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10 CFR 50, Appx I, SEC IV.B.2 and IV.B.3

BVY 21-015

May 12, 2021

ATTN: Document Control Desk,
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: 2020 Annual Radiological Environmental Operating Report
Vermont Yankee Nuclear Power Station
Docket No. 50-271
License No. DPR-28

Dear Sir or Madam:

In accordance with 10 CFR 50, Appendix I, Sections IV.B.2 and IV.B.3 and the Vermont Yankee Off-site Dose Calculation Manual, please find enclosed a copy of the 2020 Annual Radiological Environmental Operating Report.

This letter contains no new regulatory commitments.

Should you have any questions concerning this letter, or require additional information, please contact Mr. Thomas B. Silko at (802) 451-5354, Ext 2506.

Sincerely,

CRD/tbs

Enclosure: Annual Radiological Environmental Operating Report for 2020.

IE25
NRR

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Enclosure

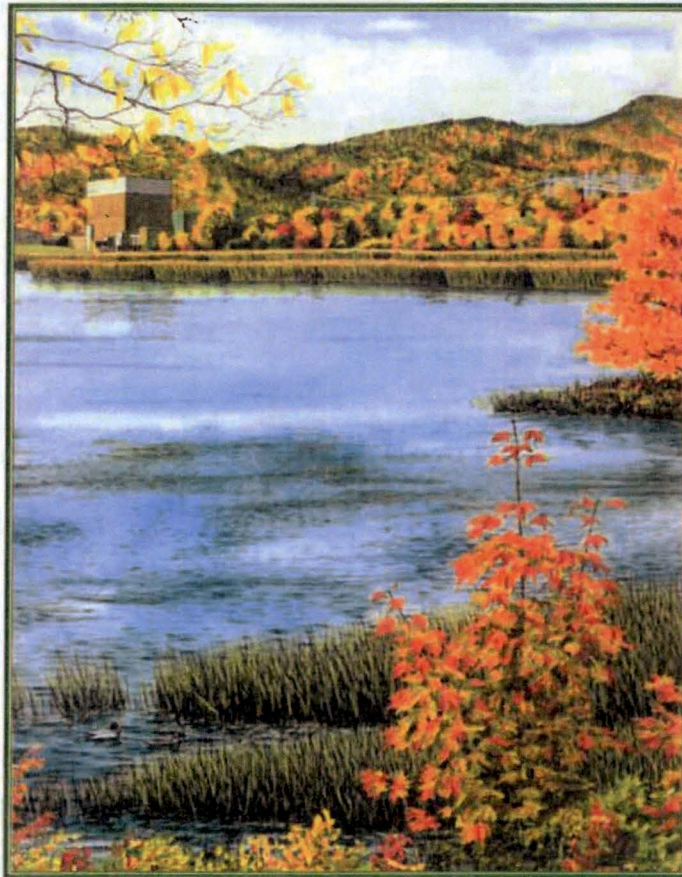
Vermont Yankee Nuclear Power Station

Annual Radiological Environmental Operating Report for 2020
(83 pages excluding this cover sheet)

NORTHSTAR - VERMONT YANKEE
Vermont Yankee Nuclear Power Station

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

Year 2020



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1. INTRODUCTION

This report summarizes the findings of the Radiological Environmental Monitoring Program (REMP) conducted by Entergy-Vermont Yankee in the vicinity of the Vermont Yankee Nuclear Power Station (VYNPS) in Vernon, Vermont during the calendar year 2020. The analyses of samples collected indicated that no plant-generated radioactive material was found in any location off site. In all cases, the possible radiological impact was negligible with respect to exposure from natural background radiation. In no case did the detected levels exceed the most restrictive federal regulatory or plant license limits for radionuclides in the environment. Measured values were several orders of magnitude below reportable levels listed in Table 4.5 of this report. Except for sample deviations listed in Section 6.1, all other samples were collected and analyzed as required by the program.

This report is submitted annually in compliance with the Vermont Yankee Offsite Dose Calculation Manual (VY ODCM), Section 10.2. The remainder of this report is organized as follows:

- Section 2:** Provides an introductory explanation of background radioactivity and radiation detected in the plant environs.
- Section 3:** Provides a brief description of the Vermont Yankee Nuclear Power Station site and its environs.
- Section 4:** Provides a description of the overall REMF program design. Included is a summary of the Vermont Yankee Nuclear Power Station (VYNPS) Off-Site Dose Calculation Manual (ODCM) requirements for REMF sampling, tables listing all locations sampled or monitored in 2020 with compass sectors and distances from the plant, and maps showing each REMF location. Tables listing Lower Limit of Detection requirements and Reporting Levels are also included.
- Section 5:** Consists of the summarized data as required by the VYNPS ODCM. The tables are in a format similar to that specified by the NRC Radiological Assessment Branch Technical Position on Environmental Monitoring (Reference 1). Also included is a summary of the 2020 environmental TLD measurements.
- Section 6:** Provides the results of the 2020 monitoring program. The performance of the program in meeting regulatory requirements as given in the ODCM is discussed, and the data acquired during the year are analyzed.
- Section 7:** Provides an overview of the Quality Assurance programs used at Environmental Dosimetry Company and Teledyne Brown Engineering for contracted analyses of environmental media.
- Section 8:** Summarizes the requirements and the results of the 2020 Land Use Census.

Section 9: Gives a summary of the 2020 Radiological Environmental Monitoring Program.

2. BACKGROUND RADIOACTIVITY

Radiation or radioactivity potentially detected in the Vermont Yankee environment can be grouped into three categories. The first is “naturally-occurring” radiation and radioactivity. The second is “man-made” radioactivity from sources other than the Vermont Yankee plant. The third potential source of radioactivity is due to emissions from the Vermont Yankee plant. For the purposes of the Vermont Yankee REMP, the first two categories are classified as “background” radiation and are the subject of discussion in this section of the report. The third category is the one that the REMP is designed to detect and evaluate.

2.1 Naturally Occurring Background Radioactivity

Natural radiation and radioactivity in the environment, which provide the major source of human radiation exposure, may be subdivided into three separate categories: “primordial radioactivity,” “cosmogenic radioactivity” and “cosmic radiation.” “Primordial radioactivity” is made up of those radionuclides that were created with the universe and that have a sufficiently long half-life to be still present on the earth. Included in this category are the newly-formed “daughter” radionuclides descending from these original elements. A few of the more significant radionuclides in this category are Uranium-238 (U-238), Thorium-232 (Th-232), Rubidium-87 (Rb-87), Potassium-40 (K-40), Radium-226 (Ra-226), and Radon-222 (Rn-222). Uranium-238 and Thorium-232 are readily detected in soil and rock, whether through direct field measurements or through laboratory analysis of samples. Radium-226 in the earth can find its way from the soil into ground water and is often detectable there. Radon-222 is one of the components of natural background in air, and its daughter products are detectable on air sampling filters. Potassium-40 comprises about 0.01 percent of all natural potassium in the earth, and is consequently detectable in most biological substances, including the human body. There are many more primordial radionuclides found in the environment in addition to the major ones discussed above (Reference 2).

The second sub-category of naturally-occurring radiation and radioactivity is “cosmogenic radioactivity.” This is produced through the nuclear interaction of high energy cosmic radiation with elements in the earth’s atmosphere, and to a much lesser degree, in the earth’s crust. These radioactive elements are then incorporated into the entire geosphere and atmosphere, including the earth’s soil, surface rock, biosphere, sediments, ocean floors, polar ice and atmosphere. The major radionuclides in this category are Carbon-14 (C-14), Hydrogen-3 (H-3 or Tritium), Sodium-22 (Na-22), and Beryllium-7 (Be-7). Beryllium-7 is the one most readily detected, and is found on air sampling filters and occasionally in biological media (Reference 2).

The third sub-category of naturally-occurring radiation and radioactivity is “cosmic radiation.” This consists of high energy atomic and sub-atomic particles of extra-terrestrial origin and the secondary particles and radiation that are produced through their interaction in the earth’s atmosphere. The majority of this radiation comes from outside of our solar system, and to a lesser degree from the sun. We are protected from most of this radiation by the earth’s atmosphere, which absorbs the radiation. Consequently, one can see that with increasing elevation one would be exposed to more cosmic radiation as a direct result of a thinner layer of air for protection. This “direct radiation” is detected in the field with gamma spectroscopy equipment, high pressure ion chambers and thermoluminescent dosimeters (TLDs).

2.2 Man-Made Background Radioactivity

The second source of “background” radioactivity in the Vermont Yankee environment is from “man-made” sources not related to the power plant. The most recent contributor (prior to year 2011) to this category was the fallout from the Chernobyl accident in April of 1986, which was detected in the Vermont Yankee environment and other parts of the world. Some smaller amounts of radioactivity were detected in the environment following the Fukushima Daiichi plants accidents in March 2011. A much greater contributor to this category, however, has been fallout from atmospheric nuclear weapons tests. Tests were conducted from 1945 through 1980 by the United States, the Soviet Union, the United Kingdom, China and France, with the large majority of testing occurring during the periods 1954-1958 and 1961-1962. (A test ban treaty was signed in 1963 by the United States, Soviet Union and United Kingdom, but not by France and China.) Atmospheric testing was conducted by the People’s Republic of China as recently as October 1980. Much of the fallout detected today is due to this explosion and the last large scale test performed in November of 1976 (Reference 3).

The radioactivity produced by these detonations was deposited worldwide. The amount of fallout deposited in any given area is dependent on many factors, such as the explosive yield of the device, the latitude and altitude of the detonation, the season in which it occurred, and the timing of subsequent rainfall which washes fallout from the troposphere (Reference 4). Most of this fallout has decayed into stable elements, but the residual radioactivity is still readily detectable in environmental samples worldwide. The two predominant radionuclides are Cesium-137 (Cs-137) and Strontium-90 (Sr-90). They are found in soil and in vegetation, and since cows and goats graze large areas of vegetation, these radionuclides are also concentrated and often detected in milk.

Other potential “man-made” sources of environmental “background” radioactivity include other nuclear power plants, coal-fired power plants, national defense installations, hospitals, research

laboratories and industry. These, collectively, are insignificant on a global scale when compared to the sources discussed above (natural and weapons-testing fallout).

3. GENERAL PLANT AND SITE INFORMATION

The Vermont Yankee Nuclear Power Station is located in the town of Vernon, Vermont in Windham County. The 130-acre site is on the west shore of the Connecticut River, immediately upstream of the Vernon Hydroelectric Station. The plant site is bounded on the north, south and west by privately-owned land and on the east by the Connecticut River. The surrounding area is generally rural and lightly populated, and the topography is flat or gently rolling on the valley floor.

Construction of the single unit 540 megawatt BWR (Boiling Water Reactor) plant began in 1967. The pre-operational Radiological Environmental Monitoring Program, designed to measure environmental radiation and radioactivity levels in the area prior to station operation, began in 1970. Commercial operation began on November 30, 1972. An Extended Power Uprate, conducted in 2006, resulted in the generation capacity increasing to 650 megawatts electric.

A decision was made in 2013 to permanently shut down and decommission Vermont Yankee Nuclear Power Station at the end of 2014. The last day of power operation occurred on December 29, 2014.

4. PROGRAM DESIGN

The Radiological Environmental Monitoring Program (REMP) for the Vermont Yankee Nuclear Power Station (VYNPS) was designed with specific objectives in mind. These are:

- To provide an early indication of the appearance or accumulation of any radioactive material in the environment caused by the operation of the station.
- To provide assurance to regulatory agencies and the public that the station's environmental impact is known and within anticipated limits.
- To verify the adequacy and proper functioning of station effluent controls and monitoring systems.
- To provide standby monitoring capability for rapid assessment of risk to the general public in the event of unanticipated or accidental releases of radioactive material.

The program was initiated in 1970, approximately two years before the plant began commercial operation. It has been functioning continuously since that time, with improvements made periodically over those years.

The current program is designed to meet the intent of NRC Regulatory Guide 4.1, *Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants*; NRC Regulatory Guide 4.8, *Environmental Technical Specifications for Nuclear Power Plants*; the NRC Radiological Assessment Branch Technical Position of November 1979, *An Acceptable Radiological Environmental Monitoring Program*; and NRC NUREG-0473, *Radiological Effluent Technical Specifications for BWRs*. The environmental TLD program has been designed and tested around NRC Regulatory Guide 4.13, *Performance, Testing and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications*. The quality assurance program is designed around the guidance given in NRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment*.

The sampling requirements of the REMP are given in the Off-Site Dose Calculation Manual Table 3.5.1 and are summarized in Table 4.1 of this report. The identification of the required sampling locations is given in the Off-Site Dose Calculation Manual (ODCM), Chapter 7. These sampling and monitoring locations are shown graphically on the maps in Figures 4.1 through 4.6 of this report.

The Vermont Yankee Radiation Protection/Chemistry Department conducts the radiological environmental monitoring program and facilitates the collection of all airborne, terrestrial and ground water samples. VYNPS maintained a contract with Normandeau Associates to collect all fish and river sediment samples. In 2020, analytical measurements of environmental samples were performed at Teledyne Brown Engineering Laboratory in Knoxville, Tennessee. TLD badges are posted and retrieved by the Vermont Yankee Chemistry Department and were analyzed by the Environmental Dosimetry Company in Sterling, Massachusetts.

4.1 Monitoring Zones

The REMP is designed to allow comparison of levels of radioactivity in samples from the area possibly influenced by the plant to levels found in areas not influenced by the plant. Monitoring locations within the first zone are called "indicators." Those within the second zone are called "controls." The distinction between the two zones, depending on the type of sample or sample pathway, is based on one or more of several factors, such as site meteorological history, meteorological dispersion calculations, relative direction from the plant, river flow, and distance.

Analysis of survey data from the two zones aids in determining if there is a significant difference between the two areas. It can also help in differentiating between radioactivity and radiation due to plant releases and that due to other fluctuations in the environment, such as atmospheric nuclear weapons test fallout or seasonal variations in the natural background.

4.2 Pathways Monitored

Four pathway categories are monitored by the REMP. They are the airborne, waterborne, ingestion and direct radiation pathways. Each of these four categories is monitored by the collection of one or more sample media, which are listed below, and are described in more detail in this section:

Airborne Pathway

- Air Particulate Sampling

Waterborne Pathways

- River Water Sampling

- Ground Water Sampling

- Sediment Sampling

Ingestion Pathways

- Silage Sampling

- Mixed Grass Sampling

- Fish Sampling

Direct Radiation Pathway

- TLD Monitoring

4.3 Descriptions of Monitoring Programs

4.3.1 Air Sampling

Continuous air samplers were installed at seven locations until August 4, 2015, when sample collection was discontinued at one station not required by the VY ODCM. Another station was removed from service in March 2016 (ODCM Rev 36) because it was a non-required control sample and with the plant in permanent shut down, it was deleted from the REMP. In December 2016, two more air sample stations were removed from service with the release of ODCM Rev 37. At the beginning of 2020, three air sample stations were situated to support the program. Currently there are two indicator stations and one control station. Data from all samples collected in 2020 are included in this report. The sampling pumps at these locations operate continuously at a flow rate of approximately one cubic foot per minute. Airborne particulates are collected by passing air through a 50 mm glass-fiber filter. A dry gas meter is incorporated into the sampling

stream to measure the total volume of air sampled in a given interval. The entire system is housed in a weatherproof structure. The filters were collected on a weekly frequency through the end of October 2018. Due to changes in the VY ODCM, the weekly collections were revised to monthly during November and December 2018. To allow for the decay of radon daughter products, the analysis for gross beta radioactivity is delayed for more than 24 hours. The monthly filters are composited by location at the environmental laboratory for a quarterly gamma spectroscopy analysis.

If the gross-beta activity on an air particulate sample is greater than ten times the yearly mean of the control samples, ODCM Table 3.5.1, Note c, requires a gamma isotopic analysis on the sample.

4.3.2 Charcoal Cartridge (Radioiodine) Sampling

Continuous air samplers were installed at seven locations until August 4, 2015 when sample collection was discontinued at one station not required by the VY ODCM. One station was removed in March 2016 (ODCM Rev 36) because it was a non-required control sample and with the plant in permanent shut down, it was removed from the REMP. In December 2016 all charcoal filters were removed from sample stations with the implementation of ODCM Rev 37. With the radioactive decay and ultimate cessation of I-131 in the plant effluent stream, there is no longer a credible source of radioiodines generated by VYNPS.

4.3.3 River Water Sampling

An automatic compositing sampler is maintained at the downstream sampling location. This sampler has been nonfunctional throughout 2020. The ODCM compensatory action for the out of service composite sampler is to obtain daily grab samples that are combined together to create a representative monthly composite sample. This has been accomplished by the Vermont Yankee Radiation Protection/Chemistry Department staff. An additional grab sample is collected monthly at the upstream control location. Each sample is analyzed for gamma-emitting radionuclides. Although not required by the VYNPS ODCM, a gross-beta analysis is also performed on each sample. The monthly samples are composited by location by the contracted environmental laboratory for a minimum frequency of quarterly tritium (H-3) analysis.

4.3.4 Ground Water (Deep Well Potable Water) Sampling

Grab samples are collected quarterly from two indicator locations and one control location. Only one indicator and one control are required by the VYNPS ODCM. Each sample is analyzed for gamma-emitting radionuclides and H-3. Although not required by the VYNPS ODCM, a gross-

beta analysis is also performed on each sample.

4.3.5 Sediment Sampling

River sediment grab samples were collected semiannually from the downriver location and at the North Storm Drain Outfall by Normandeau Associates. Each sample is analyzed at an offsite environmental laboratory for gamma-emitting radionuclides.

4.3.6 Milk Sampling

Milk sample collection was terminated in December 2016 based upon assessment of potential releases of radioiodines from the plant and a concurrent revision of the Vermont Yankee Offsite Dose Calculation Manual. Radioactive decay has removed I-131 from plant radioactive materials inventory.

4.3.7 Silage (Chopped Corn or Grass) Sampling

Silage samples are collected on a quarterly basis from two Land Use Census-identified indicator farms and one control farm. The silage from each location is shipped to the contracted environmental laboratory where each sample is analyzed for gamma-emitting radionuclides.

4.3.8 Mixed Grass Sampling

At each air sampling station, a mixed grass sample is collected quarterly, when available. Enough grass is clipped to provide the minimal sample weight needed to achieve the required Lower Limit of Detection (LLD). The mixed grass samples are analyzed for gamma-emitting radionuclides. Until iodine sampling was discontinued by ODCM Rev 37 in December 2016, the grass samples were analyzed for low-level I-131. This analysis was not required by the ODCM but had been performed for a number of years.

4.3.9 Fish Sampling

Fish samples were collected semiannually at two Connecticut River locations (upstream of the plant and in the Vernon Pond) by Normandeau Associates during 2020. The samples are frozen and delivered to the environmental laboratory where the edible and inedible portions are separately analyzed for gamma-emitting radionuclides.

4.3.10 TLD Monitoring

Direct gamma radiation exposure is continuously monitored with the use of thermoluminescent dosimeters (TLDs). Specifically, Panasonic UD-801AS1 and UD-814AS1 calcium sulfate dosimeters are used, with a total of five elements in place at each monitoring location. Each pair of dosimeters is sealed in a plastic bag, which is in turn housed in a plastic screen cylinder. This cylinder is attached to an object such as a fence or utility pole.

A total of 10 stations were required by the ODCM in 2020 and must be read out quarterly unless gaseous release controls were exceeded during the period. Vermont Yankee Radiation Protection/Chemistry Department staff posts and retrieves all TLDs, while the contracted environmental laboratory (Environmental Dosimetry Company) provides processing.

Table 4.1 Radiological Environmental Monitoring Program

(as required by ODCM Table 3.5.1)*

Exposure Pathway and/or Sample Media	Collection			Analysis	
	Number of Sample Locations	Routine Sampling Mode	Collection Frequency	Analysis Type	Analysis Frequency
1. Direct Radiation (TLDs)	10	Continuous	Quarterly	Gamma dose; de- dose only, unless gaseous release Control was exceeded	Each TLD
2. Airborne (Particulates)	3	Continuous	Monthly	Particulate Sample: Gross Beta	Each Sample
				Gamma Isotopic	Quarterly Composite (by location)
3. Waterborne					
a. Surface water	2	Downstream. Automatic composite Upstream: grab	Monthly	Gamma Isotopic	Each Sample
				Tritium (H-3)	Quarterly Composite
b. Ground water	3	Grab	Quarterly	Gamma Isotopic	Each Sample
				Tritium (H-3)	Each Sample
c. Shoreline Sediment	2	Downstream: grab N. Storm Drain Outfall: grab	Semiannually	Gamma Isotopic	Each Sample

- See ODCM Table 3.5.1 for complete footnotes.

Table 4.1 cont.**Radiological Environmental Monitoring Program**

(as required by ODCM Table 3.5.1)*

Exposure Pathway and/or Sample Media	Collection			Analysis	
	Number of Sample Locations	Routine Sampling Mode	Collection Frequency	Number of Sample Locations	Routine Sampling Mode
4. Ingestion					
a. Fish	2	Grab	Semiannually	Gamma Isotopic on Edible Portions	Each Sample
b. Vegetation					
Grass Sample	1 at each air sampling station	Grab	Quarterly when available	Gamma Isotopic	Each Sample
Silage Sample	2 Indicator 1 Control	Grab	Quarterly	Gamma Isotopic	Each Sample

* See ODCM Table 3.5.1 for complete footnotes.

**Table 4.2 Radiological Environmental Monitoring Locations (Non-TLD) In
2020**

Exposure Pathway	Station Code	Station Description	Zone ^(a)	Distance from Plant Stack (km)	Direction from Plant
1. Airborne	AP/CF-11	River Sta. No. 3.3	I	1.9	SSE
	AP/CF-12	N. Hinsdale, NH	I	3.6	NNW
	AP/CF-21	Spofford Lake	C	16.4	NNE
2. Waterborne					
a. Surface	WR-11	River Sta. No. 3.3	I	1.9	SSE
	WR-21	Rt.9 Bridge	C	11.8	NNW
b. Ground	WG-11	Main Plant Well	I	0.2	On-site
	WG-12	Vernon Green Well	I	2.1	SSE
	WT-14	Test Well 201	I	--	On-site
	WT-16	Test Well 202	I	--	On-site
	WT-17	Test Well 203	I	--	On-site
	WT-18	Test Well 204	I	--	On-site
	WG-22	Copeland Well	C	13.7	N
c. Sediment	SE-11	Shoreline Downriver	I	0.6	SSE
	SE-12	North Storm Drain Outfall	I	0.1	E
3. Ingestion					
a. Fish	FH-11	Vernon Pond	I	0.6 ^(b)	SSE
	FH-21	Rt.9 Bridge	C	11.8	NNW
b. Mixed Grass	TG-11	River Sta. No. 3.3	I	1.9	SSE
	TG-12	N. Hinsdale, NH	I	3.6	NNW
	TG-21	Spofford Lake	C	16.4	NNE
c. Silage	TC-11	Miller Farm	I	0.8	W
	TC-18	Blodgett Farm	I	3.6	SE
	TC-22	Franklin Farm	C	9.7	WSW

(a) I = Indicator Stations; C = Control Stations

(b) Fish samples are collected anywhere in Vernon Pond (Connecticut River, Vernon Hydro Station impoundment), which is adjacent to the plant (see Figure 4.1).

Table 4.3 Radiological Environmental Monitoring Locations (TLD) In 2020

Station Code	Station Description	Zone^(a)	Distance from Plant (km) ^(b)	Direction from Plant ^(b)
DR-1	River Sta. No. 3.3	AI	1.6	SSE
DR-2	N. Hinsdale, NH	AI	3.9	NNW
DR-5	Spofford Lake	C	16.5	NNE
DR-6	Vernon School	AI	0.52	WSW
DR-7	Site Boundary	SB	0.28	W
DR-8	Site Boundary	IR	0.25	SSW
DR-43	Site Boundary	IR	0.44	SSE
DR-45	Site Boundary	IR	0.12	NE
DR-46	Site Boundary	IR	0.28	NNW
DR-53A	West Cornfield	SB	0.34	WSW

(a) IR= Incident Response TLD; AI= Area of Interest TLD; C =Control TLD;
SB =Site Boundary TLD.

(b) Distance and direction is relative to the center of the Turbine Building for direct radiation monitors

Table 4.4 Environmental Lower Limit Of Detection (LLD) Sensitivity Requirements

Analysis	Water (pCi/l)	Airborne Particulates or Gases (pCi/m³)	Fish (pCi/kg)	Vegetation (pCi/kg)	Sediment (pCi/kg dry)
Gross-Beta	4	0.01			
H-3	2,000 ^(a)				
Mn-54	15		130		
Co-60	15		130		
Zn-65	30		260		
Zr- 95	15				
Cs-134	15	0.05	130	60	150
Cs-137	18	0.06	150	60	180

(a) If no drinking water pathway exists, a value of 3,000 picocuries/liter may be used.
See ODCM Table 4.5.1 for additional explanatory footnotes.

Table 4.5 Reporting Levels for Radioactivity Concentrations in Environmental Samples

Analysis	Water (pCi/l)	Airborne Particulates or Gases (pCi/m³)	Fish (pCi/kg)	Food Product (pCi/kg)	Sediment (pCi/kg dry)
H-3	20,000 ^(a)				
Mn-54	1,000		30,000		
Co-60	300		10,000		3,000 ^(b)
Zn-65	300		20,000		
Zr- 95	400				
Cs-134	30	10	1,000	1,000	
Cs-137	50	20	2,000	2,000	

(a) Reporting Level for drinking water pathways. For non-drinking water, a value of 30,000 pCi/liter may be used.

(b) Reporting level for individual grab samples taken at North Storm Drain Outfall only.

See ODCM Table 3.5.2 for additional explanatory footnotes.

Figure 4.1 Environmental Sampling Locations in Close Proximity to the Plant

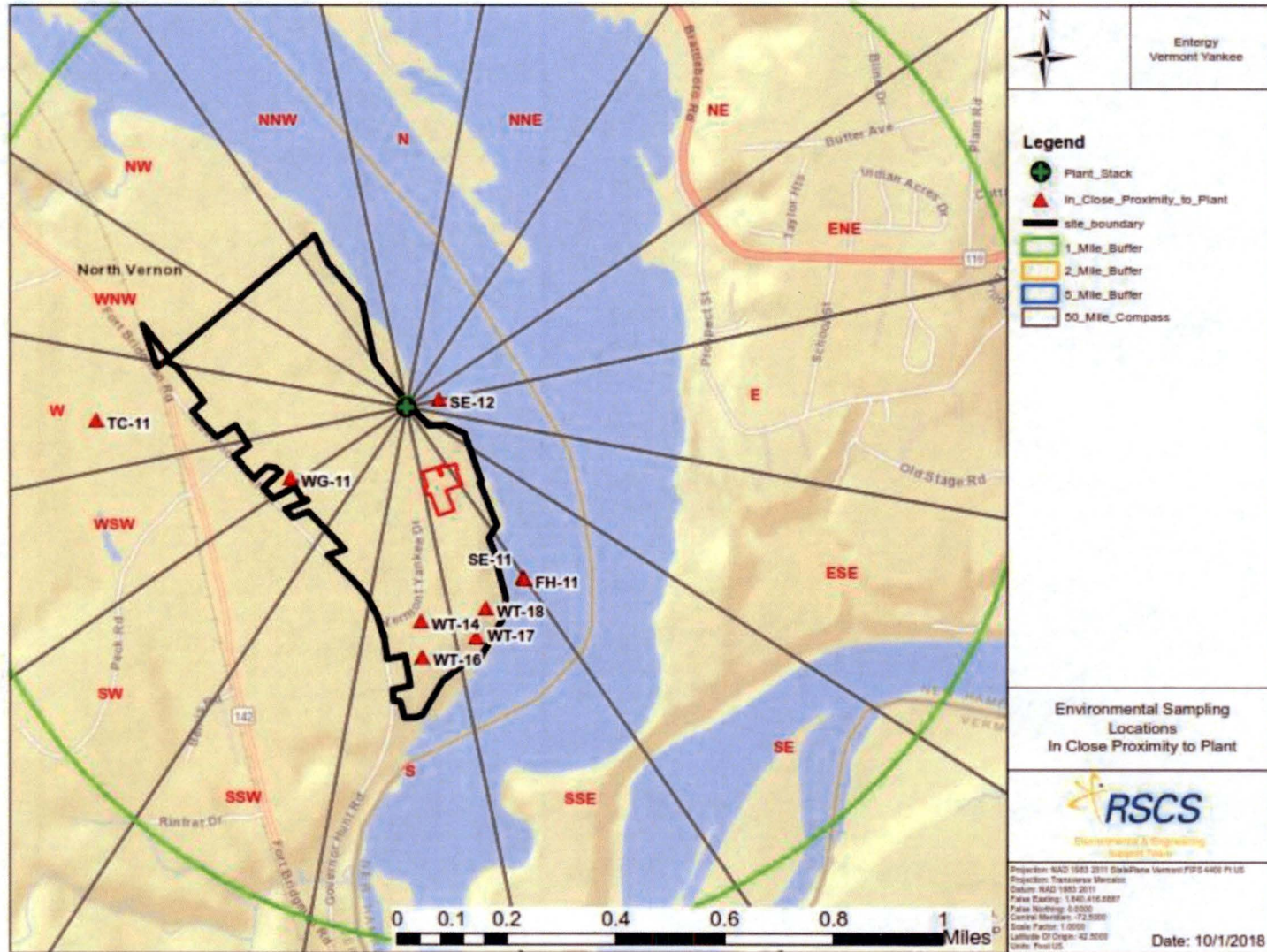


Figure 4.2 Environmental Sampling Locations Within 5 km of the Plant

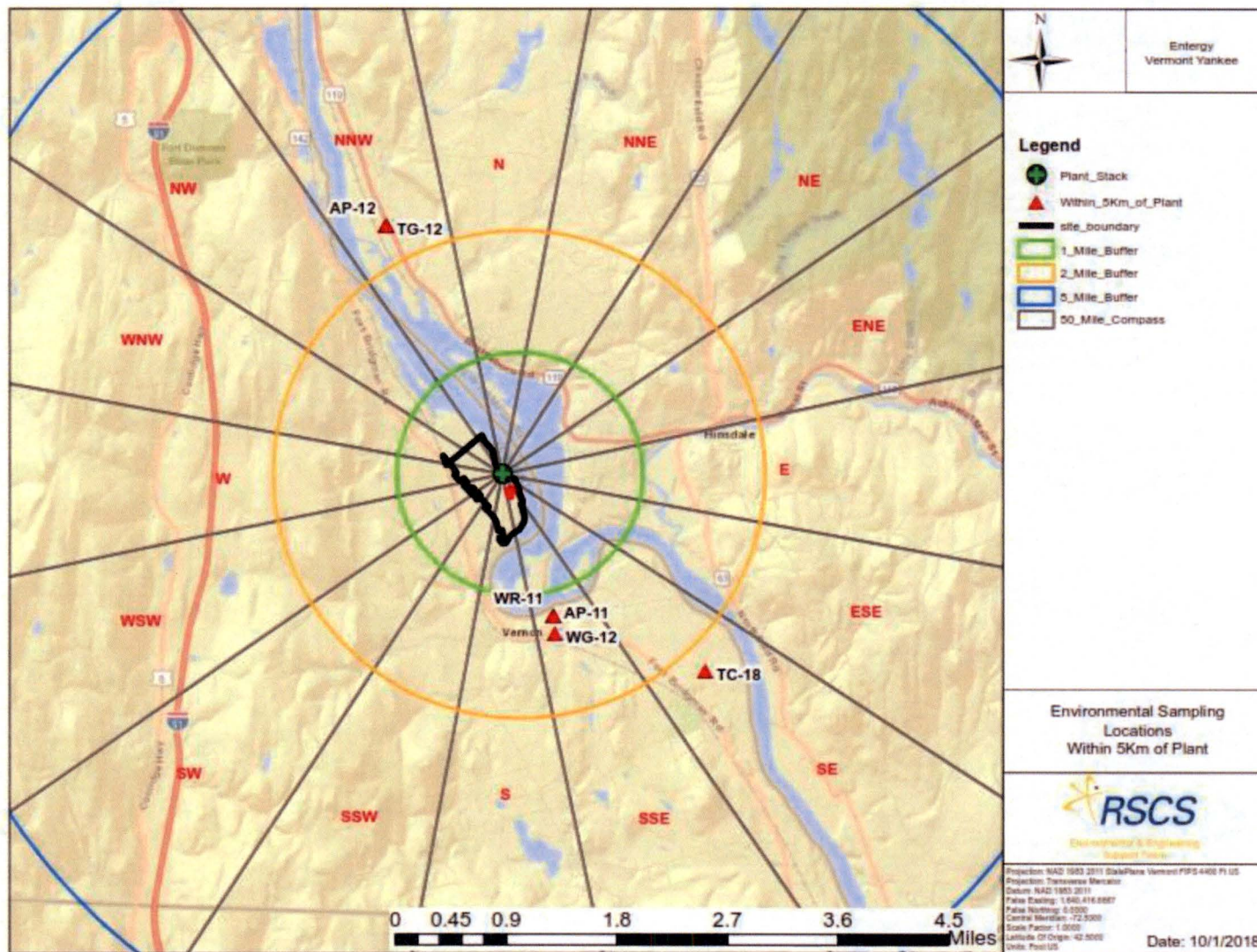


Figure 4.3 Environmental Sampling Locations Greater Than 5 km from the Plant

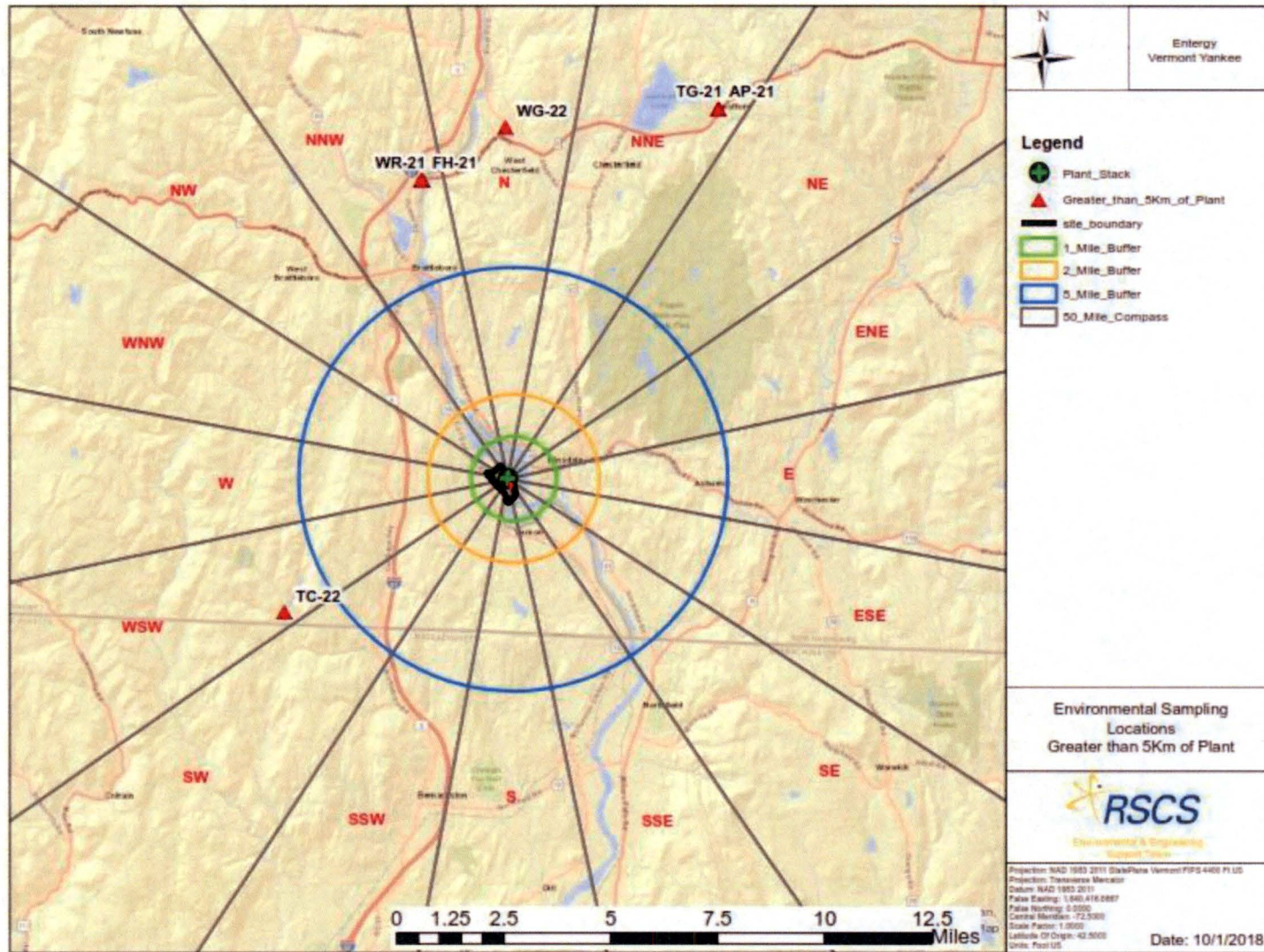


Figure 4.4 TLD Locations in Close Proximity to the Plant

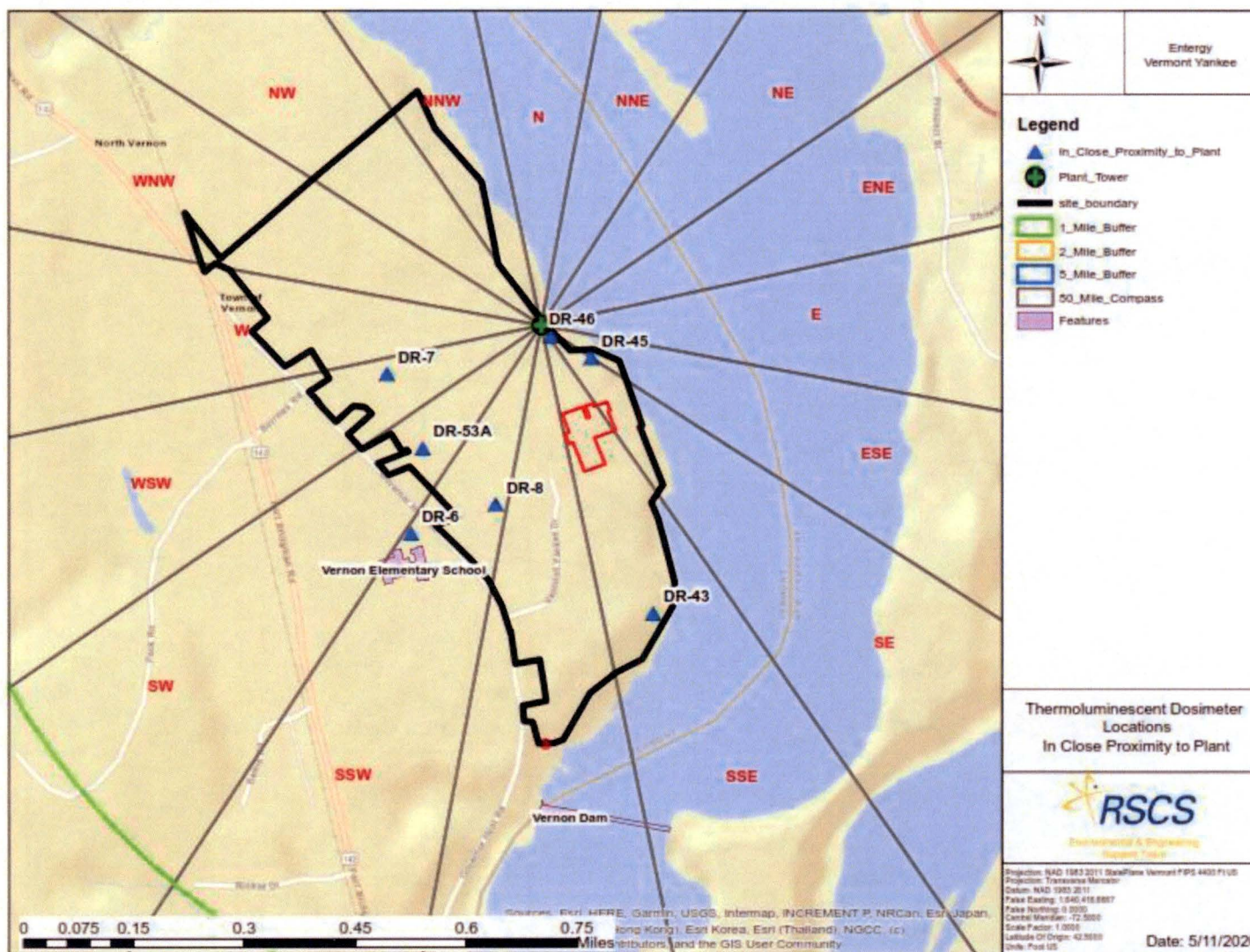


Figure 4.5 TLD Locations within 5 km of the Plant

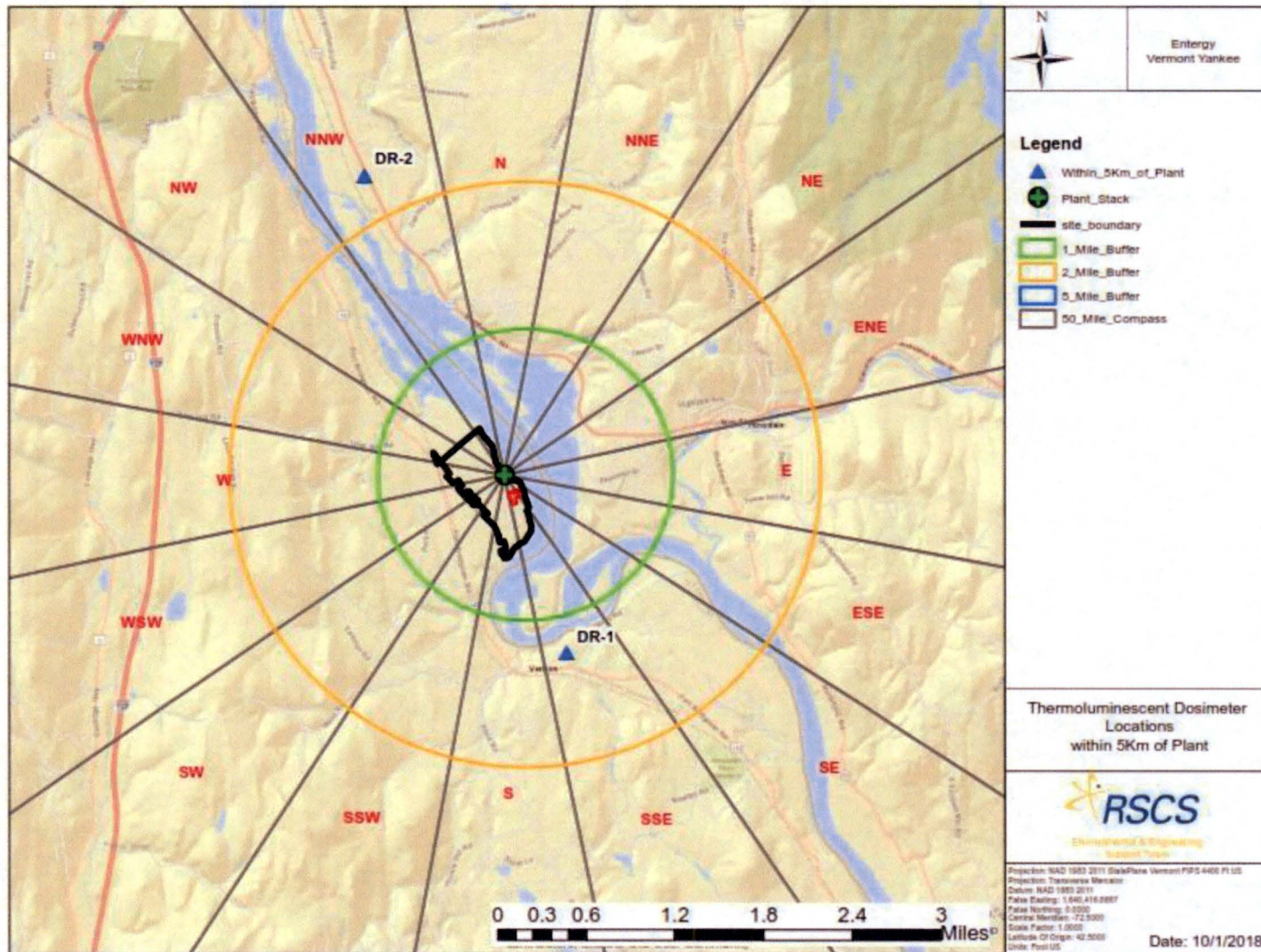
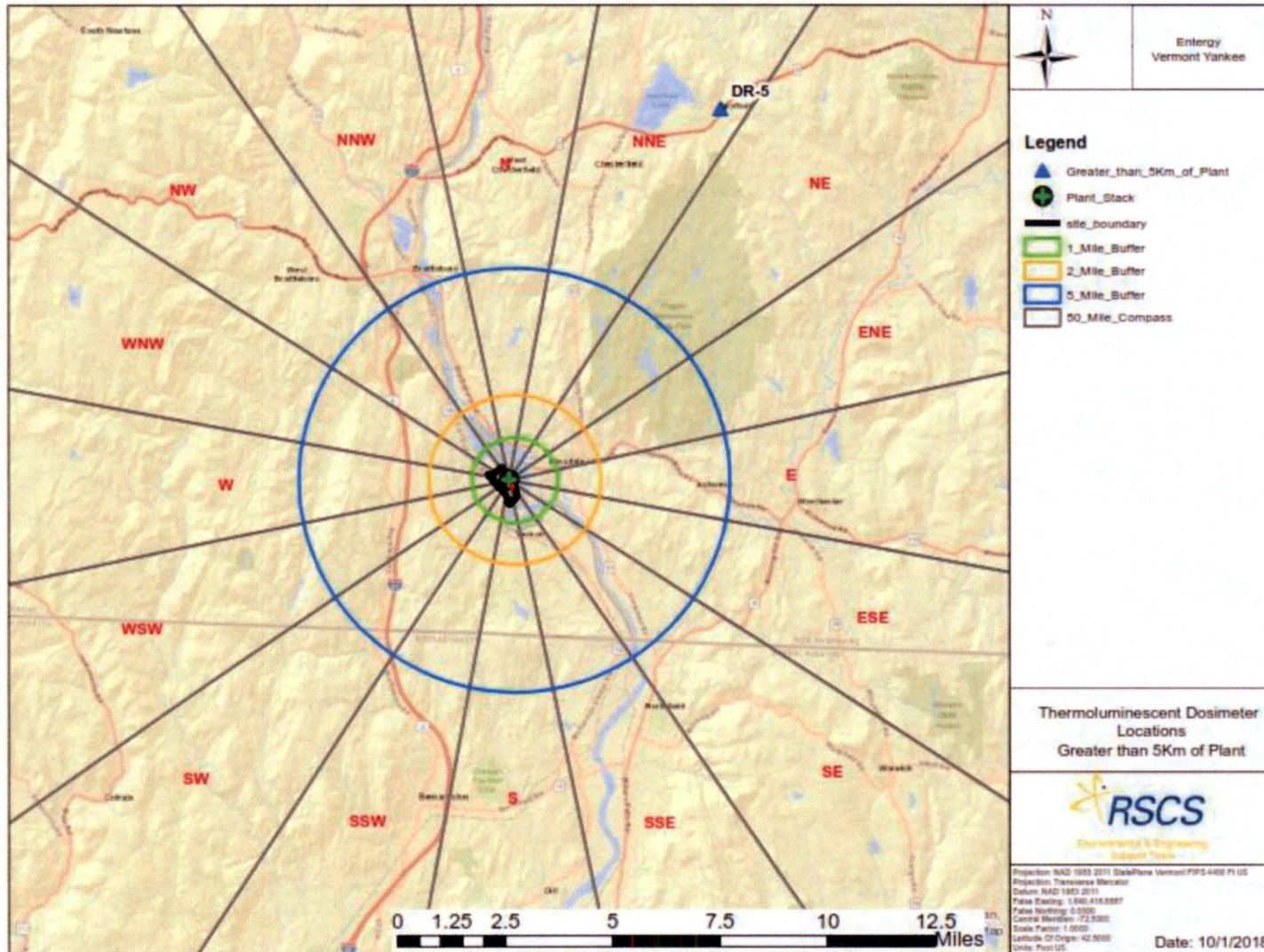


Figure 4.6 TLD Locations Greater Than 5 km of the Plant



5. RADIOLOGICAL DATA SUMMARY TABLES

This section summarizes the analytical results of the environmental samples that were collected during 2020. These results, shown in Table 5.1, are presented in a format similar to that prescribed in the NRC's Radiological Assessment Branch Technical Position on Environmental Monitoring (Reference 1). The results are ordered by sample media type and then by radionuclide. The units for each media type are also given.

In 2020, Vermont Yankee contracted with one laboratory for primary analyses of the environmental samples. A second laboratory was available, if needed, to cross-check the first laboratory for selected samples and to analyze other samples for hard-to-detect radionuclides (such as Strontium-89 and 90).

The left-most columns of Table 5.1 contains the medium or pathway sampled, the radionuclide of interest, the total number of analyses for that radionuclide in 2020 and the number of measurements which exceeded the Reporting Levels found in Table 3.5.2 of the VYNPS Off-site Dose Calculation Manual. The latter are classified as "Non-routine" measurements. The second column lists the required Lower Limit of Detection (LLD) for those radionuclides that have detection capability requirements as specified in the ODCM Table 4.5.1. The absence of a value in this column indicates that no LLD is specified in the ODCM for that radionuclide in that media. The target LLD for any analysis is typically 50 percent of the most restrictive required LLD. Occasionally the required LLD may not be met. This may be due to malfunctions in sampling equipment or lack of sufficient sample quantity which would then result in low sample volume. Delays in analysis at the laboratory could also be a factor. Such cases, if and when they should occur, would be addressed in Section 6.2.

For each radionuclide and media type, the remaining three columns summarize the data for the following categories of monitoring locations: (1) the Indicator stations, which are within the range of influence of the plant and which could be affected by its operation; (2) the Control stations, which are beyond the influence of the plant; and (3) the station which had the highest mean concentration during 2020 for that radionuclide. Direct radiation monitoring stations (using TLDs) are grouped into Inner Ring, Outer ring, Site Boundary and Control.

In each of these columns, for each radionuclide, the following statistical values are given:

- The mean value of all concentrations, including those results that are less than the *a posteriori* LLD for that analysis.
- The minimum and maximum concentration, including those results that are less than the *a*

posteriori LLD. In previous years, data less than the *a posteriori* LLD were converted to zero for purposes of reporting the means and ranges.

- The “Number Detected” is the number of positive measurements. A measurement is considered positive when the concentration is greater than three times the standard deviation in the concentration and greater than or equal to the *a posteriori* LLD (Minimum Detectable Concentration or MDC).
- The “Total Analyzed” for each column is also given.

Each single radioactivity measurement datum in this report is based on a single measurement of a sample. Any concentration below the *a posteriori* LLD for its analysis is averaged with those values above the *a posteriori* LLD to determine the average of the results. Likewise, the values are reported in ranges even though they are below the *a posteriori* LLD. To be consistent with normal data review practices used by Vermont Yankee, a “positive measurement” is considered to be one whose concentration is greater than three times its associated standard deviation, is greater than or equal to the *a posteriori* LLD and satisfies the analytical laboratory’s criteria for identification.

The radionuclides reported in this section represent those that: 1) had an LLD requirement in Table 4.5.1 of the ODCM, or a Reporting Level listed in Table 3.5.2 of the ODCM, or 2) had a positive measurement of radioactivity, whether it was naturally-occurring or man-made; or 3) were of special interest for any other reason. The radionuclides routinely analyzed and reported by the environmental laboratory (in a gamma spectroscopy analysis) were: Th-232, Ba/La-140, Be-7, Co-58, Co-60, Cs-134, Cs-137, Fe-59, K-40, Mn-54, Zn-65 and Zr-95.

Data from direct radiation measurements made by TLDs are provided in Table 5.2. The complete listing of quarterly TLD data is provided in Table 5.3.

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: 2020		50-271 2020 LOCATION WITH HIGHEST ANNUAL MEAN		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR LOCATIONS MEAN (F) RANGE	CONTROL LOCATION MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
AIR PARTICULATES (PCI/M ³)	GR-B	36	0.01	0.0138 (24/24) (0.0086/ 0.0184)	0.0142 (12/12) (0.0098/ 0.0191)	0.0148 (12/12) (0.0103/ 0.0184)	12 INDICATOR N. HINSDALE NH 3.6 KM NNW OF SITE	0
	GAMMA BE-7	12	N/A	0.1027 (8/8) (0.0795/ 0.1314)	0.1223 (4/4) (0.0909/ 0.1523)	0.1223 (4/4) (0.0909/ 0.1523)	21 CONTROL SPOFFORD LAKE (9) 16.4 KM NNE OF SITE	0
	K-40		N/A	0.0319 (0/8) (< 0.0219/< 0.0476)	0.0401 (0/4) (< 0.0266/< 0.0544)	0.0401 (0/4) (< 0.0266/< 0.0544)	21 CONTROL SPOFFORD LAKE (9) 16.4 KM NNE OF SITE	0
	CS-134		0.05	0.0020 (0/8) (< 0.0013/< 0.0025)	0.0028 (0/4) (< 0.0021/< 0.0035)	0.0028 (0/4) (< 0.0021/< 0.0035)	21 CONTROL SPOFFORD LAKE (9) 16.4 KM NNE OF SITE	0
	CS-137		0.06	0.0020 (0/8) (< 0.0015/< 0.0028)	0.0024 (0/4) (< 0.0020/< 0.0037)	0.0024 (0/4) (< 0.0020/< 0.0037)	21 CONTROL SPOFFORD LAKE (9) 16.4 KM NNE OF SITE	0
	RA-226		N/A	0.0295 (0/8) (< 0.0248/< 0.0375)	0.0391 (0/4) (< 0.0283/< 0.0489)	0.0391 (0/4) (< 0.0283/< 0.0489)	21 CONTROL SPOFFORD LAKE (9) 16.4 KM NNE OF SITE	0
	AC-228		N/A	0.0072 (0/8) (< 0.0048/< 0.0102)	0.0101 (0/4) (< 0.0074/< 0.0130)	0.0101 (0/4) (< 0.0074/< 0.0130)	21 CONTROL SPOFFORD LAKE (9) 16.4 KM NNE OF SITE	0
	TH-228		N/A	0.0028 (0/8) (< 0.0023/< 0.0039)	0.0038 (0/4) (< 0.0029/< 0.0049)	0.0038 (0/4) (< 0.0029/< 0.0049)	21 CONTROL SPOFFORD LAKE (9) 16.4 KM NNE OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATION MEAN (F) RANGE		50-271 2020 CONTROL LOCATION MEAN (F) RANGE	LOCATION WITH HIGHEST ANNUAL MEAN	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)			MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	
RIVER WATER (PCI/LITER)	GR-B	23	4	1.868 (2/11) (< 1.750/< 2.080)	1.783 (0/12) (< 1.470/< 1.980)	1.868 (2/11) (< 1.750/< 2.080)	11 INDICATOR RIVER STA. NO. 3.3 1.9 KM SSE OF SITE	0
	H-3	23	2000	499 (0/11) (<402/<554)	500 (0/12) (<400/<552)	500 (0/12) (<400/<552)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	GAMMA MN-54	23	15	1.704 (0/11) (< 1.544/< 2.118)	1.733 (0/12) (< 1.353/< 2.771)	1.733 (0/12) (< 1.353/< 2.771)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	CO-58		N/A	1.883 (0/11) (< 1.706/< 2.438)	1.779 (0/12) (< 1.447/< 3.053)	1.883 (0/11) (< 1.706/< 2.438)	11 INDICATOR RIVER STA. NO. 3.3 1.9 KM SSE OF SITE	0
	FE-59		N/A	4.336 (0/11) (< 3.811/< 5.692)	3.776 (0/12) (< 2.780/< 6.235)	4.336 (0/11) (< 3.811/< 5.692)	11 INDICATOR RIVER STA. NO. 3.3 1.9 KM SSE OF SITE	0
	CO-60		15	1.745 (0/11) (< 1.559/< 2.178)	1.896 (0/12) (< 1.394/< 3.118)	1.896 (0/12) (< 1.394/< 3.118)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	ZN-65		30	3.374 (0/11) (< 3.110/< 4.201)	3.630 (0/12) (< 2.862/< 6.390)	3.630 (0/12) (< 2.862/< 6.390)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	ZR-95		15	3.446 (0/11) (< 2.987/< 4.282)	3.144 (0/12) (< 2.449/< 5.471)	3.446 (0/11) (< 2.987/< 4.282)	11 INDICATOR RIVER STA. NO. 3.3 1.9 KM SSE OF SITE	0
	I-131		N/A	10.353 (0/11) (< 7.638/<15.5)	3.131 (0/12) (< 1.871/< 5.647)	10.353 (0/11) (< 7.638/<15.5)	11 INDICATOR RIVER STA. NO. 3.3 1.9 KM SSE OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATIONS		50-271 2020 CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN	
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (F) RANGE	MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
RIVER WATER (cont'd) (PCI/LITER)	CS-134		15	1.590 (0/11) (< 1.454/ < 2.021)	1.717 (0/12) (< 1.332/ < 3.076)	1.717 (0/12) (< 1.332/ < 3.076)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	CS-137		18	1.715 (0/11) (< 1.550/ < 2.238)	1.912 (0/12) (< 1.463/ < 3.212)	1.912 (0/12) (< 1.463/ < 3.212)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	BA/LA-140		N/A	5.968 (0/11) (< 4.462/ < 9.408)	2.898 (0/12) (< 2.039/ < 6.033)	5.968 (0/11) (< 4.462/ < 9.408)	11 INDICATOR RIVER STA. NO. 3.3 1.9 KM SSE OF SITE	0
	RA-226		N/A	41.755 (0/11) (< 33.06/ < 56.73)	42.127 (0/12) (< 31.96/ < 73.61)	42.127 (0/12) (< 31.96/ < 73.61)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
GROUND WATER (PCI/LITER)	GR-B	12	4	3.586 (7/8) (< 1.930/ 7.450)	2.743 (3/4) (< 1.440/ 4.310)	4.060 (4/4) (2.290/ 7.450)	12 INDICATOR VERNON GREEN 2.1 KM SSE OF SITE	0
	H-3	12	2000	519 (0/8) (< 480/ < 539)	517 (0/4) (< 492/ < 537)	520 (0/4) (< 489/ < 539)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	GAMMA MN-54	12	15	2.347 (0/8) (< 1.734/ < 4.500)	1.757 (0/4) (< 1.423/ < 2.055)	2.770 (0/4) (< 1.810/ < 4.500)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	CO-58		N/A	2.594 (0/8) (< 1.816/ < 5.444)	1.906 (0/4) (< 1.466/ < 2.143)	3.125 (0/4) (< 2.004/ < 5.444)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	FE-59		N/A	5.508 (0/8) (< 3.840/ < 11.02)	4.059 (0/4) (< 2.790/ < 4.667)	6.532 (0/4) (< 4.252/ < 11.02)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATION CONTROL LOCATION		50-271 2020 LOCATION WITH HIGHEST ANNUAL MEAN	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (F) RANGE	MEAN (F) RANGE	MEAN (F) RANGE		
GROUND WATER (cont'd) (PCI/LITER)	CO-60		15	2.481 (0/8) ($< 1.692 / < 4.397$)	2.000 (0/4) ($< 1.625 / < 2.386$)	2.929 (0/4) ($< 2.188 / < 4.397$)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	ZN-65		30	5.037 (0/8) ($< 3.385 / < 10.15$)	3.858 (0/4) ($< 3.049 / < 4.228$)	5.983 (0/4) ($< 3.749 / < 10.15$)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	ZR-95		15	4.228 (0/8) ($< 3.203 / < 6.131$)	3.427 (0/4) ($< 2.551 / < 4.014$)	4.778 (0/4) ($< 3.559 / < 6.131$)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	CS-134		15	2.222 (0/8) ($< 1.668 / < 3.919$)	1.711 (0/4) ($< 1.451 / < 1.926$)	2.622 (0/4) ($< 1.761 / < 3.919$)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	CS-137		18	2.444 (0/8) ($< 1.809 / < 4.601$)	1.901 (0/4) ($< 1.637 / < 2.094$)	2.864 (0/4) ($< 1.952 / < 4.601$)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	BA/LA-140		N/A	5.646 (0/8) ($< 3.425 / < 9.113$)	4.545 (0/4) ($< 2.320 / < 7.143$)	6.708 (0/4) ($< 4.403 / < 9.113$)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
	RA-226		N/A	61.161 (0/8) ($< 36.59 / < 127.7$)	41.993 (0/4) ($< 36.51 / < 50.05$)	75.443 (0/4) ($< 43.78 / < 127.7$)	11 INDICATOR MAIN PLANT WELL .2 KM ON SITE	0
SEDIMENT (PCI/KG DRY)	GAMMA BE-7	36	N/A	937.95 (0/30) ($< 372.9 / < 1605$)	1060.4 (0/6) ($< 458.6 / < 1736$)	1143.3 (0/2) ($< 694.6 / < 1592$)	17 INDICATOR N. STORM DRAIN OUTFALL T-1 0.1 KM E OF SITE	0
	K-40		N/A	18388.77 (30/30) (2869/25040)	18077.83 (6/6) (9157/22960)	23095 (2/2) (21150/25040)	23 INDICATOR N. STORM DRAIN OUTFALL U-2 0.1 KM E OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATION CONTROL LOCATION		50-271 2020 LOCATION WITH HIGHEST ANNUAL MEAN		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (F) RANGE	MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
SEDIMENT (cont'd) (PCI/KG DRY)	MN-54		N/A	55.9 (0/30) (<32.21/<85.2)	61.05 (0/6) (<42.17/<83.5)	65.75 (0/2) (<48/<83.5)	22 CONTROL N. STORM DRAIN OUTFALL U-1 0.1 KM E OF SITE	0
	CO-60		N/A	50.66 (0/30) (<24.69/<79.37)	55.51 (0/6) (<39.27/<74.41)	73.44 (0/2) (<67.5/<79.37)	17 INDICATOR N. STORM DRAIN OUTFALL T-1 0.1 KM E OF SITE	0
	ZN-65		N/A	122.6 (0/30) (<57.45/<190)	126.99 (0/6) (<66.14/<178.6)	143.99 (0/2) (<99.97/<188)	13 INDICATOR N. STORM DRAIN OUTFALL S-2 0.1 KM E OF SITE	0
	NB-95		N/A	104.84 (0/30) (<41.02/<182.2)	117.58 (0/6) (<44.68/<195)	131.01 (0/2) (<67.01/<195)	22 CONTROL N. STORM DRAIN OUTFALL U-1 0.1 KM E OF SITE	0
	CS-134		150	45.94 (0/30) (<26.43/<65.47)	51.01 (0/6) (<32.99/<67.95)	57.04 (0/2) (<50.4/<63.67)	19 INDICATOR N. STORM DRAIN OUTFALL T-3 0.1 KM E OF SITE	0
	CS-137		180	74.41 (11/30) (<38.09/112.1)	76.05 (2/6) (<49.01/114.4)	99.88 (1/2) (<85.35/114.4)	22 CONTROL N. STORM DRAIN OUTFALL U-1 0.1 KM E OF SITE	0
	BA/LA-140		N/A	4301.32 (0/30) (<166.2/<11900)	4825.1 (0/6) (<266.7/<11850)	6094.75 (0/2) (<289.5/<11900)	18 INDICATOR N. STORM DRAIN OUTFALL T-2 0.1 KM E OF SITE	0
	RA-226		N/A	2427.27 (26/30) (<1008/3403)	2357.5 (4/6) (<1281/3470)	3419.5 (2/2) (3369/3470)	22 CONTROL N. STORM DRAIN OUTFALL U-1 0.1 KM E OF SITE	0
	AC-228		N/A	2530.55 (25/30) (<95.71/4905)	2122.8 (4/6) (<351.9/4018)	4035.5 (2/2) (3166/4905)	18 INDICATOR N. STORM DRAIN OUTFALL T-2 0.1 KM E OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATION CONTROL LOCATION		50-271 2020 LOCATION WITH HIGHEST ANNUAL MEAN		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (F) RANGE	MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
SEDIMENT (cont'd) (PCI/KG DRY)	TH-228		N/A	1356.53 (30/30) (184.8/1882)	1290.05 (6/6) (457.2/1683)	1704.5 (2/2) (1527/1882)	23 INDICATOR N. STORM DRAIN OUTFALL U-2 0.1 KM E OF SITE	0
	TH-232		N/A	1178.48 (28/30) (<242.6/1808)	1137.57 (6/6) (500.8/1545)	1550 (2/2) (1292/1808)	23 INDICATOR N. STORM DRAIN OUTFALL U-2 0.1 KM E OF SITE	0
	U-238		N/A	5525.07 (0/30) (<3275/<8324)	6109.17 (0/6) (<4832/<7540)	6750.5 (0/2) (<6061/<7440)	17 INDICATOR N. STORM DRAIN OUTFALL T-1 0.1 KM E OF SITE	0
TEST WELLS (PCI/LITER) (Septage Spreading Field)	GR-B	16	4	6.2 (16/16) (3.1/10.7)	N/A	7.2 (4/4) (4.7/ 9.5)	16 INDICATOR TEST WELL 202 ON SITE	0
	H-3	16	2000	520 (0/16) (<480/<546)	N/A	534 (0/4) (<519/<546)	18 INDICATOR TEST WELL 204 ON SITE	0
	GAMMA K-40	16	N/A	48.7 (0/16) (<15.2/<143.9)	N/A	51.8 (0/4) (<15.2/<143.9)	16 INDICATOR TEST WELL 202 ON SITE	0
	MN-54		15	2.9 (0/16) (< 1.5/< 6.8)	N/A	3.1 (0/4) (< 1.7/< 6.8)	14 INDICATOR TEST WELL 201 ON SITE	0
	CO-58		N/A	3.0 (0/16) (< 1.7/< 7.9)	N/A	3.5 (0/4) (< 1.8/< 7.9)	14 INDICATOR TEST WELL 201 ON SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
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Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATION MEAN (F) RANGE		50-271 2020 CONTROL LOCATION MEAN (F) RANGE LOCATION WITH HIGHEST ANNUAL MEAN		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (F) RANGE	MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
TEST WELLS (cont'd) (PCI/LITER) (Septage Spreading Field)	FE-59		N/A	6.7 (0/16) (< 3.5/<17.4)	N/A	7.7 (0/4) (< 4.0/<17.4)	14 INDICATOR TEST WELL 201 ON SITE	0
	CO-60		15	3.1 (0/16) (< 1.7/< 7.7)	N/A	3.3 (0/4) (< 1.7/< 7.7)	17 INDICATOR TEST WELL 203 ON SITE	0
	NB-95		N/A	3.3 (0/16) (< 1.7/< 8.1)	N/A	3.6 (0/4) (< 2.0/< 8.1)	16 INDICATOR TEST WELL 202 ON SITE	0
	I-131		N/A	8.4 (0/16) (< 3.7/<22.8)	N/A	9.3 (0/4) (< 3.9/<22.8)	18 INDICATOR TEST WELL 204 ON SITE	0
	CS-134		15	2.8 (0/16) (< 1.5/< 6.9)	N/A	3.1 (0/4) (< 1.8/< 6.9)	18 INDICATOR TEST WELL 204 ON SITE	0
	CS-137		18	3.1 (0/16) (< 1.6/< 6.9)	N/A	3.2 (0/4) (< 1.8/< 6.6)	14 INDICATOR TEST WELL 201 ON SITE	0
	BA/LA-140		N/A	6.4 (0/16) (< 3.1/<18.2)	N/A	7.3 (0/4) (< 3.1/<18.2)	17 INDICATOR TEST WELL 203 ON SITE	0
SILAGE (PCI/KG WET)	GAMMA BE-7	12	N/A	250.36 (2/8) (<49.01/835.2)	189.15 (0/4) (<141.8/<232.2)	360.18 (2/4) (<49.01/835.2)	18 INDICATOR BLODGETT FARM 3.6 KM SE OF SITE	0
	K-40		N/A	5588.88 (8/8) (1964/10730)	10088 (4/4) (7623/14790)	10088 (4/4) (7623/14790)	22 CONTROL FRANKLIN FARM 9.7 KM WSW OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: 2020		50-271 LOCATION WITH HIGHEST ANNUAL MEAN		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR LOCATIONS MEAN (F) RANGE	CONTROL LOCATION MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
SILAGE (cont'd) (PCI/KG WET)	CS-134	9	60	15.68 (0/8) ($< 5.25 / < 26.21$)	21.14 (0/4) ($< 16.11 / < 25.56$)	21.14 (0/4) ($< 16.11 / < 25.56$)	22 CONTROL FRANKLIN FARM 9.7 KM WSW OF SITE	0
	CS-137		60	18.31 (0/8) ($< 6.07 / < 35.03$)	46.41 (4/4) (43.03/49.88)	46.41 (4/4) (43.03/49.88)	22 CONTROL FRANKLIN FARM 9.7 KM WSW OF SITE	0
	AC-228		N/A	77.72 (0/8) ($< 24.68 / < 135.5$)	100.15 (0/4) ($< 73.19 / < 128$)	100.15 (0/4) ($< 73.19 / < 128$)	22 CONTROL FRANKLIN FARM 9.7 KM WSW OF SITE	0
	TH-228		N/A	29.9 (0/8) ($< 9.03 / < 52.79$)	52.7 (1/4) ($< 28.58 / 100.6$)	52.7 (1/4) ($< 28.58 / 100.6$)	22 CONTROL FRANKLIN FARM 9.7 KM WSW OF SITE	0
	GAMMA BE-7		N/A	894.62 (5/6) (208/2122)	1553.53 (3/3) (300.6/3140)	1553.53 (3/3) (300.6/3140)	21 CONTROL SPOFFORD LAKE 16.4 KM NNE OF SITE	0
	K-40		N/A	4322.17 (6/6) (2746/6246)	5352 (3/3) (4864/5873)	5352 (3/3) (4864/5873)	21 CONTROL SPOFFORD LAKE 16.4 KM NNE OF SITE	0
	I-131		N/A	26.13 (0/6) ($< 10.27 / < 52.53$)	25.61 (0/3) ($< 13.94 / < 32.9$)	26.91 (0/3) ($< 14.06 / < 52.53$)	11 INDICATOR RIVER STA. NO. 3.3 1.9 KM SSE OF SITE	0
	CS-134		60	15.05 (0/6) ($< 6.18 / < 25.81$)	17.56 (0/3) ($< 8.88 / < 23.28$)	17.56 (0/3) ($< 8.88 / < 23.28$)	21 CONTROL SPOFFORD LAKE 16.4 KM NNE OF SITE	0
	CS-137		60	18.54 (0/6) ($< 7.29 / < 33.48$)	21.54 (0/3) ($< 9.89 / < 31.24$)	21.54 (0/3) ($< 9.89 / < 31.24$)	21 CONTROL SPOFFORD LAKE 16.4 KM NNE OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATIONS		50-271 2020 CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN	
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (F) RANGE	MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
MIXED GRASS (cont'd) (PCI/KG WET)	RA-226		N/A	395.8 (0/6) (<133.5/<753.2)	419.13 (0/3) (<196.9/<559.6)	419.13 (0/3) (<196.9/<559.6)	21 CONTROL SPOFFORD LAKE 16.4 KM NNE OF SITE	0
	AC-228		N/A	77.11 (0/6) (<32.66/<146.7)	89.07 (0/3) (<39.31/<114.9)	89.07 (0/3) (<39.31/<114.9)	21 CONTROL SPOFFORD LAKE 16.4 KM NNE OF SITE	0
	TH-228		N/A	30.07 (0/6) (<10.97/<52.42)	33.12 (0/3) (<16.44/<46.23)	33.12 (0/3) (<16.44/<46.23)	21 CONTROL SPOFFORD LAKE 16.4 KM NNE OF SITE	0
FISH (PCI/KG WET)	GAMMA K-40	8	N/A	2645.25 (4/4) (2241/3153)	2635.25 (4/4) (2130/3284)	2645.25 (4/4) (2241/3153)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	MN-54		130	19.07 (0/4) (<11.29/<25.18)	15.995 (0/4) (< 5.901/<20.77)	19.07 (0/4) (<11.29/<25.18)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	CO-58		N/A	29.373 (0/4) (<23.28/<38.37)	24.448 (0/4) (<14.49/<36.4)	29.373 (0/4) (<23.28/<38.37)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	FE-59		N/A	87.35 (0/4) (<71.13/<125.2)	73.828 (0/4) (<44.49/<127.1)	87.35 (0/4) (<71.13/<125.2)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	CO-60		130	18.943 (0/4) (<10.89/<23.88)	16.081 (0/4) (< 9.403/<22.02)	18.943 (0/4) (<10.89/<23.88)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	ZN-65		260	40.378 (0/4) (<26.33/<53.65)	33.945 (0/4) (<14.51/<45.74)	40.378 (0/4) (<26.33/<53.65)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATION MEAN (F) RANGE		50-271 2020 CONTROL LOCATION MEAN (F) RANGE	LOCATION WITH HIGHEST ANNUAL MEAN	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (F) RANGE	MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	
FISH (cont'd) (PCI/KG WET)	CS-134		130	17.998 (0/4) (<10.47/<25.36)	14.331 (0/4) (< 5.324/<18.16)	17.998 (0/4) (<10.47/<25.36)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	CS-137		150	18.155 (0/4) (<10.63/<25.22)	16.193 (0/4) (< 6.240/<22.52)	18.155 (0/4) (<10.63/<25.22)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	H-3	4	0.2	112 (0/2) (<74/<150)	121 (0/2) (<73/<169)	121 (0/2) (<73/<169)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	AM-241	8	N/A	1.547 (0/4) (< 0.512/< 2.017)	0.858 (0/4) (< 0.418/< 1.275)	1.547 (0/4) (< 0.512/< 2.017)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	CM-242	8	N/A	0.388 (0/4) (< 0.136/< 0.619)	0.525 (0/4) (< 0.222/< 0.955)	0.525 (0/4) (< 0.222/< 0.955)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	CM-243/244	8	N/A	1.679 (0/4) (< 0.760/< 2.502)	0.739 (0/4) (< 0.256/< 1.094)	1.679 (0/4) (< 0.760/< 2.502)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	FE-55	8	N/A	906.375 (0/4) (<456.2/<1469)	1294.5 (0/4) (<1018/<1472)	1294.5 (0/4) (<1018/<1472)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	NI-63	8	N/A	189.5 (0/4) (<141/<234)	199.75 (0/4) (<159/<283)	199.75 (0/4) (<159/<283)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	PU-238	8	N/A	2.402 (0/4) (< 1.583/< 3.907)	0.948 (0/4) (< 0.392/< 1.601)	2.402 (0/4) (< 1.583/< 3.907)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE 5.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR
THE VERMONT YANKEE NUCLEAR POWER PLANT, 2020**

Name of Facility: VERMONT YANKEE NUCLEAR POWER PLANT Location of Facility: VERNON, VT				DOCKET NUMBER: REPORTING PERIOD: INDICATOR LOCATION CONTROL LOCATION		50-271 2020 LOCATION WITH HIGHEST ANNUAL MEAN		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSES PERFORMED	NUMBER OF ANALYSES PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (F) RANGE	MEAN (F) RANGE	MEAN (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
FISH (cont'd) (PCI/KG WET)	PU-239/240	8	N/A	2.442 (0/4) ($< 1.871 / < 3.190$)	1.610 (0/4) ($< 0.998 / < 2.264$)	2.442 (0/4) ($< 1.871 / < 3.190$)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	PU-241	8	N/A	491.25 (0/4) ($< 399 / < 625$)	432.25 (0/4) ($< 337 / < 527$)	491.25 (0/4) ($< 399 / < 625$)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	PU-242	8	N/A	2.625 (0/4) ($< 1.586 / < 3.108$)	2.496 (0/4) ($< 1.422 / < 4.114$)	2.625 (0/4) ($< 1.586 / < 3.108$)	11 INDICATOR VERNON POND 0.6 KM SSE OF SITE	0
	SR-89	8	N/A	472.25 (0/4) ($< 62 / < 918$)	517.525 (0/4) ($< 70.1 / < 1240$)	517.525 (0/4) ($< 70.1 / < 1240$)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
	SR-90	8	60	51.175 (1/4) ($< 33.2 / 83.5$)	53.475 (2/4) ($27.8 / 89.9$)	53.475 (2/4) ($27.8 / 89.9$)	21 CONTROL RT. 9 BRIDGE 11.8 KM NNW OF SITE	0
DIRECT RADIATION (MILLI-ROENTGEN/QTR.)	TLD-QUARTERLY	36	N/A	7 (32/32) (6/12)	7 (4/4) (6/7)	11 (4/4) (10/12)	DR45 INDICATOR SITE BOUNDARY 0.12 KM NE OF SITE	0

FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

TABLE 5.2

**ENVIRONMENTAL TLD DATA SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 2020)**

<u>INNER RING TLD</u>	<u>OUTER RING TLD</u>	<u>OFFSITE STATION WITH HIGHEST MEAN</u>	<u>CONTROL TLDs</u>
MEAN* RANGE* (NO. MEASUREMENTS)**	MEAN* RANGE* (NO. MEASUREMENTS)**	STA.NO./ MEAN* RANGE* (NO. MEASUREMENTS)**	MEAN* RANGE* (NO. MEASUREMENTS)**
6.21 ± 0.28 5.79 to 7.02 8	6.62 ± 0.30 6.00 to 7.01 4	DR02 6.62 ± 0.30 6.00 to 7.01 4	6.76 ± 0.32 6.25 to 7.21 4
	<u>SITE BOUNDARY TLD WITH HIGHEST MEAN</u>	<u>SITE BOUNDARY TLD</u>	
	STA.NO./ MEAN* RANGE* (NO. MEASUREMENTS)**	MEAN* RANGE* (NO. MEASUREMENTS)**	
	DR45 10.82 ± 0.52 10.09 to 11.71 4	7.45 ± 0.33 6.10 to 11.71 24	

* Units are in micro-R per hour.

** Each "measurement" is typically based on quarterly readings from five TLD elements.

TABLE 5.3

ENVIRONMENTAL TLD MEASUREMENTS

2020

(Micro-R per Hour)

Sta. No.	Description	1ST QUARTER			2ND QUARTER			3RD QUARTER			4TH QUARTER			ANNUAL
		EXP.	S.D.		EXP.	S.D.		EXP.	S.D.		EXP.	S.D.		AVE. EXP.
DR-01	River Sta. No. 3.3	5.83	±	0.49	5.85	±	0.20	6.25	±	0.20	5.79	±	0.19	5.9
DR-02	N Hinsdale, NH	6.00	±	0.43	6.71	±	0.32	7.01	±	0.24	6.78	±	0.22	6.6
DR-05	Spofford Lake, NH	6.25	±	0.43	6.81	±	0.27	7.21	±	0.29	6.78	±	0.30	6.8
DR-06	Vernon School	5.96	±	0.36	6.42	±	0.40	7.02	±	0.24	6.53	±	0.15	6.5
DR-07	Site Boundary	6.11	±	0.44	6.61	±	0.30	7.15	±	0.25	6.66	±	0.18	6.6
DR-08	Site Boundary	6.26	±	0.45	6.85	±	0.38	7.30	±	0.19	6.62	±	0.21	6.8
DR-43	Site Boundary	6.10	±	0.32	6.59	±	0.26	7.02	±	0.23	6.95	±	0.27	6.7
DR-45	Site Boundary	10.09	±	0.57	11.71	±	0.42	10.20	±	0.62	11.27	±	0.47	10.8
DR-46	Site Boundary	6.38	±	0.41	6.44	±	0.30	6.81	±	0.26	6.67	±	0.27	6.6
DR-53A	West Cornfield	6.56	±	0.40	7.43	±	0.28	7.70	±	0.26	7.41	±	0.26	7.3

6. ANALYSIS OF ENVIRONMENTAL RESULTS

6.1 Sampling Program Deviations

Off-site Dose Calculation Manual Control 3.5.1 allows for deviations “if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons.” In 2020, five deviations were noted in the REMP. These deviations did not compromise the program’s effectiveness and are considered typical with respect to what is normally anticipated for any radiological environmental program. The specific deviations for 2020 were:

- a) Environmental Air Sampling Station # 12 (AP-12, located in N. Hinsdale, NH) air pump was found to be out of service on 1/28/2020 (Week 5-20). The sample timer was short by approximately one hour. A new pump was installed immediately and normal collection of environmental air sample at this location was resumed. Documented in Condition Report 2020-0090.
- b) Environmental Air Sampling Station # 12 (AP-12, located in N. Hinsdale, NH) air pump was found to be out of service on 10/27/2020 (Week 44-20). There were no hours lost on the sample timer. A new pump was installed immediately and normal collection of environmental air sample at this location was resumed. Documented in Condition Report 2020-0090.
- c) Environmental Air Sampling Station # 12 (AP-12, located in N. Hinsdale, NH) air pump was found to be out of service on 11/24/2020 (Week 48-20). There were no hours lost on the sample timer. A new pump was installed immediately and normal collection of environmental air sample at this location was resumed. Documented in Condition Report 2020-0090.
- d) Wells GZ-9, GZ-10, GZ-20 and GZ-21 were not obtained in November as required by the ground water sampling schedule. The debris from the AOG demolition has covered these wells. Now with the winter season the well heads are also covered with snow. When the weather is warmer and more conducive to finding the wells an effort shall be made to locate and sample the wells. Wells GZ-9, GZ-10 and GZ-21 are annual samples and GZ-20 is semi-annual and was last sampled in May 2020. Documented in Condition Report 2020-0090.
- e) Environmental Air Sampling Station # 21 (AP-21, located in Spofford, New Hampshire) air pump was found to be out of service on 12/29/2020 (Week 53-20). There were no hours lost on the sample timer. A new pump was installed immediately and normal collection of environmental air sample at this location was resumed. Documented in Condition Report 2020-0090.
- f) Air sample station outages during 2020 are reflected in the air sample collection time percentages listed below.

AP/CF #	1 st Quarter	2 nd Quarter	3 rd Quarter	4 th Quarter
11	92.8%	99.9%	100.0%	100.1%
12	92.8%	99.9%	100.0%	100.1%
21	92.8%	99.9%	100.0%	100.1%

6.2 Comparison of Achieved LLDs with Requirements

Table 4.5.1 of the VYNPS ODCM (also shown in Table 4.4 of this report) gives the required Lower Limits of Detection (LLDs) for environmental sample analyses. On occasion, an LLD is not achievable due to a situation such as a low sample volume caused by sampling equipment malfunction or limited sample availability. In such a case, ODCM 10.2 requires a discussion of the situation. At the contracted environmental laboratory, the target LLD for the majority of analyses is 50 percent of the most restrictive required LLD. Expressed differently, the typical sensitivities achieved for each analysis are at least 2 times greater than that required by the VYNPS ODCM.

For each analysis having an LLD requirement in ODCM Table 4.5.1, the *a posteriori* (after the fact) LLD calculated for that analysis was compared with the required LLD. During 2020, all sample analyses performed for the REMP program achieved an *a posteriori* LLD less than the corresponding LLD requirement.

6.3 Comparison of Results with Reporting Levels

ODCM Section 10.3.4 requires written notification to the NRC within 30 days of receipt of an analysis result whenever a Reporting Level in ODCM Table 3.5.2 is exceeded. Reporting Levels are the environmental concentrations that relate to the ALARA design dose objectives of 10 CFR 50, Appendix I. Environmental concentrations are averaged over the calendar quarters for the purposes of this comparison. The Reporting Levels are intended to apply only to measured levels of radioactivity due to plant effluents. During 2020, no analytical result exceeded a corresponding reporting level requirement in Table 3.5.2 of the ODCM.

6.4 Changes in Sampling Locations

The Vermont Yankee Nuclear Power Station Off-Site Dose Calculation Manual Section 10.2 states that if “new environmental sampling locations are identified in accordance with Control 3.5.2, the new locations shall be identified in the next Annual Radiological Environmental Operating Report.” There were no required sampling location changes due to the Land Use Census conducted in 2020.

Milk collection from Dunklee farm (Vern-Mont Farm in Vernon) commenced in April, 2010 at the request of the farm owner. After the shutdown of Vermont Yankee, sampling from this location was terminated in August 2015. All milk sampling was terminated by the implementation of ODCM Rev 37 in December 2016 due to the decay of radioiodines following shutdown.

6.5 Data Analysis by Media Type

The 2020 REMP data for each media type is discussed below. Whenever a specific measurement result is presented, it is given as the concentration in the units of the sample (volume or weight). An analysis is considered to yield a “detectable measurement” when the concentration exceeds three times the standard deviation for that analysis and is greater than or equal to the Minimum Detectable Concentration (MDC) for the analysis. With respect to data plots, all net concentrations are plotted as reported, without regard to whether the value is “detectable” or “non-detectable.” In previous years, values that were less than the MDC were converted to zero.

6.5.1 Airborne Pathways

6.5.1.1 Air Particulates (AP)

The periodic air particulate filters from each of the three sampling sites were analyzed for gross-beta radioactivity. At the end of each quarter, the filters from each sampling site were composited for a gamma analysis. The results of the air particulate sampling program are shown in Table 5.1 and Figures 6.1 through 6.7.

Gross beta activity was detected in all of the air particulate filters that were analyzed. As shown in Figure 6.1, there is no significant difference between the quarterly average concentrations at the indicator (near-plant) stations and the control (distant from plant) stations. Notable in Figure 6.1 is a distinct annual cycle, with the minimum concentration in the fourth quarter, and the maximum concentration in the third quarter.

Figures 6.2 through 6.7 show the monthly gross beta concentration at each air particulate sampling location compared to the control air particulate sampling location at AP-21 (Spofford Lake, NH). Small differences are evident and expected between individual sampling locations. Figure 6.2 clearly demonstrates the distinct annual cycle, with the minimum concentration in the second quarter, and the maximum concentration in the first quarter. It can be seen that the gross-beta measurements on air particulate filters fluctuate significantly over the course of a year. The measurements from control station AP-21 vary similarly, indicating that these fluctuations are due to regional changes in naturally-occurring airborne radioactive materials, and not due to Vermont Yankee operations.

There was one naturally-occurring gamma-emitting radionuclides detected on the air particulate filters during this reporting period. Be-7, a naturally-occurring cosmogenic radionuclide, was detected on all 12 filter sets analyzed.

6.5.1.2 Charcoal Cartridges (CF)

Charcoal cartridges are no longer analyzed as part of the Environmental Monitoring Program.

6.5.2 Waterborne Pathways

6.5.2.1 River Water (WR)

Daily grab samples were collected from the Connecticut River downstream of the plant discharge area and hydro station, location WR-11. These samples were combined to create a representative composite sample. Monthly grab samples were also collected at the upstream control location, also on the Connecticut River, location WR-21. The composited samples at WR-11 were collected monthly and sent along with the WR-21 grab samples to the contracted environmental laboratory for analysis. Table 5.1 shows that gross-beta measurements were positive in two out of 11 indicator samples as would be expected due to naturally-occurring radionuclides in the water. Gross-beta was not detected in any of the 12 control samples. As seen in Figure 6.8, the mean concentration of the indicator locations was similar to the mean concentration at the control location in 2020.

For each sampling site, the monthly samples were analyzed for H-3 (Tritium) analyses. None of the samples contained detectable quantities of H-3.

6.5.2.2 Ground Water – Potable Drinking Water (WG)

Quarterly ground water (deep wells supplying drinking water to the plant and selected offsite locations) samples were collected from two indicator locations (only one is required by VYNPS ODCM) and one control location during 2020. In 1999, WG-14 (PSB Well) another on-site well location was added to the program. In July 2012, WG-15 (Southwest Well) was added to the ODCM as a quarterly sample location. Table 5.1 and Figure 6.9 show that gross-beta measurements were positive in seven of eight indicator samples and in three out of four control samples. The beta activity is due to naturally-occurring radionuclides in the water. The levels at all sampling locations were consistent with those detected in previous years. No other gamma-emitting radionuclides or tritium were detected in any of the samples.

6.5.2.3 Sediment (SE)

Semi-annual river sediment grab samples were collected from two indicator locations during 2020. The North Storm Drain Outfall location (SE-12) is an area where up to 40 different locations can be sampled within a 20 ft by 140 ft area. In 2020, 15 locations were sampled at SE-12 during each of the semi-annual collections. Two samples were collected at SE-11 during the year. As would be expected, naturally-occurring Potassium-40 (K-40) was detected in all of the samples. Cobalt-60 was not detected in any of the

samples. Radium-226 (Ra-226) was detected in 30 of 36 samples. Actinium-228 (Ac-228) was detected in 29 of 36 samples. Thorium-228 (Th-228) was detected in all of the samples analyzed. Thorium-232 (Th-232) was detected in 34 of the 36 samples analyzed. Uranium-238 (U-238) was not detected in any of the 36 samples. Cesium-137 (Cs-137) was detected in 13 out of the 36 samples. The levels of Cs-137 measured were consistent with what has been measured in the previous several years and with those detected at other New England locations. Also see section 6.5.2.6 for more information.

6.5.2.4 Test Wells (WT)

During 1996, sampling was initiated at test wells around the outer edges of an area in the south portion of the VYNPS site where septic sludge is spread. This sampling continued through 2020. The test wells are summarized in Table 5.1 under the media category, Test Well (WT). In 2020, four samples were sampled quarterly at each of the four locations and all were analyzed for gamma isotopic, gross beta and H-3 activity.

Prior to the gross beta analysis, each sample was filtered through a 0.45 micron Gelman Tuffryn membrane filter. Gross beta activity was detected in all 16 samples collected with levels ranging from 3.12 to 10.7 pCi/Liter. No gamma-emitting radionuclides were detected□

6.5.2.5 Storm Drain System

The presence of plant-generated radionuclides in the onsite storm drain system has been identified in previous years at Vermont Yankee (VY). As a consequence, a 50.59 evaluation of radioactive materials discharged via the storm drain system was performed in 1998. This assessment was in response to Information and Enforcement Bulletin No. 80-10 and NRC Information Notice No. 91-40. The evaluation demonstrated that the total curies released via the VYNPS storm drain system are not sufficient to result in a significant dose (i.e. dose does not exceed 10% of the technical specification objective of 0.3 millirem per year to the total body, and 1.0 millirem per year to the target organ for the maximally exposed receptor). Water in the onsite storm drain system was routinely sampled throughout 2020 at the south storm drain. These samples are analyzed for tritium; no tritium was detected in any sample. Tritium was used as a marker and samples that had detectable levels of tritium would be analyzed for gamma emitters after tritium detection. Although not required by the VYNPS ODCM, as of March 2020 the storm drain sample was analyzed for gamma emitting radionuclides once per month.

6.5.2.6 Air Compressor Condensate and Manhole Sampling Results

The presence of tritium in station air compressor condensate and manholes (Storm Drain System) has been identified since 1995 (ER_95-0704). An evaluation has been performed (S.R.1592) which states "...leakage of tritium found in the storm drains (manholes) to ground water beneath the site will be

transported by natural ground water gradient to the Connecticut River. However, at the current measured concentrations and postulated leak rate from the storm drains, the offsite dose impact is not significant ($<2.4\text{E-}5$ mrem/year)." Data provided in Table 6.1 will be filed under the requirements of 10CFR50.75(g) and is presented here in response to ER_95-0704_04 commitments. Because of revisions in the security arrangements at the plant site, there was no water available for collection in Manholes 11H, 13 and 8 during 2020. Collection from the Air Compressor drains has been discontinued due to there being no source of tritium to the compressor air intakes and the drain were redirected.

Table 6.1 Summary of Air Compressor Condensate and Manhole Water Tritium Concentrations*

Sample Location	No. Detected**	Mean*** (microcuries/ml)	Range (microcuries/ml)
Air Compressor Condensate	0/3	Discontinued	Discontinued
Manhole 11H	0/0	No Sample Available	No Sample Available
Manhole 13	0/0	No Sample Available	No Sample Available
Manhole 8	0/0	No Sample Available	No Sample Available

* Reported per ER_950704_04.

** The fraction of sample analyses yielding detectable measurements

*** Calculated from positive results

6.5.2.7 Groundwater Monitoring Wells Samples Results (WS)

Leakage from primary system piping between the Augmented Off Gas (AOG) Building and the Turbine Building was identified early in 2010. A large pool of subsurface water became contaminated with Tritium as a result of this leak. A large number of new groundwater sample wells were installed and a significant effort was mounted to find the leak and fix it. Presently, mitigation efforts have resulted in the extraction of more than 300,000 gallons of tritiated water from this subsurface pool. Dose calculations have been performed assuming that this underground plume of contaminated water is moving towards and into the Connecticut River. The dose impacts and other details of this event are provided in the year 2020 Annual Radioactive Effluent Release Report.

6.5.3 Ingestion Pathways

6.5.3.1 Milk (TM)

As a result of re-evaluation of source terms (and subsequent revision of the Vermont Yankee Offsite Dose Calculation Manual) which identified that radioiodine releases were no longer of measurable significance in plant releases, no milk samples were collected or analyzed during 2020.

6.5.3.2 Silage (TC)

A silage sample was collected from each of the three Land Use Census-identified farm locations during each quarter of 2020. Each of these was analyzed for gamma-emitting radionuclide. As expected with all biological media, naturally-occurring Be-7 was detected in two of 12 samples and K-40 was detected in all samples. Thorium-228 was detected one sample and Cs-137 was detected in four of the 12 samples analyzed.

6.5.3.3 Mixed Grass (TG)

Mixed grass samples were collected at each of the air sampling stations during two of the four quarters of 2020. As expected with all biological media, naturally-occurring Be-7 was detected in eight of the nine samples collected. Naturally-occurring K-40 was detected in all nine samples.

6.5.3.4 Fish (FH)

Semiannual samples of fish were collected from two locations in both spring and fall of 2020 for the VY REMP. Several species may be collected such as Walleye, Small Mouth Bass, Large Mouth Bass, Yellow Perch, White Perch, and Rock Bass. The edible portions of each of these were analyzed for gamma-emitting radionuclides. In addition to the analysis of edible portions, the inedible portions were also analyzed. As expected in biological matter, naturally-occurring K-40 was detected in all eight samples (4 edible and 4 inedible). These fish portions were also analyzed for H-3, Am-241, Cm-242, Cm-243/244, Fe-55, Ni-63, Pu-238, Pu-239/240, Pu-241, Pu-242, Sr-89 and Sr-90.

Strontium 90 was detected in three of the four inedible portions (bones, guts and skin are included in the 'inedible' portion). This is the tenth year in the VY REMP program that fish has been analyzed for Hard-to-Detects such as Strontium-90. The results were compared to studies done in the Hudson River by New York State officials and it was concluded that the Strontium-90 detected is a result of weapons-testing era fallout to the environment and not from nuclear power plant releases.

As shown in Table 5.1, Cs-137 was not detected in this year's samples. It should be noted that the majority of the Cs-137 concentrations plotted in Figure 6.12 are considered "not detectable." All values were plotted regardless of whether they were considered statistically significant or not. The Cs-137 levels plotted for 2014 and previous years are typical of concentrations attributable to global nuclear weapons testing fallout.

6.5.4 Direct Radiation Pathway

Direct radiation was continuously measured at 10 locations surrounding the Vermont Yankee plant with the use of thermoluminescent dosimeters (TLDs).

The TLDs are collected every calendar quarter for readout at the environmental TLD laboratory. The complete summary of data may be found in Table 5.3.

From Tables 5.2 and 5.3 and Figure 6.13, it can be seen that the Inner and Outer Ring TLD mean exposure rates were not significantly different in 2020. This indicates no significant overall increase in direct radiation exposure rates in the plant vicinity. It can also be seen from these tables that the Control TLD mean exposure rate was not significantly different than that at the Inner and Outer Rings. Figure 6.13 also shows an annual cycle at both indicator and control locations. The lowest point of the cycle occurs usually during the winter months. This is due primarily to the attenuating effect of the snow cover on radon emissions and on direct irradiation by naturally-occurring radionuclides in the soil. Differing amounts of these naturally-occurring radionuclides in the underlying soil, rock or nearby building materials result in different radiation levels between one field site and another.

Upon examining Figure 6.17, as well as Table 5.2, it is evident that in recent years, station DR-45 had a higher average exposure rate than any other station. This location is on-site, and the higher exposure rates are due to plant operations and activities in the immediate vicinity of this TLD. There is no significant dose potential to the surrounding population or any real individual from these sources since they are located on the back side of the plant site, between the facility and the river. The same can be said for station DR-46, which has shown higher exposure rates in previous years.

Table 6.2 Trend Graph Summary Table

Figure	Title
6.1	Gross Beta Measurements on Air Particulate Filters - Quarterly Average Concentrations
6.2	Gross Beta Measurements on Air Particulate Filters (11)
6.3	Gross Beta Measurements on Air Particulate Filters (12)
6.4	Deleted
6.5	Deleted
6.6	Deleted
6.7	Deleted
6.8	Gross Beta Measurements on River Water Semi-Annual Average Concentrations
6.9	Gross Beta Measurements on Ground Water Semi-Annual Average Concentrations
6.10	Deleted
6.11	Deleted
6.12	Cesium-137 in Fish - Annual Average Concentrations
6.13	Average Exposure Rate at Inner Ring, Outer Ring, and Control TLDS

Figure	Title
6.14	Exposure Rate at Indicator TLDs, DR1-3
6.15	Exposure Rate at Indicator TLDs, DR-6 & DR-50
6.16	Exposure Rate at Site Boundary TLDs DR-7, DR-8 and DR-53A
6.17	Exposure Rate at Site Boundary TLDs DR-43 thru DR-46
6.18	Deleted
6.19	Deleted
6.20	Deleted
6.21	Deleted
6.22	Deleted
6.23	Deleted
6.24	Deleted
6.25	Deleted
6.26	Deleted
6.27	Exposure Rate at Control TLDs DR-4 & 5

Note: No year 2020 data was obtained from locations previously provided in “Deleted” graphs due to ODCM changes implemented in January 2017 as a result of source term changes in the plant. These graphs may be viewed in the year 2016 Annual Radiological Environmental Operating Report (AREOR) for comparison purposes.

Figure 6.1 - Gross Beta Measurements on Air Particulate Filters - Quarterly Average Concentrations

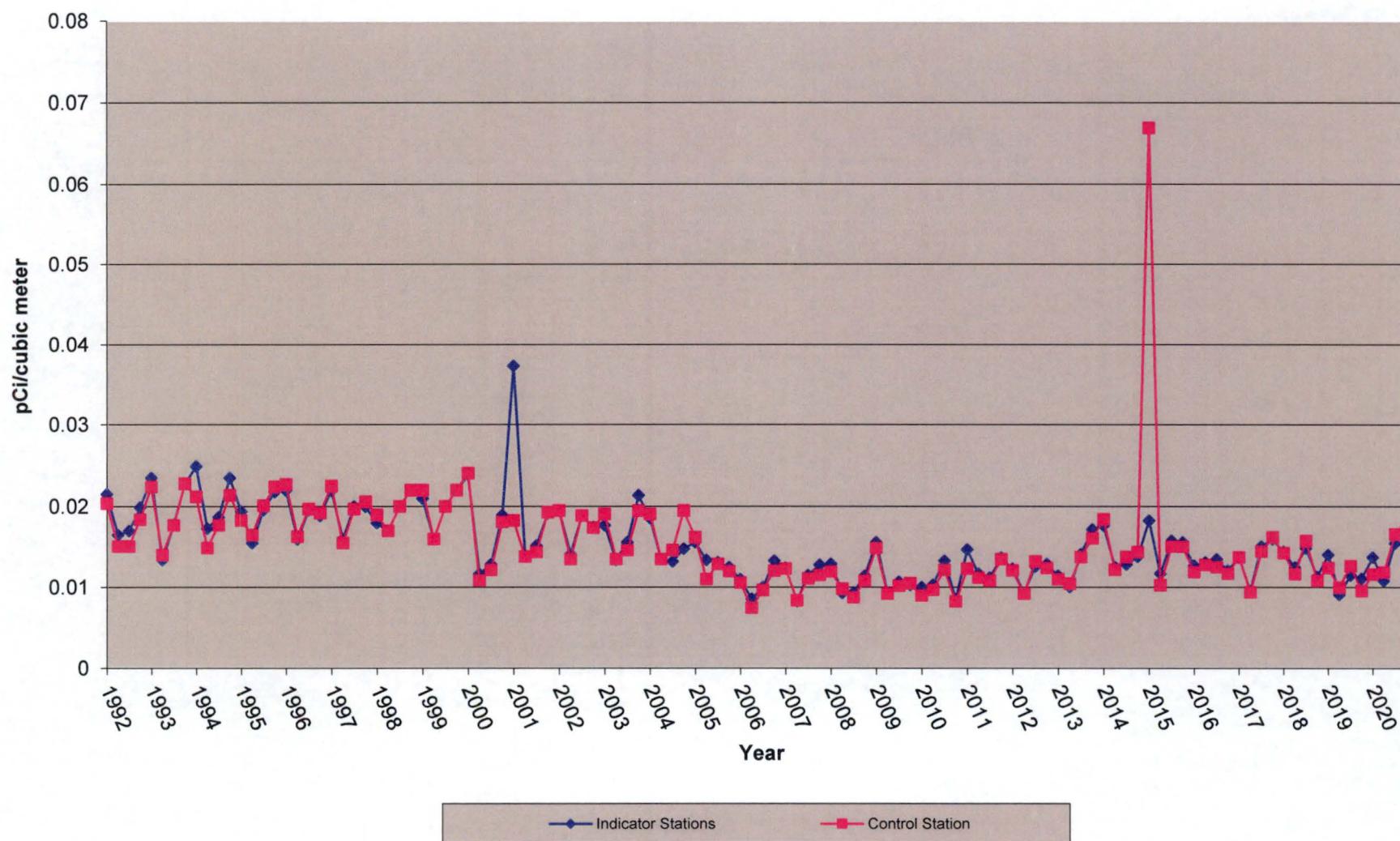


Figure 6.2 - Gross Beta Measurements on Air Particulate Filters

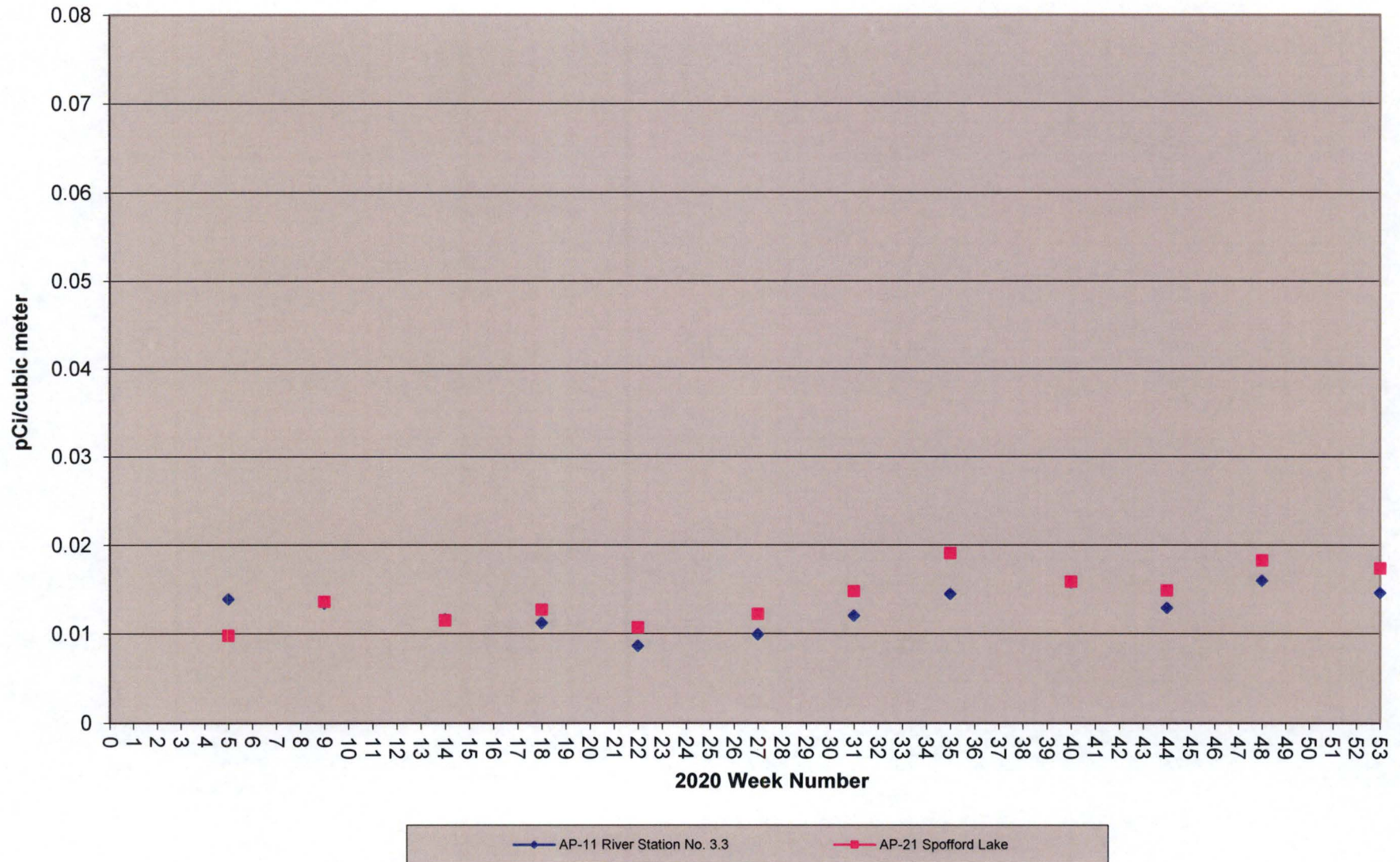
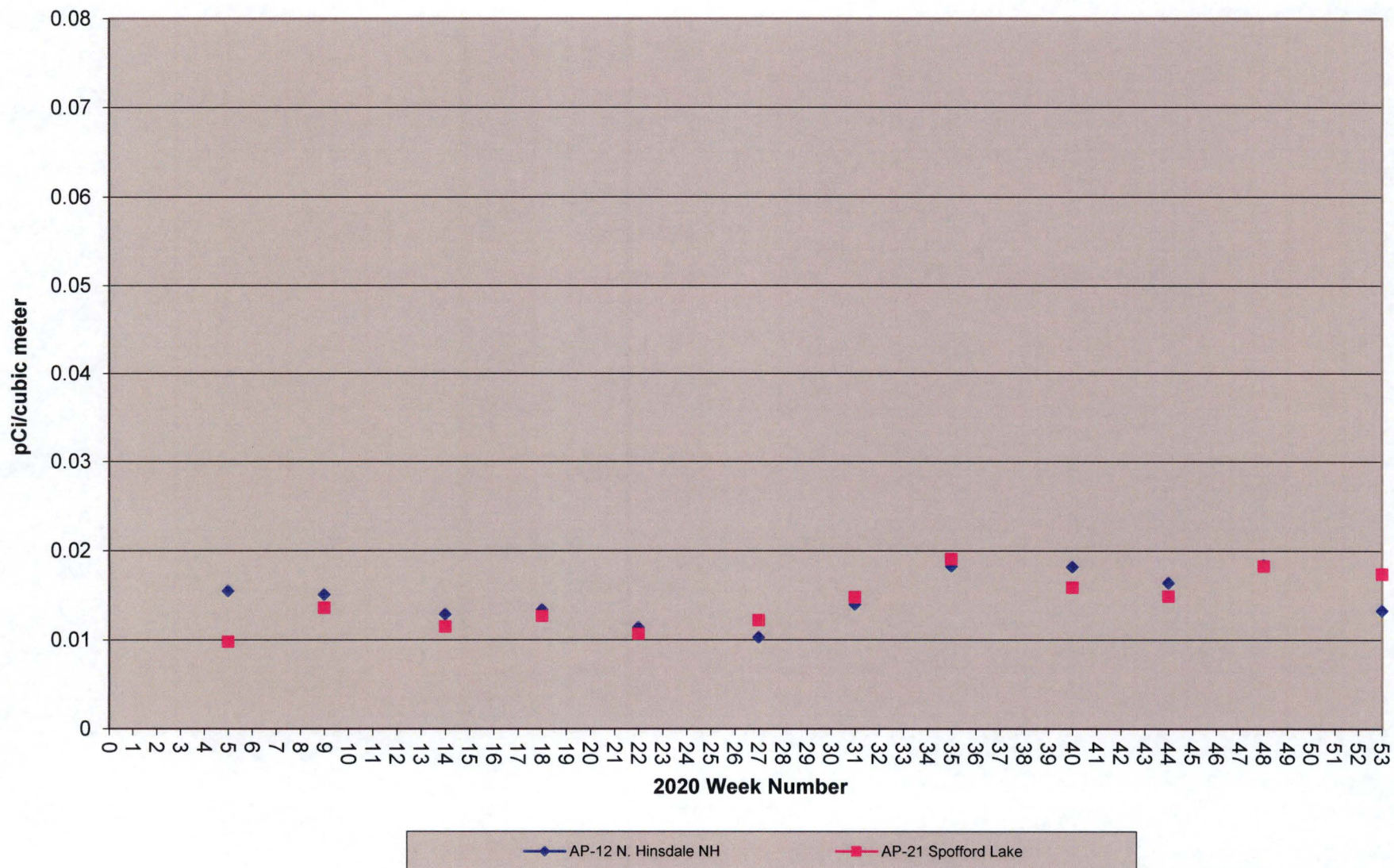


Figure 6.3 - Gross Beta Measurements on Air Particulate Filters



**Figure 6.8 - Gross Beta Measurements on
River Water Semi-Annual Average Concentration**

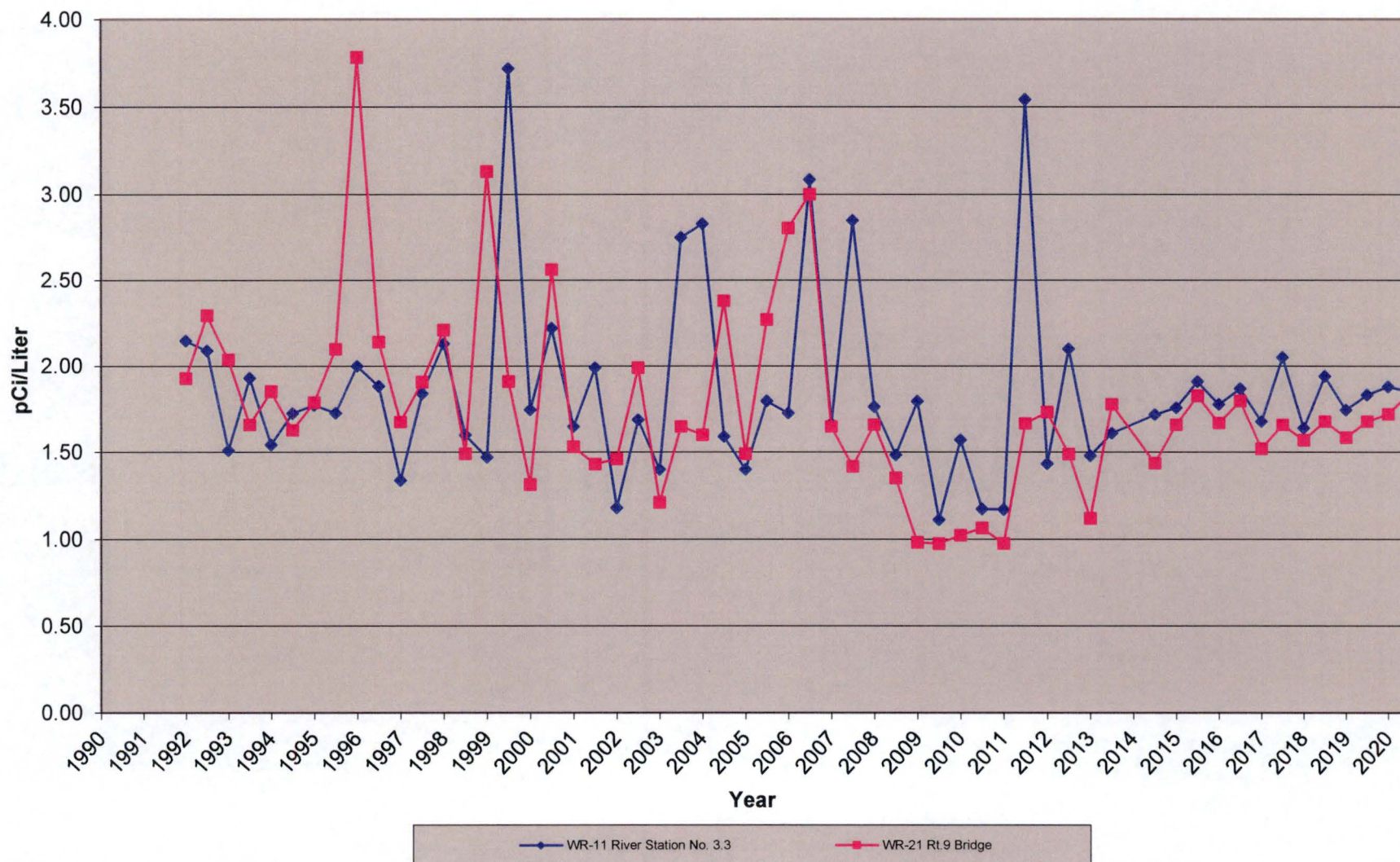


Figure 6.9 - Gross Beta Measurements on Ground Water Semi-Annual Average Concentrations

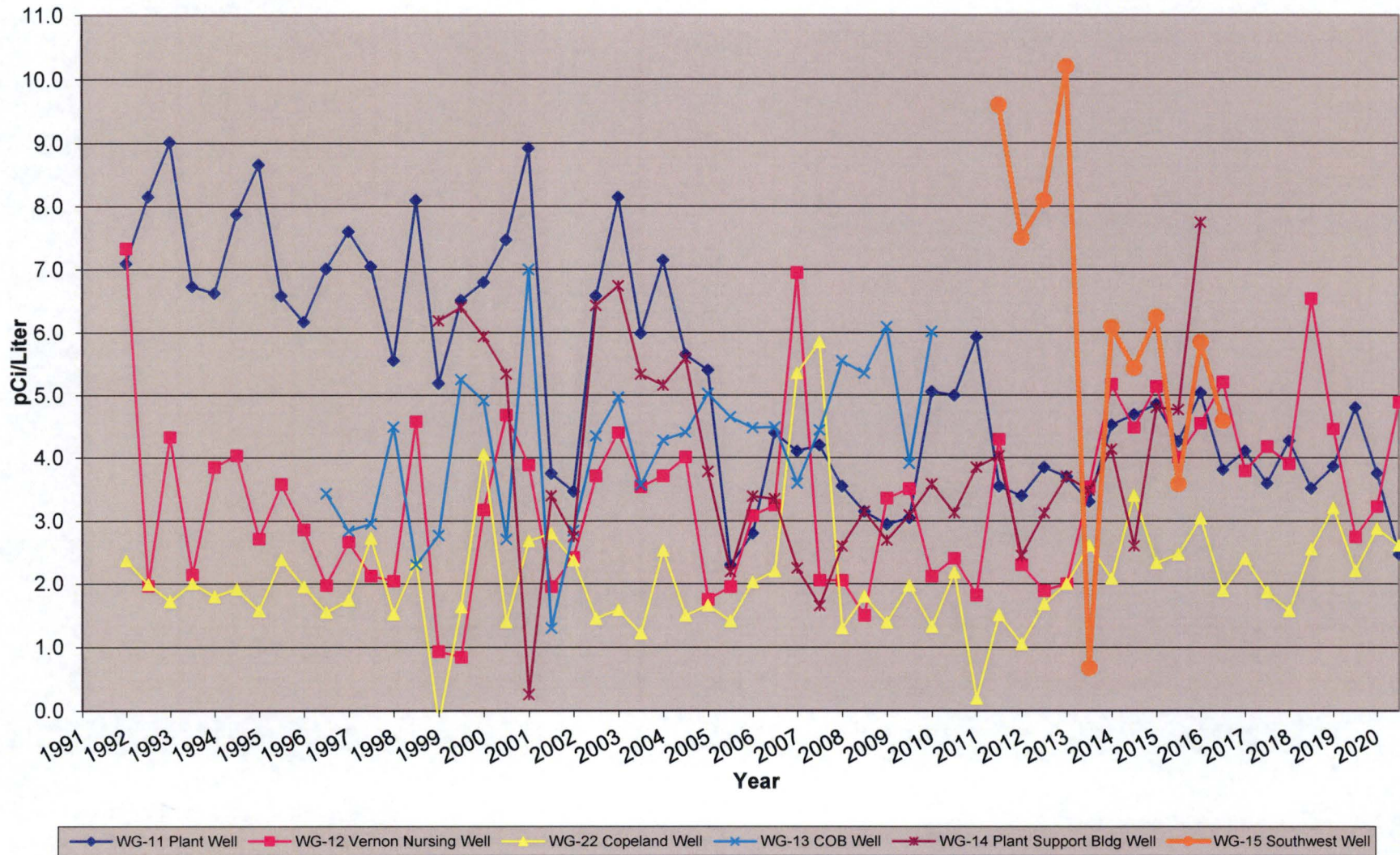


Figure 6.12 - Cesium 137 in Fish - Annual Average Concentrations

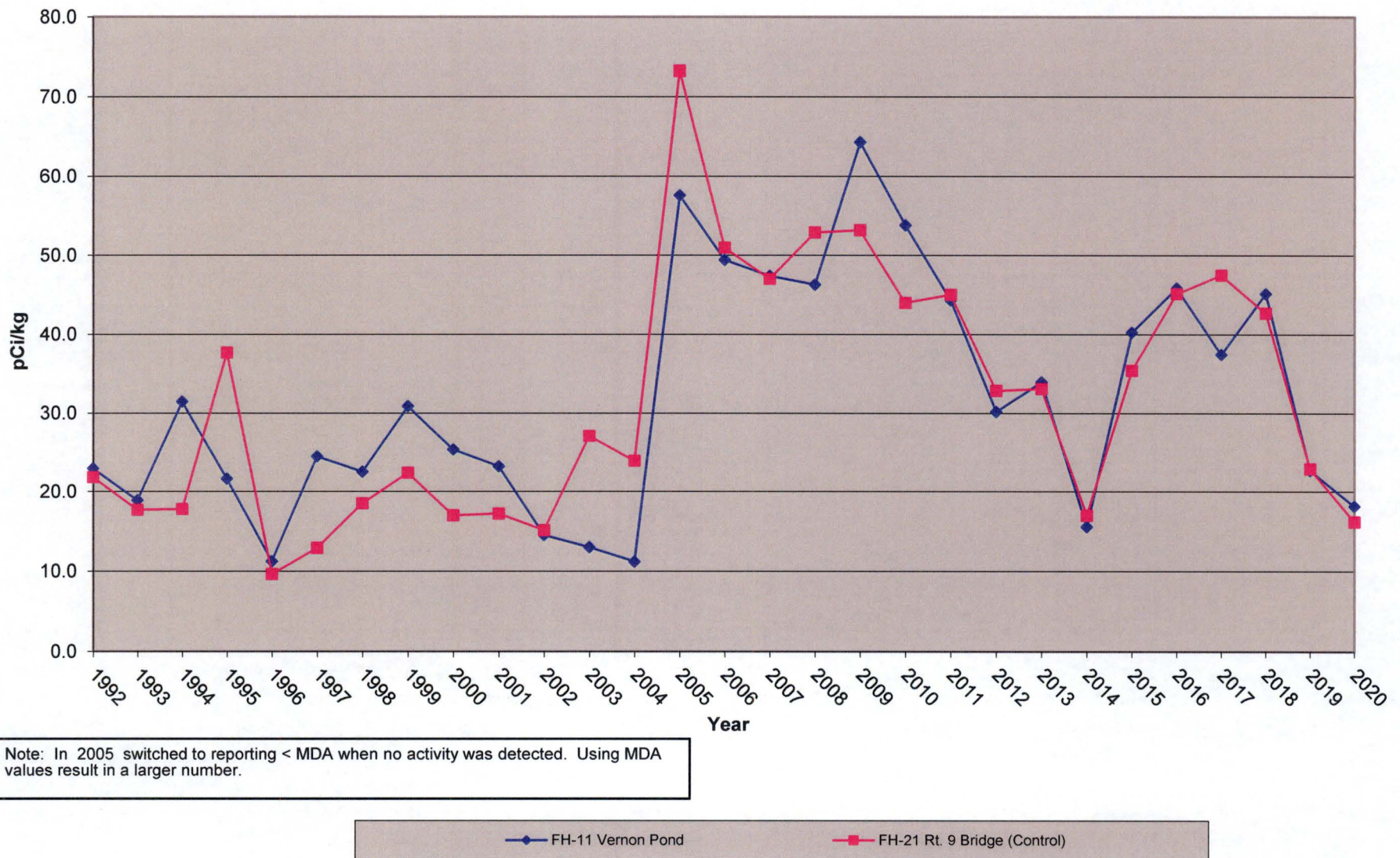


Figure 6.13 - Average Exposure Rate at Inner Ring, Outer Ring and Control TLDs

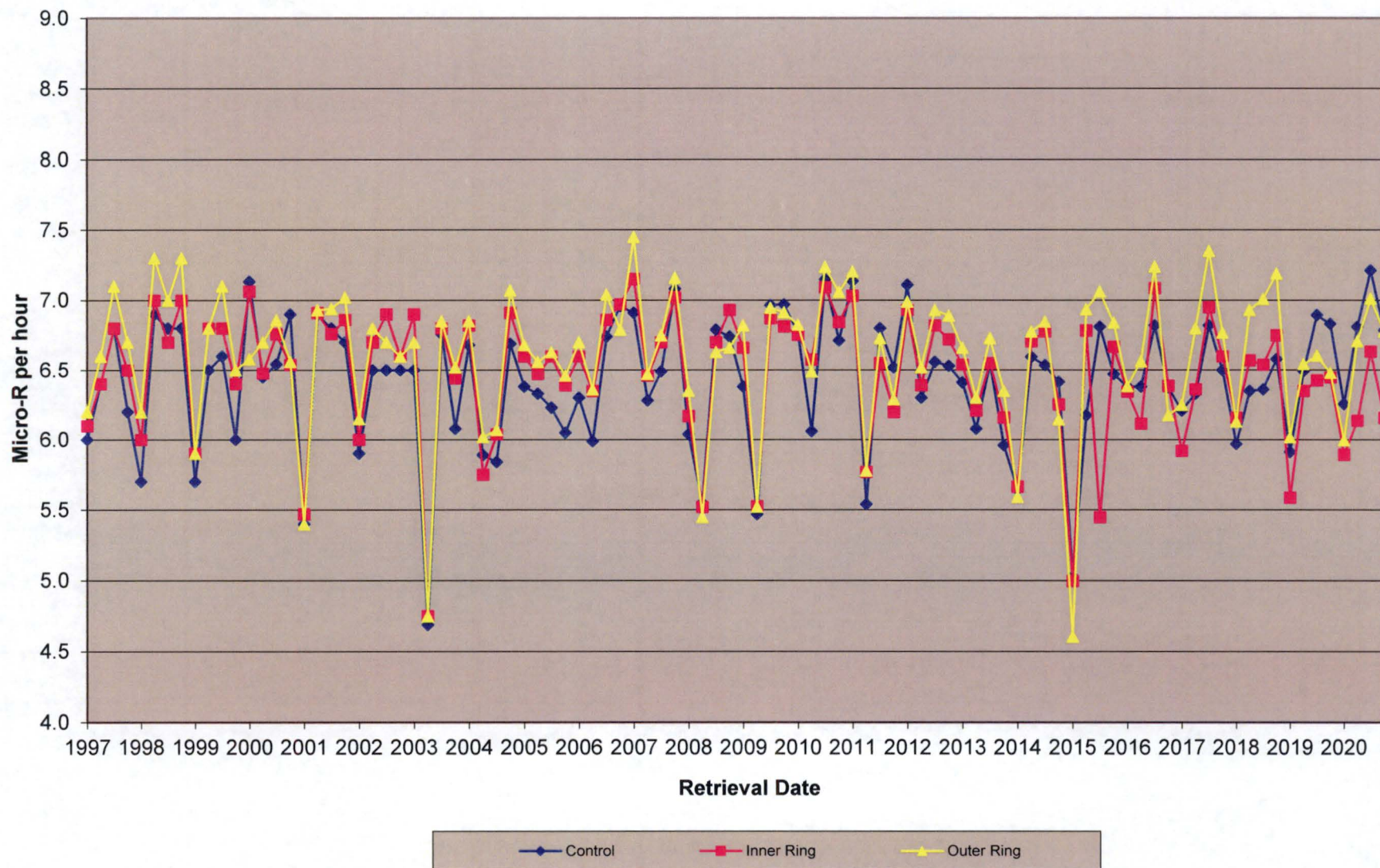


Figure 6.14 - Exposure Rate at Indicator TLDs, DR1-3

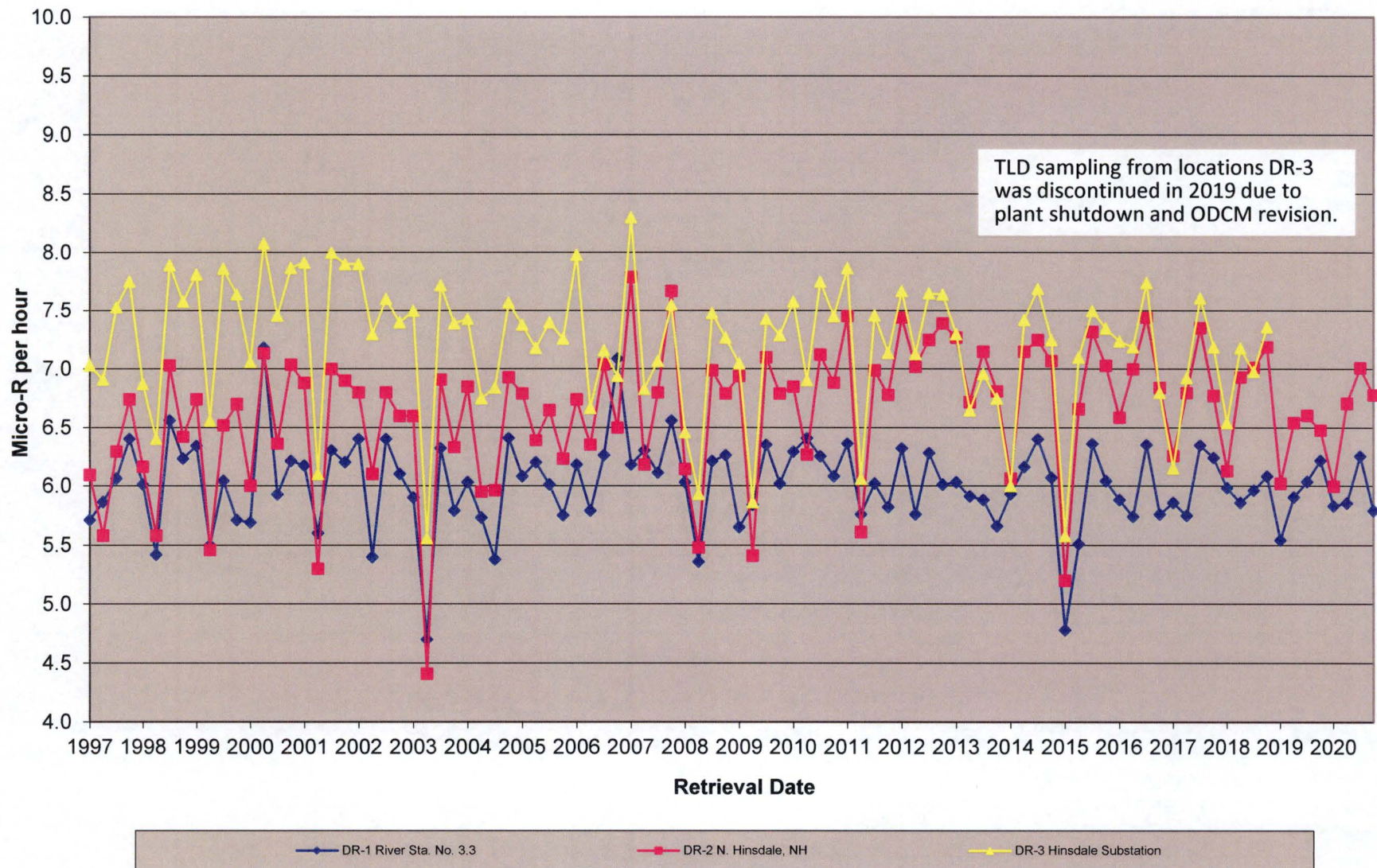


Figure 6.15 - Exposure Rate at Indicator TLDs, DR-6 & DR-50

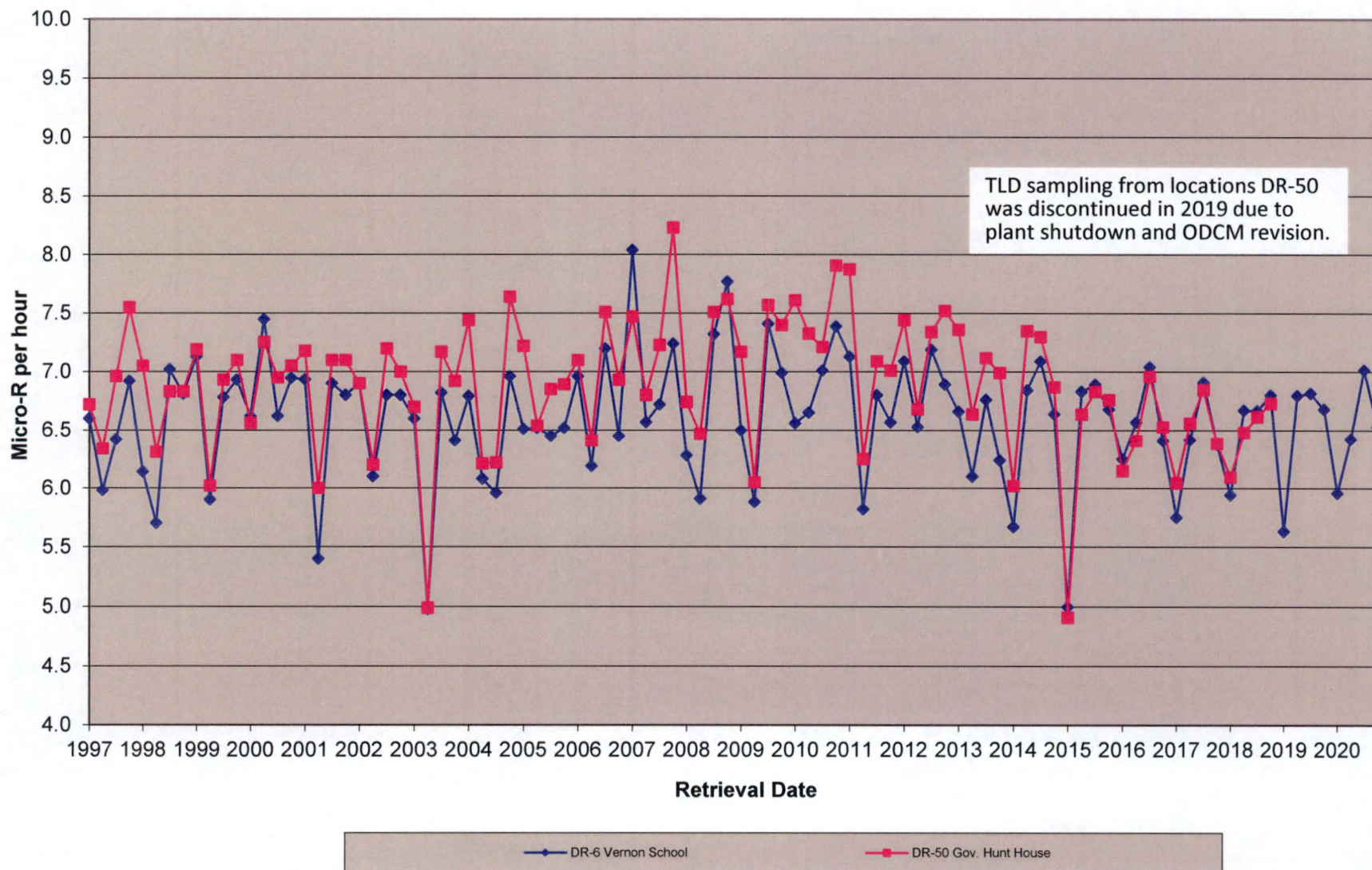


Figure 6.16 - Exposure Rate at Site Boundary TLDs DR-7, DR-8 and DR-53A

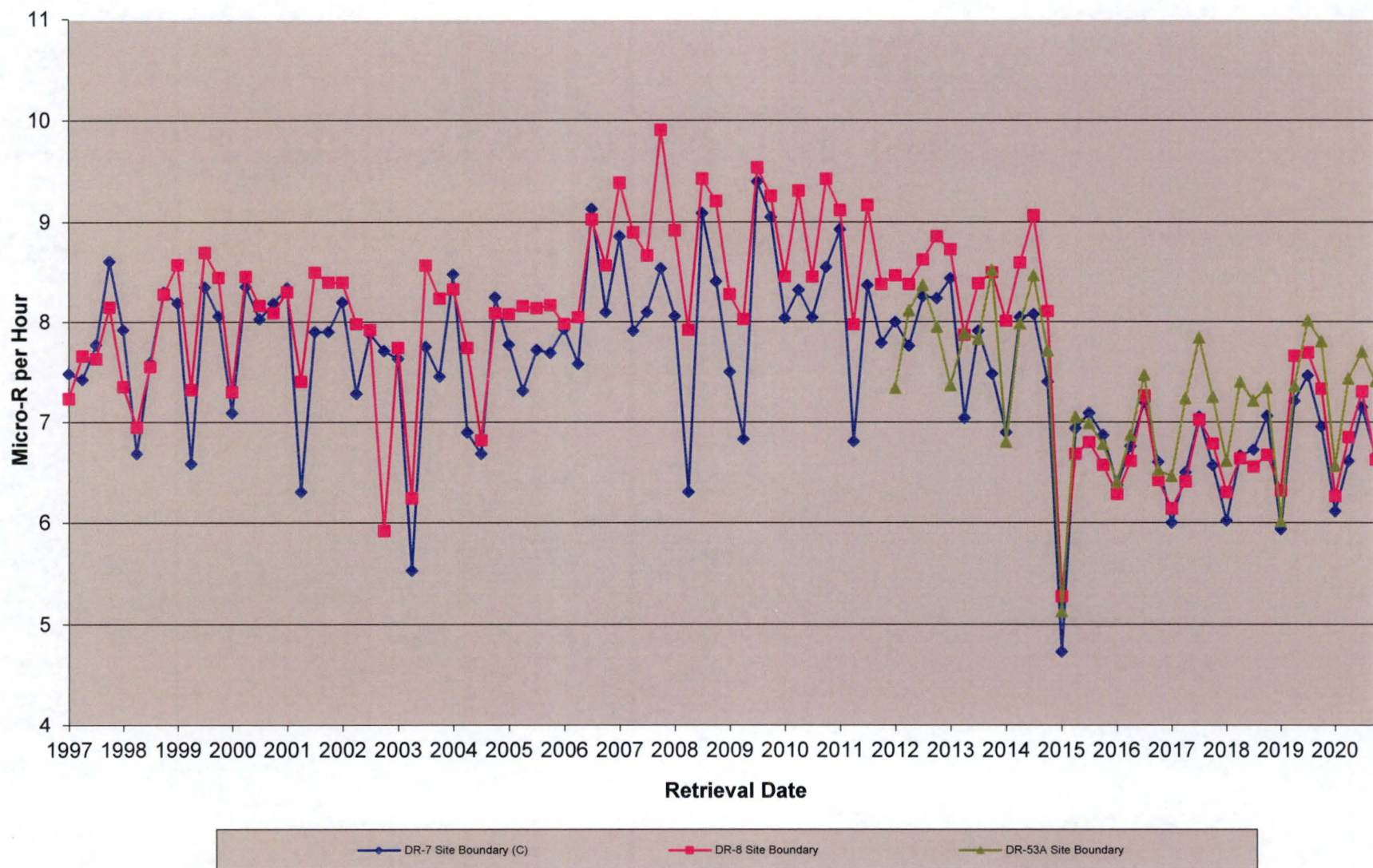


Figure 6.17 - Exposure Rate at Site Boundary TLDs - DR-43 thru 46

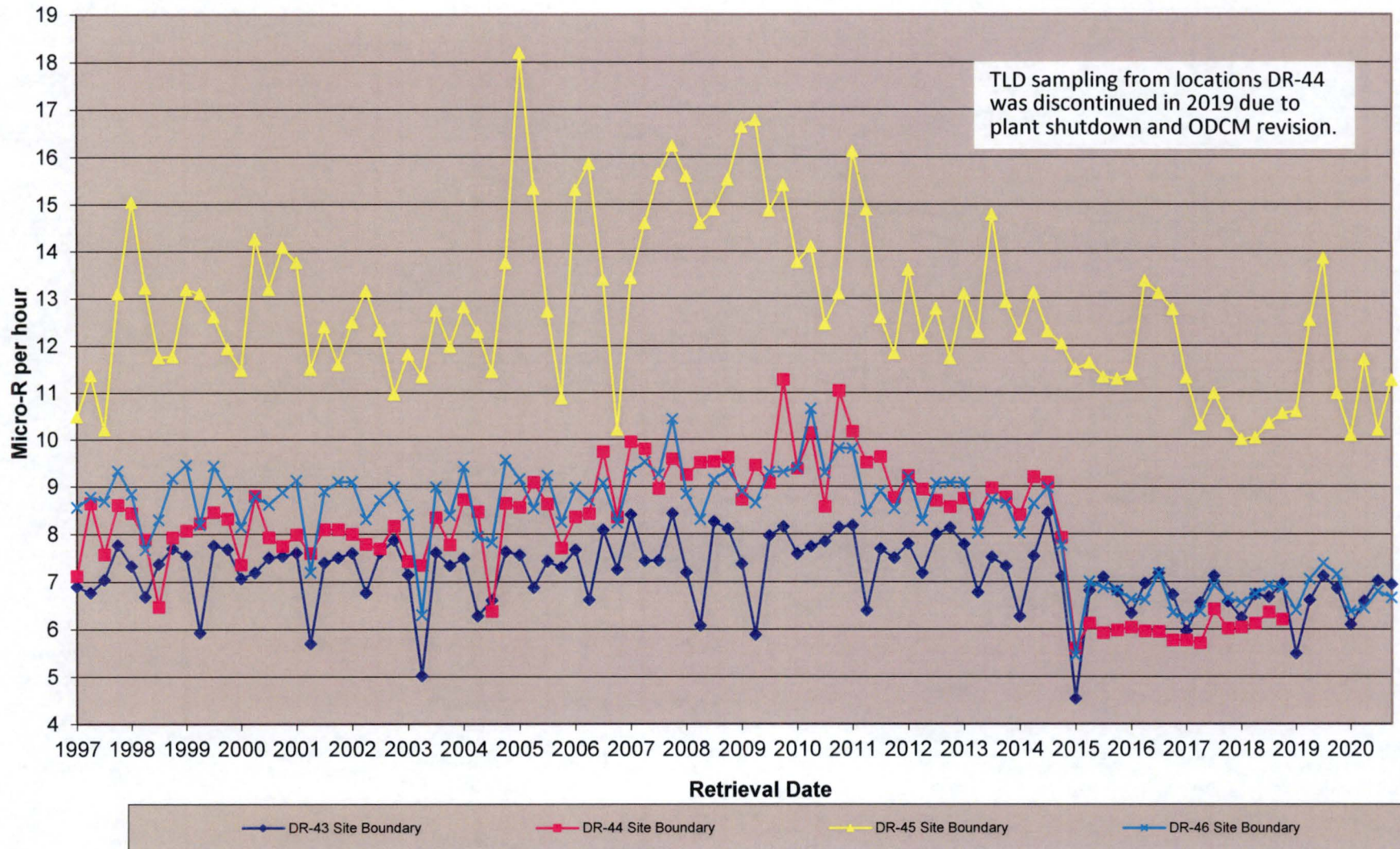
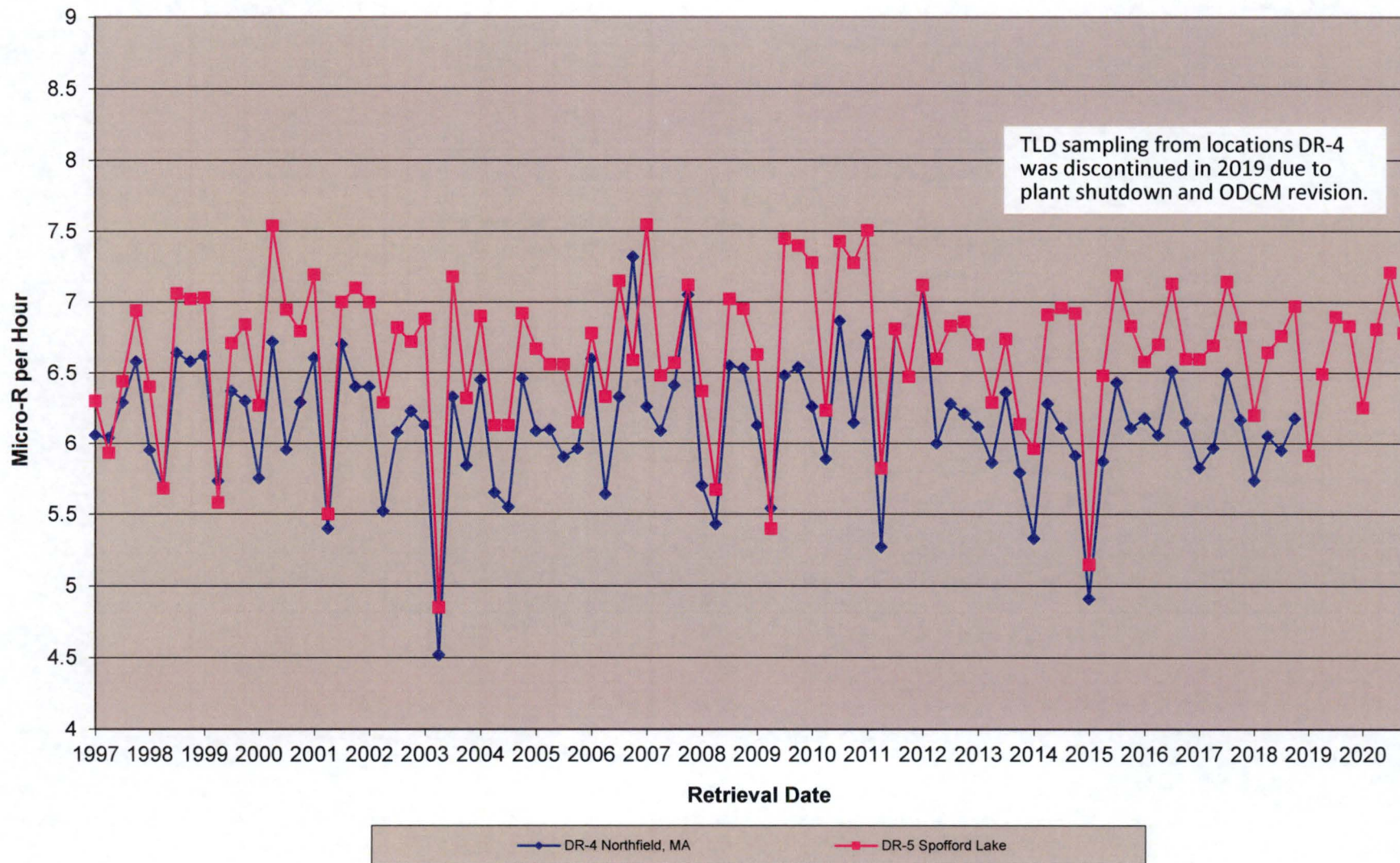


Figure 6.27 - Exposure Rate at Control TLDs DR-4 & 5



7. Quality Assurance Program

7.1 Environmental Dosimetry Company Laboratory

ENVIRONMENTAL DOSIMETRY COMPANY

ANNUAL QUALITY ASSURANCE STATUS REPORT

January - December 2020

Prepared By:

Jim Smith

Date:

3/22/21

Approved By:

Natasha Taylor

Date:

3/22/21

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EXECUTIVE SUMMARY

Routine quality control (QC) testing was performed for dosimeters issued by the Environmental Dosimetry Company (EDC) .

During this annual period 100% (72/72) of the individual dosimeters, evaluated against the EDC internal performance acceptance criteria (high-energy photons only), met the criterion for accuracy and 100% (72/72) met the criterion for precision (Table 1). In addition, 100% (12/12) of the dosimeter sets evaluated against the internal tolerance limits met EDC acceptance criteria (Table 2) and 100% (6/6) of independent testing passed the performance criteria (Table 3). Trending graphs, which evaluate performance statistic for high-energy photon irradiations and co-located stations are given in Appendix A.

One internal assessment and one external audit were performed in 2020. There was one deficiency issued in the external audit.

15 INTRODUCTION

The TLD systems at the Environmental Dosimetry Company (EDC) are calibrated and operated to ensure consistent and accurate evaluation of TLDs. The quality of the dosimetric results reported to EDC clients is ensured by in-house performance testing and independent performance testing by EDC clients, and both internal and client directed program assessments.

The purpose of the dosimetry quality assurance program is to provide performance documentation of the routine processing of EDC dosimeters. Performance testing provides a statistical measure of the bias and precision of dosimetry processing against a reliable standard, which in turn points out any trends or performance changes. Two programs are used:

A. QC Program

Dosimetry quality control tests are performed on EDC Panasonic 814 Environmental dosimeters. These tests include: (1) the in-house testing program coordinated by the EDC QA Officer and (2) independent test perform by EDC clients. In-house test are performed using six pairs of 814 dosimeters, a pair is reported as an individual result and six pairs are reported as the mean result. Results of these tests are described in this report.

Excluded from this report are instrumentation checks. Although instrumentation checks represent an important aspect of the quality assurance program, they are not included as process checks in this report. Instrumentation checks represent between 5-10% of the TLDs processed.

B. QA Program

An internal assessment of dosimetry activities is conducted annually by the Quality Assurance Officer (Reference 1). The purpose of the assessment is to review procedures, results, materials or components to identify opportunities to improve or enhance processes and/or services.

II. PERFORMANCE EVALUATION CRITERIA

A. Acceptance Criteria for Internal Evaluations

1. Bias

For each dosimeter tested, the measure of bias is the percent deviation of the reported result relative to the delivered exposure. The percent deviation relative to the delivered exposure is calculated as follows:

$$\frac{(H'_i - H_i)}{H_i} 100$$

where:

H'_i = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the exposure delivered to the i^{th} irradiated dosimeter (i.e., the delivered exposure)

2. Mean Bias

For each group of test dosimeters, the mean bias is the average percent deviation of the reported result relative to the delivered exposure. The mean percent deviation relative to the delivered exposure is calculated as follows:

$$\sum \left(\frac{(H'_i - H_i)}{H_i} \right) 100 \left(\frac{1}{n} \right)$$

where:

H'_i = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the exposure delivered to the i^{th} irradiated test dosimeter (i.e., the delivered exposure)

n = the number of dosimeters in the test group

3. Precision

For a group of test dosimeters irradiated to a given exposure, the measure of precision is the percent deviation of individual results relative to the mean reported exposure. At least two values are required for the determination of precision. The measure of precision for the i^{th} dosimeter is:

$$\left(\frac{(H'_i - \bar{H})}{\bar{H}} \right) 100$$

where:

H'_i = the reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

\bar{H} = the mean reported exposure; i.e., $\bar{H} = \sum H'_i \left(\frac{1}{n} \right)$

n = the number of dosimeters in the test group

4. EDC Internal Tolerance Limits

All evaluation criteria are taken from the "EDC Quality System Manual," (Reference 2). These criteria are only applied to individual test dosimeters irradiated with high-energy photons (Cs-137) and are as follows for Panasonic Environmental dosimeters: $\pm 15\%$ for bias and $\pm 12.8\%$ for precision.

B. QC Investigation Criteria and Result Reporting

EDC Quality System Manual (Reference 2) specifies when an investigation is required due to a QC analysis that has failed the EDC bias criteria. The criteria are as follows:

1. No investigation is necessary when an individual QC result falls outside the QC performance criteria for accuracy.
2. Investigations are initiated when the mean of a QC processing batch is outside the performance criterion for bias.

C. Reporting of Environmental Dosimetry Results to EDC Customers

1. All results are to be reported in a timely fashion.
2. If the QA Officer determines that an investigation is required for a process, the results shall be issued as normal. If the QC results prompting the investigation have a mean bias from the known of greater than $\pm 20\%$, the results shall be issued with a note indicating that they may be updated in the future, pending resolution of a QA issue.
3. Environmental dosimetry results do not require updating if the investigation has shown that the mean bias between the original results and the corrected results, based on applicable correction factors from the investigation, does not exceed $\pm 20\%$.

III. DATA SUMMARY FOR ISSUANCE PERIOD JANUARY-DECEMBER 2020

A. General Discussion

Results of performance tests conducted are summarized and discussed in the following sections. Summaries of the performance tests for the reporting period are given in Tables 1 through 3 and Figures 1 through 4.

Table 1 provides a summary of individual dosimeter results evaluated against the EDC internal acceptance criteria for high-energy photons only. During this period 100% (72/72) of the individual dosimeters, evaluated against these criteria, met the tolerance limits for accuracy and 100% (72/72) met the criterion for precision. A graphical interpretation is provided in Figures 1 and 2.

Table 2 provides the bias and standard deviation results for each group (N=6) of dosimeters evaluated against the internal tolerance criteria. Overall, 100% (12/12) of the dosimeter sets, evaluated against the internal tolerance performance criteria, met these criteria. A graphical interpretation is provided in Figure 3.

Table 3 presents the independent blind spike results for dosimeters processed during this annual period. All results passed the performance acceptance criterion. Figure 4 is a graphical interpretation of Seabrook Station blind co-located station results.

B. Result Trending

One of the main benefits of performing quality control tests on a routine basis is to identify trends or performance changes. The results of the Panasonic environmental dosimeter performance tests are presented in Appendix A. The results are evaluated against each of the performance criteria listed in Section II, namely: individual dosimeter accuracy, individual dosimeter precision, and mean bias.

All of the results presented in Appendix A are plotted sequentially by processing date.

IV. STATUS OF EDC CONDITION REPORTS (CR)

During this annual period, one EDC Condition Report was issued. CR 1-2020 was issued to document the deficiency from the DTE Energy Audit 20-003.

V. STATUS OF AUDITS/ASSESSMENTS

1. Internal

EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2020. There were no findings identified.

2. External

DTE Energy Audit 20-003 was conducted on July 28-30, 2020. There was one deficiency identified.

VI. PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2020

Manual 1 was revised on September 28, 2020.

Several procedures were reissued with no changes as part of the 5 year review cycle.

VII. CONCLUSION AND RECOMMENDATIONS

The quality control evaluations continue to indicate the dosimetry processing programs at the EDC satisfy the criteria specified in the Quality System Manual. The EDC demonstrated the ability to meet all applicable acceptance criteria.

VIII. REFERENCES

1. EDC Quality Control and Audit Assessment Schedule, 2020.
2. EDC Manual 1, Quality System Manual, Rev. 4, September 28, 2020.

TABLE 1

**PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA
JANUARY – DECEMBER 2020^{(1), (2)}**

Dosimeter Type	Number Tested	% Passed Bias Criteria	% Passed Precision Criteria
Panasonic Environmental	72	100	100

⁽¹⁾This table summarizes results of tests conducted by EDC.

⁽²⁾Environmental dosimeter results are free in air.

TABLE 2

**MEAN DOSIMETER ANALYSES (N=6)
JANUARY – DECEMBER 2020^{(1), (2)}**

Process Date	Exposure Level	Mean Bias %	Standard Deviation %	Tolerance Limit +/- 15%
4/28/2020	37	1.8	1.2	Pass
5/02/2020	94	2.9	1.4	Pass
5/20/2020	56	-0.5	1.4	Pass
7/28/2020	72	4.1	0.6	Pass
8/07/2020	111	4.0	1.3	Pass
9/24/2020	25	-4.6	1.2	Pass
10/24/2020	35	5.2	1.6	Pass
10/28/2020	60	1.6	0.7	Pass
11/18/2020	91	0.5	1.6	Pass
01/21/2021	31	3.8	1.7	Pass
02/09/2021	83	0.3	0.8	Pass
02/16/2021	46	5.3	1.5	Pass

⁽¹⁾This table summarizes results of tests conducted by EDC for TLDs issued in 2020.

⁽²⁾Environmental dosimeter results are free in air.

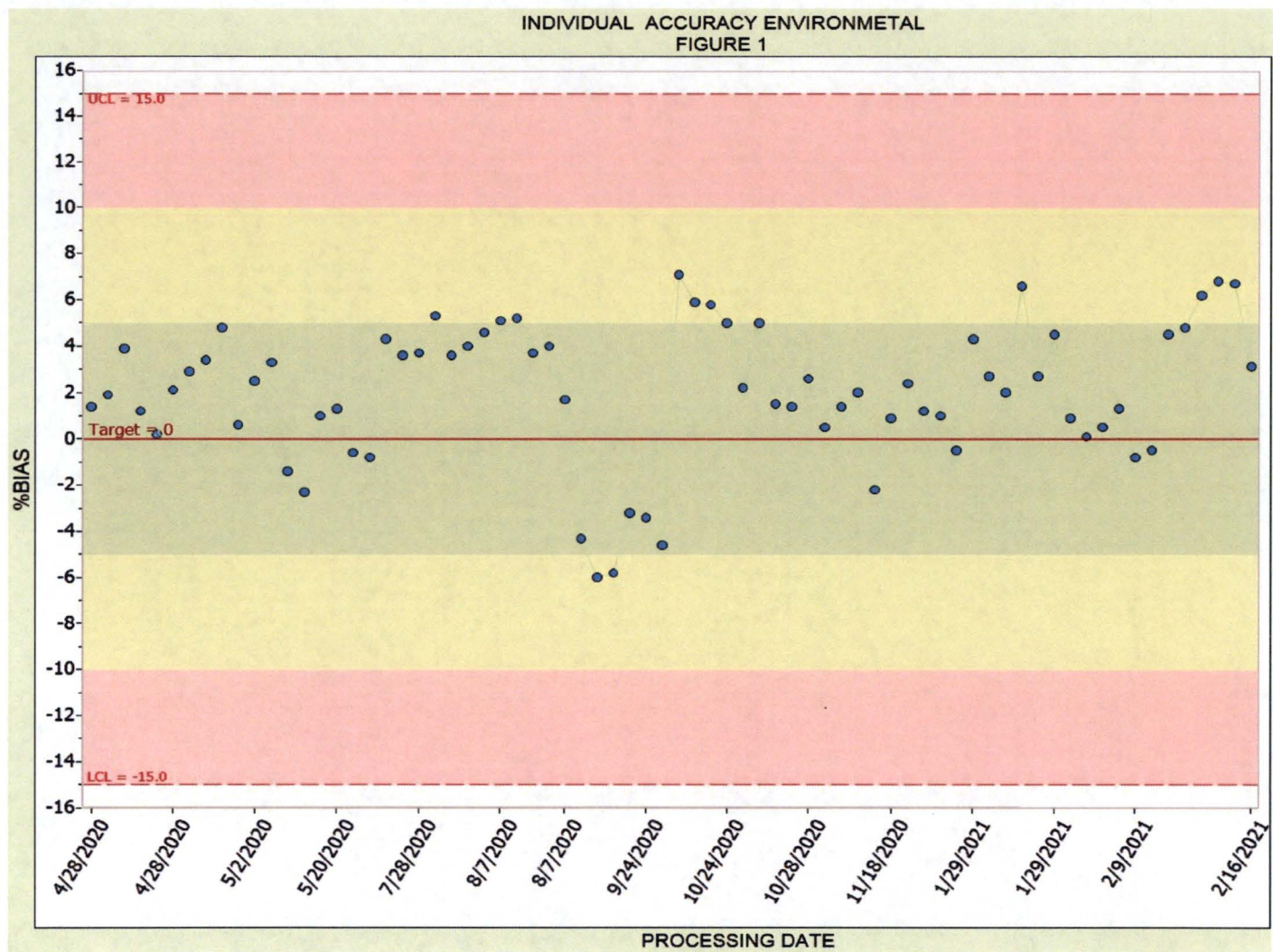
**TABLE 3
SUMMARY OF INDEPENDENT DOSIMETER TESTING
JANUARY – DECEMBER 2020^{(1), (2)}**

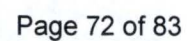
Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1 st Qtr. 2020	Millstone	-3.8	3.0	Pass
2 nd Qtr. 2020	Seabrook	0.5	1.4	Pass
2 nd Qtr. 2020	Millstone	-3.0	1.6	Pass
3 rd Qtr. 2020	Millstone	0.4	2.6	Pass
4 th Qtr. 2020	PSEG(PNNL)	-3.2	0.9	Pass
4 th Qtr. 2020	Seabrook	6.9	1.9	Pass
4 th Qtr. 2020	SONGS	-8.4	1.3	Pass
4 th Qtr. 2020	Millstone	3.0	1.9	Pass

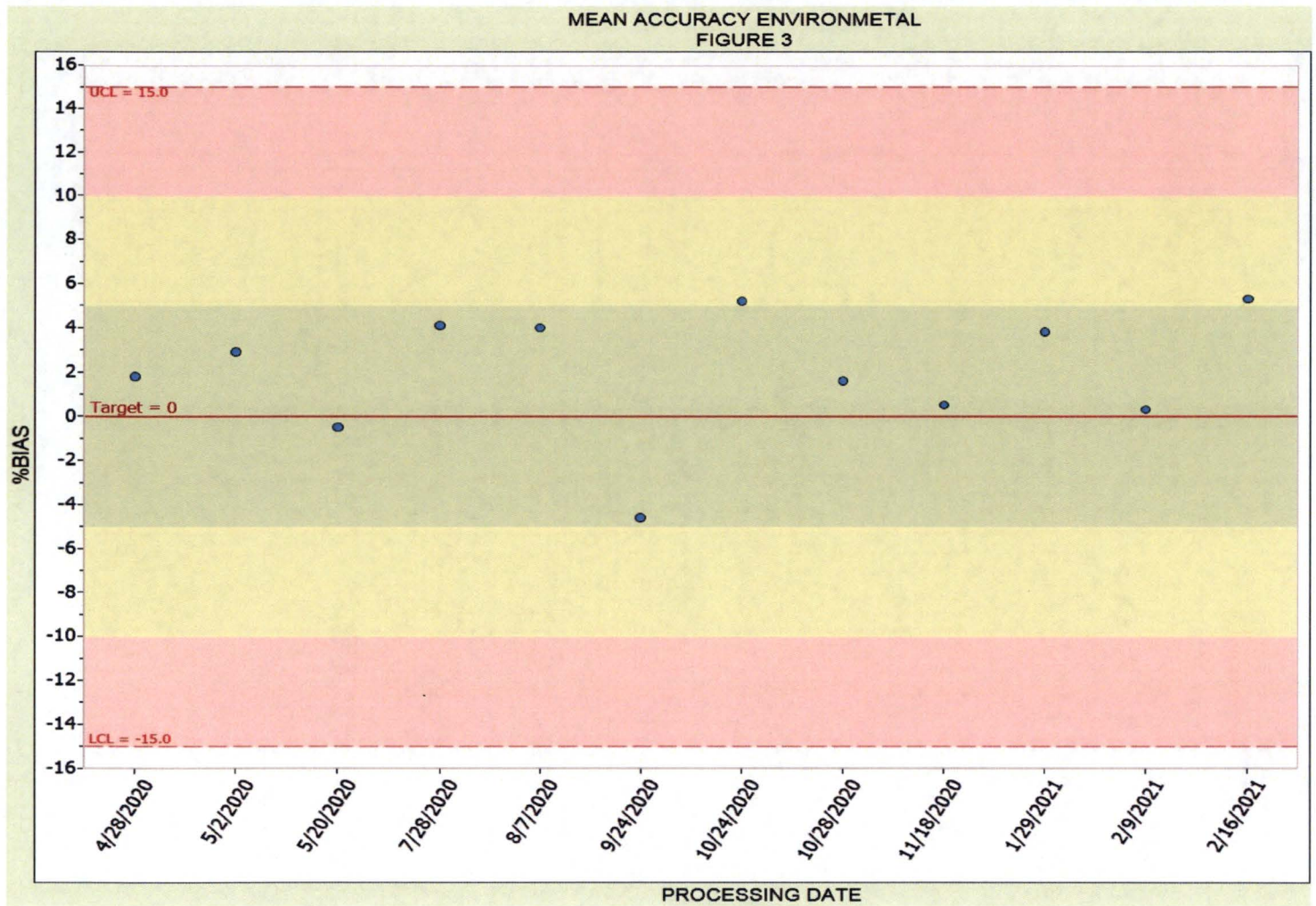
⁽¹⁾Performance criteria are +/- 15%.

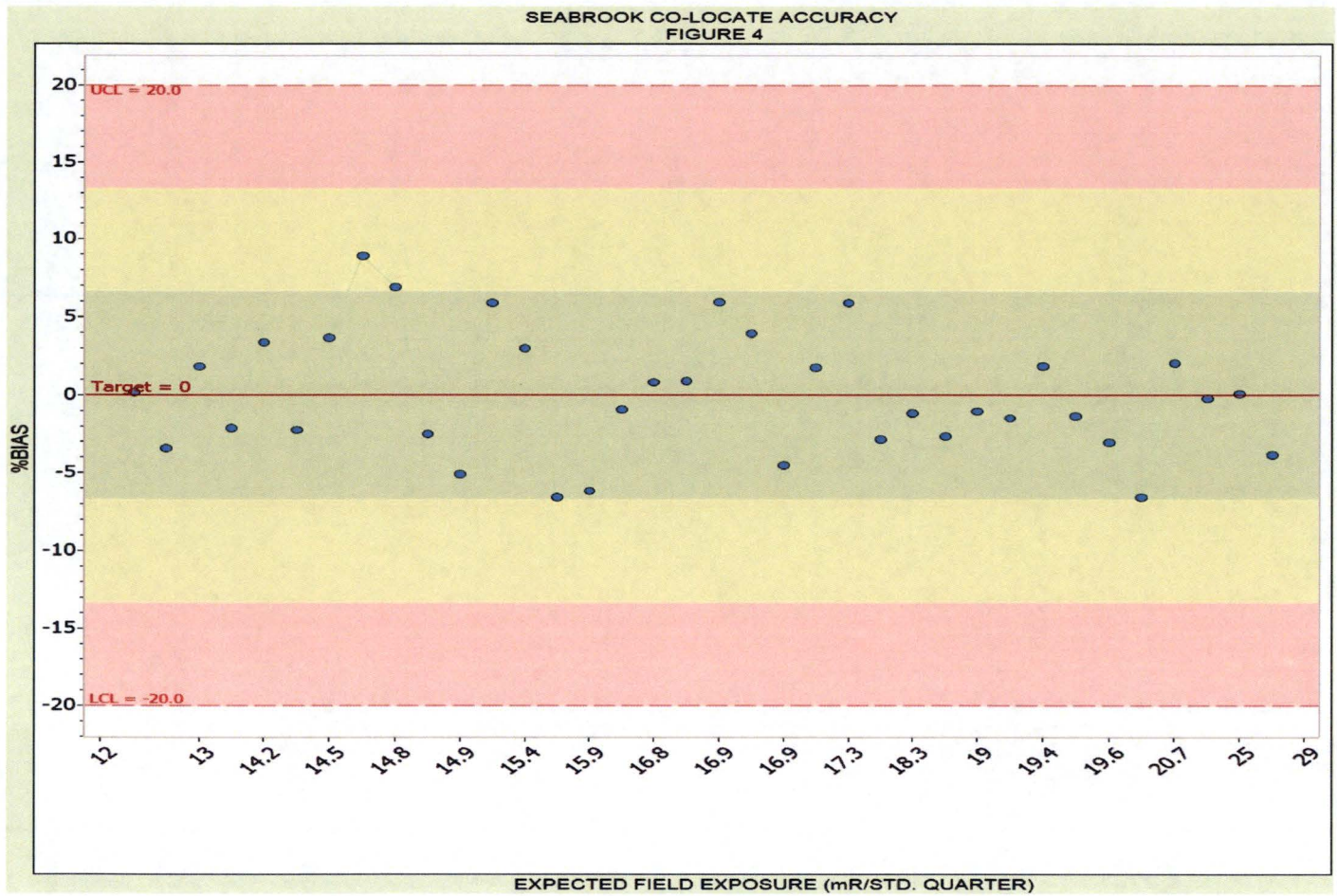
⁽²⁾Blind spike irradiations using Cs-137

APPENDIX A
DOSIMETRY QUALITY CONTROL TRENDING GRAPHS
ISSUE PERIOD JANUARY - DECEMBER 2020









7.2 Teledyne Brown Engineering Laboratory – Environmental Services (TBE-ES)

7.2.1 Operational Quality Control Scope

7.2.1.1 Inter-laboratory

The Teledyne Brown Engineering Environmental Services Laboratory Quality Control (QC) Program is designed to monitor the quality of analytical processing associated with environmental, effluent (10CFR Part 50), bioassay, industrial process, and waste characterization (10CFR Part 61) samples.

Quality Control of radioanalyses involves the internal process control program, and independent third party programs administered by Analytics and Environmental Resource Associates (ERA).

TBE-ES also participates in the Department of Energy's (DOE) Mixed Analyte Performance Evaluation Program (MAPEP) administered by the U. S. Department of Energy. The MAPEP is a set of performance evaluation samples (e.g., water, soil, air filters, etc.) designed to evaluate the ability and quality of analytical facilities performing measurement on samples that contain hazardous and radioactive (mixed) analytes.

Quality Control for radioanalyses during this reporting period consisted of internal process check samples. Results for third-party process check prepared by Analytics, ERA and the DOE's MAPEP are not available at this time due to receipt date from the vendors and are not reported during the first quarter of the year.

7.2.1.2 Intra-laboratory

The internal QC program is designed to include QC functions such as instrumentation checks (to ensure proper instrument response), blank samples (to which no analyte radioactivity has been added), for contamination checks, and instrumentation backgrounds. Process controls (or process checks) are either actual samples submitted in duplicate (duplicates) in order to evaluate the precision of laboratory measurements. Blank samples which have been spiked (spikes) with a known quantity of a radioisotope that is of interest to laboratory clients measure the accuracy of analyses. QC samples are intended to evaluate the entire radiochemical and radiometric process. Process control and qualification analyses samples seek to mimic the media type of those samples submitted for analysis by the various laboratory

clients. The magnitude of the process control program combines both internal and external sources targeted at 10% of the routine sample analysis load.

To provide direction and consistency in administering the quality assurance program, TBE-ES has developed and follows a Quality Manual and a set of Standard Operating Procedures (SOP). The plan describes the scheduled frequency and scope of Quality Assurance and Quality Control (QA/QC) considered necessary for an adequate QA/QC program conducted throughout the year.

7.2.1.3 QA Program (Internal and External Audits)

During each reporting period at least one internal assessment is conducted in accordance with the pre-established TBE-ES Quality Control and Audit Assessment Schedule. In addition, the laboratory may be audited by prospective customers during a pre-contract audit, and/or by existing clients who wish to conduct periodic audits in accordance with their contractual arrangements. The Nuclear Utilities Procurement Issues Committee (NUPIC) conducts audits of TBE-ES as a function of a Utilities Radiological Environment Measurement Program (REMP).

TBE-ES Laboratory-Knoxville has successfully completed the, State of Tennessee, Nuclear Utility Procurement Issues Committee (NUPIC), New York State and Department of Health's Environmental Laboratory Approval Program (NELAP) audits. These audits were each a comprehensive review of TBE-ES's Quality and Technical programs used to assess the laboratory's ability to produce accurate and defensible data. No significant deficiencies, which would adversely impact data quality, were identified during any of these audits. Administrative findings identified during these inspections are usually addressed promptly, according to client specifications.

7.2.2 Analytical Services Quality Control Synopsis

7.2.2.1 Results Summary

7.2.2.1.1 Environmental Services Quality Control

During this annual reporting period, twenty-five nuclides associated with six media types were analyzed by means of the laboratory's internal process control, Analytics, ERA, MAPEP and DOE quality control programs. Media types representative of

client company analyses performed during this reporting period were selected. The results for these programs are presented in Tables 7.2. Below is a synopsis of the media types evaluated:

- Air Filter
- Charcoal (Air Iodine)
- Milk
- Soil
- Vegetation
- Water

7.2.2.1.2 Analytics Environmental Cross-Check Program

Twelve nuclides in milk, air particulate, air iodine (charcoal), and soil samples were evaluated for two sets of cross-checks during 2020. TBE was not within acceptable range for one Sr-89 in milk. NCR's 20-19 was initiated and completed to address the deficiencies. All other environmental analyses performed were within the acceptable/acceptable with warning criteria.

The Analytics September 2020 milk Sr-89 result was evaluated as Not Acceptable. The reported value was 62.8 pCi/L and the known result was 95.4 (66%). All QC data was reviewed and there were no anomalies. This was the first failure for milk Sr-89 since 2013 and there have only been 3 upper/lower boundary warnings since that time. It is believed that there may have been some Sr-89 loss during sample prep. The December 2020 result was at 92% of the known. (NCR 20-19)

7.2.2.1.3 Summary of Participation in the Department of Energy (DOE) Monitoring Program

Fifteen nuclides in water, air particulate, soil, and vegetation samples were evaluated twice in 2020. For the 1st set of cross-checks, TBE was not within acceptable limits for U-234/233 and U-238 in an air particulate sample. For the 2nd set of cross-checks, TBE was not within the acceptable limits for Ni-63 in soil. NCR's 20-13, and 20-20 were initiated & completed to address the deficiencies. All other environmental analyses that were reported were within the acceptable/acceptable with warning criteria.

The MAPEP February 2020 AP U-233/234 and U-238 results were evaluated as Not Acceptable. The reported value for U-233/234 was 0.0416 ± 0.0102 Bq/sample and

the known result was 0.075 Bq/sample (acceptance range 0.053 - 0.098). The reported value for U-238 was 0.0388 ± 0.00991 Bq/sample and the known result was 0.078 Bq/sample (acceptance range 0.055 - 0.101). This sample was run as the workgroup duplicate and had RPD's of 10.4% (U-234) and 11.7% (U-238). After the known results were obtained, the sample was relogged. The filter was completely digested with tracer added originally; the R1 results were almost identical. It was concluded that the recorded tracer amount was actually double, causing the results to be skewed. Lab worksheets have been modified to verify actual tracer amount vs. LIMS data. TBE changed vendors for this cross-check to ERA MRAD during the 2nd half of 2020. Results were acceptable at 97.8% for U-234 and 106% for U-238. (NCR 20-13)

The MAPEP August 2020 soil Ni-63 result was evaluated as Not Acceptable. The reported value was 438 ± 21.1 Bq/kg and the known result was 980 Bq/kg (acceptance range 686 - 1274). It is believed that some Ni-63 loss occurred during the sample prep step. (NCR 20-20)

7.2.2.1.4 Summary of participation in the ERA Program

Eighteen nuclides were evaluated in water, air particulate, and soil samples twice during 2020. For the 2nd set of cross-check samples, Gross Alpha, Gross Beta, and I-131 results was not within the ERA acceptable range for water samples. NCR's 20-18, and 20-17 were initiated & completed to address the deficiencies. All other analyses performed were within the acceptable criteria.

The ERA October 2020 water Gross Alpha and Gross Beta results were evaluated as Not Acceptable. The reported/acceptable values and ranges are as follows:

	Reported	Known	Range
Gross Alpha	40.0	26.2	13.3 - 34.7
Gross Beta	47.5	69.1	48.0 - 76.0

All QC data was reviewed with no anomalies and a cause for failure could not be determined. This was the first failure for water Gross Beta. A Quick Response follow-up cross-check was analyzed as soon as possible with acceptable results at 96.8% for Gross Alpha and 102% for Gross Beta. (NCR 20-18)

The ERA October 2020 water I-131 result was evaluated as Not Acceptable. The reported value was 22.9 pCi/L and the known result was 28.2 (acceptance range 23.5 - 33.1). The reported result was 81% of the known, which passes TBE QC criteria. This was the first failure for water I-131. (NCR 20-17)

7.2.2.2 Intra-Laboratory Process Control Program

The TBE-ES Laboratory's internal process control program evaluated 4335 individual samples.

7.2.2.2.1 Spikes/Matrix Spikes

During this reporting period, all 1568 environmental spikes and matrix spikes analyzed were within the acceptance criteria.

7.2.2.2.2 Analytical Blanks

During this reporting period, 1574/1575 environmental blanks analyzed were less than the MDC. One QC blank was slightly above the MDC, and a case narrative was included with the sample results.

7.2.2.2.3 Duplicates Total

All of the 2845 duplicate sets analyzed were within acceptance criteria.

7.2.2.2.4 Non-Conformance Reports

There were 22 non-conformance reports issued for this reporting period. No ENNVY data was impacted by the non-conformance in each of these cases.

8. LAND USE CENSUS

The Vermont Yankee Nuclear Power Station Off-site Dose Calculation Manual 3/4.5.2 requires that a Land Use Census be conducted annually between the dates of June 1 and October 1.

The 2020 Land Use Census was completed on September 21, 2020. The requirement to identify the location of the nearest milk animal in each meteorological sector from

the land use census was eliminated from the ODCM in December of 2016. This was eliminated because the primary isotope, I-131 had decayed away. Since no additional farms have started up within five kilometers of the plant, nor have any of the nearest residences changed locations since the 2008 Land Use Census, we are using the census analysis results from that period.

No locations were identified in the census that had “at least a 20% greater dose commitment than the values currently being calculated in accordance with ODCM Control 4.3.3.” This assessment included a review of dispersion factors for all of the identified residence locations. Therefore, no change in the critical receptors assumed in the ODCM dose calculations needs to be identified in the Annual Radiological Effluent Release Report.

The 2008 Land Use Census Analysis ranked the farms according to the calculated critical organ dose. The two highest ranked farms within five kilometers of the plant (per requirement of ODCM Table 3.5.1) were Blodgett Farm and Miller Farm. These farms were part of the milk sampling program until the cessation of milk sampling in December 2016 due to the decay of radioiodines since plant shut down. No additional farms are available within a five kilometer radius of the plant. We are not required to, nor are we able to add any additional farm (or farms) to the program at this time.

The results of the 2020 Land Use Census are included in this report in compliance with ODCM 4.5.2 and ODCM 10.2. The locations identified during the census may be found in Table 8.1.

Table 8.1 2020 Land Use Census Locations*

SECTOR	NEAREST RESIDENCE km (mi)	NEAREST MILK ANIMAL km (mi)
N	1.4 (0.9)	----
NNE	1.4 (0.9)	5.52 (3.42) Cows
NE	1.3 (0.8)	----
ENE	1.0 (0.6)	----
E	0.9 (0.6)	----
ESE	1.9 (1.2)	----
SE	2.0 (1.2)	6.67 (4.4) Cows
SSE	2.1 (1.3)	----
S	0.6 (0.4)	3.6 (2.23) Cows**
SSW	0.8 (0.5)	----
SW	0.4 (0.3)	----
WSW	0.5 (0.3)	9.73 (6.03) Cows
W	0.6 (0.4)	0.82 (0.5) Cows
WNW	1.1 (0.7)	----
NW	2.3 (1.4)	----
NNW	1.7 (1.1)	----

* Sectors and distances are relative to the plant stack as determined by a Global Positioning System survey conducted in 1997.

** Location of nearest milk animal within 3 miles of the plant to the point of predicted highest annual average D/Q value in each of the three major meteorological sectors.

9. SUMMARY

During 2020, as in previous years during plant operation, a program was conducted to assess the levels of radiation or radioactivity in the Vermont Yankee Nuclear Power Station environment. Over 188 samples were collected (including TLDs) over the course of the year, with a total of over 394 radionuclide or exposure rate analyses performed. The samples included groundwater, river water, sediment, fish, silage, mixed grass, storm drain sediment, and storm drain water. In addition to these samples, the air surrounding the plant was sampled continuously and the radiation levels were measured continuously with environmental TLDs.

Three of the objectives of the Radiological Environmental Monitoring Program (REMP) are:

- To provide an early indication of the appearance or accumulation of any radioactive material in the environment caused by the operation of the station.
- To provide assurance to regulatory agencies and the public that the station's environmental impact is known and within anticipated limits.
- To verify the adequacy and proper functioning of station effluent controls and monitoring systems.

Low levels of radioactivity from three sources (discussed below) were detected in samples collected off-site as a part of the radiological environmental monitoring program. Most samples had measurable levels of naturally-occurring Potassium-40, Beryllium-7, Thorium-232 or radon daughter products. These are the most common of the naturally-occurring radionuclides.

Samples of sediment contained fallout radioactivity such as Cesium-137 from atmospheric nuclear weapons tests conducted primarily from the late 1950s through 1980.

Tritium (Hydrogen-3), at concentrations higher than background levels, was detected in on-site groundwater monitoring wells installed in 2007 and in 2010 in response to industry events and the discovery of primary system leakage from underground Augmented Off Gas (AOG) System condensate return piping into the subsurface groundwater pool under the plant site. The leakage from this piping was terminated in early February 2010. Extensive sampling and analysis was performed on groundwater samples and other media throughout all of year 2020. Steps to remediate the contamination of the subsurface groundwater layer under the plant site were terminated in December 2014. Additional assessment of the dose contribution of radioactive waterborne releases from this event is provided in the 2020 Annual Radioactive Effluent Release Report.

10. REFERENCES

1. USNRC Radiological Assessment Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program," Revision 1, November 1979.
2. NCRP Report No. 94, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, National Council on Radiation Protection and Measurements, 1987.
3. *Ionizing Radiation: Sources and Biological Effects*, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 1982 Report to the General Assembly.
4. Kathren, Ronald L., *Radioactivity and the Environment - Sources, Distribution, and Surveillance*, Harwood Academic Publishers, New York, 1984.
5. Till, John E. and Robert H. Meyer, ed., *Radiological Assessment - A Textbook on Environmental Dose Analysis*, NUREG/CR-3332, U.S. Nuclear Regulatory Commission, Washington, D.C., 1983.
6. NUREG/CR-3130, *Influence of Leach Rate and Other Parameters on Groundwater Migration*, February 1983.
7. Vermont Yankee Offsite Dose Calculation Manual (ODCM), Revision 40, October 23, 2018.