. Conc. 1963 pcβ/cc |
|---|---|---|---|---|
| **200-East Area** | | | | |
| **Wells Monitoring 216-C Disposal Facilities** | | | | |
| 216-E24-8 | 4.7 | 7.1 | .61 | 4.1 |
| 216-E27-5 | .42 | .93 | .47 | 1.0 |
| **Wells Monitoring 216-B Disposal Facilities** | | | | |
| 299-E19-1 | .34 | 1.3 | .20 | < .08 |
| 299-E23-1 | .10 | .14 | .11 | .14 |
| 299-E23-2 | .17 | .30 | .20 | .14 |
| 299-E27-1 | 3.6 | 6.5 | 1.6 | 26 |
| 299-E28-2 | .13 | .31 | .09 | .17 |
| 299-E28-3 | < .08 | .08 | .08 | < .08 |
| 299-E28-4 | .14 | .25 | .11 | .11 |
| 299-E28-5 | .33 | .39 | .33 | .36 |
| 299-E28-6 | < .08 | .11 | < .08 | < .08 |
| 299-E28-7 | .30 | .43 | .31 | .13 |
| 299-E28-9 | < .08 | .08 | < .08 | < .08 |
| 299-E28-10 | .20 | .57 | < .08 | .16 |
| 299-E32-1 | .13 | .23 | .11 | < .08 |
| 299-E33-1 | 12 | 21 | 11 | 25 |
| 299-E33-2 | 4.9 | 6.6 | 6.6 | 5.0 |
| 299-E33-3 | 31 | 41 | 7.8 | 55 |
| 299-E33-4 | 17 | 30 | 20 | 24 |
| 299-E33-5 | 2.3 | 6.0 | .11 | 4.2 |
| 299-E33-6 | 3.9 | 14 | .11 | 2.0 |
| 299-E33-7 | .41 | 1.0 | .38 | 2.0 |
| 299-E33-8 | .71 | 4.0 | .19 | 1.5 |
| 299-E33-9 | 10 | 10 | 10 | 39 |
| 299-E33-10 | < .08 | .08 | < .08 | < .08 |
| 299-E33-11 | 23 | 41 | 6.9 | 56 |
| 299-E33-12 | 33 | 53 | 17 | 76 |
| 299-E33-13 | 13 | 34 | 1.5 | 14 |

## APPENDIX

### TABLE I (contd.)

| Well Designation | Unconfined Ground Water Aquifer Avg. Conc. pcβ/cc | Max. Conc. pcβ/cc | Conc. In Latest Sample pcβ/cc | Avg. Conc. 1963 pcβ/cc |
|---|---|---|---|---|
| **200-East Area** | | | | |
| **Wells Monitoring 216-B Disposal Facilities** | | | | |
| 299-E33-14 | 23 | 54 | 6.5 | 45 |
| 299-E33-15 | 150 | 460 | 49 | 180 |
| 299-E33-16 | 43 | 144 | 7.1 | 88 |
| 299-E33-17 | 60 | 130 | 20 | 240 |
| 299-E33-18 | 7.2 | 12 | 5.3 | 12 |
| 299-E33-19 | 11 | 19 | 9.0 | 22 |
| 299-E33-20 | 13 | 27 | 8.2 | 33 |
| **Wells Monitoring 216-BC Disposal Facilities** | | | | |
| 299-E13-4 | .22 | .26 | .19 | .15 |
| 299-E13-8 | < .08 | .12 | .12 | < .08 |
| 299-E13-11 | < .08 | .08 | < .08 | < .08 |
| 299-E13-13 | .14 | .54 | .29 | < .08 |
| 299-E13-16 | .13 | .37 | .08 | < .08 |
| 299-E13-18 | < .08 | .08 | .08 | < .08 |
| 299-E13-20 | .14 | .68 | .17 | < .08 |
| **200-West Area** | | | | |
| **Wells Monitoring 216-S Disposal Facilities** | | | | |
| 299-W22-1 | 90 | 160 | 110 | 4.0 |
| 299-W22-2 | 1.4 | 2.2 | 1.2 | 2.5 |
| 299-W22-4 | < .08 | .09 | .09 | .09 |
| 299-W22-5 | 16 | 26 | 21 | 36 |
| 299-W22-6 | .11 | .26 | .26 | .08 |
| 299-W22-7 | .19 | .24 | .21 | .23 |
| 299-W22-8 | .10 | .13 | < .08 | .11 |
| 299-W22-9 | 2.8 | 3.1 | 2.7 | 4.3 |
| 299-W22-10 | .98 | 1.0 | .94 | 2.1 |
| 299-W22-11 | 1.2 | 4.7 | .11 | < .08 |
| 299-W22-12 | 490 | 650 | 430 | 1200 |
| 299-W22-13 | 930 | 3900 | 3900 | 1200 |

## APPENDIX

### TABLE I (contd.)

| Well Designation | Avg. Conc. pcβ/cc | Max. Conc. pcβ/cc | Conc. In Latest Sample pcβ/cc | Avg. Conc. 1963 pcβ/cc |
|---|---|---|---|---|
| | Unconfined Ground Water Aquifer | | | |
| **Wells Monitoring 216-S Disposal Facilities** | | | | |
| 299-W22-14 | 910 | 1700 | 1700 | 2000 |
| 299-W22-15 | 23 | 29 | 17 | 42 |
| 299-W22-16 | .18 | .45 | .45 | .15 |
| 299-W22-17 | .90 | 2.2 | .60 | 1.3 |
| 299-W22-18 | 12 | 16 | 10 | 39 |
| 299-W22-19 | 53 | 94 | 41 | 68 |
| 299-W22-20 | 4.0 | 7.2 | 1.6 | 2.8 |
| 299-W22-21 | .14 | .36 | < .08 | .15 |
| 299-W23-1 | .22 | .47 | .47 | 3.8 |
| 299-W23-2 | .09 | .15 | .15 | < .08 |
| 299-W23-3 | .11 | .16 | .16 | .09 |
| 299-W23-4 | .69 | 1.8 | 1.1 | .31 |
| 299-W26-3 | 1.4 | 1.4 | 1.4 | 1.2 |
| **Wells Monitoring 216-U Disposal Facilities** | | | | |
| 299-W19-1 | < .08 | .18 | < .08 | .11 |
| 299-W19-2 | .17 | .19 | .14 | .22 |
| 299-W19-3 | .09 | .11 | .11 | .25 |
| 299-W19-4 | < .08 | .08 | < .08 | .08 |
| 299-W21-1 | < .08 | .11 | .10 | < .08 |
| 299-W22-22 | < .08 | .11 | < .08 | .15 |
| 299-W22-24 | .17 | .17 | .17 | 3.1 |
| **Wells Monitoring 216-T Disposal Facilities** | | | | |
| 299-W6-1 | < .08 | .10 | < .08 | < .08 |
| 299-W10-1 | .08 | .81 | .81 | < .08 |
| 299-W10-3 | .43 | .50 | .35 | .59 |
| 299-W10-4 | .55 | .58 | .55 | .80 |
| 299-W10-5 | .15 | .49 | .40 | .09 |
| 299-W11-1 | < .08 | .09 | < .08 | .08 |
| 299-W11-2 | .19 | .20 | .19 | .22 |
| 299-W11-3 | < .08 | .12 | .08 | < .08 |
| 299-W11-4 | < .08 | .15 | < .08 | < .08 |

## APPENDIX

### TABLE I (contd.)

Unconfined Ground Water Aquifer

| Well Designation | Avg. Conc. pcβ/cc | Max. Conc. pcβ/cc | Conc. In Latest Sample pcβ/cc | Avg. Conc. 1963 pcβ/cc |
|---|---|---|---|---|
| Wells Monitoring 216-T Disposal Facilities | | | | |
| 299-W11-5 | < .08 | .10 | < .08 | < .08 |
| 299-W11-6 | < .08 | .09 | < .08 | < .08 |
| 299-W11-7 | < .08 | .10 | < .08 | < .08 |
| 299-W11-8 | < .08 | .09 | < .08 | < .08 |
| 299-W11-9 | < .08 | .09 | .09 | .09 |
| 299-W11-10 | < .08 | .10 | .09 | < .08 |
| 299-W11-11 | .97 | 1.1 | 1.0 | 1.5 |
| 299-W11-12 | .46 | .65 | .34 | .69 |
| 299-W11-13 | .12 | .30 | .09 | .10 |
| * 299-W11-14 | .09 | .36 | .36 | .06 |
| 299-W14-1 | .33 | .70 | .33 | .13 |
| 299-W14-2 | 8.9 | 25 | 3.1 | 4.3 |
| 299-W14-3 | .70 | 1.1 | .48 | .44 |
| 299-W15-2 | < .08 | .09 | < .08 | < .08 |
| 299-W15-3 | .31 | .38 | .30 | .50 |
| 299-W15-4 | < 1.8 | 1.9 | .18 | 2.8 |
| * 299-W12-1 | < .08 | .15 | .15 | < .08 |
| Wells Monitoring 216-Z Disposal Facilities | | | | |
| 299-W15-6 | .11 | .69 | .69 | .18 |
| 299-W18-1 | .20 | .33 | .23 | .10 |
| 299-W18-5 | .26 | .49 | .38 | .50 |
| 299-W18-6 | .32 | .32 | .32 | -- |
| 299-W18-7 | < .08 | < .08 | < .08 | -- |

Nineteen additional wells were sampled in the 200 Areas. All results were lower than the routine detection limit of 0.08 pcβ/cc.

| 600 Area Wells | | | | |
|---|---|---|---|---|
| 699-34-51 | .13 | .39 | .11 | < .08 |
| 699-25-55 | < .08 | .23 | .08 | < .08 |
| 699-24-33 | .98 | 1.7 | 1.7 | 1.4 |
| 699-20-20 | .25 | .60 | .27 | .20 |
| 699-35-9 | < .08 | .16 | < .08 | < .08 |

## APPENDIX

### TABLE I (contd.)

| Well Designation | Unconfined Ground Water Aquifer Avg. Conc. pcβ/cc | Max. Conc. pcβ/cc | Conc. In Latest Sample pcβcc | Avg. Conc. 1963 pcβ/cc |
|---|---|---|---|---|
| 600 Area Wells | | | | |
| 699-17-5 | .08 | .21 | .08 | < .08 |
| 699-2-3 | < .08 | .20 | < .08 | < .08 |
| 699-S12-3 | .19 | .51 | .51 | < .08 |
| 699-40-24 | .20 | .38 | .14 | .12 |
| 699-55-50A | .19 | .23 | .20 | .15 |
| 699-34-39A | 28 | 49 | 46 | 5.0 |
| 699-15-26 | .33 | .40 | .25 | .22 |
| 699-30-31 | 5.6 | 10 | 8.7 | 2.4 |
| 699-50-53 | 25 | 42 | 23 | 56 |
| 699-47-35 | .16 | .39 | .39 | < .08 |
| 699-37-42 | < .08 | .09 | < .08 | < .08 |
| 699-28-40 | .13 | .31 | .31 | < .08 |
| 699-32-70 | < .08 | .09 | < .08 | .10 |
| 699-51-75 | < .08 | .09 | < .08 | < .08 |
| 699-35-70 | < .08 | .08 | .08 | < .08 |
| 699-1-18 | .13 | .52 | < .08 | < .08 |
| 699-26-15 | .28 | .47 | .30 | .27 |
| 699-9-E2 | .10 | .23 | .08 | < .08 |
| 699-31-53B | .10 | .19 | < .08 | < .08 |
| 699-33-56 | < .08 | .15 | < .08 | .10 |
| 699-55-76 | .21 | .66 | .43 | < .08 |
| 699-S11-E12 | < .08 | .18 | < .08 | < .08 |
| 699-S3-E12 | .08 | .22 | < .08 | < .08 |
| 699-20-E12 | .10 | .26 | < .08 | < .08 |
| 699-S6-E4C | < .08 | .08 | < .08 | < .08 |
| 3099-45-16 | .41 | .75 | .08 | < .08 |
| 699-10-E12 | < .08 | .15 | .15 | < .08 |
| 699-29-78 | < .08 | .12 | .12 | < .08 |
| 699-62-43A | < .08 | .08 | < .08 | < .08 |
| 699-71-84 | .57 | 4.7 | 4.7 | -- |
| 699-78-62 | < .08 | .31 | .31 | < .08 |
| 699-83-47 | .38 | .87 | .22 | < .08 |
| 699-65-59 | .09 | .17 | < .08 | < .08 |
| 699-86-60 | .20 | .58 | .58 | < .08 |
| 699-71-77 | 2.0 | 10 | 10 | 2.6 |
| 699-67-86 | < .08 | .08 | < .08 | < .08 |
| 699-96-49 | .60 | .60 | .60 | .67 |
| 699-84-35 | < .08 | .12 | < .08 | < .08 |
| 699-81-58 | .14 | .27 | < .08 | < .08 |

Ninety-seven wells were sampled in the 600 Area. All results were lower than the routine detection limit of 0.08 pcβ/cc.

## APPENDIX

### TABLE II

RADIOLOGICAL MONITORING DATA FROM GROUND WATER SAMPLES, JANUARY-DECEMBER, 1964

GROSS BETA ACTIVITY

| Piezometer Tube Designation | Depth Below Water Table (ft) | Confined Ground Water Aquifers Avg. Conc. pcβ/cc | Max. Conc. pcβ/cc | Conc. In Latest Sample pcβ/cc | Avg. Conc. 1963 pcβ/cc |
|---|---|---|---|---|---|
| **200-East Area** | | | | | |
| 299-E16-1P | 184 | .14 | .17 | .17 | 1.1 |
| 299-E16-1Q | 125 | .45 | .68 | .68 | 3.5 |
| 299-E16-1R | 72 | .66 | .73 | .60 | 3.1 |
| 299-E23-2P | 110 | .10 | .17 | .11 | |
| 299-E23-2Q | 85 | .16 | .24 | .11 | |
| 299-E24-8P | 82 | .73 | .91 | .55 | |
| 299-E27-3P | 66 | .75 | .77 | .77 | |
| **200-West Area** | | | | | |
| 299-W11-2P | 262 | .21 | .21 | .21 | .17 |
| 299-W11-2Q | 188 | .21 | .21 | .21 | .14 |
| 299-W11-3R | 134 | .20 | .20 | .20 | .28 |
| 299-W11-2S | 76 | .19 | .19 | .19 | .40 |
| 299-W11-13P | 235 | <.08 | .10 | .08 | .10 |
| 299-W14-3P | 40 | .39 | .41 | .41 | .59 |
| 299-W19-1P | 48 | .88 | .96 | .80 | < .08 |
| 299-W22-11P | 87 | .10 | .17 | .17 | |
| 299-W22-14P | 98 | 35 | 96 | 96 | |
| 299-W22-24P | 331 | .11 | .11 | .11 | 1.6 |
| 299-W22-24Q | 261 | .70 | 1.3 | < .08 | 2.1 |
| 299-W22-24R | 201 | .34 | .56 | < .08 | 1.4 |
| 299-W22-24S | 141 | .26 | .46 | < .08 | 1.0 |
| 299-W22-24T | 81 | .60 | .96 | < .08 | 1.6 |
| **600 Area** | | | | | |
| 699-S31-1P | 120 | .29 | .82 | .31 | |
| 699-S6-E14P | 178 | < .08 | .08 | < .08 | |
| 699-S6-E14Q | 103 | < .08 | .09 | < .08 | |
| 699-2-33P | 239 | < .08 | .12 | < .08 | < .08 |
| 699-10-E12P | 283 | .17 | 3.3 | < .08 | |
| 699-10-E12Q | 223 | .08 | .22 | < .08 | |
| 699-10E12-R | 163 | < .08 | .30 | .10 | |
| 699-10-E12S | 103 | < .08 | .17 | < .08 | |
| 699-14-38P | 303 | < .08 | .14 | < .08 | |

## APPENDIX

### TABLE II (Contd.)

| Piezometer Tube Designation | Depth Below Water Table (ft) | Confined Ground Water Aquifers Avg. Conc. pcβ/cc | Max. Conc. pcβ/cc | Conc. In Latest Sample pcβ/cc | Avg. Conc. 1963 pcβ/cc |
|---|---|---|---|---|---|
| 600 Area (contd.) | | | | | |
| 699-14-38S | 123 | < .08 | .09 | < .08 | |
| 699-15-15P | 465 | < .08 | .15 | < .08 | .10 |
| 699-15-15Q | 385 | .10 | .14 | .11 | .08 |
| 699-15-15R | 305 | .12 | .16 | .09 | .13 |
| 699-15-15S | 225 | .14 | .18 | .12 | .11 |
| 699-15-15T | 145 | .08 | .09 | .09 | .12 |
| 699-20-E12P | 263 | .11 | .49 | < .08 | .12 |
| 699-20-E12Q | 137 | < .08 | .16 | < .08 | .14 |
| 699-20-E12R | 105 | .09 | .15 | .14 | .18 |
| 699-20-E12S | 55 | .28 | 3.9 | .11 | .14 |
| 699-28-40R | 193 | < .08 | .34 | .34 | |
| 699-28-40S | 133 | .16 | .22 | .22 | |
| 699-31-30P | 503 | .22 | .61 | .61 | |
| 699-31-30R | 333 | .27 | .85 | .85 | |
| 699-31-30S | 243 | .17 | .32 | .32 | |
| 699-31-53Q | 77 | .08 | .16 | < .08 | |
| 699-37-82P | 245 | .20 | 1.3 | < .08 | .63 |
| 699-37-82Q | 217 | .08 | .11 | < .08 | .50 |
| 699-37-82R | 157 | .18 | .70 | < .08 | .51 |
| 699-37-82S | 87 | .39 | 1.2 | < .08 | .42 |
| 699-39-79P | 61 | .13 | .17 | .17 | |
| 699-42-42P | 101 | < .08 | .09 | < .08 | |
| 699-42-42Q | 49 | < .08 | .12 | .12 | |
| 699-51-75P | 159 | < .08 | .08 | < .08 | |
| 699-55-50P | 61 | < .08 | .13 | < .08 | .13 |
| 699-55-50Q | 41 | .08 | .11 | .10 | .11 |
| 699-55-76P | 71 | < .08 | .10 | .08 | |
| 699-69-45Q | 159 | .09 | .09 | .09 | <.08 |
| 699-61-58P | 93 | < .08 | .10 | < .08 | |
| 699-84-35Q | 258 | .27 | .27 | .27 | .16 |

Twenty-eight additional piezometer tubes, located within the 600 Area showed concentrations of radionuclides below the routine detection limit of 0.08 pcβ/cc.

## APPENDIX

### TABLE III

### TRITIUM CONCENTRATIONS IN WELL WATER SAMPLES, JANUARY-DECEMBER, 1964

| Well or Piezometer Designation | Avg. Conc. pc/cc | Max. Conc. pc/cc | Conc. In Latest Sample pc/cc | Avg. Conc. 1963 pc/cc |
|---|---|---|---|---|
| 200-East Area | | | | |
| 299-E13-13 | < 2.0 | < 2.0 | < 2.0 | < 10 |
| 299-E13-20 | 6.0 | 11 | 11 | 30 |
| 299-E19-1 | 5.7 | 5.7 | 5.7 | < 10 |
| 299-E23-2 | 11 | 11 | 11 | 110 |
| 299-E24-1 | 16,000 | 16,000 | 16,000 | 49,000 |
| 299-E24-2 | 41,000 | 46,000 | 42,000 | 42,000 |
| 299-E24-7 | 35 | 35 | 35 | 43 |
| 299-E25-3 | 1,000 | 1,100 | 810 | 1,800 |
| 299-E25-7 | 1,900 | 1,900 | 1,900 | 1,700 |
| 299-E25-11 | 980 | 1,600 | 930 | 1,100 |
| 299-E26-1 | < 2.0 | < 2.0 | < 2.0 | < 10 |
| 299-E26-4 | 440 | 440 | 440 | 390 |
| 299-E26-5 | 105 | 160 | 130 | 140 |
| 299-E27-5 | 13 | 13 | 13 | |
| 299-E28-2 | < 2.0 | < 2.0 | < 2.0 | < 10 |
| 299-E33-4 | 3.8 | 3.8 | 3.8 | < 10 |
| 299-E34-1 | 35 | 35 | 35 | 23 |
| 200-West Area | | | | |
| 299-W6-1 | < 1.4 | < 1.4 | < 1.4 | < 10 |
| 299-W10-1 | < 1.8 | < 1.8 | < 1.8 | < 10 |
| 299-W11-10 | 1.9 | 3.3 | 3.3 | |
| 299-W11-14 | 16 | 16 | 16 | 18 |
| 299-W12-1 | < 1.4 | < 1.4 | < 1.4 | 230 |
| 299-W14-1 | 360 | 360 | 360 | 310 |
| 299-W14-2 | 270 | 270 | 270 | 290 |
| 299-W15-2 | < 2.0 | < 2.0 | < 2.0 | < 10 |
| 299-W19-2 | 1,300 | 1,300 | 1,300 | 1,000 |
| 299-W19-4 | < 2.0 | < 2.0 | < 2.0 | < 10 |
| 299-W21-1 | 400 | 460 | 370 | 1,000 |
| 299-W22-2 | 1,100 | 1,100 | 1,100 | 400 |
| 299-W22-14 | 97,000 | 130,000 | 64,000 | 90,000 |
| 299-W22-14P | 10,000 | 15,000 | 15,000 | |
| 299-W22-19 | 25,000 | 37,000 | 20,000 | 34,000 |
| 299-W23-4 | 98,000 | 110,000 | 84,000 | 120,000 |

## APPENDIX

TABLE III (contd.)

| Well or Piezometer Designation | Avg. Conc. pc/cc | Max. Conc. pc/cc | Conc. In. Latest Sample pc/cc | Avg. Conc. 1963 pc/cc |
|---|---|---|---|---|
| 600-Area | | | | |
| 699-S11-E12 | < .6 | < .6 | < .6 | |
| 699-S6-E15 | < 1.4 | < 1.4 | < 1.4 | < 10 |
| 699-S6-E4C | 1.8 | 2.2 | < 1.4 | |
| 699-S3-E12 | < .5 | < .5 | < .5 | < 10 |
| 699-1-18 | 1.7 | 1.9 | 1.5 | |
| 699-2-3 | < .8 | < .8 | < .8 | 1.8 |
| 699-8-17 | < .8 | < .8 | < .8 | < 10 |
| 699-9-E2 | < 1.0 | < 1.0 | < 1.0 | < 10 |
| 699-10-E12 | 1.6 | 2.7 | 2.7 | < 10 |
| 699-10-E12S | < 1.4 | < 1.4 | < 1.4 | |
| 699-15-15 | < 1.4 | < 1.4 | < 1.4 | |
| 699-15-15T | 1.1 | 1.1 | 1.1 | |
| 699-15-26 | 455 | 460 | 450 | 320 |
| 699-17-5 | < .5 | < .5 | < .5 | 3 |
| 699-20-E12 | 1.2 | 1.6 | 1.6 | < 10 |
| 699-20-E12S | 2.9 | 4.0 | 1.8 | |
| 699-20-20 | 520 | 650 | 620 | 500 |
| 699-24-33 | 800 | 800 | 800 | 640 |
| 699-25-55 | < .5 | < .5 | < .5 | .6 |
| 699-26-15 | 900 | 970 | 960 | 400 |
| 699-27-8 | 42 | 43 | 43 | 21 |
| 699-28-40 | 23 | 59 | 59 | 41 |
| 699-28-40S | 84 | 84 | 84 | 30 |
| 699-28-52 | < 1.4 | < 1.4 | < 1.4 | |
| 699-30-31 | 2,900 | 3,400 | 2,700 | 5,300 |
| 699-30-31P | 200 | 200 | 200 | |
| 699-30-31R | 110 | 110 | 110 | |
| 699-30-31S | 135 | 180 | 86 | |
| 699-31-53B | 1.1 | 2.1 | < .8 | |
| 699-31-65 | < .8 | < .8 | < .8 | < 10 |
| 699-32-62 | 1.0 | 1.0 | 1.0 | 4.6 |
| 699-32-70 | 45 | 100 | 63 | |
| 699-32-72 | 9.6 | 9.6 | 9.6 | |
| 699-34-39A | 2,700 | 3,400 | 2,400 | 4,700 |
| 699-34-51 | < 1.4 | < 1.4 | < 1.4 | 3 |
| 699-35-9 | < .8 | < .8 | < .8 | < 10 |
| 699-35-70 | 16 | 24 | 24 | 23 |
| 699-36-61A | < 1.8 | < 1.8 | < 1.8 | |
| 699-37-42 | 970 | 970 | 970 | 870 |
| 699-38-70 | 330 | 350 | 350 | 730 |

**APPENDIX**

TABLE III (contd.)

| Well or Piezometer Designation | Avg. Conc. pc/cc | Max. Conc. pc/cc | Conc. In Latest Sample pc/cc | Avg. Conc. 1963 pc/cc |
|---|---|---|---|---|
| 600 Area | | | | |
| 699-40-1 | 1.8 | 2.1 | < 1.4 | 5 |
| 699-40-24 | 4,000 | 16,000 | 270 | 100 |
| 699-40-33 | 1.1 | 1.9 | < .8 | < 10 |
| 699-40-62 | < 1.8 | < 1.8 | < 1.8 | < 10 |
| 699-42-12 | 1.2 | 1.6 | < .8 | < 10 |
| 699-42-42 | 1,200 | 2,300 | 2,300 | 750 |
| 699-45-20 | < .5 | < .5 | < .5 | < 10 |
| 699-45-42 | 270 | 310 | 260 | 400 |
| 699-45-69 | < .5 | < .5 | < .5 | < 10 |
| 699-47-35 | 1.9 | 2.5 | 1.8 | < 10 |
| 699-48-71 | < .5 | < .5 | < .5 | 10 |
| 699-49-55 | < 1.4 | < 1.4 | < 1.4 | 12 |
| 699-50-28 | 1.4 | 2.3 | < .5 | < 10 |
| 699-50-30 | < .5 | < .5 | < .5 | < 10 |
| 699-50-42 | 1.1 | 2.1 | < 1.0 | < 10 |
| 699-50-49 | < 1.8 | < 1.8 | < 1.8 | |
| 699-50-53 | 19 | 28 | 21 | 23 |
| 699-51-63 | < 1.1 | < 1.1 | < 1.1 | |
| 699-53-55 | 1.2 | 1.9 | < .5 | 5.9 |
| 699-53-55P | < 1.4 | < 1.4 | < 1.4 | |
| 699-53-55R | < 1.5 | < 1.5 | < 1.5 | |
| 699-54-57 | < .5 | < .5 | < .5 | < 10 |