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Prairie Island Technical
Specifications 6.6.B

US Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket Nos. 50-282 License Nos. DPR-42
Docket Nos. 50-306 License Nos. DPR-60

ISFSI Docket No. 72-10 License No. SNM-2506

1999 Annual Radiological Environmental Monitoring Report

In accordance with the Prairie Island Nuclear Generating Plant Technical Specifications, Appendix A to Operating License DPR-42 and DPR-60, and in accordance with the Prairie Island Independent Spent Fuel Storage Installation Technical Specifications, Appendix A to Materials License DNM-2506, we are submitting one copy of the Annual Radiological Environmental Monitoring Report covering the period January, 1999 through December 31, 1999.

Please contact us if you have any questions related to the information we have provided.

Joel P. Sorensen
Site General Manager
Prairie Island Nuclear Generating Plant

c: Regional Administrator, III, NRC
Region III
Attn: Dr. John House
NRC Project Manager
Director of NMSS
Sr. Resident Inspector, NRC
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Attachment: Annual report to the United States Nuclear Regulatory Commission, Radiation Environmental Monitoring Program, January 1, 1999 through December 31, 1999.

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PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket No. 50-282 License No. DPR-42
50-306 DPR-60

ANNUAL REPORT
to the
UNITED STATES NUCLEAR REGULATORY COMMISSION

Radiation Environmental Monitoring Program
January 1 to December 31, 1999
Project No. 8010

Prepared Under Contract
by

TELEDYNE BROWN ENGINEERING
ENVIRONMENTAL SERVICES
MIDWEST LABORATORY

Project No. 8010

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PREFACE

The staff of Teledyne Brown Engineering Environmental Services, Midwest Laboratory was responsible for the acquisition of data presented in this report. Samples were collected by members of the staff of the Prairie Island Nuclear Generating Plant, Northern States Power Company. The report was prepared by Teledyne Brown Engineering Environmental Services, Midwest Laboratory.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

This report summarizes and interprets results of the Radiation Environmental Monitoring Program (REMP) conducted by Teledyne Brown Engineering Environmental Services, Midwest Laboratory at the Prairie Island Nuclear Generating Plant, Red Wing, Minnesota, during the period January - December, 1999. This program monitors the levels of radioactivity in the air, terrestrial, and aquatic environments in order to assess the impact of the plant on its surroundings.

Tabulations of the individual analyses made during the year are not included in this report. These data are included in a reference document (Teledyne Brown Engineering Environmental Services, Midwest Laboratory, 2000b) available at Northern States Power Company, Prairie Island Nuclear Generating Plant.

Prairie Island Nuclear Generating Plant is located on the Mississippi River in Goodhue County, Minnesota, and operated by Northern States Power Company. The plant has two 575 MWe pressurized water reactors. Unit 1 achieved initial criticality on 1 December 1973. Commercial operation at full power began on 16 December 1973. Unit 2 achieved initial criticality on 17 December 1974. Commercial operation at full power began on 21 December 1974.

2.0 SUMMARY

The Radiation Environmental Monitoring Program (REMP) required by the U.S. Nuclear Regulatory Commission (NRC) Technical Specifications for the Prairie Island Nuclear Generating Plant and the Independent Spent Fuel Storage Installation (ISFSI) is described. Results for 1999 are summarized and discussed.

Program findings show background levels of radioactivity in the environmental samples collected in the vicinity of the Prairie Island Nuclear Generating Plant.

3.0 RADIATION ENVIRONMENTAL MONITORING PROGRAM (REMP)

3.1 Program Design and Data Interpretation

The purpose of the Radiation Environmental Monitoring Program (REMP) at the Prairie Island Nuclear Generating Plant is to assess the impact of the plant on its environment. For this purpose, samples are collected from the air, terrestrial, and aquatic environments and analyzed for radioactive content. In addition, ambient gamma radiation levels are monitored by thermoluminescent dosimeters (TLDs).

Sources of environmental radiation include the following:

(1) Natural background radiation arising from cosmic rays and primordial radionuclides;

(2) Fallout from atmospheric nuclear detonations;

(3) Releases from nuclear power plants;

(4) Industrial and medical radioactive waste; and

(5) Fallout from nuclear accidents.

In interpreting the data, effects due to the plant must be distinguished from those due to other sources.

A major interpretive aid in assessment of these effects is the design of the monitoring program at the Prairie Island Plant which is based on the indicator-control concept. Most types of samples are collected both at indicator locations (nearby, downwind, or downstream) and at control locations (distant, upwind, or upstream). A plant effect would be indicated if the radiation level at an indicator location was significantly larger than that at the control location. The difference would have to be greater than could be accounted for by typical fluctuations in radiation levels arising from other sources.

An additional interpretive technique involves analyses for specific radionuclides present in the environmental samples collected from the plant site. The plant's monitoring program includes analyses for tritium and iodine-131. Most samples are also analyzed for gamma-emitting isotopes with results for the following groups quantified: zirconium-95, cesium-137, cerium-144, beryllium-7, and potassium-40. The first three gamma-emitting isotopes were selected as radiological impact indicators because of the different characteristic proportions in which they appear in the fission product mix produced by a nuclear reactor and that produced by a nuclear detonation. Each of the three isotopes is produced in roughly equivalent amounts by a reactor: each constitutes about 10% of the total activity of fission products 10 days after reactor shutdown. On the other hand, 10 days after a nuclear explosion, the contributions of zirconium-95, cerium-144, and cesium-137 to the activity of the resulting debris are in the approximate ratio 4:1:0.03 (Eisenbud, 1963). Beryllium-7 is of cosmogenic origin and potassium-40 is a naturally-occurring isotope. They were chosen as calibration monitors and should not be considered radiological impact indicators.

The other group quantified consists of niobium-95, ruthenium-103 and -106, cesium-134, barium-lanthanum-140, and cerium-141. These isotopes are released in small quantities by nuclear power plants, but to date their major source of injection into the general environment has been atmospheric nuclear testing. Nuclides of the final group, manganese-54, iron-59, cobalt-58 and -60, and zinc-65, are activation products and

3.1 Program Design and Data Interpretation (continued)

arise from activation of corrosion products. They are typical components of a nuclear power plant's effluents, but are not produced in significant quantities by nuclear detonations.

Other means of distinguishing sources of environmental radiation are employed in interpreting the data. Current radiation levels are compared with previous levels, including those measured before the Plant became operational. Results of the plant's monitoring program can be related to those obtained in other parts of the world. Finally, results can be related to events known to cause elevated levels of radiation in the environment, e.g., atmospheric nuclear detonations.

3.2 Program Description

The sampling and analysis schedule for the radiation environmental monitoring program at Prairie Island is summarized in Table 5.1 and briefly reviewed below. Table 5.2 defines the sampling location codes used in Table 5.1 and specifies for each location its type (indicator or control) and its distance, direction, and sector relative to the reactor site or ISFSI facility, as appropriate. To assure that sampling is carried out in a reproducible manner, detailed sampling procedures have been prescribed (Prairie Island Nuclear Generating Plant, 1999). Maps of fixed sampling locations are included in Appendix E.

To monitor the air environment, airborne particulates are collected on membrane filters by continuous pumping at five locations. Also, airborne iodine is collected by continuous pumping through charcoal filters at all of these locations. Filters are changed and counted weekly. Particulate filters are analyzed for gross beta activity and charcoal filters for iodine-131. A quarterly composite of the particulate filters from each location is gamma-scanned on an HPGe detector. One of the five locations is a control (P-1), and four are indicators (P-2, P-3, P-4, and P-6).

Offsite ambient gamma radiation is monitored at thirty-four locations, using $CaSO_4$:Dy dosimeters with four sensitive areas at each location: ten in an inner ring in the general area of the site boundary, fifteen in the outer ring within a 4-5 mile radius, eight at special interest locations, and one control location, 11.1 miles distant from the plant. They are replaced and measured quarterly. Also, a complete emergency set of TLDs for the inner ring, outer ring and special interest locations are placed in the field at the same time as regular sets. The emergency set is returned to TBEESML quarterly for annealing and repackaging.

Ambient gamma radiation is monitored at the Independent Spent Fuel Storage Installation (ISFSI) Facility by twenty $CaSO_4$:Dy dosimeters. Twelve dosimeters are located inside of the earthen berm in direct line of sight from the storage casks and eight dosimeters are located outside of the earthen berm. They are replaced and measured quarterly.

Milk samples are collected monthly from five farms (four indicator and one control) and analyzed for iodine-131 and gamma-emitting isotopes. The milk is collected biweekly during the growing season (May - October), because the milk animals may be on pasture.

For additional monitoring of the terrestrial environment, green leafy vegetables (cabbage) are collected annually from the highest D/Q garden and a control location (P-38), and analyzed for gamma-emitting isotopes, including iodine-131. Corn is collected annually only if fields are irrigated with river water and analyzed for gamma-emitting isotopes. Well water and ground water are collected quarterly from four locations near the plant and analyzed for tritium and gamma-emitting isotopes. River water is collected weekly at

3.2 Program Description (continued)

two locations, one upstream of the plant (P-5) and one downstream (P-6, Lock and Dam No.3). Monthly composites are analyzed for gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

Drinking water is collected weekly from the City of Red Wing well. Monthly composites are analyzed for gross beta, iodine-131, and gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

The aquatic environment is also monitored by semi-annual upstream and downstream collections of fish, periphyton or invertebrates, and bottom sediments. Shoreline sediment is collected semi-annually from one location. All samples are analyzed for gamma-emitting isotopes.

Due to detectable levels of tritium in a well south of the plant in 1989, special tritium sampling has been implemented. A summary of the special tritium sampling of ground and well water is included in Appendix D.

3.3 Program Execution

The Program was executed as described in the preceding section with the following exceptions:

(1) No air particulate/air iodine sample was available for air station P-1 for the week ending April 21, 1999, due to sampler pump failure.

(2) No surface water samples were available for locations P-6 and P-11 for the week ending July 28, 1999. The samples were collected, but damaged in shipment.

(3) Approximately 10.5 hours of sampling time were lost from the air particulate/air iodine sample location (P-6) for the week ending 08-25-99, due to a power interruption.

(4) No milk sample was available for location P-25 for the week ending 10-12-99. Dairy operations at this location were discontinued.

(5) Approximately 110 hours of sampling time were lost from the air particulate/air iodine sample location (P-1) for the week ending 11-09-99, due to sampler pump failure.

(6) No air particulate/air iodine sample was available from air station P-3 for the week ending 12-28-99, due to sampler pump failure.

Deviations from the program are summarized in Table 5.3.

3.4 Laboratory Procedures

All iodine-131 analyses in milk and drinking water were made by using a sensitive radiochemical procedure which involves separation of the element by use of an ion-exchange resin and subsequent beta counting. All gamma-spectroscopic analyses were

3.4 Laboratory Procedures (continued).

performed with an HPGe detector. Levels of airborne iodine-131 in charcoal samples were measured by gamma spectrometry.

Levels of iodine-131 in cabbage and were determined by gamma spectrometry.

Tritium levels were determined by liquid scintillation technique.

Analytical Procedures used by TBEESML are on file and are available for inspection. Procedures are based on those prescribed by the Health and Safety Laboratory of the U.S. Dep't of Energy, Edition 28, 1997, U.S. Environmental Protection Agency for Measurement of Radioactivity in Drinking Water, 1980, and the U.S. Environmental Protection Agency, EERF, Radiochemical Procedures Manual, 1984.

Teledyne Brown Engineering Environmental Services, Midwest Laboratory has a comprehensive quality control/quality assurance program designed to assure the reliability of data obtained. Details of TBEESML's Quality Assurance Program are presented elsewhere (Teledyne Brown Engineering Midwest Laboratory, 1999). The TBEESML Quality Assurance Program includes participation in Interlaboratory Comparison (Crosscheck) Programs. Results obtained in crosscheck programs are presented in Appendix A.

3.5 Program Modifications

The control location,(P-25, Rohl Farm) discontinued dairy operations in October, 1999. It was replaced by the Huppert Farm (P-41).

3.6 Land Use Census

In accordance with the Prairie Island Nuclear Generating Plant Offsite Dose Calculation Manual, H4, (ODCM) a land use census is conducted in order to identify the location of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 ft^2 producing fresh leafy vegetables in each of the 16 meteorological sectors within a distance of 5 miles. This census is conducted at least once per 12 months between the dates of May 1 and October 31. If new locations yield a calculated dose or dose equivalent (via the same exposure pathway) twenty percent greater than the required locations per the ODCM, then the new locations are added to the radiation environmental monitoring program within 30 days, and sampling locations having lower calculated doses or a lower dose commitment may be deleted from this monitoring program after October 31 of the year in which the land use census was conducted.

This land use census insures the updating of the radiation environmental monitoring program should sampling locations change within the 5 mile radius from the plant.

The 1999 Land Use Census was completed in October, 1999. There were no changes in any of the highest D/Q locations for dairy, nearest residence, or garden sites in 1999. The critical receptor location did not change in 1999 due to the requirements of the land use census.

No downstream irrigation of corn was discovered within 5 miles of the Prairie Island Plant. Therefore, no corn samples were collected for analysis.

4.0 RESULTS AND DISCUSSION

All of the scheduled collections and analyses were made except those listed in Table 5.3.

All results are summarized in Table 5.4 in a format recommended by the Nuclear Regulatory Commission in Regulatory Guide 4.8. For each type of analysis of each sampled medium, this table lists the mean and range for all indicator locations and for all control locations. The locations with the highest mean and range are also shown.

4.1 Atmospheric Nuclear Detonations and Nuclear Accidents

There were no reported atmospheric nuclear tests in 1999. The last reported test was conducted on October 16, 1980 by the People's Republic of China.

There were no reported accidents at nuclear reactor facilities in 1999.

4.2 Summary of Preoperational Data

The following constitutes a summary of preoperational studies conducted at the Prairie Island Nuclear Power Plant during the years 1970 to 1973, to determine background levels expected in the environment, and provided, where applicable, as a means for comparison with present day levels. Strict comparisons, however, are difficult, since background levels of radiation were much higher in these years due to radioactive fallout from the atmosphere. Gross beta measurements in fallout declined yearly from a level of 12,167 pCi/m^2 to 1,020 pCi/m^2, and these declining values are reflected throughout the various media tested.

In the air environment, ambient gamma radiation (TLDs) averaged 9.4 mR/4 weeks during preoperational studies. Gross beta in air particulates declined from levels of 0.38 to 0.037 pCi/m^3. Average present day levels have stabilized at around 0.025 pCi/m^3. Airborne radioiodine remained below detection levels.

In the terrestrial environment of 1970 to 1973, milk, agricultural crops, and soil were monitored. In milk samples, low levels of Cs-137, I-131, and Sr-90 were detected. Cs-137 levels declined from 16.5 to 8.6 pCi/L. Present day measurements for both Cs-137 and I-131 are below detection levels. Agricultural crop measurements averaged 57.7 pCi/g for gross beta and 0.47 pCi/g for Cs-137. Gross beta measured in soil averaged 52 pCi/g .

The aqueous environment was monitored by testing of river , well and lake waters, bottom sediments, fish , aquatic vegetation and periphyton. Specific location comparison of drinking, river and well water concentrations for tritium and gross beta are not possible. However, tritium background levels, measured at eight separate locations, declined steadily from an average concentration of 1020 pCi/L to 490 pCi/L. Present day environmental levels of tritium are below detection limits. The special tritium sampling program, described in Appendix D, employs a very sensitive detection method, and indicates tritium levels at or near the natural background levels. Values for gross beta, measured from 1970 to 1973, averaged 9.9 pCi/L in downstream Mississippi River water, 8.2 pCi/L for well waters, and 11.0 pCi/L for lake waters. Gamma emitters were below the lower limit of detection (LLD). In bottom sediments, gross beta background levels were determined at 51.0 pCi/g. Cs-137 activity during preoperational studies in 1973 measured 0.25 pCi/g upstream and 0.21 pCi/g downstream. The lower levels occasionally observed today can still be attributed to residual activity from atmospheric fallout. Gross beta in fish, measured in both flesh and skeletal samples, averaged 7.3 and 11.7 pCi/g,respectively. Gross beta background levels in aquatic vegetation, algae and periphyton samples measured 76.0 pCi/g , 46.0 pCi/g, and 13.6 pCi/g, respectively.

4.3 Program Findings

Results obtained show background levels of radioactivity in the environmental samples collected in the vicinity of the Prairie Island Nuclear Generating Plant in 1999.

Offsite Ambient Radiation (TLDs)

Ambient radiation was measured in the general area of the site boundary, at the outer ring 4 - 5 mi distant from the Plant, at special interest areas and at one control location. The means ranged from 15.7 mR/91 days at inner ring locations to 17.2 mR/91 days at outer ring locations. The mean at special locations was 15.8 mR/91 days and 17.5 mR/91 days at the control location. The dose rates measured at the inner and outer ring and the control locations were similar to those observed from 1984 through 1998. The results are tabulated below. No plant effect on ambient gamma radiation was indicated (Figure 5-1).

Year	Average (Inner and Outer Rings)	Control
1984	15.0	15.4
1985	14.0	15.3
1986	17.1	17.3
1987	16.9	17.0
1988	15.4	16.0
1989	16.5	16.7
1990	15.9	16.3
1991	14.9	14.5
1992	16.3	14.8
1993	15.9	15.4
1994	15.2	16.0
1995	15.6	16.6
1996	14.8	16.4
1997	15.1	16.0
1998	16.7	17.3
1999	16.6	17.5

Ambient gamma radiation as measured by thermoluminescent dosimetry. Average quarterly dose rates (mR/91 days).

ISFSI Facility Operations Monitoring

Ambient radiation was measured inside the ISFSI earth berm, outside the ISFSI earth berm and at two special locations between the plant ISFSI and the Prairie Island Indian Community. The mean dose rates measured 60.1 mR/91 days inside the ISFSI earth berm and 18.5 mR/91 days outside the ISFSI earth berm. Two additional casks were placed on the ISFSI pad in 1999. There were nine loaded casks on the ISFSI pad during 1999. The higher levels inside the earth berm are expected due to the loaded spent fuel casks being in direct line-of-sight from the TLDs. The ambient radiation levels measured outside the earth berm show a slight increase as compared to other offsite dose rates around the plant. If the dose rates outside the earth berm are an indication of gamma skyshine from the casks, they are consistent with predictions given in the ISFSI Safety Analysis Report, Table 7A-7, "Total Skyshine Dose Rate". The cumulative average of the two special Prairie Island Indian Community TLDs measured 15.5 and 15.6 mR/91 days. No spent fuel storage effect on offsite ambient gamma radiation was indicated (Fig. 5-1).

Airborne Particulates

The annual gross beta concentration in airborne particulates for indicator locations averaged 0.024 pCi/m^3 and for the control location,0.022 pCi/m^3. These averages were similar to or slightly lower than the average means observed from 1984 through 1998. The results are tabulated below. The data for 1986 does not include the results from May 19 to June 9, 1986, which were influenced by the accident at Chernobyl. (Figure 5-2).

Year	Average of Indicators	Control
	Concentration (pCi/m^3)	
1984	0.025	0.027
1985	0.025	0.025
1986	0.024	0.029
1987	0.024	0.023
1988	0.030	0.030
1989	0.028	0.027
1990	0.024	0.023
1991	0.025	0.025
1992	0.023	0.021
1993	0.022	0.019
1994	0.022	0.022
1995	0.022	0.022
1996	0.023	0.020
1997	0.021	0.021
1998	0.022	0.018
1999	0.024	0.022

Average annual gross beta concentrations in airborne particulates.

A spring peak in beta activity had been observed almost annually for many years (Wilson *et al.*, 1969). It had been attributed to fallout of nuclides from the stratosphere (Gold *et al.*, 1964). It was pronounced in 1981, occurred to a lesser degree in 1982, and has not occurred since 1983. The highest averages for gross beta occur during the months of January and December, and the first and fourth quarters, as in 1984 through 1999.

Two pieces of evidence indicate conclusively that the elevated activity observed during the winter months was not attributable to the Plant operation. In the first place, elevated activity of similar size occurred simultaneously at both indicator and control locations. Secondly, an identical pattern was observed at the Monticello Nuclear Generating Plant, about 100 miles distant from the Prairie Island Nuclear Generating Plant (Northern States Power Company, 2000a).

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded similar results for indicator and control locations. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation (Arnold and Al-Salih, 1955), was detected in all samples. All other gamma-emitting isotopes were below their respective LLD limits.

Airborne Iodine

Weekly levels of airborne iodine-131 were below the lower limit of detection (LLD) of 0.07 pCi/m^3 in all samples. There was no indication of a plant effect.

Milk

Iodine-131 results were below the detection limit of 1.0 pCi/L in all samples. Cs-137 results were below the LLD level of 15 pCi/L in all samples. No other gamma-emitting isotopes, except naturally-occurring potassium-40, were detected in any milk samples. This is consistent with the findings of the National Center for Radiological Health that most radiocontaminants in feed do not find their way into milk due to the selective metabolism of the cow. The common exceptions are radioisotopes of potassium, cesium, strontium, barium, and iodine (National Center for Radiological Health, 1968).

In summary, the milk data for 1999 show no radiological effects of the plant operation.

Drinking Water

In drinking water from the City of Red Wing well, tritium activity was below the LLD level of 190 pCi/L in all samples. As with the other well water samples, all analyses for gamma-emitting isotopes yielded results below detection limits. Gross beta averaged 5.3 pCi/L and was similar to levels observed from 1984 through 1998. In summary, drinking water data for 1999 show no effects of plant operation.

Year		Gross Beta (pCi/L)
1984		7.9
1985		7.1
1986		6.8
1987		7.9
1988		8.0
1989		7.0
1990		7.0
1991		8.0
1992		7.6
1993		7.5
1994		5.8
1995		3.9
1996		6.3
1997		5.1
1998		5.4
1999		5.3

Average annual concentrations; Gross beta in drinking water.

River Water

At both the upstream and downstream collection sites, quarterly composite tritium levels were below the LLD level of 190 pCi/L . Gamma-emitting isotopes were below detection limits in all samples. There was no indication of a plant effect.

Well Water

At the control well P-25, Rohl Farm and the three indicator wells (P-8, Community Center, P-6, Lock and Dam No. 3, and P-9, Plant Well No. 2) no tritium was detected above the LLD level of 183 pCi/L in all samples. Gamma-emitting isotopes were below detection limits in all samples.

In summary, well water data for 1999 show no radiological effects of the plant operation.

Crops

Two samples of cabbage were collected in August and analyzed for gamma-emitting isotopes, including iodine-131. The I-131 level was below 0.021 pCi/g wet weight in both samples. With the exception of naturally-occurring potassium-40, all other gamma-emitting isotopes were below their respective detection limits.There was no indication of a plant effect.

The field sampling personnel conducted an annual land use survey and found that there was no river water taken for irrigation into fields within 5 miles downstream from the Prairie Island Plant. Therefore, it was not necessary to collect and analyze corn samples.

Fish

Fish samples were collected in May and September, 1999 and analyzed for gamma emitting isotopes. Only naturally-occurring potassium-40 was detected, and there was no significant difference between upstream and downstream results. There was no indication of a plant effect.

Aquatic Insects or Periphyton

Aquatic insects (invertebrates) or periphyton were collected in July and September, 1999.

All gamma-emitting isotopes were below their respective detection limits. There was no indication of any plant effect.

Bottom and Shoreline Sediments

Sediment collections were made in June and September, 1999 and analyzed for gamma-emitting isotopes. All other gamma-emitting isotopes, excepting naturally-occurring potassium-40, were below their respective LLDs. No plant effect was indicated.

5.0 FIGURES AND TABLES

PRAIRIE ISLAND

Table 5.1. Sample collection and analysis program, Prairie Island Nuclear Generating Plant

Medium	Location No.	Location Codes (and Type)[a]	Collection Type and Frequency[b]	Analysis Type and Frequency[c]
Ambient radiation (TLD's)	54	P-01A - P-10A P-01B - P-15B P-01S - P-08S P-01IA - P-08IA P-01IB - P-08IB P-01IX- P-04IX, P-01C	C/Q	Ambient gamma
Airborne Particulates	5	P-1(C), P-2, P-3, P-4, P-6	C/W	GB, GS (QC of each location)
Airborne Iodine	5	P-1(C), P-2, P-3, P-4, P-6	C/W	I-131
Milk	4	P-14, P-18, P-37 P-25 (C), P-41 (C)	G/M[d]	I-131, GS
Milk	1	P-39	G/M	I-131, GS
River water	2	P-5(C), P-6	G/W	GS(MC), H-3(QC)
Drinking water	1	P-11	G/W	GB(MC), I-131(MC) GS (MC), H-3 (QC)
Well water	5	P-6, P-8, P-9, P-24, P-41 (C)	G/Q	H-3, GS
Edible cultivated crops - leafy green vegetables	2	P-38(C), P-24	G/A	GS (I-131)
Fish (one species, edible portion)	2	P-19(C), P-13	G/SA	GS
Periphyton or invertebrates	2	P-40(C), P-6	G/SA	GS
Bottom sediment	2	P-20(C), P-6	G/SA	GS
Shoreline sediment	1	P-12	G/SA	GS

[a] Location codes are defined in Table D-2. Control stations are indicated by (C). All other stations are indicators.

[b] Collection type is coded as follows: C/ = continuous, G/ = grab. Collection frequency is coded as follows: W= weekly, M = monthly, Q = quarterly, SA = semiannually, A = annually.

[c] Analysis type is coded as follows: GB = gross beta, GS = gamma spectroscopy, H-3 = tritium, I-131 = iodine-131. Analysis frequency is coded as follows: MC = monthly composite, QC = quarterly composite.

[d] Milk is collected biweekly during the grazing season (May - October).

PRAIRIE ISLAND

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant.

Code	Type[a]	Collection Site	Sample Type[b]	Distance and Direction from Reactor
P-1	C	Air Station P-1	AP, AI	11.8 mi @ 316°/NNW
P-2		Air Station P-2	AP, AI	0.5 mi @ 294°/WNW
P-3		Air Station P-3	AP, AI	0.8 mi @ 313°/NW
P-4		Air Station P-4	AP, AI	0.4 mi @ 359°/N
P-5	C	Upstream of Plant	RW	1.8 mi @ 11°/N
P-6		Lock and Dam #3 & Air Station P-6	AP, AI, RW WW, BS, BO[c]	1.6 mi @ 129°/SE
P-8		Community Center	WW	1.0 mi @ 321°/WNW
P-9		Plant Well #2	WW	0.3 mi @ 306°/NW
P-11		Red Wing Service Center	DW	3.3 mi @ 158°/SSE
P-12		Downstream of Plant	SS	3.0 mi @ 116°/ESE
P-13		Downstream of Plant	F[c]	3.5 mi @ 113°/ESE
P-14		Gustafson Farm	M	2.3 mi @ 173°/S
P-18		Christiansen Farm	M	3.8 mi @ 88°/E
P-19	C	Upstream of Plant	F[c]	1.3 mi @ 0°/N
P-20	C	Upstream of Plant	BS	0.9 mi @ 45°/NE
P-24		Suter Residence	VE, WW	0.6 mi @ 158°/SSE
P-25	C	Rohl Farm	M, WW	12.9 mi @ 352°/N
P-37		Welsch Farm	M	4.1 mi @ 87°/E
P-38	C	Cain Residence	VE	14.2 mi @ 359°/N
P-39		Born Farm	M	2.8 mi @ 239°/WSW
P-40	C	Upstream of Plant	BO[c]	0.4 mi @ 0°/N
P-41	C	Huppert Farm	M, WW	13.8 mi @ 354°/N
General Area of the Site Boundary				
P-01A		Property Line	TLD	0.4 mi @ 359°/N
P-02A		Property Line	TLD	0.3 mi @ 10°/N
P-03A		Property Line	TLD	0.5 mi @ 183°/S
P-04A		Property Line	TLD	0.4 mi @ 204°/SWW
P-05A		Property Line	TLD	0.4 mi @ 225°/SW
P-06A		Property Line	TLD	0.4 mi @ 249°/WSW
P-07A		Property Line	TLD	0.4 mi @ 268°/W
P-08A		Property Line	TLD	0.4 mi @ 291°/WNW
P-09A		Property Line	TLD	0.7 mi @ 317°/NW
P-10A		Property Line	TLD	0.5 mi @ 333°/NNW

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant, (continued).

Code	Type[a]	Collection Site	Sample Type[b]	Distance and Direction from Reactor
Approximately 4 to 5 miles Distant from the Plant				
P-01B		Thomas Killian Residence	TLD	4.7 mi @ 355°/N
P-02B		Roy Kinneman Residence	TLD	4.8 mi @ 17°/NNE
P-03B		Wayne Anderson Farm	TLD	4.9 mi @ 46°/NE
P-04B		Nelson Drive (Road)	TLD	4.2 mi @ 61°/ENE
P-05B		Country Road E and Coulee	TLD	4.2 mi @ 102°/ESE
P-06B		William Hauschiblt Residence	TLD	4.4 mi @ 112°/ESE
P-07B		Red Wing Public Works	TLD	4.7 mi @ 140°/SE
P-08B		David Wnuk Residence	TLD	4.1 mi @ 165°/SSE
P-09B		Highway 19 South	TLD	4.2 mi @ 187°/S
P-10B		Cannondale Farm	TLD	4.9 mi @ 200°/SSW
P-11B		Wallace Weberg Farm	TLD	4.5 mi @ 221°/SW
P-12B		Ray Gergen Farm	TLD	4.6 mi @ 251°/WSW
P-13B		Thomas O'Rourke Farm	TLD	4.4 mi @ 270°/W
P-14B		David J. Anderson Farm	TLD	4.9 mi @ 306°/NW
P-15B		Holst Farms	TLD	3.8 mi @ 345°/NNW
Special Interest Locations				
P-01S		Federal Lock & Dam #3	TLD	1.6 mi @ 129°/SE
P-02S		Charles Suter Residence	TLD	0.5 mi @ 155°/SSE
P-03S		Carl Gustafson Farm	TLD	2.2 mi @ 173°/S
P-04S		Richard Burt Residence	TLD	2.0 mi @ 202°/SSW
P-05S		Kinney Store	TLD	2.0 mi @ 270°/W
P-06S		Earl Flynn Farm	TLD	2.5 mi @ 299°/WNW
P-07S		Indian Community	TLD	0.7 mi @ 271°/W
P-08S		Indian Community	TLD	0.7 mi @ 287°/NWW
P-01C	C	Robert Kinneman Farm	TLD	11.1 mi @ 331°/NNW

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant, (continued).

Code	Type[a]	Collection Site	Type of Sample[b]	Approximate Distance and Direction from ISFSI Center.
ISFSI Area Inside Earth Berm				
P-01IA		ISFSI Nuisance Fence	TLD	190' @ 45°/NE
P-02IA		ISFSI Nuisance Fence	TLD	360' @ 82°/E
P-03IA		ISFSI Nuisance Fence	TLD	370' @ 100°/E
P-04IA		ISFSI Nuisance Fence	TLD	200' @ 134°/SE
P-05IA		ISFSI Nuisance Fence	TLD	180' @ 219°/SW
P-06IA		ISFSI Nuisance Fence	TLD	320' @ 258°/WSW
P-07IA		ISFSI Nuisance Fence	TLD	320' @ 281°/WNW
P-08IA		ISFSI Nuisance Fence	TLD	190' @ 318°/NW
P-01IX		ISFSI Nuisance Fence	TLD	140' @ 180°/S
P-02IX		ISFSI Nuisance Fence	TLD	310' @ 270°/W
P-03IX		ISFSI Nuisance Fence	TLD	140' @ 0°/N
P-04IX		ISFSI Nuisance Fence	TLD	360' @ 90°/E
ISFSI Area Outside Earth Berm				
P-01IB		ISFSI Berm Area	TLD	340' @ 3°/N
P-02IB		ISFSI Berm Area	TLD	380' @ 28°/NNE
P-03IB		ISFSI Berm Area	TLD	560' @ 85°/E
P-04IB		ISFSI Berm Area	TLD	590' @ 165°/SSE
P-05IB		ISFSI Berm Area	TLD	690' @ 186°/S
P-06IB		ISFSI Berm Area	TLD	720' @ 201°/SSW
P-07IB		ISFSI Berm Area	TLD	610' @ 271°/W
P-08IB		ISFSI Berm Area	TLD	360' @ 332°/NNW

[a] "C" denotes control location. All other locations are indicators.

[b] Sample Codes:

AP	Airborne particulates	F	Fish
AI	Airborne Iodine	M	Milk
BS	Bottom (river) sediments	SS	Shoreline Sediments
BO	Bottom organisms (periphyton or macroinvertebrates)	SW	Surface Water
		VE	Vegetation/vegetables
DW	Drinking water	WW	Well water

[c] Distance and direction data for fish and bottom organisms are approximate since availability of sample specimen may vary at any one location.

Table 5.3. Missed collections and analyses, 1999. Prairie Island Nuclear Generating Plant. All required samples were collected and analyzed as scheduled except the following:

Sample Type	Analysis	Location	Collection Date or Period	Reason for not Conducting REMP as Required	Plan for Preventing Recurrence
AP/AI	Gross Beta, I-131	P-1	04-21-99	No flow through air sampler. Vacuum pump failure.	Replaced sampler with previously calibrated unit.
SW	Gamma	P-6, P-11	07-28-99	Samples collected, but damaged in shipping.	Isolated incident, none planned at this time.
AP/AI	Gross Beta, I-131	P-6	08-25-99	Approximately 10.5 hrs. run-time lost.	None - Power interruption from utility company.
MI	Gamma, I-131	P-25	10-12-99	Dairy operations discontinued.	New control location established.
AP/AI	Gross Beta, I-131	P-1	11-09-99	Air sampler failure, approximately 110 hrs. run-time lost.	Open fuse; Sampler tested satisfactorily and was returned to service.
AP/AI	Gross Beta, I-131	P-3	12-28-99	Sampler pump failure.	Replaced sampler with previously calibrated unit.

Figure 5-1. Offsite Ambient Radiation (TLDs); average of inner and outer ring indicator locations versus control location.

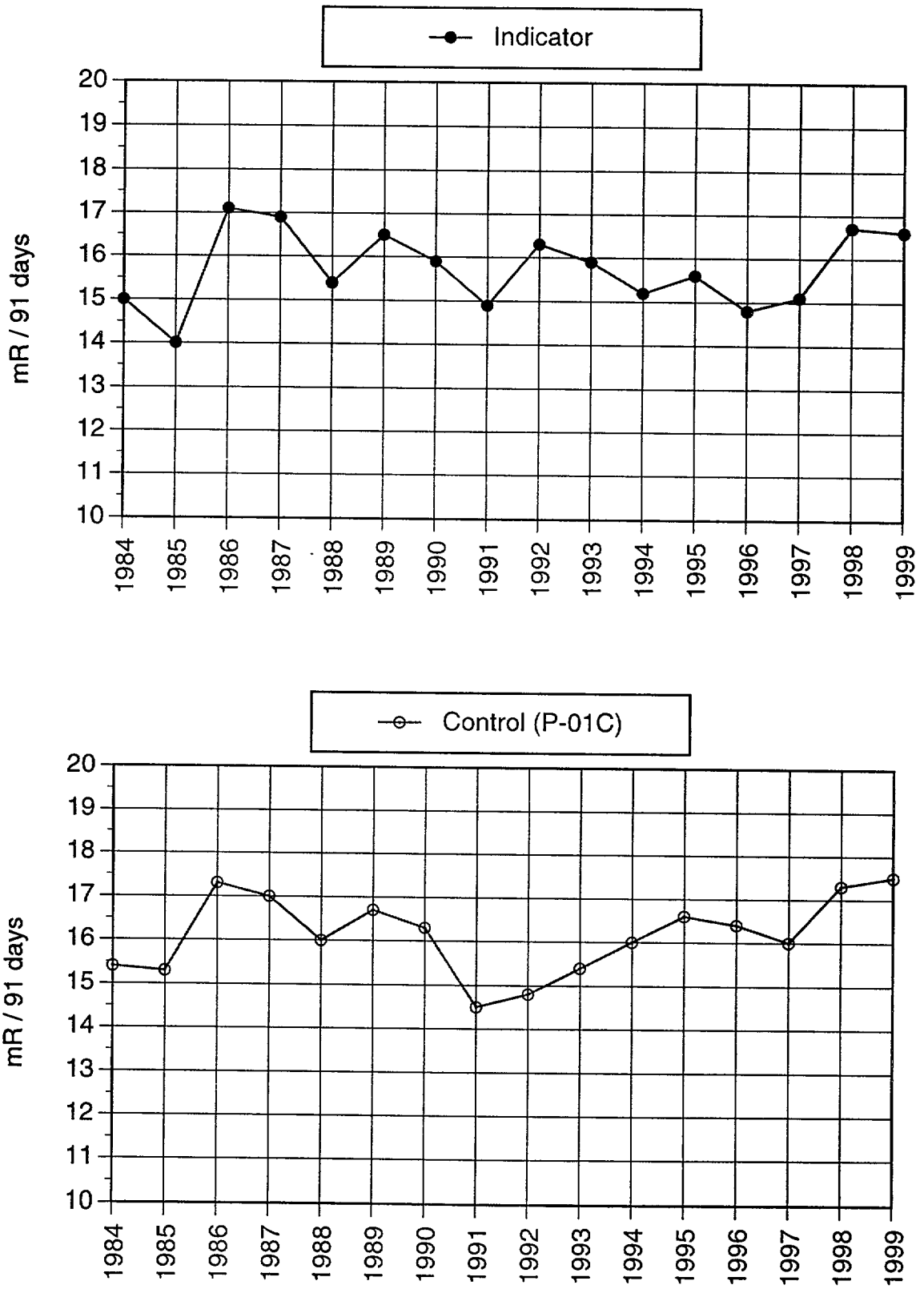

Figure 5-2. Airborne Particulates; analysis for gross beta, average mean of all indicator locations versus control location.

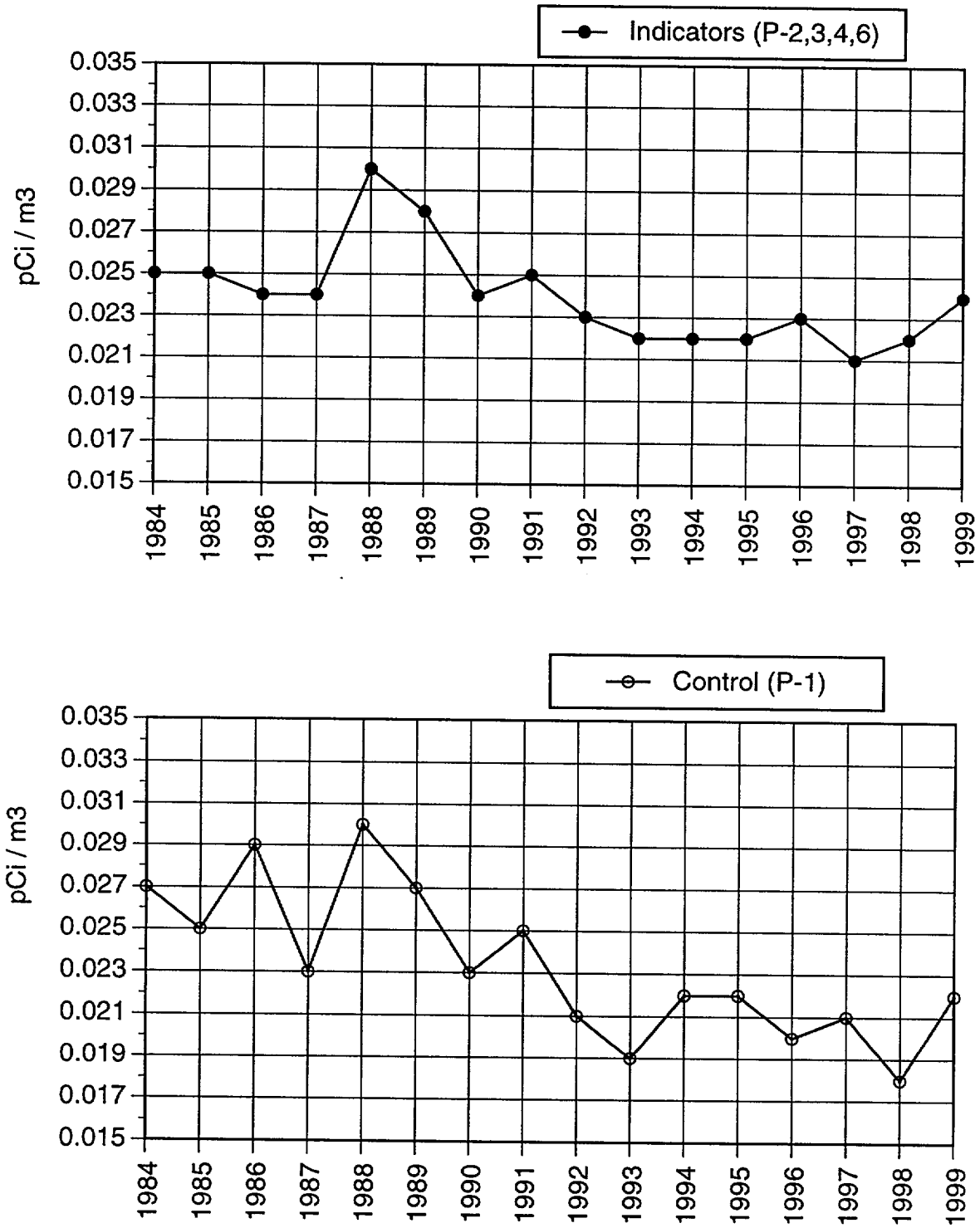

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility: Prairie Island Nuclear Power Station — Docket No. 50-282, 50-306
Location of Facility: Goodhue, Minnesota (County, State) — Reporting Period January-December, 1999

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
TLD (Inner Ring, Area at Site Boundary) mR/91 days)	Gamma 40	3.0	15.7 (40/40) (12.6-17.5)	P-04A 0.4 mi @ 204° /WSW	16.4 (4/4) (14.8-17.5)	(See Control below.)	0
TLD (Outer Ring, 4-5 mi. distant) mR/91 days)	Gamma 60	3.0	17.2 (60/60) (13.4-22.1)	P-02B, Roy Kinneman, 4.8 mi @ 17° /NNE	19.7 (4/4) (16.1-22.1)	(See Control below.)	0
TLD (Special Interest Areas) mR/91 days)	Gamma 32	3.0	15.8 (32/32) (12.2-19.7)	P-03S, Gustafson Farm, 2.2 mi @ 173° /S	18.3 (4/4) (16.1-19.6)	(See Control below.)	0
TLD (Control) mR/91 days)	Gamma 4	3.0	None	P-01C, R. Kinneman, 11.1 mi @ 331° /NNW	17.5 (4/4) (15.7-18.8)	17.5 (4/4) (15.7-18.8)	0
Airborne Particulates (pCi/m³)	GB 259	0.005	0.024 (208/208) (0.007-0.048)	P-02, Air Station 0.5 mi @ 294° /WNW	0.024 (52 /52) (0.007-0.048)	0.022 (51/51) (0.011-0.045)	0
	GS 20						
	Be-7	0.015	0.070 (16/16) (0.052-0.087)	P-04, Air Station 0.4 mi @ 359° /N	0.074 (4/4) (0.055-0.087)	0.064 (4/4) (0.045-0.084)	0
	Mn-54	0.0009	< LLD	-	-	< LLD	0
	Co-58	0.0010	< LLD	-	-	< LLD	0
	Co-60	0.0011	< LLD	-	-	< LLD	0
	Zn-65	0.0021	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.0021	< LLD	-	-	< LLD	0
	Ru-103	0.0014	< LLD	-	-	< LLD	0
	Ru-106	0.0071	< LLD	-	-	< LLD	0
	Cs-134	0.0009	< LLD	-	-	< LLD	0
	Cs-137	0.0010	< LLD	-	-	< LLD	0
	Ba-La-140	0.0035	< LLD	-	-	< LLD	0
	Ce-141	0.0025	< LLD	-	-	< LLD	0
	Ce-144	0.0058	< LLD	-	-	< LLD	0
Airborne Iodine (pCi/m³)	I-131 259	0.07	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility: Prairie Island Nuclear Power Station — Docket No. 50-282, 50-306
Location of Facility: Goodhue, Minnesota (County, State) — Reporting Period January-December, 1999

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Milk (pCi/L)	I-131 71	1.0	< LLD	-	-	< LLD	0
	GS 71						
	K-40	200	1445 (54/54) (1223-1677)	P-37, Welsch Farm 4.1 mi @ 87° /E	1480 (18 /18) (1366-1677)	1386 (17/17) (1115-1260)	0
	Cs-134	15	< LLD	-	-	< LLD	0
	Cs-137	15	< LLD	-	-	< LLD	0
	Ba-La-140	15	< LLD	-	-	< LLD	0
River Water (pCi/L)	H-3 8	190	< LLD	-	-	< LLD	0
	GS 24						
	Mn-54	15	< LLD	-	-	< LLD	0
	Fe-59	30	< LLD	-	-	< LLD	0
	Co-58	15	< LLD	-	-	< LLD	0
	Co-60	15	< LLD	-	-	< LLD	0
	Zn-65	30	< LLD	-	-	< LLD	0
	Zr-Nb-95	15	< LLD	-	-	< LLD	0
	Cs-134	15	< LLD	-	-	< LLD	0
	Cs-137	18	< LLD	-	-	< LLD	0
	Ba-La-140	15	< LLD	-	-	< LLD	0
	Ce-144	55	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility: Prairie Island Nuclear Power Station
Location of Facility: Goodhue, Minnesota (County, State)
Docket No.: 50-282, 50-306
Reporting Period: January-December, 1999

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Drinking Water (pCi/L)	GB 12	1.0	5.3 (12/12) (1.8-11.1)	P-11, Red Wing S.C. 3.3 mi @ 158° /SSE	5.3 (12/12) (1.8-11.1)	None	0
	I-131 12	1.0	< LLD	-	-	None	0
	H-3 4	190	< LLD	-	-	None	0
	GS 12						
	Mn-54	15	< LLD	-	-	None	0
	Fe-59	30	< LLD	-	-	None	0
	Co-58	15	< LLD	-	-	None	0
	Co-60	15	< LLD	-	-	None	0
	Zn-65	30	< LLD	-	-	None	0
	Zr-Nb-95	15	< LLD	-	-	None	0
	Cs-134	10	< LLD	-	-	None	0
	Cs-137	10	< LLD	-	-	None	0
	Ba-La-140	15	< LLD	-	-	None	0
	Ce-144	64	< LLD	-	-	None	0
Well Water (pCi/L)	H-3 16	183	< LLD	-	-	< LLD	0
	GS 16						
	Mn-54	15	< LLD	-	-	< LLD	0
	Fe-59	30	< LLD	-	-	< LLD	0
	Co-58	15	< LLD	-	-	< LLD	0
	Co-60	15	< LLD	-	-	< LLD	0
	Zn-65	30	< LLD	-	-	< LLD	0
	Zr-Nb-95	15	< LLD	-	-	< LLD	0
	Cs-134	10	< LLD	-	-	< LLD	0
	Cs-137	18	< LLD	-	-	< LLD	0
	Ba-La-140	15	< LLD	-	-	< LLD	0
	Ce-144	93	< LLD	-	-	< LLD	0
Crops - Cabbage (pCi/gwet)	I-131 2	0.021	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility: Prairie Island Nuclear Power Station — Docket No. 50-282, 50-306
Location of Facility: Goodhue, Minnesota (County, State) — Reporting Period January-December, 1999

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean Location[d]	Location with Highest Annual Mean Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Fish	GS 4						
(pCi/g wet)	K-40	0.10	3.45 (2/2) (3.40-3.50)	P-19, Upstream 1.3 mi. @ 0° /N	3.58 (2/2) (3.42-3.73)	3.58 (2/2) (3.42-3.73)	0
	Mn-54	0.012	< LLD	-	-	< LLD	0
	Fe-59	0.093	< LLD	-	-	< LLD	0
	Co-58	0.033	< LLD	-	-	< LLD	0
	Co-60	0.017	< LLD	-	-	< LLD	0
	Zn-65	0.042	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.032	< LLD	-	-	< LLD	0
	Cs-134	0.017	< LLD	-	-	< LLD	0
	Cs-137	0.016	< LLD	-	-	< LLD	0
	Ba-La-140	0.89	< LLD	-	-	< LLD	0
Invertebrates	GS 4						
(pCi/g wet)	Be-7	0.65	< LLD	-	-	< LLD	0
	K-40	1.47	< LLD	-	-	< LLD	0
	Mn-54	0.057	< LLD	-	-	< LLD	0
	Co-58	0.050	< LLD	-	-	< LLD	0
	Co-60	0.067	< LLD	-	-	< LLD	0
	Zn-65	0.24	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.10	< LLD	-	-	< LLD	0
	Ru-103	0.097	< LLD	-	-	< LLD	0
	Ru-106	0.52	< LLD	-	-	< LLD	0
	Cs-134	0.071	< LLD	-	-	< LLD	0
	Cs-137	0.055	< LLD	-	-	< LLD	0
	Ba-La-140	0.34	< LLD	-	-	< LLD	0
	Ce-141	0.14	< LLD	-	-	< LLD	0
	Ce-144	0.28	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility: Prairie Island Nuclear Power Station — Docket No. 50-282, 50-306
Location of Facility: Goodhue, Minnesota (County, State) — Reporting Period January-December, 1999

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Bottom and Shoreline Sediments (pCi/g dry)	GS 6						
	Be-7	0.27	< LLD	-	-	< LLD	0
	K-40	0.10	8.11 (4/4) (7.65-8.37)	P-20, Upstream 0.9 mi. @ 45° /NE	10.03 (4/4) (9.64-10.42)	10.03 (4/4) (9.64-10.42)	0
	Mn-54	0.019	< LLD	-	-	< LLD	0
	Co-58	0.022	< LLD	-	-	< LLD	0
	Co-60	0.019	< LLD	-	-	< LLD	0
	Zn-65	0.088	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.039	< LLD	-	-	< LLD	0
	Ru-103	0.028	< LLD	-	-	< LLD	0
	Ru-106	0.21	< LLD	-	-	< LLD	0
	Cs-134	0.040	< LLD	-	-	< LLD	0
	Cs-137	0.024	< LLD	-	-	< LLD	0
	Ba-La-140	0.063	< LLD	-	-	< LLD	0
	Ce-141	0.052	< LLD	-	-	< LLD	0
	Ce-144	0.15	< LLD	-	-	< LLD	0

[a] GB = gross beta, GS = gamma scan.

[b] LLD = nominal lower limit of detection based on a 4.66 sigma counting error for background sample.

[c] Mean and range are based on detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

[d] Locations are specified: (1) by name, and/or station code (Table 2) and (2) by distance (miles) and direction relative to reactor site.

[e] Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten time the typical preoperational value for the medium or location.

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APPENDIX A

INTERLABORATORY COMPARISON PROGRAM RESULTS

NOTE: Teledyne Brown Engineering - Environmental Services, Midwest Laboratory participates in intercomparison studies administered by Environmental Resources Associates, and serves as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. Results are reported in Appendix A. TLD Intercomparison results, in-house spikes, blanks, duplicates and mixed analyte performance evaluation program results are also reported. Appendix A is updated four times a year; the complete Appendix is included in March, June, September and December monthly progress reports only.

January, 1999 through December, 1999

Appendix A

Interlaboratory Comparison Program Results

Teledyne Brown Engineering Environmental Services Midwest Laboratory has participated in interlaboratory comparison (crosscheck) programs since the formulation of it's quality control program in December 1971. These programs are operated by agencies which supply environmental type samples (e.g., milk or water) containing concentrations of radionuclides known to the issuing agency but not to participant laboratories. The purpose of such a program is to provide an independent check on the laboratory's analytical procedures and to alert it to any possible problems.

Participant laboratories measure the concentration of specified radionuclides and report them to the issuing agency. Several months later, the agency reports the known values to the participant laboratories and specifies control limits. Results consistently higher or lower than the known values or outside the control limits indicate a need to check the instruments or procedures used.

The results in Table A-1 were obtained through participation in the environmental sample crosscheck program for milk, water and air filters during the past twelve months. Data for previous years is available upon request.

This program was conducted by Environmental Resources Associates and serves to replace studies conducted by the U.S. Environmental Protection Agency.

The results in Table A-2 were obtained for Thermoluminescent Dosimeters (TLDs), via various International Intercomparisons of Environmental Dosimeters under the sponsorships listed in Table A-2. Also Teledyne testing results are listed.

Table A-3 lists results of the analyses on in-house "spiked" samples for the past twelve months. All samples are prepared using NIST traceable sources. Data for previous years available upon request.

Table A-4 lists results of the analyses on in-house "blank" samples for the past twelve months. Data for previous years available upon request.

Table A-5 list results of the in-house "duplicate" program for the past twelve months. Acceptance is based on the difference of the results being less than the sum of the errors. Data for previous years available upon request.

The results in Table A-6 were obtained through participation in the Mixed Analyte Performance Evaluation Program.

The results in Table A-7 were obtained through participation in the Environmental Measurement Laboratory Quality Assessment Program.

Attachment A lists acceptance criteria for "spiked" samples.

Out-of-limit results are explained directly below the result.

ATTACHMENT A

ACCEPTANCE CRITERIA FOR "SPIKED" SAMPLES

LABORATORY PRECISION: ONE STANDARD DEVIATION VALUES FOR VARIOUS ANALYSES[a]

Analysis	Level	One Standard Deviation for single determinations
Gamma Emitters	5 to 100 pCi/liter or kg >100 pCi/liter or kg	5.0 pCi/liter 5% of known value
Strontium-89[b]	5 to 50 pCi/liter or kg >50 pCi/liter or kg	5.0 pCi/liter 10% of known value
Strontium-90[b]	2 to 30 pCi/liter or kg >30 pCi/liter or kg	5.0 pCi/liter 10% of known value
Potassium-40	>0.1 g/liter or kg	5% of known value
Gross alpha	≤20 pCi/liter >20 pCi/liter	5.0 pCi/liter 25% of known value
Gross beta	≤100 pCi/liter >100 pCi/liter	5.0 pCi/liter 5% of known value
Tritium	≤4,000 pCi/liter >4,000 pCi/liter	1s = (pCi/liter) = $169.85 \times (\text{known})^{0.0933}$ 10% of known value
Radium-226,-228	<0.1 pCi/liter	15% of known value
Plutonium	0.1 pCi/liter, gram, or sample	10% of known value
Iodine-131, Iodine-129[b]	≤55 pCi/liter >55 pCi/liter	6.0 pCi/liter 10% of known value
Uranium-238, Nickel-63[b] Technetium-99[b]	≤35 pCi/liter >35 pCi/liter	6.0 pCi/liter 15% of known value
Iron-55[b]	50 to 100 pCi/liter >100 pCi/liter	10 pCi/liter 10% of known value
Others[b]	–	20% of known value

[a] From EPA publication, "Environmental Radioactivity Laboratory Intercomparison Studies Program, Fiscal Year, 1981-1982, EPA-600/4-81-004.

[b] Teledyne limit.

Table A-1. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA), comparison of ERA and Teledyne Midwest Laboratory results[a].

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L[b] Teledyne Results ±2 Sigma[c]	ERA Result[d] 1s, N=1	Control Limits
STW-861	WATER	Sep, 1999	Ra-226	15.6 ± 0.3	16.5 ± 1.7	12.2 - 20.8
STW-861	WATER	Sep, 1999	Ra-228	3.2 ± 0.3	2.2 ± 0.2	1.2 - 3.1
The activity reported is the average of three separate analyses. Individual results : 2.6, 2.9 and 4.0.						
STW-861	WATER	Sep, 1999	Uranium	39.4 ± 1.2	45.4 ± 4.5	37.7 - 53.1
STW-862	WATER	Nov, 1999	I-131	23.9 ± 0.1	23.3 ± 2.3	18.1 - 28.5

[a] Results obtained by Teledyne Brown Engineering Environmental Services Midwest Laboratory as a participant in the environmental sample crosscheck program operated by Environmental Resource Associates(ERA).

[b] All results are in pCi/L, except for elemental potassium (K) data in milk, which are in mg/L; air filter samples, which are in pCi/Filter.

[c] Unless otherwise indicated, the TBEESML results are given as the mean ± 2 standard deviations for three determinations.

[d] ERA results are presented as the known values and expected laboratory precision (1s, 1 determination) and control limits as defined by ERA.

Table A-2. Crosscheck program results; Thermoluminescent Dosimeters. (TLDs).

Lab Code	TLD Type	Date	Measurement	mR: Teledyne Results ± 2 Sigma	mR: Known Value	mR: Average ± 2 Sigma (All Participants)
Teledyne Testing						
98-1	LiF-100 Chips	May, 1998	Lab, 1	15.5 ± 1.3	16.7	-
98-1	LiF-100 Chips	May, 1998	Lab, 2	23.9 ± 0.9	32.4	-
98-1	LiF-100 Chips	May, 1998	Lab, 3	59.8 ± 1.9	60.2	-
98-1	$CaSO_4$: Dy Cards	May, 1998	Reader 1, #1	18.5 ± 0.8	16.7	-
98-1	$CaSO_4$: Dy Cards	May, 1998	Reader 1, #2	27.3 ± 1.7	32.4	-
98-1	$CaSO_4$: Dy Cards	May, 1998	Reader 1, #3	70.0 ± 4.7	60.2	-
Chips and Cards were irradiated by Teledyne Brown Engineering, Westwood, New Jersey, in May, 1998.						
Teledyne Testing						
99-1	LiF-100 Chips	Mar, 1999	Lab, 1	14.5 ± 0.5	15.4	-
99-1	LiF-100 Chips	Mar, 1999	Lab, 2	29.3 ± 1.0	31.8	-
99-1	LiF-100 Chips	Mar, 1999	Lab, 3	60.0 ± 0.2	59.1	-
99-1	$CaSO_4$: Dy Cards	Mar, 1999	Reader 1, #1	18.3 ± 0.5	15.4	-
99-1	$CaSO_4$: Dy Cards	Mar, 1999	Reader 1, #2	35.9 ± 1.3	31.8	-
99-1	$CaSO_4$: Dy Cards	Mar, 1999	Reader 1, #3	66.5 ± 4.4	59.1	-
Chips and Cards were irradiated by Teledyne Brown Engineering, Westwood, New Jersey, in March, 1999.						

Table A-3. In-house "spike" samples.

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L[a] Teledyne Results 2s, n=1[b]	Known Activity	Control[c] Limits
SPW-140	WATER	Jan, 1999	Ra-226	14.51 ± 0.52	13.79	9.65 - 17.93
SPW-140	WATER	Jan, 1999	Ra-228	9.47 ± 1.49	8.28	5.80 - 10.76
SPW-142	WATER	Jan, 1999	Gr. Alpha	30.82 ± 2.49	33.97	16.99 - 50.96
SPW-142	WATER	Jan, 1999	Gr. Beta	30.87 ± 1.91	30.18	20.18 - 40.18
SPW-254	WATER	Jan, 1999	H-3	37752.00 ± 540.00	38559.00	30847.20 - 46270.80
SPAP-270	AIR FILTER	Jan, 1999	Cs-137	2.04 ± 0.02	1.82	1.09 - 2.55
SPAP-787	AIR FILTER	Jan, 1999	Gr. Beta	5.97 ± 0.02	5.38	0.00 - 15.38
SPW-789	WATER	Jan, 1999	Co-60	44.83 ± 7.11	40.46	30.46 - 50.46
SPW-789	WATER	Jan, 1999	Cs-137	45.17 ± 8.63	37.70	27.70 - 47.70
SPW-791	WATER	Feb, 1999	Ra-226	15.50 ± 0.60	13.80	9.66 - 17.94
SPW-791	WATER	Feb, 1999	Ra-228	6.36 ± 1.39	8.20	5.74 - 10.66
SPW-792	WATER	Feb, 1999	Gr. Alpha	24.36 ± 2.08	33.97	16.99 - 50.96
SPW-792	WATER	Feb, 1999	Gr. Beta	28.98 ± 1.79	30.13	20.13 - 40.13
SPU-1030	WATER	Feb, 1999	Ra-226	38.81 ± 1.30	34.45	24.12 - 44.79
SPW-1460	WATER	Mar, 1999	Ra-226	13.26 ± 0.55	13.79	9.65 - 17.93
SPW-1460	WATER	Mar, 1999	Ra-228	12.53 ± 1.47	16.26	11.38 - 21.13
SPW-1466	WATER	Mar, 1999	Gr. Alpha	61.00 ± 3.08	49.44	24.72 - 74.15
SPW-1466	WATER	Mar, 1999	Gr. Beta	35.52 ± 1.86	30.07	20.07 - 40.07
SPMI-1677	MILK	Mar, 1999	Cs-137	17.17 ± 2.08	18.78	8.78 - 28.78
SPMI-1677	MILK	Mar, 1999	Sr-90	34.94 ± 1.53	31.85	25.48 - 38.22
SPW-1681	WATER	Mar, 1999	Sr-89	49.30 ± 3.85	59.20	47.36 - 71.04
SPW-1681	WATER	Mar, 1999	Sr-90	29.00 ± 1.65	31.85	25.48 - 38.22
SPW-2264	WATER	Apr, 1999	Ra-226	12.44 ± 0.14	13.80	9.66 - 17.94
SPW-2264	WATER	Apr, 1999	Ra-228	18.73 ± 1.92	16.08	11.26 - 20.90
SPAP-2395	AIR FILTER	Apr, 1999	Cs-137	1.86 ± 0.02	1.81	1.09 - 2.53
SPW-2265	WATER	Apr, 1999	Gr. Alpha	62.89 ± 5.90	49.40	24.70 - 74.10
SPW-2265	WATER	Apr, 1999	Gr. Beta	34.52 ± 3.24	30.00	20.00 - 40.00
SPW-2574	WATER	Apr, 1999	H-3	56548.00 ± 648.00	57517.00	46013.60 - 69020.40
SPMI-2686	MILK	Apr, 1999	Cs-134	23.56 ± 5.30	22.30	12.30 - 32.30
SPMI-2686	MILK	Apr, 1999	Cs-137	40.21 ± 7.19	37.50	27.50 - 47.50
SPW-2688	WATER	Apr, 1999	Co-60	20.79 ± 5.61	19.64	9.64 - 29.64
SPW-2688	WATER	Apr, 1999	Cs-134	23.16 ± 6.13	22.29	12.29 - 32.29
SPW-2688	WATER	Apr, 1999	Cs-137	37.49 ± 3.75	31.60	21.60 - 41.60
SPAP-2653	AIR FILTER	Apr, 1999	Gr. Beta	8.96 ± 0.05	8.19	0.00 - 18.19
SPVE-2977	VEGETATION	May, 1999	Cs-134	0.67 ± 0.04	0.68	0.41 - 0.95
SPVE-2977	VEGETATION	May, 1999	Cs-137	0.55 ± 0.05	0.58	0.35 - 0.81
SPW-3314	WATER	May, 1999	Ra-226	13.62 ± 0.35	13.79	9.65 - 17.93
SPW-3314	WATER	May, 1999	Ra-228	16.57 ± 1.73	15.93	11.15 - 20.71
SPSO-3317	SOIL	May, 1999	Cs-134	0.09 ± 0.01	0.07	0.04 - 0.10
SPSO-3317	SOIL	May, 1999	Cs-137	0.54 ± 0.05	0.42	0.25 - 0.59
SPSO-3318	SOIL	May, 1999	Cs-134	0.09 ± 0.02	0.07	0.04 - 0.10

Table A-3. In-house "spike" samples.

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L[a] Teledyne Results 2s, n=1[b]	Known Activity	Control[c] Limits
SPSO-3318	SOIL	May, 1999	Cs-137	0.54 ± 0.02	0.42	0.25 - 0.59
SPW-3315	WATER	May, 1999	Gr. Beta	32.57 ± 1.63	29.95	19.95 - 39.95
SPF-3777	FISH	May, 1999	Cs-134	0.43 ± 0.03	0.52	0.31 - 0.73
SPF-3777	FISH	May, 1999	Cs-137	0.57 ± 0.04	0.60	0.36 - 0.84
SPW-3721	WATER	Jun, 1999	Rn-222	553.52 ± 46.70	610.35	366.21 - 854.49
SPW-4005	WATER	Jun, 1999	Ra-226	13.85 ± 0.42	13.79	9.65 - 17.93
SPW-4005	WATER	Jun, 1999	Ra-228	16.42 ± 1.81	15.77	11.04 - 20.50
SPW-4006	WATER	Jun, 1999	Gr. Alpha	46.32 ± 2.80	49.41	24.71 - 74.12
SPW-4006	WATER	Jun, 1999	Gr. Beta	32.12 ± 1.83	29.90	19.90 - 39.90
SPW-4869	WATER	Jul, 1999	Ra-226	14.00 ± 0.47	13.79	9.65 - 17.93
SPW-4869	WATER	Jul, 1999	Ra-228	14.96 ± 1.53	15.62	10.93 - 20.31
SPW-4870	WATER	Jul, 1999	Gr. Alpha	70.07 ± 3.45	29.84	14.92 - 44.76
SPW-4870	WATER	Jul, 1999	Gr. Beta	84.01 ± 2.62	41.18	31.18 - 51.18
Results for gross alpha and beta appear to be approximately 2x the spike level. The sample volume or spike level is suspect.						
SPW-4964	WATER	Jul, 1999	H-3	60442.00 ± 679.00	56807.00	45445.60 - 68168.40
SPAP-5001	AIR FILTER	Jul, 1999	Cs-137	2.03 ± 0.02	1.79	1.07 - 2.51
SPAP-5003	AIR FILTER	Jul, 1999	Gr. Beta	7.48 ± 0.02	8.15	0.00 - 18.15
SPMI-5348	MILK	Jul, 1999	Sr-89	46.85 ± 4.96	55.53	44.42 - 66.64
SPMI-5348	MILK	Jul, 1999	Sr-90	31.47 ± 1.65	31.60	25.28 - 37.92
SPW-5502	WATER	Jul, 1999	Sr-89	43.27 ± 2.81	51.15	40.92 - 61.38
SPW-5502	WATER	Jul, 1999	Sr-90	31.80 ± 1.56	31.59	25.27 - 37.91
SPF-5676	FISH	Jul, 1999	Cs-134	0.67 ± 0.04	0.65	0.39 - 0.91
SPF-5676	FISH	Jul, 1999	Cs-137	0.63 ± 0.05	0.60	0.36 - 0.83
SPCH-5833	CHARCOAL CANISTER	Aug, 1999	I-131(g)	1.46 ± 0.06	1.40	0.84 - 1.96
SPVE-5826	VEGETATION	Aug, 1999	I-131(g)	1.43 ± 0.09	1.25	0.75 - 1.75
SPMI-5828	MILK	Aug, 1999	Cs-134	31.46 ± 5.05	30.23	20.23 - 40.23
SPMI-5828	MILK	Aug, 1999	Cs-137	39.22 ± 7.60	37.23	27.23 - 47.23
SPMI-5828	MILK	Aug, 1999	I-131	72.33 ± 1.06	79.17	63.34 - 95.00
SPMI-5828	MILK	Aug, 1999	I-131(g)	77.99 ± 8.12	79.17	47.50 - 89.17
SPW-5830	WATER	Aug, 1999	Ra-226	13.82 ± 0.34	13.79	9.65 - 17.93
SPW-5830	WATER	Aug, 1999	Ra-228	13.59 ± 1.80	15.46	10.82 - 20.10
SPW-5831	WATER	Aug, 1999	Gr. Alpha	46.05 ± 2.93	41.17	20.59 - 61.76
SPW-5831	WATER	Aug, 1999	Gr. Beta	35.66 ± 2.01	29.78	19.78 - 39.78
SPW-6076	WATER	Aug, 1999	I-131-	83.72 ± 0.98	99.30	79.44 - 119.16
SPW-6076	WATER	Aug, 1999	I-131(g)	105.38 ± 18.30	99.30	59.58 - 109.30
SPW-6542	WATER	Sep, 1999	Ra-226	15.38 ± 0.52	13.79	9.65 - 17.93
SPW-6542	WATER	Sep, 1999	Ra-228	16.48 ± 2.25	15.46	10.82 - 20.10
SPW-6543	WATER	Sep, 1999	Gr. Alpha	47.77 ± 2.69	41.17	20.59 - 61.76
SPW-6543	WATER	Sep, 1999	Gr. Beta	35.25 ± 1.86	29.78	19.78 - 39.78
SPW-7468	WATER	Oct, 1999	Ra-226	14.36 ± 0.41	13.79	9.65 - 17.93

Table A-3. In-house "spike" samples.

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L[a] Teledyne Results 2s, n=1[b]	Known Activity	Control[c] Limits
SPW-6543	WATER	Sep, 1999	Gr. Beta	35.25 ± 1.86	29.78	19.78 - 39.78
SPW-7468	WATER	Oct, 1999	Ra-226	14.36 ± 0.41	13.79	9.65 - 17.93
SPW-7468	WATER	Oct, 1999	Ra-228	13.41 ± 1.45	15.16	10.61 - 19.71
SPW-7469	WATER	Oct, 1999	Gr. Beta	31.37 ± 3.16	29.68	19.68 - 39.68
SPW-7486	WATER	Oct, 1999	I-131	49.26 ± 0.89	48.82	36.82 - 60.82
SPMI-7488	MILK	Oct, 1999	I-131	49.54 ± 0.89	48.82	36.82 - 60.82
SPSO-7761	SOIL	Oct, 1999	Cs-134	0.06 ± 0.01	0.07	0.04 - 0.10
SPSO-7761	SOIL	Oct, 1999	Cs-137	0.53 ± 0.01	0.49	0.29 - 0.69
SPAP-7763	AIR FILTER	Oct, 1999	Cs-137	1.84 ± 0.02	1.79	1.07 - 2.51
SPW-7469	WATER	Oct, 1999	Gr. Alpha	43.55 ± 4.67	41.16	20.58 - 61.74
SPF-8545	FISH	Oct, 1999	Cs-134	0.60 ± 0.03	0.59	0.36 - 0.83
SPF-8545	FISH	Oct, 1999	Cs-137	0.60 ± 0.04	0.59	0.36 - 0.83
SPMI-9028	MILK	Oct, 1999	Cs-134	39.43 ± 6.37	37.43	27.43 - 47.43
SPMI-9028	MILK	Oct, 1999	Cs-137	40.93 ± 9.42	37.05	27.05 - 47.05
SPW-8773	WATER	Nov, 1999	Ra-226	11.30 ± 0.14	13.79	9.65 - 17.93
SPW-8773	WATER	Nov, 1999	Ra-228	15.18 ± 2.26	15.00	10.50 - 19.50
SPW-8774	WATER	Nov, 1999	Gr. Alpha	43.12 ± 3.09	41.15	20.58 - 61.73
SPW-8774	WATER	Nov, 1999	Gr. Beta	31.98 ± 2.06	29.62	19.62 - 39.62
SPW-9133	WATER	Nov, 1999	Co-60	30.70 ± 4.43	29.06	19.06 - 39.06
SPW-9133	WATER	Nov, 1999	Cs-134	40.56 ± 4.53	36.59	26.59 - 46.59
SPW-9133	WATER	Nov, 1999	Cs-137	38.20 ± 6.14	36.98	26.98 - 46.98
SPW-9720	WATER	Nov, 1999	H-3	57335.00 ± 657.00	58177.00	46541.60 - 69812.40
SPW-9717	WATER	Dec, 1999	Ra-228	18.88 ± 1.80	14.80	10.36 - 19.24
SPW-9719	WATER	Dec, 1999	Ra-226	14.91 ± 0.48	13.79	9.65 - 17.93
SPCH-9806	CHARCOAL CANISTER	Dec, 1999	I-131(g)	0.06 ± 0.01	0.06	0.04 - 0.09
SPW-9718	WATER	Dec, 1999	Gr. Alpha	44.82 ± 2.39	44.81	22.41 - 67.22
SPW-9718	WATER	Dec, 1999	Gr. Beta	33.93 ± 1.72	29.54	19.54 - 39.54
SPW-9718	WATER	Dec, 1999	Gr. Beta	33.93 ± 1.72	29.54	19.54 - 39.54

[a] All results are in pCi/L, except for elemental potassium (K) in milk, which are in mg/L.; air filter samples, which are in pCi/Filter; and food products, which are in mg/kg.
[b] All samples are the results of single determinations.
[c] Control limits are based on Attachment A, page A2 of this report.

NOTE: For fish, Jello is used for the spike matrix.

Table A-4. In-house "blank" samples.

Lab Code	Sample Type	Sample Date	Analysis	Concentration pCi/L[a]. Teledyne Results (4.66 Sigma) LLD	Teledyne Results (4.66 Sigma) Activity[b]	Acceptance Criteria (4.66 Sigma)
SPW-141	WATER	Jan 1999	Gr. Alpha	< 0.470	0.207 ± 0.320	< 1.00
SPW-141	WATER	Jan 1999	Gr. Beta	< 0.890	0.234 ± 0.591	< 3.20
SPW-141	WATER	Jan 1999	Ra-226	< 0.064	0.054 ± 0.030	< 1.00
SPW-141	WATER	Jan 1999	Ra-228	< 1.000	0.460 ± 0.530	< 1.00
SPW-255	WATER	Jan 1999	H-3	< 178.000	23.455 ± 94.510	< 200.00
SPW-790	WATER	Feb 1999	Gr. Alpha	< 0.440	-0.130 ± 0.250	< 1.00
SPW-790	WATER	Feb 1999	Gr. Beta	< 1.010	-0.250 ± 0.610	< 3.20
SPW-790	WATER	Feb 1999	Ra-226	< 0.036	0.026 ± 0.017	< 1.00
SPW-790	WATER	Feb 1999	Ra-228	< 0.850	0.355 ± 0.440	< 1.00
SPW-1461	WATER	Mar 1999	Gr. Alpha	< 0.800	0.060 ± 0.540	< 1.00
SPW-1461	WATER	Mar 1999	Gr. Beta	< 1.600	0.460 ± 1.080	< 3.20
SPW-1461	WATER	Mar 1999	Ra-226	< 0.044	0.071 ± 0.028	< 1.00
SPW-1461	WATER	Mar 1999	Ra-228	< 0.700	0.280 ± 0.350	< 1.00
SPMI-1678	MILK	Mar 1999	Sr-89	< 0.590	-0.190 ± 0.670	< 5.00
SPMI-1678	MILK	Mar 1999	Sr-90		1.020 ± 0.360	< 1.00
Low level of Sr-90 concentration in milk (1-5 pCi/L) is not unusual.						
SPW-1682	WATER	Mar 1999	Sr-89	< 0.530	-0.310 ± 0.450	< 5.00
SPW-1682	WATER	Mar 1999	Sr-90	< 0.590	0.256 ± 0.307	< 1.00
SPW-2263	WATER	Apr 1999	Gr. Alpha	< 0.380	-0.160 ± 0.240	< 1.00
SPW-2263	WATER	Apr 1999	Gr. Beta	< 0.880	0.320 ± 0.580	< 3.20
SPW-2263	WATER	Apr 1999	Ra-226	< 0.013	0.023 ± 0.009	< 1.00
SPW-2263	WATER	Apr 1999	Ra-228	< 0.680	0.310 ± 0.360	< 1.00
SPW-2575	WATER	Apr 1999	H-3	< 158.000	23.150 ± 79.380	< 200.00
SPAP-2652	AIR FILTER	Apr 1999	Gr. Beta	< 0.003	-0.000 ± 0.001	< 3.20
SPW-3316	WATER	May 1999	Ra-226	< 0.027	0.030 ± 0.014	< 1.00
SPW-3316	WATER	May 1999	Ra-228	< 0.800	0.192 ± 0.397	< 1.00
SPW-3316	WATER	May 1999	Gr. Alpha	< 0.830	0.310 ± 0.600	< 1.00
SPW-3316	WATER	May 1999	Gr. Beta	< 1.580	0.220 ± 1.110	< 3.20
SPW-4004	WATER	Jun 1999	Gr. Alpha	< 0.870	-0.030 ± 0.570	< 1.00
SPW-4004	WATER	Jun 1999	Gr. Beta	< 1.740	0.470 ± 1.150	< 3.20
SPW-4004	WATER	Jun 1999	Ra-226	< 0.023	0.036 ± 0.014	< 1.00
SPW-4004	WATER	Jun 1999	Ra-228	< 0.990	0.770 ± 0.551	< 1.00
SPW-4871	WATER	Jul 1999	Gr. Alpha	< 0.660	-0.420 ± 0.470	< 1.00
SPW-4871	WATER	Jul 1999	Gr. Beta	< 1.420	0.400 ± 1.060	< 3.20
SPW-4871	WATER	Jul 1999	Ra-226	< 0.019	0.021 ± 0.013	< 1.00
SPW-4871	WATER	Jul 1999	Ra-228	< 0.620	0.610 ± 0.360	< 1.00

Table A-4. In-house "blank" samples.

Lab Code	Sample Type	Sample Date	Analysis	Concentration pCi/L[a]. Teledyne Results (4.66 Sigma) LLD	Activity[b]	Acceptance Criteria (4.66 Sigma)
SPW-4965	WATER	Jul 1999	H-3	< 176.000	8.100 ± 87.800	< 200.00
SPMI-5349	MILK	Jul 1999	Sr-89	< 0.410	-0.750 ± 0.540	< 5.00
SPMI-5349	MILK	Jul 1999	Sr-90		1.140 ± 0.360	< 1.00
Low level of Sr-90 concentration in milk (1-5 pCi/L) is not unusual.						
SPW-5501	WATER	Jul 1999	Sr-89	< 0.450	0.150 ± 0.450	< 5.00
SPW-5501	WATER	Jul 1999	Sr-90	< 0.580	0.280 ± 0.310	< 1.00
SPMI-5829	MILK	Aug 1999	I-131	< 0.240	0.140 ± 0.140	< 0.50
SPW-5832	WATER	Aug 1999	Gr. Alpha	< 0.890	0.570 ± 0.600	< 1.00
SPW-5832	WATER	Aug 1999	Gr. Beta	< 2.000	0.590 ± 1.230	< 3.20
SPW-5832	WATER	Aug 1999	Ra-226	< 0.020	0.090 ± 0.010	< 1.00
SPW-5832	WATER	Aug 1999	Ra-228	< 0.780	0.110 ± 0.370	< 1.00
SPW-6067	WATER	Aug 1999	I-131	< 0.250	0.017 ± 0.170	< 0.50
SPW-6541	WATER	Sep 1999	Gr. Alpha	< 0.770	0.360 ± 0.530	< 1.00
SPW-6541	WATER	Sep 1999	Gr. Beta	< 1.690	0.410 ± 1.130	< 3.20
SPW-6541	WATER	Sep 1999	Ra-226	< 0.020	0.160 ± 0.020	< 1.00
SPW-6541	WATER	Sep 1999	Ra-228	< 1.280	0.018 ± 0.594	< 1.00
SPW-7467	WATER	Oct 1999	Ra-226		0.069 ± 0.014	< 1.00
SPW-7467	WATER	Oct 1999	Ra-228	< 0.892	0.461 ± 0.467	< 1.00
SPW-7487	WATER	Oct 1999	I-131	< 0.260	0.080 ± 0.150	< 0.50
SPMI-7489	MILK	Oct 1999	I-131	< 0.250	0.140 ± 0.150	< 0.50
SPW-8775	WATER	Nov 1999	Ra-226		0.050 ± 0.012	< 1.00
SPW-8775	WATER	Nov 1999	Ra-228	< 0.989	0.380 ± 0.500	< 1.00
SPW-9721	WATER	Nov 1999	H-3	< 158.000	51.400 ± 80.600	< 200.00
SPW-9719	WATER	Dec 1999	Ra-226		0.031 ± 0.013	< 1.00

[a] Liquid sample results are reported in pCi/Liter, air filter sample results are in pCi/filter, charcoal sample results are in pCi/charcoal, and solid sample results are in pCi/kilogram.

[b] The activity reported is the net activity result.

Table A-5. In-house "duplicate" samples.

Lab Codes	Sample Date	Analysis	Concentration in pCi/L[a] First Result	Second Result	Averaged Result
E-47, 48	Jan, 1999	Gr. Beta	1.206 ± 0.056	1.265 ± 0.061	1.236 ± 0.041
E-47, 48	Jan, 1999	K-40	1.283 ± 0.136	1.394 ± 0.182	1.339 ± 0.114
SW-68, 69	Jan, 1999	K-40 (FP)	1.300 ± 0.130	1.300 ± 0.130	1.300 ± 0.092
LW-153, 154	Jan, 1999	Gr. Beta	1.509 ± 0.647	1.619 ± 0.646	1.564 ± 0.457
WW-373, 374	Jan, 1999	H-3	171.100 ± 83.600	131.700 ± 81.800	151.400 ± 58.481
SW-867, 868	Jan, 1999	H-3	1,149.300 ± 122.100	1,225.000 ± 124.400	1,187.150 ± 87.155
SWT-425, 426	Jan, 1999	Gr. Beta	2.572 ± 0.639	2.646 ± 0.598	2.609 ± 0.438
CW-450, 451	Jan, 1999	Gr. Beta	0.600 ± 1.100	0.700 ± 1.100	0.650 ± 0.778
SW-570, 571	Feb, 1999	K-40 (FP)	1.730 ± 0.173	1.644 ± 0.164	1.687 ± 0.119
LW-614, 615	Feb, 1999	Gr. Alpha	0.354 ± 0.369	0.666 ± 0.390	0.510 ± 0.268
LW-614, 615	Feb, 1999	Gr. Beta	2.213 ± 0.406	2.613 ± 0.442	2.413 ± 0.300
MI-682, 683	Feb, 1999	Co-60	0.200 ± 0.600	-0.400 ± 2.700	-0.100 ± 1.383
MI-682, 683	Feb, 1999	Cs-137	0.300 ± 3.700	0.600 ± 2.700	0.450 ± 2.290
MI-682, 683	Feb, 1999	I-131	0.200 ± 0.300	0.200 ± 0.300	0.200 ± 0.212
WW-968, 969	Feb, 1999	H-3	199.300 ± 89.600	80.900 ± 84.500	140.100 ± 61.580
CW-1042, 1043	Feb, 1999	Gr. Beta	3.200 ± 1.500	3.500 ± 1.530	3.350 ± 1.071
LW-1523, 1524	Feb, 1999	Gr. Beta	1.930 ± 0.567	2.197 ± 0.584	2.063 ± 0.407
MI-1627, 1628	Mar, 1999	K-40	1,340.200 ± 118.000	1,409.300 ± 112.000	1,374.750 ± 81.345
WW-1808, 1809	Mar, 1999	H-3	4.400 ± 83.400	47.400 ± 85.300	25.900 ± 59.648
LW-2937, 2938	Mar, 1999	Gr. Beta	3.044 ± 0.663	3.242 ± 0.660	3.143 ± 0.468
AP-2155, 2156	Mar, 1999	Be-7	0.078 ± 0.017	0.073 ± 0.015	0.075 ± 0.011
AP-2357, 2358	Mar, 1999	Be-7	0.081 ± 0.016	0.086 ± 0.020	0.084 ± 0.013
AP-1991, 1992	Mar, 1999	Be-7	0.218 ± 0.079	0.149 ± 0.062	0.184 ± 0.050
AP-1991, 1992	Mar, 1999	Be-7	0.083 ± 0.011	0.082 ± 0.015	0.083 ± 0.009
LW-2405, 2406	Mar, 1999	Gr. Beta	3.322 ± 0.473	2.292 ± 0.468	2.807 ± 0.333
LW-2474, 2475	Mar, 1999	Gr. Beta	2.003 ± 0.592	2.742 ± 0.648	2.372 ± 0.439
LW-2474, 2475	Mar, 1999	H-3	124.016 ± 84.129	151.507 ± 85.318	137.762 ± 59.910
MI-2019, 2020	Apr, 1999	K-40	1,277.300 ± 173.000	1,377.800 ± 107.000	1,327.550 ± 101.708
MI-2019, 2020	Apr, 1999	Sr-90	0.615 ± 0.366	1.126 ± 0.368	0.871 ± 0.260
WW-2040, 2041	Apr, 1999	Gr. Beta	1.424 ± 0.316	1.233 ± 0.329	1.329 ± 0.228
WW-2040, 2041	Apr, 1999	K-40 (FP)	1.100 ± 0.110	1.100 ± 0.110	1.100 ± 0.078
MI-2134, 2135	Apr, 1999	K-40	1,316.000 ± 147.000	1,485.100 ± 168.000	1,400.550 ± 111.617
AP-2658, 2659	Apr, 1999	Be-7	0.134 ± 0.067	0.175 ± 0.105	0.154 ± 0.062
MI-2019, 2020	Apr, 1999	Calcium	0.850 ± 0.085	0.880 ± 0.088	0.865 ± 0.061
MI-2251, 2252	Apr, 1999	K-40	1,261.900 ± 156.000	1,320.800 ± 141.000	1,291.350 ± 105.139

Table A-5. In-house "duplicate" samples.

Lab Codes	Sample Date	Analysis	Concentration in pCi/L[a] First Result	Second Result	Averaged Result
MI-2451, 2452	Apr, 1999	K-40	1,647.700 ± 201.000	1,706.300 ± 159.000	1,677.000 ± 128.142
SS-2528, 2529	Apr, 1999	Gr. Beta	7.724 ± 1.978	9.287 ± 1.970	8.505 ± 1.396
SS-2528, 2529	Apr, 1999	K-40	7.530 ± 0.520	8.073 ± 0.388	7.802 ± 0.324
SS-2758, 2759	Apr, 1999	Gr. Beta	6.540 ± 2.200	4.960 ± 2.190	5.750 ± 1.552
SS-2758, 2759	Apr, 1999	K-40	7.483 ± 0.416	7.357 ± 0.432	7.420 ± 0.300
SS-2758, 2759	Apr, 1999	Sr-90	0.006 ± 0.008	-0.005 ± 0.007	0.000 ± 0.005
BS-3093, 3094	Apr, 1999	Gr. Beta	5.180 ± 1.350	5.960 ± 1.370	5.570 ± 0.962
F-3072, 3073	Apr, 1999	K-40	2.991 ± 0.332	2.438 ± 0.347	2.714 ± 0.240
MI-3001, 3002	Apr, 1999	K-40	1,485.800 ± 142.000	1,564.900 ± 162.000	1,525.350 ± 107.713
LW-3149, 3150	Apr, 1999	Gr. Beta	1.982 ± 0.595	2.120 ± 0.612	2.051 ± 0.427
SW-3047, 3048	May, 1999	Gr. Beta	2.281 ± 0.585	2.194 ± 0.567	2.238 ± 0.407
SW-3047, 3048	May, 1999	K-40 (FP)	1.300 ± 0.130	1.400 ± 0.140	1.350 ± 0.096
F-3238, 3239	May, 1999	Gr. Beta	3.329 ± 0.135	3.388 ± 0.144	3.358 ± 0.099
F-3238, 3239	May, 1999	K-40	2.866 ± 0.366	2.792 ± 0.337	2.829 ± 0.249
BS-3195, 3196	May, 1999	K-40	8.610 ± 0.620	9.320 ± 0.540	8.965 ± 0.411
AP-3769, 3770	May, 1999	Be-7	0.135 ± 0.075	0.188 ± 0.097	0.161 ± 0.061
MI-3259, 3260	May, 1999	K-40	1,444.800 ± 94.200	1,460.300 ± 166.000	1,452.550 ± 95.433
AP-3304, 3305	May, 1999	Be-7	0.104 ± 0.083	0.095 ± 0.068	0.099 ± 0.054
G-3461, 3462	May, 1999	Be-7	0.454 ± 0.210	0.350 ± 0.154	0.402 ± 0.130
G-3461, 3462	May, 1999	K-40	5.341 ± 0.492	4.837 ± 0.619	5.089 ± 0.395
SW-3217, 3218	May, 1999	Gr. Alpha	1.223 ± 1.323	2.490 ± 1.230	1.857 ± 0.903
SW-3217, 3218	May, 1999	Gr. Beta	4.956 ± 1.232	5.715 ± 1.221	5.336 ± 0.867
LW-2937, 2938	May, 1999	Gr. Beta	2.379 ± 0.626	2.864 ± 0.641	2.622 ± 0.448
SWU-2853, 2854	May, 1999	Gr. Beta	2.860 ± 0.539	3.065 ± 0.577	2.962 ± 0.395
DW-2878, 2879	May, 1999	Gr. Beta	0.706 ± 0.319	0.849 ± 0.335	0.777 ± 0.231
G-3461, 3462	May, 1999	Gr. Beta	5.205 ± 0.169	5.166 ± 0.110	5.186 ± 0.101
SO-3482, 3483	May, 1999	Cs-137	0.456 ± 0.059	0.467 ± 0.048	0.461 ± 0.038
SO-3482, 3483	May, 1999	Gr. Beta	24.880 ± 1.980	26.170 ± 2.150	25.525 ± 1.461
SO-3482, 3483	May, 1999	K-40	20.631 ± 1.240	20.077 ± 0.906	20.354 ± 0.768
SO-2832, 2833	May, 1999	Cs-137	0.390 ± 0.052	0.403 ± 0.031	0.397 ± 0.030
SO-2832, 2833	May, 1999	K-40	26.000 ± 0.660	24.673 ± 1.240	25.337 ± 0.702
SWT-3675, 3676	May, 1999	Gr. Beta	2.439 ± 0.598	2.530 ± 0.630	2.484 ± 0.434
LW-3699, 3700	May, 1999	Gr. Beta	2.488 ± 0.596	3.002 ± 0.654	2.745 ± 0.442
MI-3748, 3749	Jun, 1999	K-40	1,553.800 ± 178.000	1,408.600 ± 149.000	1,481.200 ± 116.066
SW-4107, 4108	Jun, 1999	Gr. Alpha	3.993 ± 0.919	3.606 ± 0.875	3.800 ± 0.635

Table A-5. In-house "duplicate" samples.

Lab Codes	Sample Date	Analysis	Concentration in pCi/L[a] First Result	Second Result	Averaged Result
SW-4107, 4108	Jun, 1999	Gr. Beta	6.271 ± 0.754	6.910 ± 0.807	6.591 ± 0.552
SS-4065, 4066	Jun, 1999	K-40	7.350 ± 0.400	7.945 ± 0.370	7.648 ± 0.272
AP-3986, 3987	Jun, 1999	Be-7	0.272 ± 0.147	0.182 ± 0.085	0.227 ± 0.085
G-4007, 4008	Jun, 1999	Be-7	0.830 ± 0.210	0.950 ± 0.200	0.890 ± 0.145
G-4007, 4008	Jun, 1999	K-40	5.790 ± 0.460	4.990 ± 0.400	5.390 ± 0.305
MI-4172, 4173	Jun, 1999	K-40	1,423.600 ± 115.000	1,481.300 ± 129.000	1,452.450 ± 86.409
MI-4293, 4294	Jun, 1999	K-40	1,397.200 ± 179.000	1,388.100 ± 130.000	1,392.650 ± 110.613
AP-4317, 4318	Jun, 1999	Be-7	0.201 ± 0.125	0.213 ± 0.088	0.207 ± 0.076
AP-4894, 4895	Jun, 1999	Be-7	0.092 ± 0.019	0.091 ± 0.014	0.092 ± 0.012
G-4426, 4427	Jun, 1999	Be-7	0.730 ± 0.210	0.630 ± 0.170	0.680 ± 0.135
G-4426, 4427	Jun, 1999	K-40	3.230 ± 0.350	3.400 ± 0.440	3.315 ± 0.281
AP-4454, 4455	Jun, 1999	Be-7	0.205 ± 0.120	0.238 ± 0.087	0.222 ± 0.074
SWU-4601, 4602	Jun, 1999	Gr. Beta	2.209 ± 0.568	1.980 ± 0.589	2.094 ± 0.409
SWU-4601, 4602	Jun, 1999	Gr. Beta	2.209 ± 0.568	1.980 ± 0.589	2.094 ± 0.409
SW-4622, 4623	Jun, 1999	Gr. Beta	2.130 ± 0.854	2.267 ± 0.803	2.198 ± 0.586
AP-4915, 4916	Jun, 1999	Be-7	0.089 ± 0.012	0.094 ± 0.015	0.091 ± 0.010
LW-4974, 4975	Jun, 1999	Gr. Beta	1.916 ± 0.578	2.617 ± 0.644	2.267 ± 0.433
LW-5039, 5040	Jun, 1999	Gr. Beta	2.170 ± 0.610	2.030 ± 0.580	2.100 ± 0.421
LW-5039, 5040	Jun, 1999	H-3	90.659 ± 81.800	162.800 ± 85.000	126.730 ± 58.984
G-4643, 4644	Jul, 1999	Be-7	1.326 ± 0.460	1.555 ± 0.390	1.441 ± 0.302
G-4643, 4644	Jul, 1999	Gr. Beta	5.870 ± 0.151	5.798 ± 0.150	5.834 ± 0.106
G-4643, 4644	Jul, 1999	K-40	5.738 ± 0.780	6.200 ± 0.733	5.969 ± 0.535
SW-4664, 4665	Jul, 1999	Gr. Beta	1.956 ± 0.415	1.836 ± 0.429	1.896 ± 0.298
SW-4664, 4665	Jul, 1999	K-40	1.120	1.120	1.120
WW-4690, 4691	Jul, 1999	Co-60	0.860 ± 1.840	0.374 ± 0.344	0.617 ± 0.936
WW-4690, 4691	Jul, 1999	Cs-137	-0.806 ± 3.130	-2.010 ± 2.610	-1.408 ± 2.038
WW-4690, 4691	Jul, 1999	H-3	399.519 ± 103.570	564.249 ± 109.428	481.884 ± 75.335
WW-4808, 4809	Jul, 1999	Co-60	-0.360 ± 1.910	1.420 ± 25.700	0.530 ± 12.885
WW-4808, 4809	Jul, 1999	Cs-137	0.446 ± 2.260	-1.060 ± 1.720	-0.307 ± 1.420
WW-4808, 4809	Jul, 1999	H-3	72.004 ± 90.621	94.545 ± 91.551	83.274 ± 64.409
MI-4742, 4743	Jul, 1999	K-40	1,344.000 ± 66.000	1,375.000 ± 112.000	1,359.500 ± 65.000
CW-5018, 5019	Jul, 1999	H-3	364.162 ± 92.219	430.163 ± 94.673	397.163 ± 66.082
VE-4873, 4874	Jul, 1999	Be-7	2.023 ± 0.294	1.882 ± 0.338	1.953 ± 0.224
VE-4873, 4874	Jul, 1999	K-40	7.894 ± 0.650	7.394 ± 0.655	7.644 ± 0.461
F-5124, 5125	Jul, 1999	K-40	2.394 ± 0.364	2.802 ± 0.360	2.598 ± 0.256

Table A-5. In-house "duplicate" samples.

Lab Codes	Sample Date	Analysis	Concentration in pCi/L[a] First Result	Second Result	Averaged Result
VE-5187, 5188	Jul, 1999	K-40	2.990 ± 0.422	3.265 ± 0.446	3.128 ± 0.307
VE-5187, 5188	Jul, 1999	Sr-90	0.005 ± 0.002	0.002 ± 0.002	0.004 ± 0.002
CW-5212, 5213	Jul, 1999	Gr. Beta	2.187 ± 1.449	2.452 ± 1.381	2.320 ± 1.001
CW-5212, 5213	Jul, 1999	Gr. Beta	-0.405 ± 1.220	-0.438 ± 1.196	-0.422 ± 0.854
MI-5260, 5261	Jul, 1999	K-40	1,367.000 ± 172.000	1,462.000 ± 161.000	1,414.500 ± 117.797
MI-5287, 5288	Jul, 1999	K-40	1,417.900 ± 89.000	1,280.700 ± 163.000	1,349.300 ± 92.857
PW-5237, 5238	Jul, 1999	H-3	189.773 ± 96.797	220.943 ± 97.971	205.358 ± 68.862
AP-5329, 5330	Jul, 1999	Be-7	0.168 ± 0.065	0.140 ± 0.122	0.154 ± 0.069
SWU-5379, 5380	Jul, 1999	Gr. Beta	2.571 ± 0.605	2.219 ± 0.611	2.395 ± 0.430
SWU-5379, 5380	Jul, 1999	H-3	484.749 ± 105.455	520.309 ± 106.709	502.529 ± 75.013
G-5354, 5355	Jul, 1999	Be-7	1.120 ± 0.270	1.030 ± 0.160	1.075 ± 0.157
G-5354, 5355	Jul, 1999	K-40	6.160 ± 0.450	5.990 ± 0.530	6.075 ± 0.348
MI-5520, 5521	Jul, 1999	Co-60	-1.180 ± 3.460	-2.330 ± 2.740	-1.755 ± 2.207
MI-5520, 5521	Jul, 1999	Cs-137	1.450 ± 2.200	3.160 ± 2.660	2.305 ± 1.726
MI-5520, 5521	Jul, 1999	I-131	0.184 ± 0.283	0.009 ± 0.285	0.096 ± 0.201
AP-5499, 5500	Jul, 1999	Be-7	0.181 ± 0.070	0.175 ± 0.066	0.178 ± 0.048
CW-5550, 5551	Jul, 1999	Gr. Beta	1.858 ± 1.362	1.361 ± 1.329	1.609 ± 0.952
CW-5550, 5551	Jul, 1999	Gr. Beta	1.208 ± 1.334	-0.174 ± 0.933	0.517 ± 0.814
WW-5575, 5576	Jul, 1999	H-3	224.412 ± 93.866	220.812 ± 93.728	222.612 ± 66.325
MI-5596, 5597	Jul, 1999	K-40	1,355.200 ± 157.000	1,370.900 ± 191.000	1,363.050 ± 123.622
MI-5644, 5645	Jul, 1999	Calcium	0.830 ± 0.083	0.840 ± 0.084	0.835 ± 0.059
MI-5644, 5645	Jul, 1999	K-40	1,327.000 ± 141.000	1,488.000 ± 169.000	1,407.500 ± 110.048
MI-5644, 5645	Jul, 1999	Sr-90	1.300 ± 0.350	1.070 ± 0.350	1.185 ± 0.247
MI-4742, 4743	Aug, 1999	Sr-90	0.502 ± 0.243	0.702 ± 0.303	0.602 ± 0.194
MI-5666, 5667	Aug, 1999	K-40	1,639.000 ± 161.000	1,724.800 ± 207.000	1,681.900 ± 131.120
WW-5756, 5757	Aug, 1999	Gr. Beta	1.704 ± 0.568	2.432 ± 0.567	2.068 ± 0.401
CW-5712, 5713	Aug, 1999	Gr. Beta	1.906 ± 1.360	1.608 ± 1.270	1.757 ± 0.930
CW-5712, 5713	Aug, 1999	Gr. Beta	-0.269 ± 1.174	-0.634 ± 1.076	-0.451 ± 0.796
G-5735, 5736	Aug, 1999	Be-7	2.961 ± 0.296	3.295 ± 0.492	3.128 ± 0.287
G-5735, 5736	Aug, 1999	K-40	6.731 ± 0.548	6.997 ± 0.492	6.864 ± 0.368
LW-8450, 8451	Aug, 1999	Sr-90	0.390 ± 0.310	0.570 ± 0.310	0.480 ± 0.219
SW-5841, 5842	Aug, 1999	Gr. Alpha	2.850 ± 1.675	2.500 ± 1.685	2.675 ± 1.188
SW-5841, 5842	Aug, 1999	Gr. Beta	9.343 ± 1.425	12.378 ± 1.634	10.860 ± 1.084
VE-5905, 5906	Aug, 1999	Co-60	0.013 ± 0.066	-0.000 ± 0.002	0.006 ± 0.033
VE-5905, 5906	Aug, 1999	Cs-137	0.006 ± 0.008	0.001 ± 0.009	0.004 ± 0.006

Table A-5. In-house "duplicate" samples.

Lab Codes	Sample Date	Analysis	Concentration in pCi/L[a] First Result	Second Result	Averaged Result
CW-6148, 6149	Aug, 1999	H-3	141.545 ± 89.443	74.402 ± 86.675	107.974 ± 62.275
PW-5968, 5969	Aug, 1999	H-3	1,625.921 ± 147.401	1,698.481 ± 149.269	1,662.201 ± 104.891
MI-6072, 6073	Aug, 1999	K-40	1,478.600 ± 163.000	1,675.400 ± 202.000	1,577.000 ± 129.782
G-6116, 6117	Aug, 1999	Be-7	4.178 ± 0.306	4.319 ± 0.378	4.248 ± 0.243
G-6116, 6117	Aug, 1999	K-40	5.525 ± 0.548	5.657 ± 0.486	5.591 ± 0.366
AP-6200, 6201	Aug, 1999	K-40	8.465 ± 0.356	8.822 ± 0.666	8.643 ± 0.378
DW-6121, 6122	Aug, 1999	Gr. Beta	1.229 ± 0.325	1.022 ± 0.332	1.126 ± 0.233
SWU-6345, 6346	Aug, 1999	Gr. Beta	2.417 ± 0.582	1.870 ± 0.587	2.144 ± 0.413
MI-6242, 6243	Aug, 1999	Co-60	-1.160 ± 3.210	-0.075 ± 0.105	-0.617 ± 1.606
MI-6242, 6243	Aug, 1999	Cs-137	-0.395 ± 2.610	0.534 ± 2.270	0.070 ± 1.730
MI-6242, 6243	Aug, 1999	I-131	-0.112 ± 0.226	0.119 ± 0.239	0.003 ± 0.164
VE-6263, 6264	Aug, 1999	Co-60	0.001 ± 0.002	0.009 ± 0.027	0.005 ± 0.013
VE-6263, 6264	Aug, 1999	Cs-137	0.010 ± 0.010	-0.004 ± 0.009	0.003 ± 0.007
SW-6389, 6390	Aug, 1999	K-40 (FP)	13.000 ± 1.300	12.000 ± 1.200	12.500 ± 0.885
SWU-6452, 6453	Aug, 1999	Gr. Beta	2.587 ± 0.598	2.053 ± 0.561	2.320 ± 0.410
WW-6604, 6605	Aug, 1999	Gr. Beta	2.199 ± 0.578	1.878 ± 0.594	2.039 ± 0.414
WW-6677, 6678	Aug, 1999	H-3	202.838 ± 101.400	122.240 ± 98.143	162.539 ± 70.559
WW-6506, 6507	Sep, 1999	Co-60	-0.789 ± 7.010	0.416 ± 1.310	-0.187 ± 3.566
WW-6506, 6507	Sep, 1999	Cs-137	0.568 ± 3.270	0.834 ± 3.180	0.701 ± 2.281
WW-6506, 6507	Sep, 1999	H-3	29,273.964 ± 494.519	30,525.051 ± 504.610	29,899.507 ± 353.264
MI-6410, 6411	Sep, 1999	K-40	1,128.500 ± 159.000	1,355.900 ± 174.000	1,242.200 ± 117.853
VE-6431, 6432	Sep, 1999	Gr. Beta	1.880 ± 0.053	1.917 ± 0.053	1.899 ± 0.037
VE-6431, 6432	Sep, 1999	K-40	1.697 ± 0.202	1.603 ± 0.192	1.650 ± 0.139
VE-6558, 6559	Sep, 1999	K-40	2.200 ± 0.204	2.222 ± 0.189	2.211 ± 0.139
AP-6704, 6705	Sep, 1999	Be-7	0.020 ± 0.055	0.018 ± 0.081	0.019 ± 0.049
VE-6649, 6650	Sep, 1999	Co-60	0.008 ± 0.015	-0.001 ± 0.004	0.004 ± 0.008
VE-6649, 6650	Sep, 1999	Cs-137	-0.001 ± 0.007	-0.001 ± 0.007	-0.001 ± 0.005
AP-6727, 6728	Sep, 1999	Be-7	0.109 ± 0.043	0.158 ± 0.089	0.134 ± 0.049
VE-6793, 6794	Sep, 1999	Gr. Beta	1.115 ± 0.037	1.139 ± 0.035	1.127 ± 0.025
SO-6937, 6938	Sep, 1999	Cs-137	0.225 ± 0.027	0.260 ± 0.040	0.243 ± 0.024
SO-6937, 6938	Sep, 1999	K-40	10.450 ± 0.520	10.428 ± 0.760	10.439 ± 0.460
SO-6937, 6938	Sep, 1999	Sr-90	0.041 ± 0.017	0.034 ± 0.014	0.038 ± 0.011
SWU-7045, 7046	Sep, 1999	Gr. Beta	2.623 ± 0.606	2.720 ± 0.593	2.672 ± 0.424
AP-7087, 7088	Sep, 1999	Be-7	0.091 ± 0.068	0.119 ± 0.054	0.105 ± 0.043
PW-7013, 7014	Sep, 1999	H-3	3,002.639 ± 183.527	3,038.815 ± 184.318	3,020.727 ± 130.053

Table A-5. In-house "duplicate" samples.

Lab Codes	Sample Date	Analysis	Concentration in pCi/L[a] First Result	Second Result	Averaged Result
SWT-7964, 7965	Sep, 1999	Sr-90	0.826 ± 0.411	0.501 ± 0.285	0.664 ± 0.250
W-7302, 7303	Sep, 1999	H-3	364.860 ± 109.550	221.740 ± 104.150	293.300 ± 75.578
SS-7432, 7433	Sep, 1999	K-40	8.619 ± 0.487	8.049 ± 0.508	8.334 ± 0.352
AP-7541, 7542	Sep, 1999	Be-7	0.086 ± 0.012	0.092 ± 0.014	0.089 ± 0.009
AP-7520, 7521	Sep, 1999	Be-7	0.087 ± 0.012	0.091 ± 0.011	0.089 ± 0.008
PW-7228, 7229	Oct, 1999	H-3	6,053.000 ± 243.000	6,177.000 ± 245.000	6,115.000 ± 172.536
SW-7252, 7253	Oct, 1999	H-3	544.000 ± 116.000	659.000 ± 120.000	601.500 ± 83.451
SO-7344, 7345	Oct, 1999	Cs-137	0.067 ± 0.020	0.066 ± 0.023	0.067 ± 0.015
SO-7344, 7345	Oct, 1999	Gr. Beta	27.800 ± 3.580	26.320 ± 3.550	27.060 ± 2.521
SO-7344, 7345	Oct, 1999	K-40	18.510 ± 0.690	19.680 ± 0.810	19.095 ± 0.532
SO-7344, 7345	Oct, 1999	Sr-90	0.020 ± 0.009	0.014 ± 0.008	0.017 ± 0.006
WW-7365, 7366	Oct, 1999	Gr. Beta	1.712 ± 0.500	1.341 ± 0.482	1.527 ± 0.347
WW-7365, 7366	Oct, 1999	K-40	1.200 ± 0.120	1.100 ± 0.110	1.150 ± 0.081
MI-7323, 7324	Oct, 1999	K-40	1,404.100 ± 111.000	1,374.200 ± 181.000	1,389.150 ± 106.163
F-7478, 7479	Oct, 1999	Co-60	0.010 ± 0.050	0.000 ± 0.010	0.005 ± 0.025
F-7478, 7479	Oct, 1999	Cs-137	0.000 ± 0.010	-0.010 ± 0.010	-0.005 ± 0.007
MI-7728, 7729	Oct, 1999	K-40	1,567.700 ± 170.000	1,471.900 ± 125.000	1,519.800 ± 105.505
MI-7587, 7588	Oct, 1999	K-40	1,263.200 ± 162.000	1,449.800 ± 122.000	1,356.500 ± 101.400
AP-7619, 7620	Oct, 1999	Be-7	0.166 ± 0.071	0.110 ± 0.090	0.138 ± 0.057
SL-7749, 7750	Oct, 1999	Gr. Beta	3.088 ± 0.278	3.320 ± 0.285	3.204 ± 0.199
SL-7749, 7750	Oct, 1999	K-40	1.190 ± 0.560	2.160 ± 0.500	1.675 ± 0.375
BS-7943, 7944	Oct, 1999	Gr. Beta	13.816 ± 2.943	14.263 ± 2.888	14.040 ± 2.062
BS-7943, 7944	Oct, 1999	K-40	11.681 ± 0.551	12.691 ± 0.754	12.186 ± 0.467
G-7898, 7899	Oct, 1999	Be-7	1.315 ± 0.188	1.342 ± 0.186	1.329 ± 0.132
G-7898, 7899	Oct, 1999	K-40	6.436 ± 0.449	6.292 ± 0.486	6.364 ± 0.331
CW-8058, 8059	Oct, 1999	Gr. Beta	2.520 ± 1.490	2.320 ± 1.490	2.420 ± 1.054
F-8379, 8380	Oct, 1999	K-40	2.980 ± 0.240	3.063 ± 0.262	3.021 ± 0.178
F-8171, 8172	Oct, 1999	Co-60	-0.010 ± 0.020	-0.010 ± 0.010	-0.010 ± 0.011
F-8171, 8172	Oct, 1999	Cs-137	-0.010 ± 0.010	0.000 ± 0.010	-0.005 ± 0.007
SWU-8316, 8317	Oct, 1999	Gr. Beta	2.310 ± 0.690	2.248 ± 0.691	2.279 ± 0.488
SWU-8316, 8317	Oct, 1999	H-3	187.623 ± 94.958	223.391 ± 96.366	205.507 ± 67.645
SP-8954, 8955	Oct, 1999	Gr. Beta	6.535 ± 1.721	4.745 ± 1.412	5.640 ± 1.113
CW-8425, 8426	Oct, 1999	Gr. Beta	1.720 ± 1.430	1.510 ± 1.410	1.615 ± 1.004
SS-8474, 8475	Oct, 1999	K-40	9.117 ± 0.719	9.634 ± 0.542	9.376 ± 0.450
LW-8747, 8748	Oct, 1999	Gr. Beta	1.984 ± 0.431	2.120 ± 0.476	2.052 ± 0.321

Table A-5. In-house "duplicate" samples.

Lab Codes	Sample Date	Analysis	Concentration in pCi/L[a] First Result	Second Result	Averaged Result
G-8572, 8573	Oct, 1999	Be-7	3.500 ± 0.338	3.410 ± 0.235	3.455 ± 0.206
G-8572, 8573	Oct, 1999	Gr. Beta	6.249 ± 0.167	6.679 ± 0.171	6.464 ± 0.120
G-8572, 8573	Oct, 1999	K-40	6.900 ± 0.518	6.961 ± 0.374	6.930 ± 0.319
SW-8506, 8507	Oct, 1999	H-3	5,114.000 ± 212.000	5,279.000 ± 215.000	5,196.500 ± 150.971
LW-8747, 8748	Oct, 1999	H-3	4,144.300 ± 194.900	4,392.700 ± 199.513	4,268.500 ± 139.456
SW-8614, 8615	Nov, 1999	Gr. Beta	3.884 ± 0.886	3.386 ± 0.836	3.635 ± 0.609
CW-8641, 8642	Nov, 1999	Gr. Beta	1.310 ± 1.400	2.250 ± 1.470	1.780 ± 1.015
AP-8688, 8689	Nov, 1999	Be-7	0.153 ± 0.083	0.144 ± 0.058	0.149 ± 0.051
SW-8975, 8976	Nov, 1999	H-3	-70.000 ± 85.000	-68.000 ± 85.000	-69.000 ± 60.104
MI-8928, 8929	Nov, 1999	K-40	1,328.300 ± 144.000	1,366.000 ± 163.000	1,347.150 ± 108.749
AP-9179, 9180	Nov, 1999	Be-7	0.145 ± 0.097	0.103 ± 0.055	0.124 ± 0.056
SW-9151, 9152	Nov, 1999	H-3	3,208.000 ± 174.000	3,517.000 ± 180.000	3,362.500 ± 125.176
SW-9227, 9228	Nov, 1999	Co-60	-1.320 ± 12.400	0.120 ± 0.330	-0.600 ± 6.202
SW-9227, 9228	Nov, 1999	Cs-137	0.060 ± 2.330	-0.530 ± 1.660	-0.235 ± 1.430
SW-9227, 9228	Nov, 1999	Gr. Beta	8.590 ± 1.880	9.810 ± 1.980	9.200 ± 1.365
SWU-9275, 9276	Nov, 1999	Gr. Beta	1.590 ± 0.586	1.404 ± 0.529	1.497 ± 0.395
CW-9307, 9308	Dec, 1999	Gr. Beta	0.700 ± 1.500	2.050 ± 1.630	1.375 ± 1.108
CW-9358, 9359	Dec, 1999	Gr. Beta	3.610 ± 0.460	4.210 ± 0.510	3.910 ± 0.343
CW-9358, 9359	Dec, 1999	H-3	14,646.000 ± 339.000	14,764.000 ± 340.000	14,705.000 ± 240.063
MI-9402, 9403	Dec, 1999	K-40	2,074.100 ± 174.000	1,967.700 ± 134.000	2,020.900 ± 109.809
CW-9423, 9424	Dec, 1999	Gr. Beta	1.870 ± 1.610	1.930 ± 1.610	1.900 ± 1.138
AP-9478, 9479	Dec, 1999	Be-7	0.156 ± 0.098	0.091 ± 0.058	0.123 ± 0.057
BS-9587, 9588	Dec, 1999	K-40	11.890 ± 0.550	11.624 ± 0.740	11.757 ± 0.461
LW-9525, 9526	Dec, 1999	Be-7	2.690 ± 0.630	2.340 ± 0.620	2.515 ± 0.442
AP-9767, 9768	Dec, 1999	Be-7	0.104 ± 0.072	0.144 ± 0.085	0.124 ± 0.056
SWU-9837, 9838	Dec, 1999	Gr. Beta	1.530 ± 0.530	2.504 ± 0.607	2.017 ± 0.403
CW-9870, 9871	Dec, 1999	H-3	1,221.000 ± 123.000	1,027.000 ± 117.000	1,124.000 ± 84.879
SW-9964, 9965	Dec, 1999	Co-60	-0.740 ± 2.710	0.950 ± 2.110	0.105 ± 1.717
SW-9964, 9965	Dec, 1999	Cs-137	-2.910 ± 3.140	1.830 ± 2.230	-0.540 ± 1.926
AP-10027, 10028	Dec, 1999	Be-7	0.059 ± 0.008	0.064 ± 0.011	0.062 ± 0.007
SW-9912, 9913	Dec, 1999	H-3	29.000 ± 87.000	113.000 ± 91.000	71.000 ± 62.948
WW-10069, 10070	Dec, 1999	Gr. Beta	2.539 ± 0.664	2.223 ± 0.591	2.381 ± 0.445

[a] All concentrations are reported in pCi/liter, except solid samples, which are reported in pCi/gram.

[b] Lab codes are comprised of the sample media and the sample numbers. Client codes have been eliminated to protect client anonymity.

Table A-6. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP), comparison of MAPEP and Teledyne's Midwest Laboratory results for various sample media[a].

Lab Code	Sample Type	Date Collected	Analysis	Concentration[b] Teledyne Result[c]	MAPEP Result[d] 1s, N=1	Control Limits
SPW-846	WATER	Jan, 1999	Co-57	337.60 ± 33.76	358.00	250.60 - 465.40
SPW-846	WATER	Jan, 1999	Cs-137	656.60 ± 65.66	637.00	445.90 - 828.10
SPW-846	WATER	Jan, 1999	Fe-55	724.50 ± 72.45	664.00	464.80 - 863.20
SPW-846	WATER	Jan, 1999	Mn-54	234.20 ± 23.42	229.00	160.30 - 297.70
SPW-846	WATER	Jan, 1999	Pu-238	1.10 ± 0.11	1.45	1.02 - 1.89
SPW-846	WATER	Jan, 1999	Pu-239/40	3.20 ± 0.32	4.04	2.83 - 5.25
SPW-846	WATER	Jan, 1999	Sr-90	40.90 ± 4.09	39.50	27.65 - 51.35
SPW-846	WATER	Jan, 1999	U-233/4	2.70 ± 0.27	2.67	1.87 - 3.47
SPW-846	WATER	Jan, 1999	U-238	20.80 ± 2.08	21.20	14.84 - 27.56
SPW-846	WATER	Jan, 1999	Zn-65	1,508.90 ± 150.90	1,560.00	1,092.00 - 2,028.00
STSO-854	SOIL	Jan, 1999	Am-241	6.16 ± 0.70	6.55	4.59 - 8.52
STSO-854	SOIL	Jan, 1999	Co-57	311.11 ± 3.60	360.00	252.00 - 468.00
STSO-854	SOIL	Jan, 1999	Co-60	134.57 ± 2.15	131.00	91.70 - 170.30
STSO-854	SOIL	Jan, 1999	Cs-134	682.35 ± 4.50	752.00	526.40 - 977.60
STSO-854	SOIL	Jan, 1999	Cs-137	319.50 ± 3.60	331.00	231.70 - 430.30
STSO-854	SOIL	Jan, 1999	K-40	667.04 ± 21.50	652.00	456.40 - 847.60
STSO-854	SOIL	Jan, 1999	Mn-54	349.01 ± 7.00	345.00	241.50 - 448.50
STSO-854	SOIL	Jan, 1999	Pu-238	25.28 ± 1.00	27.50	19.25 - 35.75
STSO-854	SOIL	Jan, 1999	Pu-239/40	45.66 ± 1.00	48.10	33.67 - 62.53
STSO-854	SOIL	Jan, 1999	U-233/4	139.56 ± 1.80	157.00	109.90 - 204.10
STSO-854	SOIL	Jan, 1999	U-238	23.47 ± 0.75	40.70	28.49 - 52.91
The analysis was repeated. Result of reanalysis; 29.5±6.3 Bq/kg.						
STSO-854	SOIL	Jan, 1999	Zn-65	2,697.20 ± 25.00	2,840.00	1,988.00 - 3,692.00

[a] Results obtained by Teledyne Brown Engineering Environmental Services Midwest Laboratory as a participant in the Department of Energy's Mixed Analyte Performance Evaluation Program, Idaho Operations office, Idaho Falls, Idaho.

[b] All results are in Bq/kg or Bq/L as requested by the Department of Energy.

[c] Unless otherwise indicated, the TBEESML results are given as the mean ± 1 standard deviations for three determinations.

[d] MAPEP results are presented as the known values and expected laboratory precision (1 sigma, 1 determination) and control limits as defined by the MAPEP.

Table A-7. Environmental Measurements Laboratory Quality Assessment Program (EML), comparison of EML and Teledyne's Midwest Laboratory results for various sample media[a].

Lab Code	Sample Type	Date Collected	Analysis	Concentration[b] Teledyne Result[c]	Concentration[b] EML Result[d]	Control Limits[e]
STAF-848	AIR FILTER	Mar, 1999	Gr. Alpha	1.24 ± 0.03	1.61 ± 0.16	0.60 - 1.64
STAF-848	AIR FILTER	Mar, 1999	Gr. Beta	1.98 ± 0.04	1.56 ± 0.16	0.60 - 1.64
STW-850	WATER	Mar, 1999	Am-241	1.22 ± 0.16	1.15 ± 0.05	0.73 - 2.58
STW-850	WATER	Mar, 1999	Co-60	54.40 ± 2.00	51.10 ± 3.00	0.92 - 1.18
STW-850	WATER	Mar, 1999	Cs-137	43.50 ± 2.00	39.38 ± 2.41	0.90 - 1.28
STW-850	WATER	Mar, 1999	Fe-55	81.50 ± 19.50	97.40 ± 1.65	0.31 - 1.54
STW-850	WATER	Mar, 1999	Gr. Alpha	1,169.00 ± 37.00	1,090.00 ± 20.00	0.50 - 1.29
STW-850	WATER	Mar, 1999	Gr. Beta	1,274.60 ± 33.30	1,100.00 ± 40.00	0.50 - 1.29
STW-850	WATER	Mar, 1999	H-3	90.30 ± 24.80	121.08 ± 6.78	0.65 - 1.91
STW-850	WATER	Mar, 1999	Ni-63	125.80 ± 6.30	114.00 ± 10.00	0.50 - 1.50
STW-850	WATER	Mar, 1999	Pu-238	0.80 ± 0.01	0.77 ± 0.04	0.78 - 1.42
STW-850	WATER	Mar, 1999	Pu-239/40	1.03 ± 0.07	1.01 ± 0.06	0.78 - 1.42
STW-850	WATER	Mar, 1999	Sr-90	3.63 ± 1.20	4.10 ± 0.05	0.50 - 1.50
STW-850	WATER	Mar, 1999	U-233/4	0.33 ± 0.08	0.27 ± 0.02	0.77 - 1.35
STW-850	WATER	Mar, 1999	U-238	0.33 ± 0.08	0.26 ± 0.02	0.77 - 1.35
STVE-851	VEGETATION	Mar, 1999	Am-241	3.35 ± 0.85	3.52 ± 0.59	0.68 - 2.78
STVE-851	VEGETATION	Mar, 1999	Cm-244	0.56 ± 0.41	1.67 ± 0.54	0.49 - 1.69
STVE-851	VEGETATION	Mar, 1999	Co-60	21.00 ± 1.90	21.45 ± 1.00	0.62 - 1.42
STVE-851	VEGETATION	Mar, 1999	Cs-137	453.90 ± 5.70	467.00 ± 20.00	0.81 - 1.45
STVE-851	VEGETATION	Mar, 1999	K-40	667.60 ± 33.70	656.50 ± 20.00	0.79 - 1.50
STVE-851	VEGETATION	Mar, 1999	Sr-90	704.80 ± 27.80	736.10 ± 7.70	0.48 - 1.29
STSO-852	SOIL	Mar, 1999	Ac-228	45.10 ± 7.40	47.15 ± 2.99	0.50 - 1.50
STSO-852	SOIL	Mar, 1999	Am-241	5.65 ± 2.41	4.89 ± 0.97	0.52 - 2.65
STSO-852	SOIL	Mar, 1999	Bi-214	67.30 ± 3.30	69.90 ± 5.66	0.50 - 1.50
STSO-852	SOIL	Mar, 1999	Cs-137	620.50 ± 5.90	659.50 ± 24.95	0.80 - 1.34
STSO-852	SOIL	Mar, 1999	K-40	355.70 ± 24.60	362.75 ± 20.16	0.73 - 1.67
STSO-852	SOIL	Mar, 1999	Pb-212	47.90 ± 3.00	47.93 ± 2.57	0.50 - 1.50
STSO-852	SOIL	Mar, 1999	Pb-214	70.10 ± 4.80	71.00 ± 7.04	0.50 - 1.50
STSO-852	SOIL	Mar, 1999	Pu-239/40	7.32 ± 1.32	8.11 ± 1.07	0.66 - 1.93
STSO-852	SOIL	Mar, 1999	Sr-90	28.30 ± 3.50	32.40 ± 0.53	0.46 - 2.84
STSO-852	SOIL	Mar, 1999	Th-234	227.40 ± 35.20	138.00 ± 4.08	0.50 - 2.00
STSO-852	SOIL	Mar, 1999	U-233/4	132.90 ± 6.90	140.67 ± 1.16	0.35 - 1.55
STSO-852	SOIL	Mar, 1999	U-238	139.40 ± 7.00	145.00 ± 1.73	0.35 - 1.55
STAF-853	AIR FILTER	Mar, 1999	Am-241	0.14 ± 0.02	0.13 ± 0.01	0.68 - 2.41
STAF-853	AIR FILTER	Mar, 1999	Co-57	3.32 ± 0.06	3.01 ± 0.14	0.62 - 1.22
STAF-853	AIR FILTER	Mar, 1999	Co-60	5.28 ± 0.15	4.96 ± 0.28	0.62 - 1.42
STAF-853	AIR FILTER	Mar, 1999	Cs-137	6.96 ± 0.15	6.05 ± 0.30	0.72 - 1.32
STAF-853	AIR FILTER	Mar, 1999	Pu-238	0.26 ± 0.02	0.27 ± 0.00	0.62 - 1.46

Table A-7. Environmental Measurements Laboratory Quality Assessment Program (EML), comparison of EML and Teledyne's Midwest Laboratory results for various sample media[a].

Lab Code	Sample Type	Date Collected	Analysis	Concentration[b] Teledyne Result[c]	EML Result[d]	Control Limits[e]
STAF-853	AIR FILTER	Mar, 1999	Pu-239/40	0.12 ± 0.02	0.12 ± 0.00	0.62 - 1.46
STAF-853	AIR FILTER	Mar, 1999	Sb-125	4.35 ± 0.30	3.59 ± 0.31	0.62 - 1.39
STAF-853	AIR FILTER	Mar, 1999	Sr-90	0.65 ± 0.19	0.64 ± 0.01	0.66 - 2.65
STAF-853	AIR FILTER	Mar, 1999	U-233/4	0.07 ± 0.03	0.06 ± 0.00	0.78 - 3.00
STAF-853	AIR FILTER	Mar, 1999	U-238	0.07 ± 0.03	0.06 ± 0.00	0.78 - 3.00
STW-855	WATER	Sep, 1999	Am-241	1.13 ± 0.24	0.85 ± 0.10	0.75 - 1.49
STW-855	WATER	Sep, 1999	Co-60	54.10 ± 1.10	52.40 ± 2.20	0.80 - 1.20
STW-855	WATER	Sep, 1999	Cs-137	77.10 ± 1.40	76.00 ± 3.40	0.80 - 1.26
STW-855	WATER	Sep, 1999	Fe-55	48.60 ± 6.80	53.00 ± 2.00	0.44 - 1.53
STW-855	WATER	Sep, 1999	H-3	136.00 ± 25.00	80.70 ± 3.70	0.71 - 1.79
STW-855	WATER	Sep, 1999	Pu-238	0.78 ± 0.05	0.79 ± 0.08	0.78 - 1.25
STW-855	WATER	Sep, 1999	Pu-239/40	0.84 ± 0.07	0.87 ± 0.10	0.80 - 1.39
STW-855	WATER	Sep, 1999	Sr-90	2.20 ± 1.00	1.72 ± 1.00	0.75 - 1.50
STW-855	WATER	Sep, 1999	U-233/4	0.50 ± 0.09	0.37 ± 0.02	0.80 - 1.40
STW-855	WATER	Sep, 1999	U-233/4	0.50 ± 0.09	0.37 ± 0.02	0.83 - 1.92
STW-855	WATER	Sep, 1999	U-238	0.46 ± 0.09	0.36 ± 0.02	0.80 - 1.26
Increasing the sample counting time achieved acceptable results (0.42±0.07 Bq/L).						
STW-856	WATER	Sep, 1999	Gr. Alpha	1,543.00 ± 44.00	1,580.00 ± 20.00	0.61 - 1.32
STW-856	WATER	Sep, 1999	Gr. Beta	1,053.00 ± 31.00	740.00 ± 40.00	0.55 - 1.54
STSO-857	SOIL	Sep, 1999	Ac-228	127.30 ± 7.50	124.00 ± 4.80	0.79 - 1.75
STSO-857	SOIL	Sep, 1999	Bi-212	107.40 ± 2.60	140.00 ± 14.00	0.42 - 1.22
STSO-857	SOIL	Sep, 1999	Bi-214	90.10 ± 4.20	69.50 ± 1.80	0.75 - 1.42
STSO-857	SOIL	Sep, 1999	Cs-137	195.90 ± 4.00	204.00 ± 5.00	0.83 - 1.32
STSO-857	SOIL	Sep, 1999	K-40	744.70 ± 37.70	780.00 ± 27.00	0.78 - 1.53
STSO-857	SOIL	Sep, 1999	Pb-212	123.40 ± 3.70	127.00 ± 4.80	0.74 - 1.33
STSO-857	SOIL	Sep, 1999	Pb-214	96.50 ± 5.00	72.00 ± 0.42	0.65 - 1.45
STSO-857	SOIL	Sep, 1999	Sr-90	12.99 ± 1.44	13.00 ± 0.47	0.60 - 3.66
STSO-857	SOIL	Sep, 1999	Th-234	298.70 ± 24.60	198.00 ± 5.60	0.59 - 1.85
STSO-857	SOIL	Sep, 1999	U-233/4	184.40 ± 8.50	190.00 ± 5.20	0.47 - 1.30
STSO-857	SOIL	Sep, 1999	U-238	184.80 ± 8.50	190.00 ± 5.20	0.47 - 1.30
STVE-858	VEGETATION	Sep, 1999	Am-241	3.30 ± 0.88	2.88 ± 0.22	0.68 - 2.70
STVE-858	VEGETATION	Sep, 1999	Cm-244	2.12 ± 0.86	1.61 ± 0.36	0.47 - 1.74
STVE-858	VEGETATION	Sep, 1999	Co-60	17.60 ± 1.90	17.60 ± 1.00	0.69 - 1.46
STVE-858	VEGETATION	Sep, 1999	Cs-137	414.60 ± 5.70	440.00 ± 20.00	0.80 - 1.40
STVE-858	VEGETATION	Sep, 1999	K-40	502.80 ± 34.70	513.00 ± 20.00	0.79 - 1.42
STVE-858	VEGETATION	Sep, 1999	Pu-239/40	4.13 ± 1.00	4.30 ± 0.46	0.68 - 1.59
STAP-859	AIR FILTER	Sep, 1999	Am-241	0.14 ± 0.05	0.13 ± 0.01	0.73 - 2.58
STAP-859	AIR FILTER	Sep, 1999	Co-57	8.10 ± 0.10	7.73 ± 0.03	0.65 - 1.39

Table A-7. Environmental Measurements Laboratory Quality Assessment Program (EML), comparison of EML and Teledyne's Midwest Laboratory results for various sample media[a].

Lab Code	Sample Type	Date Collected	Analysis	Concentration [b] Teledyne Result[c]	EML Result[d]	Control Limits[e]
STAP-859	AIR FILTER	Sep, 1999	Co-60	6.70 ± 0.10	6.35 ± 0.41	0.75 - 1.32
STAP-859	AIR FILTER	Sep, 1999	Cs-137	7.10 ± 0.20	6.43 ± 0.42	0.73 - 1.37
STAP-859	AIR FILTER	Sep, 1999	Mn-54	8.80 ± 0.20	7.91 ± 0.45	0.76 - 1.42
STAP-859	AIR FILTER	Sep, 1999	Pu-238	0.05 ± 0.04	0.10 ± 0.01	0.74 - 1.40
STAP-859	AIR FILTER	Sep, 1999	Pu-239/40	0.07 ± 0.02	0.14 ± 0.01	0.76 - 1.44
Insufficient sample volume (15 ml.) for accurate plutonium analyses.						
STAP-859	AIR FILTER	Sep, 1999	Ru-106	5.90 ± 0.80	5.50 ± 1.76	0.59 - 1.30
STAP-859	AIR FILTER	Sep, 1999	Sr-90	0.60 ± 0.20	0.34 ± 0.01	0.61 - 1.93
STAP-859	AIR FILTER	Sep, 1999	U-233/4	0.09 ± 0.03	0.07 ± 0.00	0.83 - 1.92
STAP-859	AIR FILTER	Sep, 1999	U-238	0.07 ± 0.03	0.07 ± 0.01	0.84 - 2.61
STAP-860	AIR FILTER	Sep, 1999	Gr. Alpha	3.18 ± 0.06	2.77 ± 0.26	0.50 - 1.55
STAP-860	AIR FILTER	Sep, 1999	Gr. Beta	3.65 ± 0.06	2.66 ± 0.26	0.72 - 1.67

[a] The Environmental Measurements Laboratory provides the following nuclear species : Air Filters, Soil, Vegetation and Water.

[b] Results are reported in Bq/L with the following exceptions: Air Filter results are reported in Bq/Filter, Soil results are reported in Bq/Kg, Vegetation results are reported in Bq/Kg.

[c] Teledyne results are reported as the mean of three determinations±standard deviation.

[d] The EML result listed is the mean of replicate determinations for each nuclide±the standard error of the mean.

[e] The control limits are reported by EML as the ratio of Reported Value / EML value and are established from percentiles of historic data distributions (1982-1992). The evaluation of this historic data and the development of the control limits is presented in DOE report EML-564.

APPENDIX B

DATA REPORTING CONVENTIONS

Data Reporting Conventions

1.0. All activities, except gross alpha and gross beta, are decay corrected to collection time or the end of the collection period.

2.0. Single Measurements

Each single measurement is reported as follows: $x \pm s$

where: x = value of the measurement;

s = 2s counting uncertainty (corresponding to the 95% confidence level).

In cases where the activity is less than the lower limit of detection L, it is reported as: <L,

where L = the lower limit of detection based on 4.66s uncertainty for a background sample.

3.0. Duplicate analyses

3.1 Individual results: For two analysis results; $x_1 \pm s_1$ and $x_2 \pm s_2$

Reported result: $x \pm s$; where $x = (1/2)(x_1 + x_2)$ and $s = (1/2)\sqrt{s_1^2 + s_2^2}$

3.2. Individual results: $<L_1$, $<L_2$ Reported result: <L, where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$, <L Reported result: $x \pm s$ if $x \geq L$; <L otherwise.

4.0. Computation of Averages and Standard Deviations

4.1 Averages and standard deviations listed in the tables are computed from all of the individual measurements over the period averaged; for example, an annual standard deviation would not be the average of quarterly standard deviations. The average $\bar{x}$ and standard deviation s of a set of n numbers $x_1, x_2 \ldots x_n$ are defined as follows:

$$\bar{x} = \frac{1}{n} \sum x \qquad s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

4.2 Values below the highest lower limit of detection are not included in the average.

4.3 If all values in the averaging group are less than the highest LLD, the highest LLD is reported.

4.4 If all but one of the values are less than the highest LLD, the single value x and associated two sigma error is reported.

4.5 In rounding off, the following rules are followed:

4.5.1. If the figure following those to be retained is less than 5, the figure is dropped, and the retained figures are kept unchanged. As an example, 11.443 is rounded off to 11.44.

4.5.2. If the figure following those to be retained is equal to or greater than 5, the figure is dropped and the last retained figure is raised by 1. As an example, 11.445 is rounded off to 11.45.

APPENDIX C

Maximum Permissible Concentrations

of Radioactivity in Air and Water

Above Background in Unrestricted Areas

Table C-1. Maximum permissible concentrations of radioactivity in air and water above natural background in unrestricted areas[a].

	Air (pCi/m^3)		Water (pCi/L)
Gross alpha	1×10^{-3}	Strontium-89	8,000
Gross beta	1	Strontium-90	500
Iodine-131[b]	2.8×10^{-1}	Cesium-137	1,000
		Barium-140	8,000
		Iodine-131	1,000
		Potassium-40[c]	4,000
		Gross alpha	2
		Gross beta	10
		Tritium	1×10^6

[a] Taken from Table II of Appendix B to Code of Federal Regulations Title 10, Part 20, and appropriate footnotes. Concentrations may be averaged over a period not greater than one year.

[b] Value adjusted by a factor of 700 to reduce the dose resulting from the air-grass-cow-milk-child pathway.

[c] A natural radionuclide.

APPENDIX D

Special Ground

and Well Water Samples

1.0 INTRODUCTION

This appendix to the Radiation Environmental Monitoring Program Annual Report to the United States Regulatory Commission summarizes and interprets results of the special well and seepage water samples taken at the Prairie Island Nuclear Generating Plant, Red Wing, Minnesota, during the period January - December, 1999. This supplemental special sampling program was established in December of 1989 when higher than expected levels of tritium were detected in a nearby residence well sample.

Tabulations of the special sampling program individual analyses made during the year are included in this appendix. A summary table of tritium analyses is also included in this appendix.

2.0 SUMMARY

This special sampling program was established following the detection of tritium in a residence well water sample south of the PINGP during 1989. This program is described and the results for 1999 are summarized and discussed.

The program findings for 1999 detected tritium in nearby residence wells and ground water seepage samples at expected natural background levels. The 1999 sample results ranged from <19 pCi/L to 147 pCi/L. These results are far below the Environmental Protection Agency's drinking water standard of 20,000 pCi/L and present no harm to any members of the public.

The special sampling program was terminated as of December, 1999, based on findings of the USGS Water Resources Investigation Report 99-4069. The report concludes that the level of ground water tritium measured south of the plant's property is most likely the result of past nuclear device testing and naturally-produced tritium from precipitation.

The nearest residence well south of the PINGP will be added to the regular well water sampling and incorporated into the Radiological Environmental Monitoring Program (REMP).

3.0 Special Tritium Sampling Program

3.1 Program Design and Data Interpretation

The purpose of this sampling program was to assess the impact of any tritium possibly leaching into the environment (ground water system) from the PINGP discharge canal. For this purpose, special water samples were collected and analyzed for radioactive content.

3.2 Program Description

The sampling and analysis schedule for the special water sampling program is summarized in Table 4.1 and briefly reviewed below. Table 4.2 defines the additional sample locations and codes for the special water sampling program.

Special well and ground water samples were collected semi-annually at nine locations: one sample from the PINGP Environmental Laboratory (P-30); one from the nearest residence deep well (P-24d, Suter residence); two ground water seepages from near Birch Lake (P-31 and P-32); well water from the Prairie Island Training Center (P-26); well water from the Prairie Island Indian Community (P-8); and three other nearby residences (P-27, Nauer residence; P-28, Allyn (Perkins) residence; P-29, Childs residence). The Rohl farm well (part of the quarterly REMP sampling) is used as a control location for these special samples.

In order to detect low levels of tritium at or below natural background levels, analyses of the samples have been contracted to a laboratory (University of Waterloo Laboratories) capable of detecting tritium concentrations down to 19 pCi/L. Waterloo Laboratories report tritium analyses results in Tritium Units (1 TU = 3.2 pCi/L). The tritium results in this report are indicated in pCi/L.

3.3 Program Execution

The special water sampling was executed as described in the preceding section.

3.4 Program Modifications

There were no changes to the program in 1999.

3.5 Results and Discussion

Results obtained show tritium in well water and ground water samples at expected background levels. Table 4.4 provides the complete data table of results for each period and sampling location.

Tritium levels have decreased yearly from 1989 through 1995, and since 1996 have measured at or below expected background levels. Averages for the nearest resident south of the plant measured: 1430 pCi/L in 1989, 1360 pCi/L in 1990, 960 pCi/L in 1991, 835 pCi/L in 1992, 516 pCi/L in 1993, 370 pCi/L in 1994, 170 pCi/L in 1995, 64 pCi/L in 1996, 61 pCi/L in 1997, <19 pCi/L in 1998 and 76 pCi/L in 1999.

The 1999 levels fall within the range of expected background tritium levels for shallow ground water and surface water due to tritium concentrations measured in precipitation.

Results and Discussion (continued)

The USGS 1999 Water Study Report (Water Resources Investigations Report 99-4069, "Water Resources of the Prairie Island Indian Reservation, Minnesota, 1994-97", USGS, 1999) concluded that tritium in precipitation, both natural and from nuclear device testing, most reasonably explains the tritium in the off-site samples. At its peak in 1964, the tritium concentration in precipitation in southeastern Minnesota was 14,400 pCi/L. The water in the Mississippi River most likely provided this source of tritium into the local aquifer.

Table D-4.1 Sample collection and analysis program for special well and seepage water samples, Prairie Island Nuclear Generating Plant, 1999.

Medium	No.	Location codes and type[a]	Collection type and frequency[b]	Analysis type[c]
Well water semi-annual	8	P-24d, P-25 (C), P-26, P-27, P-28, P-29, P-30, P-8	G/SA	H-3
Ground water	2	P-31, P-32	G/SA	H-3

[a] Location codes are defined in table D-4.2. Control Station are indicated by (C). All other stations are indicators.

[b] Collection type is codes as follows: C/ = continuous; G/ = grab. Collection frequency is coded as follows: W = weekly; M = monthly; Q = quarterly; SA = semi-annually; A = annually; X = no specified frequency or one time.

[c] Analysis type is coded as follows: GB = gross beta; GS = gamma spectroscopy; H-3 = tritium; I-131 = iodine 131.

Table D-4.2. Sampling locations for special well and seepage water samples, Prairie Island Nuclear Generating Plant, 1999.

Code type[a]	Collection site	Type of sample[b]	Distance and direction from reactor
P-24d	Suter residence, deep well	WW	0.6 mi. @ 158°/SSE
P-25 C	Rohl farm	WW	12.9 mi @ 352°/N
P-26	PITC	WW	0.4 mi. @ 258°/WSW
P-27	Nauer residence	WW	0.9 mi. @ 154°/SSE
P-28	Allyn (Perkins) residence	WW	1.0 mi. @ 152°/SSE
P-29	Childs residence	WW	1.2 mi. @ 149°/SSE
P-30	PINGP Environmental Laboratory	WW	0.2 mi. @ 32°/NNE
P-31	Birch Lake Seepage #1	GW	0.7 mi. @ 179°/S
P-32	Birch Lake Seepage #2	GW	0.8 mi. @ 169°/SSE
P-8	Prairie Island Indian Community Well	WW	1.0 mi. @ 321°/WNW

[a] "C" denotes control location. All other locations are indicators.

[b] Sample codes: WW = Well water; GW = Ground Water.

Table D-4.3 Radiation Environmental Monitoring Program Summary: Special well and seepage water samples.

Name of Facility Prairie Island Nuclear Power Station — Docket No. 50-282, 50-306
Location of Facility Goodhue, Minnesota (County, State) — Reporting Period January - December 1999

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Semi-Annual Mean Location[d]	Location with Highest Semi-Annual Mean Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range	Number Non-Routine Results[e]
Well Water (pCi/L)	H-3 15	19	102 (9/13) (64-147)	P-29, Childs well, 1.2 mi. @ 149°/SSE	145 (2/2) (144-147)	76 (2/2) (74-77)	0
Ground Water (pCi/L)	H-3 4	19	122 (2/2) (115-128)	P-32, Birch Lake Seepage #2, 0.8 mi. @ 169°/SSE	128 (1/1)	76 (2/2) (74-77)	0

a H-3 = tritium

b LLD = Nominal lower limit of detection based on 4.66 sigma error for background sample. Value shown is lowest for the period.

c Mean and range are based on detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

d Locations are specified: (1) by name, and code (Table 2) and (2) by distance, direction and sector relative to reactor site.

e Non-routine results are those which exceed ten times the control station value.

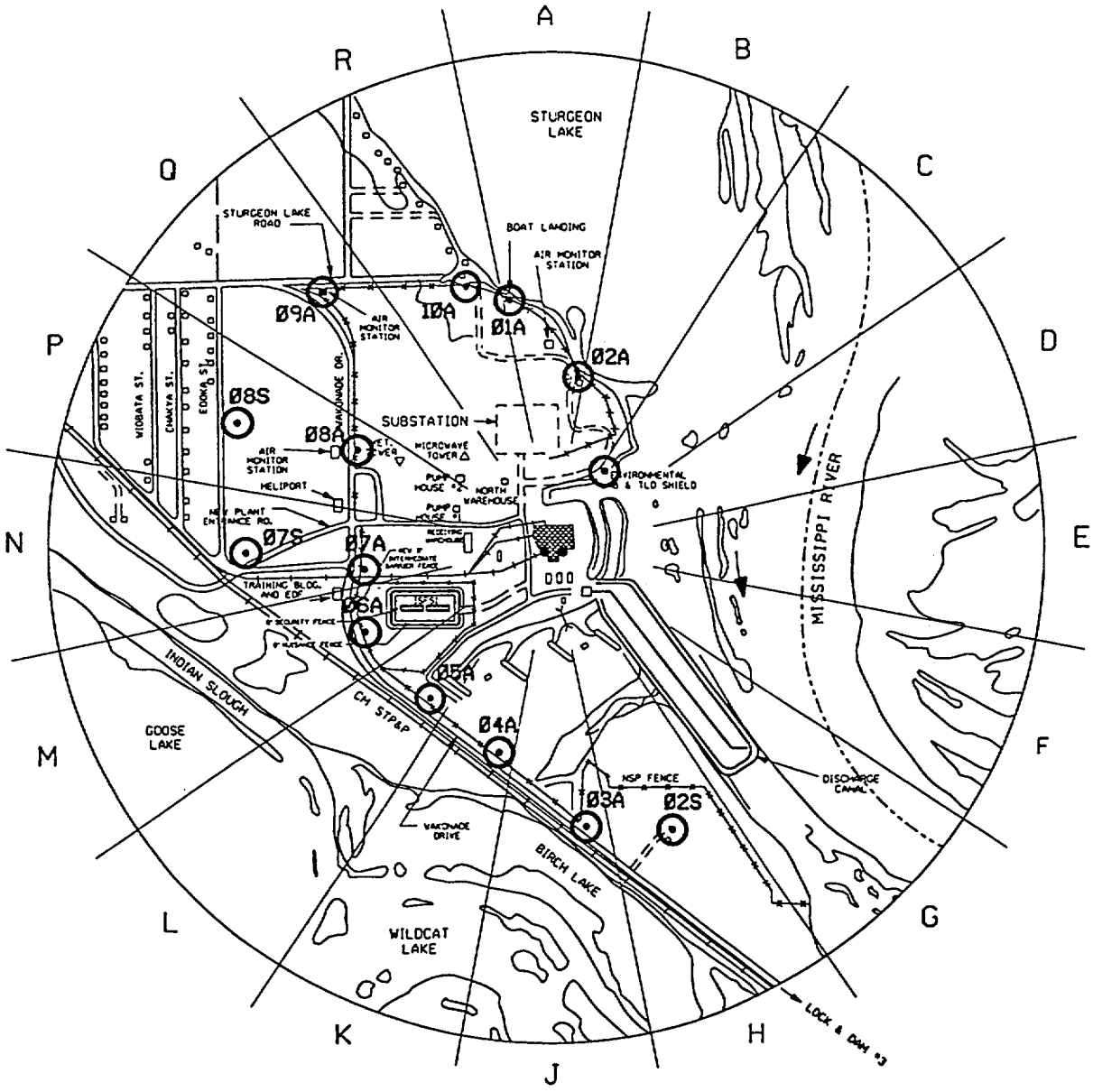
Table D-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 1999.

SAMPLE DATES	MAY, JUNE 1999		OCT. 1999
SAMPLE LOCATIONS	pCi/L		pCi/L
Suter residence	77		74
Rohl Farm (Control)	77		74
PITC	102		93
Nauer residence	64		--
Allyn (Perkin) residence	138		77
Childs residence	147		144
Environmental Lab	<19		<19
Birch Lake Seepage #1	--		115
Birch Lake Seepage #2	--		128
Prairie Island Indian Community Well	<19		<19

APPENDIX E

Sampling Location Maps

TLD LOCATIONS
ONE MILE RADIUS



PLANT AREA ENLARGED PLAN [1.00 MILE RADIUS]

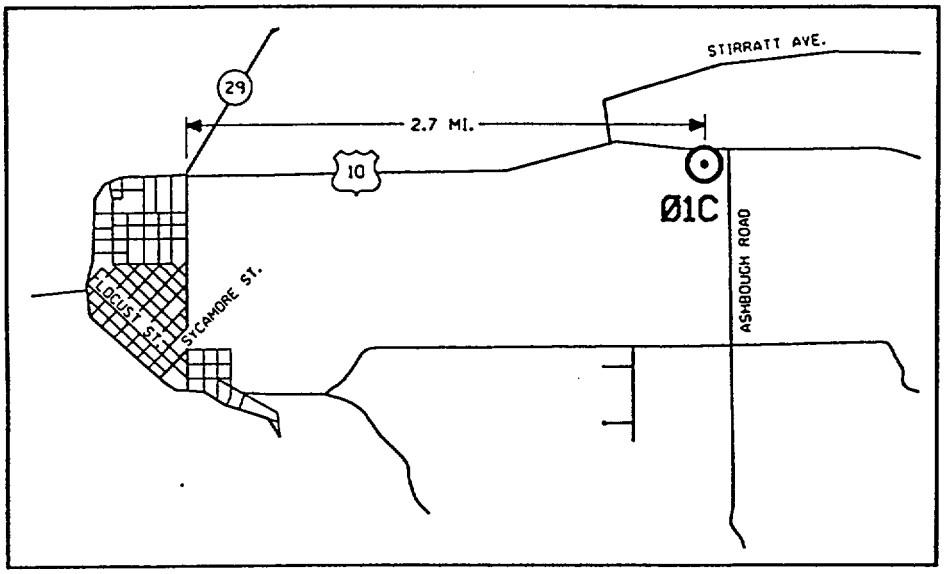
[NO SCALE]

MONITORING LEGEND:

⊙ N.S.P. TLD POINTS

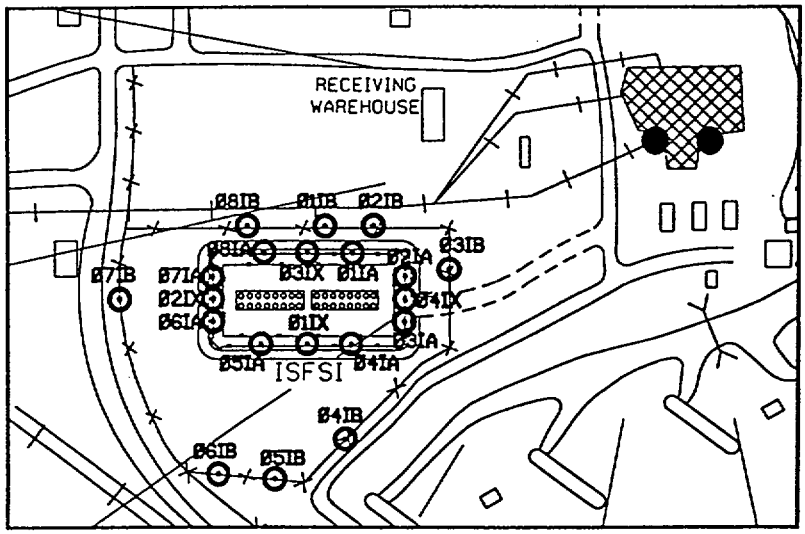
TLDØ1.DGN

TLD LOCATIONS



CONTROL POINTS

PRESCOTT, WISCONSIN



ISFSI AREA TLD LOCATIONS

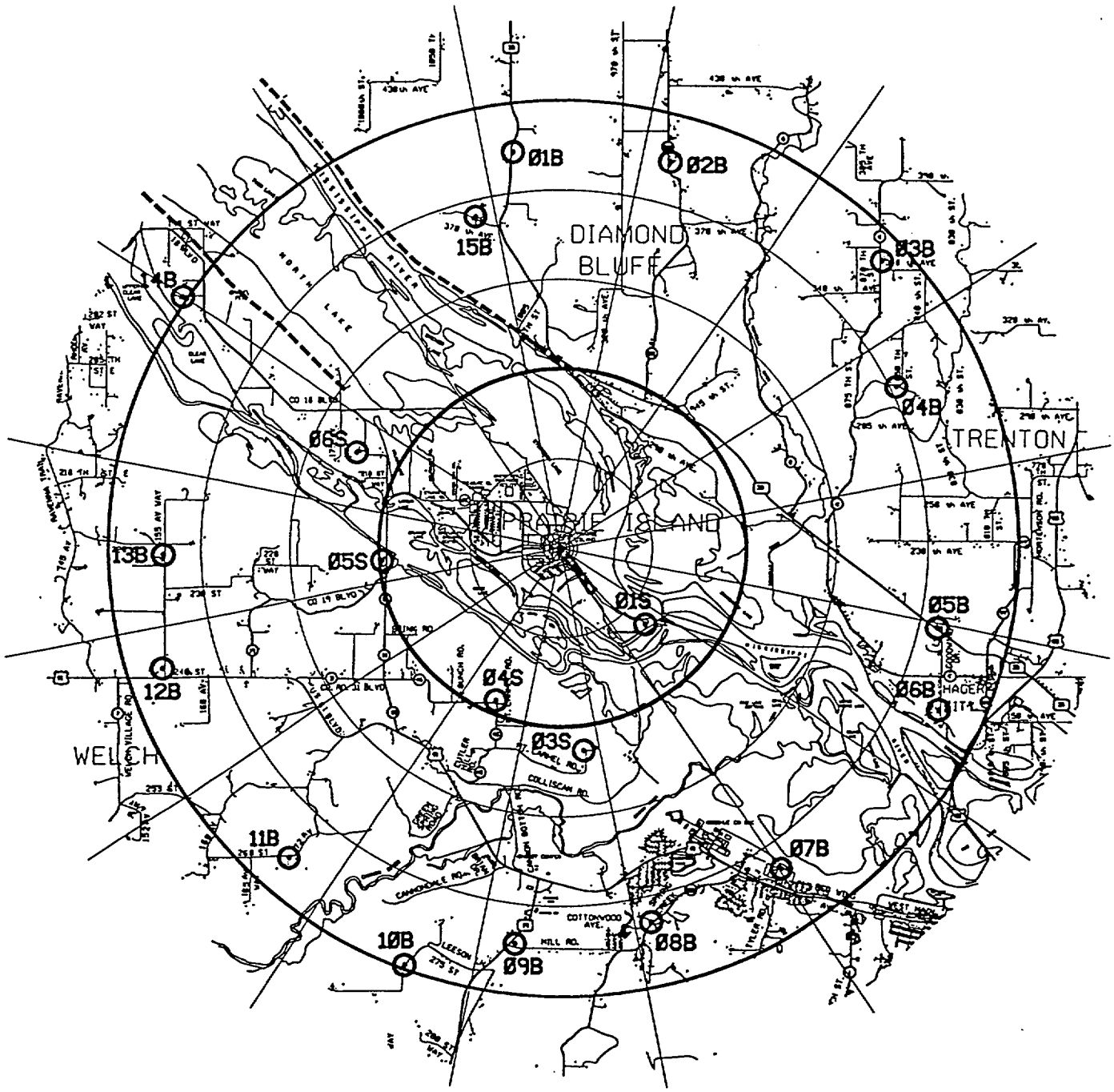
MONITORING LEGEND:

⊙ N.S.P. TLD POINTS

TLDØ2.DGN

TLD LOCATIONS

FIVE MILE RADIUS

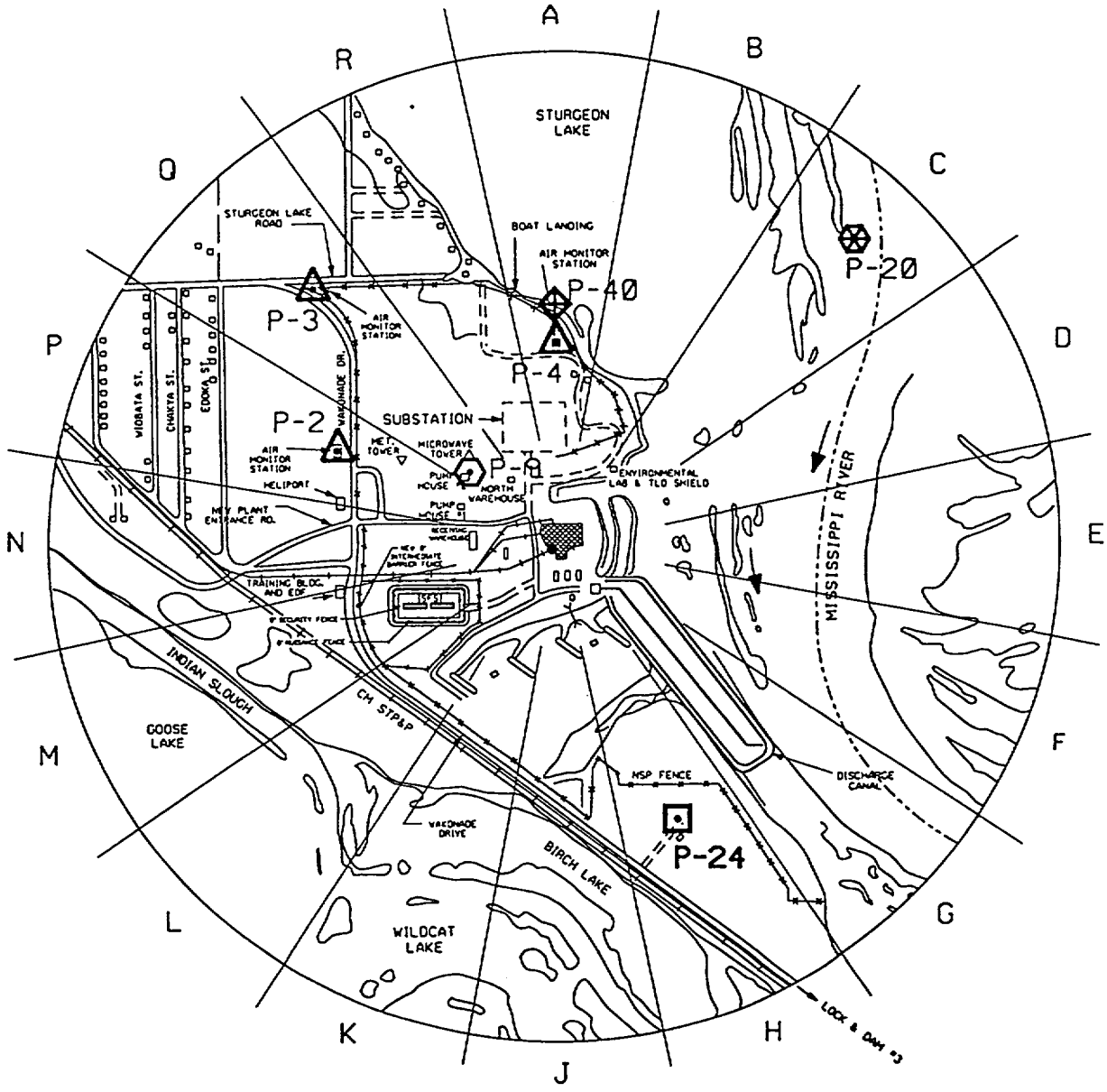


MONITORING LEGEND:

⊙ N.S.P. TLD POINTS

TLDØ3.DGN

ENVIRONMENTAL SAMPLING POINTS
ONE MILE RADIUS



PLANT AREA ENLARGED PLAN [1.00 MILE RADIUS]

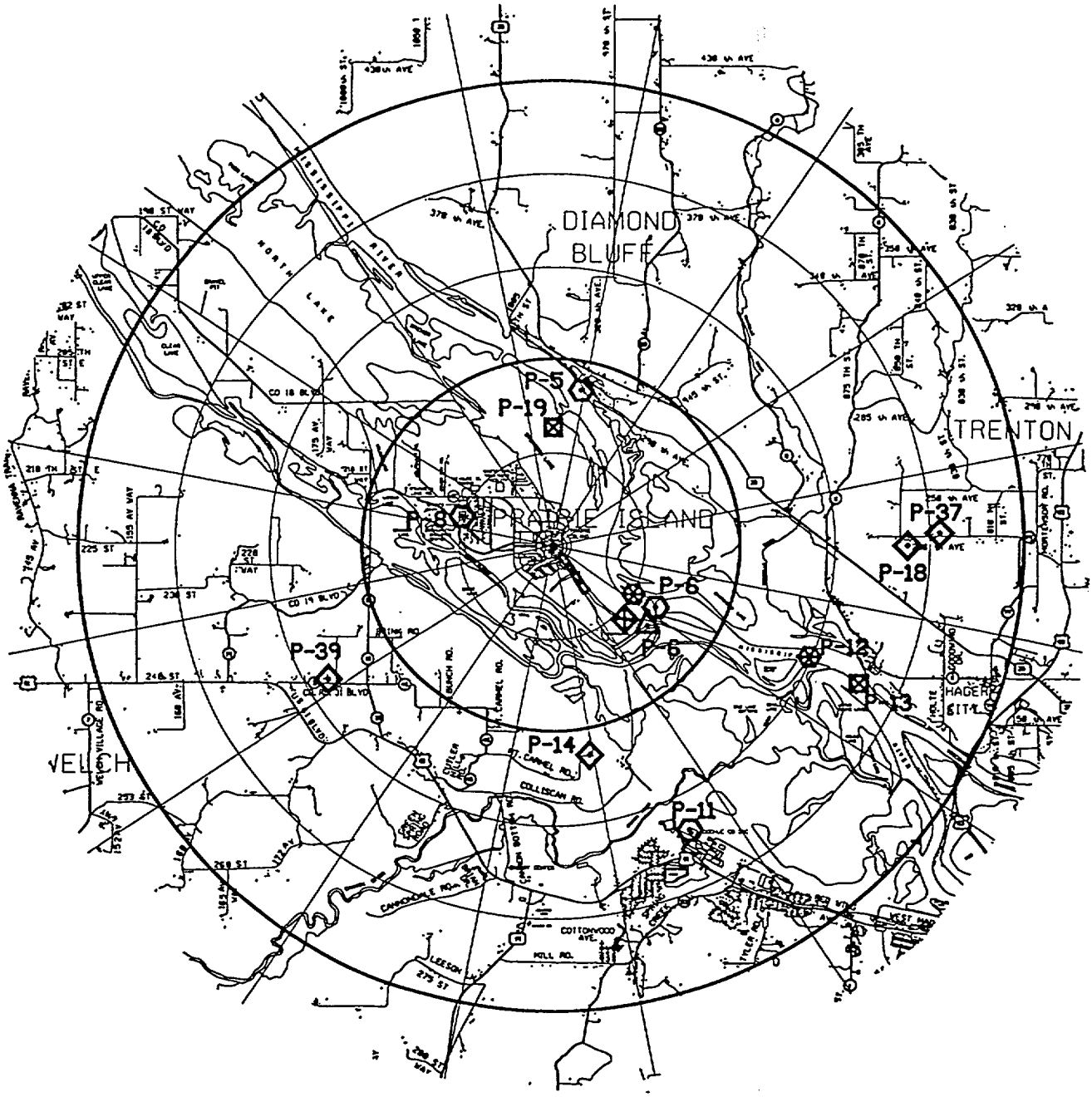
[NO SCALE]

MONITORING LEGEND

- MILK SAMPLING POINT ID NUMBERS
  P-14, P-18, P-25, P-37, P-39
- AIR SAMPLING POINT ID NUMBERS
  P-1, P-2, P-3, P-4, P-6
- WATER SAMPLING POINT ID NUMBERS
  P-5, P-6, P-8, P-9, P-11, P-25
- VEGETATION / VEGETABLES ID NUMBERS
  P-24, P-38
- FISH SAMPLING POINT ID NUMBERS
  P-13, P-19
- INVERTEBRATES POINT ID NUMBERS
  P-6, P-40
- SEDIMENT SAMPLING POINT ID NUMBERS
  P-6, P-12, P-20

SAMP01.DGN

ENVIRONMENTAL SAMPLING POINTS
FIVE MILE RADIUS

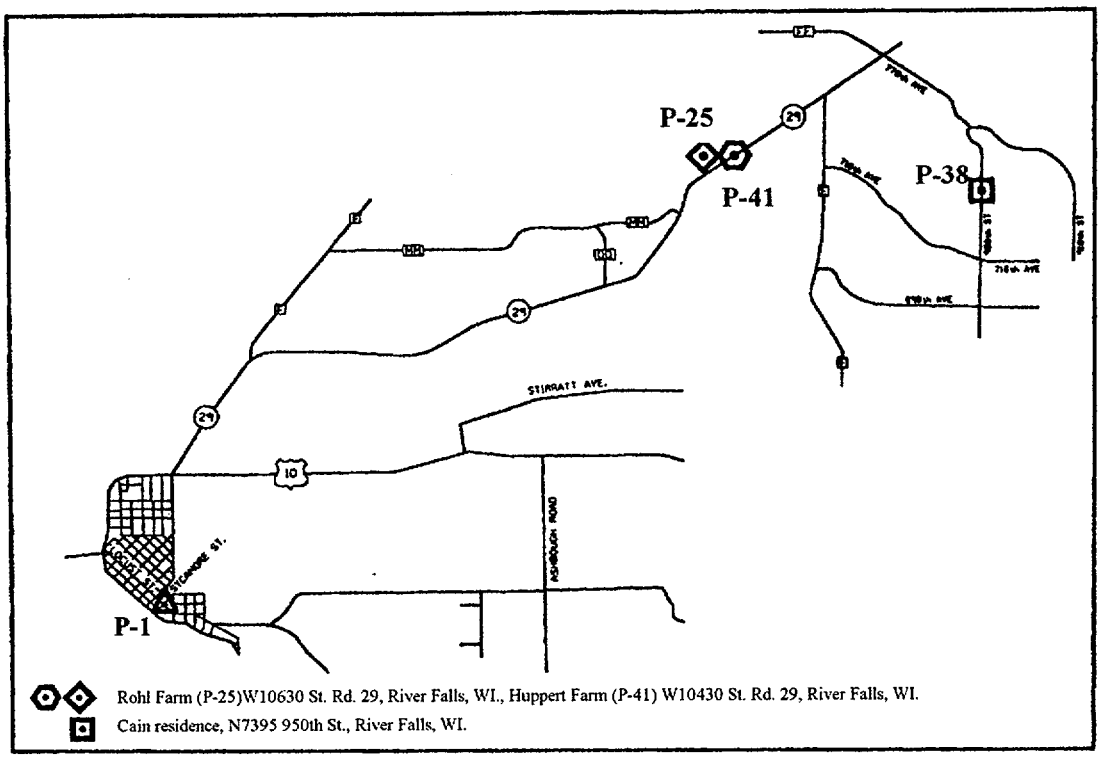


MONITORING LEGEND

- MILK SAMPLING POINT ID NUMBERS P-14, P-18, P-25, P-37, P-39
- FISH SAMPLING POINT ID NUMBERS P-13, P-19
- AIR SAMPLING POINT ID NUMBERS P-1, P-2, P-3, P-4, P-6
- INVERTEBRATES POINT ID NUMBERS P-6, P-40
- WATER SAMPLING POINT ID NUMBERS P-5, P-6, P-8, P-9, P-11, P-25
- SEDIMENT SAMPLING POINT ID NUMBERS P-6, P-12, P-20
- VEGETATION / VEGETABLES ID NUMBERS P-24, P-38

SAMP03.DGN

ENVIRONMENTAL SAMPLING POINTS



CONTROL POINTS
PRESCOTT, WISCONSIN

MONITORING LEGEND

- Milk Sampling Point ID Numbers
  P-14, P-18, P-25, P-37, P-39, P-41
- Air Sampling Point ID Numbers
  P-1, P-2, P-3, P-4, P-6
- Water Sampling Point Numbers
  P-5, P-6, P-8, P-9, P-11, P-25, P-41
- Vegetation/Vegetables ID Numbers
  P-24, P-38

SAMP02.DGN