MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

MICHIGAN

RADIATION ENVIRONMENTAL MONITORING

PROGRAM REPORT

SUPPLEMENT 1

1997-1999

John Engler, Governor
www.deq.state.mi.us
Russell J. Harding, Director

Michigan Department of Environmental Quality
Drinking Water and Radiological Protection Division
Radiological Protection Section
3423 North Martin L. King Jr. Blvd.
P.O. Box 30630
Lansing, Michigan 48909-8130

Environmental Assistance Center: 1-800-662-9278

Printed by authority of Part 135 of 1978 PA 368, as amended.
Total number of copies 250 Total Cost:$ 2,095 Cost per copy: $ 8.38
DEQ **Michigan Department of Environmental Quality**

MICHIGAN

RADIATION ENVIRONMENTAL MONITORING

PROGRAM REPORT

SUPPLEMENT 1

1997-1999

Prepared by

Michigan Department of Environmental Quality
Drinking Water and Radiological Protection Division
Radiological Protection Section

TABLE OF CONTENTS

TABLE OF CONTENTS

MICHIGAN

RADIATION ENVIRONMENTAL MONITORING

PROGRAM REPORT

Supplement 1

1997-1999

Executive Summary

Recognizing that the use of nuclear energy to produce electricity could have an adverse impact on public health and the environment, the state of Michigan established the Michigan Radiation Environmental Monitoring Program (MREMP) in 1958 to monitor the environs near the nuclear power plant sites to assure that Michigan's citizens and environment are not adversely impacted. Environmental samples in the form of air particulates, air vapors, milk, surface water, and direct radiation are taken from various sites in Michigan and analyzed to determine if any radiological effects due to nuclear power plants can be detected.

Historically, sample results from all media have indicated elevated levels of radioactivity, but the vast majority of these elevated levels are attributable to past atmospheric testing of nuclear weapons. Analytical results that could be attributed to nuclear power plant operations have only been detected on-site at the plants and were within the allowable U.S. Nuclear Regulatory Commission limits. No analytical results attributable to nuclear power plant operations have been detected off site at any of the plants (see *MREMP Report 1958-1996*).

This report (*MREMP Report, Supplement 1, 1997-1999*) contains the results of radiation environmental monitoring for the years 1997-99, extending by three years the previously reported data published in 1998 (*MREMP Report 1958-1996*). Although a few samples were found to contain elevated levels of radioactivity attributable to nuclear power plant operations, these samples were collected within the nuclear plant site property and did not represent a regulatory, public health, or environmental concern. The influence of atmospheric fallout from past testing of nuclear weapons can no longer be readily seen in environmental samples, and monitoring levels from all off-site samples now fluctuate in the range of natural background radiation.

In conclusion, the results of the MREMP for the years 1997-99 indicate that no public health or environmental radiological impact has yet been detected in the off-site environs of Michigan's nuclear power plants due to the operation of nuclear power reactors.

Introduction

Program History

In 1958 the Michigan Department of Health established the Michigan Radiation Environmental Monitoring Program (MREMP) to determine the impact of nuclear power plants on the environment and public health. Specific statutory authority for an environmental monitoring program was provided to the Michigan Department of Public Health in 1972 with the enactment of 1972 PA 305. Later, the Public Health Code (1978 PA 368) provided this authority in Section 13518 of Part 135 of the Code. In April 1996 the MREMP was transferred to the Michigan Department of Environmental Quality by Executive Order 1996-1, along with other radioactive material radiation protection programs. The MREMP monitoring program has been in continuous operation since its inception in 1958.

This report is a sequel to the Michigan Radiation Environmental Monitoring Program Report 1958-1996 published in May 1998, by the Michigan Department of Environmental Quality. It extends the monitoring period of the 1958-1996 report to include years 1997 through 1999. As a sequel, this report will focus on the 1997-99 monitoring results and refer to the original report for discussions of historical trends and preoperational baseline results.

Nuclear Power Plants in Michigan

Big Rock Point

Consumers Energy Company's Big Rock Point plant, a boiling water reactor (BWR) near Charlevoix, was the first operational nuclear power plant in Michigan. The 240 megawatt thermal (MWt) plant achieved initial criticality on September 27, 1962 and commenced electrical power production before the end of the year. On August 29, 1997, which was the thirty-fifth anniversary of the Atomic Energy Commission issuance of an operating license to Big Rock Point, the plant was shut down for the final time. Site decommissioning activities were initiated shortly after the final shut down and will continue over the next several years, when the decommissioning and site restoration projects are completed. The Big Rock Point plant has been under MREMP surveillance since July 1960.

Palisades

Located near South Haven, Michigan, is Consumers Energy Company's Palisades plant, a 2530 MWt pressurized water reactor (PWR), that went into operation in 1971. The Palisades plant has been in essentially continuous operation since 1971 except for two lengthy periods, one in the mid-1970s and another in the fall of 1990, when extensive steam generator repair and/or steam generator replacement took place. MREMP surveillance of the plant was initiated in 1968.

D. C. Cook

The American Electric Power Company's D. C. Cook plant is a two-reactor facility located near Bridgman, Michigan. D. C. Cook I, a 3250 MWt PWR, commenced operation in early 1975 and has operated essentially continuously through September 1997. D. C. Cook II, a 3411 MWt PWR, commenced electrical power production in 1978 and, with the exception of a steam generator replacement in 1988, has operated essentially continuously through September 1997. American Electric Power Company shut down both reactors of the D. C. Cook plant in September 1997 due to concerns raised regarding the long-term reliability of reactor and reactor containment cooling systems. Restart of the plant's two reactors is not anticipated until early 2000. MREMP surveillance of the D. C. Cook plant was initiated in 1971.

Fermi 2

Fermi 2, Michigan's newest nuclear power plant, is located on the same site as was the original Enrico Fermi nuclear power plant near Monroe, Michigan. The 3430 MWt BWR achieved initial criticality in June 1985 but, due to a variety of problems, did not start reliable electrical power production until November 1988. Fermi 2 experienced a routine operational history until Christmas Day in 1993, when a failure of one of the low pressure turbines caused major damage to the turbine and the main generator. After a thirteen month outage to repair the damaged nonnuclear plant components and clean up the affected areas of the plant, the plant was once again operational and has been in routine power production mode ever since. Since the Fermi 2 plant is adjacent to the Enrico Fermi plant, MREMP surveillance of the plant was technically initiated in 1958. Monitoring at the plant site was scaled back in 1975, with the completion of the major portion of the original Enrico Fermi plant decommissioning, and expanded in the fall of 1983 just prior to the scheduled initial date of operation for Fermi 2.

Environmental Monitoring Phases

The purpose of the MREMP is to assess the environmental impact from operating nuclear power plants in Michigan and to determine any public health impact that may be the result of plant operations. This program also provides verification of the plant operated effluent monitoring system for each nuclear plant, as well as its associated radiological environmental monitoring network, and also serves as an in-place sampling network in the event of an accidental release. Atmospheric, terrestrial, aquatic, and direct radiation pathways are monitored to determine the potential impact of nuclear power plant operations on the environment and public health.

Preoperational environmental samples are collected and analyzed to provide background data on natural radioactivity and/or man-made sources of radioactivity in the vicinity of a planned operational nuclear power plant. Data accumulated during the preoperational period establish a baseline with which to compare operational measurements. A minimum of one year of data is usually collected prior to reactor operation for an adequate preoperational monitoring program. For all four nuclear power plant sites in Michigan, at least two years of data were collected. In addition to the preoperational monitoring conducted in the environs of Michigan's four nuclear power plant sites, a background reference station is operated in Lansing, Michigan, for data comparison.

The operational phase of the radiological environmental monitoring program is a natural extension of the preoperational monitoring program. Once the reactor becomes operational, environmental samples are collected from the network of sampling sites established for the preoperational phase, and individual and cumulative measurement results are compared to baseline data to discern any trends that may be indicative of the impact of plant operations. Measurement results from each of the nuclear plant areas are also compared to the results from the Lansing reference station, as well as the results from the other plant environs to assure that data anomalies and/or trends are adequately assessed. The Palisades, D. C. Cook, and Fermi 2 plants are currently in this phase of monitoring.

The postoperational phase of the radiological environmental monitoring program is initiated at the conclusion of the operational phase. When the plant is shutdown for decommissioning, environmental samples are collected from the network of sampling sites established for preoperational and operational monitoring. Individual and cumulative measurement results are compared to baseline data to discern any trends that may be indicative of the impact of plant activities during the final phase of the plant's operations. During this final phase of environmental monitoring, the number of samples and the frequency of sample collection are often reduced as the plant decommissioning nears completion. The Big Rock Point plant is currently in this phase of monitoring.

Atmospheric Monitoring

Sampling Network

The atmospheric monitoring network consists of three to six sampling stations in the vicinity of each of the four Michigan nuclear power plant sites and a background reference station in Lansing. At each station a highly efficient vacuum pump continuously draws ambient air, first through a particulate filter and then through a charcoal filter to collect air particulates and air vapors, respectively. Particulate filters are analyzed for gross beta activity three days after the end of sample collection, and charcoal filters are analyzed as soon as possible after the end of sample collection for the presence of radioactive iodine isotopes. Radiation atmospheric monitoring in Michigan was initiated in November 1958, with the first sampling station at the Fermi plant site. Air monitoring stations were added to the Fermi site vicinity as well as setting up multiple sampling stations in the vicinities of the Big Rock Point (July 1960), Palisades (November 1968), and D. C. Cook (September 1971) plant sites. The background reference station in Lansing became operational in February 1961.

Historical and Preoperational Atmospheric Monitoring

A detailed presentation of both historical and preoperational atmospheric monitoring results, historical monitoring trends and determination of preoperational air monitoring baselines for the four Michigan nuclear power plant areas were presented in the MREMP Report 1958-1996. These detailed discussions are not repeated in this report, but updated versions of two atmospheric monitoring historical plots are shown in Figures 1 and 2. The air monitoring baseline analyses are presented in Tables 1-4 for each of the four plants.

The plot of the monthly average air particulate gross beta activity for the longest running MREMP air station, at the Fermi plant site, has been updated with the additional three years of data and is shown in Figure 1. Also, the quarterly average air particulate activity for the four nuclear plant sites along with the Lansing background reference site is updated through 1999 and is shown in Figure 2. Visual examination of the two figures reveals that the additional three years of monitoring results are essentially a continuation of the natural background trend that has prevailed since the Chernobyl accident in 1986.

Figure 1

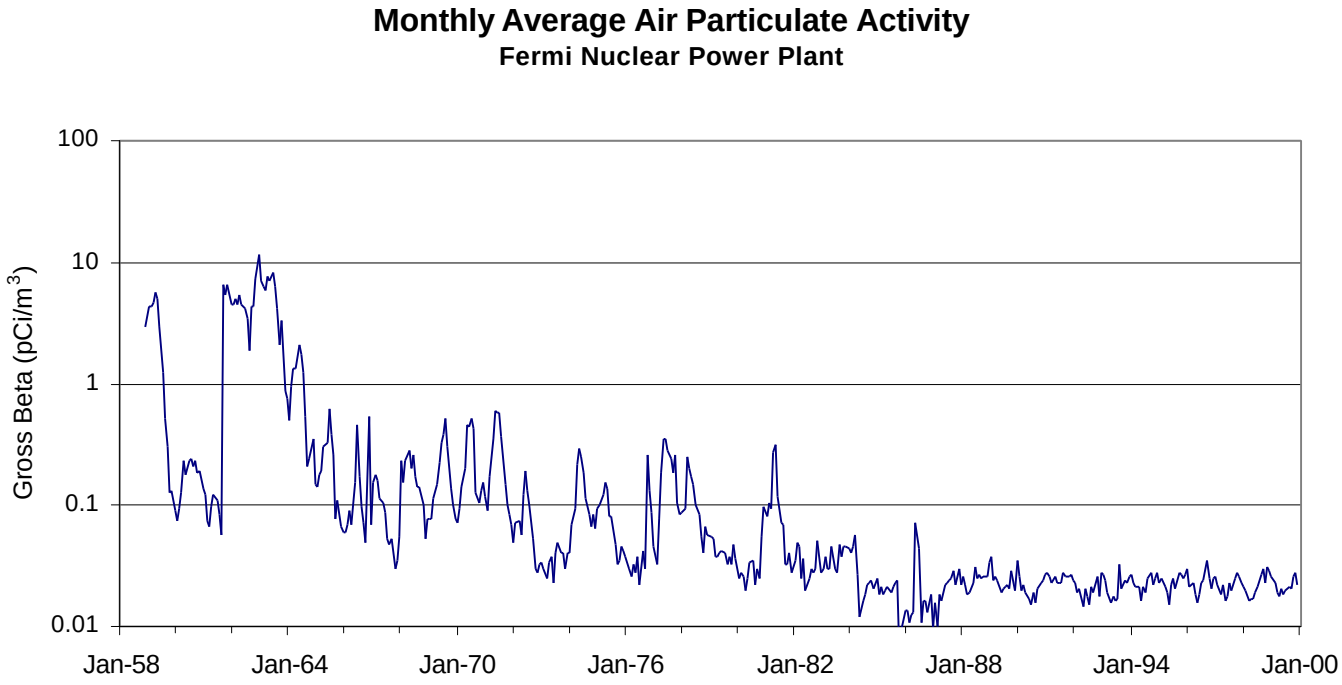
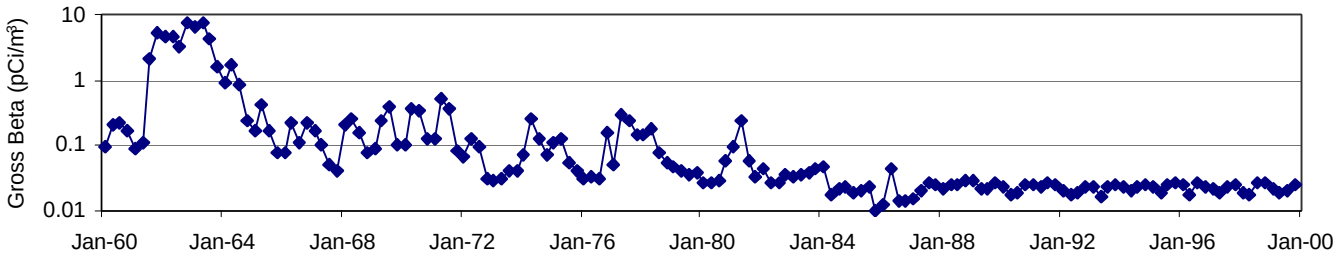
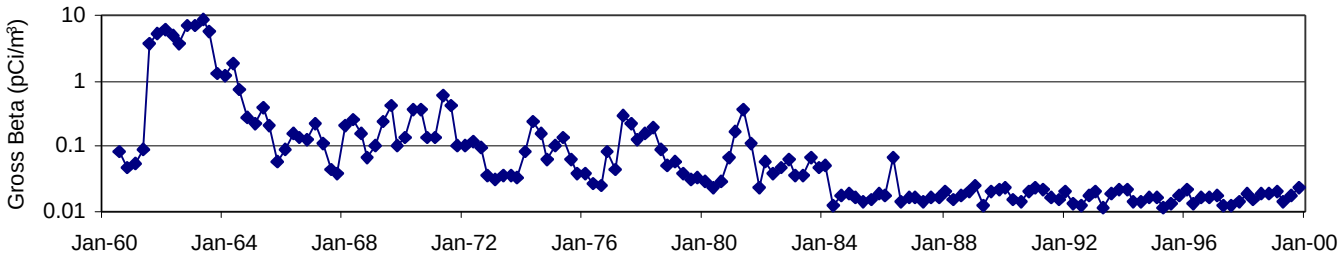


Figure 2

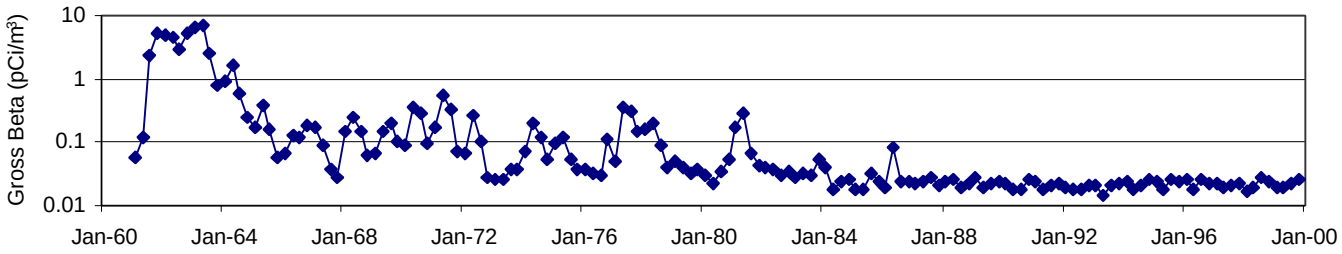
Quarterly Average Air Particulate Activity
Fermi Nuclear Power Plant Site



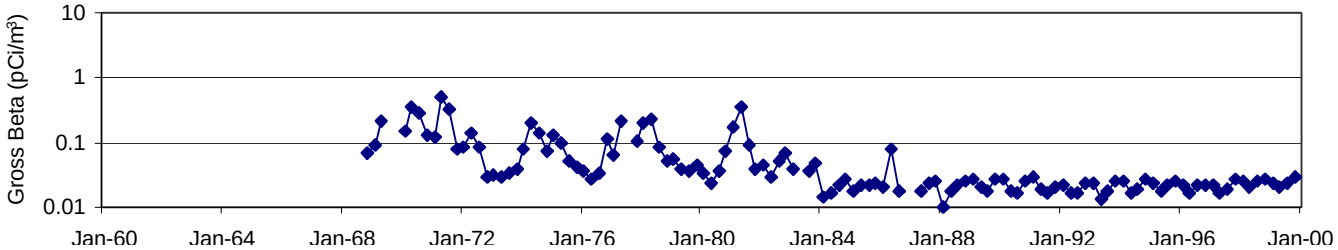
Quarterly Average Air Particulate Activity
Big Rock Point Nuclear Power Plant Site



Quarterly Average Air Particulate Activity
Lansing Background Reference Site



Quarterly Average Air Particulate Activity
Palisades Nuclear Power Plant Site



Quarterly Average Air Particulate Activity
D. C. Cook Nuclear Power Plant Site

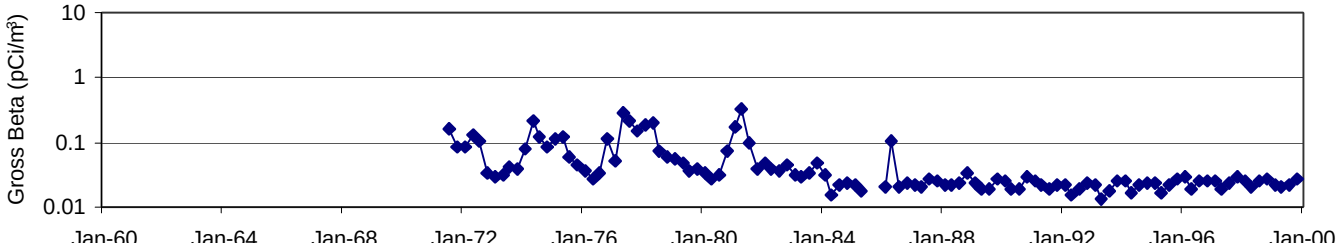


Table 1
BIG ROCK POINT PREOPERATIONAL AIR PARTICULATE MONITORING RESULTS

	Reactor Site	Charlevoix	Burgess
Number of Samples	58	60	60
Highest Result (pCi/m^3)	0.13	0.15	0.14
Lowest Result (pCi/m^3)	0.02	0.02	0.03
Arithmetic Mean (pCi/m^3)	0.07	0.07	0.07
Geometric Mean(pCi/m^3)	0.06	0.06	0.06

Table 2
PALISADES PREOPERATIONAL AIR PARTICULATE MONITORING RESULTS

	Reactor Site	Covert	South Haven
Number of Samples	57	55	44
Highest Result (pCi/m^3)	0.70	0.92	0.64
Lowest Result (pCi/m^3)	0.06	0.06	0.07
Arithmetic Mean (pCi/m^3)	0.24	0.25	0.25
Geometric Mean (pCi/m^3)	0.19	0.20	0.21

Table 3
D. C. COOK PREOPERATIONAL AIR PARTICULATE MONITORING RESULTS

	Reactor Site	Bridgman	Stevensville	Livingston Road	Peddy Farm
Number of Samples	48	22	30	25	28
Highest Result (pCi/m^3)	0.34	0.24	0.37	0.37	0.20
Lowest Result (pCi/m^3)	0.04	0.05	0.04	0.04	0.03
Arithmetic Mean (pCi/m^3)	0.13	0.13	0.11	0.09	0.10
Geometric Mean (pCi/m^3)	0.11	0.11	0.09	0.08	0.08

Table 4
FERMI 2 PREOPERATIONAL AIR PARTICULATE MONITORING RESULTS

	Reactor Site	Rockwood	Pointe Aux Peaux Rd.	Nadeau Rd.	Dixie Hwy.	Fix Farm
Number of Samples	125	132	106	130	127	131
Highest Result (pCi/m^3)	0.09	0.09	0.08	0.11	0.07	0.07
Lowest Result (pCi/m^3)	0.01	0.01	0.01	0.01	0.01	0.01
Arithmetic Mean (pCi/m^3)	0.03	0.03	0.03	0.03	0.03	0.03
Geometric Mean (pCi/m^3)	0.03	0.02	0.03	0.03	0.03	0.03

Atmospheric Monitoring 1997-99

The air particulate monitoring results from the four nuclear power plant areas and the Lansing background reference station were very consistent with previous years of this decade. During the 1997-99 monitoring period, air particulate levels remained at natural background levels, with no discernable increasing or decreasing trends. There were no air vapor ^{131}I results exceeding the analytical Minimum Detectable Activity (MDA) level of 0.02 to 0.03 pCi/m^3, decay corrected to the end of sample, for samples collected during the three-year period. Details of the air particulate gross beta monitoring results for each of the four plants with comparisons to their respective preoperational baseline data and to the Lansing station are discussed below. Also, plots of gross beta results of each station for 1997 through 1999 are shown in Figures 3-20. The air monitoring results in tabular form are presented in Appendix A of this report.

Big Rock Point

Atmospheric monitoring for Big Rock Point for 1997 through 1999 consisted of the three monitoring stations; one at the reactor site, one east of the plant site in Burgess, and one southwest of the plant site in Charlevoix. For the three-year period, there were no distinguishable peaks or trends in the gross beta results for all three stations, with the levels oscillating between the extremes of 0.004 pCi/m^3 and 0.040 pCi/m^3. Gross beta data from the three stations were analyzed for central tendencies and measurement extremes, and the results of these analyses are presented in Table 5.

Table 5
BIG ROCK POINT AIR PARTICULATE RESULTS 1997-99

1997 Monitoring Results			
	Reactor Site	Charlevoix	Burgess
Number of Samples	52	52	52
Highest Result (pCi/m^3)	0.033	0.024	0.027
Lowest Result (pCi/m^3)	0.005	0.004	0.005
Arithmetic Mean (pCi/m^3)	0.014	0.012	0.013
Geometric Mean (pCi/m^3)	0.013	0.012	0.012
1998 Monitoring Results			
	Reactor Site	Charlevoix	Burgess
Number of Samples	52	52	52
Highest Result (pCi/m^3)	0.030	0.023	0.025
Lowest Result (pCi/m^3)	0.006	0.005	0.006
Arithmetic Mean (pCi/m^3)	0.018	0.013	0.014
Geometric Mean (pCi/m^3)	0.016	0.013	0.013
1999 Monitoring Results			
	Reactor Site	Charlevoix	Burgess
Number of Samples	52	52	52
Highest Result (pCi/m^3)	0.040	.0.26	0.031
Lowest Result (pCi/m^3)	0.007	0.007	0.006
Arithmetic Mean (pCi/m^3)	0.019	0.014	0.015
Geometric Mean (pCi/m^3)	0.018	0.013	0.015

The average air particulate gross beta concentration during the preoperational monitoring period was 0.070 pCi/m^3 for the Big Rock Point area. This preoperational average is four to five times higher than the 1997-99 area average concentrations of 0.015 pCi/m^3. The 1997 area average level of 0.013 pCi/m^3 was slightly lower than the 1995 level of 0.015 pCi/m^3 and the 1996 level of 0.016 pCi/m^3. The 1998 area average level of 0.015 pCi/m^3 and the 1999 area average of 0.016 pCi/m^3 are the same as the 1995 and 1996 area averages. The average air particulate gross beta concentration for the Lansing background reference station during 1997-98 was 0.021 pCi/m^3, which is about 50% higher than the Big Rock Point area average and is consistent with results from 1995 and 1996.

Palisades

Three atmospheric monitoring stations were operated in the environs of the Palisades plant during 1997-99 period; one at the reactor site, a second north of the plant in South Haven, and the third southeast of the plant near Covert. There were no distinguishable peaks or trends in the gross beta results for all three stations during the three-year period, with the levels oscillating between the extremes of 0.005 pCi/m^3 and 0.058 pCi/m^3. Gross beta data from the three stations were analyzed for central tendencies and measurement extremes and are presented in Table 6.

Table 6
PALISADES AIR PARTICULATE MONITORING RESULTS 1997-99

1997 Monitoring Results			
	Reactor Site	Covert	South Haven
Number of Samples	52	51	52
Highest Result (pCi/m^3)	0.058	0.034	0.052
Lowest Result (pCi/m^3)	0.008	0.006	0.008
Arithmetic Mean (pCi/m^3)	0.021	0.016	0.020
Geometric Mean (pCi/m^3)	0.020	0.015	0.019
1998 Monitoring Results			
	Reactor Site	Covert	South Haven
Number of Samples	52	52	52
Highest Result (pCi/m^3)	0.040	0.027	0.048
Lowest Result (pCi/m^3)	0.007	0.005	0.006
Arithmetic Mean (pCi/m^3)	0.025	0.016	0.020
Geometric Mean (pCi/m^3)	0.024	0.016	0.019
1999 Monitoring Results			
	Reactor Site	Covert	South Haven
Number of Samples	51	46	51
Highest Result (pCi/m^3)	0.047	0.031	0.035
Lowest Result (pCi/m^3)	0.014	0.014	0.007
Arithmetic Mean (pCi/m^3)	0.024	0.019	0.018
Geometric Mean (pCi/m^3)	0.023	0.018	0.017

The average air particulate gross beta concentration during the preoperational monitoring period was 0.25 pCi/m^3 for the Palisades plant area. This preoperational average was more than twelve times higher than the area average concentrations of 0.020 pCi/m^3, measured in 1997-99. The 1997, 1998, and 1999 area averages are 0.019 pCi/m^3, 0.020 pCi/m^3, and 0.020 pCi/m^3, respectively. The area averages for all three of these years are slightly less than the 1995 and 1996 area averages of 0.023 pCi/m^3 and 0.021 pCi/m^3, respectively. The average air particulate gross beta concentration for the Lansing background reference station was 0.021 pCi/m^3 during the 1997-99 period, which is slightly higher than the average level of the three Palisades stations.

D. C. Cook

Five atmospheric monitoring stations were operated in the environs of the D. C. Cook plant during 1997-99. One is located at the reactor site, a second is south of the plant in Bridgman, a third is northeast of the plant in Stevensville, a fourth is at the west end of Livingston Road, and a fifth is about three miles due east of the plant. The Bridgman station was shutdown for half of 1997 due to an extensive building renovation project. Also, the Peddy Farm station was moved to the next property to the north (a few hundred feet) due to the sale of the farm. This station continues to be referred to as the Peddy Farm station, since the new site was once part of the farm.

There were no distinguishable peaks or trends in the gross beta results for all five stations during the 1997-99 period, with the levels oscillating between the extremes of 0.004 pCi/m^3 and 0.066 pCi/m^3. Gross beta data from the five stations were analyzed for central tendencies and measurement extremes. The results of these analyses are presented in Table 7.

Table 7
D. C. COOK AIR PARTICULATE MONITORING RESULTS 1997-99

1997 Monitoring Results					
	Reactor Site	Bridgman	Stevensville	Livingston Road	Peddy Farm
Number of Samples	52	26	52	52	52
Highest Result (pCi/m^3)	0.066	0.032	0.053	0.052	0.048
Lowest Result (pCi/m^3)	0.012	0.011	0.009	0.009	0.008
Arithmetic Mean (pCi/m^3)	0.024	0.020	0.020	0.020	0.019
Geometric Mean (pCi/m^3)	0.023	0.020	0.019	0.019	0.018
1998 Monitoring Results					
	Reactor Site	Bridgman	Stevensville	Livingston Road	Peddy Farm
Number of Samples	52	50	50	44	47
Highest Result (pCi/m^3)	0.037	0.032	0.033	0.029	0.034
Lowest Result (pCi/m^3)	0.008	0.004	0.006	0.004	0.004
Arithmetic Mean (pCi/m^3)	0.024	0.020	0.020	0.018	0.020
Geometric Mean (pCi/m^3)	0.023	0.019	0.020	0.017	0.018
1999 Monitoring Results					
	Reactor Site	Bridgman	Stevensville	Livingston Road	Peddy Farm
Number of Samples	48	51	51	49	51
Highest Result (pCi/m^3)	0.044	0.038	0.037	0.038	0.036
Lowest Result (pCi/m^3)	0.012	0.011	0.012	0.011	0.011
Arithmetic Mean (pCi/m^3)	0.023	0.020	0.020	0.020	0.018
Geometric Mean (pCi/m^3)	0.022	0.019	0.019	0.019	0.017

The average air particulate gross beta concentration during the preoperational monitoring period was 0.11 pCi/m^3 for the D. C. Cook plant area. This preoperational gross beta concentration is approximately five times higher than the average concentration of 0.020 pCi/m^3, measured in 1997-99 for the same five stations. The 1997 and 1998 area average levels of 0.021 pCi/m^3 and the 1999 area average level of 0.020 pCi/m^3 were slightly lower than the 1995 and 1996 area average levels of 0.022 pCi/m^3. The average air particulate gross beta concentration for the Lansing background reference station was 0.021 pCi/m^3 during the 1997-99 period, which is almost identical to the area average levels at the five D. C. Cook stations during 1997-99.

Fermi 2

Six atmospheric monitoring stations were operated in the environs of the Fermi 2 plant during 1997-99. One is located at the reactor site, a second north of the plant in Rockwood, a third south of the plant on Pointe Aux Peaux Road, a fourth southwest of the plant on Nadeau Road, a fifth on Dixie Highway due west of the plant, and the sixth station at the Fix Farm, northwest of the plant on Post Road. There were no distinguishable peaks or trends in the gross beta results for all six stations during the 1997-99 period, with the levels oscillating between the extremes of 0.004 pCi/m^3 and 0.086 pCi/m^3. Gross beta data from the six stations were analyzed for central tendencies and measurement extremes. The results of these analyses are presented in Table 8.

Table 8 **FERMI 2 AIR PARTICULATE MONITORING RESULTS 1997-99**						
1997 Monitoring Results						
	Reactor Site	Rockwood	Pointe Aux Peaux Rd.	Nadeau Rd.	Dixie Hwy.	Fix Farm
Number of Samples	52	52	52	52	51	52
Highest Result (pCi/m^3)	0.040	0.039	0.033	0.037	0.055	0.041
Lowest Result (pCi/m^3)	0.009	0.010	0.009	0.010	0.009	0.010
Arithmetic Mean (pCi/m^3)	0.022	0.021	0.020	0.022	0.027	0.022
Geometric Mean (pCi/m^3)	0.021	0.020	0.019	0.021	0.025	0.021
1998 Monitoring Results						
	Reactor Site	Rockwood	Pointe Aux Peaux Rd.	Nadeau Rd.	Dixie Hwy.	Fix Farm
Number of Samples	46	51	49	52	52	48
Highest Result (pCi/m^3)	0.040	0.051	0.045	0.045	0.086	0.048
Lowest Result (pCi/m^3)	0.005	0.006	0.005	0.004	0.010	0.007
Arithmetic Mean (pCi/m^3)	0.022	0.023	0.019	0.021	0.035	0.021
Geometric Mean (pCi/m^3)	0.021	0.021	0.018	0.020	0.032	0.020
1999 Monitoring Results						
	Reactor Site	Rockwood	Pointe Aux Peaux Rd.	Nadeau Rd.	Dixie Hwy.	Fix Farm
Number of Samples	51	52	51	51	49	49
Highest Result (pCi/m^3)	0.049	0.044	0.071	0.046	0.053	0.052
Lowest Result (pCi/m^3)	0.007	0.005	0.008	0.006	0.007	0.005
Arithmetic Mean (pCi/m^3)	0.022	0.019	0.028	0.020	0.026	0.017
Geometric Mean (pCi/m^3)	0.021	0.018	0.026	0.018	0.024	0.016

The area average air particulate gross beta concentration during the preoperational monitoring period was 0.03 pCi/m^3 for all six stations at Fermi 2. This preoperational gross beta concentration is just slightly higher than the area average concentrations of 0.023 pCi/m^3 measured in 1997-99, for the same six stations. The 1997, 1998, and 1999 area averages were 0.022 pCi/m^3, 0.024 pCi/m^3, and 0.022 pCi/m^3, respectively. These area averages were essentially the same as the 1995 and the 1996 area averages of 0.023 pCi/m^3. The average air particulate gross beta concentration for the Lansing background reference station was 0.021 pCi/m^3 during the 1997-99 period, which is slightly lower than the average levels measured in the Fermi 2 area.

Figure 3

Air Particulate Monitoring

Big Rock Point Reactor Site 1997-99

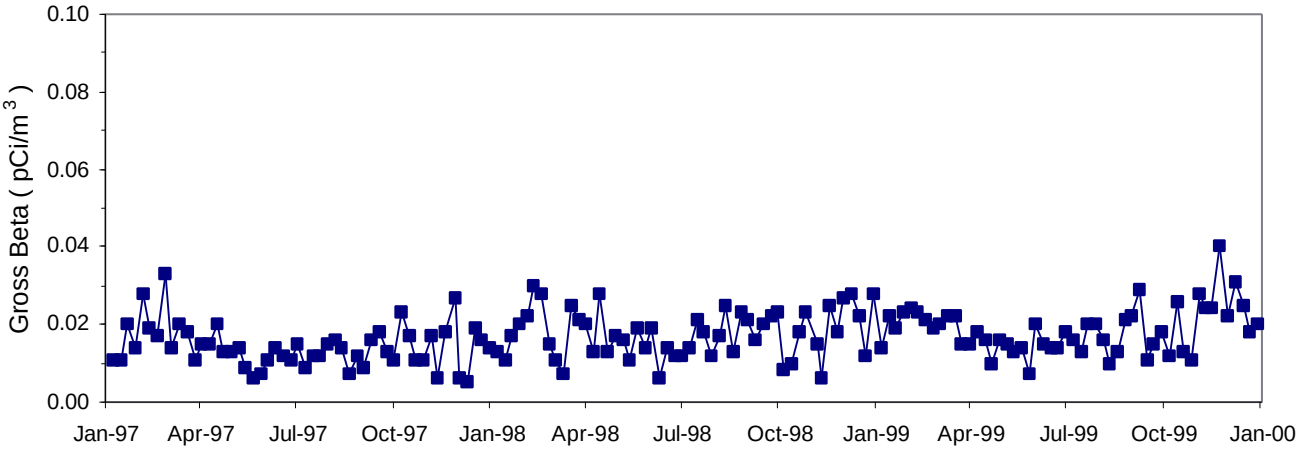


Figure 4

Air Particulate Monitoring

Big Rock Point Charlevoix Site 1997-99

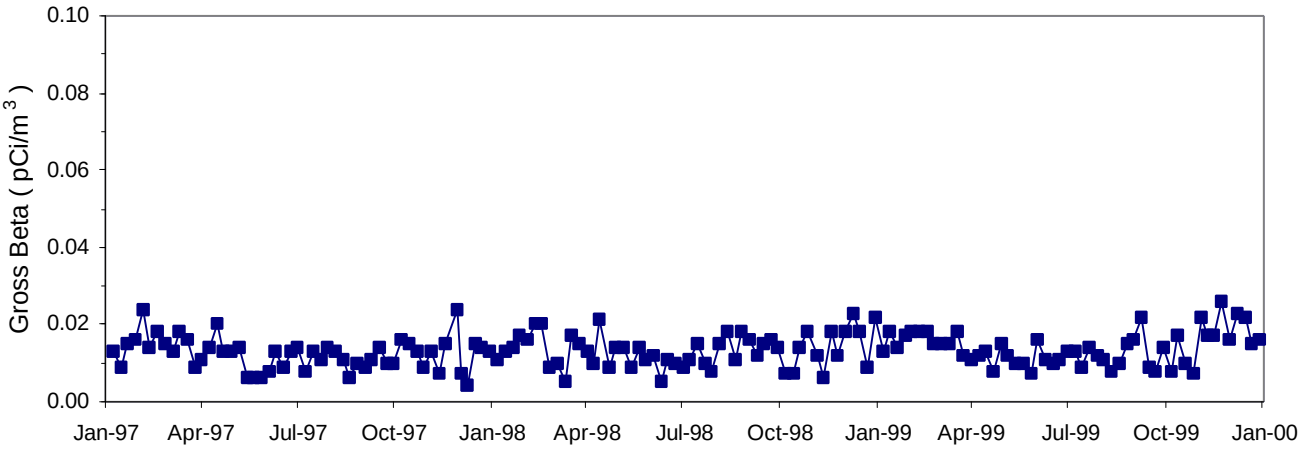


Figure 5

Air Particulate Monitoring

Big Rock Point Burgess Site 1997-99

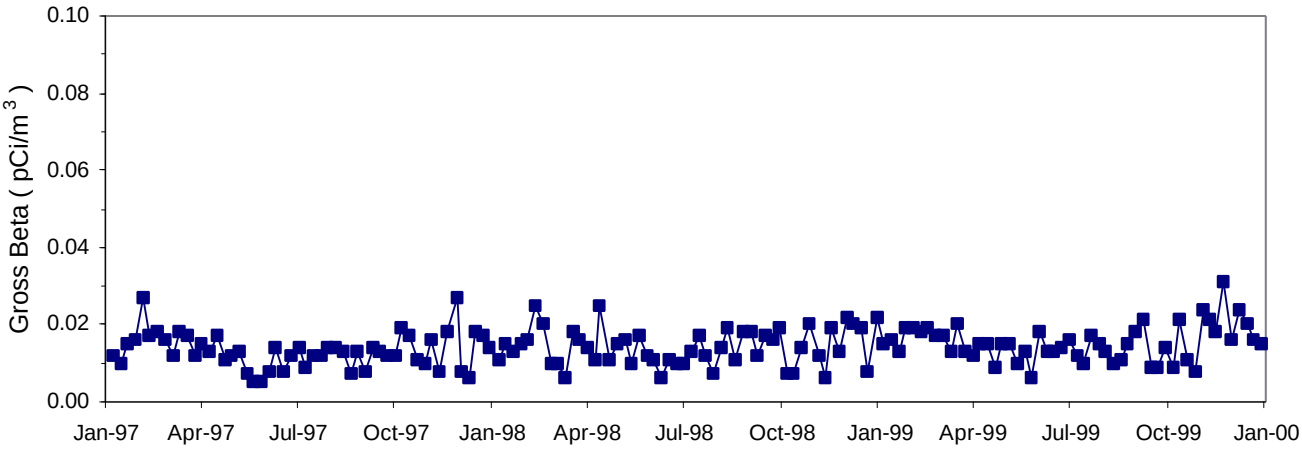


Figure 6

Air Particulate Monitoring

Palisades Reactor Site 1997-99

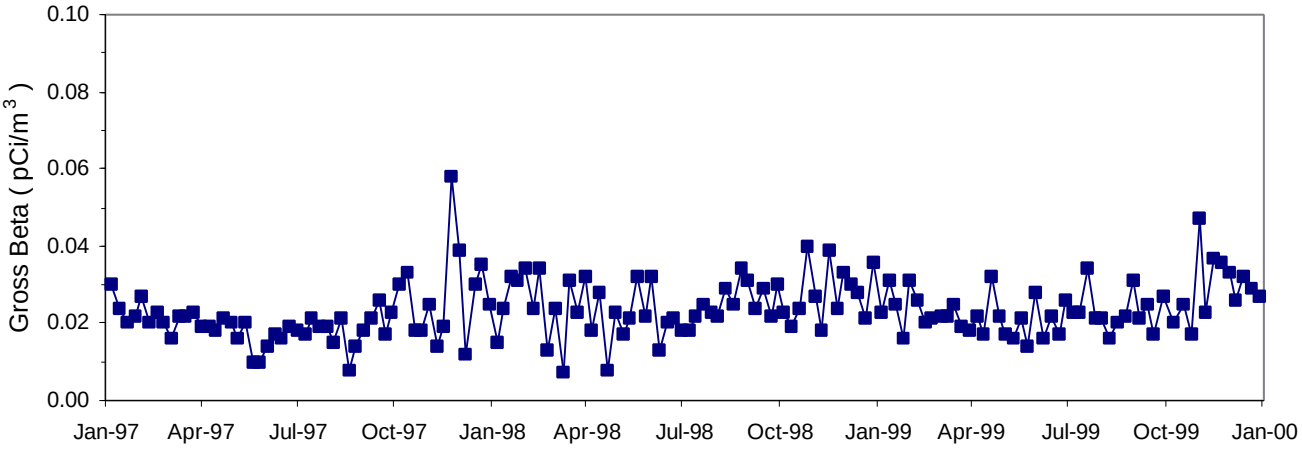


Figure 7

Air Particulate Monitoring

Palisades Covert Site 1997-99

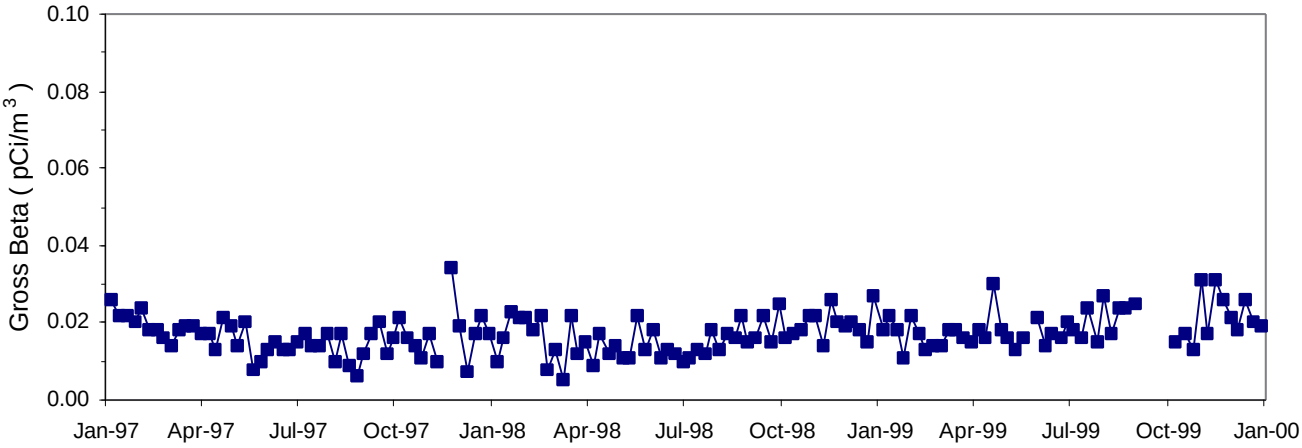


Figure 8

Air Particulate Monitoring

Palisades South Haven Site 1997-99

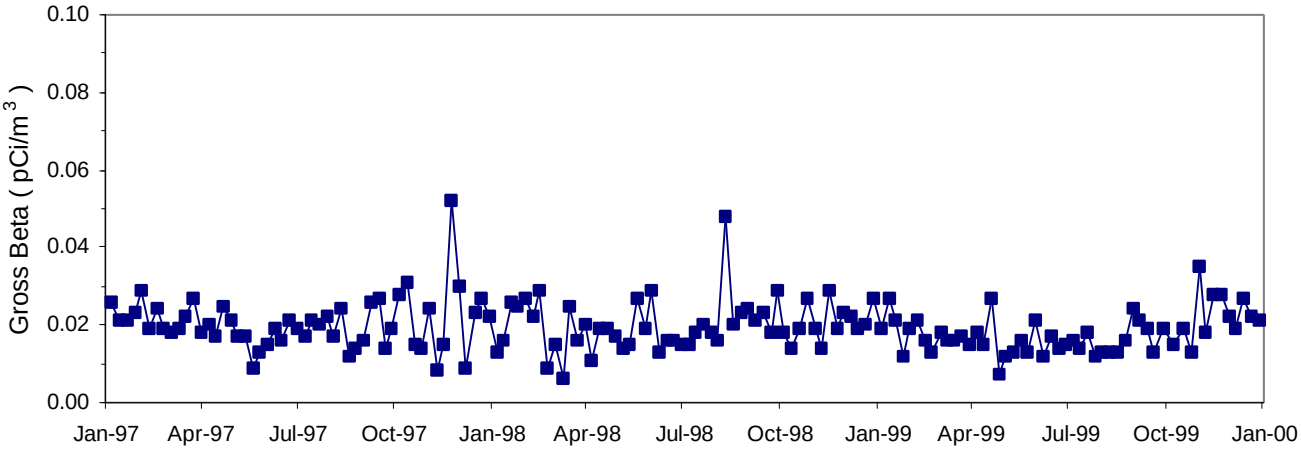


Figure 9

Air Particulate Monitoring

D. C. Cook Reactor Site 1997-99

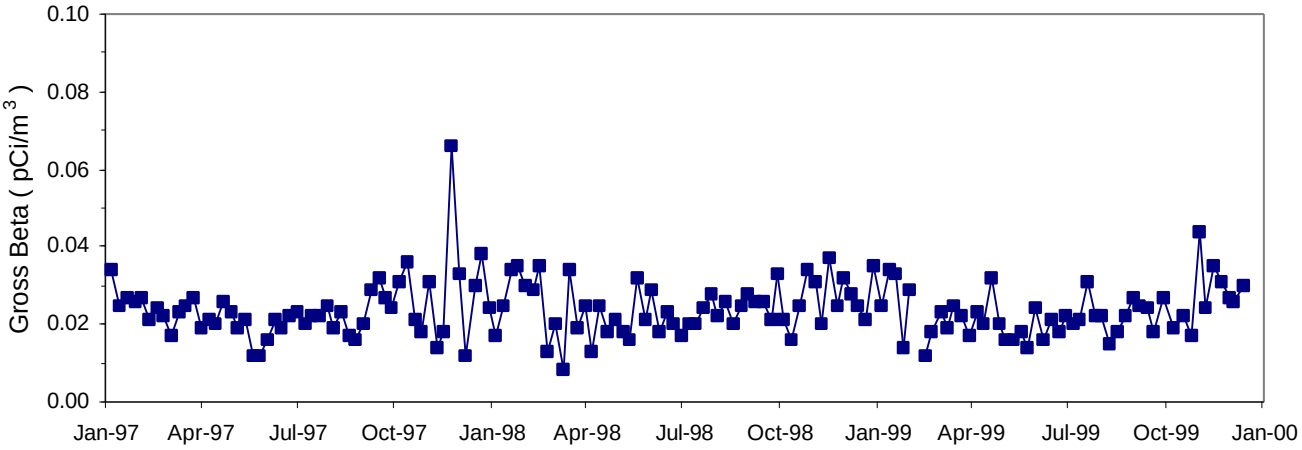


Figure 10

Air Particulate Monitoring

D. C. Cook Bridgman Site 1997-99

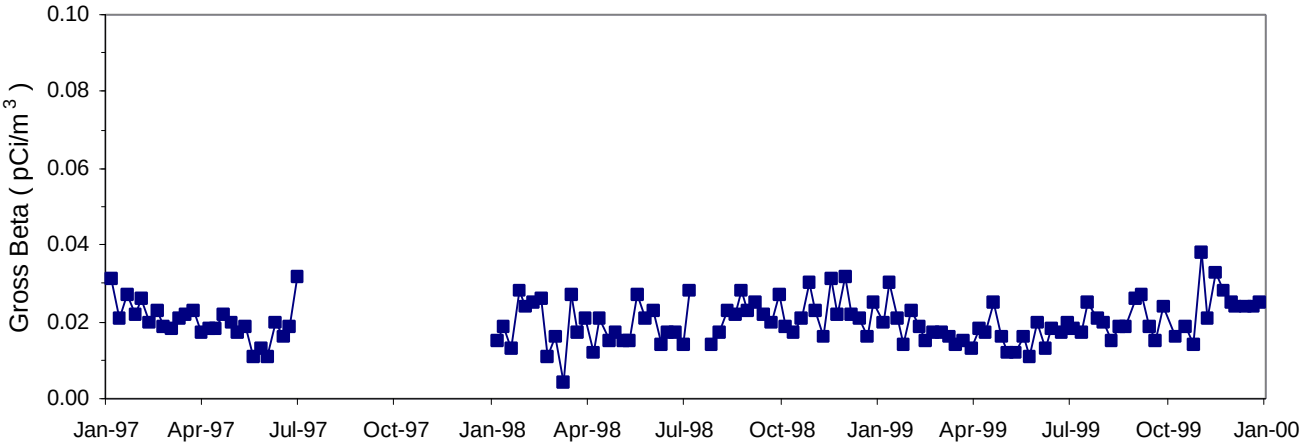


Figure 11

Air Particulate Monitoring

D. C. Cook Stevensville Site 1997-99

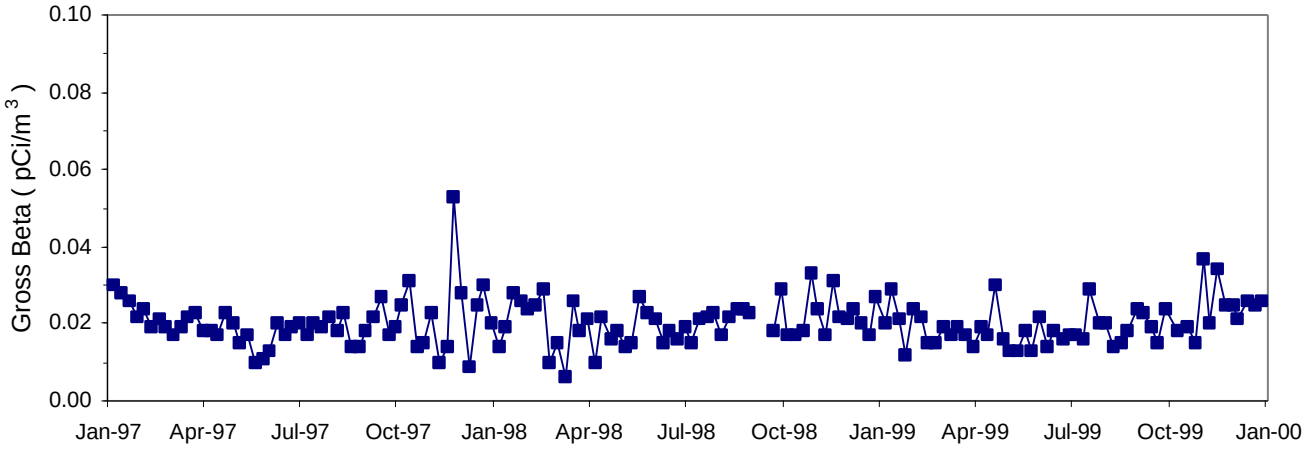


Figure 12

Air Particulate Monitoring

D. C. Cook Livingston Road Site 1997-99

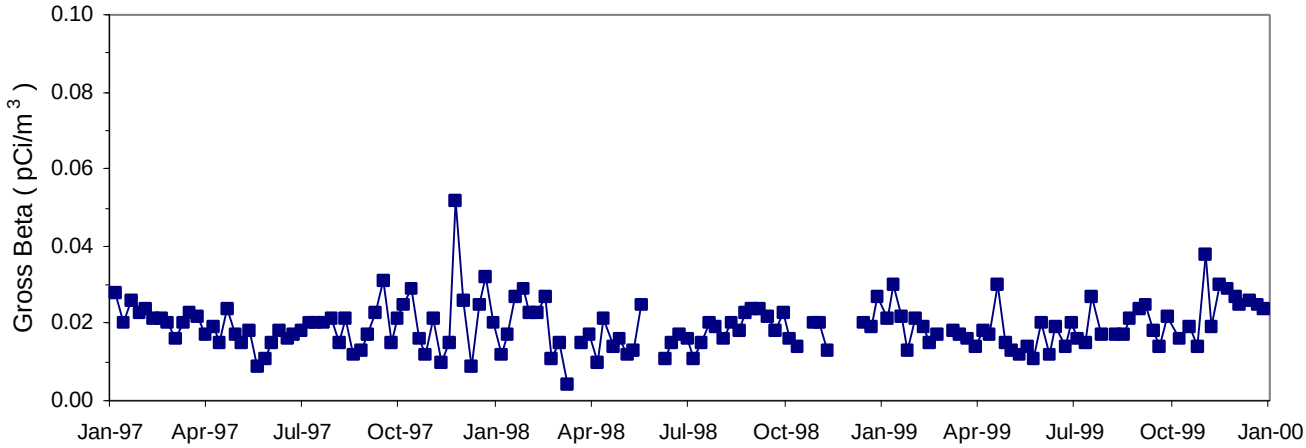


Figure 13

Air Particulate Monitoring

D. C. Cook Peddy Farm Site 1997-99

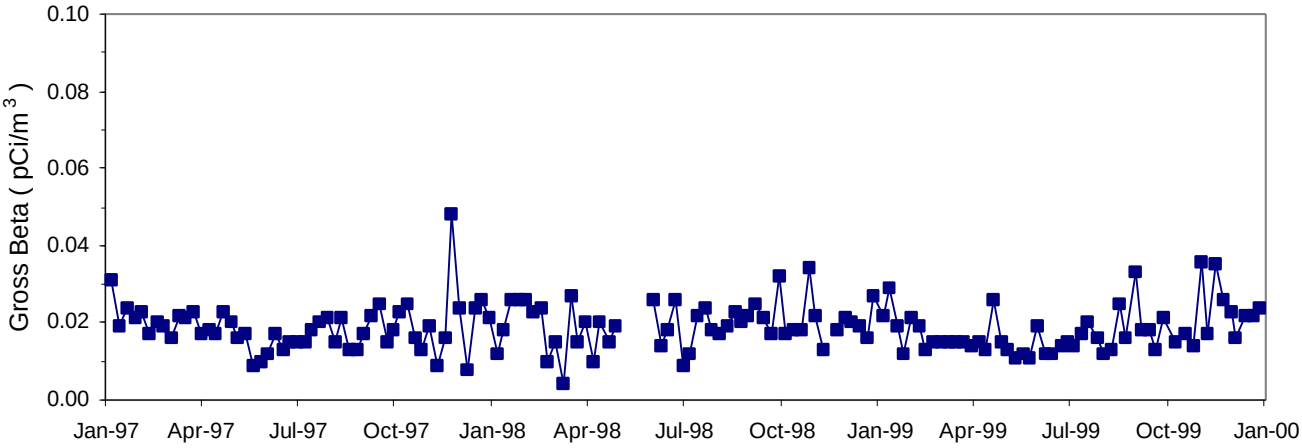


Figure 14

Air Particulate Monitoring

Fermi 2 Reactor Site 1997-99

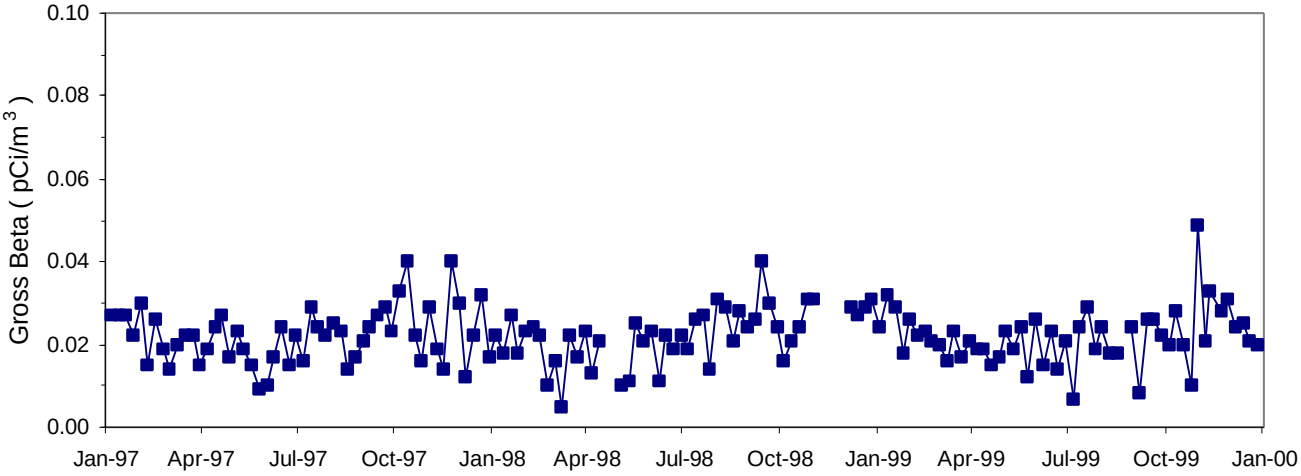


Figure 15

Air Particulate Monitoring

Fermi 2 Rockwood Site 1997-99

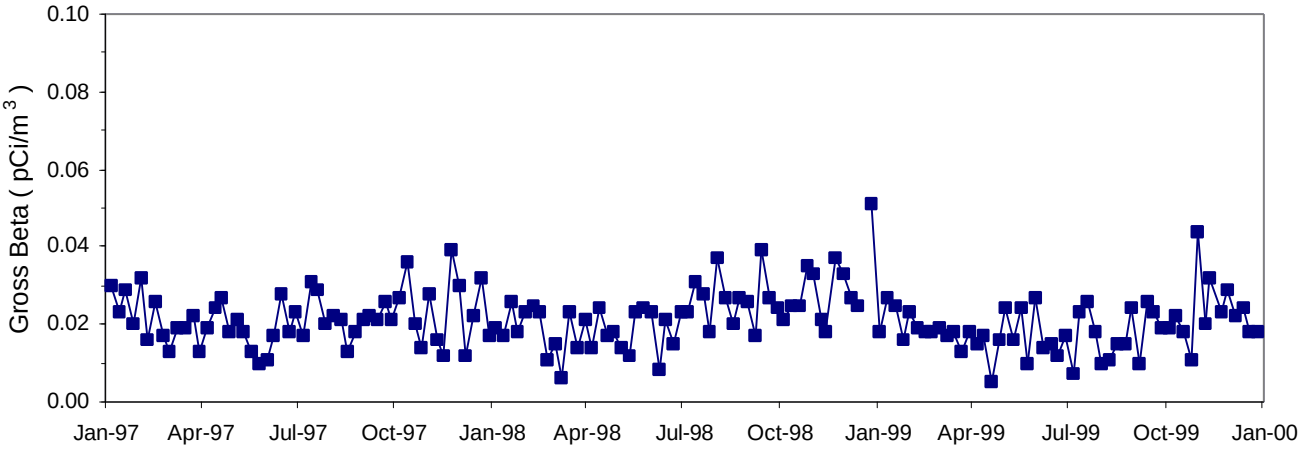


Figure 16

Air Particulate Monitoring

Fermi 2 Pointe Aux Peaux Road Site 1997-99

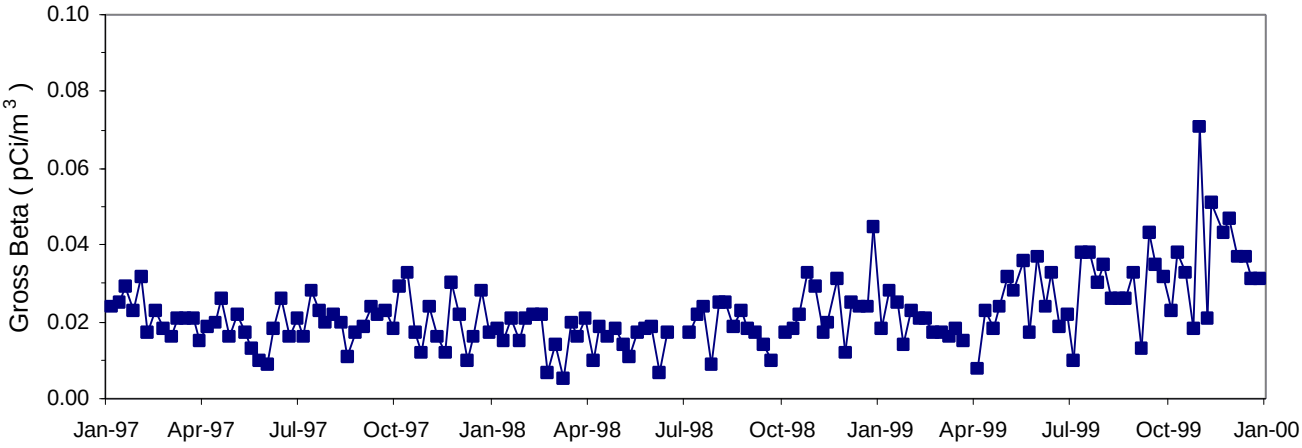


Figure 17

Air Particulate Monitoring

Fermi 2 Nadeau Road Site 1997-99

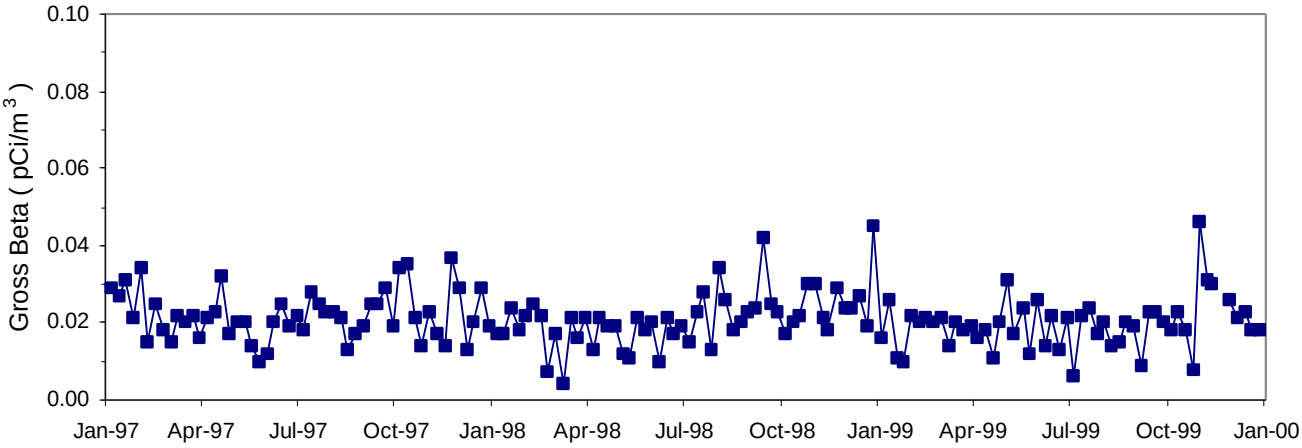


Figure 18

Air Particulate Monitoring

Fermi 2 Dixie Highway Site 1997-99

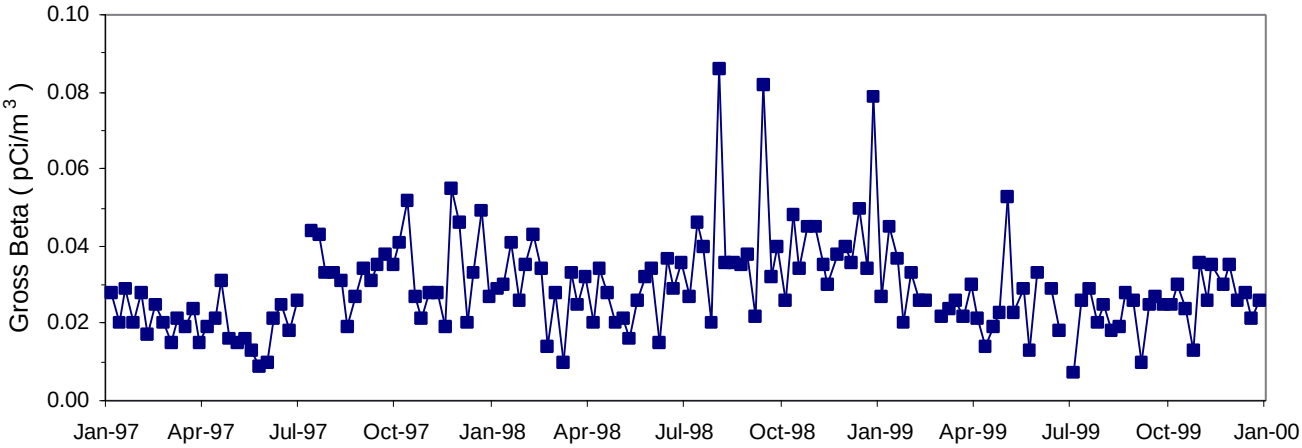


Figure 19

Air Particulate Monitoring

Fermi 2 Fix Farm Site 1997-99

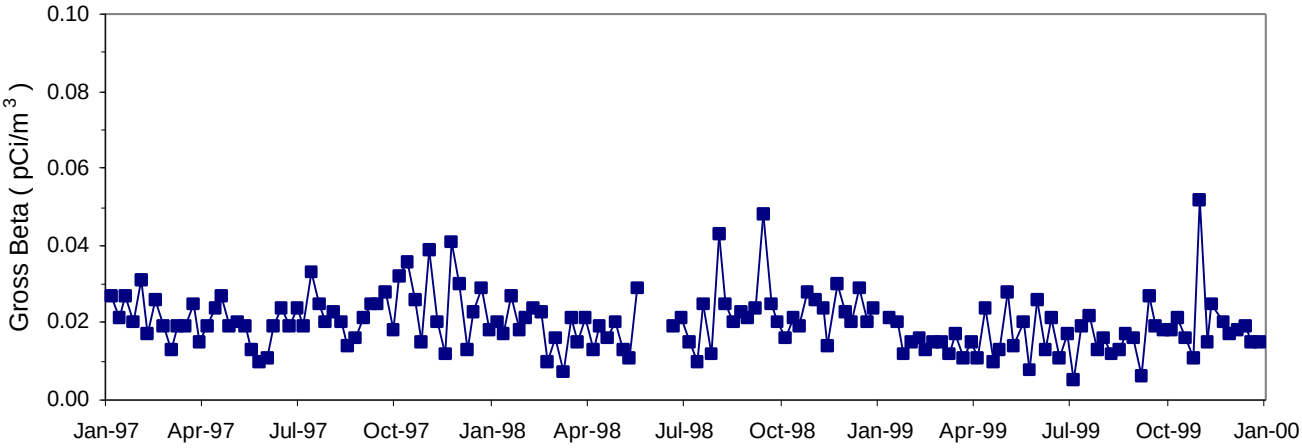
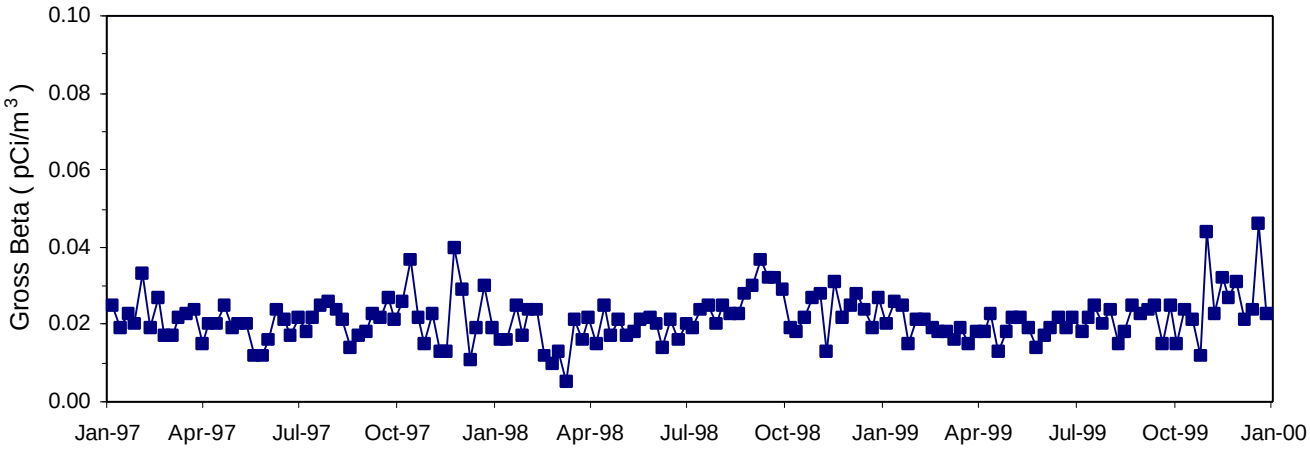


Figure 20

Air Particulate Monitoring

Lansing Background Reference Site 1997-99



Terrestrial Monitoring

Sampling Network

The terrestrial monitoring network consists of seven milk sampling stations, three of which are located near the state's nuclear power plants and the other four scattered around the state for geographical and population coverage. Sampling at the Charlevoix, Detroit, Grand Rapids, Lansing, Marquette, and Monroe milk stations was initiated in late 1962 and the South Haven milk station was added in 1969. Originally, milk samples were collected on a weekly basis for all seven stations, but over the years the sampling schedule evolved to weekly samples for the Charlevoix and South Haven stations, biweekly for the Lansing, Marquette, and Monroe stations, and monthly for the Detroit and Grand Rapids stations. Pasteurized milk samples from a local dairy were collected for all seven stations until the late 1970s. During the late 1970s and the early 1980s, all local dairies in the Charlevoix, Monroe, and South Haven areas closed and sampling for these three stations were shifted to raw milk samples from a local dairy farm. Pasteurized milk samples, collected from a local dairy, for the Detroit, Grand Rapids, Lansing, and Marquette stations have continued through 1998. All samples are analyzed for gamma emitting radionuclides and one sample per month from each station is analyzed for ^{90}Sr by a chemical separation method using ion exchange and beta counting.

Historical Terrestrial Monitoring Trends

Historical and preoperational milk monitoring results, historical monitoring trends, and the determination of preoperational milk monitoring baselines for the four plant areas was presented in detail in MREMP Report 1958-1996. These discussions are not repeated in this report but the final results of the preoperational baseline analysis is presented in Tables 9-12 for comparison with the 1997 and 1998 milk monitoring results.

Table 9
BIG ROCK POINT PREOPERATIONAL MILK MONITORING RESULTS

1963 Milk Monitoring Results	^{131}I (pCi/l)	^{137}Cs (pCi/l)	^{90}Sr (pCi/l)
Charlevoix Average	Less than 20	136	17
Charlevoix Highest	Less than 20	232	22
Charlevoix Lowest	Less than 20	70	11
Statewide Average without Charlevoix	Less than 20	119	15
1964 Milk Monitoring Results			
Charlevoix Average	Less than 20	137	21
Charlevoix Highest	Less than 20	182	29
Charlevoix Lowest	Less than 20	71	13
Statewide Average without Charlevoix	Less than 20	116	19

Table 10 **PALISADES PREOPERATIONAL MILK MONITORING RESULTS**			
1969 Milk Monitoring Results	^{131}I (pCi/l)	^{137}Cs (pCi/l)	^{90}Sr (pCi/l)
South Haven Average	Less than 14	11	7
South Haven Highest	Less than 14	16	8
South Haven Lowest	Less than 14	6	6
Statewide Average without South Haven	Less than 14	15	7
1970 Milk Monitoring Results			
South Haven Average	Less than 14	11	8
South Haven Highest	Less than 14	41	9
South Haven Lowest	Less than 14	Less than 6	6
Statewide Average without South Haven	Less than 14	14	10

Table 11 **D. C. COOK PREOPERATIONAL MILK MONITORING RESULTS**			
1973 Milk Monitoring Results	^{131}I (pCi/l)	^{137}Cs (pCi/l)	^{90}Sr (pCi/l)
South Haven Average	Less than 14	6	8
South Haven Highest	Less than 14	20	18
South Haven Lowest	Less than 14	Less than 6	Less than 2
Statewide Average without South Haven	Less than 14	7	8
1974 Milk Monitoring Results			
South Haven Average	Less than 14	8	11
South Haven Highest	Less than 14	17	27
South Haven Lowest	Less than 14	Less than 6	5
Statewide Average without South Haven	Less than 14	9	11

Table 12 **FERMI 2 PREOPERATIONAL MILK MONITORING RESULTS**			
1983 Milk Monitoring Results	^{131}I (pCi/l)	^{137}Cs (pCi/l)	^{90}Sr (pCi/l)
Monroe Average	Less than 6	Less than 5	Less than 2
Monroe Highest	Less than 6	13	2
Monroe Lowest	Less than 6	Less than 5	Less than 2
Statewide Average without Monroe	Less than 6	Less than 5	Less than 2
1984 Milk Monitoring Results			
Monroe Average	Less than 6	Less than 5	Less than 2
Monroe Highest	Less than 6	6	2
Monroe Lowest	Less than 6	Less than 5	Less than 2
Statewide Average without Monroe	Less than 6	Less than 5	Less than 2

1997 Terrestrial Monitoring

The 1997 individual milk monitoring results were almost all less than the MDA levels, and the average levels for each monitoring station are summarized in Table 13. Of the 201 milk samples analyzed during 1997, there were none with detectable amounts of ^{131}I; fourteen samples with detectable amounts of ^{137}Cs (five at 4 pCi/l, eight at 3 pCi/l, and one at 2 pCi/l); and two samples with detectable amounts of ^{90}Sr (one at 3 pCi/l and one at 2 pCi/l). The detectable amounts of ^{137}Cs and ^{90}Sr were either equal to or slightly above the MDA levels indicating, very little, if any, of the long-lived radioactive fallout from past atmospheric nuclear device detonations or the Chernobyl accident are still present in milk produced in Michigan. Also, the fifteen samples with detectable amounts of either ^{137}Cs or ^{90}Sr represent less than 8% of the total MREMP milk samples analyzed during 1997. The 8% of samples with results exceeding analytical MDA values is a increase over past years (1995 and 1996 were both less than 3%) due to improved instrumentation yielding much lower MDA values. Overall, the milk monitoring results from all sampling stations were lower than levels recorded during preoperational monitoring periods or, in the case of Big Rock Point, during the early years of plant operation. A tabular presentation of MREMP milk monitoring results for 1997 is located in Appendix B.

Table 13
1997 MILK MONITORING RESULT AVERAGES

	Number of Samples	^{131}I (pCi/l)	^{137}Cs (pCi/l)	^{90}Sr (pCi/l)
Charlevoix	51	Less than 4	Less than 3	Less than 2
Detroit	12	Less than 4	Less than 3	Less than 3
Grand Rapids	12	Less than 3	Less than 3	Less than 2
Lansing	26	Less than 3	Less than 3	Less than 2
Marquette	22	Less than 4	Less than 3	Less than 2
Monroe	26	Less than 3	Less than 3	Less than 2
South Haven	52	Less than 3	Less than 3	Less than 3
Statewide	201	Less than 3	Less than 3	Less than 2

1998 Terrestrial Monitoring

Milk monitoring results for individual samples in 1998 were, like 1997 results, almost all less than the MDA levels. The average levels for each monitoring station are summarized in Table 14. Of the 199 milk samples analyzed during 1998, there were none with detectable amounts of ^{131}I; three samples with detectable amounts of ^{137}Cs (one at 5 pCi/l, one at 3 pCi/l, and one at 2 pCi/l); and none with detectable amounts of ^{90}Sr. The detectable amounts of ^{137}Cs in milk samples were either equal to or slightly above the MDA levels, which for the ^{137}Cs analysis in particular and for gamma analysis in general, the MDA values were lowered during 1998 due to a new, more efficient detector. Also, the three samples with detectable amounts of ^{137}Cs represent less than 2% of the total MREMP milk samples analyzed during 1996. Overall, the milk monitoring results from all sampling stations were lower than levels recorded during preoperational monitoring periods or, in the case of Big Rock Point, during the early years of plant operation. A tabular presentation of MREMP milk monitoring results for 1998 is located in Appendix B.

Table 14
1998 MILK MONITORING RESULT AVERAGES

	Number of Samples	^{131}I (pCi/l)	^{137}Cs (pCi/l)	^{90}Sr (pCi/l)
Charlevoix	52	Less than 4	Less than 2	Less than 3
Detroit	12	Less than 5	Less than 2	Less than 3
Grand Rapids	12	Less than 3	Less than 2	Less than 2
Lansing	26	Less than 3	Less than 3	Less than 3
Marquette	21	Less than 4	Less than 2	Less than 3
Monroe	26	Less than 3	Less than 2	Less than 3
South Haven	50	Less than 3	Less than 2	Less than 3
Statewide	199	Less than 3	Less than 2	Less than 3

Aquatic Monitoring

Sampling Network

The aquatic monitoring network consists of nine sampling stations for the four Michigan nuclear plant sites. At the Big Rock Point plant, a monthly grab sample is collected from the plant discharge canal, except during months when the canal is frozen over. A monthly grab sample is collected from the Palisades plant discharge line when the plant is operational. At the D. C. Cook plant, monthly grab samples are collected from pre-discharge holding tanks for each reactor, when the reactors are operational. A monthly surface water grab sample is collected from Lake Erie in front of the Fermi plant, and four daily composite surface/drinking water sampling stations of the Detroit Edison Company are split with the MREMP on a monthly basis. All samples are analyzed for gamma emitting radionuclides, gross beta and tritium activity.

Historical and Preoperational Aquatic Monitoring

A detailed presentation of both historical and preoperational atmospheric monitoring results, historical monitoring trends and determination of preoperational surface water monitoring baselines for the four Michigan nuclear power plant areas was presented in MREMP Report 1958-1996. These detailed discussions are not repeated in this report but updated versions of four aquatic monitoring historical plots are shown in Figures 21-24 and the final results of the aquatic monitoring baseline analysis is presented in Tables 15-18. Visual examination of the Big Rock Point and Palisades historical surface water plots reveals a continuation of the trend that has prevailed over the last decade. For 1997, the D. C. Cook plant also followed a similar trend but for 1998 there were no surface water samples collected from the Cook plant due to both reactor being shut down for the entire year. Examination of the Fermi 2 historical surface water plot shows the 1997 gross beta annual average to be very similar to the previous years but the 1998 level being somewhat higher due to one elevated sample result.

Figure 21

Annual Average Gross Beta Activity
Big Rock Point Reactor Site - Surface Water

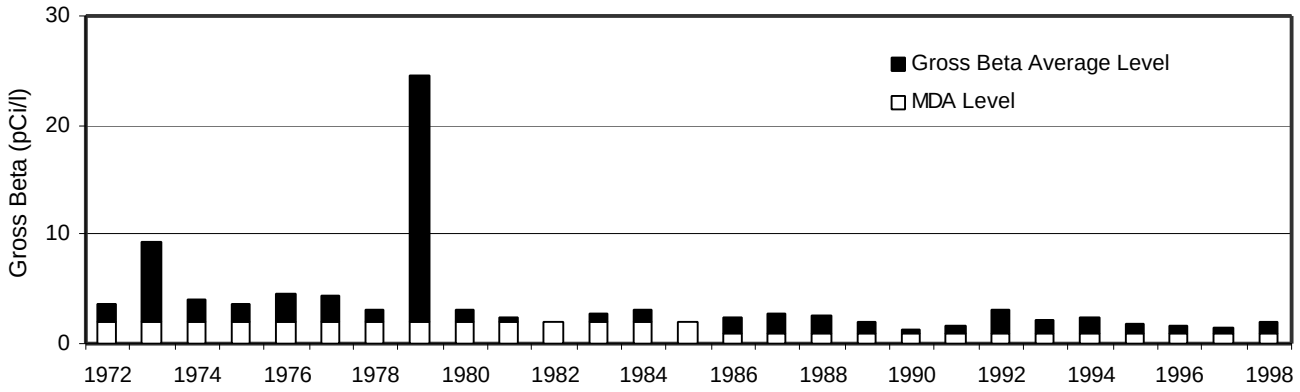


Figure 22

Annual Average Gross Beta Activity
Palisades Reactor Site - Surface Water

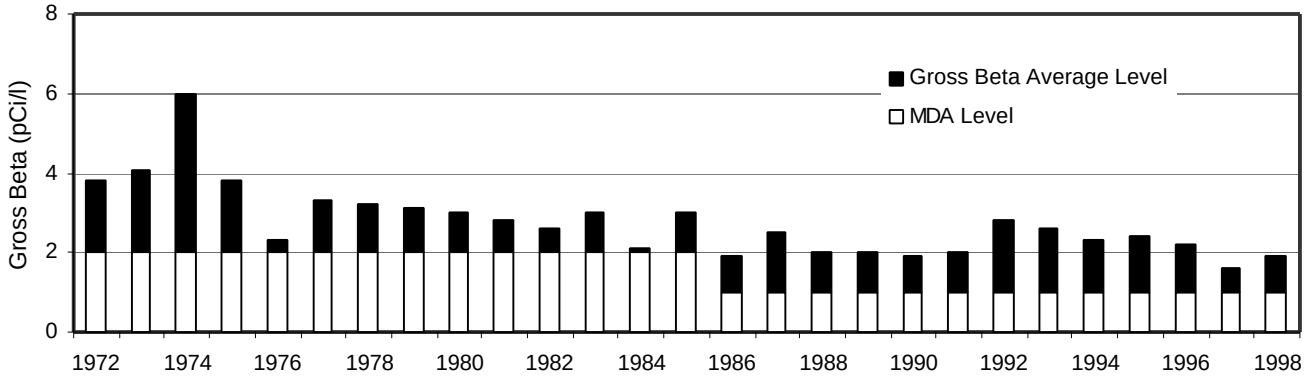


Figure 23

Annual Average Gross Beta Activity
D. C. Cook Reactor Site - Surface Water

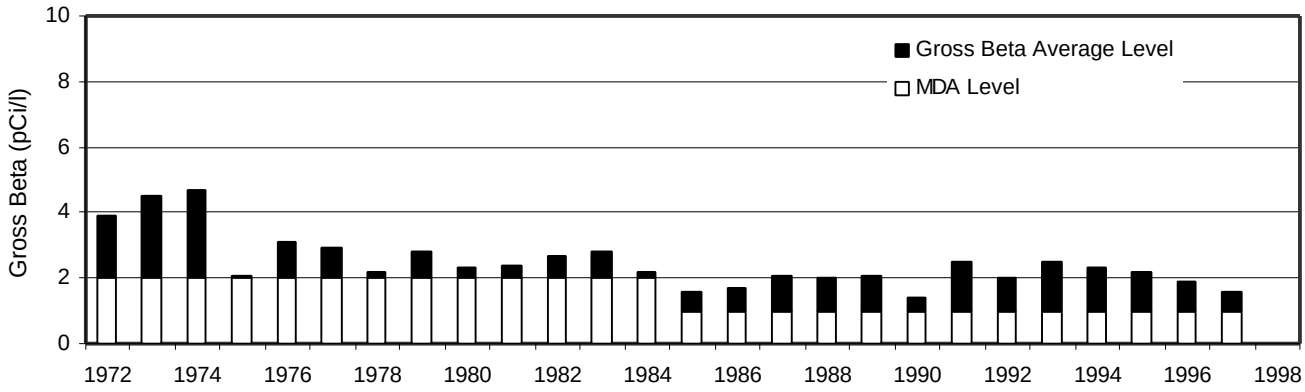


Figure 24

Annual Average Gross Beta Avtivity
Fermi 2 Reactor Site - Surface Water

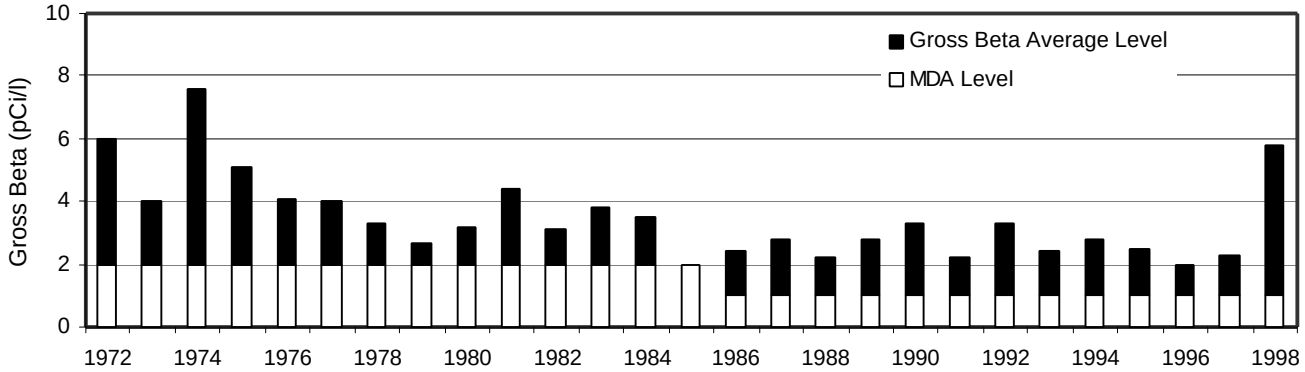


Table 15 **1972-73 BIG ROCK POINT SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site	7.1	1100
Reactor Site (without 12/73 sample)	3.8	400
Non-Reactor Sites	3.9	500
Non-Reactor Sites (without 12/73 sample)	3.5	300

Table 16 **1972-73 PALISADES SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site	4.0	300
Non-Reactor Sites	5.1	200

Table 17 **1973-74 D. C. COOK SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site	4.2	300
Non-Reactor Sites	4.4	300

Table 18 **1983-84 FERMI 2 SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
Reactor Site	3.6	200

1997 and 1998 Aquatic Monitoring

The 1997 and 1998 surface water results for all four plants were generally in alignment with results from recent years with 1997 results collectively running slightly lower than1998 monitoring results. Gross beta levels measured in 1997 and 1998 were close to the MDA levels, with one notable exception being the July 6,1998 sample collected at the Fermi 2 reactor site, which had a gross beta level of 17 pCi/l. This was also the only sample that indicated any activity from gamma emitting radionuclides above the minimum detectable activity levels during the two-year period. Gamma analysis of the sample revealed 4 ± 1 pCi/l of ^{131}I and 90 ± 20 of ^{40}K in the sample. The radioactive iodine is indicative of plant operations but is less than any regulatory limits whereas the radioactive potassium isotope is a naturally occurring radionuclide, which is ubiquitous throughout the earth's crust. Tritium levels over the two years averaged below the minimum detectable activity level of 100 pCi/l for all surface water monitoring stations. Details of the 1997 and 1998 surface water monitoring results for the four plants and comparisons to their respective preoperational baseline data are discussed below. Figures 25-42 at the end of this section, show gross beta and tritium results for the nine sampling stations for 1997 and 1998. A tabular presentation of 1997 and 1998 surface water results is provided in Appendix C.

Big Rock Point

Aquatic monitoring for Big Rock Point in 1997 and 1998 consisted of the one sampling station at the reactor site. Monthly grab samples were collected from the reactor discharge canal and analyzed in the same manner as they were during the baseline assessment period. The results are summarized in Table 19. The gross beta averages of 1.5 pCi/l in 1997 and 2.1 pCi/l in 1998 are much lower than the 3.8 pCi/l average measured during the 1972-73 baseline assessment period. The less than 100 pCi/l tritium averages for both years is also much less than the 400 pCi/l tritium level measured during 1972-73.

Table 19
1997 AND 1998 BIG ROCK POINT SURFACE WATER RESULT AVERAGES

	Gross Beta (pCi/l)	Tritium (pCi/l)
1997 Monitoring Results		
Reactor Site	1.5	Less Than 100
1998 Monitoring Results		
Reactor Site	2.1	Less Than 100

Palisades

Aquatic monitoring for Palisades in 1997 and 1998 consisted of the one sampling station at the reactor site. Monthly grab samples were collected from the reactor discharge and analyzed in the same manner as they were during the baseline assessment period. The results are summarized in Table 20. Palisades surface water result averages for 1997 and 1998 were, like Big Rock Point, also much less than the baseline assessment period gross beta average of 4.0 pCi/l and tritium average of 300 pCi/l.

Table 20
1997 AND 1998 PALISADES SURFACE WATER RESULT AVERAGES

	Gross Beta (pCi/l)	Tritium (pCi/l)
1997 Monitoring Results		
Reactor Site	1.6	Less Than 100
1998 Monitoring Results		
Reactor Site	1.9	Less Than 100

D. C. Cook

Aquatic monitoring for D. C. Cook in 1997 and 1998 consisted of the two sampling stations at the reactor site, one for each reactor unit. Monthly grab samples were collected from the reactor discharge holding tank for each unit and analyzed in the same manner as they were during the baseline assessment period. The results are summarized in Table 21. Cook surface water result averages for 1997 were also much less than the preoperational baseline assessment period, which indicated a gross beta average of 4.2 pCi/l and a tritium average of 300 pCi/l at the reactor site. No samples were collected during 1998 for both units due to the extended shut down of both reactors.

Table 21 **1997 AND 1998 D. C. COOK SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
1997 Monitoring Results		
Reactor Site - Unit 1	2.3	Less Than 100
Reactor Site - Unit 2	1.6	Less Than 100
1998 Monitoring Results		
Reactor Site - Unit 1	No samples collected during 1998	
Reactor Site - Unit 2	No samples collected during 1998	

Fermi 2

Fermi 2 aquatic monitoring for 1997 and 1998 consisted of five sampling stations. A monthly grab sample is collected from the Lake Erie shore directly in front of the reactor site by MREMP staff and four daily composited samples, are collected monthly by Fermi 2 plant staff and split with the MDEQ. All monthly samples are analyzed in the same manner as they were during the baseline assessment period. The results are summarized in Table 22.

Fermi 2 surface water gross beta averages for 1997 were slightly lower than the preoperational baseline assessment period average of 3.6 pCi/l. Tritium averages in 1997 were lower than during the baseline assessment period and no 1997 samples indicated any significant gamma activity above MDA levels. Gross beta levels during 1998 were slightly higher than in 1997 for all five Fermi 2 collection sites, similar to the pattern for Big Rock Point and Palisades sampling sites. The reactor site shoreline sampling station had the highest average gross beta level for all surface water collection sites statewide in 1998, which was influenced by the July 1998 elevated result and the amount of ^{40}K in the reactor site samples compared to the other sampling sites. Tritium averages in 1998 were all lower than the MDA level of 100 pCi/l for all five sampling stations and no 1998 samples indicated any significant gamma activity above MDA levels except for the July reactor site sample.

Table 22 **1997 AND 1998 FERMI 2 SURFACE WATER RESULT AVERAGES**		
	Gross Beta (pCi/l)	Tritium (pCi/l)
1997 Monitoring Results		
Reactor Site	2.3	Less Than 100
Monroe Intake Site	1.4	Less Than 100
Trenton Channel Site	1.6	Less Than 100
Allen Park Intake Site	1.4	Less Than 100
Fermi 2 Intake Site	2.3	Less Than 100
1998 Monitoring Results		
Reactor Site	5.8	Less Than 100
Monroe Intake Site	1.5	Less Than 100
Trenton Channel Site	1.8	Less Than 100
Allen Park Intake Site	1.6	Less Than 100
Fermi 2 Intake Site	2.5	Less Than 100

Figure 25

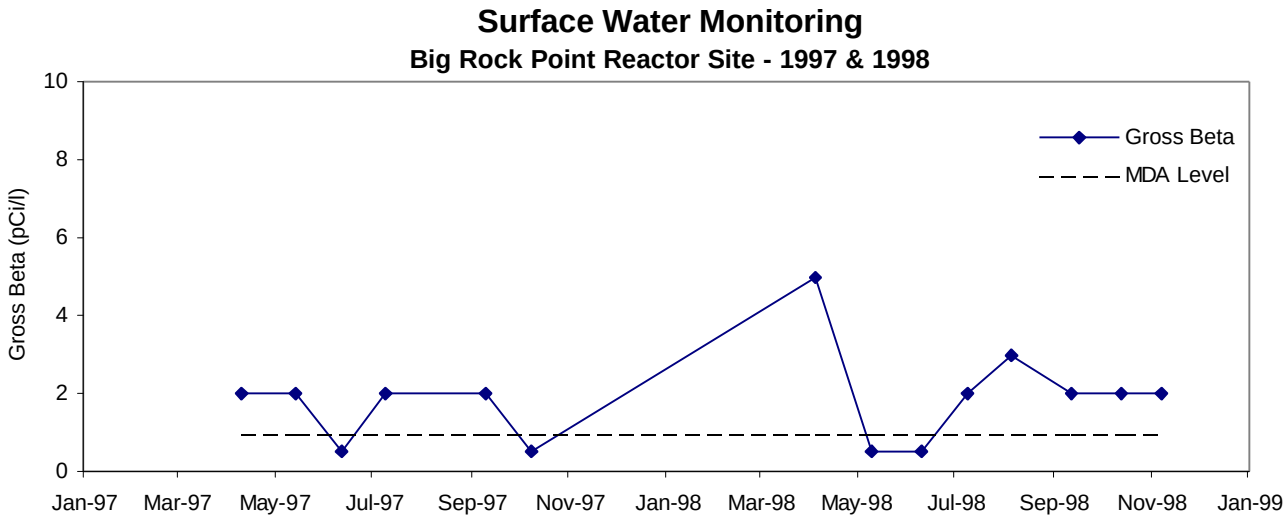


Figure 26

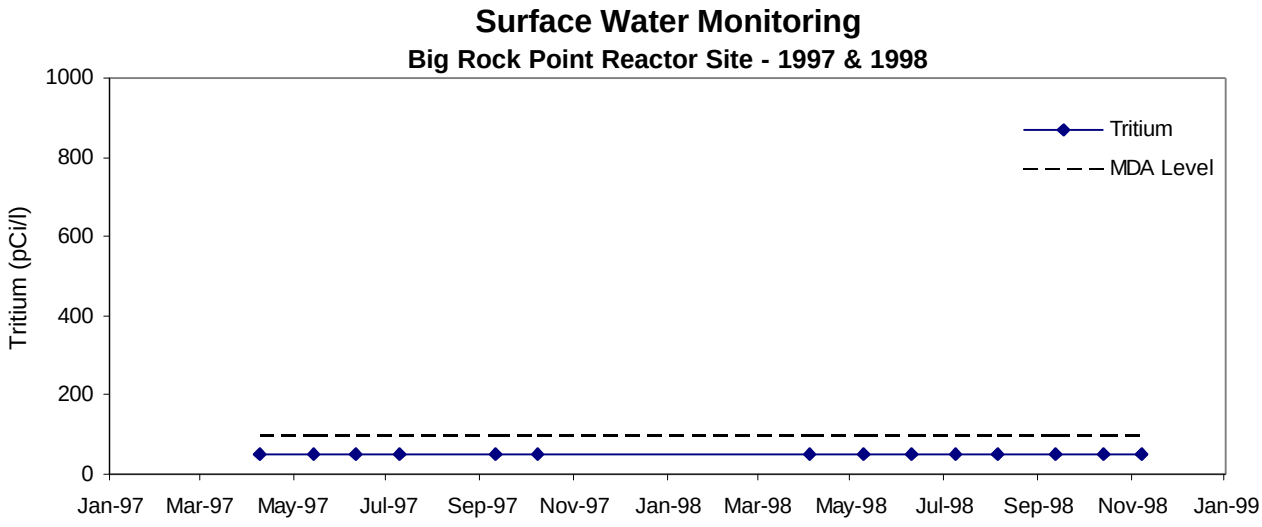


Figure 27

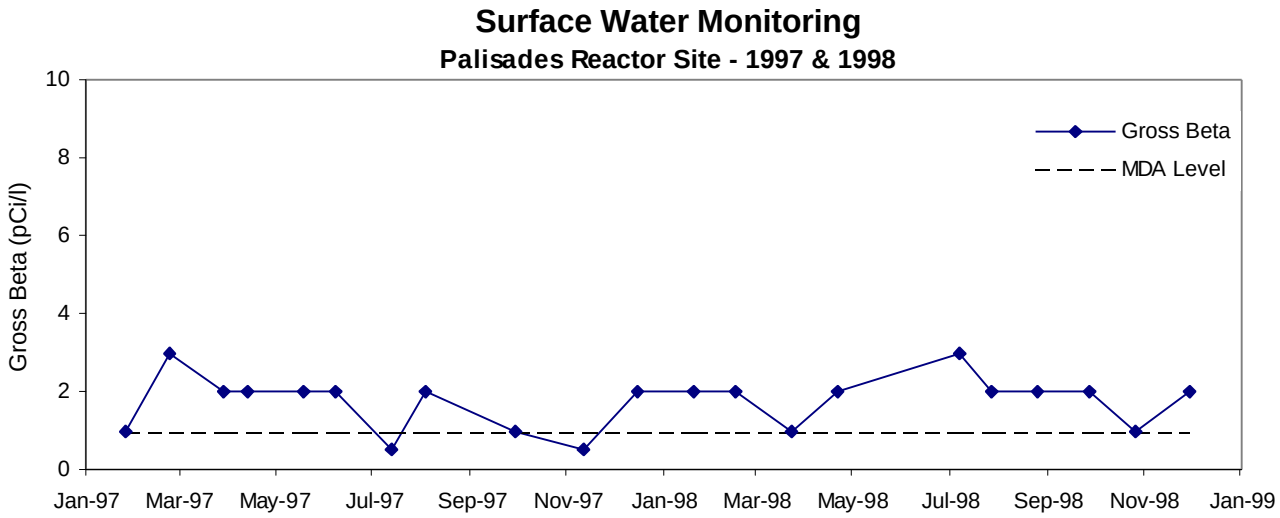


Figure 28

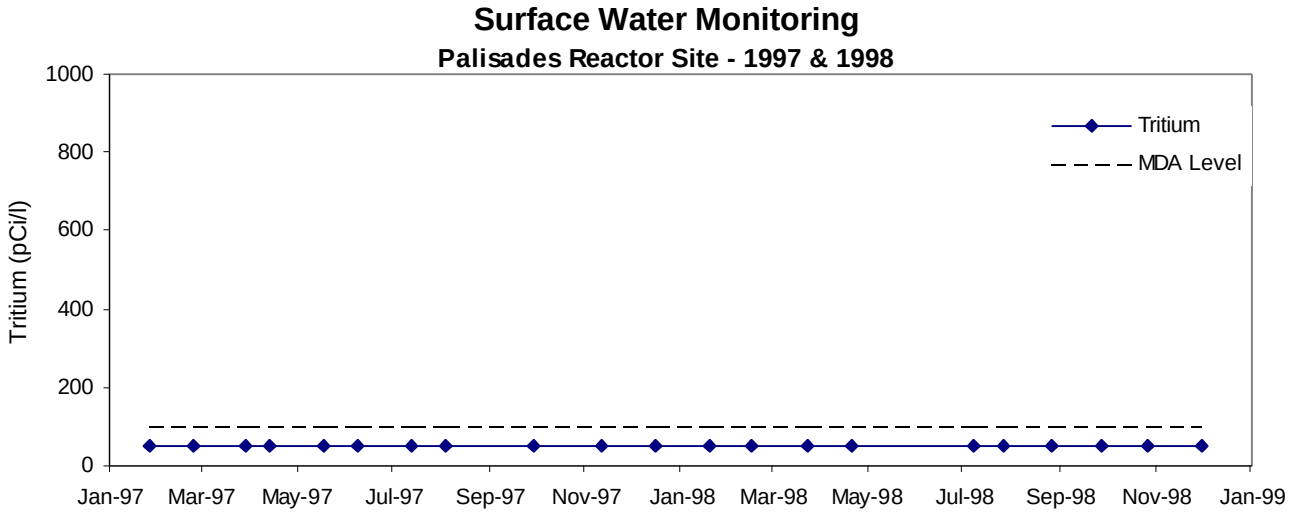


Figure 29

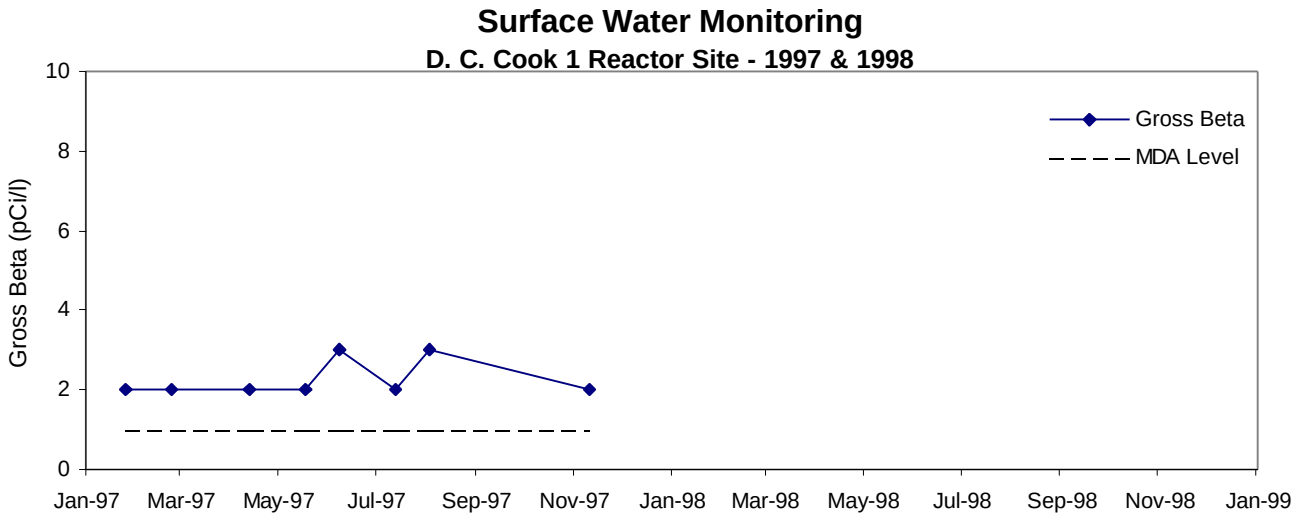


Figure 30

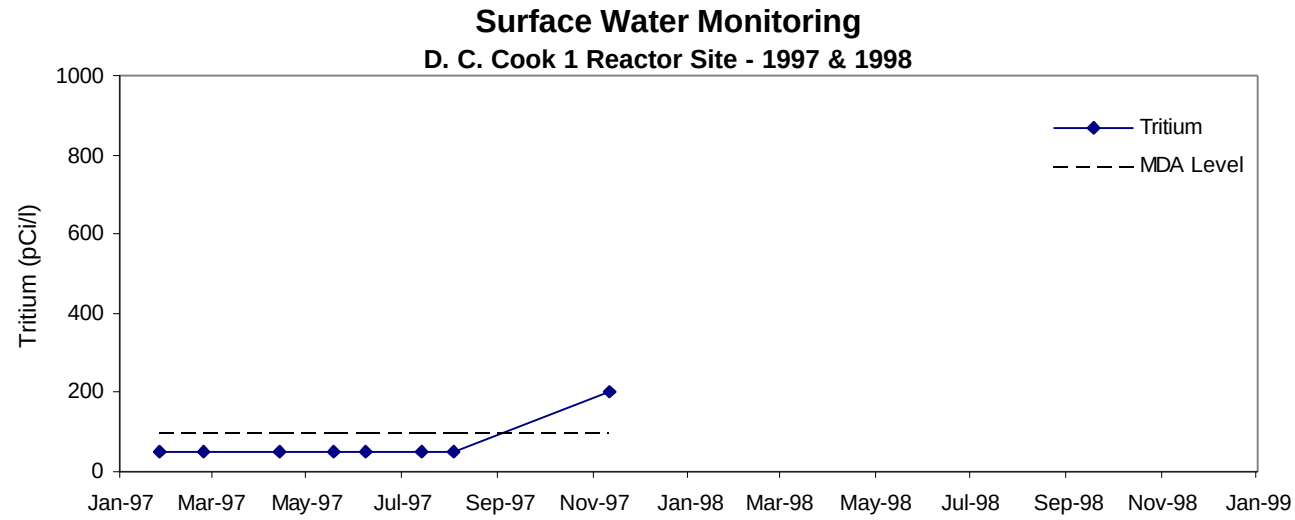


Figure 31

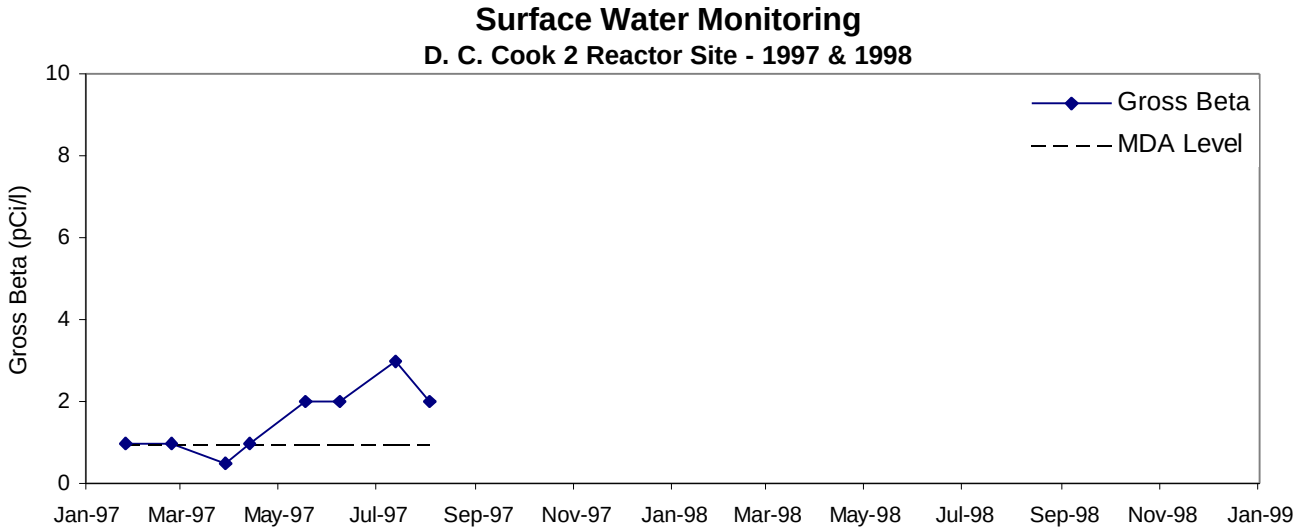


Figure 32

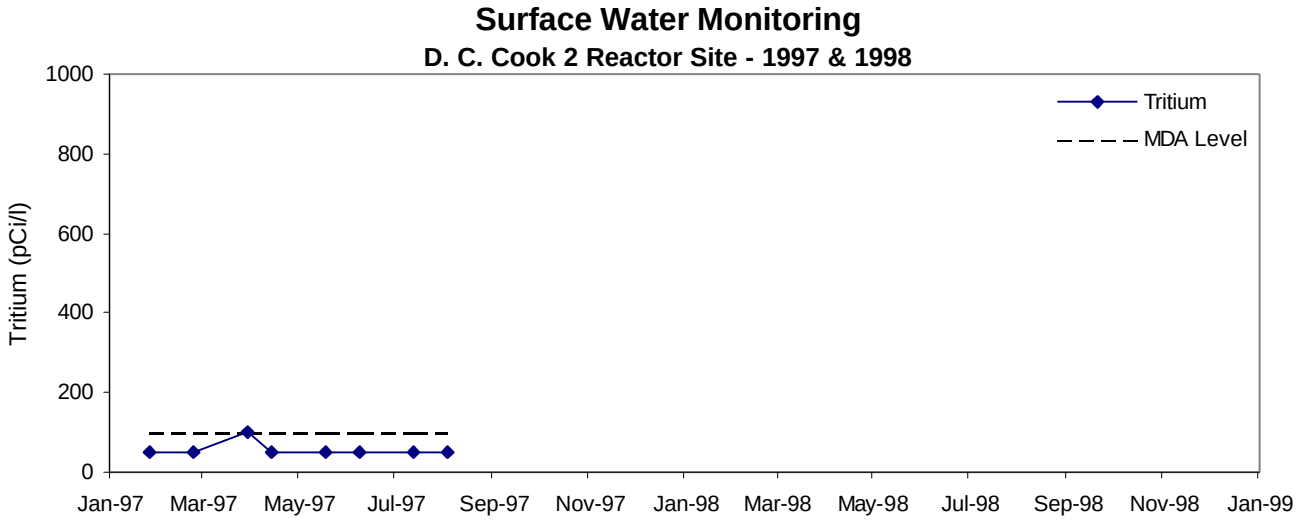


Figure 33

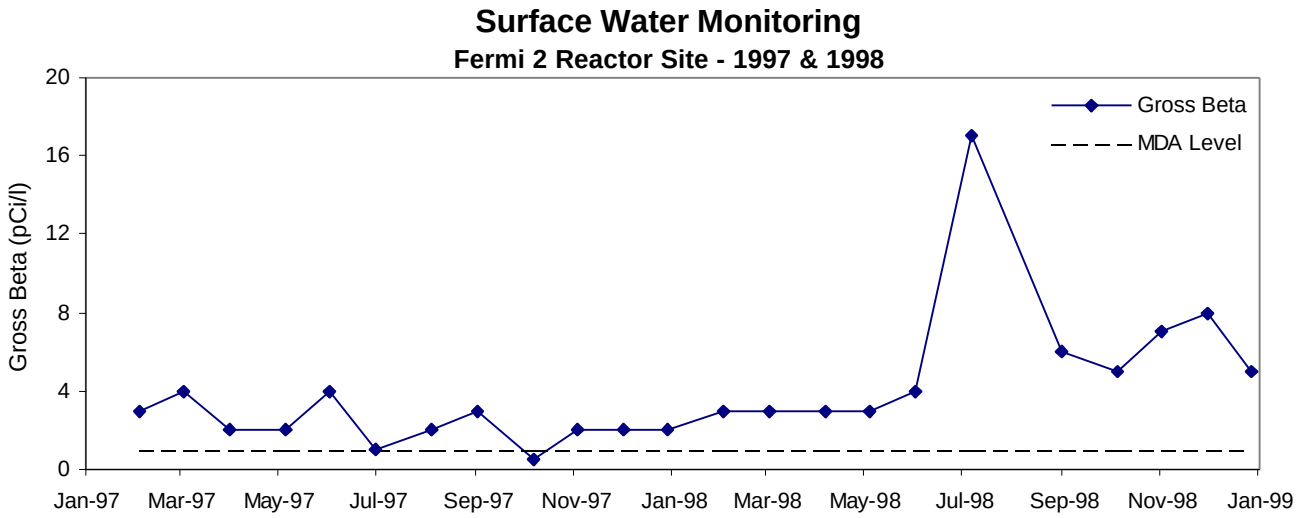


Figure 34

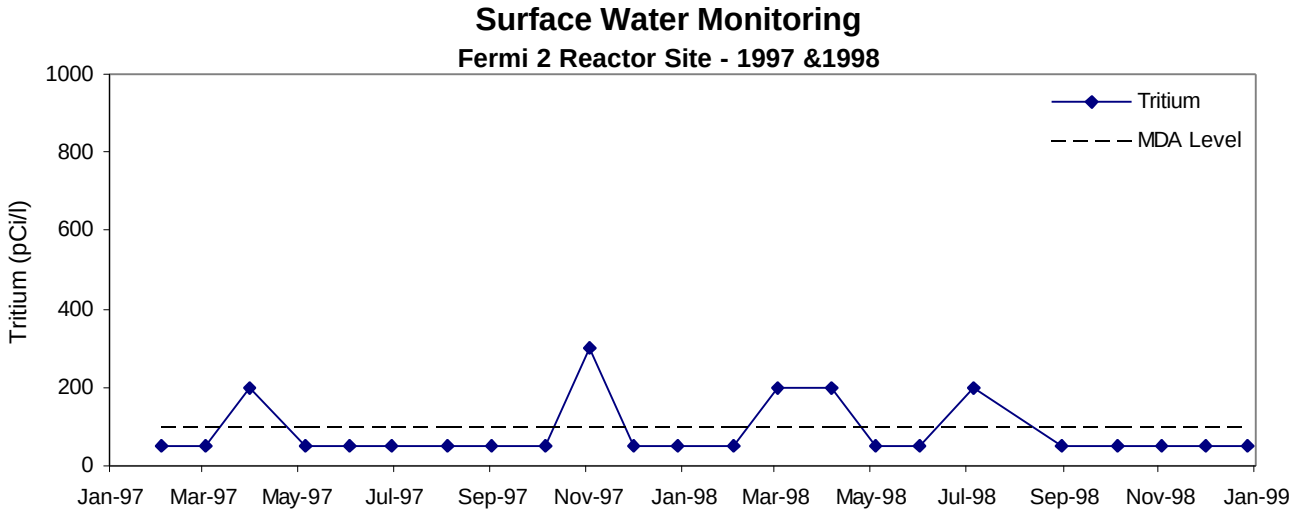


Figure 35

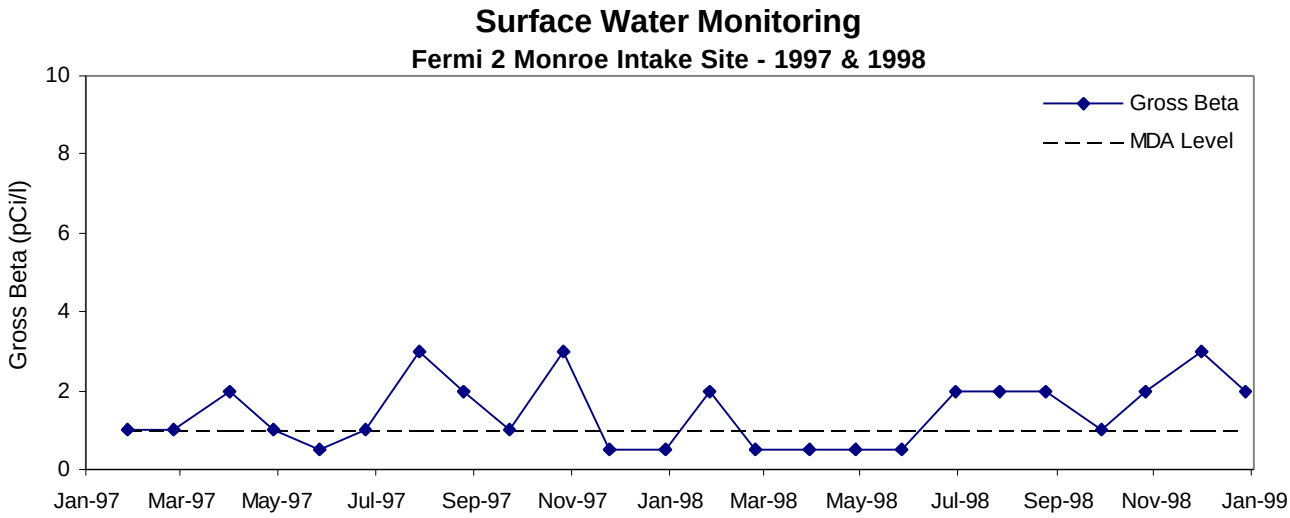


Figure 36

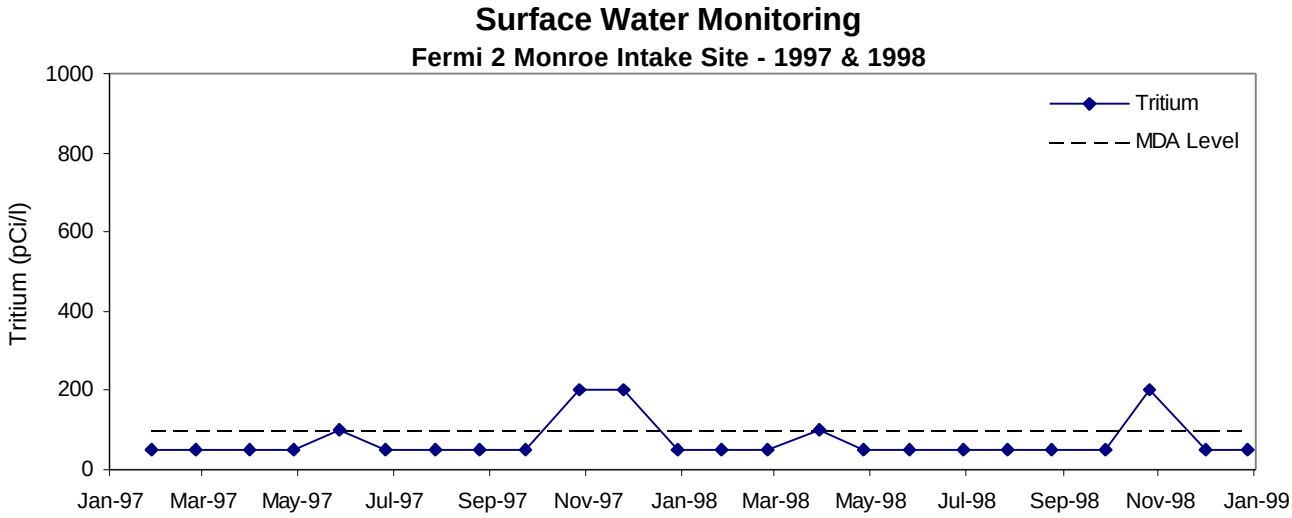


Figure 37

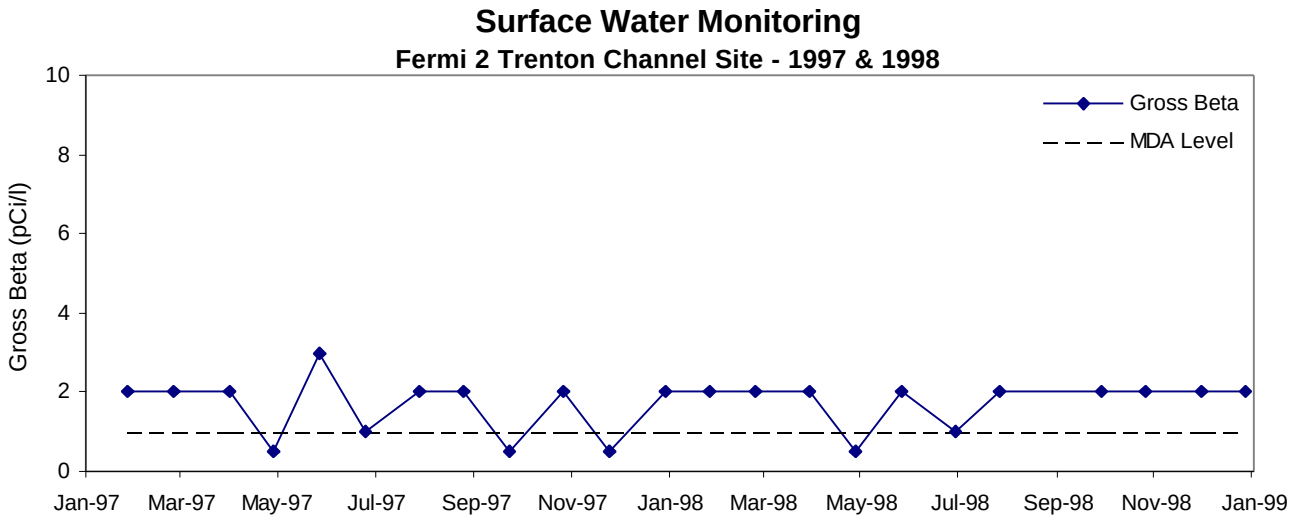


Figure 38

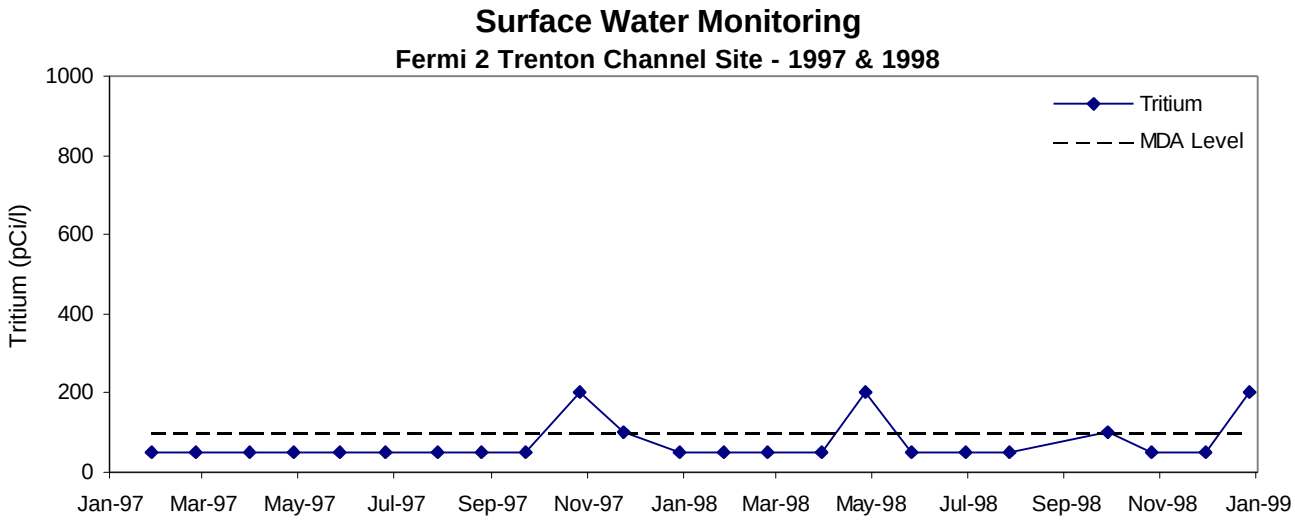


Figure 39

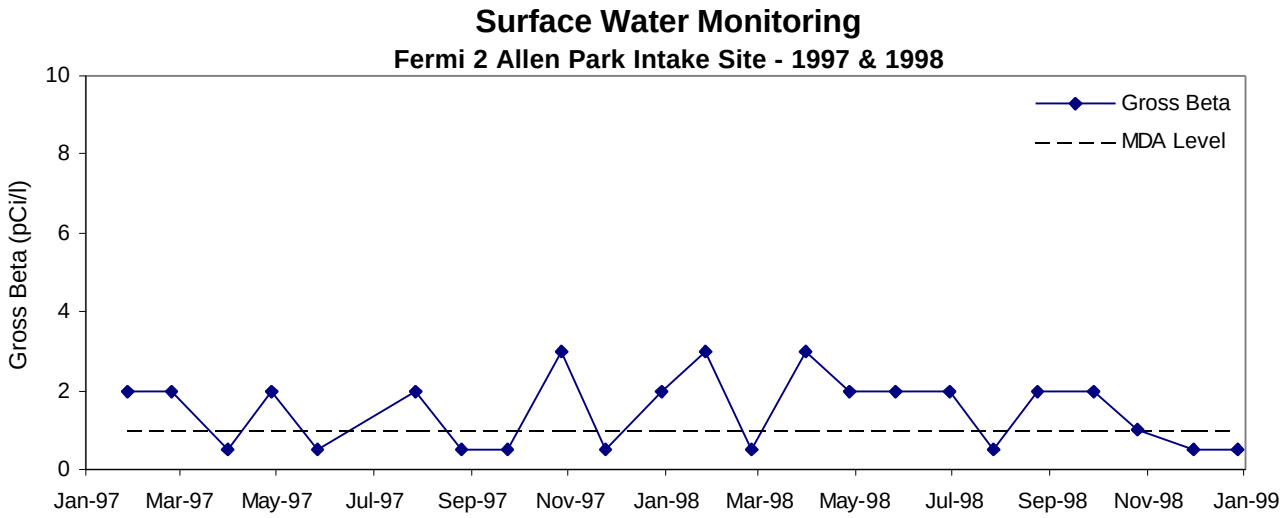


Figure 40

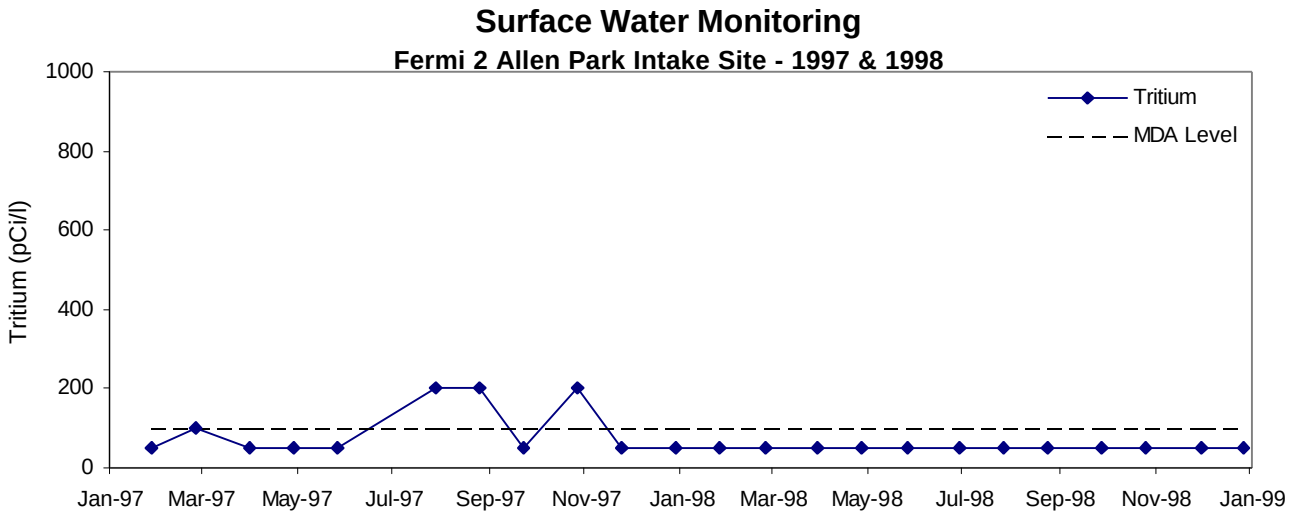


Figure 41

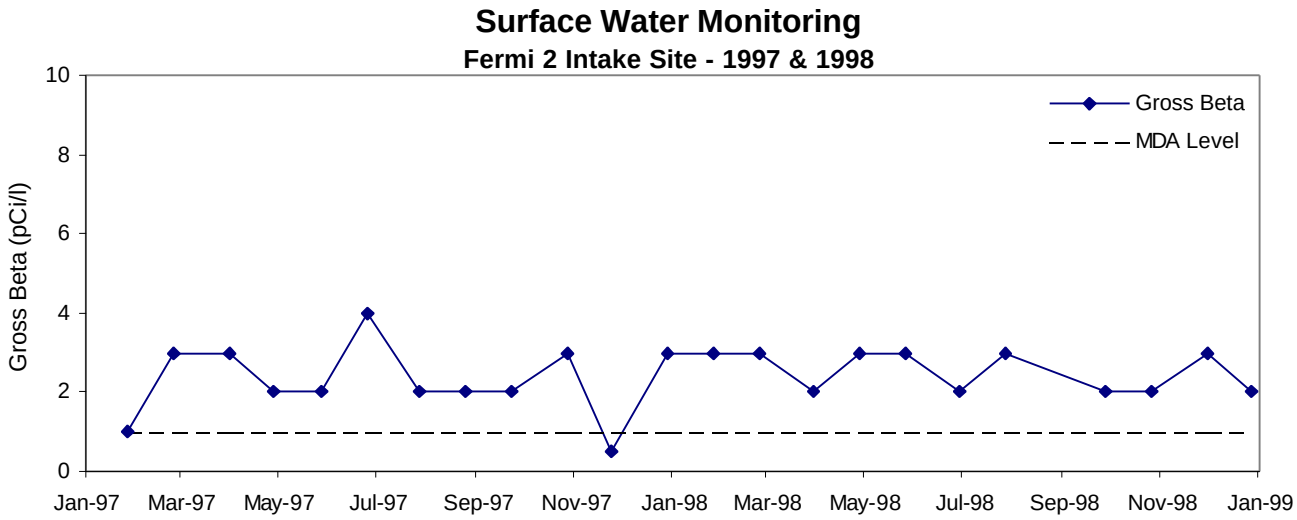
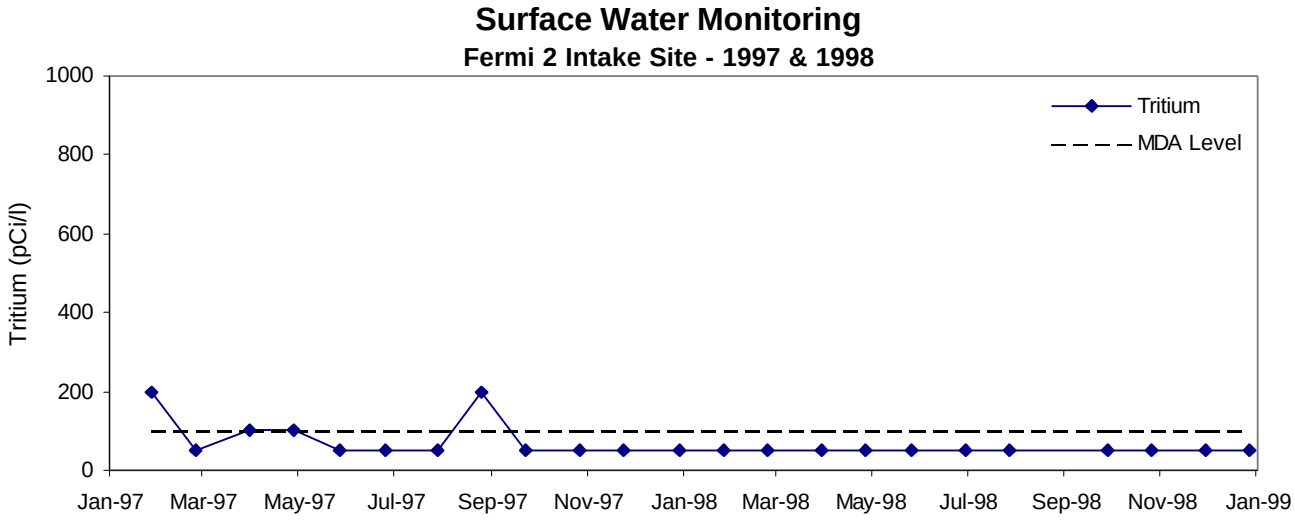


Figure 42



Direct Radiation Monitoring

Sampling Network

The direct radiation monitoring network consists of 33 to 43 measurement sites in the vicinity of each of the four Michigan nuclear power plants and a background reference measurement site in Lansing The NRC network of quarterly TLDs were initially placed in the spring of 1981 for the Big Rock Point, Palisades, and Cook plants and was expanded to include the Fermi 2 plant in the summer of 1982.

Historical Direct Radiation Monitoring Trends

Direct radiation monitoring is a cumulative measure of ionizing radiation over a relatively long period of