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Subject: **SUPPLY SYSTEM NUCLEAR PLANT NO. 2**
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
ANNUAL REPORT FOR 1996

References: 1) WNP-2 (Operating License No. NPF-21), Technical Specification 5.6.2
2) EFSEC Resolution No. 260, January 13, 1992

Enclosed are three (3) copies of the subject report which are submitted per the referenced requirements.

Respectfully,

D. W. Coleman for

D.A. Swank (Mail Drop PE20)
Manager, Regulatory Affairs

Enclosures

000034

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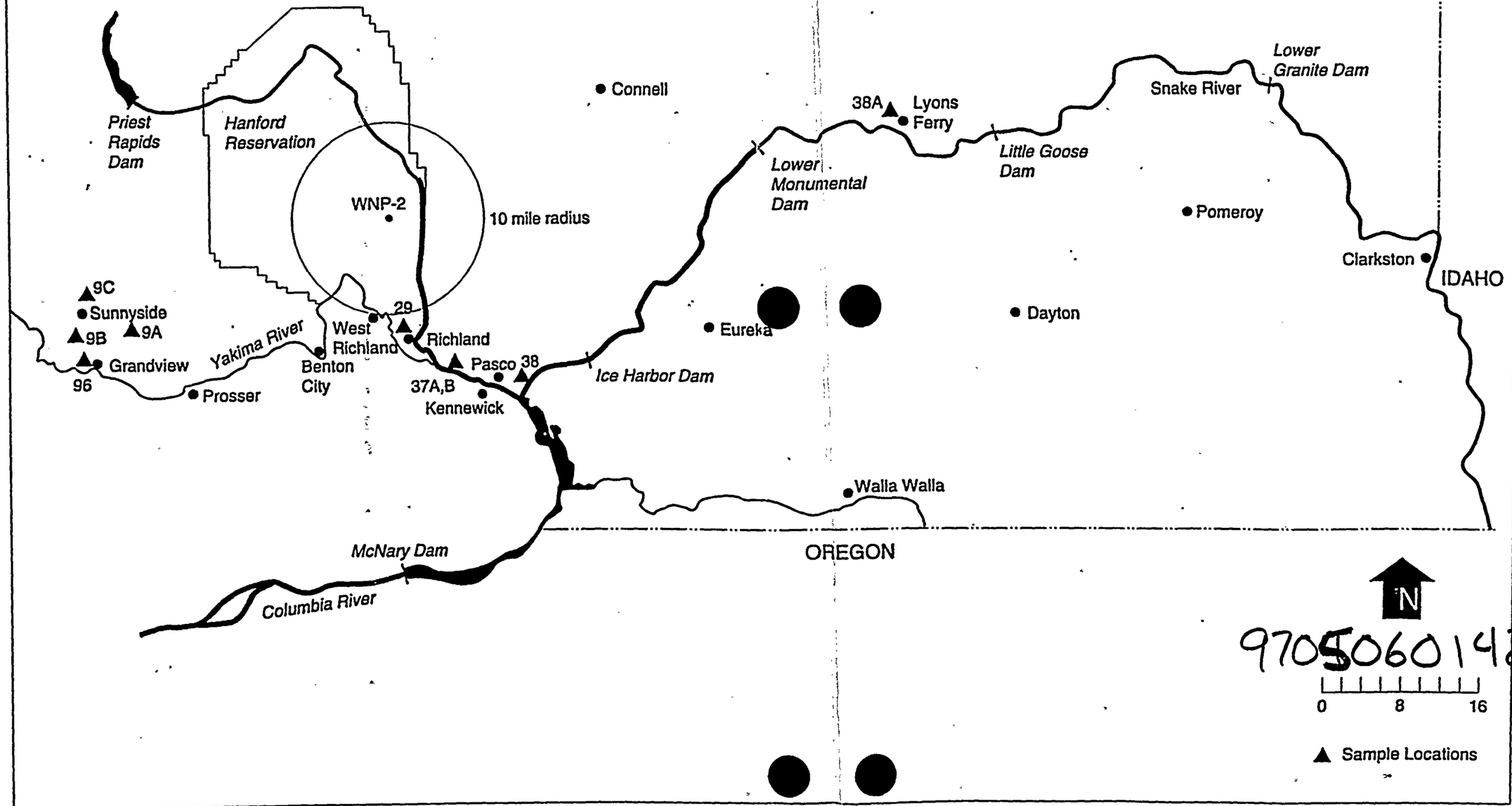

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FIGURE 4-2 REMP SAMPLING LOCATIONS OUTSIDE THE 10-MILE RADIUS

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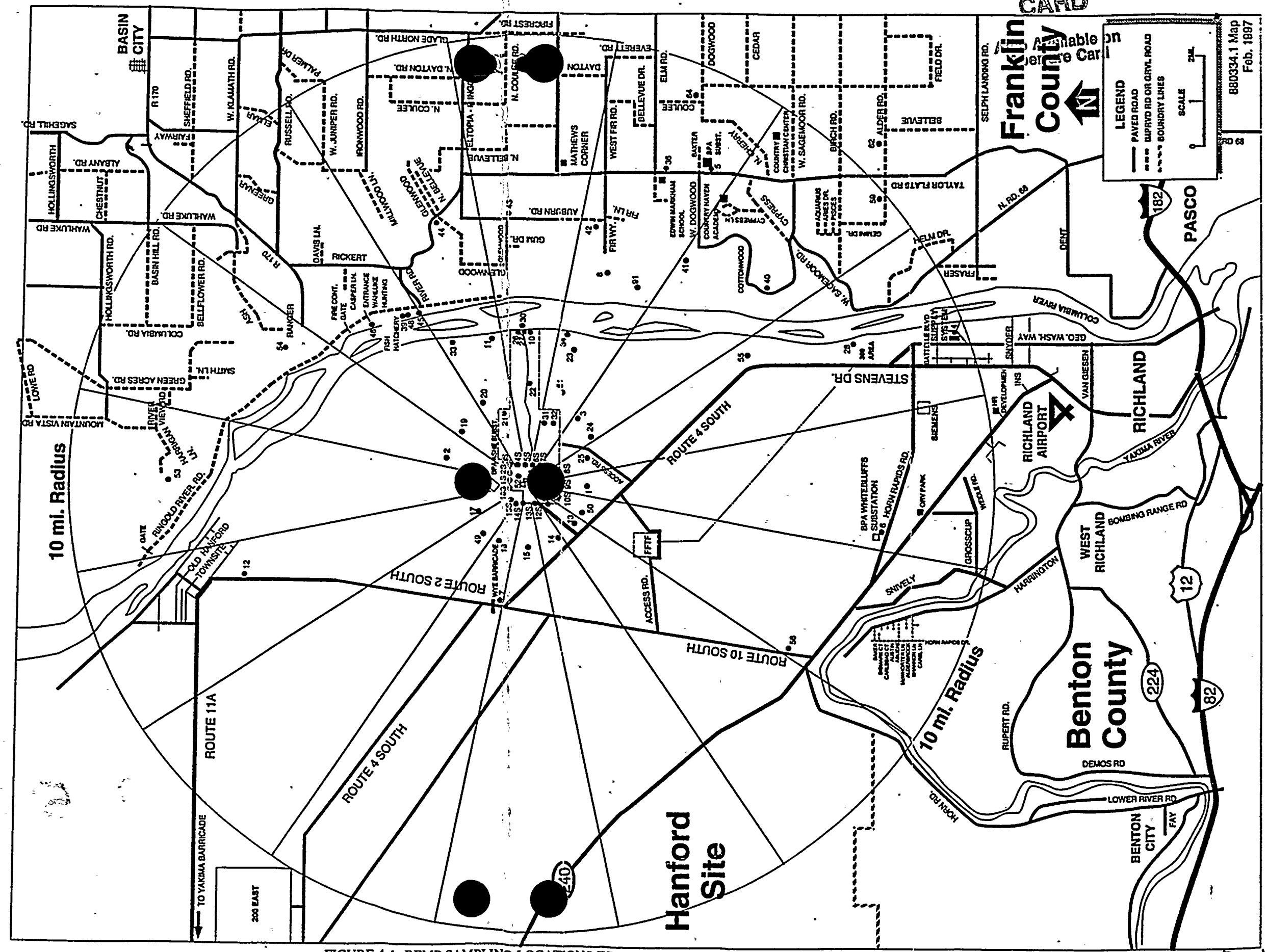

FIGURE 4-1 REMP SAMPLING LOCATIONS WITHIN THE 10-MILE RADIUS

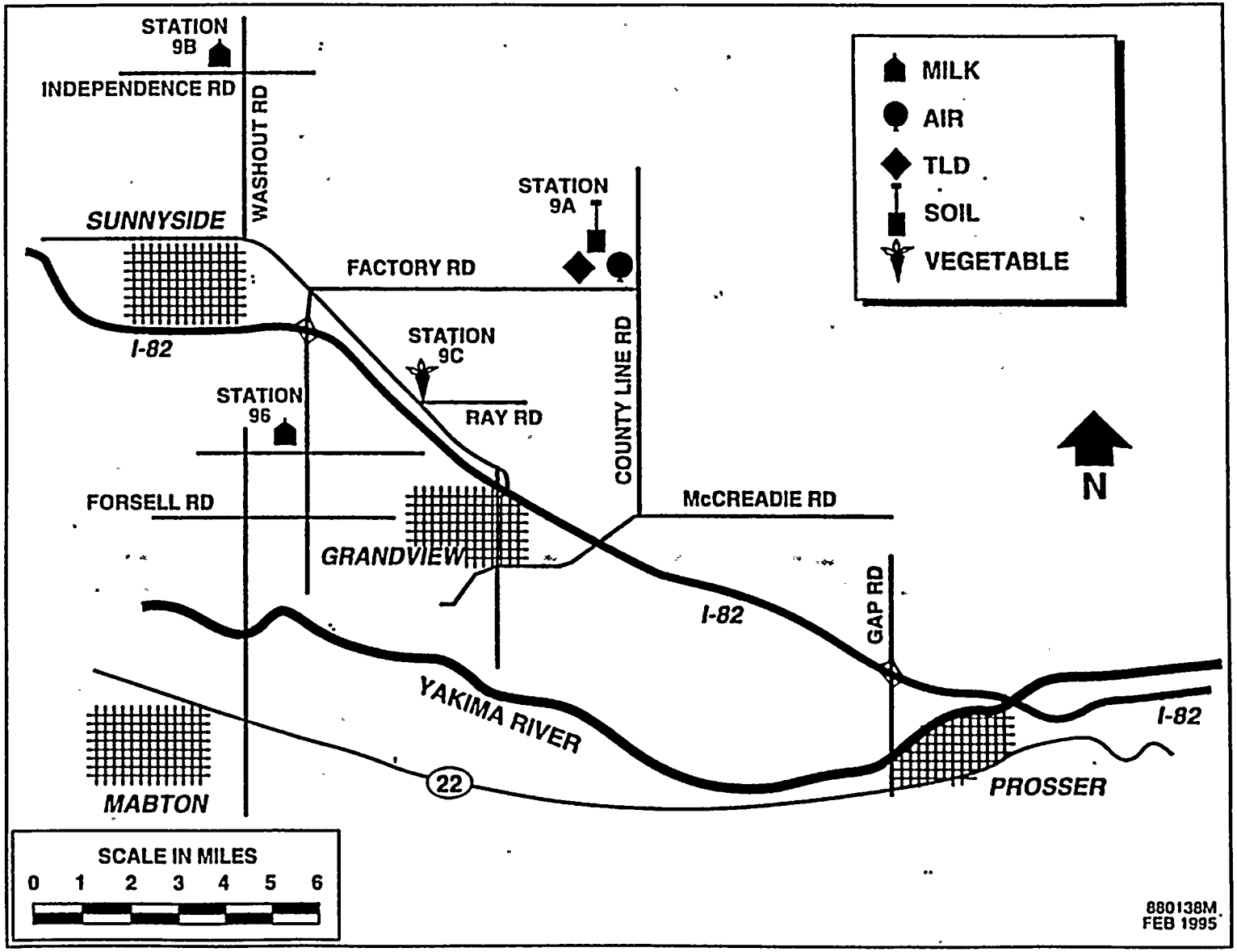

FIGURE 4-3 REMP SAMPLING LOCATIONS SUNNYSIDE/GRANDVIEW AREA

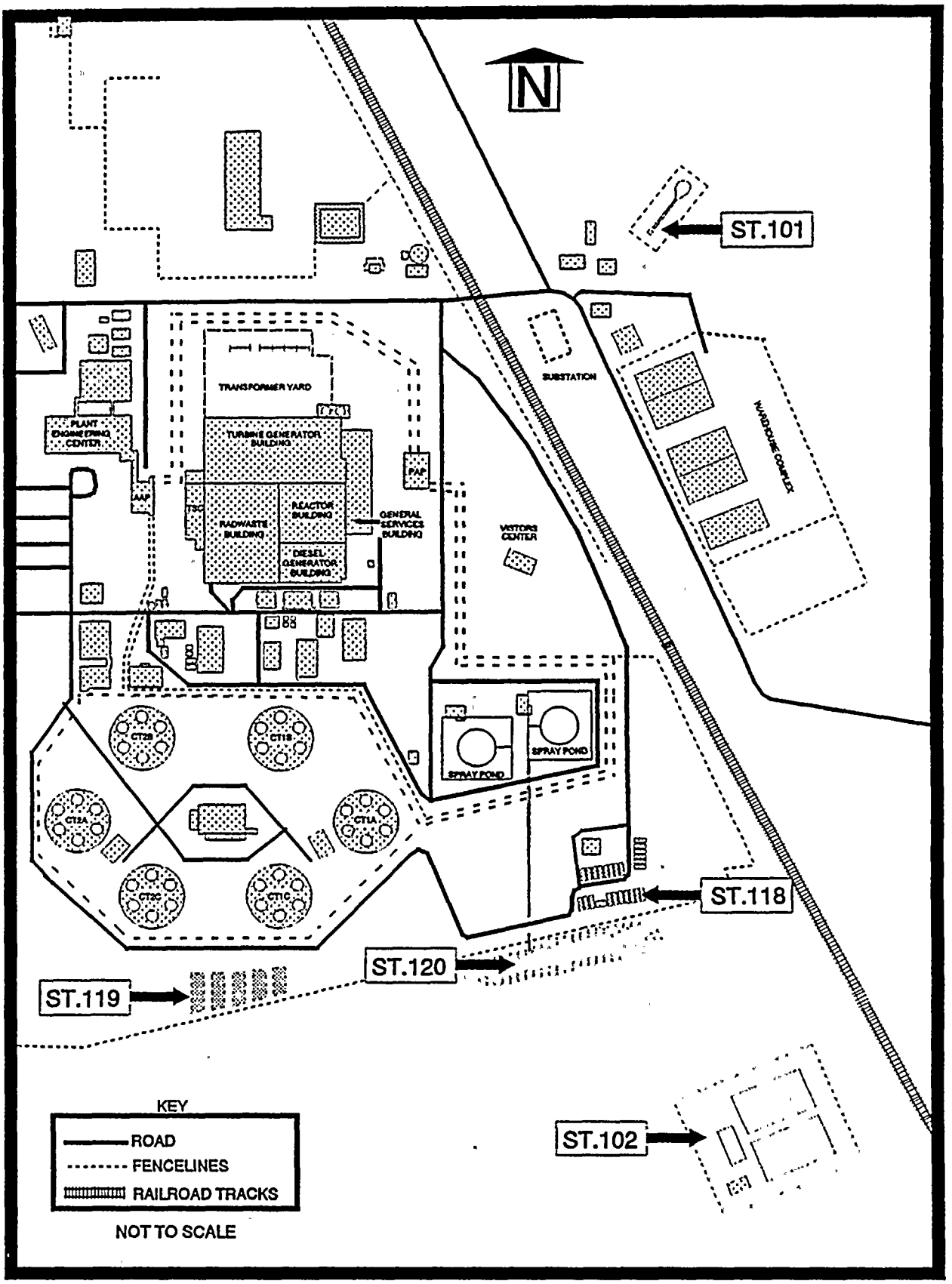

FIGURE 4-4 REMP NEAR PLANT SAMPLING LOCATIONS

5.0 RESULTS AND DISCUSSION

During 1996, the analyses of REMP samples were performed by Teledyne Brown Engineering Environmental Services in Westwood, New Jersey. The thermoluminescent dosimeters were processed by ThermoNutech in West Richland, Washington. Table 5-1 presents the means and ranges of selected 1996 results for each type of sample collected and Table 5-3 provides a summary of detectable results. The means and ranges of the preoperational and the previous operational data from 1984 to 1995 are also included in the table for comparison. The data tables of 1996 results comprise a separate volume that is available to interested parties.

The data for the preoperational period and the first six months of 1984 included "less than" (<) designations for results below the actual LLD, the contractual LLD, or the two-sigma error, depending upon the convention employed by the analytical contractor. Consequently, the data averages using "less than" values are biased high. The use of the "less than" values was discontinued in mid-1984. Since then, REMP data have been reported as net (total results minus the detector counting background).

Since the primary focus of the REMP is to determine whether Plant 2 operations had an impact on the environment, the 1996 results are compared in this report to the results obtained during the preoperational period and the results obtained during the previous years of Plant 2 operation. They are also compared to state and federal regulatory limits. Because of the use of "less than" values, rather than net results, during the preoperational period and during the first year of operation, and because of the impact of the 1986 Chernobyl accident on environmental radiation levels, the interpretation of the 1996 measurements relative to previous measurements must bear this in mind. Some of the parameters considered in the evaluations discussed in this report are presented as the means, ranges and standard deviations or standard errors of the results. Comparative plots and frequency distributions of the data are some of the tools that have been employed in the interpretation of the 1996 REMP data.

The 1996 analytical results for the REMP sampling locations established since the preoperational period are very similar to the results reported for previous years. The 1996 annual and quarterly TLD results were also very much like those observed previously. No significant trends indicating an environmental impact or unexpected change in the environmental concentrations or exposure rates at REMP monitoring stations were observed.

5.1 Direct Radiation

Environmental radiation exposure rates at near plant and remote stations, as determined by thermoluminescent dosimeters (TLDs), remained consistent with data from previous years.

Figure 5-1 presents a plot of the mean 1996 quarterly TLD results for each of the sixteen meteorological sectors at the site boundary ("S" stations). The chart also includes preoperational and previous operational periods.

The relationship of the mean 1996 results to the results for the preoperational and previous operational periods is very similar for each sector. This indicates that there were no significant directional effects observed in the 1996 TLD results.

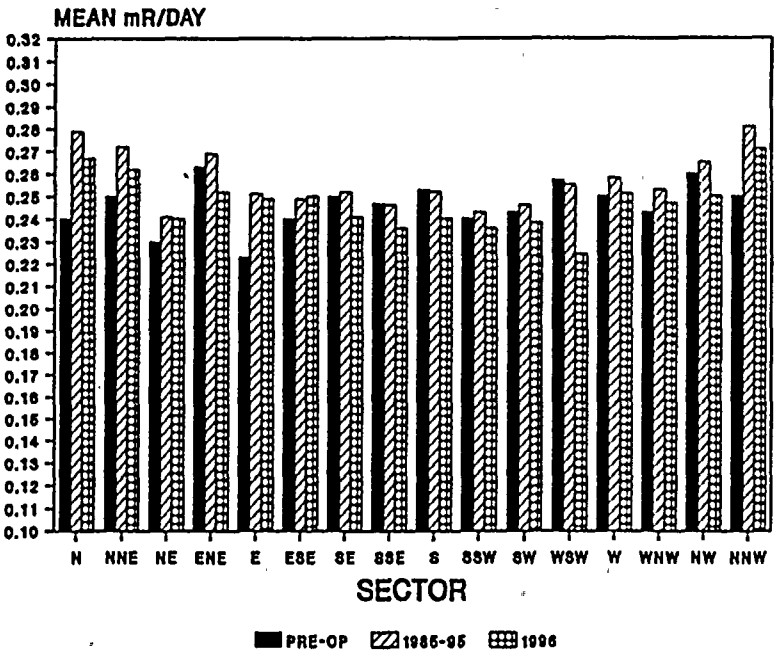

Figure 5-1 Site Boundary Quarterly TLDs - Annual Mean by Sector

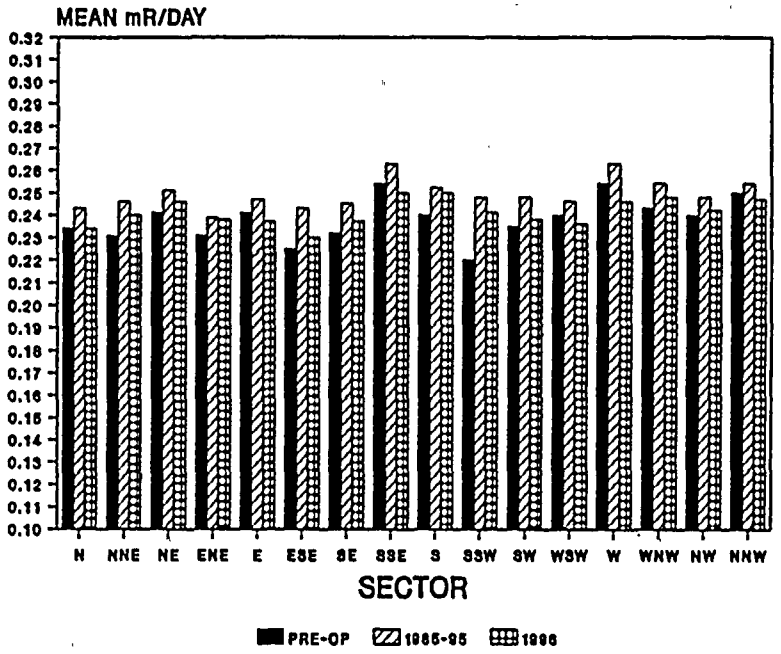

Figure 5-2 Near-Plant Quarterly TLDs - Annual Mean by Sector

The higher exposures in the N, NNE, and NNW sectors for the "S" stations is a result of those TLDs being physically closer to the plant than those of the other "S" station TLDs. It also reflects the more operational days and the power uprate of the plant. This is evident by comparing the data presented in Figure 5-1 with that of Figure 5-2, where the near-plant TLDs are more an equidistant from the plant.

Summaries of the environmental radiation exposure rates, determined by thermoluminescent dosimeters (TLDs) are presented in Tables 5-4 and 5-5, and 5-6.

For the remote TLDs, Station 46 in the Wahluke Reserve (NE sector) remained the location with the highest mean exposure rate, as shown in Figure 5-3.

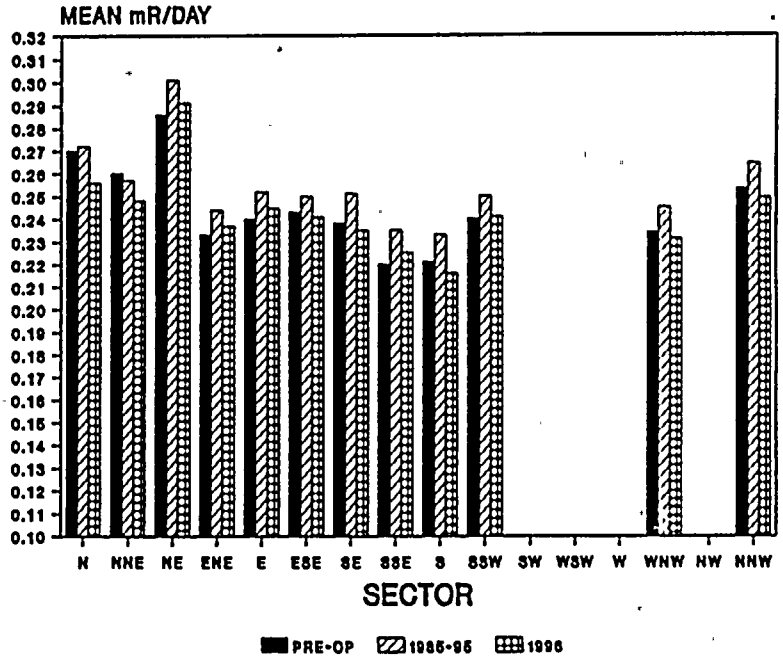

Figure 5-3 Remote Quarterly TLDs - Annual Mean by Sector

Since the preoperational measurement phase, the results for this location have exceeded the results for all other locations. Variations in the soil and underlying rock composition most likely account for localized differences such as shown in the TLD results for Station 46.

Frequency distribution plots of the 1996 quarterly TLD results are presented in Figure 5-4. The plots varied slightly from quarter to quarter, with 0.23 mR/day being the most frequent result, followed by 0.25 mR/day, 0.26 mR/day and 0.24 mR/day. The results for Station 46 remained upscale and separate from the main distribution. The frequency distributions for the previous operational TLD results are shown in Figure 5-5.

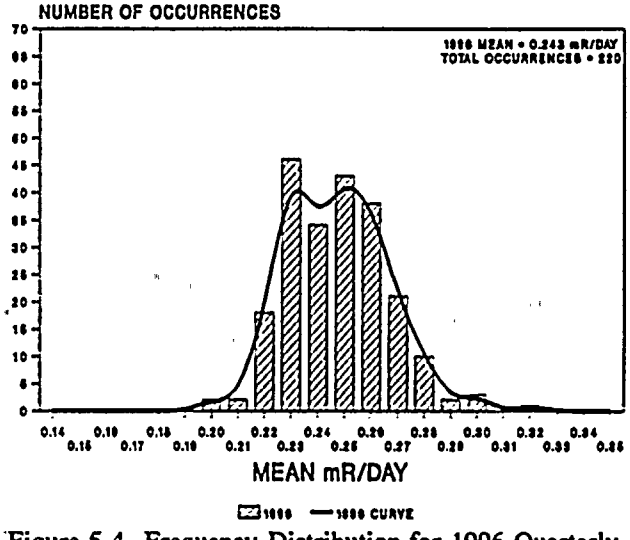

Figure 5-4 Frequency Distribution for 1996 Quarterly TLDs

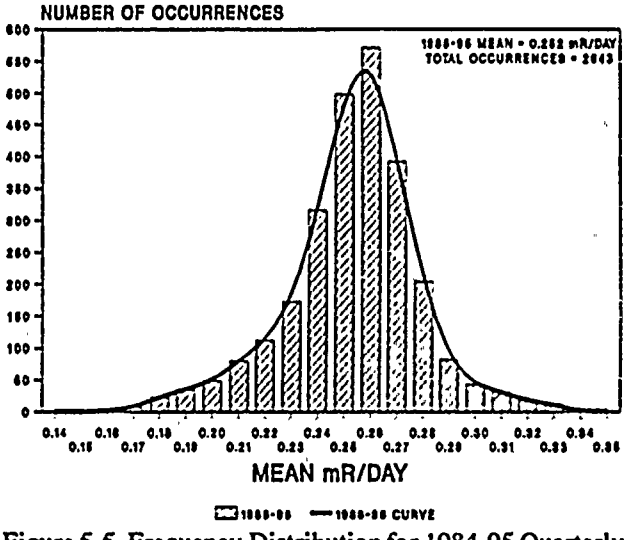

Figure 5-5 Frequency Distribution for 1984-95 Quarterly TLDs

5.2 Airborne Particulate/Iodine

The 1996 mean weekly gross beta on particulate filter results for selected indicator stations near Plant 2 are plotted in Figure 5-6. The gross beta in air results for 1996 were within the ranges observed during the preoperational period and during previous operational periods, as shown in Table 5-1. In Figure 5-7, the similarity between results from near-plant locations and those from remote locations are evident. The control location (Station 9A) results follow a very similar pattern to the remote and near-plant indicator locations. As observed previously, gross beta levels increased during periods of inversion occurring in the fall and winter months. Gross beta results plotted over a period of several years show a cyclic pattern of fall and winter increases. The increase, which was evident in the results of all the air sampling locations, is due to an increase in radon and radon daughter concentrations during the inversions.

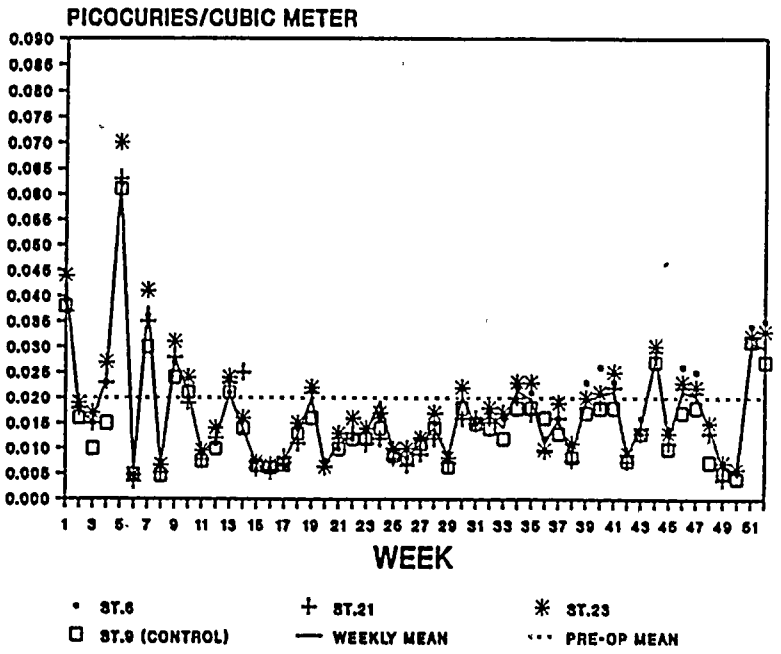

Figure 5-6 Gross Beta in Air, Near-Plant Stations - 1996

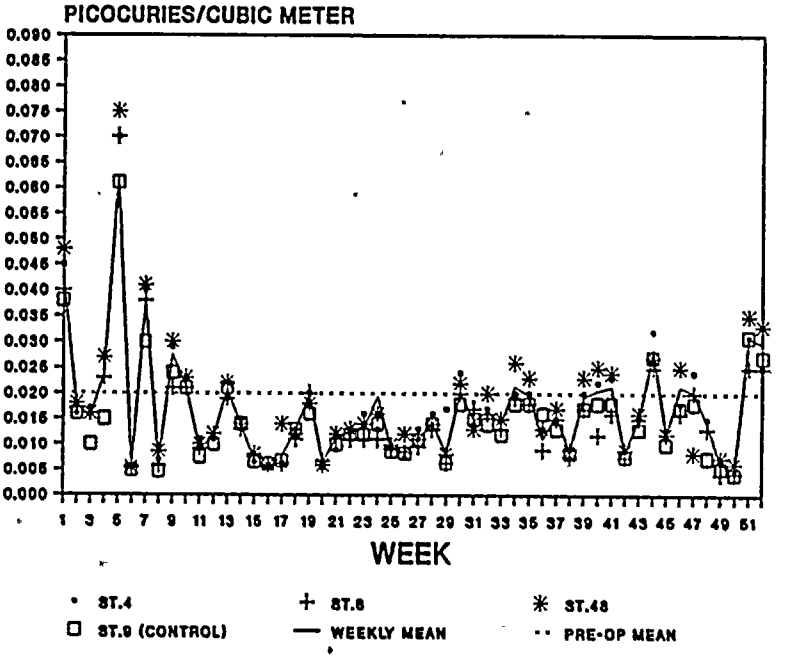

Figure 5-7 Gross Beta in Air, Remote Stations - 1996

The quarterly gamma analyses of the particulate filter composites indicated only the presence of two naturally-occurring radionuclides, beryllium-7 and potassium-40, at levels above detection limits at indicator locations and the control location. All iodine-131 in air results for 1996 were less than the 0.02 picocuries/cubic meter (pCi/m^3) LLD.

No evidence of any impact of plant operations on the environment was apparent in the particulate filter and charcoal cartridge results for 1996.

5.3 Water

All river/drinking water results for gross beta were within the ranges normally observed and less than 8 picocuries/liter (pCi/l), the level at which a strontium analysis is performed to verify compliance with the Washington State drinking water standard for strontium-90*. The 1996 gross beta concentrations in river/drinking water, relative to the state annual average concentration limit[11], are presented in Figure 5-8. The mean gross beta results in discharge water for 1996 are presented in Figure 5-9. The 1996 average results compare well to the averages from previous periods.

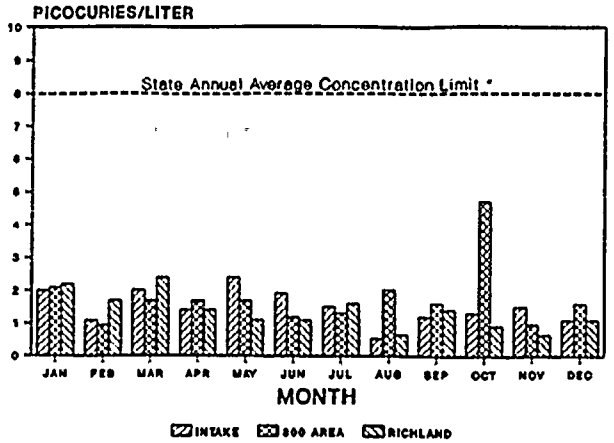

Figure 5-8 Gross Beta in River/Drinking Water-1996

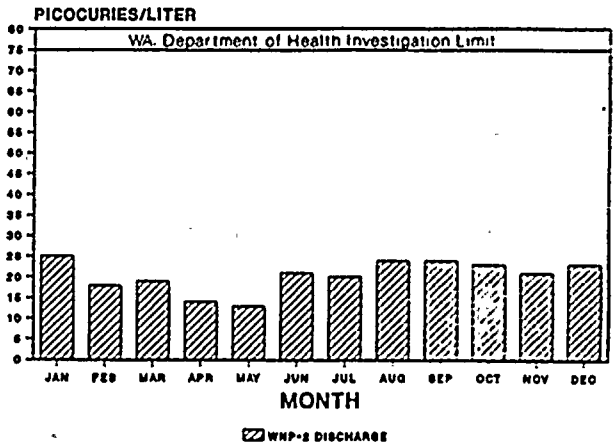

Figure 5-9 Gross Beta in Plant Discharge Water-1996

The gross beta levels in the discharge sample reflect the concentrations of naturally-occurring radionuclides, principally potassium-40, and any radionuclides from upstream sources of past Hanford activities present in the makeup water, in addition to radionuclides from Plant 2 discharges. The discharge sample results are representative of the radioactivity present in plant discharges before any mixing with river water occurs. All results were below the level Washington Department of Health's (WDOH) investigation level, which is the point the Supply System would notify WDOH of the result.

The 1996 tritium levels in the river/drinking water and groundwater were comparable with results obtained for prior years. Tritium levels in the discharge water were higher than the levels observed for the river/drinking water samples because of plant releases and because discharge water samples are taken prior to the water reaching the river and becoming diluted. As shown in Figure 5-10, the concentration of tritium was lower than the mean levels observed for the 1992 through 1995 periods. This reduction is due to an overall reduction in the volume of the radwaste discharges and the finding that a corrosion inhibitor used in Plant 2 (now discontinued) had been introducing small amounts of boron into the primary system, which helped to increase tritium levels.

Tritium concentrations in the discharge water for 1996 ranged from 100 to 4200 pCi/l, which is low when compared to the NRC reporting level of 20,000 pCi/l for a quarterly average concentration in drinking water. The quarterly tritium results for 1996 are shown in Figure 5-11.

*Strontium-90 is assumed to account for the gross beta result.

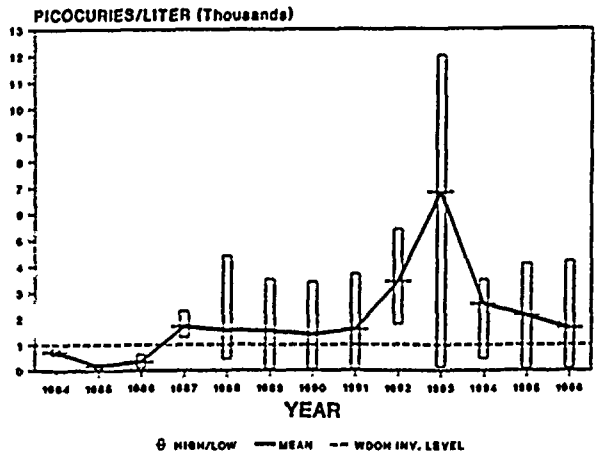

Figure 5-10 Tritium in Discharge Water 1984 - 1996

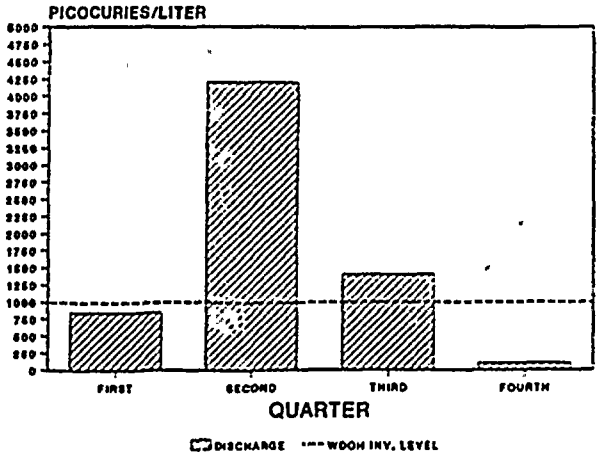

Figure 5-11 Tritium in Discharge Water 1996

Other than tritium in the discharge, there were no detectable nuclides in the river/drinking, discharge or groundwater samples during 1996.

5.4 Soil

Gamma spectrometry performed on soil samples in 1996 indicated a range of cesium-137 from 23.6 picocuries/kilogram (pCi/kg) to 162 pCi/kg at the indicator stations and a result of 64 pCi/kg at the control station. As shown in Table 5-1, and presented in Figures 5-12 and 5-13, the cesium-137 levels in the soil samples were well within the range observed during preoperational and previous operational sampling. The gamma spectrometry results for the soil samples did not indicate any impact from Plant 2 operations on the environment.

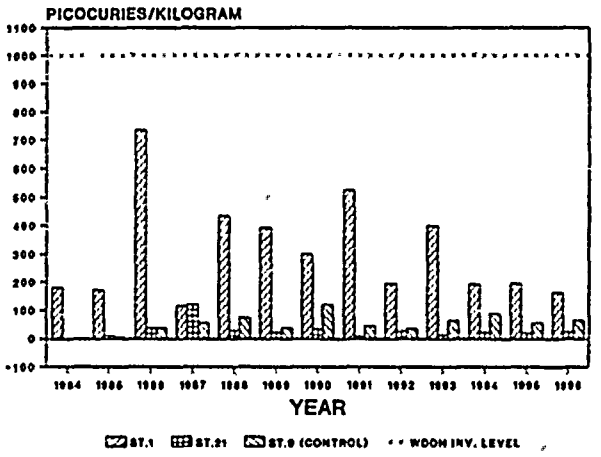

Figure 5-12 Cesium-137 in Soil 1984 - 1996, Stations 1, 21 and 9

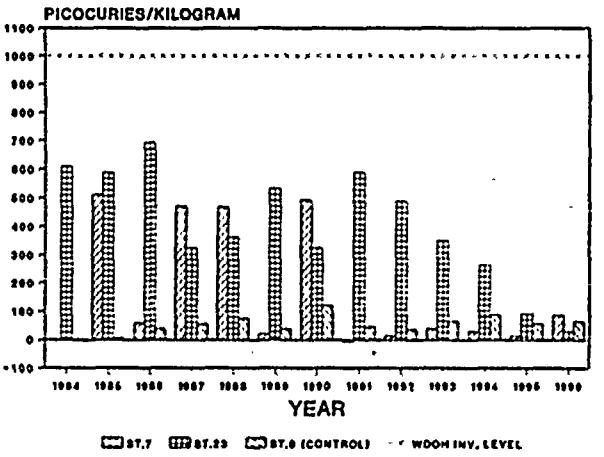

Figure 5-13 Cesium-137 in Soil 1984 - 1996, Stations 7, 23 and 9

No strontium analysis was required in 1996. Aside from cesium-137, the only radionuclides detected in the samples were potassium-40, radium-226 and thorium-228. These are part of the natural radioactivity typically found in soils.

5.5 River Sediment

The results of gamma spectrometry of river sediment indicated that aside from the naturally-occurring radionuclides (potassium-40, radium-226 and thorium-228), only cesium-137 was detected downstream of the plant (Station 34). Cesium-137 was also detected in the control location (Station 33) sample. The cesium-137 concentration upstream from the plant discharge was 60.8 pCi/kg dry weight; the concentration downstream from the discharge was 269 pCi/kg dry weight.

Cesium-137 has been detected in preoperational samples and in samples taken since plant operation began. It has also been previously identified as components of the Columbia River sediment originating from the operation of the old Hanford Reservation reactors.[14]

5.6 Fish

The gamma spectrometry results of fish samples collected in the vicinity of the Plant 2 discharge and at the control location on the Snake River were below detection limits, except for potassium-40, a naturally-occurring radionuclide.

5.7 Milk

All the results of iodine-131 analyses of milk samples collected during 1996 were less than detection limits. All milk sample results for the indicator and control locations were less than the detection limits, except for potassium-40, which is naturally-occurring.

5.8 Garden Produce

The gamma isotopic analysis results for all root, fruit and leafy vegetables collected in 1996 were below detection limits other than potassium-40, which occurs naturally.

5.9 Special Interest Stations

The storm drain pond, Sanitary Waste Treatment Facility (SWTF) and the containerized storage area were incorporated into the routine sampling schedule in 1992. The cooling tower sediment disposal area was added in 1995. Discussions of the results from each of the locations are given in the following sections. Thermoluminescent dosimeters were placed around the spray pond drainfield (ST120) after investigative soil samples found detectable amounts of cesium-137 and cobalt-60 in May 1995. As a result, three quarterly TLDs, two in the drainfield and one on the south bank, were put in place for fourth quarter 1995. Annual TLDs were placed for first quarter 1996.

Until incorporated into the REMP, the sediment samples collected during previous years at the storm drain and SWTF were analyzed by the Supply System. The storm drain and SWTF sediment samples were analyzed wet, so the results were in terms of wet weight instead of the dry weight concentrations determined by Teledyne. Consequently, direct comparison of the wet sample results with the dried sample results is difficult since the percent solids can vary from sample to sample.

5.9.1 Storm Drain Pond (Station 101)

The storm drain pond is located approximately 1500 feet northeast of Plant 2. Water is conveyed to the pond via a 18-inch diameter pipe which discharges into a 300-foot long earthen channel that leads to a 100-foot diameter pond. The pond is a shallow, unlined percolation/evaporation basin.

REMP personnel collected water, sediment, soil and vegetation samples at the outfall during 1996. Additional monthly water grab samples and sediment samples were taken from the pond area beginning in July of 1994. Monthly sediment and water sampling at the pond was discontinued in July 1996. At the outfall, flow proportional composite water samples were collected from an automatic sampler. Sediment sampling at the outfall was changed from monthly to biannually in July of 1996. Vegetation was sampled annually near the outfall.

Tritium was the only isotope detected during 1996. Figure 5-14 shows the monthly average for 1992-94 monthly averages versus the 1996 monthly average. The tritium comes primarily from moisture in building exhaust ventilation condensing outside and then entering the storm drains. Sample results for 1996 indicate the measures taken by the plant have resulted in significant curtailment of the release of tritium to the pond.

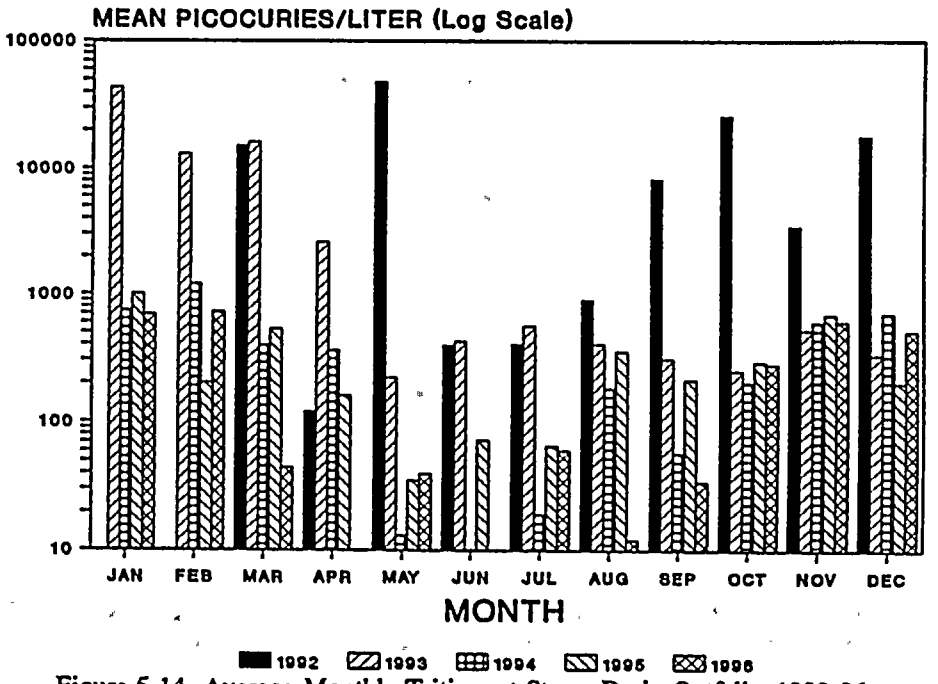

Figure 5-14 Average Monthly Tritium at Storm Drain Outfall - 1992-96

The range for positive tritium results at the outfall was from 180 pCi/l to 1400 pCi/l. At the pond, the range for positive results was 500 pCi/l to 1500 pCi/l. Detectable gross beta activity at the outfall averaged 4.2 pCi/l with a range of 2.8 to 7.2 pCi/l. Gross beta at the pond ranged from 1.7 pCi/l to 5.3 pCi/l and averaged 3.2 pCi/l.

Sediment at ST101 was, until July, sampled monthly at the outfall and at the pond. In the sediment samples from the outfall, cobalt-60, cesium-137 and manganese-54 were detected along with the natural-occurring nuclides potassium-40, radium-226 and thorium-228. Detectable cobalt-60

averaged 306 pCi/kg dry and ranged from 55.6 pCi/kg dry to 1050 pCi/kg dry. The detectable cesium-137 ranged from 13.9 pCi/kg dry to 84 pCi/kg dry and averaged 36.2 pCi/kg dry. Manganese-54 was detected in a single sample and measured 14.3 pCi/kg dry.

Samples collected at the pond had detectable amounts of cesium-137 and cobalt-60. Cesium-137 results ranged from 42.1 pCi/kg dry to 247 pCi/kg dry and averaged 105 pCi/kg dry. Cobalt-60 averaged 525 pCi/kg dry and ranged from 184 pCi/kg dry to 1100 pCi/kg dry. The gamma spectrometry results for both the outfall and the pond were within levels seen in previous years.

All the quarterly soil samples, taken on the east and west banks, had detectable amounts of cesium-137 in them. The natural radionuclides of potassium-40, radium-226 and thorium-228 were also detected. Cesium-137 averaged 35.2 pCi/kg on the east bank and ranged from 18.1 pCi/kg to 55.5 pCi/kg. On the west bank, cesium-137 averaged 39.8 pCi/kg and ranged from 32.6 pCi/kg to 47.3 pCi/kg. There was a detectable cobalt-60 result of 31.5 pCi/kg taken on the east bank. These results are within the ranges observed in previous years.

In the annual vegetation sample taken in the stream, no detectable radionuclides were found other than potassium-40 and beryllium-7, which occur naturally.

5.9.2 Sanitary Waste Treatment Facility (Station 102)

The Sanitary Waste Treatment Facility (SWTF), located approximately 0.3 mile south of Plant 2, processes the sanitary waste from Plant 2, the WNP-1 and WNP-4 sites and the Plant Support Facility (PSF). Discharge standards and monitoring requirements for the SWTF are established in EFSEC Resolution No. 259[15]. Until April 1992, the SWTF sediment was sampled semiannually and analyzed in the Support Services radiation laboratory and the radionuclide concentrations were given in terms of wet weight.

Gross beta results in water samples averaged 30.5 pCi/l and ranged from 5.9 pCi/l to 53 pCi/l. The gross beta results for the south stabilization pond averaged 41 pCi/l and ranged from 28 pCi/l to 53 pCi/l. An investigation in 1994 into the source of the gross beta indicated potassium-40, a natural isotope, was the major contributor. Other contributors to the beta appear to be natural isotopes and no fission or activation products were detected that would indicate Plant 2 as a source.

Gamma analysis of sediment collected from the north pond reveals detectable cobalt-60 and cesium-137 in addition to the naturally occurring radionuclide potassium-40, radium-226 and thorium-228. The results for cobalt-60 during 1996 were 172 pCi/kg dry and 617 pCi/kg dry. Cesium-137 results were 104 pCi/kg dry and 206 pCi/kg dry. The results for both nuclides are within ranges observed since 1992.

5.9.3 Containerized Storage Area (Station 118)

Station 118, consists of twenty-nine large metal storage containers holding the low-pressure turbine rotor parts removed from the plant during the 1992 maintenance outage. Soil samples and ionization chamber readings were taken at Station 118. Beginning in September 1994, samples from different areas were composited and sent to Teledyne Brown for analysis

Soil samples taken at Station 118 before the storage of the low-pressure turbine rotor parts contained no detectable radioactivity except that from naturally-occurring radionuclides, such as potassium-40 and radium-226.

5.9.4 Cooling Tower Sediment Disposal Area (Station 119)

On May 8, 1995, EFSEC approved Resolution No. 278[16] that authorized the onsite disposal of cooling tower sediments containing low levels of radionuclides. This area is located just south of the cooling towers in the landfill area. According to Resolution No. 278, the REMP is to monitor the area's direct radiation exposure rate with annual pressurized ion chamber measurements. Direct radiation dose is measured by quarterly and annual TLDs and a dry composite sediment sample is taken from the disposal cell within thirty days following each cleaning to confirm that the disposal criteria outlined in the resolution have not been exceeded.

An estimated total of 36 cubic yards of material was disposed of during the two 1996 cleanings. This material had an in-place density range of 1.2 grams/cubic centimeter (g/cm^3) to 1.6 g/cm^3. Using the volume and the average density of 1.4 g/cm^3, along with the activity, it is estimated that the following quantities of nuclides were placed in the disposal area:

Cobalt-60	6.80E-06 curies
Manganese-54	3.00E-07 curies
Zinc-65	1.24E-06 curies
Cesium-134	2.41E-06 curies
Cesium-137	1.71E-05 curies

Of the above nuclides, only cobalt-60 and cesium-137 were above detection levels. The results for cobalt-60 were 92.3 pCi/kg dry and 84.1 pCi/kg dry. The cesium-137 results were 211 pCi/kg dry and 234 pCi/kg dry. Since the results for manganese-54, zinc-65 and cesium-134 were lower than the detection limit, the estimated quantities disposed of those nuclides are estimates of maximum possible concentration.

Measurements of direct radiation were taken using TLDs and a Reuter Stokes pressurized ion chamber. The TLDs were collected quarterly and annually. Two locations are used, one next to the collection area and the other approximately 100 yards to the east as the control. The mean result for the station next to the collection area was 0.26 mR/day and the control was also 0.26 mR/day. The annual TLD results were 0.30 mR/day next to the collection area and 0.28 mR/day at the control. The pressurized ion chamber readings were taken monthly for 1996. Weather didn't allow any measurements to be taken in January or December. In June, the recording unit malfunctioned and no readings were taken. The mean results for readings taken for the February through April period, which was prior to disposal of new sediment to the area, was 0.0071 mR/hr with the plant at 60% power in February and 0% during March and April. The May reading, taken after disposal, was 0.0065 mR/hr with the plant at 0% power. The August through November readings averaged 0.0099 mR/hr with the plant running between 64% power and 100% power.

5.9.5 Spray Pond Drainfeld (Station 120)

Sediment from spray pond cleanings had been discharged to a trench located approximately 100 yards south of the spray ponds. These cleanings were initially done using divers with a vacuum pump. In 1995, soil samples taken in the trench revealed detectable amounts of cesium-137 and cobalt-60. Because of this, it was decided to place two TLDs in the trench, one at the east end and one at the west end, where sampling had indicated the highest concentration of the radionuclides. Another TLD was placed outside on the south bank and acted as the control location. The mean results for the quarterly TLDs were 0.26 mR/day for the east TLD and 0.27 mR/day for the west TLD. The quarterly mean for the control location was 0.25 mR/day. The annual results were 0.31 mR/day at the east location, 0.33 mR/day for the west and 0.29 mR/day for the control location.

In August 1996, the contaminated trench sediments were relocated to a disposal cell south of the cooling towers.

5.10 1996 Sample Deviations

Air sampler outages made up the majority of sample deviations for 1996. Problems ranged from pump failure to power outages. Deviations are shown in Table 5-2.

TABLE 5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1996[d] MEAN	(RANGE)
Air: pCi/m³						
Gross Beta	<0.02	(<0.003 - 0.130)	0.021	(0.001 - 0.741)	0.018	(0.003 - 0.091)
I-131[e]	<0.05	(<0.01 - 0.11)	0.00	(-0.07 - 0.82)	0.00	(-0.01 - 0.02)
Gamma						
Cs-134	<0.01	(<0.001 - 0.040)	0.0003	(-0.0021 - 0.0149)	0.0000	(-0.0002 - 0.0004)
Cs-137	<0.01	(<0.001 - 0.040)	0.0007	(-0.0011 - 0.0356)	0.0000	(-0.0003 - 0.0003)
River/Drinking Water: pCi/l						
Gross Beta	<3	(<1 - <6)	1.9	(-0.2 - 9.1)	1.6	(0.4 - 4.8)
Gamma						
Cs-134	<3.8	(<1 - <12)	0.2	(-5.4 - 5.2)	0.0	(-5.0 - 3.1)
Cs-137	<4.1	(<1 - <13)	1	(-5.7 - 6.2)	1.2	(-0.6 - 3.1)
Co-58	<5.1	(<1 - <25)	-0.1	(-3.3 - 2.9)	0.0	(-1.1 - 1.8)
Co-60	<4.7	(<1 - <13)	0.8	(-4.9 - 7.1)	0.5	(-1 - 2.1)
Fe-59	<13.3	(<2 - <93)	0.7	(-8.9 - 6.9)	1.3	(-0.7 - 3.1)
Zn-65	<8.3	(<2 - <27)	-1.1	(-16.2 - 8.2)	0.9	(-3.8 - 10.5)
H-3	<481.7	(220 - <820)	119	(-500 - 596)	47.3	(-55 - 150)
Groundwater: pCi/l						
Gamma						
Cs-134	<4	(<1 - <12)	0.4	(-4.1 - 5.4)	0.6	(-0.9 - 3.4)
Cs-137	<3.8	(0.8 - <8)	1	(-6 - 4.9)	0.7	(-3.5 - 3.1)
Co-58	<4.7	(<1 - <12)	-0.4	(-3.3 - 1.9)	-0.4	(-2.2 - 2.5)
Co-60	<4.1	(0.1 - <9)	0.9	(-2.4 - 8.4)	0.2	(-0.9 - 1.5)
Fe-59	<11.6	(<2 - <33)	0.7	(-4.5 - 5.7)	0.4	(-1.7 - 5.1)
Zn-65	<8.6	(<2 - 17)	-0.9	(-46.8 - 15)	1.4	(-3.7 - 9.6)
H-3	<467.8	(<10 - 2600)	30.2	(-516 - 324)	-38.8	(-120 - 51)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1995. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Charcoal cartridge results.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1996[d] MEAN	(RANGE)
Discharge Water: pCi/l						
Gross Beta	<2.8	(<1.9 - 4)	17.8	(0.6 - 56)	11.7	(3.1 - 23)
Gamma						
Cs-134	<3.7	(<1 - <8)	0.6	(-3.9 - 10.1)	-0.4	(-2.1 - 1.1)
Cs-137	<4.7	(<1 - 16)	2	(-5.3 - 23.1)	1.9	(-0.7 - 3.4)
Co-58	<1.4	(1 - 13)	0.0	(-2.6 - 4.6)	0.1	(-0.4 - 1.2)
Co-60	<5.0	(<1.9 - <13)	5.9	(-8.7 - 57.6)	2	(-0.2 - 4.3)
Fe-59	<11.9	(<3 - <38)	0.8	(-5.9 - 13)	1.5	(-0.3 - 5.1)
Zn-65	<8.6	(<2 - 27)	4.4	(-8.2 - 86.7)	0.9	(-2.3 - 2.5)
H-3	<420	(<80 - 700)	2054.5	(55 - 12000)	1637.5	(100 - 4200)
Sr-90	<3		0.8	(0.5 - 1.1)	Analysis Not Performed	
Storm Drain Water: pCi/l						
Gross Beta	Analysis Not Performed		13.2	(0.3 - 1100)	3.3	(1.3 - 7.2)
Gamma	Analysis Not Performed					
Cs-134			0.0	(-9.6 - 8.1)	0.1	(-2.3 - 2.1)
Cs-137			1.4	(-11 - 252)	1.2	(-5.4 - 3.1)
Co-58			-0.4	(-7.6 - 3.4)	-0.5	(-2.7 - 1.6)
Co-60			1	(-4.2 - 125)	0.4	(-2 - 2.7)
Fe-59			0.8	(-14 - 12)	1.1	(-2.6 - 4.7)
Zn-65			0.8	(-13 - 53)	0.3	(-4.4 - 6.5)
Mn-54			0.6	(-6.2 - 6.7)	0.4	(-1.8 - 2)
I-131			-0.1	(-17 - 21.1)	0.0	(-7.4 - 3.4)
Ce-141			-0.9	(-441 - 707)	-1.9	(-10.2 - 2.6)
I-131[e]			0.4	(-0.2 - 8.3)	Analysis Not Performed	
H-3	Analysis Not Performed		6548.5	(-170 - 270000)	270.8	(-150 - 1500)
Sanitary Waste Water: pCi/l						
Gross Alpha	Analysis Not Performed		0.4	(-0.7 - 1.6)	1	(-0.2 - 2.3)
Gross Beta	Analysis Not Performed		37.8	(13 - 61)	30.5	(5.9 - 53)
Cs-134			0.3	(-2.6 - 4.9)	0.1	(-1.4 - 1.8)
Cs-137			0.6	(-5.1 - 4.2)	1.1	(-1.5 - 2.9)
Co-58			-0.3	(-2.9 - 1.8)	-0.5	(-1.8 - 0.8)
Co-60			0.4	(-12.9 - 4)	0.3	(-2.4 - 2.1)
H-3	Analyses Not Performed		258	(-120 - 1700)	6.9	(-160 - 190)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1995. Some of the data means and ranges are biased high due to Chernobyl in 1986
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Resin method

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b,c] MEAN	(RANGE)	1996[d] MEAN	(RANGE)
River Sediment: pCi/kg (dry)						
Gamma						
Cs-134	<112.5	(<50 - <150)	53.6	(7 - 172)	23.9	
Cs-137	<287	(<50.0 - <560.0)	319.6	(153 - 1890)	269.3	
Co-60	<254.6	(130 - 610)	38.8	(11 - 129)	18.5	
Storm Drain Sediment: pCi/kg (dry)						
Gamma:	Analysis Not Performed[e]					
Cs-134			64.2	(4.1 - 1140)	30.2	(18.1 - 53.2)
Cs-137			168	(-3.6 - 2900)	69	(10.5 - 246.7)
Co-58			-1.8	(-27 - 58)	-3.6	(-7.6 - 1.8)
Co-60			779	(-6.4 - 25400)	415.6	(55.6 - 1104)
Zn-65			125.3	(-24.6 - 4650)	9.4	(-11.4 - 53.2)
Mn-54			24	(-9.6 - 670)	7.8	(3.6 - 16.2)
Ce-141			37.8	(-28.8 - 3740)	3.5	(-8 - 18.7)
Sanitary Waste Sediment: pCi/kg (dry)						
Gamma:	Analysis Not Performed[e]					
Cs-134			27.9	(-15.6 - 55.2)	29.8	(18.8 - 40.7)
Cs-137			149.5	(0 - 255.1)	155.3	(104.4 - 205.7)
Co-60			224.7	(-3.4 - 728.2)	394.4	(172 - 616.7)
Zn-65			12.1	(-106 - 125)	36.9	(12.9 - 60.8)
Mn-54			5.7	(-26 - 95)	18.9	(-16.6 - 21.1)
Soil: pCi/kg (dry)						
Gamma						
Cs-134	<65.3	(<20 - <150)	26.2	(1 - 53.2)	17.2	(12.6 - 22.3)
Cs-137	364.3	(<20.0 - <1880.0)	249.5	(-7.3 - 735)	75	(23.6 - 162.4)
Sr-90	Analysis Not Performed		178.8	(0.2 - 455)	Analysis Not Performed	

(a) All stations all years.
(b) Indicator stations only for the years 1984 to 1995. Some of the data means and ranges are biased high due to Chernobyl in 1986
(c) The data used for these averages does not include the "less the" values reported in 1984.
(d) Indicator stations only.
(e) Prior to February 1992, these samples were analyzed as wet weight. These numbers are for the samples analyzed as dry weight.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1996[d] MEAN	(RANGE)
ST 118 Soil: pCi/kg (dry)						
Gamma	Analysis Not Performed					
Cs-134			22.8	(-2.9 - 45.6)	14.2	(14.1 - 14.3)
Cs-137			15.1	(-8.2 - 47.6)	15.5	(13.7 - 17.2)
Storm Drain Soil: pCi/kg (dry)						
Gamma	Analysis Not Performed					
Cs-134			22	(-1.4 - 38)	24.7	(17.1 - 31.5)
Cs-137			42.7	(12.5 - 77.3)	37.5	(18.1 - 55.5)
Milk: pCi/l						
Gamma						
Cs-134	<3.7	(<0.9 - <14)	0.8	(-8.7 - 22.6)	0.0	(-4.2 - 2.7)
Cs-137	<3.8	(<1 - <12)	2.4	(-6.6 - 47.3)	1	(-3.3 - 4.2)
Ba-140	<72.1	(<6 - <2000)	0.2	(-44.3 - 55)	0.4	(-5.5 - 6.1)
La-140	<33.3	(<5 - 1000)	-0.4	(-24.2 - 9.7)	-0.1	(-2.4 - 3.6)
I-131[e]	<0.5	(<0.1 - <1)	0.7	(-0.8 - 143.6)	0.0	(-0.3 - 0.4)
Sr-90	Analysis Not Performed		1.9	(1.3 - 3.9)	Analysis Not Performed	
Fish: pCi/kg (wet)						
Gamma						
Cs-134	<61.2	(<6 - <130)	1.8	(-20.4 - 24)	-1	(4.5 - 3)
Cs-137	<88.8	(<10 - <130)	14.7	(-35.1 - 57)	7.6	(-3.7 - 14.7)
Co-58	<87.7	(<9 - <130)	0.7	(-16.8 - 25.8)	-2.2	(-4.1 - 0.2)
Co-60	<80.6	(<9 - <130)	1.6	(-18.4 - 21)	1.4	(-2.6 - 8)
Fe-59	<130	(<30 - <260)	0.0	(-34.2 - 30)	4.5	(-5.5 - 16.5)
Mn-54	<88.3	(<8 - <130)	1.5	(-20 - 30.9)	1.3	(0.4 - 2.3)
Produce: pCi/kg (wet)						
Gamma						
Cs-134	<49.1	(<10 - <140)	0.8	(-24.8 - 19.8)	0.6	(-2.7 - 5.2)
Cs-137	<69.8	(<10 - <140)	3.3	(-9.8 - 20.9)	1.2	(-2.3 - 6.2)
I-131	<105.6	(<10 - <1000)	-0.4	(-26 - 59)	-4.7	(-36.2 - 2.1)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1995. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Resin method.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1996[d] MEAN	(RANGE)
Storm Drain Vegetation[e]: pCi/kg (wet)						
Gamma	Analysis Not Performed					
Mn-54			12	(-2 - 32.2)	10.4	
Co-60			21.1	(-3.7 - 48.2)	7	
Zn-65			26.1	(-4.3 - 57.4)	13.1	
Cs-134			7.5	(-6.5 - 45.8)	4.8	
Cs-137			27.1	(3.9 - 93.5)	24.9	
Cooling Tower						
Gamma	Analysis Not Performed					
Mn-54			14.9		3.9	(2.8 - 4.9)
Co-60			69.6		88.2	(84.1 - 92.3)
Zn-65			14.6		16.1	(4.5 - 27.8)
Cs-134			31.2		31.3	(28 - 34.6)
Cs-137			237		222.5	(211 - 234)
TLD: mR/day						
Quarterly	0.24	(0.17 - 0.31)	0.25	(0.16 - 0.35)	0.24	(0.20 - 0.32)
Annual	0.23	(0.20 - 0.29)	0.23	(0.18 - 0.32)	0.28	(0.24 - 0.34)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1995. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator Stations only.
(e) Routine samples from the outfall only.

TABLE 5-2

1996 SAMPLE DEVIATIONS

SAMPLE MEDIA	DATE	LOCATION	PROBLEM
Air Particulate/Iodine	01/05 - 01/08	Station 40	Replacement unit unavailable, reduced hours. Sample volume acceptable.
	01/15 - 01/22	Station 1	Unit failure, reduced hours. Sample volume unacceptable.
	01/22 - 01/29	Station 8	Unit failure, reduced hours. Sample volume acceptable.
	01/29 - 02/06	Station 7	Unit failure, reduced hours. Sample volume unacceptable.
	01/29 - 02/06	Station 40	Unit failure, reduced hours. Sample volume unacceptable.
	02/06 - 02/12	Station 7	Unit failure, reduced hours. Sample volume unacceptable.
	02/06 - 02/12	Station 40	Unit failure, reduced hours. Sample volume unacceptable.
	03/11 - 03/18	Station 1	Unit failure, reduced hours. Sample volume unacceptable.
	03/18 - 03/25	Station 1	Unit failure, reduced hours. Sample volume unacceptable.
	04/22 - 04/29	Station 48	Unit failure, reduced hours. Sample volume unacceptable.
	05/13 - 05/20	Station 9	Unit failure, reduced hours. Sample volume unacceptable.
	05/20 - 05/28	Station 4	Unit failure, reduced hours. Sample volume acceptable.
	06/03 - 06/10	Station 21	Unit failure, reduced hours. Sample volume unacceptable.
	06/10 - 06/17	Station 40	Unit failure, reduced hours. Sample volume unacceptable.
	07/15 - 07/22	Station 4	Unit failure, reduced hours. Sample volume unacceptable.
	07/15 - 07/22	Station 40	Power outage, reduced hours. Sample volume acceptable.
	07/22 - 07/29	Station 9	Power outage, reduced hours. Sample volume acceptable.
	10/14 - 10/21	Station 57	Unit failure, reduced hours. Sample volume acceptable.
	10/21 - 10/28	Station 57	Unit failure, reduced hours. Sample volume acceptable.

TABLE 5-2

1996 SAMPLE DEVIATIONS

SAMPLE MEDIA	DATE	LOCATION	PROBLEM
Air Particulate/Iodine	10/28 - 11/04	Station 9	Power outage, reduced hours. Sample volume acceptable.
	11/18 - 11/25	Station 5	Unit failure, reduced hours. Sample volume unacceptable.
	11/18 - 11/25	Station 7	Unit failure, reduced hours. Sample volume unacceptable.
	11/18 - 11/25	Station 48	Unit failure, reduced hours. Sample volume unacceptable.
	11/25 - 12/02	Station 5	Unit unavailable, No sample.
	11/25 - 12/02	Station 7	Power outage, reduced hours. Sample volume acceptable.
	11/25 - 12/02	Station 48	Unit unavailable, No sample.
	12/02 - 12/09	Station 5	Unit placed in field late due to snow. Sample volume unacceptable.
	12/02 - 12/09	Station 48	Unit placed in field late due to snow. Sample volume unacceptable.
	12/23 - 12/30	Station 1	No sample, unable to reach station due to snow conditions.
	12/23 - 12/30	Station 57	No sample, unable to reach station due to snow conditions.
Water	R-11 Outage	Station 27	Timed Mode for Plant Outage Work.
Sediment	04/96	Station 33, Station 34	No spring sample due to extreme high water conditions.
Soil	12/31	ST101	No sample due to weather conditions.
Fruits and Vegetables	05/21	Station 9C, Station 37	No fruits or root vegetables available, leafy vegetable collected.
Milk	06/11	Station 36, Station 64, Station 96	Samples lost in shipment.

TABLE 5-3

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1996

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Air Particulates (pCi/m3)	Gross Beta 618	0.003	0.017(563/566) (0.003-0.075)	23 3.0 mi ESE	0.018(52/52) (0.005-0.070)	0.015(51/52) (0.004-0.061)	0
	Gamma (Quarterly) 48						
	Be-7	0.01	0.124(44/44) (0.072-0.200)	23 3.0 mi ESE	0.146(4/4) (0.096-0.200)	0.131(4/4) (0.089-0.173)	0
	K-40	0.01	0.007(5/44) (0.004-0.012)	4 9.3 mi SSE	0.012(1/4)	0.005(1/4)	0
Air Iodine (pCi/m3)	I-131 619	0.01	-(0/567)			-(0/52)	0
Soil (pCi/kg dry)	Gamma 5						
	K-40	700	13475(4/4) (12600-14900)	01 1.3 mi S	14900(1/1)	11600(1/1)	0
	Cs-137	40	74.9(4/4) (23.6-162)	01 1.3 mi S	162(1/1)	64(/1)	0
	Ra-226	400	803(4/4) (615-1010)	07 2.7 mi WNW	1010(1/1)	903(1/1)	0
	Th-228	50	544(4/4) (430-596)	09 30.0 mi WSW	601(1/1)	601(1/1)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1996

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)		All Indicator Locations Mean (Ratio) (Range) [a]	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Water (River/Drinking) (pCi/liter)	Gross Beta	36	4	1.73(20/24) (1.1-4.8)	29 7.4 mi SSE	1.85(10/12) (1.1-4.8)	1.61(11/12) (0.82-2.4)	0
	Tritium	12	200	-(0/8)			-(0/4)	0
	Gamma	36						
	K-40		200	-(0/24)			-(0/12)	0
Water (Discharge) (pCi/liter)	Gross Beta	12	12	16.2(6/12) (13-23)	27 3.2 mi E	16.2(6/12) (13-23)	-(0/0)	0
	Tritium	4	200	2150(3/4) (850-4100)	27 3.2 mi E	2150(3/4) (850-4100)	-(0/0)	0
	Gamma	12						
	Co-60		10	-(0/12)			-(0/0)	0
	Cs-137		10	-(0/12)			-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contr[illegible]Ds. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1996

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Water (Ground) (pCi/liter)	Tritium 12	200	-(0/12)			-(0/0)	0
	Gamma 12						
	K-40		-(0/12)			-(0/0)	0
Sediment (pCi/kg dry)	Gamma 2						
	K-40	700	14600(1/1)	33 3.6 mi ENE	15300(1/1)	15300(1/1)	0
	Co-60	30	-(0/1)			-(0/1)	0
	Cs-137	40	269(1/1)	34 3.5 mi ESE	269(1/1)	60.8(1/1)	0
	Ra-226	400	1010(1/1)	33 3.6 mi ENE	1360(1/1)	1360(1/1)	0
	Th-228	50	573(1/1)	33 3.6 mi ENE	1160(1/1)	1160(1/1)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1996

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (b) (LLD)	ALL INDICATOR LOCATIONS MEAN (RATIO) [a] (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RATIO)[a] (RANGE)	CONTROL LOCATION MEAN (RATIO) [a] (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Fish (pCi/kg wet)	Gamma 6						
	K-40	1000	3940(3/3) (3870-4000)	30 3.3 mi E	3940(3/3) (3870-4000)	3243(3/3) (2720-3560)	0
Milk (pCi/liter)	I-131 69	1	-(0/52)			-(0/17)	0
	Gamma 69						
	K-40	200	1377(52/52) (1130-1530)	64 9.7 MI ESE	1443(17/17) (1330-1520)	1400(17/17) (1250-1670)	0
Roots (pCi/kg wet)	Gamma 8		-(0/4)			-(0/4)	0
Fruits (pCi/kg wet)	Gamma 9		-(0/5)			-(0/4)	0
Vegetables (pCi/kg wet)	Gamma 10		-(0/5)			-(0/5)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Conservative LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1996

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) (a) (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio (a) (Range)	Control Location MEAN (RATIO) (a) (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Water Station 101 (pCi/liter)	Gr-Beta 38		4.20(23/38) (2.8-5.0)	101 0.1 mi ENE	4.20(23/38) (2.8-5.0)	-(0/0)	0
	Tritium 38	200	577(15/38) (180-1400)	101 0.3 mi ENE	577(15/38) (180-1400)	-(0/0)	0
	Gamma 38						
	K-40	200	-(0/38)			-(0/0)	0
	Cs-137	10	-(0/38)			-(0/0)	0
	Th-228	10	-(0/38)			-(0/0)	0
Storm Drain Water Station 101E (pCi/liter)	Gr-Beta 7		3.19(7/7) (1.7-5.3)	101 0.3 mi ENE	3.19(7/7) (1.7-5.3)	-(0/0)	0
	Tritium 7	200	1033(3/7) (500-1500)	101 0.3 mi ENE	1033(3/7) (500-1500)	-(0/0)	0
	Gamma 7		-(0/7)			-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1996

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (b) (LLD)	ALL INDICATOR LOCATIONS MEAN (RATIO) [a] (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RATIO)[a] (RANGE)	CONTROL LOCATION MEAN (RATIO) [a] (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
St 119 Direct RadiationTLD Quarterly TLD's (mR/day)	8	-	0.26(4/4) (0.24-0.28)	119 50.1 mi SSE	0.26(4/4) (0.24-0.28)	0.26(4/4) (0.24-0.29)	0
St 119 Direct RadiationTLD Annual TLD's (mR/day)	2	-	0.30(1/1)	119 0.1 mi SSE	0.30(1/1)	0.28(1/1)	0
St 120 Direct RadiationTLD Quarterly TLD's (mR/day)	12	-	0.26(8/8) (0.22-0.32)	120W 0.1 mi S	0.27(4/4) (0.22-0.32)	0.25(4/4) (0.23-0.26)	0
St 120 Direct RadiationTLD Annual TLD's (mR/day)	3	-	0.32(2/2) (0.31-0.33)	120W 0.1 mi S	0.33(1/1)	0.29(1/1)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Con[illegible]LDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1996

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Sediment Station 101-Outfall (pCi/kg)	Gamma	7					
	K-40	700	11129(7/7) (8850-15800)	101 0.3 mi ENE	11129(7/7) (8850-15800)	-(0/0)	0
	Mn-54	40	14.3(1/7)	101 0.3 mi ENE	14.3(1/7)	-(0/0)	0
	Co-60	30	306(7/7) (55.6-1050)	101 0.3 mi ENE	306(7/7) (55.6-1050)	-(0/0)	0
	Zn-65	100	-(0/7)			-(0/0)	0
	Cs-137	40	36.2(6/7) (13.9-84)	101 0.3 mi ENE	36.2(6/7) (13.9-84)	-(0/0)	0
	Ra-226	400	1028(7/7) (804-1520)	101 0.3 mi ENE	1028(7/7) (804-1520)	-(0/0)	0
	Th-228	50	529(7/7) (467-692)	101 0.3 mi ENE	529(7/7) (467-692)	-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1996

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio[a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Sediment Station 101C-Pond (pCi/kg)	Gamma	7					
	K-40	700	14681(7/7) (13550-15200)	101 0.3 mi ENE	14681(7/7) (13550-15200)	-(0/0)	0
	Mn-54	40	-(0/7)			-(0/0)	0
	Co-60	30	525(7/7) (184-1100)	101 0.3 mi ENE	525(7/7) (184-1100)	-(0/0)	0
	Zn-65	30	-(0/7)			-(0/0)	0
	Cs-137	40	105(7/7) (42.1-247)	101 0.3 mi ENE	105(7/7) (42.1-247)	-(0/0)	0
	Ra-226	400	1397(7/7) (1100-1690)	101 0.3 mi ENE	1397(7/7) (1100-1690)	-(0/0)	0
	Th-228	50	684(7/7) (618-777)	101 0.3 mi ENE	684(7/7) (618-777)	-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Co[redacted] LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1996

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) (a) (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio (a) (Range)	Control Location MEAN (RATIO) (a) (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Vegetation (pCi/kg wet)	Gamma	1					
	Be-7	-	807(1/1)	101 0.3 mi ENE	807(1/1)	-(0/0)	0
	K-40	-	6550(1/1)	101 0.3 mi ENE	6550(1/1)	-(0/0)	0
Sanitary Waste Treatment Facility Water (pCi/l)	Gross Alpha	4	-(0/2)			-(0/0)	0
	Gross Beta	15 1	30.5(15/15) (5.9-53)	102C 0.3 mi ENE	41(4/4) (28-53)	-(0/0)	0
	Tritium	18 200	-(0/18)			-(0/0)	0
	Gamma	18					
	K-40	200	55.8(1/18)	102B 0.3 mi ENE	55.8(1/18)	-(0/0)	0
Sanitary Waste Treatment Facility Sediment (pCi/kg)	Gamma	2					
	K-40	700	12885(2/2) (9960-15810)	102 0.3 mi ENE	12885(2/2) (9960-15810)	-(0/0)	0
	Co-60	30	394(2/2) (172-617)	102 0.3 mi ENE	394(2/2) (172-617)	-(0/0)	0
	Cs-137	40	155(2/2) (104-206)	102 0.3 mi ENE	155(2/2) (104-206)	-(0/0)	0
	Ra-226	400	1454(2/2) (1011-1900)	102 0.3 mi ENE	1454(2/2) (1011-1900)	-(0/0)	0
	Th-228	50	600(2/2) (470-729)	102 0.3 mi ENE	600(2/2) (470-729)	-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1996

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Soil (pCi/kg)							
	Gamma	6					
	K-40	700	14820(6/6) (13530-16110)	101 0.3 mi ENE	14820(6/6) (13530-16110)	-(0/0)	0
	Cs-137	40	37.5(6/6) (18.1-55.5)	101 0.3 mi ENE	37.5(6/6) (18.1-55.5)	-(0/0)	0
	Ra-226	400	798(6/6) (677-969)	101 0.3 mi ENE	798(6/6) (677-969)	-(0/0)	0
	Th-228	50	531(6/6) (450-636)	101 0.3 mi ENE	531(6/6) (450-636)	-(0/0)	0
Station 118 Soil (pCi/kg dry)							
	Gamma	2					
	K-40	700	12195(2/2) (11600-12800)	118 0.3 mi S	12195(2/2) (11600-12800)	-(0/0)	0
	Ra-226	40	815(2/2) (807-823)	118 0.3 mi S	815(2/2) (807-823)	-(0/0)	0
	Th-228	50	521(2/2) (504-538)	118 0.3 mi S	521(2/2) (504-538)	-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Co[illegible]LDs. Actual LLDs may be lower for specific samples.

TABLE 5-4

MEAN QUARTERLY TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1995 OPERATIONAL		1996 OPERATIONAL	
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD ERROR
1	0.24	0.02	0.25	0.01	0.25	0.01
2	0.23	0.02	0.25	0.01	0.24	0.01
3	0.22	0.01	0.24	0.01	0.23	0.01
4	0.22	0.02	0.23	0.01	0.21	0.01
5	0.23	0.01	0.23	0.01	0.22	0.01
6	0.22	0.01	0.23	0.01	0.22	0.01
7	0.23	0.01	0.24	0.01	0.23	0.02
8	0.26	0.01	0.27	0.01	0.25	0.01
9	0.22	0.01	0.23	0.01	0.21	0.03
10	0.23	0.01	0.24	0.01	0.23	0.02
11	0.24	0.01	0.24	0.01	0.24	0.01
12	0.25	0.01	0.26	0.01	0.25	0.01
13	0.24	0.01	0.25	0.01	0.24	0.01
14	0.24	0.02	0.25	0.00	0.24	0.02
15	0.25	0.01	0.26	0.01	0.25	0.02
16	0.24	0.01	0.25	0.01	0.25	0.02
17	0.25	0.01	0.25	0.01	0.25	0.02
18	0.24	0.01	0.25	0.01	0.24	0.02
19	0.24	0.01	0.25	0.01	0.25	0.01
20	0.24	0.01	0.25	0.01	0.25	0.01
21	0.23	0.01	0.23	0.00	0.23	0.01
22	0.24	0.01	0.25	0.01	0.24	0.02
23	0.24	0.01	0.24	0.01	0.23	0.02
24	0.24	0.01	0.25	0.01	0.24	0.02
25	0.25	0.01	0.26	0.01	0.25	0.02
40	0.22	0.01	0.23	0.01	0.22	0.01
41	0.26	0.02	0.26	0.01	0.25	0.02
42	0.25	0.01	0.25	0.01	0.26	0.02
43	0.25	0.01	0.26	0.01	0.26	0.02
44	0.23	0.01	0.24	0.01	0.23	0.01
45	0.23	0.01	0.24	0.01	0.24	0.02
46	0.29	0.02	0.30	0.01	0.29	0.02
47	0.22	0.02	0.23	0.01	0.23	0.02
49	0.24	0.00	0.25	0.01	0.24	0.02
50	0.22	0.00	0.25	0.01	0.24	0.01
51	0.23	0.01	0.24	0.01	0.23	0.01

(a) This preoperational mean is for the 1982-1983 data only.

TABLE 5-4 (Cont.)

MEAN QUARTERLY TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1995 OPERATIONAL		1996 OPERATIONAL	
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD ERROR
53	0.27	0.00	0.27	0.01	0.26	0.02
54	0.26	0.00	0.26	0.01	0.25	0.01
55	0.23	0.00	0.24	0.01	0.24	0.01
56	0.24	0.00	0.25	0.01	0.24	0.01
61	(b)		0.27	0.01	(b)	
71(1S)	0.24	0.02	0.28	0.01	0.27	0.03
72(2S)	0.25	0.01	0.27	0.01	0.26	0.02
73(3S)	0.23	0.01	0.24	0.01	0.24	0.02
74(4S)	0.26	0.01	0.27	0.01	0.25	0.01
75(5S)	0.22	0.02	0.25	0.01	0.25	0.01
76(6S)	0.24	0.01	0.25	0.01	0.25	0.02
77(7S)	0.25	0.01	0.25	0.01	0.24	0.02
78(8S)	0.25	0.01	0.25	0.01	0.24	0.01
79(9S)	0.25	0.01	0.25	0.01	0.24	0.01
80(10S)	0.24	0.01	0.24	0.01	0.24	0.01
81(11S)	0.24	0.02	0.25	0.00	0.24	0.01
82(12S)	0.26	0.02	0.26	0.01	0.24	0.01
83(13S)	0.25	0.01	0.26	0.01	0.25	0.01
84(14S)	0.24	0.01	0.25	0.01	0.25	0.01
85(15S)	0.26	0.02	0.27	0.01	0.25	0.01
86(16S)	0.25	0.01	0.28	0.01	0.27	0.03
119B	(c)		0.26	0.00	0.26	0.02
119Ctrl	(c)		0.27	0.00	0.26	0.02
120East	(c)		0.34	0.00	0.26	0.04
120West	(c)		0.34	0.00	0.27	0.04
120Ctrl	(c)		0.26	0.00	0.25	0.02
All	0.24	0.00	0.25	0.00	0.24	0.00

(a) This preoperational mean is for 1982-1983 data only.
(b) Station 61 was added in 1989 and discontinued in 1992.
(c) Stations 119B, 119Ctrl, 120East, 120West and 120Ctrl added in 1995.

TABLE 5-5

ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1995 OPERATIONAL		1996 OPERATIONAL
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	RESULT
1	0.23	0.04	0.24	0.01	0.28
2	0.22	0.04	0.23	0.01	0.27
3	0.21	0.04	0.22	0.01	0.26
4	0.22	0.06	0.21	0.01	0.24
5	0.22	0.04	0.21	0.01	0.24
6	0.21	0.04	0.21	0.01	0.25
7	0.22	0.02	0.23[b]	0.01	0.27
8	0.25	0.04	0.25[b]	0.01	0.30
9	0.20	0.02	0.21	0.01	0.25
10	0.22	0.04	0.22	0.01	[e]
11	0.22	0.04	0.23	0.01	0.27
12	0.24	0.04	0.24	0.01	[e]
13	0.22	0.04	0.23	0.01	0.27
14	0.22	0.04	0.23	0.01	0.27
15	0.23	0.06	0.24	0.01	0.29
16	0.23	0.04	0.24	0.01	0.28
17	0.23	0.02	0.24[b]	0.01	0.28
18	0.25	0.02	0.23	0.01	0.28
19	0.22	0.04	0.23	0.01	0.29
20	0.23	0.04	0.23	0.01	0.28
21	0.23	0.02	0.21	0.01	0.25
22	0.22	0.02	0.23	0.01	0.27
23	0.24	0.02	0.23	0.01	0.26
24	0.22	0.02	0.23	0.01	0.27
25	0.24	0.02	0.24	0.01	0.28
40	0.21(c)	0.02	0.21	0.01	0.24
41	0.26(c)	0.04	0.24	0.01	0.28
42	0.24(c)	0.02	0.23	0.01	0.29
43	0.24(c)	0.02	0.25	0.01	0.30
44	0.24	0.02	0.22	0.01	0.26
45	0.24	0.01	0.23	0.01	0.26
46	0.29	0.01	0.28	0.01	0.34
47	0.22(c)	0.03	0.22	0.01	0.26
49	(d)		0.23	0.01	0.28

(a) This preoperational mean is for 1982 - 1983 data only.
(b) 1985 TLD missing.
(c) There was only one annual exchange during the preoperational period.
(d) Stations 49-56 were first monitored during Fourth Quarter 1983. Station 61 was added in 1989 and discontinued in 1992.
(e) TLD missing.

TABLE 5-5 (Cont.)

ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1995 OPERATIONAL		1996 OPERATIONAL
STATION	MEAN[c]	STANDARD ERROR	MEAN	STANDARD ERROR	RESULT
50	(d)		0.23	0.01	0.27
51	(d)		0.22	0.01	0.27
53	(d)		0.25	0.01	0.28
54	(d)		0.24	0.01	0.27
55	(d)		0.22	0.01	0.26
56	(d)		0.23	0.01	0.28
61	(d)		0.26[d]	0.01	(e)
71 (1S)	0.24[c]	0.02	0.26	0.01	0.31
72 (2S)	0.25[c]	0.02	0.26	0.01	0.30
73 (3S)	0.23[c]	0.01	0.22	0.01	0.26
74 (4S)	0.24[c]	0.01	0.25	0.01	0.29
75(5S)	0.24[c]	0.01	0.23	0.01	0.28
76(6S)	0.24[c]	0.02	0.23	0.01	0.28
77 (7S)	0.25[c]	0.02	0.23	0.01	0.27
78 (8S)	0.25[c]	0.04	0.23	0.01	0.27
79 (9S)	0.25[c]	0.02	0.23	0.01	0.28
80 (10S)	0.23[c]	0.05	0.22	0.01	0.27
81 (11S)	0.23[c]	0.02	0.23	0.01	0.26
82 (12S)	0.25[c]	0.03	0.24	0.01	0.28
83 (13S)	0.25[c]	0.02	0.24	0.01	0.27
84 (14S)	0.23[c]	0.02	0.23	0.01	0.27
85 (15S)	0.26[c]	0.02	0.25	0.01	0.29
86 (16S)	0.24[c]	0.02	0.27	0.01	0.31
119B					0.30
119Ctrl					0.28
120East					0.31
120West					0.33
120Ctrl					0.29
All	0.23	0.02	0.23	0.00	0.26

(a) This preoperational mean is for 1982 - 1983 data only.
(b) 1985 TLD missing.
(c) There was only one annual exchange during the preoperational period.
(d) Stations 49-56 were first monitored during Fourth Quarter 1983. Station 61 was added in 1989.
(e) Station 61 discontinued on June 29, 1992

TABLE 5-6

1996 MEAN QUARTERLY VERSUS ANNUAL TLD DATA
Results in mR/day

	1984-95 TLDs			1996 TLDs		
STATION	QUARTERLY MEAN[a]	ANNUAL MEAN	RATIO[b]	QUARTERLY MEAN[a]	ANNUAL RESULTS	RATIO[b]
1	0.25	0.23	1.07	0.25	0.28	0.89
2	0.25	0.23	1.08	0.24	0.27	0.89
3	0.24	0.22	1.10	0.23	0.26	0.90
4	0.23	0.21	1.09	0.21	0.24	0.87
5	0.23	0.21	1.09	0.22	0.24	0.91
6	0.23	0.21	1.09	0.22	0.25	0.87
7	0.24	0.23	1.07	0.23	0.27	0.87
8	0.27	0.25	1.06	0.25	0.30	0.85
9	0.23	0.21	1.09	0.21	0.25	0.85
10	0.24	0.22	1.09	0.23	(c)	
11	0.24	0.23	1.08	0.24	0.27	0.87
12	0.26	0.24	1.08	0.25	(c)	
13	0.25	0.23	1.08	0.24	0.27	0.89
14	0.25	0.23	1.09	0.24	0.27	0.89
15	0.26	0.24	1.08	0.25	0.29	0.86
16	0.25	0.24	1.08	0.25	0.28	0.89
17	0.25	0.24	1.07	0.25	0.28	0.89
18	0.25	0.23	1.07	0.24	0.28	0.86
19	0.25	0.23	1.09	0.25	0.29	0.86
20	0.25	0.23	1.08	0.25	0.28	0.88
21	0.23	0.21	1.08	0.23	0.25	0.92
22	0.25	0.23	1.08	0.24	0.27	0.89
23	0.24	0.23	1.08	0.23	0.26	0.89
24	0.25	0.23	1.08	0.24	0.27	0.88
25	0.26	0.24	1.07	0.25	0.28	0.91
40	0.23	0.21	1.09	0.22	0.24	0.95
41	0.26	0.24	1.08	0.25	0.28	0.88
42	0.25	0.23	1.09	0.26	0.29	0.91
43	0.26	0.25	1.07	0.26	0.30	0.87
44	0.24	0.22	1.08	0.23	0.26	0.91
45	0.24	0.23	1.08	0.24	0.26	0.91
46	0.30	0.28	1.07	0.29	0.34	0.86
47	0.23	0.22	1.07	0.23	0.26	0.88
49	0.25	0.23	1.09	0.24	0.28	0.88
50	0.25	0.23	1.09	0.24	0.27	0.88

(a) Mean of the quarterly results.
(b) Quarterly result/Annual result
(c) TLD missing.

TABLE 5-6 (Cont.)

1996 MEAN QUARTERLY VERSUS ANNUAL TLD DATA
Results in mR/day

	1984-95 TLDs			1996 TLDs		
STATION	QUARTERLY MEAN[a]	ANNUAL MEAN	RATIO[b]	QUARTERLY MEAN[a]	ANNUAL RESULTS	RATIO[b]
51	0.24	0.22	1.09	0.23	0.27	0.86
53	0.27	0.25	1.07	0.26	0.28	0.90
54	0.26	0.24	1.07	0.25	0.27	0.91
55	0.24	0.23	1.08	0.24	0.26	0.91
56	0.25	0.23	1.08	0.24	0.28	0.87
61[c]	0.27	0.26	1.06			
71 (1S)	0.28	0.26	1.07	0.27	0.31	0.87
72 (2S)	0.27	0.26	1.06	0.26	0.30	0.86
73 (3S)	0.24	0.22	1.09	0.24	0.26	0.93
74 (4S)	0.27	0.25	1.09	0.25	0.29	0.87
75 (5S)	0.25	0.23	1.08	0.25	0.28	0.90
76 (6S)	0.25	0.23	1.07	0.25	0.28	0.90
77 (7S)	0.25	0.23	1.08	0.24	0.27	0.89
78 (8S)	0.25	0.23	1.07	0.24	0.27	0.89
79 (9S)	0.25	0.23	1.10	0.24	0.28	0.87
80 (10S)	0.24	0.22	1.09	0.24	0.27	0.89
81 (11S)	0.25	0.23	1.08	0.24	0.26	0.90
82 (12S)	0.26	0.24	1.07	0.24	0.28	0.87
83 (13S)	0.26	0.24	1.06	0.25	0.27	0.94
84 (14S)	0.25	0.23	1.08	0.25	0.27	0.91
85 (15S)	0.27	0.25	1.07	0.25	0.29	0.86
86 (16S)	0.28	0.27	1.06	0.27	0.31	0.88
119B	0.26			0.26	0.30	0.88
119Cntrl	0.27			0.26	0.28	0.94
120East	0.26			0.26	0.31	0.83
120West	0.34			0.27	0.33	0.81
120Cntrl	0.34			0.25	0.29	0.85
ALL	0.26	0.23	1.09	0.24	0.28	0.88

(a) Mean of the quarterly results.
(b) Quarterly result/Annual result.
(c) Station 61 was added in 1989 and discontinued in 1992.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

The REMP is designed to meet the quality assurance and quality control criteria of Regulatory Guide 4.15[4]. To accomplish this, the REMP requires that its analytical contractors meet these criteria also. In-depth audits are performed of the REMP records and activities and the records and activities of its support organizations at least annually by the Supply System Quality Assurance group.

Quality assurance and technical audits of the analytical contractor (Teledyne Brown Engineering) are also conducted periodically to verify their compliance to regulatory and contractual requirements. The adequacy of their quality assurance program is also assessed during the audits.

Intercomparison programs, which involve the comparison of Supply System analytical results for samples containing known concentrations of various radionuclides with the known values and with the results reported by other monitoring programs, are also a major component of the quality assurance activities of the REMP. The program participates in the Environmental Protection Agency (EPA) and Environmental Measurements Laboratory (EML) intercomparison programs. It also participates in local and regional intercomparison studies. The following sections summarize the quality assurance and quality control aspects of the TLD and analytical components of the REMP.

6.1 Quality Control For the Supply System Environmental TLD Program

The Quality Control Program includes the preparation, processing and evaluation of environmental TLDs. QA dosimeters, which are annealed just prior to being given a known exposure to cesium-137 gamma radiation or strontium-90 beta radiation and processed among the field dosimeters, serve as indicators that the readout, calibration and evaluation of the field dosimeters were properly performed. The number of QA dosimeters used during each processing is generally 10% of the number of field dosimeters. Since 1994, the same QA dosimeters have been used repeatedly throughout the year in order to track their sensitivity and to provide consistency from run to run.

If the mean QA dosimeter results are vary more than $\pm$ 5% (or 5 mR) from the given exposure, an investigation into the source of the discrepancy is initiated. Evaluation of the 1996 QA dosimeter results indicated only small biases for the four quarters.

Control dosimeters (trip controls) are used for each set of field dosimeters to monitor the contribution of the exposure received by the field TLDs while in transit. The radiation background in the storage area is also monitored by a separate set of control dosimeters (building controls). If the trip control results are significantly greater than the building control results, the difference between the two is subtracted from the field dosimeters.

Spiked dosimeters, which are exposed to known levels of radiation below the 100 mR given to the QA dosimeters, were processed with the field dosimeters during each run to verify the accuracy of the environmental TLD evaluations. All results were within $\pm$18 of the given exposure and are provided in Table 6-1. This may reflect differences in the anneal or readout techniques of the TLD vendor or in the manner of TLD irradiation.

6.2 Quality Control For the Analytical Program

Quality control for the analytical program involves two components: the quality control activities performed by the Supply System and the quality control program of the analytical contractor, Teledyne Brown Engineering. Both of these components are described in the following sections.

6.2.1 Supply System Quality Control Activities

The Supply System has participated in the U.S. Department of Energy's Environmental Measurements Laboratory (EML) Quality Assessment Program since 1987. In general, the Teledyne Brown results agreed with the EML values as seen in Table 6-2. The gross alpha in air result was the only analysis to receive a Not Acceptable rating.

Duplicate samples were also submitted to Teledyne Brown for analysis during 1996. These duplicates consisted of two sets of milk samples and one set of air filters from EML. The milk duplicates were marked Station 37 and were submitted for analysis at the same time as the milk samples from Station 36.

6.2.2 Teledyne Brown Engineering Quality Control Program

The goal of the quality control program at Teledyne Brown Engineering is to produce analytical results which are accurate, precise and supported by adequate documentation. The program is based on the requirements of 10CFR50, Appendix B, Regulatory Guide 4.15 and the implemented program, as described in Teledyne's Quality Assurance Manual IWL-0032-395 and Quality Control Manual IWL-0032-365.

All measuring equipment is calibrated for efficiency at least annually using standard reference material traceable to the National Institute of Standards and Technology (NIST). For alpha and beta counting, check sources are prepared and counted every day the counter is in use. Control charts are maintained with three-sigma limits specified. Backgrounds are usually measured at least once per week.

The gamma spectrometers are calibrated annually with a NIST-traceable standard reference material selected to cover the energy range of the nuclides to be monitored for all of the geometries measured. Backgrounds are determined every other week and check sources are counted weekly. The energy resolution and efficiency are plotted at two energy levels (59.5 and 1332 KeV) and held within three-sigma control limits.

The efficiency of the liquid scintillation counters is determined at least annually by counting a NIST traceable standards which have been diluted in a known amount of distilled water and various amounts of quenching agent. The background of each counter is measured with each batch of samples. A control chart is maintained for the background and check source measurements as a stability check.

Results are reviewed before being entered into the data system by the Quality Assurance and/or the Department Manager for reasonableness of the parameters (background, efficiency, decay, etc.). Any results which are suspect, being higher or lower than results in the past, are returned to the laboratory for recount. If a longer count, decay check, recount on another system or recalculation

does not give acceptable results based on experience, a new aliquot is analyzed. The complete information about the sample is contained on the worksheets accompanying the sample results.

Teledyne Brown also participates in the US EPA Interlaboratory Comparison Program to the fullest extent possible. That is, they participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability. Beginning with 1996, the US EPA discontinued providing milk and air particulate filter samples. Teledyne purchased comparable spiked samples from Analytics, Inc.

Table 6-5 presents the results of the 1996 intercomparison as reported to the Supply System. Footnotes in the table refer to investigations of problems encountered in a few cases and the steps taken by Teledyne Brown to prevent reoccurrence.

Iodine-131 Cartridges

A blank charcoal filter was analyzed with each group of samples assayed. Fifty-two blanks were analyzed in 1996. The average activity was -4.0 ± 9.8 E-01 total pCi. Activities were calculated without considering detection limits.

Gross-Beta - Filters

One blank filter was measured with each set of filters assayed. Fifty-two blanks were counted for 1996. The average activity 8.0 ± 1.4 E-01 total pCi, which indicated a relatively stable background for the filter and the gross beta proportional counters.

I-131 - Milk

A blank milk was analyzed with each group of samples assayed. The results showed that there was no contamination in the laboratory or counting area. The measurements of the blank samples indicated that there was no bias on the low background counters. The average activity for seventeen samples in 1996 was 1.0 ± 7.8 E-02 pCi/liter without considering detection limits. In addition fifty blanks were analyzed as part of the Teledyne Brown Engineering - Environmental Services' quality control program. The average result for 1996 was 5.1 ± 18.9 E-02 pCi/liter.

Sr-90 - Milk and Water

Fifty blank water samples were analyzed during 1996. The average result, without considering the detection limits, was 1.6 ± 1.8 E-01 pCi/liter. Fifty spiked water samples were analyzed during 1996. The average value of the samples was 3.6 ± 0.1 E+01 pCi/l compared with a spike level of 3.6 ± 0.6 E+01 pCi/l. During 1996, a total of twenty-four spiked milk samples were analyzed. The average value of the samples was 3.5 ± 0.2 E+01 pCi/liter compared to a spike value of 3.6 ± 0.6 E+01 pCi/l. These were within the limits as specified by the EPA Intercomparison Studies Program. Twenty-four blank milk samples were analyzed with an average activity of 7.0 ± 2.5 E-01 pCi/liter of Sr-90, which is the natural content of milk.

Gross Beta - Water

Fifty-two blanks were prepared from distilled water. The average result without considering detection limits was 1.3 ± 1.7 E-01 pCi/l. Fifty-two gross beta samples with a spike level of 2.1 ± 0.5 pCi/l were analyzed during 1996. The average result was 2.2 ± 0.2 E+01 pCi/l. The results were well within the guidelines outlined in Table 2 of the document, "Environmental Radioactivity Laboratory Intercomparison Studies Program," EPA-600/4-81-004.

Tritium in Water

Fifty-two blank samples were analyzed during 1996. The average result, without considering detection levels, was -1.4 ± 3.6 E+01 pCi/l. Fifty-two tritium samples with a spike level of 1.5 ± 0.5 E+03 pCi/l were analyzed by liquid scintillation counting during 1996. The average result was 1.4 ± 0.1 E+03 pCi/l.

Gamma Spectroscopy

A blank water sample was analyzed weekly in the gamma spectroscopy laboratory. All nuclides were less than the normal level of detection indicating no contamination. Spike samples were measured weekly using the Cs-137 peak at 662 KeV. The average activity of fifty-two measurements during 1996 was 2.1 ± 0.03 E+04 pCi/l as compared with a spike level of 2.2 ± 0.3 E+04 pCi/liter.

TABLE 6-1

1996 ENVIRONMENTAL SPIKED DOSIMETER RESULTS

DISTRIBUTION PERIOD	GIVEN EXPOSURE (mR)	REPORTED EXPOSURE (mR)	BIAS (%)
First Quarter	23.0	22.2	3.5
		22.6	1.7
		22.9	0.4
		22.7	1.3
Second Quarter	26.0	22.5	13.5
		21.4	17.7
		22.2	14.6
		21.9	15.8
Third Quarter	27.0	25.4	5.9
		25.6	5.2
		25.2	6.7
Fourth Quarter	24.0	27.6	15.0
		26.8	11.7
		27.2	13.3
		25.1	4.6
Annual	75.0	74.2	1.1
		73.9	1.5
		74.9	0.1
		73.8	1.6
		74.8	0.3
		76.1	1.5
		69.7	7.1

TABLE 6-2

1996 ENVIRONMENTAL MEASUREMENTS LABORATORY (EML)
QUALITY ASSESSMENT PROGRAM RESULTS

DATE	SAMPLE TYPE	NUCLIDE	REPORTED RESULT	ERROR	EML VALUE	RATIO REPORTED/EML
12/96	Air (Bq/filter)[a]	Mn-54	6.76E+00	0.310	6.35E+00	1.07
		Co-57	1.37E+01	0.170	1.48E+01	0.93
		Co-60	8.84E+00	0.390	8.64E+00	1.02
		Sb-125	9.63E+00	0.540	1.08E+01	0.89
		Cs-137	8.31E+00	0.320	8.52E+00	0.98
		Gr-α	5.60E-01	0.074	1.15E+00	0.49
		Gr-β	5.90E-01	0.037	5.00E-01	1.18
		Ru-106	1.04E+01	1.600	1.08E+01	0.96
		Sr-90	4.10E-01	0.037	5.60E-01	0.78
12/96	Soil (Bq/kg)	K-40	3.49E+02	31.000	3.00E+02	1.16
		Sr-90	7.00E+01	3.700	6.99E+01	1.00
		Co-60	3.00E+00	1.400	2.92E+00	1.03
		Cs-137	1.89E+03	18.000	1.55E+03	1.22
12/96	Vegetation (Bq/kg)	K-40	1.10E+03	57.000	9.92E+02	1.11
		Co-60	1.37E+01	3.300	1.09E+01	1.26
		Cs-137	2.06E+02	6.300	1.90E+02	1.08
		Sr-90	1.60E+03	37.000	1.39E+03	1.15
12/96	Water (Bq/l)	H-3	4.80E+02	37.000	5.87E+02	0.82
		Mn-54	6.38E+01	1.700	6.05E+01	1.05
		Co-60	6.45E+01	1.900	6.11E+01	1.06
		Sr-90	2.80E+00	0.150	2.71E+00	1.03
		Cs-137	9.57E+01	2.000	8.95E+01	1.07
		Gr-α	1.20E+03	74.000	1.21E+03	0.99
		Gr-β	4.10E+02	37.000	5.40E+02	0.76

[a] Bq = becquerel; the EML results are reported in becquerel instead of picocuries. One picocurie equals 0.037 becquerel.

TABLE 6-3

1996 TELEDYNE BROWN QUALITY CONTROL DATA - BLANKS

NUCLIDE	MEDIUM	NUMBER	AVERAGE RESULT	UNITS
I-131	MILK	17[a]	1.0 ± 7.8E-02	pCi/l
		50	5.1 ± 18.9E-02	pCi/l
Sr-90	Milk	24[d]	7.0 ± 2.5E-01	pCi/l
Sr-90	Water	50	1.6 ± 1.8E-01	pCi/l
H-3 (10 ml)	Water	52	-1.4 ± 3.6E+01	pCi/l
Gross Beta	Water	52	1.3 ± 1.7E-01	pCi/l
Gamma	Water	52	*	pCi/l
Gross Beta	AP Filter	52[c]	8.0 ± 1.4E-01	Total pCi
I-131	Charcoal	52[a]	-4.0 ± 9.8E-01	Total pCi

* All nuclides less than minimum detection level

(a) This average is calculated from the Supply System quality control samples without considering detection limits.

(b) The in-house weekly quality control blanks for AP filters and charcoals are calculated in total pCi.

(c) This average includes only the blank AP filters analyzed for the Supply System. A blank planchette (counter background) and a blank filter are counted with each set of filters analyzed (approximately 10 sets per week).

(d) This is the natural content in milk.

TABLE 6-4

1996 TELEDYNE BROWN QUALITY CONTROL DATA - SPIKES

NUCLIDE	MEDIUM	NUMBER	AVERAGE RESULT	SPIKE LEVEL
Gross Beta	Water	52	2.2 ± 0.2E+01	2.1 ± 0.5E+01
H-3 (10 ml)	Water	52	1.4 ± 0.1E+03	1.5 ± 0.5E+03
Sr-90	Water	50	3.6 ± 0.1E+01	3.6 ± 0.6E+01
Sr-90	Milk	24	3.5 ± 0.2E+01	3.6 ± 0.6 E+01
Gamma (Cs-137)	Water	52	2.1 ± 0.03E+04	2.2 ± 0.3E+04

TABLE 6-5

1996 EPA INTERCOMPARISON PROGRAM RESULTS

ISOTOPE	COLLECTION DATE	TI RESULTS[a]	EPA RESULTS[b]	OTHER LABS[c]
		MEDIUM - WATER (pCi/liter)		
Sr-89	01/23/96	73.67 ± 3.21	73.0 ± 5.0	70.58 ± 9.14
Sr-90	01/23/96	5.00 ± 0.00	5.0 ± 5.0	5.2 ± 1.73
Sr-89	04/16/96	41.33 ± 2.31	43.0 ± 5.0	41.09 ± 4.21
Sr-90	04/16/96	15.33 ± 0.58	16.0 ± 5.0	15.39 ± 2.49
Sr-89	07/12/96	22.67 ± 1.53	25.0 ± 5.0	23.88 ± 3.73
Sr-90	07/12/96	12.33 ± 1.15	12.0 ± 5.0	11.79 ± 2.47
Sr-89	10/15/96	9.00 ± 0.00	10.0 ± 5.0	10.36 ± 3.27
Sr-90	10/15/96	26.00 ± 1.00	25.0 ± 5.0	23.68 ± 3.17
Gr-Alpha	01/26/96	19.00 ± 1.00[d]	12.1 ± 5.0	11.90 ± 2.52
Gr-Beta	01/26/96	7.13 ± 0.21	7.0 ± 5.0	8.50 ± 1.94
Gr-Alpha	04/16/96	63.67 ± 2.89	74.8 ± 18.7	68.69 ± 12.02
Gr-Beta	04/16/96	160.00 ± 0.00	166.9 ± 25.0	158.64 ± 17.25
Gr-Alpha	07/19/96	22.67 ± 0.58	24.4 ± 6.1	19.67 ± 4.68
Gr-Beta	07/19/96	45.33 ± 2.08	44.8 ± 5.0	44.38 ± 5.65
Gr-Alpha	10/15/96	55.67 ± 5.03	59.1 ± 14.8	59.91 ± 11.14
Gr-Beta	10/15/96	110.0 ± 0.00	111.8 ± 16.8	107.72 ± 10.98
Gr-Alpha	10/25/96	9.03 ± 0.72	10.3 ± 5.0	8.86 ± 2.89
Gr-Beta	10/25/96	39.67 ± 0.58	34.6 ± 5.0	35.29 ± 4.47
I-131	02/02/96	71.67 ± 3.06	67.0 ± 7.0	68.53 ± 4.93
I-131	10/02/96	26.33 ± 2.31	27.0 ± 6.0	27.61 ± 3.08
Co-60	04/16/96	31.67 ± 1.15	31.0 ± 5.0	31.60 ± 2.10
Cs-134	04/16/96	42.33 ± 1.53	46.0 ± 5.0	43.10 ± 3.11
Cs-137	04/16/96	53.33 ± 1.53	50.0 ± 5.0	51.17 ± 3.31
Ra-226	04/16/96	3.40 ± 0.00	3.0 ± 0.5	3.02 ± 0.46
Ra-228	04/16/96	3.63 ± 0.61	5.0 ± 1.3	5.38 ± 1.15
Co-60	06/07/96	99.00 ± 1.73	99.0 ± 5.0	98.12 ± 5.59
Zn-65	06/07/96	309.33 ± 2.08	300.0 ± 30.0	309.37 ± 17.49
Cs-134	06/07/96	69.67 ± 1.53[e]	79.0 ± 5.0	72.92 ± 5.50
Cs-137	06/07/96	202.00 ± 2.65	197.0 ± 10.0	200.79 ± 10.03
Ba-133	06/07/96	711.00 ± 71.42	745.0 ± 75.0	720.13 ± 39.53
Ra-226	06/21/96	5.50 ± 0.26	4.9 ± 0.7	4.90 ± 0.64

TABLE 6-5

1996 EPA INTERCOMPARISON PROGRAM RESULTS

ISOTOPE	COLLECTION DATE	TI RESULTS[a]	EPA RESULTS[b]	OTHER LABS[c]
Ra-228	06/21/96	9.73 ± 0.46	9.0 ± 2.3	8.84 ± 1.51
Ra-226	09/27/96	14.00 ± 1.00	14.0 ± 2.1	13.64 ± 2.00
Ra-228	09/27/96	6.20 ± 0.50[f]	4.7 ± 1.2	4.92 ± 1.13
Ra-226	10/15/95	10.00 ± 0.00	9.9 ± 1.5	9.60 ± 1.21
Ra-228	10/15/96	5.74 ± 0.31	5.1 ± 1.3	5.40 ± 1.19
Co-60	10/15/96	14.67 ± 1.53	15.0 ± 5.0	15.24 ± 1.75
Cs-134	10/15/96	19.67 ± 1.15	20.0 ± 5.0	18.45 ± 1.75
Cs-137	10/15/96	29.33 ± 1.15	30.0 ± 5.0	30.50 ± 2.14
Co-60	11/08/96	44.67 ± 0.58	44.0 ± 5.0	44.53 ± 2.87
Zn-65	11/08/96	38.67 ± 0.58	35.0 ± 5.0	36.08 ± 5.45
Cs-134	11/08/96	12.00 ± 0.00	11.0 ± 5.0	10.62 ± 1.55
Cs-137	11/08/96	20.67 ± 1.15	19.0 ± 5.0	20.36 ± 1.93
Ba-133	11/08/96	56.67 ± 3.21[g]	64.0 ± 6.0	61.39 ± 3.70
Ra-226	12/06/96	20.33 ± 0.58	20.1 ± 3.0	19.25 ± 1.80
Ra-228	12/06/96	10.33 ± 0.58	10.2 ± 2.6	10.10 ± 1.18
H-3	03/08/96	22000.00 ± 0.00	22002.0 ± 2200.0	21573.18 ± 1274.81
H-3	08/09/96	9800.00 ± 346.41	10879.0 ± 1088.0	10590.90 ± 721.5

Footnotes:

(a) Teledyne Results - Average ± one sigma. Units are pCi/liter.

(b) EPA Results - Expected laboratory precision (±1 sigma). Units are pCi/liter.

(c) Average concentration ± one sigma, based on range of values encountered from other participating labs.

(d) The variation was due to self-absorption properties of the EPA sample matrix. On future EPA water samples of this type, Teledyne will detemine the overall alpha counting efficiency by spiking the matrix with Th-230 in accordance with their recent advisory.

(e) To verify the cause for the deviation, a Cs-134 standard has been purchased. If the Cs-134 efficiency is lower than the efficiency at 604 KeV, then rather than change those efficiencies (which may be needed for other isotopes of comparable energies), the Cs-134 branching intensity shall be adjusted.

(f) Erroneously low cerium yields were obtained in back-extraction from HDEHP. Greater care to be taken during back-extraction. If this operation is incomplete, the cerium carrier yield becomes lower than the Ac-228 yield. The proceddure had been revised to require additional back-extractions for longer periods of time to ensure that proper cerium yields are obtained. The procedure is under review to determine if additional back-extractions are required.

(g) An investigation is being conducted of the Teledyne result.

TABLE 6-6

1996 ANALYTICS CROSS CHECK COMPARISON PROGRAM

SAMPLE ID	MEDIA	NUCLIDE	TI RESULT[a]	ANALYTICS RESULT	RATIO[b]
EO633-396 TI #11912 03/12/96	Water	I-131	39.0 ± 5.0	36.0 ± 2.0	1.08
		Ce-141	89.0 ± 9.0	88.0 ± 4.0	1.01
		Cr-51	330.0 ± 30	322.0 ± 16.0	1.02
		Cs-134	53.0 ± 5.0	58.0 ± 3.0	0.91
		Cs-137	65.0 ± 7.0	64.0 ± 3.0	1.02
		Co-58	49.0 ± 5.0	48.0 ± 2.0	1.02
		Mn-54	37.0 ± 4.0	31.0 ± 2.0	1.19
		Fe-59	93.0 ± 9.0	83.0 ± 4.0	1.12
		Zn-65	100.0 ± 10.0	97.0 ± 5.0	1.03
		Co-60	81.0 ± 8.0	76.0 ± 4.0	1.07
E0635-396 TI #11914 03/12/96	Milk	I-131	16.0 ± 6.0	13.0 ± 1.0	1.23
		Ce-141	240.0 ± 20.0	234.0 ± 12.0	1.03
		Cr-51	880.0 ± 90.0	858.0 ± 43.0	1.03
		Cs-134	150.0 ± 20.0	154.0 ± 8.0	0.97
		Cs-137	180.0 ± 20.0	170.0 ± 9.0	1.06
		Co-58	140.0 ± 10.0	128.0 ± 6.0	1.09
		Mn-54	93.0 ± 9.0	84.0 ± 4.0	1.11
		Fe-59	250.0 ± 30.0	223.0 ± 11.0	1.12
		Zn-65	260.0 ± 30.0	260.0 ± 13.0	1.00
		Co-60	220.0 ± 20.0	204.0 ± 10.0	1.08
E0632-396 TI #11911 03/12/96	Water	Sr-89	30.0 ± 4.0	24.0 ± 1.0	1.25
		Sr-90	23.0 ± 2.0	21.0 ± 1.0	1.10
E0634-396 TI #11914 03/12/96	Milk	Sr-89	30.0 ± 4.0	31.0 ± 2.0	0.97
		Sr-90	17.0 ± 1.0	16.0 ± 1.0	1.06
E0636-396 TI #11913 03/12/96	Water	H-3	2800.0 ± 200	2982.0 ± 149	0.94
E0746-396 TI #19220 06/19/96	Air Filter	Gross Alpha	37.0 ± 3.0	35.0 ± 2.0	1.06
		Gross Beta	150.0 ± 10	144.0 ± 7.0	1.04

TABLE 6-6

1996 ANALYTICS CROSS CHECK COMPARISON PROGRAM

SAMPLE ID	MEDIA	NUCLIDE	TI RESULT[a]	ANALYTICS RESULT	RATIO[b]
E0747-396 TI #19221 06/19/96	Air Filter	Ce-141	500.0 ± 50.0	400.0 ± 20.0	1.25
		Cr-51	1200.0 ± 100.0	1048.0 ± 52.0	1.15
		Cs-134	310.0 ± 30.0	310.0 ± 16.0	1.00
		Cs-137	910.0 ± 90.0	764.0 ± 38.0	1.19
		Co-58	210.0 ± 20.0	173.0 ± 9.0	1.21
		Mn-54	690.0 ± 70.0	559.0 ± 28.0	1.23
		Fe-59	190.0 ± 20.0	144.0 ± 7.0	1.32
		Zn-65	140.0 ± 10.0	108.0 ± 5.0	1.30
		Co-60	180.0 ± 20.0	156.0 ± 8.0	1.15
E0748-396 TI #19222 06/19/96	Air Filter	Sr-90	71.0 ± 3.0	74.0 ± 4.0	0.96
E074-396 TI #19223 06/19/96	Air Filter	Sr-90	46.0 ± 3.0	49.0 ± 2.0	0.94
E0750-396 TI #19224 06/19/96	Air Filter	Sr-90	66.0 ± 4.0	63.0 ± 3.0	1.05

Footnotes:

(a) Teledyne Results - counting error is two standard deviations. Units are pCi/liter for water and milk. For gamma results, if two standard deviations are less than 10%, then a 10% error is reported. Units are total pCi for air particulate filters.

(b) Ratio of Teledyne Brown Engineering to Analytics results.

7.0 REFERENCES

1. U.S. Nuclear Regulatory Commission, "Programs For Monitoring Radioactivity in the Environs of Nuclear Power Plants," Regulatory Guide 4.1, Revision 1, April 1975.

2. U.S. Nuclear Regulatory Commission, "Environmental Technical Specifications For Nuclear Power Plants," Regulatory Guide 4.8, December 1975.

3. U.S. Nuclear Regulatory Commission, "An Acceptable Radiological Environmental Monitoring Program," Assessment Branch Technical Position Revision 1, November 1979.

4. U.S. Nuclear Regulatory Commission, "Quality Assurance For Radiological Environmental Monitoring Program (Normal Operations), Effluent Streams and the Environment," Regulatory Guide 4.15, Revision 1, February 1979.

5. U.S. Nuclear Regulatory Commission, "Performance, Testing and Procedural Specifications For Thermoluminescence Dosimetry-Environmental Applications," Regulatory Guide 4.13, Revision 1, July 1977.

6. Energy Facility Site Evaluation Council, Resolution No. 260, January 1992.

7. Washington Public Power Supply System Nuclear Plant No. 2, Operating License NSF-21, Technical Specifications 3/4.12.1, Table 3.13.1.

8. WNP-2 Offsite Dose Calculation Manual (ODCM).

9. Code of Federal Regulations, Title 10 Part 20, "Standards For Protection Against Radiation."

10. Code of Federal Regulations, Title 10 Part 50, "Domestic Licensing of Production and Utilization Facilities."

11. Washington Administrative Code 246-290, "Group A Public Water Systems."

12. Washington Administrative Code 173-200, "Water Quality Standards for Ground Water of the State of Washington."

13. Washington Administrative Code 173-201A, "Water Quality Standards for Surface Waters of the State of Washington."

14. Robertson, D. E., and J. J. Fix, Association of Hanford Origin Radionuclides With Columbia River Sediment, BNWL-2305, August 1977.

15. Energy Facility Site Evaluation Council, Resolution 259, amended November 1994.

16. Energy Facility Site Evaluation Council, Resolution 278, approved May 8, 1995.

8.0 1995 REMP REPORT ERRATA

Corrections to errors found in the 1995 Radiological Environmental Monitoring Program Annual Report are listed below. Corrections to the Table 5-2 1995 Sample Deviations for air particulate/iodine are listed in Table 8-1.

Page 4-15, Table 4-2: NNW sector, Station 12 estimated distance in meters should be 4988.

Page 5-11, Section 5.9.3: The final two sentences in the last paragraph of the section should read as follows: "The first quarter composite had detectable cesium-137 and cobalt-60 at 10.2 pCi/kg and 14.6 pCi/kg, respectively. The isotopes were not detected in subsequent samples."

TABLE 8-1

1995 SAMPLE DEVIATIONS

SAMPLE MEDIA	DATE	LOCATION	PROBLEM
Air Particulate/Iodine	03/20 - 03/27	Station 57	Power outage, maintenance at Ashe Substation. Sample volume unacceptable.
	03/27 - 04/03	Station 57	Power outage, maintenance at Ashe Substation. Sample volume acceptable.
	04/03 - 04/10	Station 48	Power outage. Sample volume unacceptable.
	04/10 - 04/17	Station 48	Power outage. Sample volume unacceptable.
	05/15 - 05/22	Station 1	Power outage due to R-10. Sample volume acceptable.
	05/15 - 05/22	Station 21	Power outage due to R-10. Sample volume acceptable.
	05/22 - 05/30	Station 1	Power outage due to R-10. Sample volume unacceptable.
	05/30 - 06/05	Station 8	Unit failure. Sample volume acceptable.
	06/12 - 06/19	Station 5	Unit failure. Sample volume unacceptabl
	06/26 - 07/03	Station 1	Unit failure. Sample volume acceptable.
	07/24 - 07/31	Station 1	Unit failure. Sample volume acceptable.
	09/11 - 09/18	Station 23	Power outage. Sample volume acceptable.
	10/30 - 11/06	Station 8	Unit failure. Sample volume unacceptable.
	10/30 - 11/06	Station 9	Unit failure. Sample volume unacceptable.
	11/13 - 11/20	Station 9	Unit failure. Sample volume acceptable.
	11/13 - 11/20	Station 21	Power outage. Sample volume unacceptable.
	12/12 - 12/18	Station 5	Blown fuse. Sample volume unacceptable.
	12/18 - 12/27	Station 5	Unit failure. Sample volume unacceptable.
	12/27 - 01/02	Station 40	Unit failure. Sample volume acceptable.

WASHINGTON PUBLIC POWER
SUPPLY SYSTEM

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

NUCLEAR PLANT 2

1995 ANNUAL REPORT

JANUARY 1 to DECEMBER 31, 1995

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Prepared by

Washington Public Power Supply System

and

Teledyne Brown Engineering Environmental Services

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1.0 EXECUTIVE SUMMARY

The Washington Public Power Supply System Radiological Environmental Monitoring Program (REMP) evaluates the radiological impact of Plant 2 operations on the environment in the **Airborne, Direct Radiation, Waterborne, and Ingestion** pathways as specified in the Offsite Dose Calculation Manual (ODCM). The Supply System's Plant 2 is a 1200 MW commercial nuclear power plant that achieved initial criticality on January 19, 1984.

Samples of air, water, milk, soil, sediment, fish and garden produce were collected throughout the year and analyzed for radionuclides specific to plant operations. Radiation levels were also monitored continuously during 1995 with thermoluminescent dosimeters (TLDs).

The samples were collected in established areas near the plant and at other locations which could be affected by Plant 2 effluents. This information was compared to samples taken in areas that were unlikely to be affected by plant operations. The 1995 REMP data was also compared to data collected during previous years of plant operation and also compared to the data collected prior to initial plant operation.

Most of the results of samples collected by the REMP during 1995 were below detection levels. Some analyses, such as gross beta in air and water, were above the detection level for nearly all samples. This is due to the low detection limit for the gross beta analysis and also to the abundance of naturally occurring beta-emitting radionuclides in the environment. Other results above detection levels, such as cesium-137 in soil and sediment, reflect the effect of past Hanford activities or fallout from Chernobyl and past nuclear weapons testing.

The REMP analytical results and TLD results were demonstrated to be accurate through intercomparison programs which are provided as part of the quality assurance activities conducted during 1995. Such intercomparisons tested the performance of the Supply System monitoring program to other monitoring programs using known radioactive standards. The Supply System REMP performed well in the Environmental Measurements Laboratory (EML) and Environmental Protection Agency Intercomparison Studies conducted during 1995.

The analytical data collected by the REMP in 1995 remained consistent with the environmental data collected during the preoperational period and the prior operational years. Based on the data, no significant new trends or changes in the environmental radiological levels around the plant were observed.

2.0 DEFINITIONS

Airborne Activity Sampling: Continuous sampling of air through the collection of particulates and radionuclides on filter media.

Periodic soil samples are collected for gamma isotopic analysis to provide information on deposition to the soil from airborne releases.

Alpha Particle (α): A charged particle emitted from the nucleus of an atom having a mass and charge equal in magnitude of a helium nucleus.

Becquerel (Bq): One disintegration per second. One picocurie (pCi) equals 0.037 becquerel.

Beta Particle (β): Charged particle emitted from the nucleus of an atom, with a mass and charge equal in magnitude to that of an electron.

Blank Sample: A sample of the same media as the field sample being analyzed but without the radionuclide(s) being measured. It enables correction for the inherent sample background.

Composite Sample: A series of single collected portions (aliquots) analyzed as one sample. The aliquots making up the sample are collected at time intervals that are very short compared to the composite period.

Control Station: A background sampling location. i.e., a location not likely to be affected by plant effluents due to its distance and/or direction from Plant 2.

Counting Error: An estimate of the two-sigma uncertainty associated with the sample results based respective count times.

$$+/- 2\sqrt{\left(\frac{Sample\ CPM}{Count\ Time} + \frac{Bkg\ Cpm}{Count\ Time}\right)}$$

Curie (Ci): 3.7×10^{10} disintegrations per second, or 2.22×10^{12} disintegrations per minute.

Direct Radiation Monitoring: The measurement of radiation dose at various distances from the plant is assessed through the use of thermoluminescent dosimeters and pressurized ionization chambers.

DOH: Washington State Department of Health.

EFSEC: Energy Facility Site Evaluation Council.

FFTF: U.S. Department of Energy's Fast Flux Test Facility near Plant 2.

Flow Proportional Sampling: Sample collection volume or frequency determined as a function of the flow rate of the water being sampled.

Grab Sample: A single discrete sample drawn at one point in time.

Indicator Station: A sampling location that could be affected by plant effluents due to its proximity and/or direction from Plant 2.

Ingestion Pathway Monitoring: The ingestion pathway includes milk, soil, fish, garden produce. Also sampled (under special circumstances) are other media such as vegetation and animal products such as eggs and meat when additional information about particular radionuclides is needed.

Lower Limit of Detection (LLD): The smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with a 5% probability of a false conclusion that a blank observation represents "real" signal.

$$LLD = \frac{4.66Sb}{(2.22 * Vol * Eff * Yield * e^{-\lambda t})}$$

where LLD is the "a priori" or 'before-the-fact' measurement and not "a posteriori" or 'after-the-fact' measurement.

Mean: The average, i.e., the sum of results divided by the number of results.

Microcurie: 3.7×10^{4} disintegrations per second, or 2.22×10^{6} disintegrations per minute.

Milliroentgen (mR): 1/1000 Roentgen; a unit of exposure to X- or gamma radiation.

NIST: National Institute of Standards and Technology.

NRC: U.S. Nuclear Regulatory Commission.

ODCM: Offsite Dose Calculation Manual, which contains the program requirements formerly contained in the Technical Specifications.

Picocurie (pCi): 1×10^{-12} Curie or 2.22 disintegrations per minute; one millionth of a microcurie.

REMP: Radiological Environmental Monitoring Program.

Range: The difference between the smallest and largest results.

Restricted Area: Any area to which access is controlled for purposes of protection of individuals from exposure to radiation and radioactive materials.

Results: The results of sample collection are discussed and interpreted by comparing them to similar measurements made during the preoperational and previous operational periods and to the detection capabilities associated with the current methods of analysis.

Roentgen: Unit of exposure to X- or gamma (γ) radiation in air.

Site Certification Agreement (SCA): The Plant 2 licensing agreement with the State of Washington.

Spike Sample: A sample containing a known concentration of the radionuclide(s) being measured.

Standard Deviation: A measure of the scatter of a set of observations (or samples) around their mean value. Indicated by (σ).

Standard Error of the Mean: An estimate of the uncertainty associated with the mean of observation (or sample) averages.

$$SE = \sqrt{\left(\frac{S^2}{n}\right)}$$

where S^2, the variance is

$$S_m^2 = \frac{1}{(n-1)} \sum^n (X_i - X)^2$$

SWTF: Sanitary Waste Treatment Facility; sanitary waste processing facility for Plant 2 and WNP-1 and WNP-4 sites.

TEDA: Triethylene diamine

TLD: A thermoluminescent dosimeter that contains a phosphor which stores energy from exposure to radiation and emits that energy in the form of light when heated.

3.0 INTRODUCTION

3.1 Site Description

The Washington Public Power Supply System's Nuclear Plant 2 is located in a sparsely populated shrub-steppe region within the Department of Energy's Hanford Site in southeastern Washington. The plant is approximately three miles west of the Columbia River and is surrounded on all sides by uninhabited desert land. The nearest population centers are Richland, Pasco and Kennewick, which are 12 miles south, 18 miles southeast, and 21 miles southeast, respectively. The nearest privately-owned lands are located approximately four miles ENE of the plant, across the Columbia River. Given the prevailing wind directions, shown in the 1995 wind frequency distribution in Figure 3-1, the focus of REMP sampling is the farming region east of the plant site.

Because Plant 2 is located on the Hanford Site, other potential sources of radioactive materials are in close proximity to Plant 2. For this reason, sampling locations near the plant provide useful information for separating the potential effects of Plant 2 from those of the other sources on the Hanford Site.

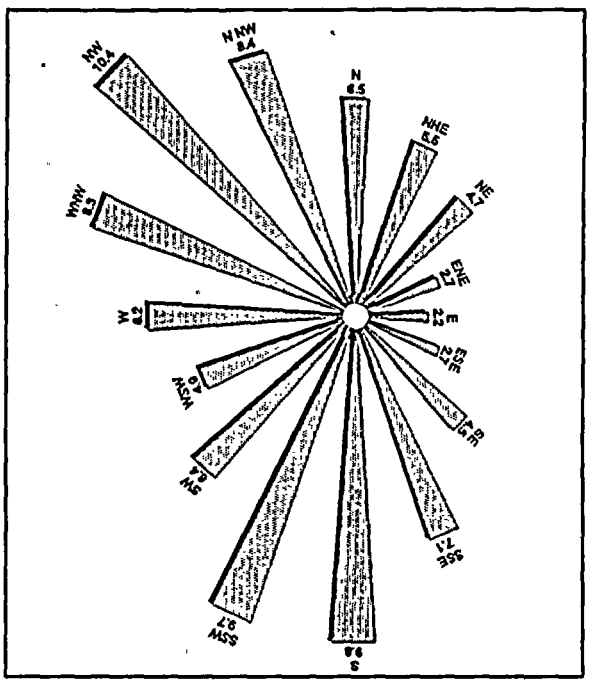

Figure 3-1 Average Wind Direction (percent) During 1995

3.2 Program Background

The REMP is designed to conform to the regulatory guidance of the Nuclear Regulatory Commission (NRC) as provided by Regulatory Guides. 4.1[1] and 4.8[2], including the Radiological Assessment Branch Technical Position[3].

The quality assurance aspects of the program and the thermoluminescent dosimetry are conducted in accordance with Regulatory Guides 4.15[4] and 4.13[5]. The REMP also must adhere to the requirements of the Washington Energy Facility Site Evaluation Council (EFSEC)[6], the Plant 2 Technical Specifications[7] and the Offsite Dose Calculation Manual (ODCM)[8]. These requirements cover not only the environmental sampling and sample analysis aspects of the program, but also the reporting and quality assurance requirements of the program.

The preoperational phase of the program, which lasted from March 1978 until initial criticality in January 1984, provided a baseline of background environmental data. The variability in the background levels of radioactivity due to differences in geologic composition, Chernobyl and nuclear weapons test fallout, meteorological conditions and seasonal changes.

REMP environmental samples are analyzed by a contract analytical laboratory. Since June 1986, Teledyne Brown Engineering Environmental Services (formerly Teledyne Isotopes, Inc.) in Westwood, New Jersey has performed the analysis of REMP samples. The thermoluminescent dosimeters used in the REMP to assess the direct radiation are processed by the Supply System.

Any radiological effect of Plant 2 on the environment must be distinguished from the normal variation in background radiation levels and from the effects of other sources of radioactive effluents in the area. The monitoring results obtained during each year of the plant's operation are compared to the preoperational data and to data from previous operating years, to determine whether a significant accumulation of plant-produced radionuclides has occurred in the environment.

Quarterly averages of the results are also compared to the NRC non-routine reporting levels listed in the ODCM. In addition to evaluating the environmental concentrations against federal standards or limits, the REMP also compares the results to state standards.[11][12][13] The results are discussed and interpreted by comparing them to similar measurements made during the preoperational and previous operational periods and to the detection capabilities associated with the current methods of analysis. The quality assurance and quality control aspects of the program are also discussed in this report.

3.3 Program Objectives

The REMP provides a mechanism for determining whether the levels of radioactivity in the plant environs are within established limits and to ensure that the accumulation of radionuclides in the environment will not become significant as a result of plant operations.

While in-plant monitoring programs are used to ensure that 10CFR20[9] and 10CFR50[10] criteria for releases of radioactive effluents are met, the REMP provides supplemental verification that the concentrations of radionuclides in the environment are not greater than anticipated.

4.0 PROGRAM DESCRIPTION

The requirement for the Radiological Environmental Monitoring Program (REMP) is defined by the WNP-2 Offsite Dose Calculation Manual (ODCM). The sampling plan to meet ODCM requirements is presented as Table 4-1 in this report and provides a summary of the sample locations, collection frequency, and types of analyses performed. The methods of sampling and sampling frequencies utilized in the program have been determined by such factors as the half-lives and major exposure pathways for the radionuclides potentially released from the plant to the surrounding environment.

4.1 Sample Locations

Eighty-one sample locations were included in the 1995 monitoring program. Seventy-three indicator and three control (i.e. background) stations were located within 10 miles (16 kilometers) of Plant 2. Three additional control stations and two indicator stations were outside the 10-mile radius from the plant. Sample stations are listed in Table 4-2 by meteorological sector, sample media and approximate distance from the plant. The numbers and locations of sample stations are based primarily on factors such as population distribution and meteorological conditions and also on station accessibility, security throughout the year and the requirements of applicable regulations. Other factors, such as the need to monitor locations which potentially could be impacted by Plant 2 operations, influence the location of REMP sampling sites.

The REMP sampling locations listed in Tables 4-1 and 4-2 are shown in Figures 4-1 and 4-2. Figure 4-3 provides a more detailed map of sampling locations in the Sunnyside/Grandview area. Figure 4-4 shows the locations of the storm drain (Station 101), the Sanitary Waste Treatment Facility (Station 102) and the containerized storage area (Station 118), which are special interest stations.

4.2 Land Use Census

The land use census for areas within 5 miles of Plant 2 was performed in August. The objectives of the land use census are to identify the locations of the nearest milk animal, residence, and garden greater than 50 m^2 (500 ft^2) producing broadleaf vegetation and to determine whether any site located during the census has a calculated dose or dose commitment greater than the sites currently monitored for the same exposure pathway. If a new location with a higher dose commitment is found, routine sampling of that dose pathway would be initiated at that new site.

The results of the 1995 land use census within 5 miles of Plant 2 are given in Table 4-3. No significant changes from the 1994 land use census were observed. No milk animals are located within the 5-mile radius. The closest milk locations were at 7.2 miles ESE and 8.3 miles SE.

4.3 Sampling Methods

Environmental samples were collected according to the schedule in Table 4-1. All samples were collected by Supply System personnel. Documented procedures for sample collection and TLD analyses are contained in the Supply System's Health Physics Instruction (HPI) and in the Environmental and Analytical Laboratory Instruction (EALI) manuals. The sample analyses procedures are prepared and maintained by the analytical contractor and reviewed by the Supply System prior to implementation.

The following sections describe the sampling and preparation methods.

4.3.1 Direct Radiation

During 1995, thermoluminescent dosimeters (TLDs) were used to determine the direct radiation levels at fifty-eight (58) monitoring locations listed in Table 4-1. In June, two new stations were added at the cooling tower sediment disposal area. These stations are 119B and 119-Control. The control station TLD (background) is located at Station 9A in Sunnyside. The remaining TLDs served as indicator TLDs throughout the year.

Two sets of TLDs placed three feet above ground were employed at each location. One set of TLDs was exchanged on a quarterly basis (Quarterly TLDs) and the other exchanged on an annual basis (Annual TLDs). Exposure received by the field TLDs during transport to the TLD sites was monitored by a set of trip control dosimeters that accompanied the field dosimeters to and from the field locations. Another set of TLDs were used as building controls which were used to determine the exposure of the TLDs at the controlled storage location. The TLD exposure during transport to and from the field was determined by subtracting the difference between the building control results and the trip control results.

The environmental dosimeters were processed on a Harshaw Model 8800 TLD Reader. The file generated when the Harshaw TLD reader processes the environmental TLDs was stored in the host computer and used as input for the Harshaw algorithm that calculates environmental doses. The TLD reader is calibrated within 7 days prior to processing field TLDs. The TLD reader is routinely calibrated in units of mR using calibration cards irradiated on the local cesium-137 source. "Relative response" factors (mR/R) are used by the dose algorithm to convert an element reading in mR form the reader, to the Roentgen equivalent reading.

The exposure values determined for calibration exposures, as well as the exposures of the QA dosimeters (processing control dosimeters) and audit dosimeters (spiked dosimeters), were based on the calculated field strength of the encapsulated cesium-137 source. The calculated field strength of the source was determined from National Institute of Standards and Technology (NIST) traceable ionization chamber measurements made over a period of several years during the routine use and calibration of the source. Ionization chamber measurements made during TLD calibration were used to confirm the calculated exposure. If the calculated exposure and the ionization chamber reading differed by 5% or more, an investigation was performed to resolve the difference.

Three Reuter Stokes pressurized ionization chambers (PICs) provided additional capability for measuring direct radiation exposure. These units are no longer part of the routine monitoring program, but they are used in special monitoring situations and maintained as back-up monitoring systems.

4.3.2 Airborne Particulate/Iodine

Air particulate and air iodine (I-131) samples were obtained through the use of portable, low volume (1.5 cfm) constant flow-rate sampling units at each of twelve locations. The samples drawn at Station 9A (Figure 4-3) were considered control samples; the ones drawn at the other locations (Figure 4-1) were indicator samples. Air particulates were collected by drawing air through a 47mm diameter glass fiber filter. Air iodine was collected by drawing air through a 57mm diameter TEDA impregnated charcoal cartridge. The particulate air filter and charcoal cartridge were placed in tandem, particulate filter first, in a holder that attached to the air inlet of the sampler unit. The sampler units were placed in ventilated metal weatherproof housings mounted on elevated platforms at each air sample location. The filter media are changed weekly and shipped to the analytical contractor for analysis within one or two days of collection.

4.3.3 Water

There were nine sampling locations for water sampling: three for the evaluation of river/drinking water, one for plant discharge water, three for groundwater, one for the storm drain water, and one for sanitary waste water. One river/drinking water location, Station 26, was used for evaluation of the plant intake water, i.e., the river water taken upstream of the plant discharge point. This sample location can be considered a drinking water sample since Plant 2 draws its drinking water from the intake water. It is considered the river/drinking water control sample because of its upstream location. Two additional locations, Stations 28 and 29, were used to evaluate the water at the two nearest drinking water locations, the Department of Energy 300 Area and the Richland Water Treatment Plant. These two stations were considered indicator stations.

The ODCM requirement for a downstream water sample "near but beyond the mixing zone" was met by sampling water from Station 27, the plant discharge line to the Columbia River. This sample reflects the radioactivity present in the plant discharge prior to any river dilution, rather than the concentrations that would be found after dilution in the mixing zone. Water is drawn at this location because it was not feasible to perform flow-proportional composite sampling in the mixing zone area of the river downstream from the plant discharge point. The Station 27 sample is also considered an indicator sample.

Composite samplers are installed at the Columbia River pumphouse to monitor the cooling tower discharge line (Station 27). There are composite samplers at two drinking water locations (Stations 28 and 29), and the control location (Station 26). Samples collected are 25-ml aliquots of water at regular intervals of time or flow.

Non-routine analyses on the drinking water samples include strontium-90 and iodine-131 analysis. Strontium-90 analysis is required when the gross beta activity exceeds either 8 pCi/liter or ten times the mean of the previous three months' activity for a specific location. Iodine-131 analysis is required when the dose calculated for the consumption of water exceeds one millirem per year. Neither of these analyses were required during 1995.

There are three wells within the vicinity of Plant 2 that are used as groundwater sampling locations. These are a deep well on the Plant 2 site (0.1 mile north of the Reactor Building) and two wells on the WNP-1 site (1.2 miles downgradient from Plant 2). Water from the Plant 2 well can be used as a backup source for drinking and fire protection. Water from the WNP-1 wells supplies the drinking and fire protection water for the WNP-1 site. Although none of these wells draw from the unconfined aquifer, they are considered indicator samples. Quarterly grab samples were taken from each of these wells. One gallon (3.8 liters) was collected from each well for gamma analysis and 250 ml was drawn for tritium analysis.

Water samples were also collected from the storm drain (Station 101) for Plant 2, and at the Sanitary Waste Treatment Facility (SWTF; Station 102). In January 1994, a flume was installed at the storm drain outfall allowing flow-proportional composite sampling using the existing automatic sampler. The SWTF samples are grab samples collected monthly at the headworks, semi-annually at the west end of both ponds and before discharge at the discharge weir of the south pond.

4.3.4 Soil

As required by the Site Certification Agreement, annual soil samples were taken at Stations 1, 7, 21 and 23. One sample was taken at the control location, Station 9A (Figure 4-3). Quarterly soil samples were collected at two special interest locations, Station 101 and Station 118, as shown in Figures 4-4.

Each sample was collected from an area of approximately one square foot to a depth of approximately one inch. Approximately two kilograms of soil were collected in each sample. Soil samples were shipped to the analytical contractor after collection and analyzed for gamma activity.

If the gamma isotopic analysis indicates that cesium levels in any of the indicator samples exceeds ten (10) times the level in the control sample, a strontium analysis is performed on the sample(s). No strontium analysis was required during 1995.

4.3.5 Sediment

Sediment samples were collected twice during 1995 from two sampling locations along the Columbia River. The upstream sediment sample (Station 33) was collected from a location approximately two miles upriver from the plant discharge. The downstream sample (Station 34) was collected approximately one mile downstream of the plant discharge. Each sample consisted of approximately two kilograms of the shallow surface sediment scooped from below the waterline. The samples were shipped to the analytical contractor.

Sediment samples were also taken from the storm drain (Station 101) outfall and pond and the SWTF (Station 102) north stabilization pond. Sediment sampling in these locations was performed in a manner similar to river sediment sampling. Special care was taken to prevent loss of the fine particulates in the sediment. In addition, formalin was added to the sanitary pond sediment prior to shipping, to inhibit gas formation within the sample container.

Dried sediment from the cooling towers is collected within thirty days of the finish of cleaning the cooling towers. One sample of 2 kilograms is collected from the site of the newest sediment and analyzed by gamma spectrometry.

4.3.6 Fish

Fish sampling was performed in late September when the likelihood of obtaining anadromous species was high. Fish samples collected from the Columbia River (Station 30 in Figure 4-1) were indicator samples, whereas the fish collected on the Snake River (Stations 38 and 38A in Figure 4-2) were control samples.

Four separate fish samples, consisting of an anadromous species and three other species generally considered edible or potentially edible (such as carp, catfish and whitefish) were collected at each location. Most of the fish were collected using electro-shocking, but samples of the anadromous species were also collected from the Ringold hatchery on the Columbia River and at the Lyons Ferry Fish Hatchery on the Snake River. The fish were filleted to obtain one kilogram of edible flesh per sample. The fillets were placed in clean plastic bags and frozen until shipment to the analytical contractor. Fish are sampled annually unless elevated radiation levels related to plant operations are observed, in which case sampling is conducted semi-annually.

4.3.7 Milk

Milk samples were collected monthly during January, February, March, October, November and December and semi-monthly during the remaining six months when the cows were likely to be grazing. One gallon of raw milk was collected from each sampling location. The milk samples were chilled and shipped to the analytical contractor within a day of collection.

Routine samples were collected from two indicator locations (Stations 36, and 64) across the Columbia River in Franklin County. Milk samples were also collected at one indicator station (Station 9B) and one control location (Station 96) in the Sunnyside/Grandview area (in Figure 4-3). Station 9B in Sunnyside serves as an indicator station because a portion of the feed for the cows at that location is hay from Franklin County north of Pasco. That factor makes it unsuitable for use as a control location.

4.3.8 Garden Produce

Samples of local garden produce were collected monthly from April to September when the produce was readily available. When possible, three types of produce samples, a root crop, fruit and a leafy vegetable, were collected at each location. The indicator samples were collected from a region in a predominant downwind direction (Station 37 in Figure 4-2) where crops are irrigated with Columbia River water. The control samples were obtained from produce stands

in the Sunnyside area (Station 9C in Figure 4-3), the direction least likely to be affected by plant effluents. Apples were collected in September from Station 91, the Rio Vista Farms orchard, which is irrigated with Columbia River water.

4.3.9 Vegetation

The annual sample of vegetation growing in the storm drain pond was collected in June. Cattails and grasses were the principal types of vegetation collected. Approximately two kilograms of sample were collected each time. Care was taken to avoid including the roots or soil from around the roots in the samples.

4.4 Analytical Procedures

The analytical procedures used for the 1995 REMP samples are described below. Teledyne Brown Engineering Environmental Services performed all routine analyses of REMP samples during 1995.

4.4.1 Gross Beta Activity on Particulate Filters

The particulate filters were counted in a gas flow-proportional counter after a delay of five or more days to allow for the radon-222 and radon-220 (thoron) daughter products to decay. An unused air particulate filter was counted as the blank with each weekly set of filters.

4.4.2 Measurement of Gamma Emitters

A shielded Ge(Li) detector system was coupled to a computer-based data acquisition system which performed pulse height and gamma energy analysis. The information collected about each peak was compared to a library of known peaks. Isotopic identification was performed as was the radioactivity calculation which used the appropriate fractional gamma ray abundance, half-life, detector efficiency, and net counts in the peak region.

Milk and Water
A 1-liter Marinelli beaker was filled with a representative aliquot of the sample. The sample was then counted for at least 1000 minutes (16.7 hours).

Foodstuff
As much of the edible portion of the sample as possible was loaded into a tared Marinelli beaker and weighed. The sample was then counted for at least 1000 minutes (16.7 hours).

Vegetation
As much sample as possible is placed in a 1-liter Marinelli beaker and counted for approximately 1000 minutes (16.7 hours). The sample is not dried prior to counting, so the results are given in terms of wet weight.

Soils and Sediments

A large quantity of the sample was dried at a temperature below 100°C. As much sample as possible was loaded into a tared 1-liter Marinelli beaker and weighed. The sample was then counted for at least 360 minutes (6 hours).

Charcoal Cartridges (Air Iodine)

Charcoal filters were counted up to five at a time, with one positioned on the face and up to four on the side of the calibrated Ge(Li) detector. The detection limit for a charcoal cartridge was uniquely determined for each filter and by using its position. In the event that iodine-131 would have been observed in the initial counting of a set, each charcoal cartridge in the set was then positioned separately on the face of the detector and counted.

Air Particulate Filters

Four air particulate filters for a quarterly composite from each field station were aligned one in front of another and counted for at least 360 minutes (6 hours).

4.4.3 Gross Beta Activity in Water

A one-liter aliquot of each sample was evaporated to a small volume and transferred to a stainless steel planchet. The sample was dried under heat lamps, cooled, then counted on an automatic beta proportional counter. The results were calculated using empirical self-absorption curves which enabled the correction of effective counting efficiency based on the sample residue mass.

4.4.4 Iodine-131 in Water

Two liters of sample were first equilibrated with a stable iodide carrier. A batch treatment with anion exchange resin was used to remove iodine from the sample. The iodine was then stripped from the resin with sodium hypochlorite solution, reduced with hydroxylamine hydrochloride, and extracted into carbon tetrachloride as free iodine. It was then back-extracted as iodide into sodium bisulfite solution and precipitated as palladium iodide. The precipitate was weighed for chemical yield and mounted on a nylon planchet for low-level beta counting. The chemical yield was corrected by measuring the stable iodide content of the water with a specific ion electrode. During 1995, this procedure was used only on intercomparison samples, since the doses calculated via ODCM methodology for the consumption of drinking water did not exceed one millirem per year.

4.4.5 Tritium in Water

The analysis of tritium in water is performed utilizing liquid scintillation. Liquid scintillation requires 10 milliliters of water mixed with 10 milliliters of liquid scintillation "cocktail." The mixture is then counted in an automatic liquid scintillation detector.

4.4.6 Strontium-89 and 90 in Water, Milk and Soil

During 1995, strontium analyses were not required for any routine REMP water, milk or soil samples. It was used for intercomparison water and sediment analyses. The techniques used to analyze for strontium in the various media are described below.

Water

Stable strontium carrier was added to one liter of sample and the volume is reduced by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid.

Milk

Stable strontium carrier is added to one liter of sample. The sample is then evaporated and ashed in a muffle furnace. The ash is dissolved and strontium precipitated as a phosphate. The sample is then redissolved and strontium precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid.

Soil and Sediment

The sample is first dried under heat lamps and a 10-gram aliquot is taken. Stable strontium carrier is added and the sample is leached in hydrochloric acid. After the mixture is filtered, phosphates are then precipitated, collected by filtration, and dissolved in nitric acid. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for five days or more for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and reprecipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and counted in a low-level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and covered with an 80 mg/cm^2 aluminum absorber for low-level beta counting.

4.4.7 Iodine-131 in Milk

Two liters of sample are first equilibrated with stable iodide carrier. A batch treatment with anion exchange resin is used to remove iodine from the sample. The iodine is then stripped from the resin with sodium hypochlorite solution, reduced with hydroxylamine hydrochloride, and extracted into carbon tetrachloride as free iodine. It was then back-extracted as iodide into sodium bisulfite solution and precipitated as palladium iodide. The precipitate was weighed for chemical yield and mounted on a nylon planchet for low-level beta counting. The chemical yield is corrected by measuring the stable iodide content of the milk with a specific ion electrode.

4.5 Data Analysis Methods

Since mid-1984, the results of the REMP analyses have been presented as net results calculated from the gross or total counts determined for each radionuclide minus the background counts of the counting or detection instrument. Consequently, for several sample types, the results range from negative to positive numbers. This manner of presenting environmental data prevents the

bias and loss of individual results inherent in the use of "less than" (<) values, where the "less than" numbers can have a variety of meanings, such as "less than the lower limit of detection (LLD)." A listing of the LLDs determined for each analysis is provided in Table 4-4 as a reference when reviewing the sample results.

Plots of the sample results versus time are used to represent the results for analyses such as gross beta on air particulate filters, where the results are normally above the lower limits of detection. In such cases, the indicator station results are plotted with the control station results for easy comparison. Other data analysis techniques, such as frequency distributions, are also used to represent the data and to determine whether trends that could be attributed to Plant 2 operations are evident. Thermoluminescent dosimeter (TLD) data is presented in terms of the net mR/day exposure rate. These results are determined from the total exposure (in mR) calculated for each TLD from its total thermoluminescent output minus the TLD background, minus any transit (or trip) exposure received during distribution and retrieval, and divided by the number of days the TLD was in the field. Frequency distributions and graphs of TLD data by meteorological sector and distance from the plant are used to interpret trends in the results.

TLD data summaries include the term "standard error." The standard error, which is the estimate of the precision of the mean, is used for the means of quarterly and annual data and is an indicator of the uncertainty associated with the results. The mean results of the quarterly TLDs are compared with the results of annual TLDs and expressed as a ratio by dividing the quarterly results by the annual result.

TABLE 4-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM PLAN

SAMPLE TYPE[a]	SAMPLE STATION [b] NUMBER	SAMPLING AND COLLECTION FREQUENCY[c]	TYPE AND FREQUENCY OF ANALYSIS
1. AIRBORNE			
Particulates and radioiodine (6/12)[d]	1, 4-8, 9A, 21, 23, 40, 48, and 57	Continuous sampling; weekly collection	Particulate: Weekly gross beta[e]; gamma isotopic[f] of quarterly composite (by location)
			Iodine: Weekly gamma analysis.
Soil[g](0/7)	9A, 1, 7, 21 and 23, 101, 118	Annually Quarterly or more often as needed.	Gamma isotopic[f]; strontium-90[h] Gamma isotopic
2. DIRECT RADIATION			
TLD[i](34/58)	1-8, 9A, 10-25, 40-47, 49-51, 53-56, 71-86 (1S-16S)[j], 119B, 119-Control	Quarterly, annually	Thermoluminescent output; quarterly and annual processing.
PIC	Various locations, as needed [k]	Continuous recording, as needed	Exposure rate accumulated on mag card and in internal memory
3. WATERBORNE			
River/Drinking Water[l] (3/4)	26, 27, 28 and 29	Composite aliquots[m]; monthly collection	Gamma isotopic[f], gross beta, quarterly; tritium composite; strontium-90[n]; I-131[o]
Storm Drain Water (1/1)	101	Composite aliquots[m], weekly collection; grab samples	Gamma isotopic[f], tritium, gross beta
Sanitary Waste Treatment Facility Water (1/1)	102	Monthly, annually, pre-discharge and as needed.	Gamma isotopic[f], gross beta, gross alpha, strontium-90[n], tritium
Ground Water (2/3)[p]	31, 32, and 52	Quarterly	Gamma isotopic[f]; tritium
River Sediment (1/2)[q]	33 and 34	Semiannually	Gamma isotopic[f]
Sanitary Waste Treatment Facility Sediment (1/1)	102	Monthly or more often as needed	Gamma Isotopic[f]

TABLE 4-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM PLAN

SAMPLE TYPE[a]	SAMPLE STATION [b] NUMBER	SAMPLING AND COLLECTION FREQUENCY[c]	TYPE AND FREQUENCY OF ANALYSIS
Cooling Tower Sediment Disposal Area (0/1)	119	Within 30 days following Cooling Tower cleaning event	Gamma Isotopic[f]
4. INGESTION			
Milk[r] (4/4)	9B, 36, 64 and 96[s]	Semi-monthly during grazing season, monthly at other times	Gamma isotopic[f]; iodine-131; strontium-90[f]
Fish[u] (2/2)	30, 38	Annually [v]	Gamma isotopic[f]
Garden Produce[w](1/3)	9C, 91[x] and 37	Monthly during growing season in the Riverview area of Pasco and a control near Grandview; annual collection at Station 91.	Gamma isotopic[f]
Vegetation (1/1)	101	annually	Gamma isotopic[f]

(a) The fraction in parentheses for each sample type indicates the ratio of ODCM-required sample locations to the total number of sample locations currently being monitored in the surveillance program. The SCA also requires certain numbers of sampling stations for each type of media.

(b) The underlined sample location designates a control station.

(c) Deviations are permitted if samples are unobtainable due to hazardous conditions, seasonal availability, malfunction of automatic sampling equipment, or other legitimate reasons. Such deviations are documented in Section 5

(d) The SCA requires nine or more air sampling stations.

(e) Particulate sample filters will be analyzed for gross beta after at least 24 to 48 hours to allow for the decay of radon daughter products. If gross beta activity is greater than 10 times the mean of the result for the control, Station 9A, gamma isotopic analysis shall be performed on the individual sample.

(f) Gamma isotopic means identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents of Plant 2.

(g) Soil samples are collected to satisfy the requirements of the Site Certification Agreement (SCA)[6] for Plant 2. The SCA requires that soil samples be collected at five air sampling locations.

(h) Strontium-90 analysis shall be performed on any indicator soil sample having cesium results greater than ten times the results for the control location.

(i) TLD refers to thermoluminescent dosimeter. For purposes of the REMP, a TLD is a phosphor card (31.75mm x 44.75mm x 0.4mm) with eight individual read-out areas (four main dosimeter areas and four back-up dosimeter areas) in each badge case. TLDs used in the REMP meet the requirements of Reg Guide 4.13[5] and ANSI N545-1975, except for specified energy-dependence response. Correlation factors are available for energy ranges with response outside of specified tolerances.

(j) TLD Stations 71-86 are special interest stations and are not included among the 34 routine TLD stations required by the ODCM Table 6.3.1.1-1 (3.12-1). Their alternate designations are 1S-16S. The SCA requires that 25 or more TLD stations are located within a 10-mile radius of the plant.

(k) Pressurized ion chambers (PICs) are not required as part of the routine monitoring program, but they are required by the SCA to be maintained as a supplemental or backup system. PICs were used routinely at various locations during 1995 to provide supplemental information.

(l) The term "river/drinking water," instead of "surface/drinking water," is used throughout this report because the surface water is taken from the Columbia River. Station 26, Plant 2 makeup water intake from the Columbia River is both an upstream surface, or river, water sample and the drinking water control sample location. Station 28 (300 Area) and Station 29 samples are drinking water samples. The Station 27 sample, which is drawn from the plant discharge line, is taken in place of a "downstream" water sample near but beyond the mixing zone. It reflects the radioactivity present in the plant discharge prior to any river dilution. The SCA requires two drinking water locations downstream from the plant discharge and requires sampling from the plant intake and discharge water. Station 101, the storm drain pond, and Station 102, the Sanitary Waste Treatment Facility, are represented individually because they are unique sampling locations requiring special attention.

(m) Composite (integrated grab) samples are collected with equipment which collects an aliquot at time intervals that are short relative to the compositing period.

(n) When the gross beta activity in drinking water exceeds 8 pCi/liter, a strontium-90 analysis is performed.

(o) When the dose calculated via ODCM methodology for consumption of water exceeds 1 mrem per year, iodine-131 analyses are performed on the drinking water samples.

(p) The SCA requires sampling from wells used for fire protection and as backup drinking water sources.

(q) The SCA requires sediment sample collection upstream and downstream of the plant discharge.

(r) Milk samples will be obtained from farms or individual milk animals which are located in the most prevalent wind directions from Plant 2. Routine milk samples are collected in areas of high dose potential instead of within 5 kilometers, due to the locations of milk animals. The SCA requires at least three milk locations within the 10-mile radius of the plant and one in a control location.

(s) Station 96 is the control station for milk samples because it was determined that the cows at Station 9B in Sunnyside were given feed grown in the Franklin County area across the Columbia River from Plant 2.

TABLE 4-1 (Cont.)

(t) If cesium-134 or cesium-137 is measured in an individual milk sample in excess of 30 pCi/l, then the strontium-90 analysis will be performed.

(u) There are no commercially important species in the Hanford Reach of the Columbia River. Most recreationally important species in the area are anadromous (primarily salmonids), which ascend rivers from the sea for breeding. Four fish species will normally be collected by the electroshock technique in the vicinity of the plant discharge (Station 30) and from the Snake River (Station 38). If electro-shocking produces insufficient anadromous fish samples from the Snake River, samples may be obtained from the fish trap at Ice Harbor Dam, Lyons Ferry Fish Hatchery, or other similar facility. If insufficient anadromous fish samples are produced through electro-shocking on the Columbia River, samples may be obtained at the Ringold Fish Hatchery.

(v) If an impact is indicated, sampling will be conducted semiannually.

(w) Garden produce will routinely be obtained from farms or gardens using Columbia River water for irrigation. One sample of a root crop, leafy vegetable, and a fruit is collected each sample period, if available. The variety of the produce obtained will be dependent on seasonal availability.

(x) Station 91 is an apple orchard irrigated with Columbia River water. The apple crop from Station 91 is sampled annually.

TABLE 4-2

REMP SAMPLE LOCATIONS BY SECTOR

SECTOR[a]		STATION[b] NUMBER	ESTIMATED DISTANCE[c] MILES	METERS	SAMPLE TYPE[d]
N	(1)	52	0.1	161	GW
		71(1S)	0.3	483	TLD
		47	0.5	805	TLD
		57	0.8	1201	AP/AI
		18	1.1	1770	TLD
		53	7.5	12068	TLD
NNE	(2)	72(2S)	0.4	644	TLD
		2	1.8	2896	TLD
		54	6.5	10459	TLD
NE	(3)	73(3S)	0.5	805	TLD
		19	1.8	2896	TLD
		48	4.5	7241	AP/AI
		39	4.4	7084	FI
		46	5.0	8045	TLD
ENE	(4)	101	0.3	483	SDW/SE/SO/VE
		74(4s)	0.4	644	TLD
		21	1.5	2414	AP/AI/SO/TLD
		20	1.9	3057	TLD
		11	3.1	4988	TLD
		33	3.6	5792	SE
		45	4.3	6919	TLD
		44	5.8	9332	TLD
E	(5)	75(5S)	0.4	644	TLD
		22	2.1	3379	TLD
		10	3.1	4988	TLD
		26	3.2	5149	PW
		27[e]	3.2	5149	DW
		30	3.3	5311	FI
		43	5.8	9332	TLD
ESE	(6)	76(6S)	0.4	644	TLD
		31	1.1	1770	GW
		32	1.2	1931	GW
		51	2.1	3379	TLD
		23	3.0	4827	AP/AI/SO/TLD
		34	3.5	5632	SE
		91	4.4	7079	FR
		8	4.5	7241	AP/AI/TLD
		42	5.6	9010	TLD
		36[e]	7.2	11585	MI
		5	7.7	12389	AP/AI/TLD
		64	9.7	15610	MI
		38	26.5	42639	FI

TABLE 4-2 (Cont.)

REMP SAMPLE LOCATIONS BY SECTOR

SECTOR[a]		STATION[b] NUMBER	ESTIMATED DISTANCE[c] MILES	METERS	SAMPLE TYPE[d]
SE	(7)	102	0.3	483	SWW/SE
		118	0.3	483	SO
		77(7S)	0.5	805	TLD
		24	1.9	3057	TLD
		3	2.0	3218	TLD
		41	5.8	9332	TLD
		40	6.4	10298	AP/AI/TLD
SSE	(8)	119-Control	0.2	335	TLD
		78(8S)	0.7	1126	TLD
		25	1.6	2574	TLD
		55	6.2	9976	TLD
		28	7.4	11907	PW
		4	9.3	14964	AI/AP/TLD
		29	11.0	17699	PW
		37	16.0	25744	GP
S	(9)	119	0.2	366	SO
		119B	0.2	381	TLD
		79(9S)	0.7	1126	TLD
		1	1.3	2092	AP/AI/SO/TLD
		6	7.7	12389	AP/AI/TLD
SSW	(10)	80(10S)	0.8	1287	TLD
		50	1.2	1931	TLD
		56	7.0	11263	TLD
SW	(11)	81(11S)	0.7	1126	TLD
		13	1.4	2253	TLD
		96	36.0	49250	MI
WSW	(12)	82(12S)	0.5	805	TLD
		14	1.4	2253	TLD
		9A, 9B, 9C	30:0	48270	AP/AI/MI/GP/TLD/SO
W	(13)	83(13S)	0.5	805	TLD
		15	1.4	2253	TLD
WNW	(14)	84(14S)	0.5	805	TLD
		16	1.4	2253	TLD
		7	2.7	4344	AP/AI/SO/TLD
NW	(15)	85(15S)	0.5	805	TLD
		49	1.2	1931	TLD
NNW	(16)	86(16S)	0.4	644	TLD
		17	1.2	1931	TLD
		12	3.1	9815	TLD

TABLE 4-2 (Cont.)

(a) The area in the vicinity of Plant 2 is separated into 16 separate sectors for reporting purposes. The 16 sectors cover 360 degrees in equal 22.5 degree sections, beginning with Sector 1 (N) at 348.75 to 11.25 degrees and continuing clockwise through Sector 16 (NNW).

(b) The alternate designations for TLD Stations 71-86 are given in parentheses, i.e., 1S-16S.

(c) Distances are estimated from map positions for each location as a radial distance from Plant 2 containment.

(d) Sample Type Key:

AI	- Air Iodine	AP	- Air Particulate
DW	- Discharge Water	FI	- Fish
FR	- Fruit	GP	- Garden Produce
GW	- Ground Water	MI	- Milk
PW	- Surface (River)/Drinking Water	SDW	- Storm Drain Water
SE	- Sediment	SO	- Soil
SWW	- Sanitary Waste Water	TLD	- Thermoluminescent Dosimeter
VE	- Vegetation		

Station 9 designates the Sunnyside-Grandview control area. It is actually three separate stations (Stations 9A for TLD, AI/AP and SO, 9B for milk, and 9C for GP) within a few miles of each other and all within 30-35 miles of Plant 2. Station 96, which is the control station for milk, is also located within the control area. It is 36 miles from Plant 2. Station 9B, which was the control location for milk until 1986, is now an indicator milk location.

(e) Duplicate samples, i.e., samples drawn at the same time as the routine samples and submitted for analysis as a quality assurance check, are collected at this location. The station designation for the duplicate of Station 27 is Station 72 for second and fourth quarters and 92 for first and third quarters . The station designation for the duplicate of Station 36 is Station 37.

TABLE 4-3

1995 FIVE MILE LAND USE CENSUS RESULTS

SECTOR[a]	NEAREST RESIDENT[b]	GARDEN (>50M^2)	DAIRY[c] ANIMALS	LIVESTOCK
NE	4.3	none	none	4.8
ENE	4.1	4.1[d]	none	none
E	4.5	none	none	none
ESE	4.1	4.1[d]	none	4.6
SE	none	none	none	none

(a) Eleven of the sixteen meteorological sectors within the five-mile radius of Plant 2 are on the federally-owned Hanford Site; the remaining land is comprised of 4.5 sq. miles of privately-owned farm land. Only those sectors containing points of interest are presented here.

(b) Estimated distances in miles.

(c) The closest dairy animal locations are at 8.3 miles SE and 7.2 and 9.7 miles ESE. The dairy at 8.3 miles SE is not used for milk sample collection due to the owner's reluctance to participate in the sampling program.

(d) Small garden with broadleaf; samples were not available due to the small amounts grown.

TABLE 4-4

COMPARISON OF TELEDYNE NOMINAL LOWER LIMITS OF DETECTION WITH BRANCH TECHNICAL POSITION[3] REQUIREMENTS

MEDIA (UNITS)	ANALYSIS	TELEDYNE LLDs[a]	BTP REQUIRED LLDs
Air (pCi/m³)	Gross Beta	0.003	0.01
	Gamma Spectrometry		
	Cs-134	0.001	0.05
	Cs-137	0.001	0.06
	I-131	0.01	0.07
Water: (pCi/l)	Gross Beta	4	4
	Tritium	100-200	2000
	I-131	1	1
	Sr-90	1	—
	Gamma Spectrometry		
	Mn-54	10	15
	Fe-59	20	30
	Co-58	10	15
	Co-60	10	15
	Zn-65	20	30
	Zr-95	20	30
	Nb-95	10	15
	Cs-134	10	15
	Cs-137	10	18
	Ba-140	20	60
	La-140	10	15
Soil/Sediment: (pCi/kg dry)	Gamma Spectrometry		
	Co-57	120	—
	Co-60	30	—
	Zn-65	100	—
	Cs-134	30	150
	Cs-137	40	180
	Sr-90	10	—
Fish: (pCi/kg wet)	Gamma Spectrometry		
	Mn-54	20	130
	Fe-59	30	260
	Co-58	20	130
	Co-60	20	130
	Zn-65	30	260
	Cs-134	20	130
	Cs-137	20	150
Milk: (pCi/l)	I-131	0.5	1
	Gamma Spectrometry		
	Cs-134	10	15
	Cs-137	10	18
	Ba-140	20	60
	La-140	10	15
	Sr-90	1	—
Garden Produce: (pCi/kg wet)	Gamma Spectrometry		
	Cs-134	20	60
	Cs-137	20	80
	I-131	30	60

[a] These are the contract LLD's. Actual LLDs may be lower for specific samples.