Surveillance2009

Vermont Yankee Nuclear Power Station

Report on Public Health Monitoring
September 2010

VERMONT
DEPARTMENT OF HEALTH
Agency of Human Services

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Executive Summary

The Vermont Department of Health has been monitoring and reporting on radiation emissions and radiological effluents from the Vermont Yankee Nuclear Power Station since 1971. The purpose of this environmental surveillance effort is to verify that Vermont Yankee is operating within the limits of the state's radiological health rule to protect the health and safety of Vermonters. This *2009 Surveillance Report* details more than 1,300 separate measurements of air, water, milk, soil, vegetation, sediment and fish samples taken during the year at the site boundary, from the Connecticut River, and in the towns surrounding the power station.

In 2009, the Health Department revised the Radiological Health Rule: http://www.healthvermont.gov/regs/documents/radio_health_amended_rule.pdf
The revision replaced a direct gamma radiation limit, expressed in terms of calculated dose equivalent in millirem, with a limit expressed in the same units as the measuring instruments – exposure in milliroentgen. Other changes were made to the rule, primarily to incorporate modern scientific definitions and approaches. The findings of this report are made using these approaches. The Vermont Department of Health's regulatory limit is 20 milliroentgen per year at the site boundary, a limit that is more protective than any other state or federal agency. The Nuclear Regulatory Commission limits radiation doses to the general public at the site boundary to 100 millirem per year.

Surveillance of Vermont Yankee for 2009 is most notable for one groundwater well result. On November 17, water samples were taken by Vermont Yankee from its groundwater monitoring well GZ-3. On January 6, 2010, laboratory results showed concentrations of radioactive tritium above the lower limit of detection. Vermont Yankee obtained and analyzed a second set of samples on January 7. Laboratory results again confirmed the presence of tritium in the groundwater at GZ-3, and measured the concentration at more than 20 times greater than the sample taken two months earlier.

These findings signaled an unintended and unmonitored release of radioactive material into the environment. Vermont Yankee began its own investigation to identify the source or sources of the tritium leak and the magnitude of contamination.

The Health Department organized a team of state health and environmental experts from multiple agencies to independently monitor, test and report on the investigation, and analyze possible risks and remediation actions. An extensive report and documentation of the investigation from January 2010 to date is available at the Health Department's website: http://www.healthvermont.gov/enviro/rad/yankee/tritium.aspx. The surveillance report for 2010 will include detailed information and data related to this event.

Overall, the many samples and measurements of the environment around Vermont Yankee continue to provide evidence that no significant adverse health effects from radiological exposures have resulted from the operation of Vermont Yankee during 2009. Even with the positive tritium results in groundwater monitoring well GZ-3, the Health Department found no instances of non-compliance with the Radiological Health Rule.

However, the identification of radioactive materials in water leaking from the station's structures, systems and components through unmonitored pathways in 2009 and 2010 has prompted an expanded long-term monitoring effort. The Health Department's continuing analysis of health statistics for people who live in the communities surrounding Vermont Yankee shows that health outcomes do not differ significantly from people in the rest of Windham County, elsewhere in Vermont, or the U.S. as a whole.

A summary table of environmental surveillance results is found in the Introduction, and detailed presentations of sampling methods and data make up most of this report. The information is sometimes complex, and we invite interested readers to contact the Vermont Department of Health's Radiological Health Program at 802-863-7730 with any questions.

Introduction

This 2009 report profiles the radiological conditions around Vermont Yankee Nuclear Power Station, using more than 1,300 samples and measurements taken in the communities surrounding the power station. Included in the report are comparisons of some 2009 results to long-term historical trends. These comparisons show no significant increased radiological exposures due to Vermont Yankee Nuclear Power Station operations for 2009. In November 2009 a sample of groundwater was obtained and analyzed, leading to initial identification of a plume of radioactive tritium on-site at Vermont Yankee. Tritium and other radioactive materials that leaked from the Advanced Off-Gas Building have not been detected in drinking water, the Connecticut River, or any other media through which people could be exposed. However, an expanded program of environmental surveillance and independent monitoring of Vermont Yankee is ongoing as a result of this event.

With the Vermont Department of Health's revision of the Radiological Health Rule in 2009, a different approach to determining compliance to the direct gamma radiation limits is applied. In particular, the Health Department no longer converts the exposures at the site boundary using a dose conversion factor to evaluate compliance to the limit as expressed in units of dose. The revision replaced a direct gamma radiation limit, expressed in terms of calculated dose equivalent in millirem, with a limit expressed in the same units as the measuring instruments – exposure in milliroentgen.

This report also contains results that are compared to background levels. Background levels, in this case, are the levels of radioactivity found in the air, water, soil and sediment that cannot be attributed to Vermont Yankee Nuclear Power Station. Some background measurements were obtained in Windham County, and others were obtained elsewhere in Vermont. Measurements around Vermont Yankee that are significantly above the normal range of background may generally be attributed to the power station, other uses of radioactivity in the measurement area, and/or changing meteorological

conditions. The report includes maps that show the locations where samples are collected, or where measurements are made.

All of the measurements in this report are presented at the 95 percent confidence level. This means we are 95 percent certain (not due to chance alone) that the results lie within two standard deviations on either side of the mean. The mean is the reported result, usually found in the tables next to the location identifier, and the uncertainty, often called the error, is the plus or minus factor associated with that result. The uncertainty is usually found in the column immediately next to the mean result in the tables. The Health Department regulates on the basis of the mean result. The uncertainty only demonstrates how confident we are that the mean result reported is accurate.

Some samples and measurements are being collected or made continuously. Other samples are taken periodically. With one exception, all of the samples are analyzed by the Vermont Department of Health Laboratory in Burlington, Vermont. Measurements of direct gamma radiation exposures using thermoluminescent dosimeters are analyzed by a National Voluntary Laboratory Accreditation Program vendor of dosimetry.

This report contains results from the following:

- Direct gamma radiation emanations as measured continuously more than 70 of thermoluminescent dosimeter (TLD) sites.
- Amount and identity of radioactive particulates, gases, vapors and radioactive iodine that may be found in the air as collected with numerous continuous air samplers.
- Water from wells and waterways surrounding the station and milk from local dairy farms that are sampled every month to determine the amount and identity of natural and human-made radioactivity within them.
- Various wild and cultivated vegetation, river bed sediments, fish and soils that are sampled at least twice a year, and analyzed for human-made and naturally occurring radioactivity.

This report also describes the expertise and capabilities of the Health Department Laboratory and its scientific staff. All radiological analyses of the laboratory are subject to high levels of quality control.

The entire report is published at the Vermont Department of Health web site www.healthvermont.gov. Should you have questions about the content, please call the Vermont Department of Health Radiological Health Program at 802-865-7730.

Program Results Summary

The number of samples and analyses in the Vermont Department of Health environmental surveillance program for the Vermont Yankee Nuclear Power Station is indicative of a significant commitment to evaluating compliance with Health Department regulations to protect public health. Presented here is summary information for 2009. More detailed discussion about the sample results make up most of this report.
With each discussion are tables that show the results and map location identification numbers. Some maps are more easily viewed on the Vermont Department of Health web site, where they can be enlarged. This is especially true of Map 1. You can view this report and all of the maps at http://healthvermont.gov

Summary Information

- TABLE 1 summarizes the type of samples analyzed, locations sampled, number of sample analyzed, type of analysis used, and overall results.
- MAP 1 shows all of the locations where samples were taken.
- MAP 2 shows the locations in Vernon where samples were taken.

Advanced Off-Gas (AOG) System Leaks

On November 17, 2009 a set of water samples was obtained by Entergy Vermont Yankee's environmental contractor. These samples were taken from groundwater monitoring wells that were installed in November 2007 as part of Vermont Yankee's groundwater protection program. The wells were installed to detect radioactive tritium as an indicator that one of the station's systems was leaking, or had leaked, radioactivity into the environment. As with other samples taken quarterly since October 2008, these were sent to Vermont Yankee's contract laboratory and to the Health Department Laboratory. On January 6, 2010, Vermont Yankee received the results of the November 17 samples. Groundwater monitoring well GZ-3 tested positive for tritium at 705 picocuries per liter (pCi/L). Vermont Yankee employees obtained another sample on January 7 from GZ-3, and lab analysis confirmed tritium contamination of the groundwater. The confirmatory sample measured 17,072 pCi/L.

Vermont Yankee notified the Department of Health and the Department of Public Service about the situation on January 7. On January 8, the Health Department obtained drinking water samples from nearby residences and from the Vernon Elementary School. This was done to verify that tritium was not in drinking water near the site. Starting on January 11, the Health Department initiated twice daily meetings with Entergy Vermont Yankee. These meetings proved vital to keeping the public informed of the situation at Vermont Yankee, of plans and actions to find and repair the source of the groundwater contamination, and of contamination levels in the environment.

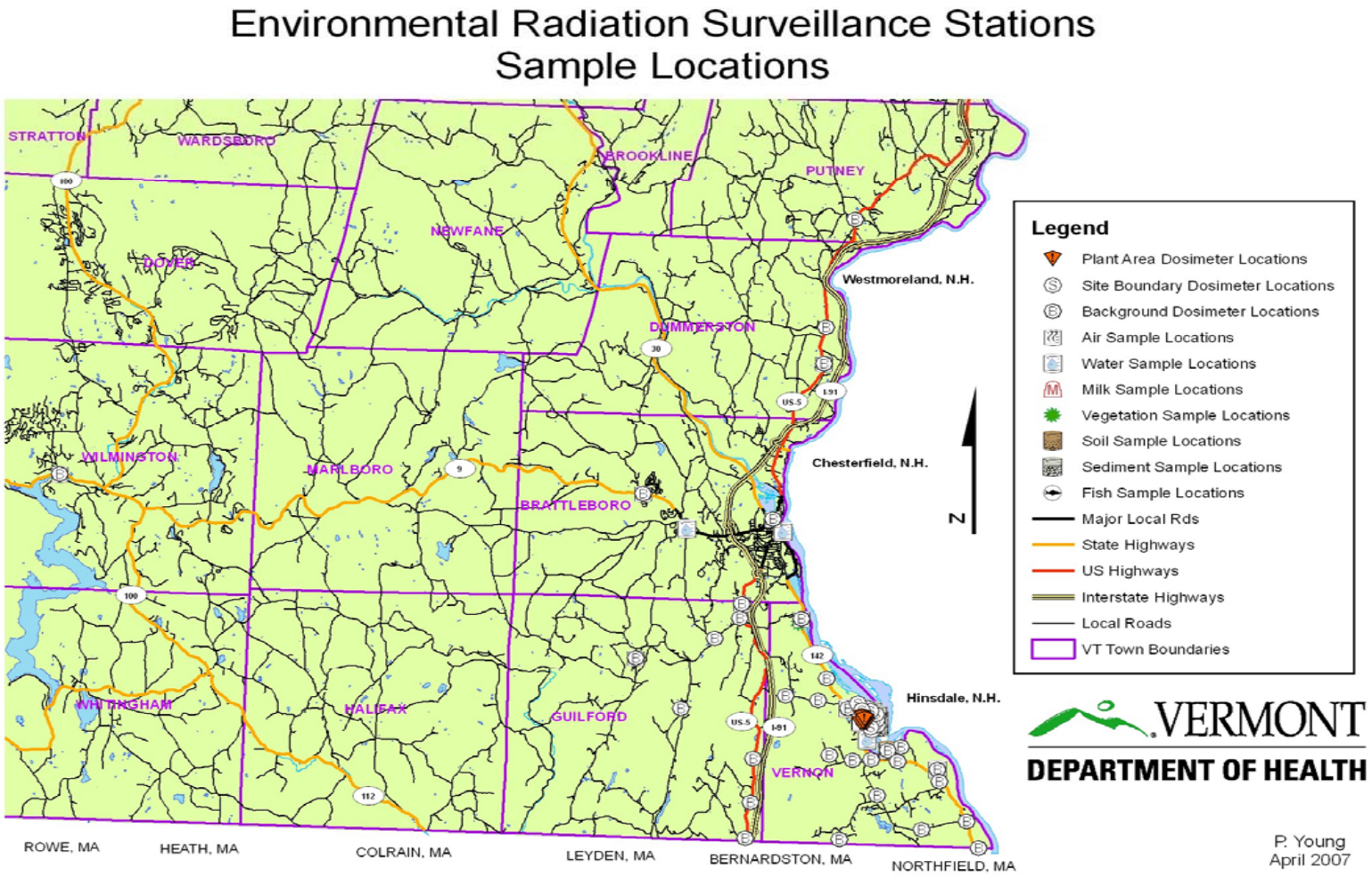
Since January 2010, the Health Department has reported on the investigation with extensive information, maps, lab test results, charts and graphics: http://www.healthvermont.gov/enviro/rad/yankee/tritium.aspx

The 2010 environmental surveillance report, to be published in 2011, will describe this event in detail and will include the results of many more water sampling sites. Prompted by the 2010 AOG leak, the Health Department increased the number of sites where water is sampled for radioactive contamination from Vermont Yankee. The frequency of sampling has also increased. In addition, the Health Department expanded the kinds of analyses conducted in 2010. For the first time, the Health Department is analyzing water, fish, soil and other samples for strontium-90 and other radioactive materials that are hard to detect without special analytical techniques practiced by only a small number of radiochemistry laboratories in the United States.

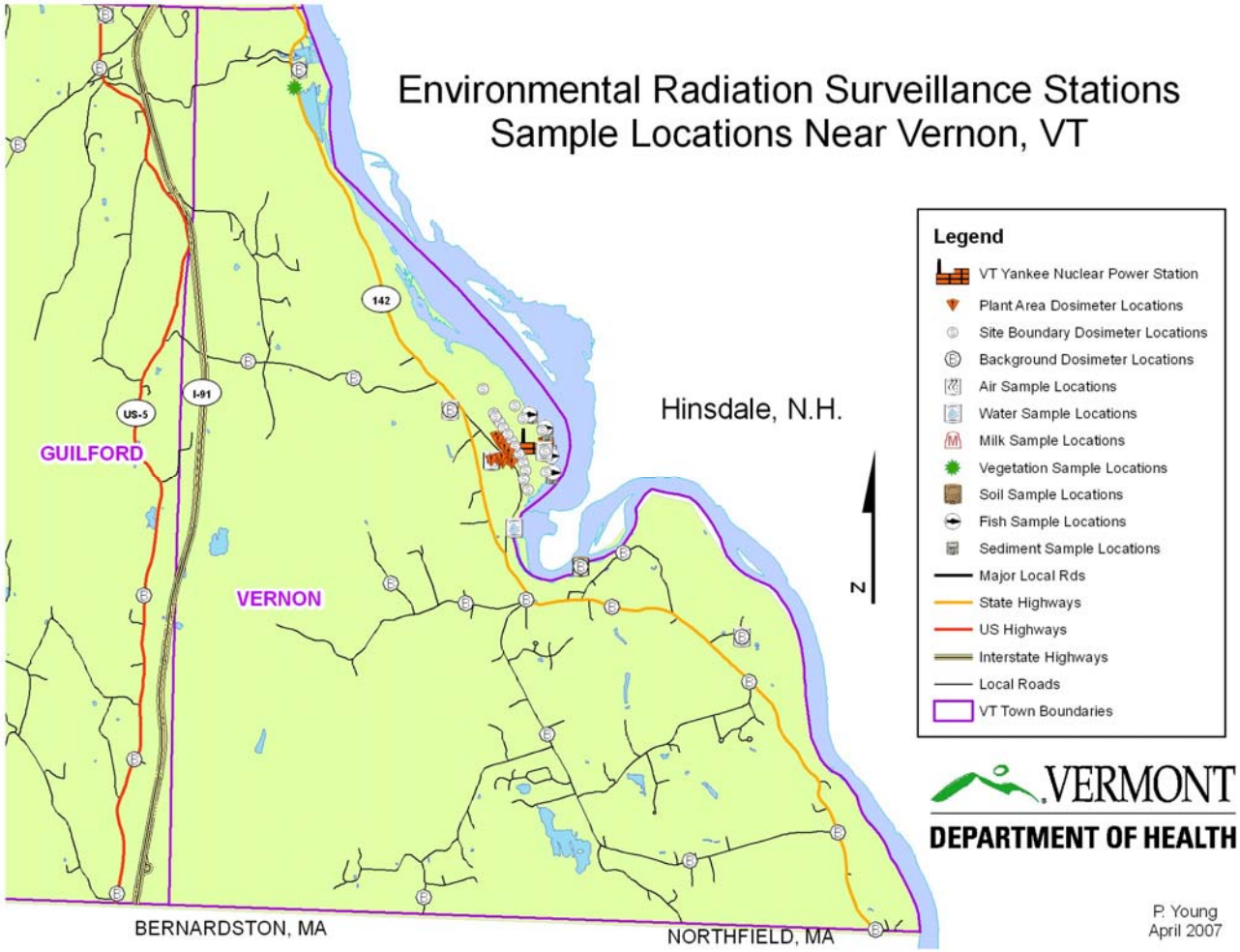
Table 1. Summary of 2009 Samples, Analyses and Results

Sample Type	Locations	Samples	Analysis Type	Results
Direct Gamma Radiation	71	284	Thermoluminescent Dosimeter	Less than 20 milliroentgen per year at the site boundary
Air Particulates, Gases, Vapors	9	108	Total Alpha Radioactivity	No radioactivity associated with VYNPS operations leading to doses even a small fraction of the annual dose limit
		108	Total Beta Radioactivity	No radioactivity associated with VYNPS operations leading to doses even a small fraction of the annual dose limit
		108	Iodine-131 Radioactivity	All samples less than calculated limit of detection of 0.003 pCi/m^3
		108	Total Gamma Radioactivity	All detected gamma radioactivity of natural origin
		4	Total Particulate Gamma Radioactivity	All detected gamma radioactivity of natural origin
Water	13	120	Total Alpha Radioactivity	No radioactivity associated with VYNPS operations leading to doses even a small fraction of the annual dose limit
		120	Total Beta Radioactivity	No radioactivity associated with VYNPS operations leading to doses even a small fraction of the annual dose limit
		120	Tritium Radioactivity	All samples less than the calculated limit of detection of 300 pCi/L or well below the limit for liquid effluents
		120	Total Gamma Radioactivity	All detected gamma radioactivity of natural origin
Milk	3	12	Iodine-131 Radioactivity	All samples less than the calculated limit of detection of 3 pCi/L
		12	Total Gamma Radioactivity	All detected gamma radioactivity of natural origin
Groundwater	7	7	Total Gamma Radioactivity	All detected gamma radioactivity of natural origin
		7	Tritium Radioactivity	**Groundwater monitoring well GZ-3 found positive for tritium radioactivity 11/17/09**
Vegetation	4	4	Total Gamma Radioactivity	All detected gamma radioactivity attributable to natural, Chernobyl or nuclear weapons testing
Soil	4	4	Total Gamma Radioactivity	All detected gamma radioactivity attributable to natural, Chernobyl or nuclear weapons testing
River Sediments	19	38	Total Gamma Radioactivity	All detected gamma radioactivity attributable to natural, Chernobyl or nuclear weapons testing
Fish	4	4	Total Gamma Radioactivity	All detected gamma radioactivity of natural origin
Eggs	1	1	Total Gamma Radioactivity	All detected gamma radioactivity of natural origin
Totals	122	1315		

Map 1. All Samples, All Locations



Map 2. All Samples in Vernon, Vermont



Ionizing Radiation Risks

The radiations to which people may be exposed as a result of Vermont Yankee Nuclear Power Station operations are called ionizing radiations. According to the International Agency for Research on Cancer, ionizing radiation is a known human carcinogen. Cancer may result from exposure to ionizing radiation because the energy absorbed may directly or indirectly damage the DNA of human cells. DNA damage is a general requirement of carcinogenesis.

It has been clearly demonstrated that at high doses, generally in excess of 10 rem or 10,000 millirem (1 rem = 1,000 millirem), people who are exposed have a statistically higher risk of cancer compared to people who have lower doses. As with other carcinogens, it is impossible to prove that low doses are without risk. With radiation exposure, it is assumed that no dose is without risk. Still, at very low doses such as those reported here, the risk of developing cancer is considered to be very low, if it exists at all.

The risk management approach used for public health protection with carcinogenic agents is precautionary. In the field of radiation protection, this precautionary approach is called the ALARA Principle: Every reasonable effort must be made to maintain exposures and doses *As Low As Reasonably Achievable*. The Vermont Department of Health's Radiological Health Rule not only requires that exposures to ionizing radiation be less than specific limits, but also that users of ionizing radiation – in all forms of industry, medicine and education – maintain exposures as low as reasonably achievable.

For more information about ionizing radiation risk:

- The National Academies of Science: http://books.nap.edu/openbook.php?isbn=030909156X
- The Health Physics Society: http://hps.org/documents/risk_ps010-1.pdf
- The International Agency for Research on Cancer monographs series: http://monographs.iarc.fr/ENG/Monographs/allmonos90.php

Starting with the *Surveillance 2006 Report on Public Health Monitoring* published in 2007, the Vermont Department of Health began presenting information about certain health outcomes in the vicinity of Vermont Yankee. Environmental sampling is important for determining compliance with regulations, and for verifying that radioactivity and radiation exposures remain at or near background levels. Assessments of the health of people living near the power station help us understand if there are any adverse health events in the area.

The primary concern about chronic low level exposure to ionizing radiation is its potential to increase people's risk of developing cancer. Therefore, Health Department data for cancer incidence (new cancer cases diagnosed) and cancer mortality (people dying from cancer) are provided for Windham County and for the six towns nearest Vermont Yankee Nuclear Power Station that make up the Emergency Planning Zone.

Cancer Prevalence

Cancer is, unfortunately, very common. Roughly one out of every two men and one out of every three women will develop cancer in their lifetime. Cancer prevalence is the number of people alive today who have ever been diagnosed with cancer. According to 2008 Behavioral Risk Factor Surveillance System (BRFSS) data, approximately 29,000 (4 to 6 percent) of Vermonters age 18 and older have ever been told by a doctor they had cancer. This includes those who are newly diagnosed, in active treatment, have completed active treatment, and those living with progressive symptoms of their disease.

With 9 percent of people age 50 and older living with cancer in the U.S., it is not unusual to know several people who have cancer. As a population ages, the occurrence of new cancer cases is expected to increase. With treatment advances, people are living longer with a cancer diagnosis. The number of cancer survivors has doubled in the past 20 years.

The source of the information in Table 2 is the Vermont Department of Health Cancer Registry. It was updated in May 2010. The incidence rates are for all cancers, for invasive thyroid cancers, for leukemia and for childhood (pediatric) cancers for the years 1998 to 2007.

The data in Table 2 indicate that:

- For all cancer types combined, the rate of cancer incidence in the six towns near Vermont Yankee Nuclear Power Station (Brattleboro, Dummerston, Guilford, Halifax, Marlboro and Vernon) is lower than rates in Windham County, Vermont as a whole, and the U.S. white population.
- Incidence rates for invasive thyroid cancer and leukemia are not different from Windham County, Vermont as a whole, or the U.S. white population.
- Incidence rates for pediatric cancers in the six towns could not be calculated as there were too few cases (fewer than six) over the time period studied.
- The pediatric cancer incidence rate in Windham County, however, was calculated and is not different from Vermont as a whole, or the U.S. white population.
- Similar results were seen in the incidence rates in the 2008 report.

Thyroid cancers and leukemia are of particular interest because increased risk is associated with excess radiation exposure. There is no evidence of excessive radiation exposure in these geographic areas, but the focus on these kinds of cancers remains useful. Pediatric cancers are important because radiation health effects are generally more likely when individuals are exposed prenatally or at an early age. The embryo or fetus is most radiosensitive.

Table 2. Cancer Incidence Rates Near VYNPS, in Vermont and in U.S.

Age Adjusted Vermont and U.S. Cancer Incidence, All Sites,
Males and Females per 100,000 population, 1998-2007.
(Urinary Bladder includes malignant and in situ)

	Rate	Lower CL	Upper CL	Avg. cases per year
U.S. White	489.4	488.5	490.4	105,667
Vermont	500.1	494.7	505.6	3,300
Windham County	484.1	465.1	503.9	247
Emergency Zone	435.6	409.0	463.9	102

Age Adjusted Vermont and U.S. Cancer Incidence, Invasive Thyroid,
Males and Females per 100,000 population, 1998-2007.

	Rate	Lower CL	Upper CL	Avg. cases per year
U.S. White	9.8	9.7	10.0	2,113
Vermont	9.5	8.7	10.3	61
Windham County	6.9	4.7	9.8	3
Emergency Zone	6.0	3.2	10.8	1

Age Adjusted Vermont and U.S. Cancer Incidence, Leukemia,
Males and Females per 100,000 population, 1998-2007.

	Rate	Lower CL	Upper CL	Avg. cases per year
U.S. White	13.7	13.6	13.9	2,941
Vermont	13.6	12.7	14.5	87
Windham County	15.4	12.2	19.4	8
Emergency Zone	10.0	6.3	15.5	2

Age Adjusted Vermont and U.S. Cancer Incidence, Pediatric Cancers (Ages 0-19),
Males and Females per 100,000 population, 1998-2007.
(Urinary Bladder includes malignant and in situ)

	Rate	Lower CL	Upper CL	Avg. cases per year
U.S. White	17.8	17.5	18.2	999
Vermont	19.0	16.9	21.3	31
Windham County	18.1	11.0	28.2	2
Emergency Zone	--	--	--	--

-- Rates are only presented when the number of cases is greater than 5.
Emergency Zone towns include: Brattleboro, Dummerston, Guilford, Halifax, Marlboro, and Vernon.
All rates are age adjusted to the 2000 U.S. standard population and rates are per 100,000 population. A policy change of the Department of Veterans Affairs (VA) regarding sharing of VA cancer data has resulted in incomplete reporting of VA hospital cases in 2007.

Cancer Mortality

In Table 3, mortality rates from cancer in the United States (U.S. white rate), Vermont, Windham County and the six towns near Vermont Yankee Nuclear Power Station are presented for the 10 years 1998 to 2007. The Vermont data are from the Vermont Department of Health's Vital Statistics System, last updated in May 2010. U.S. data were taken from the Surveillance, Epidemiology, and End Results (SEER) Program at the National Cancer Institute: www.seer.cancer.gov .

The data in this table indicate that, for the years 1998 to 2007, cancer mortality rates in the Emergency Planning Zone do not differ from those for Windham County, Vermont as a whole, or the U.S. white population. Characterizations that one population is at more risk, or at less risk, of dying from cancer as compared to another are not valid.

Cancer Surveillance Methodology

The method used to determine if one rate is different from another is as follows: (1) compute an age-adjusted cancer incidence or mortality rate; (2) compute the confidence interval, which is a range of values within which the true rate is expected to fall; (3) compare the confidence intervals (ranges) of the two rates. If the confidence intervals of two rates overlap, then any difference between the two rates is not statistically significant. If the confidence intervals do not overlap, then the rates are considered different.

The rates in this document are calculated at a 95 percent confidence level. This means that we are 95 percent confident (not due to chance alone) that the true 1998 to 2007 U.S. white cancer incidence rate of 489.4 per 100,000 population is in the range of 488.5 to 490.4 per 100,000. In the six towns near Vermont Yankee, the cancer incidence rate for all types of cancer combined is 435.6 cases per 100,000 people. Statistically speaking, this means we are 95 percent confident that the actual rate is between 409.0 cases and 463.9 cases per 100,000 people. Since the confidence intervals do not overlap, a statistical difference exists between the two rates. After adjusting for age and population

size, people in the six towns near Vermont Yankee Nuclear Power Station were diagnosed with fewer cancers between 1998 and 2007 than the people in Windham County, Vermont as a whole, or the U.S. white population.

In Table 3, it initially appears that deaths from malignant neoplasms (all sites, all ages) in the six towns near Vermont Yankee may be higher than in Windham County. In Windham County, the death rate from malignant neoplasms was 199.2 deaths per 100,000 people, while the death rate from malignant neoplasms in the six towns near Vermont Yankee was 205.3 deaths per 100,000 people. However, this difference is not statistically significant. We are 95 percent confident that these rates fall between 187.1 and 211.9 deaths per 100,000 people in Windham County, and the Vermont Yankee Emergency Planning Zone rate falls between 187.3 and 224.9 deaths per 100,000 people. Because these confidence intervals overlap, the two cancer mortality rates are not statistically different. The same conclusion is drawn for Vermont as a whole – the all sites, all ages cancer mortality rates are not significantly different. Also, the same is true for the U.S. white population – the all sites, all ages cancer mortality rates are not significantly different since the confidence intervals overlap.

Data Limitations

One limitation about the use of these data is that the numbers of cancer cases and the number of cancer deaths in the six towns near Vermont Yankee are small. There are challenges associated with computing rates for relatively small geographical areas, such as the Vermont Yankee Emergency Planning Zone, with an estimated population of 19,800. When the rates are based on a small number of cases, it is almost impossible to distinguish random fluctuation from true changes in the underlying risk of disease. This is particularly an issue in a state like Vermont that has many communities with relatively small populations. To improve rate stability, the cases have been combined for the 10 year period from 1998 through 2007.

Cancer develops gradually as a result of a complex mix of factors related to lifestyle choices, environment and genetics. Each type of cancer is caused by a different set of factors, some well established, some uncertain, and some unknown. The exact causes of most cancers are unknown, and research continues to examine how and why normal cellular growth becomes uncontrolled. Every year, the Health Department updates these cancer statistics in the geographical area near the Vermont Yankee Nuclear Power Station to help reconcile the differences between perceived risks for developing cancer, and the actual experience of cancer diagnoses in the community.

For more information about cancer in Vermont:
http://healthvermont.gov/prevent/cancer/cancer_programs.aspx#stats.

Table 3. Cancer Mortality Rates Near VYNPS, in Vermont and in U.S.

Age Adjusted Vermont and U.S. Cancer Mortality, All Sites,
Males and Females per 100,000 population, 1998-2007.

	Rate	Lower CL	Upper CL	Avg. deaths per year
U.S. White	188.6	188.4	188.8	479,784
Vermont	188.2	184.9	191.6	1,234
Windham County	199.2	187.1	211.9	102
Emergency Zone	205.3	187.3	224.9	49

Age Adjusted Vermont and U.S. Cancer Mortality, Thyroid,
Males and Females per 100,000 population, 1998-2007.

	Rate	Lower CL	Upper CL	Avg. deaths per year
U.S. White	0.5	0.5	0.5	1,193
Vermont	0.4	0.2	0.6	2
Windham County	0.4	0.1	1.6	<1
Emergency Zone	0.4	0.0	3.2	<1

Age Adjusted Vermont and U.S. Cancer Mortality, Leukemia,
Males and Females per 100,000 population, 1998-2007.

	Rate	Lower CL	Upper CL	Avg. deaths per year
U.S. White	7.6	7.6	7.6	19,249
Vermont	7.8	7.1	8.5	50
Windham County	7.7	5.5	10.6	4
Emergency Zone	7.4	4.2	12.4	2

Age Adjusted Vermont and U.S. Cancer Mortality, Pediatric Cancers (Ages 0-19),
Males and Females per 100,000 population, 1998-2007.

	Rate	Lower CL	Upper CL	Avg. deaths per year
U.S. White	2.8	2.7	2.8	1,739
Vermont	2.5	1.8	3.4	4
Windham County	1.9	0.2	6.8	<1
Emergency Zone	2.3	0.0	16.8	<1

Emergency Zone towns include: Brattleboro, Dummerston, Guilford, Halifax, Marlboro, and Vernon.
All rates are age adjusted to the 2000 U.S. standard population and rates are per 100,000 population.

Surveillance Methods

The types of surveys and analyses performed by the Vermont Department of Health are described here in relationship to their role in protecting public health.

Direct Gamma Radiation

The Health Department uses thermoluminescent dosimeters (TLDs) to monitor direct gamma radiation. Direct gamma radiation is the energy emanating from the Vermont Yankee Nuclear Power Station systems and components. Direct gamma radiation is not a contaminant that collects on surfaces in the same way that particles, gases or vapors released from a facility might. Direct gamma radiation is energy that affects the body only when a person is located in an area where gamma radiation exists. Everyone is continuously exposed to direct gamma radiation from natural and human-made sources.

These Health Department thermoluminescent dosimeters are installed all the way around the Vermont Yankee site fence line, along its site boundary, and in the publicly occupied spaces around the station to identify the amount of public exposure that may be associated with operations at the power station. Additional Health Department thermoluminescent dosimeters are installed throughout the towns of Vernon and Guilford, and in locations in Brattleboro, Dummerston, Putney and Wilmington to establish background levels of direct gamma radiation in the absence of radiation from the Vermont Yankee Nuclear Power Station.

The gamma radiation measured by the Health Department thermoluminescent dosimeters is an electromagnetic wave similar to X-rays. Gamma radiation passes through the skin and may pass through the entire body. As it passes through the body, the radiation energy delivers ionizing radiation dose to the tissues with which it interacts.

With a thermoluminescent dosimeter, the gamma radiation interacts with and changes the physical composition of the materials in the thermoluminescent dosimeter. When the thermoluminescent dosimeter is removed from its monitoring location and sent to a

laboratory for analysis, the physical changes in the thermoluminescent dosimeter are reversed. When this occurs, light is emitted, and the amount of light measured in the process is directly proportional to the amount of ionizing radiation energy to which the thermoluminescent dosimeter was exposed.

Typical gamma radiation-emitting radioactive materials include the potassium-40 inside the human body, the beryllium-7 in most earthen materials, and the nitrogen-16 in neutron-activated reactor coolant water at a nuclear power station. Other important reactor-generated gamma radiation emitters include the particulate solids cobalt-60 and cesium-137, vaporous iodine-131 and gaseous krypton-88 and xenon-133.

Personal thermoluminescent dosimeters, like those worn by workers in nuclear power stations and in medical and research facilities, are calibrated to provide a measure of biological dose for the wearer. Dose is the amount of an agent to which you are exposed that actually affects you. The dose of ionizing radiation is recorded in units called millirem.

However, environmental thermoluminescent dosimeters including those reported on here, are not calibrated to provide direct measures of dose in millirem. Environmental thermoluminescent dosimeters are only calibrated to provide a measure of exposure. These thermoluminescent dosimeter exposures are recorded in milliroentgen. With the 2009 revision of the Radiological Health Rule, the Vermont Department of Health regulates direct gamma radiation on the basis of the measured exposure in milliroentgen.

In 2009, no thermoluminescent dosimeter exposures at the site boundary bordered by land exceeded measured values of 20 millroentgen, the annual site boundary limit.

The remaining sample types are used to determine the amount of radioactivity, or radioactive contamination, in the media being sampled. Identifying the quantities and types of radioactive materials in the environment helps to predict how much may end up in our bodies from the air we breathe, and in the water and food we eat.

Air Monitoring

The Health Department uses continuously operating air samplers to monitor the air near Vermont Yankee Nuclear Power Station in Vernon, as well as air in the nearby towns of Guilford, Brattleboro, Dummerston and Wilmington. Air samples allow us to evaluate the amount of three different kinds of radiation to which people may be exposed in the air they breathe. These are alpha, beta and gamma radiation.

Alpha and beta radiation are similar to gamma radiation in that the health risk associated with each is carcinogenesis from damage to DNA. Alpha and beta radiation differ from gamma radiation because they are particle forms of radiation energy, and gamma radiation is an electromagnetic wave of energy. While electromagnetic waves like gamma radiation travel great distances and through most materials, particle radiations like alpha and beta radiation travel relatively short distances and are completely stopped by simple materials.

Alpha particle radiation is the most biologically hazardous form of ionizing radiation. For equal amounts of alpha, beta and gamma radiation energy, alpha particle radiation may cause approximately 20 times more tissue damage. Radon gas and its radioactive decay daughter products emit alpha, beta and gamma radiation. It is the alpha radiation that leads to so much concern about lung cancer from radon daughter products in buildings.

Fortunately, alpha radiation cannot penetrate the simplest of materials. For example, a sheet of paper can completely stop an alpha particle, as can the dead layer of skin that covers the outer surface of the skin of our bodies. The only way alpha particles can

actually harm us is if radioactive material that emits alpha radiation is inhaled, ingested or otherwise taken into the body.

Most alpha-emitting radioactive materials are heavy metals like human-made americium-241 and plutonium-239 or naturally occurring uranium-238 or thorium-232. Radon-222 is unusual because it is a radioactive gas. It is this characteristic that adds to our exposures and risks from radon. Radon gas seeps from the earth's crust and accumulates in buildings and other structures, unlike solids like uranium and thorium that are trapped in soil and rock.

Beta particle radiations also have predictable ranges through materials and are stopped by simple materials. Most beta particle radiations are stopped by plastics and simple construction materials. The dead layer of skin on the outside of our bodies is not always capable of protecting the living skin beneath it. Most beta particle radiation can also cause skin dose. Risks from beta radiation exposure of the skin are low, on the order of 10 times lower than whole body irradiation by gamma rays.

Still, beta particles do not penetrate the living skin more than a few millimeters, so our internal organs are only affected by beta particle radiation if we inhale or ingest beta particle-emitting radioactive materials. Once taken into the body, like alpha particle radiation, the beta particle radiation may damage the tissues of our internal organs. This is why monitoring of the air, water and food chain is so important in an environmental surveillance program.

Materials that emit beta particle radiation include the naturally occurring carbon-14 in all living things, as well as hydrogen-3 (also known as tritium), which may be both human-made or of natural origin. Strontium-90 is a beta radiation-emitting radioactive material. It is a product of the fission process that may be found in nuclear reactor coolant water.

Radioactive materials that emit alpha, beta or gamma radiation behave chemically just like non-radioactive materials. For example, radioactive hydrogen in water (tritiated water) goes everywhere water (a compound of two atoms of hydrogen and one atom of oxygen) goes in our bodies. Radioactive iodine goes to the thyroid gland like non-radioactive iodine does. Radioactive strontium goes to the bone just like non-radioactive strontium does. Radioactive materials in these parts of the body may subject a person to unnecessary risk. So far in the history of Vermont Yankee surveillance, the Health Department has found no reactor-produced radioactive contaminants that would lead to measurable exposure to radon in the environment outside the station. Health Department records indicate that those contaminants that have been identified in past years were small amounts unlikely to be associated with any adverse public health effects.

Results for 2009 do not indicate any additional Vermont Yankee-related radioactive contaminants in the public environment. Although tritium contamination of groundwater on-site was first detected in a sample obtained in November 2009, this did not result in measurable amounts of tritium in the public environment, i.e. in drinking water or in Connecticut River water.

Alpha and beta particle radiation in radioactive materials in the air is determined by drawing air through a glass fiber filter. Radioactive materials are trapped on the filter and the filter is counted on a gas flow proportional counter in the Health Department Laboratory. All radiological analyses of the laboratory are subject to high levels of quality control.

Radioactive materials that emit gamma radiation are also monitored in the air samples the Health Department takes each month. Specifically, a charcoal cartridge is positioned in the air sampler immediately downstream from the glass fiber filter described above.

While the glass fiber filter traps particulate materials, the charcoal cartridge traps molecules of gas and vapors.

Iodine-131 is a vapor at temperatures above room temperature. It is created during the fission of nuclear reactor fuel. Leaks in fuel rod cladding, the tubes in reactor fuel that contain the fuel pellets, allow the iodine-131 to leak into the reactor coolant, the water that runs through the reactor core, and other components and systems. The iodine-131 vapor may be trapped by the station's ventilation system charcoal beds, but some may also be released from the plant stack. Iodine-131 is not generally found in the environment except where used in medicine and produced by nuclear facilities.

Iodine-131 that is inhaled, like other isotopes of iodine that may also be released, travels through the bloodstream to the thyroid gland in a person's neck. That which is not taken up by the thyroid gland is soon excreted from the body with other waste fluids. If a person's thyroid gland is saturated with iodine, most of the iodine-131 taken into the body passes straight from the bloodstream to the urine for elimination. This is the benefit of taking potassium iodide under certain exposure conditions. If one takes a sufficient dose of potassium iodide, about 130 milligrams (mg) for an adult and 65 mg for children between the ages of 3 and 18, radioactive iodine-131 will not be taken up into the thyroid, and risks of thyroid cancer or other thyroid disease will be reduced significantly.

For more information about potassium iodide availability and use: http://healthvermont.gov/enviro/rad/KI_program.aspx.

In addition to analyzing the charcoal cartridges for radioactive iodine-131, both the charcoal cartridges and the air filters are analyzed for many other gamma radiation-emitting radioactive materials. Gamma radiation is analyzed by gamma spectroscopy. Gamma spectroscopy relies on the unique energy signatures of radioactive materials that emit gamma radiation. These unique gamma radiation energies are analyzed to identify the specific radioactive materials in the sample. Gamma spectroscopy can also determine

the amount of radioactivity in the sample by measuring the number of gamma radiation photons emitted by the sample over a given counting time. Gamma spectroscopy is performed by the Health Department Laboratory under relatively ideal conditions.

In summary, the Health Department looks for radioactive material that could be emitted from the Vermont Yankee Nuclear Power Station and found in air.

No alpha, beta or gamma radioactivity related to the operations of Vermont Yankee Nuclear Power Station was identified in the Vermont Department of Health air samples in 2009.

Water Monitoring

Drinking water, groundwater and surface water around the Vermont Yankee Nuclear Power Station is monitored with methods similar to those used for air. Water is collected from separate wells that supply water to two Vernon farms and to the Vernon Elementary School. Samples are also taken from the Brattleboro municipal water supply. Surface water is sampled from the Connecticut River near the plant discharge, downstream of Vernon Dam and upstream in Brattleboro. On-site groundwater is obtained from wells on Vermont Yankee property.

Most water samples are collected monthly by the Health Department or by an environmental monitoring contractor. All of the samples are analyzed by the Health Department Laboratory using various methods. The Laboratory analyzes all water samples for total alpha radioactivity and total beta radioactivity. It also analyzes for gamma radiation-emitting radioactive materials through gamma spectroscopy. All of these water samples are analyzed specifically for tritium (hydrogen-3).

Beginning in 2008, the Health Department incorporated monitoring of the wells on-site at Vermont Yankee. These seven wells are only accessed on the station property. Groundwater samples were analyzed for gamma radioactivity and tritium in a manner similar to the other groundwater samples taken from outside the power station.

No off-site drinking water or surface water samples obtained in 2009 were found to contain radioactive materials attributable to the operations of Vermont Yankee Nuclear Power Station. On November 17, 2009, one on-site groundwater monitoring well sample was found to have detectable levels of tritium.

Monitoring of the Inputs to the Food Chain

Food is another potential pathway for public exposure from Vermont Yankee Nuclear Power Station. To evaluate the food chain and inputs to it, the Health Department takes samples from the soil, from sediments that support fish and other aquatic species in waterways, from wild and cultivated vegetation, from fish, and from cow's raw milk.

Every soil, sediment, vegetation, fish and milk sample is evaluated for gamma radiation-emitting radioactive materials, while raw cow's milk is also specifically analyzed for iodine-131. These analyses are via gamma spectroscopy at the Health Department Laboratory.

For 2009, no radioactive materials related to the operations of Vermont Yankee were found in samples of inputs into the food chain.

Direct Gamma Radiation Results

Direct gamma radiation is what we call the electromagnetic energy that is emitted from the reactor and turbine systems at Vermont Yankee Nuclear Power Station. Like light from a bulb, this energy is emitted in all directions from certain station components and operations. Like light, this direct gamma radiation is reduced in intensity with increasing distance. Also like light, it scatters and reflects off nearby materials. Some direct gamma radiation reflects from the atmosphere above the station back to earth. This is called skyshine.

The Vermont Department of Health direct gamma radiation measurements also account for any gamma radiation exposures from gases, vapors and particles in the air. This includes gamma radiation exposures from gases like krypton-88 and xenon-133 that might be released from the Vermont Yankee Nuclear Power Station plant stack, as well as particulates and vapors, including radioactive iodine. These exposures are very small, especially as compared to the direct gamma radiation and scattered and skyshine radiation from station components, systems and operations.

Direct gamma radiation can contribute to public exposures outside the site boundary of the power station. The Health Department limits direct gamma radiation exposures for members of the public. The limit is expressed in millirem, a unit that accounts for both the amount of radiation energy absorbed, and the potential biological effects of that radiation energy absorption. The unit millirem quantifies what is called the biological dose equivalent. The Health Department's regulations for radiological health can be found at: http://healthvermont.gov/regs/radio_health.pdf

The biological dose equivalent allowed annually for a member of the general public from direct gamma radiation emitted from Vermont Yankee Nuclear Power Station is limited to 5 millirem. Because it is impossible to verify that the biological dose equivalent to every single person exposed throughout the year is less than 5 millirem, the regulations provide for measurements of the site boundary exposure measured in milliroentgen as an

acceptable alternative for verifying compliance. Measurements of the actual exposure at a location along the site boundary are readily obtained. Specifically, the regulations limit the measured exposure at the site boundary to no more than 20 milliroentgen per year, and no more than 10 milliroentgen per calendar quarter.

It is important to note that the Vermont Department of Health regulations for site boundary direct gamma radiation dose pertain only to that portion of the site boundary bordered by land. Thermoluminescent dosimeter locations DR42, DR43, DR44, DR45, DR46 and DR47 in Table 5 below are on the site boundary along the Connecticut River. Thermoluminescent dosimeter exposure results in Tables 5 and 6 are expressed in units of milliroentgen. The unit milliroentgen (mR) is a unit of exposure, and environmental thermoluminescent dosimeters only record exposure.

There are two relevant regulatory limits: no more than 10 milliroentgen per calendar quarter and no more than 20 milliroentgen per calendar year. For 2009, the quarterly limit and the annual limit were never exceeded. Given that the 20 milliroentgen per year and 10 milliroentgen per quarter limits at the site boundary bordered by land were not exceeded, the annual effective dose equivalent limit of 5 millirem for any member of the public in an unrestricted area was not exceeded for 2009.

Background Gamma Radiation

To determine the direct gamma radiation exposure attributable only to Vermont Yankee Nuclear Power Station, background radiation must be subtracted from measurements. The 71 thermoluminescent dosimeters the Health Department deploys for environmental surveillance all record gross measurements. Gross measurements of gamma radiation include exposures from all natural and human-made sources of radiation where the thermoluminescent dosimeter is physically located, including the background radiation not attributable to Vermont Yankee Nuclear Power Station operations.

Gross gamma radiation measurements include exposures from radon gas in the air, from naturally occurring radioactive materials in the soil, water and vegetation, from radioactive materials in building materials, from contaminants deposited as a result of above-ground nuclear weapons testing, from passing vehicles containing radioactive materials, from people who have varying amounts of natural and human-made radioactive materials within their bodies, and from the direct and scattered gamma radiation from the systems, components and operations at Vermont Yankee Nuclear Power Station.

For thermoluminescent dosimeter measurements, the Health Department uses the results of measurements at 34 locations unlikely to be affected by Vermont Yankee Nuclear Power Station to establish what the background exposure levels are. These 34 thermoluminescent dosimeters are located as far west as Wilmington, as far north as Putney, and as far south as the Vermont/Massachusetts state line in Guilford and Vernon.

Each quarter's average (or mean) exposure to these 34 thermoluminescent dosimeters is calculated to estimate background radiation. Determinations of background gamma radiation were from the mean of two thermoluminescent dosimeter stations, one in Putney and one Wilmington prior to 2006. This change from the past was implemented because the calculated mean background is more accurate when 34 measurements are used than when only two measurements are used. The mean background exposures are reported in Table 4.

The exposures reported in Tables 5 and 6 for comparison to the quarterly and annual limits are the net thermoluminescent dosimeter results. The net is the gross thermoluminescent dosimeter reading minus the mean background radiation.

Background gamma radiation levels for the four quarters of 2009 are presented in summary in Table 4 at the 95 percent confidence level. This summary table presents the mean background as calculated using the 34 dosimeter sites in Table 6. These results, as

well as the complete results in Tables 5 and 6, are provided in units of gamma radiation exposure measured in milliroentgen (mR).

Background exposures and calculated doses from 2007, 2008 and 2009 are very similar. This is displayed at the bottom of Table 4. In particular, the 2007, 2008 and 2009 background exposures vary by only 1.7 milliroentgen for a year. That is less than 3 percent variation over three years. These comparisons provide evidence that our methods of determining background, taking the mean of 34 different distant site measurements of exposure, and choice of dosimeters are appropriate.

Table 4. Mean Direct Gamma Radiation Background for 2009

Calendar Quarter of 2009	Mean Background Exposure and Error (mR) at the 95% Confidence Level
January 1 to March 31	13.3 ± 2.4
April 1 to June 30	15.0 ± 2.5
July 1 to September 30	15.4 ± 2.5
October 1 to December 31	14.3 ± 2.1
	Mean Background Exposure and Error (mR) at the 95% Confidence Level
Calendar Year (CY) 2009	57.9 ± 4.8
CY 2008 For Comparison	56.4 ± 4.6
CY 2007 For Comparison	56.2 ± 5.2

Uncertainty of Dosimeter Measurements

All dosimeter measurements over time are estimates. They are best estimates, but these measurements are subject to error or uncertainty. It is appropriate when reporting measurements to also report the amount of uncertainty. Uncertainty results from variability in what is being measured, in the measurement devices, and in the people doing the measurements. The uncertainty in what is being measured – radioactivity – can be accounted for statistically, the uncertainty in measurement instruments can be

determined readily in a laboratory, and the uncertainty in human performance during measurement can be reasonably estimated.

Uncertainty can be minimized as well. For example, the amount of uncertainty in the background measurements the Health Department uses was greater when only two dosimeters were used to calculate the mean background compared to when the mean background is calculated from 34 background thermoluminescent dosimeter measurements, which is the method used since 2006. Generally, the greater the number in the sample size, the more accurate statistics like the mean and standard deviation will be. The same is true of time. The longer you collect measurements, the more likely it is that the measurement accurately characterizes the condition. For example, it may be better to characterize background radiation using 10 years of measurements than to use the measurements for a three-month calendar quarter.

2009 Direct Gamma Radiation Exposures

In the two tables below are the results of Health Department's thermoluminescent dosimeter measurements of direct gamma radiation at the Vermont Yankee Nuclear Power Station-site boundary, in the immediate area around the power station (Table 5) and, to establish a background radiation level, in parts of Windham County distant from the station (Table 6).

Dosimeter locations on the site boundary bordered by land, and reflecting the Entergy Vermont Yankee purchases that closed on or before August 1, 2008, are highlighted in magenta in Table 5. As a result, there are 12 Health Department dosimeter locations that are on the site boundary bordered by land. They are called VY SW Fence, VY SW Fence #2, VDH DR48, VY North Fence, VY North Fence #2, VDH T07A, VDH TO7B, VDH DR51A, VY Parking Lot A, VDH DR53A, Gov Hunt Road # 39 and VDH DR52A.

All the exposure results in Table 5 were arrived at by subtracting the mean exposure from the 34 background dosimeters from the net exposure results for each of the site boundary

dosimeters. The physical locations of these 34 background dosimeters, and the net results for each of them, are found in Table 6. The error for the annual results is the total propagated error at the 95 percent confidence level. The formula for the propagation of error is a root-mean-square formula of the form:

$$[(\sigma_1^2) + (\sigma_2^2) + (\sigma_3^2) + (\sigma_4^2)]^{1/2}$$

Where (σ_1^2) is the error for quarter 1, (σ_2^2) is the error for quarter 2, (σ_3^2) is the error for quarter 3 and (σ_4^2) is the error for quarter 4 of 2009.

Note that the exposure results outside the Vernon Elementary School are much less than the exposure values for the station's western site boundary. The Vernon Elementary School measurement locations are listed as Vernon School Nurse, VDH DR06, Vernon School A/S and Vernon School Pole. The Vernon School Nurse measurement site is inside the school, while the other locations are outside the building. The exposure levels in the Vernon School nurse's office may be higher than outside the school due to measurable radiation from indoor radon or from building materials. The location called Governor Hunt Road #39 is a telephone pole immediately between the station's site boundary and the school.

The net background exposure results are displayed in Table 6. Like the results in Table 5, these results are net measurements, meaning that the mean of the 34 background dosimeter exposures was subtracted from each of the individual measurements. That is why some of the measurements are close to zero. Overall, the net exposure measurements at the site boundary for 2009 range from 1.9 to 14.7 milliroentgen.

Maps 3, 4 and 5 show the locations of the site boundary, plant area and background dosimeters. Maps 6 and 7 show the locations of the background dosimeters. The ID numbers on the maps are matched to the locations in Tables 5 and 6.

Table 5. Net VYNPS, Plant Area and Site Boundary TLD Exposure Results for 2009 in Milliroentgen

2009 Results	Qtr 1	Mean	Net	Error	Qrtr 2	Mean	Net	Error	Qrtr 3	Mean	Net	Error	Qrtr 4	Mean	Net	Error	2009	Error
Location, Map ID	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Net	+/-
VDH T01, ID#22	12.5	13.3	0.0	1.6	15.3	15.0	0.3	1.3	16.3	15.4	0.9	1.4	14.3	14.3	0.0	1.5	1.2	2.9
VDH T02, ID#38	12.1	13.3	0.0	1.7	15.2	15.0	0.2	1.4	16.0	15.4	0.6	1.2	14.2	14.3	0.0	1.0	0.8	2.7
VDH T03, ID#26	12.7	13.3	0.0	1.2	16.3	15.0	1.3	1.8	15.5	15.4	0.1	1.3	15.1	14.3	0.8	1.5	2.2	2.9
VDH T04, ID#29	13.4	13.3	0.1	1.2	16.2	15.0	1.2	1.8	16.9	15.4	1.5	1.5	15.3	14.3	1.0	1.5	3.8	3.0
VDH T05, ID#28	13.9	13.3	0.6	1.9	17.3	15.0	2.3	1.8	17.5	15.4	2.1	2.7	16.0	14.3	1.7	1.3	6.8	4.0
VDH T06, ID#30	15.1	13.3	1.8	2.4	17.9	15.0	2.9	1.7	18.9	15.4	3.5	1.2	16.2	14.3	1.9	2.0	10.2	3.8
VDH DR07, ID#31	15.6	13.3	2.3	1.8	18.4	15.0	3.4	2.5	20.0	15.4	4.6	2.0	18.3	14.3	4.0	1.3	14.3	3.9
VDH DR08, ID#15	18.3	13.3	5.0	2.3	19.5	15.0	4.5	1.6	21.1	15.4	5.7	2.7	19.0	14.3	4.7	1.8	19.9	4.3
VDH DR41, ID#16	14.6	13.3	1.3	1.8	16.5	15.0	1.5	1.9	17.2	15.4	1.8	2.8	15.7	14.3	1.4	1.6	6.1	4.2
VY SW Fence, ID#36	12.6	13.3	0.0	1.7	16.2	15.0	1.2	3.1	15.6	15.4	0.2	2.1	14.8	14.3	0.5	1.8	1.9	4.5
VY SW Fence #2, ID#37	13.1	13.3	0.0	1.0	15.6	15.0	0.6	1.2	16.7	15.4	1.3	2.5	14.4	14.3	0.1	1.3	2.0	3.3
VDH DR42, ID#17	12.3	13.3	0.0	1.4	15.6	15.0	0.6	1.4	16.6	15.4	1.2	1.5	14.8	14.3	0.5	1.1	2.2	2.7
VDH DR43, ID#18	14.0	13.3	0.8	2.1	17.9	15.0	2.9	1.6	18.1	15.4	2.7	2.1	16.2	14.3	1.9	1.2	8.3	3.6
VDH DR44, ID#19	20.8	13.3	7.6	1.5	20.1	15.0	5.1	2.1	21.8	15.4	6.4	1.6	19.7	14.3	5.4	1.6	24.5	3.5
VDH DR45, ID#12	38.7	13.3	25.4	3.9	35.2	15.0	20.2	3.3	38.9	15.4	23.5	4.2	30.2	14.3	15.9	3.7	84.9	7.6
VDH DR46, ID#13	19.8	13.3	6.5	2.3	21.6	15.0	6.6	2.0	21.2	15.4	5.8	2.5	20.4	14.3	6.1	1.8	25.1	4.3
VDH DR47, ID#20	15.4	13.3	2.2	1.4	18.8	15.0	3.8	1.5	18.3	15.4	2.9	1.2	16.7	14.3	2.4	1.5	11.3	2.8
VDH DR48, ID#22	12.7	13.3	0.0	1.6	17.2	15.0	2.2	2.3	13.8	15.4	0.0	1.3	12.7	14.3	0.0	1.0	2.2	3.2
VY North Fence, ID#32	12.3	13.3	0.0	2.6	16.2	15.0	1.2	2.0	16.6	15.4	1.2	1.4	15.3	14.3	1.0	1.2	3.5	3.8
VY North Fence #2, ID#33	12.7	13.3	0.0	1.2	16.3	15.0	1.3	1.5	16.6	15.4	1.2	1.4	15.4	14.3	1.1	1.3	3.7	2.7
VDH DR49, ID#27	12.8	13.3	0.0	1.2	15.0	15.0	0.0	1.3	15.4	15.4	0.0	1.2	13.9	14.3	0.0	1.2	0.0	2.5
VDH DR51, ID#23	15.1	13.3	1.9	1.5	20.5	15.0	5.5	1.6	20.6	15.4	5.2	1.8	19.6	14.3	5.3	1.6	17.9	3.3
VDH DR52, ID#24	19.7	13.3	6.5	2.6	20.7	15.0	5.7	2.1	21.8	15.4	6.4	1.7	20.2	14.3	5.9	3.1	24.5	4.9
VY Parking Lot, ID#35	18.1	13.3	4.8	1.9	21.6	15.0	6.6	2.0	24.1	15.4	8.7	4.7	21.2	14.3	6.9	1.7	27.0	5.7
VY Parking Lot #2, ID#34	18.4	13.3	5.2	2.9	22.1	15.0	7.1	2.2	23.4	15.4	8.0	2.1	22.2	14.3	7.9	2.0	28.1	4.7
VDH DR53, ID#25	19.3	13.3	6.1	1.9	22.9	15.0	7.9	2.7	23.8	15.4	8.4	2.2	22.0	14.3	7.7	2.3	30.1	4.6

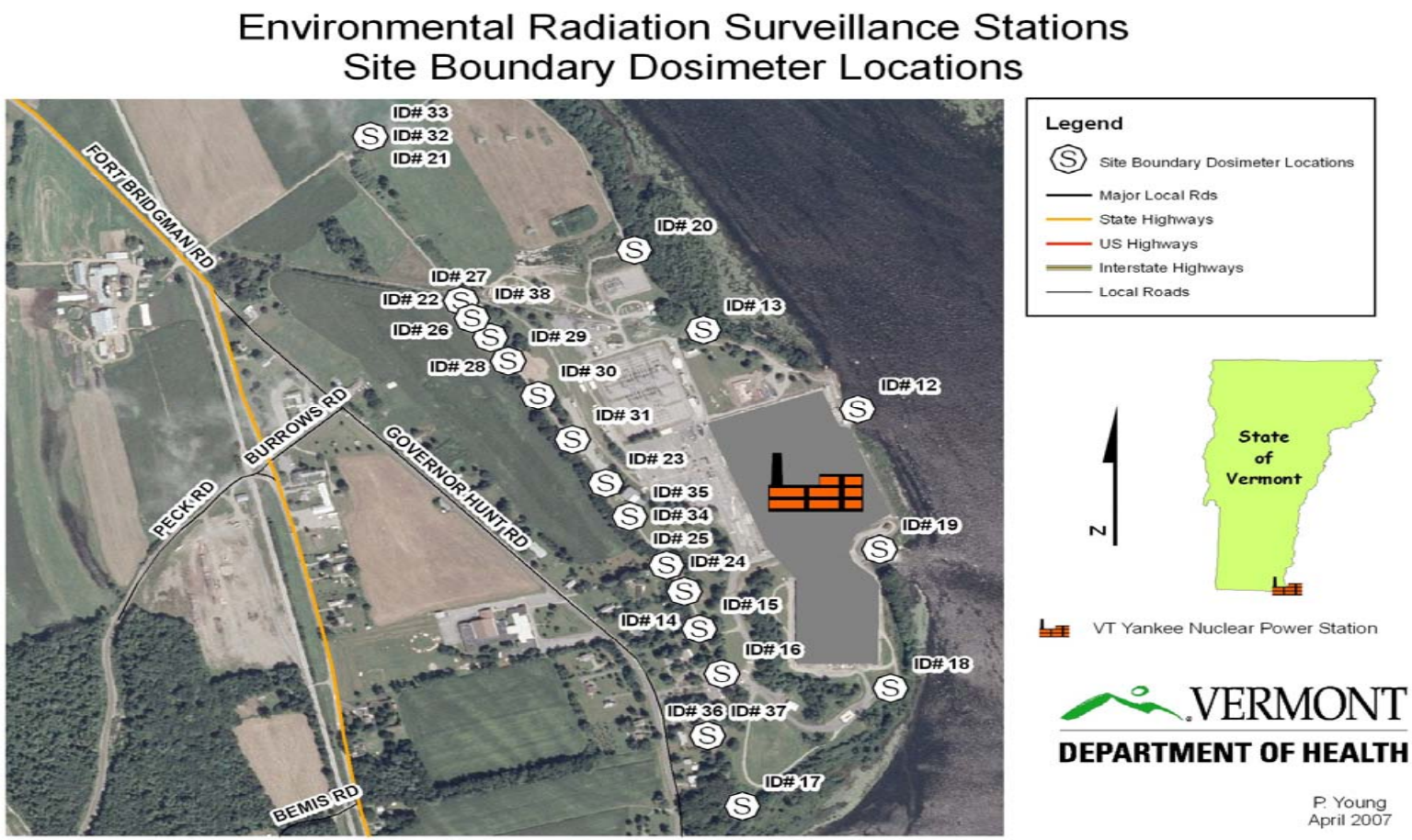
Site Boundary Dosimeter Locations are Shaded in Magenta

Table 5. Net VYNPS, Plant Area and Site Boundary TLD Exposure Results for 2009 in Milliroentgen

2009 Results	Qtr 1	Mean	Net	Error	Qrtr 2	Mean	Net	Error	Qrtr 3	Mean	Net	Error	Qrtr 4	Mean	Net	Error	2009	Error
Location, Map ID	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Net	+/-
VDH T07A, ID#6	13.5	13.3	0.2	2.4	16.7	15.0	1.7	2.3	17.1	15.4	1.7	1.9	16.1	14.3	1.8	1.3	5.3	4.0
VDH T07B, ID#7	12.5	13.3	0.0	1.8	17.1	15.0	2.1	1.6	17.5	15.4	2.1	1.8	15.5	14.3	1.2	1.3	5.4	3.3
VDH DR51A, ID#3	15.3	13.3	2.0	1.6	17.3	15.0	2.3	1.5	17.5	15.4	2.1	2.0	16.5	14.3	2.2	1.7	8.6	3.4
VY PARKING LOT A, ID#11	15.0	13.3	1.7	2.4	17.9	15.0	2.9	2.3	18.4	15.4	3.0	2.2	17.1	14.3	2.8	1.2	10.5	4.1
VDH DR53A, ID#5	16.0	13.3	2.8	1.4	19.1	15.0	4.1	1.6	19.4	15.4	4.0	1.5	18.1	14.3	3.8	1.3	14.7	2.9
Gov Hunt Road # 39, ID#1	15.7	13.3	2.4	1.3	17.4	15.0	2.4	1.6	18.0	15.4	2.6	2.5	16.6	14.3	2.3	1.9	9.7	3.8
Vernon Schl Nurse, ID#9	18.6	13.3	5.4	2.0	18.6	15.0	3.6	1.7	19.6	15.4	4.2	2.8	18.7	14.3	4.4	1.8	17.6	4.2
VDH DR06, ID#2	13.2	13.3	0.0	1.6	15.4	15.0	0.4	2.3	16.0	15.4	0.6	1.6	14.9	14.3	0.6	1.7	1.6	3.6
Vernon School A/S, ID#8	13.2	13.3	0.0	1.5	15.5	15.0	0.5	1.5	15.8	15.4	0.4	1.6	15.3	14.3	1.0	1.3	1.9	3.0
VDH DR52A, ID#4	14.9	13.3	1.6	1.4	17.1	15.0	2.1	1.6	18.7	15.4	3.3	2.4	16.3	14.3	2.0	1.8	9.0	3.7
Vernon School Pole, ID#10	13.4	13.3	0.2	1.2	16.5	15.0	1.5	1.5	15.7	15.4	0.3	1.5	14.6	14.3	0.3	1.4	2.3	2.9

Site Boundary Dosimeter Locations are Shaded in Magenta

Map 3


Environmental Radiation Surveillance Stations
Site Boundary Dosimeter Locations
ID# 33
ID# 32
ID# 21
ID# 20
ID# 27
ID# 22
ID# 38
ID# 26
ID# 29
ID# 28
ID# 30
ID# 13
ID# 12
ID# 31
ID# 23
ID# 35
ID# 34
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ID# 15
ID# 14
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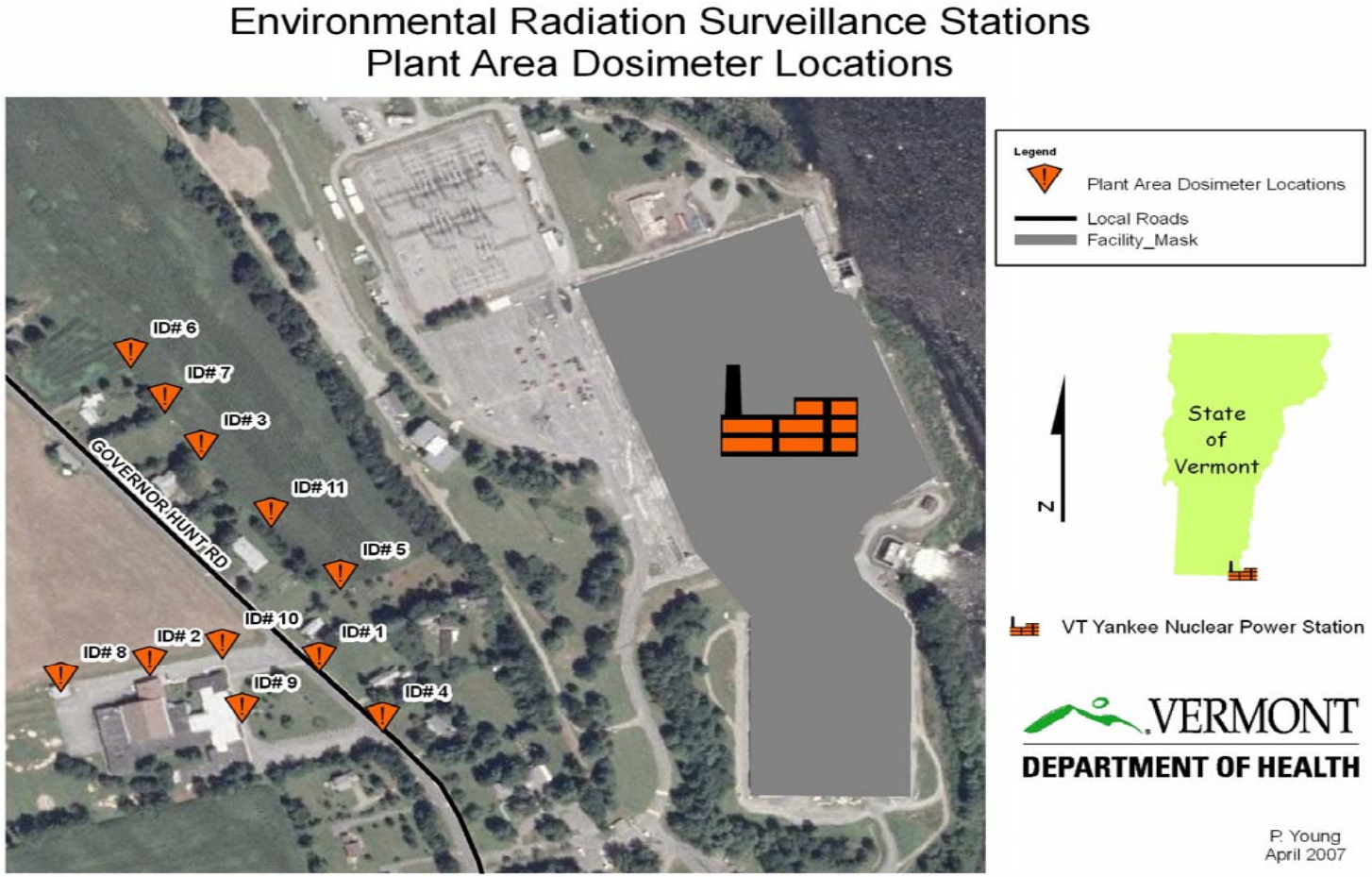
ID# 18
ID# 36
ID# 37
ID# 17
FORT BRIDGMAN RD
BURROWS RD
GOVERNOR HUNT RD
PECK RD
BEMIS RD
Legend
Site Boundary Dosimeter Locations
Major Local Rds
State Highways
US Highways
Interstate Highways
Local Roads
N
State of Vermont
VT Yankee Nuclear Power Station
VERMONT
DEPARTMENT OF HEALTH
P. Young
April 2007

Map 4


Environmental Radiation Surveillance Stations
Plant Area Dosimeter Locations
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ID# 3
ID# 11
ID# 5
ID# 10
ID# 1
ID# 2
ID# 8
ID# 9
ID# 4
GOVERNOR HUNT RD
Legend
Plant Area Dosimeter Locations
Local Roads
Facility_Mask
N
State of Vermont
VT Yankee Nuclear Power Station
VERMONT
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Map 5

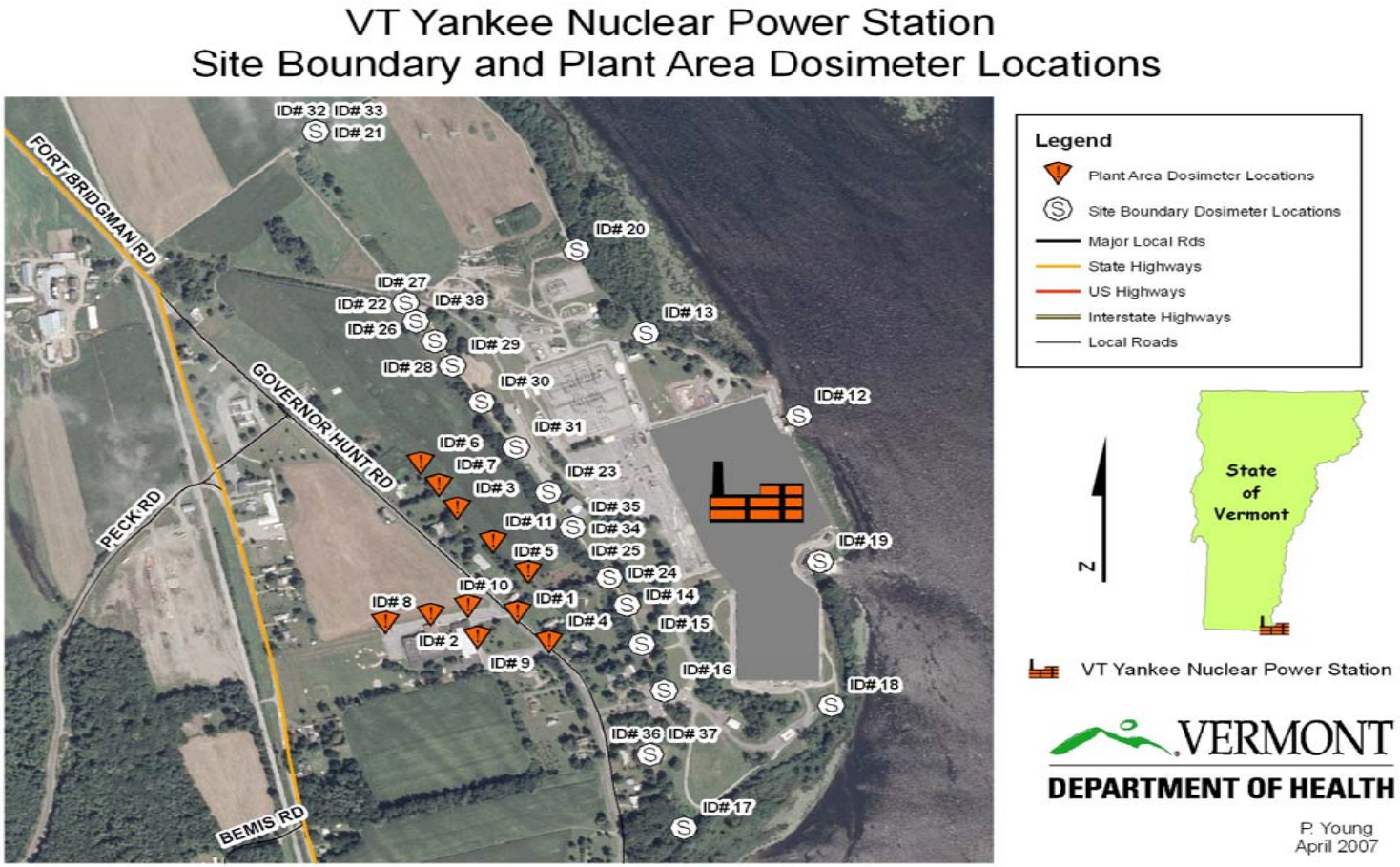
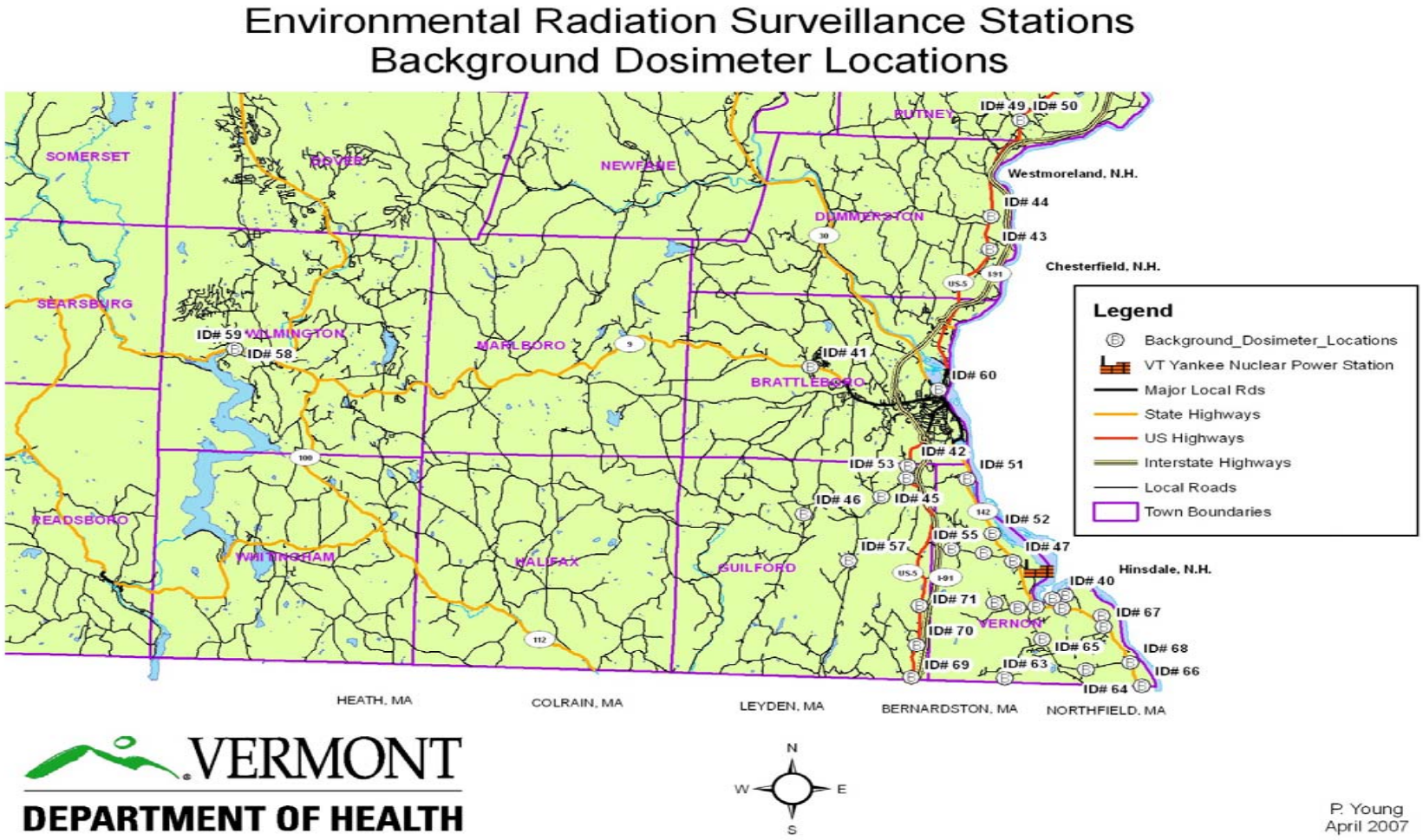

VT Yankee Nuclear Power Station
Site Boundary and Plant Area Dosimeter Locations
FORT BRIDGMAN RD
GOVERNOR HUNT RD
PECK RD
BEMIS RD
ID# 32
ID# 33
ID# 21
ID# 20
ID# 27
ID# 22
ID# 38
ID# 26
ID# 29
ID# 28
ID# 30
ID# 13
ID# 12
ID# 31
ID# 6
ID# 7
ID# 23
ID# 3
ID# 35
ID# 11
ID# 34
ID# 5
ID# 25
ID# 24
ID# 10
ID# 14
ID# 8
ID# 1
ID# 4
ID# 15
ID# 2
ID# 9
ID# 16
ID# 19
ID# 18
ID# 36
ID# 37
ID# 17
Legend
Plant Area Dosimeter Locations
Site Boundary Dosimeter Locations
Major Local Rds
State Highways
US Highways
Interstate Highways
Local Roads
N
State of Vermont
VT Yankee Nuclear Power Station
VERMONT
DEPARTMENT OF HEALTH
P. Young
April 2007

Table 6. Net VYNPS Background TLD Exposure Results for 2009 in Milliroentgen

Results	Qtr 1	Mean	Net	Error	Qrtr 2	Mean	Net	Error	Qrtr 3	Mean	Net	Error	Qrtr 4	Mean	Net	Error	2009	Error
Location, Map ID	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Gross	BKGD	>=0	+/-	Net	+/-
Putney Town Clerk, ID#50	13.5	13.3	0.2	1.4	13.8	15.0	0.0	1.6	14.2	15.4	0.0	1.5	12.6	14.3	0.0	1.0	0.2	2.8
Putney Pole, ID#49	13.6	13.3	0.4	1.6	16.5	15.0	1.5	1.5	16.4	15.4	1.0	1.5	15.2	14.3	0.9	1.2	3.8	2.9
Dummerston School, ID#44	11.8	13.3	0.0	1.4	15.4	15.0	0.4	1.3	16.6	15.4	1.2	2.0	13.8	14.3	0.0	1.4	1.6	3.1
Dummerston AOT, ID#43	13.6	13.3	0.4	1.6	15.6	15.0	0.6	1.4	15.3	15.4	0.0	1.4	14.4	14.3	0.1	1.1	1.1	2.8
Windham Cnty Crt, ID#60	16.1	13.3	2.8	2.5	15.5	15.0	0.5	1.8	16.4	15.4	1.0	1.6	15.2	14.3	0.9	1.2	5.2	3.6
Renaud Brothers, ID#51	16.3	13.3	3.0	1.5	16.9	15.0	1.9	1.8	17.7	15.4	2.3	1.9	16.8	14.3	2.5	1.5	9.8	3.3
Rt 142 N Trans Line, ID#52	12.5	13.3	0.0	2.0	14.7	15.0	0.0	1.4	15.7	15.4	0.3	1.6	14.1	14.3	0.0	1.2	0.3	3.2
Tyler Hill Road, ID#54	11.1	13.3	0.0	1.4	15.7	15.0	0.7	2.1	16.4	15.4	1.0	2.6	14.9	14.3	0.6	1.0	2.3	3.8
Miller Farm, ID#47	13.7	13.3	0.5	1.8	13.9	15.0	0.0	2.9	13.4	15.4	0.0	1.3	14.0	14.3	0.0	1.5	0.5	3.9
142/Pond Road N, ID#39	13.1	13.3	0.0	1.2	14.0	15.0	0.0	1.4	14.1	15.4	0.0	1.7	14.3	14.3	0.0	1.5	0.0	3.0
Fairman Road, ID#62	12.6	13.3	0.0	1.7	15.4	15.0	0.4	1.3	15.2	15.4	0.0	1.7	14.5	14.3	0.2	1.4	0.6	3.0
West Rd/Edgewood, ID#72	12.3	13.3	0.0	2.4	14.7	15.0	0.0	1.7	14.7	15.4	0.0	1.5	14.2	14.3	0.0	2.9	0.0	4.4
Vernon Fire Station, ID#56	13.3	13.3	0.0	3.6	14.0	15.0	0.0	1.3	14.9	15.4	0.0	1.9	13.4	14.3	0.0	1.0	0.0	4.4
Power Line R Crssng, ID#48	13.7	13.3	0.5	1.7	14.4	15.0	0.0	1.4	15.5	15.4	0.1	1.4	14.4	14.3	0.1	1.1	0.7	2.8
A&M Auto/Smead Rd, ID#40	13.3	13.3	0.0	1.4	14.2	15.0	0.0	1.8	15.1	15.4	0.0	1.5	14.0	14.3	0.0	1.2	0.0	3.0
Blodgett Farm, ID#61	15.0	13.3	1.7	2.3	14.8	15.0	0.0	1.4	15.6	15.4	0.2	2.2	14.7	14.3	0.4	1.2	2.4	3.7
Rt 142 & Newton Rd, ID#67	11.9	13.3	0.0	1.5	13.0	15.0	0.0	1.1	13.8	15.4	0.0	1.5	13.0	14.3	0.0	1.0	0.0	2.6
Rt 142 & Pond Rd S, ID#68	13.3	13.3	0.0	1.6	15.1	15.0	0.1	1.3	15.0	15.4	0.0	1.4	13.8	14.3	0.0	1.3	0.1	2.8
Rt 142 & Depot St, ID#66	12.9	13.3	0.0	1.2	15.0	15.0	0.0	1.7	15.5	15.4	0.1	1.5	14.5	14.3	0.2	1.5	0.3	3.0
Pond Rd & Houghton, ID#64	11.8	13.3	0.0	2.1	14.4	15.0	0.0	1.3	15.2	15.4	0.0	1.4	13.6	14.3	0.0	2.0	0.0	3.5
Pond Rd/Vernon Rec, ID#65	12.2	13.3	0.0	1.9	13.0	15.0	0.0	2.2	13.2	15.4	0.0	1.7	12.4	14.3	0.0	0.9	0.0	3.5
Huckle Hill Rd.VT Ln,ID#63	13.4	13.3	0.1	1.1	17.7	15.0	2.7	2.3	17.0	15.4	1.6	1.5	15.5	14.3	1.2	1.4	5.7	3.3
Route 5/Wolosko Rd, ID#69	14.6	13.3	1.4	1.6	17.3	15.0	2.3	1.5	17.5	15.4	2.1	2.0	16.0	14.3	1.7	2.4	7.5	3.9
Rt 5/Andrews Cmtry, ID#70	12.8	13.3	0.0	3.2	15.6	15.0	0.6	1.8	14.8	15.4	0.0	1.8	14.2	14.3	0.0	1.7	0.6	4.5
Rt 5/Tkaczyk Frm Rd, ID#71	13.0	13.3	0.0	1.3	15.7	15.0	0.7	1.6	15.8	15.4	0.4	1.6	14.6	14.3	0.3	2.3	1.4	3.5
Tyler Rd/Franklin Rd, ID#55	13.5	13.3	0.2	1.5	15.6	15.0	0.6	1.4	15.8	15.4	0.4	1.7	14.2	14.3	0.0	1.3	1.1	3.0
D&E Tree, Rt 5, Glfrd, ID#42	12.5	13.3	0.0	2.3	14.0	15.0	0.0	1.2	13.9	15.4	0.0	1.8	13.6	14.3	0.0	1.3	0.0	3.4
Rt 5/Guilford Ctr Rd, ID#53	12.8	13.3	0.0	1.4	14.4	15.0	0.0	1.1	14.5	15.4	0.0	1.2	14.9	14.3	0.6	1.4	0.6	2.6
Glfrd Ctr Rd/Tater Rd, ID#45	12.8	13.3	0.0	1.4	15.0	15.0	0.0	1.5	14.1	15.4	0.0	1.7	14.2	14.3	0.0	1.2	0.0	3.0

Results	Qtr 1	Mean	Net	Error	Qrtr 2	Mean	Net	Error	Qrtr 3	Mean	Net	Error	Qrtr 4	Mean	Net	Error	2009	Error
Location, Map ID	**Gross**	**BKGD**	**>=0**	**+/-**	**Gross**	**BKGD**	**>=0**	**+/-**	**Gross**	**BKGD**	**>=0**	**+/-**	**Gross**	**BKGD**	**>=0**	**+/-**	**Net**	**+/-**
Weatherhead Hll Rd, ID#57	11.7	13.3	0.0	1.2	13.3	15.0	0.0	1.7	15.2	15.4	0.0	4.3	13.1	14.3	0.0	1.0	0.0	4.9
Guilford Twn Garage, ID#46	14.5	13.3	1.2	1.7	15.2	15.0	0.2	1.5	15.9	15.4	0.5	1.7	13.9	14.3	0.0	1.4	1.9	3.2
West Brattleboro SP, ID#41	12.4	13.3	0.0	1.5	12.8	15.0	0.0	1.1	13.8	15.4	0.0	1.5	12.4	14.3	0.0	1.2	0.0	2.7
Wilmingtn AOT Pole, ID#58	13.7	13.3	0.4	1.6	15.1	15.0	0.1	1.6	16.4	15.4	1.0	1.9	14.5	14.3	0.2	1.1	1.7	3.2
Wilmington AOT A/S, ID#59	15.8	13.3	2.5	2.6	18.2	15.0	3.2	1.5	18.8	15.4	3.4	2.2	17.3	14.3	3.0	2.2	12.1	4.4

Map 6


Environmental Radiation Surveillance Stations
Background Dosimeter Locations
SOMERSET
ROYER
NEWFANE
PUTNEY
DUMMERSTON
SEARSBURG
WILMINGTON
MARLBORO
BRATTLEBORO
READSBORO
WHITINGHAM
HALIFAX
GUILFORD
VERNON
ID# 49
ID# 50
Westmoreland, N.H.
ID# 44
ID# 43
Chesterfield, N.H.
ID# 59
ID# 58
ID# 41
ID# 60
ID# 42
ID# 53
ID# 51
ID# 46
ID# 45
ID# 52
ID# 55
ID# 57
ID# 47
Hinsdale, N.H.
ID# 40
ID# 71
ID# 67
ID# 70
ID# 65
ID# 68
ID# 69
ID# 63
ID# 66
ID# 64
HEATH, MA
COLRAIN, MA
LEYDEN, MA
BERNARDSTON, MA
NORTHFIELD, MA
Legend
Background_Dosimeter_Locations
VT Yankee Nuclear Power Station
Major Local Rds
State Highways
US Highways
Interstate Highways
Local Roads
Town Boundaries
VERMONT
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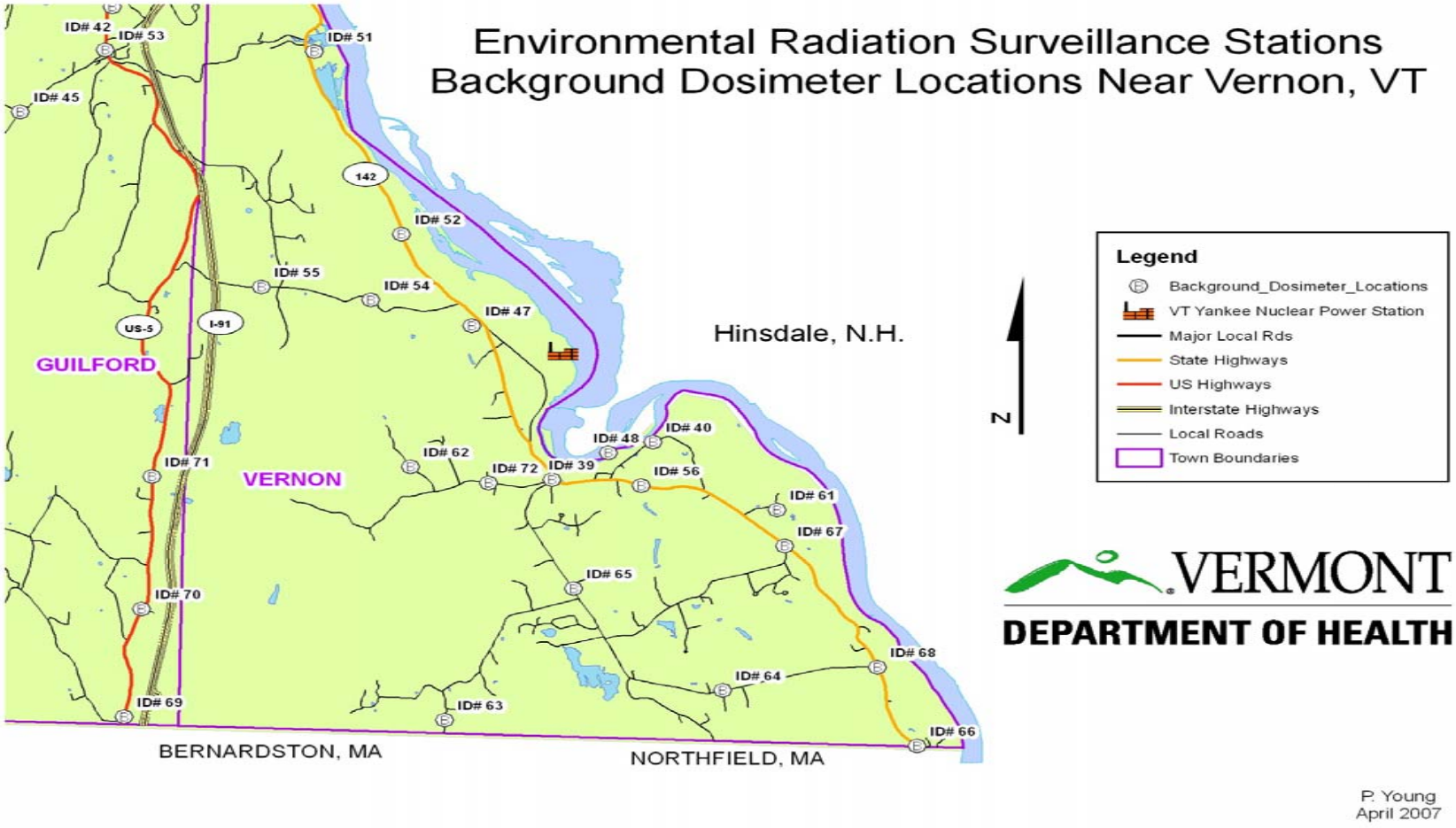
Map 7


Environmental Radiation Surveillance Stations
Background Dosimeter Locations Near Vernon, VT
ID# 42
ID# 53
ID# 51
ID# 45
142
ID# 52
ID# 55
ID# 54
ID# 47
US-5
I-91
GUILFORD
Hinsdale, N.H.
ID# 48
ID# 40
ID# 62
ID# 72
ID# 39
ID# 56
ID# 71
VERNON
ID# 61
ID# 67
ID# 65
ID# 70
ID# 68
ID# 64
ID# 69
ID# 63
ID# 66
BERNARDSTON, MA
NORTHFIELD, MA
N
Legend
Background_Dosimeter_Locations
VT Yankee Nuclear Power Station
Major Local Rds
State Highways
US Highways
Interstate Highways
Local Roads
Town Boundaries
VERMONT
DEPARTMENT OF HEALTH
P. Young
April 2007

Air Sampling Results

Using nine air sampling stations, the Vermont Department of Health assesses radioactivity in the air around Vermont Yankee. The locations of the air samplers are shown on Map 9 below. The ID numbers on the map may be matched with those on Tables 7, 8, 9 and 10. The sampling apparatus uses a mechanical pump to pull environmental air through sample media. Between the pump and sample media is positioned an in-line flow meter. The flow meter tracks the volume of air drawn through the sample media. The air samplers run continuously, and the air samples collected there are retrieved and analyzed at least monthly.

The air samplers use two different sample media to capture airborne radioactivity. One is a glass fiber filter. This filter collects particulate material. The air filter is analyzed by the Health Department Laboratory, which reports the results numerically (as calculated) as total alpha radioactivity and total beta radioactivity. Alpha radioactivity is a measure of radioactive materials that emit alpha radiation, while beta radioactivity is a measure of radioactive materials that emit beta radiation. The air filters are also counted for gamma radioactivity in what are called the quarterly composites. An example of a natural radioactive particulate is beryllium-7. A radioactive particulate only associated with human activity is cesium-137.

The second media is a charcoal cartridge treated with triethylenediamine (TEDA). This cartridge has an affinity for radioactive iodine. As air passes through the cartridge, radioactive iodine gets trapped in the charcoal cartridge. The radioactive iodine is measured at the Health Department Laboratory. In addition, other radioactive gases and vapors may be trapped in the charcoal cartridge. These, too, are analyzed by the laboratory. A radioactive iodine of particular interest is iodine-131. The Laboratory reports the iodine-131 radioactivity, and identifies any other radioactive gases or vapors that were collected on the cartridge.

Alpha and beta radioactivity on the glass fiber filters is measured using a gas flow proportional counter. This analysis is particularly useful with environmental levels of radioactivity, and allows discrimination between alpha and beta radioactivity. Glass fiber filter results are presented numerically with their associated error.

The charcoal cartridges are analyzed for radioactive iodine and other gamma radiation emitting radioactive materials with a gamma spectrometer system using a reverse electrode germanium detector. This instrument can detect hundreds of different radioisotopes and identify them individually by their unique gamma radiation energy signatures. The instruments used at the Health Department Laboratory are very sensitive and subject to significant quality controls. Still, each instrument has a limit of detection. When a sample is analyzed and no radioactivity is detected, the result is not recorded as zero, but it is recorded as less than the limit of detection. Limits of detection (LOD) are calculated periodically and represent an activity value that can be distinguished from the absence of that activity. LODs are calculated for gamma instruments, taking into consideration instrument and sample characteristics such as sample type, count times and sample sizes. The calculated limit of detection for iodine-131, for example is 0.003 pCi/m^3.

Total alpha, total beta, and iodine-131 radioactivity is reported in picocuries per cubic meter. A picocurie (pCi) is a measure of radioactivity. One pCi is one-trillionth of a curie, and one curie is the amount of radioactivity in one gram of radium-226. A cubic meter (m^3) is a measure of volume, so the number of pCi/m^3 in these air samples is a measure of the airborne radioactivity concentration. Table 7 presents the total alpha radioactivity results from the 2009 air sample filters. Table 8 presents the total beta radioactivity from these filters. Table 9 presents the radioactive iodine-131 results following analysis of the charcoal cartridge samples. Table 10 presents the gamma spectrometry results for the analysis of these charcoal cartridges.

The 2009 alpha radioactivity results for all 99 samples but one are within the historical range of less than the calculated limits of detection to 0.0071 pCi/m^3. All but four samples out of 99 are within the mean alpha radioactivity at the 95 percent confidence level. The one air sample outside the historical range for alpha radioactivity is that for the Vernon Elementary School taken on August 24. That air sample, along with the January 29 Guilford Town Garage, the March 6 Power Line River Crossing and the March 30 Guilford Town Garage air samples, is also outside the mean for all samples at the 95 percent confidence level. Specific concentrations for alpha radioactivity ranged from 0.000001 pCi/m^3 to 0.00942 pCi/m^3. The mean alpha radioactivity for all air samples at the 95 percent confidence level is 0.001863 pCi/m^3 $\pm$ 0.003212 pCi/m^3.

Beta radioactivity results for 2009 are all within the historical range of less than the calculated limits of detection to 0.0251 pCi/m^3. Two of the beta radioactivity in air results are greater than the mean at the 9 percent confidence level. These two samples are the same two that registered greater than the mean for alpha radioactivitiy at the Guilford Town Garage on January 29 and March 30. The specific concentrations for beta radioactivity ranged from 0.00001 pCi/m^3 to 0.0221 pCi/m^3. The mean beta radioactivity for all air samples at the 95 percent confidence level is 0.007854 pCi/m^3 $\pm$ 0.012095 pCi/m^3.

In Figure 2, the mean alpha radioactivity for each of the nine Health Department air sample stations is plotted. The graph indicates that there is a significant difference between results at locations close to Vermont Yankee Nuclear Power Station and at locations far from the station. For example, the mean results for the Power Line River Crossing and Vernon Elementary School sites are about twice the concentrations at the Wilmington Garage or the Windham County Courthouse. However, there are no gamma radiation results that help attribute this elevated alpha radioactivity to Vermont Yankee releases. It is likely the higher concentrations of alpha radioactivity are due to naturally occurring radioactive materials that are detected in each of these air filter samples.

The mean air sample total beta radioactivity indicates trends similar to those for alpha radioactivity: there is a significant difference between beta radioactivity air sample results in Vernon and Guilford locations nearer the station as compared to locations in Brattleboro and Wilmington further from the station. Absent gamma radioactivity results of non-natural origin, it is difficult to assign this trend to Vermont Yankee releases. It may be more likely that the difference is due to lesser amounts of natural sources of alpha and beta radioactivity in Wilmington, a location of high elevation and Brattleboro, a more urban setting. Both the alpha and beta radioactivity results require more study. The mean air sample beta radioactivity results from the nine air sample stations are plotted in the graph in Figure 3.

Table 9 presents the monthly results of iodine-131 sample analysis. No iodine-131 above the calculated limit of detection was identified at any of the nine air sampling stations. The calculated limit of detection is 0.003 picocuries per cubic meter (pCi/m^3).

Table 10 is presents the gamma spectroscopy results for air sample charcoal cartridges for the nine air samplers in the Vermont Yankee Nuclear Power Station area. All of the results indicate only naturally occurring radioactive materials were detected. In addition to the gamma spectroscopy of the air cartridge, each calendar quarter the air filter samples from all nine air sample locations are analyzed together in what is called a quarterly composite. The filters are analyzed with the gamma spectrometer system used to evaluate the air cartridges for radioactive materials. Table 11 presents the quarterly composite results. The results show only naturally occurring beryllium-7.

Table 12 provides a list of some of the naturally occurring radioactive materials found in gamma spectroscopy at the Health Department Laboratory. Table 13 is a list of radioactive materials that may be identified through gamma spectroscopy that are predominantly associated with nuclear facilities.

Table 11 presents the quarterly air sample composite analysis. The quarterly composites are analyses of all air filters collected from the nine air sampling stations over the three-month calendar quarter. The 27 filters collected over the calendar quarter are analyzed by gamma spectroscopy, which can identify any radioactivity that emits gamma radiation. The analysis of these filters indicated only naturally occurring beryllium-7 present in excess of the calculated limit of detection. Beryllium-7 is a cosmogenic radioactive material. Cosmogenic radioactive materials are created by cosmic radiation interactions in the earth's atmosphere. The beryllium-7 accumulates on the surface of the earth when washed out of the atmosphere by precipitation.

Alpha and beta radioactivity sample results for 2009 include six of 198 analytical results that exceed the historical range and the mean for all samples at the 95 percent confidence level. There is insufficient data to support the conclusion that alpha or beta radioactivity in the region is affected by operations at Vermont Yankee. The alpha and beta radioactivity measurements are most likely associated with variations of natural radioactive materials in the air. Gamma spectroscopy of air sample cartridges and filters around Vermont Yankee showed no evidence of radioactivity from the station.

Map 8

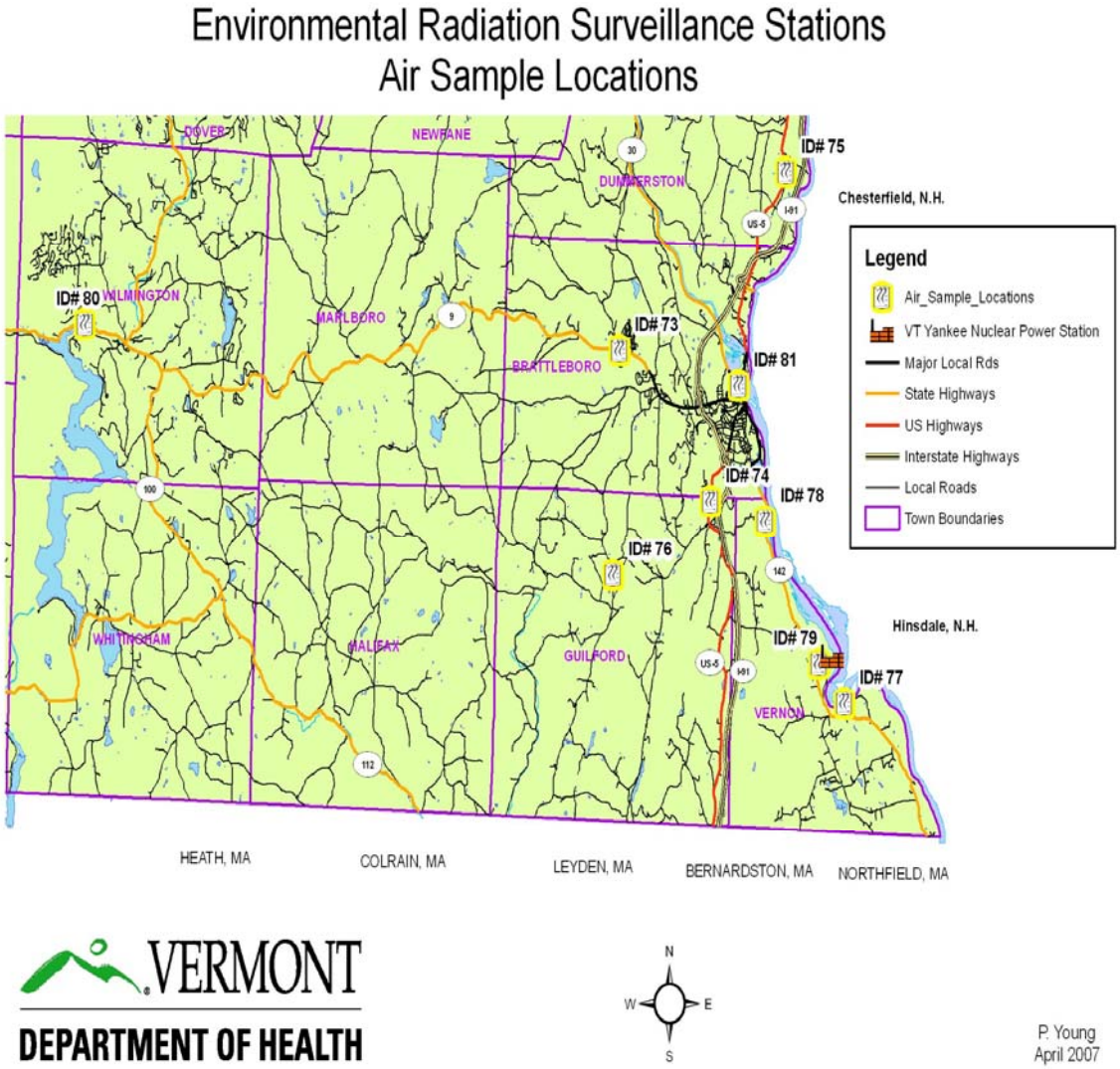

Environmental Radiation Surveillance Stations
Air Sample Locations
DOVER
NEWFANE
DUMMERSTON
ID# 75
Chesterfield, N.H.
ID# 80
WILMINGTON
MARLBORO
ID# 73
BRATTLEBORO
ID# 81
ID# 74
ID# 78
ID# 76
WHITINGHAM
MALIFAX
GUILFORD
Hinsdale, N.H.
ID# 79
ID# 77
VERNON
Legend
Air_Sample_Locations
VT Yankee Nuclear Power Station
Major Local Rds
State Highways
US Highways
Interstate Highways
Local Roads
Town Boundaries
HEATH, MA
COLRAIN, MA
LEYDEN, MA
BERNARDSTON, MA
NORTHFIELD, MA
VERMONT
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Table 7. 2009 Air Sample Alpha Radioactivity Results

Sample Date	Sample Location	Map ID No.	Results pCi/m^3	Error pCi/m^3
1/29/2009	Brattleboro State Police	73	0.00391	0.0008
1/29/2009	D & E Tree	74	0.00001	0.000237
1/29/2009	Dummerston State Garage	75	0.00398	0.0008
1/29/2009	Guilford Town Garage	76	0.00667	0.00111
1/29/2009	Power Line River Crossing	77	0.00496	0.0009
1/29/2009	Renauld Brothers	78	0.000566	0.000374
1/29/2009	Vernon Elementary School	79	0.000317	0.000304
1/29/2009	Wilmington State Garage	80	0.00287	0.00063
1/29/2009	Windham County Court	81	0.000238	0.000271
3/6/2009	Brattleboro State Police	73	0.00403	0.00082
3/6/2009	D & E Tree	74	0.00373	0.00079
3/6/2009	Dummerston State Garage	75	0.00418	0.00083
3/6/2009	Guilford Town Garage	76	0.000666	0.000424
3/6/2009	Power Line River Crossing	77	0.00516	0.00093
3/6/2009	Renauld Brothers	78	0.00412	0.00084
3/6/2009	Vernon Elementary School	79	0.00432	0.00083
3/6/2009	Wilmington State Garage	80	0.0025	0.00063
3/6/2009	Windham County Court	81	0.00216	0.0006
3/30/2009	Brattleboro State Police	73	0.00325	0.00095
3/30/2009	D & E Tree	74	0.00313	0.00093
3/30/2009	Dummerston State Garage	75	0.00343	0.00098
3/30/2009	Guilford Town Garage	76	0.00532	0.00127
3/30/2009	Power Line River Crossing	77	0.0029	0.00092
3/30/2009	Renauld Brothers	78	0.00278	0.00089
3/30/2009	Vernon Elementary School	79	0.00296	0.00065
3/30/2009	Wilmington State Garage	80	0.00288	0.00088
3/30/2009	Windham County Court	81	0.00369	0.00098
5/13/2009	Brattleboro State Police	73	0.00203	0.00055
5/13/2009	D & E Tree	74	0.00192	0.00054
5/13/2009	Dummerston State Garage	75	0.00221	0.00058
5/13/2009	Guilford Town Garage	76	0.00245	0.00063
5/13/2009	Power Line River Crossing	77	0.00252	0.00062
5/13/2009	Renauld Brothers	78	0.00209	0.00055
5/13/2009	Vernon Elementary School	79	0.00302	0.00066
5/13/2009	Wilmington State Garage	80	0.00301	0.00064
5/13/2009	Windham County Court	81	0.00259	0.0006

Table 7. 2009 Air Sample Alpha Radioactivity (continued)

Sample Date	Sample Location	Map ID No	Results pCi/m^3	Error pCi/m^3
6/25/2009	Brattleboro State Police	73	0.00161	0.00051
6/25/2009	D & E Tree	74	0.00183	0.00054
6/25/2009	Dummerston State Garage	75	0.00193	0.00055
6/25/2009	Guilford Town Garage	76	0.00231	0.00061
6/25/2009	Power Line River Crossing	77	0.00237	0.00061
6/25/2009	Renauld Brothers	78	0.00202	0.00055
6/25/2009	Vernon Elementary School	79	0.0027	0.00063
6/25/2009	Wilmington State Garage	80	0.00209	0.00056
6/25/2009	Windham County Court	81	0.000256	0.000457
7/22/2009	Brattleboro State Police	73	0.00109	0.00065
7/22/2009	D & E Tree	74	0.00141	0.0007
7/22/2009	Dummerston State Garage	75	0.000786	0.000608
7/22/2009	Guilford Town Garage	76	0.00147	0.00073
7/22/2009	Power Line River Crossing	77	0.0021	0.00081
7/22/2009	Renauld Brothers	78	0.000932	0.0006
7/22/2009	Vernon Elementary School	79	0.000873	0.000608
7/22/2009	Wilmington State Garage	80	0.00146	0.00069
7/22/2009	Windham County Court	81	0.000256	0.000457
8/24/2009	Brattleboro State Police	73	0.00102	0.00054
8/24/2009	D & E Tree	74	0.00348	0.00087
8/24/2009	Dummerston State Garage	75	0.000983	0.000406
8/24/2009	Guilford Town Garage	76	0.000795	0.000508
8/24/2009	Power Line River Crossing	77	0.00312	0.00083
8/24/2009	Renauld Brothers	78	0.0011	0.00055
8/24/2009	Vernon Elementary School	79	0.00942	0.00062
8/24/2009	Wilmington State Garage	80	0.000381	0.000304
8/24/2009	Windham County Court	81	0.000389	0.000396
9/23/2009	Brattleboro State Police	73	0.000424	0.000361
9/23/2009	D & E Tree	74	0.00209	0.00072
9/23/2009	Dummerston State Garage	75	0.000226	0.000616
9/23/2009	Guilford Town Garage	76	0.000755	0.00054
9/23/2009	Power Line River Crossing	77	0.00263	0.0008
9/23/2009	Renauld Brothers	78	0.00168	0.00069
9/23/2009	Vernon Elementary School	79	0.000142	0.000387
9/23/2009	Wilmington State Garage	80	0.000131	0.000359
9/23/2009	Windham County Court	81	0.000401	0.000425

Table 7. 2009 Air Sample Alpha Radioactivity (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/m^3	Error pCi/m^3
10/22/2009	Brattleboro State Police	73	0.0019	0.00074
10/22/2009	D & E Tree	74	0.00216	0.00078
10/22/2009	Dummerston State Garage	75	0.000359	0.000476
10/22/2009	Guilford Town Garage	76	0.000118	0.000472
10/22/2009	Power Line River Crossing	77	0.0022	0.0008
10/22/2009	Renauld Brothers	78	0.00119	0.0008
10/22/2009	Vernon Elementary School	79	0.000462	0.000509
10/22/2009	Wilmington State Garage	80	0.000384	0.000461
10/22/2009	Windham County Court	81	0.000351	0.00083
11/23/2009	Brattleboro State Police	73	0.000666	0.000461
11/23/2009	D & E Tree	74	0.000401	0.00032
11/23/2009	Dummerston State Garage	75	0.00059	0.000434
11/23/2009	Guilford Town Garage	76	0.000495	0.000468
11/23/2009	Power Line River Crossing	77	0.000304	0.000383
11/23/2009	Renauld Brothers	78	0.000741	0.000493
11/23/2009	Vernon Elementary School	79	0.000001	0.000304
11/23/2009	Wilmington State Garage	80	0.000123	0.000317
11/23/2009	Windham County Court	81	0.000124	0.000249
12/28/2009	Brattleboro State Police	73	0.000281	0.000272
12/28/2009	D & E Tree	74	0.000324	0.000287
12/28/2009	Dummerston State Garage	75	0.000425	0.000305
12/28/2009	Guilford Town Garage	76	0.00163	0.00059
12/28/2009	Power Line River Crossing	77	0.000233	0.000257
12/28/2009	Renauld Brothers	78	0.00325	0.00078
12/28/2009	Vernon Elementary School	79	0.000279	0.000269
12/28/2009	Wilmington State Garage	80	0.000258	0.000249
12/28/2009	Windham County Court	81	0.00198	0.00058

Figure 1. 2009 Mean Alpha Radioactivity in Air Around VYNPS

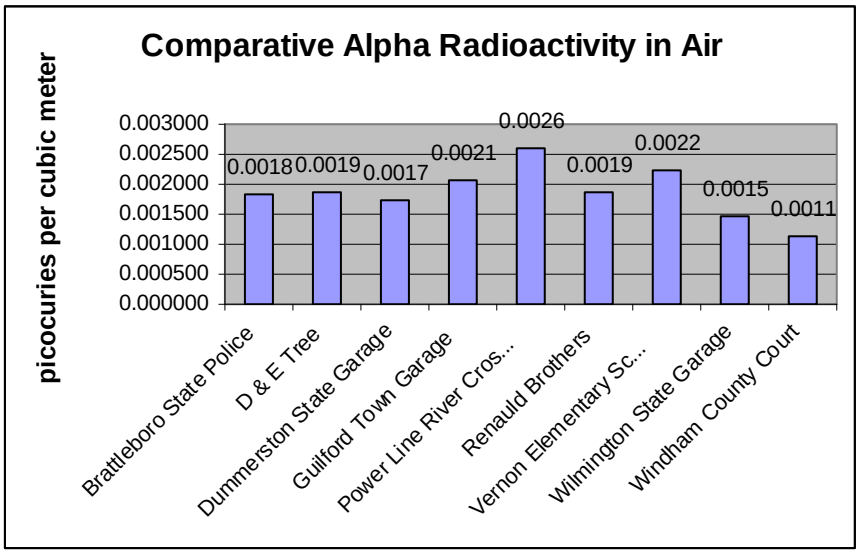


Table 8. 2009 Air Sample Beta Radioactivity Results

Sample Date	Sample Location	Map ID No.	Results pCi/m^3	Error pCi/m^3
1/29/2009	Brattleboro State Police	73	0.015800	0.001200
1/29/2009	D & E Tree	74	0.000010	0.000237
1/29/2009	Dummerston State Garage	75	0.018300	0.001300
1/29/2009	Guilford Town Garage	76	0.022100	0.001600
1/29/2009	Power Line River Crossing	77	0.019400	0.001400
1/29/2009	Renauld Brothers	78	0.000566	0.000374
1/29/2009	Vernon Elementary School	79	0.001270	0.000480
1/29/2009	Wilmington State Garage	80	0.001630	0.000500
1/29/2009	Windham County Court	81	0.001210	0.000450
3/6/2009	Brattleboro State Police	73	0.015100	0.001300
3/6/2009	D & E Tree	74	0.015500	0.001300
3/6/2009	Dummerston State Garage	75	0.016100	0.001300
3/6/2009	Guilford Town Garage	76	0.002610	0.000720
3/6/2009	Power Line River Crossing	77	0.017600	0.001400
3/6/2009	Renauld Brothers	78	0.017200	0.001400
3/6/2009	Vernon Elementary School	79	0.017100	0.001300
3/6/2009	Wilmington State Garage	80	0.009980	0.001010
3/6/2009	Windham County Court	81	0.012500	0.001100
3/30/2009	Brattleboro State Police	73	0.017700	0.001700
3/30/2009	D & E Tree	74	0.017700	0.001700
3/30/2009	Dummerston State Garage	75	0.017400	0.001700
3/30/2009	Guilford Town Garage	76	0.021400	0.002000
3/30/2009	Power Line River Crossing	77	0.019600	0.001800
3/30/2009	Renauld Brothers	78	0.018300	0.001800
3/30/2009	Vernon Elementary School	79	0.010200	0.000900
3/30/2009	Wilmington State Garage	80	0.016300	0.001600
3/30/2009	Windham County Court	81	0.017100	0.001700
5/13/2009	Brattleboro State Police	73	0.010200	0.001000
5/13/2009	D & E Tree	74	0.009720	0.000940
5/13/2009	Dummerston State Garage	75	0.010900	0.001000
5/13/2009	Guilford Town Garage	76	0.012400	0.001100
5/13/2009	Power Line River Crossing	77	0.011200	0.001000
5/13/2009	Renauld Brothers	78	0.008280	0.000860
5/13/2009	Vernon Elementary School	79	0.010100	0.000900
5/13/2009	Wilmington State Garage	80	0.010400	0.000900
5/13/2009	Windham County Court	81	0.010400	0.000900

Table 8. 2009 Air Sample Beta Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/m^3	Error pCi/m^3
6/25/2009	Brattleboro State Police	73	0.007600	0.000870
6/25/2009	D & E Tree	74	0.008980	0.000930
6/25/2009	Dummerston State Garage	75	0.008170	0.000890
6/25/2009	Guilford Town Garage	76	0.008180	0.000920
6/25/2009	Power Line River Crossing	77	0.009540	0.000960
6/25/2009	Renauld Brothers	78	0.005760	0.000760
6/25/2009	Vernon Elementary School	79	0.007640	0.000860
6/25/2009	Wilmington State Garage	80	0.007200	0.000830
6/25/2009	Windham County Court	81	0.001620	0.000760
7/22/2009	Brattleboro State Police	73	0.004380	0.001020
7/22/2009	D & E Tree	74	0.008500	0.001250
7/22/2009	Dummerston State Garage	75	0.005050	0.001080
7/22/2009	Guilford Town Garage	76	0.006780	0.001190
7/22/2009	Power Line River Crossing	77	0.008540	0.001270
7/22/2009	Renauld Brothers	78	0.004470	0.000990
7/22/2009	Vernon Elementary School	79	0.005350	0.001070
7/22/2009	Wilmington State Garage	80	0.008100	0.001200
7/22/2009	Windham County Court	81	0.001620	0.000760
8/24/2009	Brattleboro State Police	73	0.006080	0.000910
8/24/2009	D & E Tree	74	0.014200	0.001300
8/24/2009	Dummerston State Garage	75	0.001330	0.000640
8/24/2009	Guilford Town Garage	76	0.005110	0.000860
8/24/2009	Power Line River Crossing	77	0.015400	0.001400
8/24/2009	Renauld Brothers	78	0.005660	0.000880
8/24/2009	Vernon Elementary School	79	0.009420	0.001080
8/24/2009	Wilmington State Garage	80	0.001250	0.000520
8/24/2009	Windham County Court	81	0.001150	0.000520
9/23/2009	Brattleboro State Police	73	0.001920	0.000730
9/23/2009	D & E Tree	74	0.013500	0.001400
9/23/2009	Dummerston State Garage	75	0.001050	0.000990
9/23/2009	Guilford Town Garage	76	0.006520	0.001090
9/23/2009	Power Line River Crossing	77	0.013200	0.001400
9/23/2009	Renauld Brothers	78	0.006430	0.001080
9/23/2009	Vernon Elementary School	79	0.002920	0.000810
9/23/2009	Wilmington State Garage	80	0.000503	0.000565
9/23/2009	Windham County Court	81	0.002330	0.000730

Table 8. 2009 Air Sample Beta Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/m^3	Error pCi/m^3
10/22/2009	Brattleboro State Police	73	0.006410	0.001050
10/22/2009	D & E Tree	74	0.010800	0.001300
10/22/2009	Dummerston State Garage	75	0.001670	0.000720
10/22/2009	Guilford Town Garage	76	0.001390	0.000760
10/22/2009	Power Line River Crossing	77	0.009410	0.001230
10/22/2009	Renauld Brothers	78	0.002300	0.001000
10/22/2009	Vernon Elementary School	79	0.003650	0.000880
10/22/2009	Wilmington State Garage	80	0.000560	0.000589
10/22/2009	Windham County Court	81	0.001240	0.001440
11/23/2009	Brattleboro State Police	73	0.004790	0.000870
11/23/2009	D & E Tree	74	0.000766	0.000580
11/23/2009	Dummerston State Garage	75	0.002930	0.000730
11/23/2009	Guilford Town Garage	76	0.005100	0.000960
11/23/2009	Power Line River Crossing	77	0.001580	0.000640
11/23/2009	Renauld Brothers	78	0.002620	0.000760
11/23/2009	Vernon Elementary School	79	0.000708	0.000567
11/23/2009	Wilmington State Garage	80	0.000242	0.000489
11/23/2009	Windham County Court	81	0.000594	0.000528
12/28/2009	Brattleboro State Police	73	0.000548	0.000426
12/28/2009	D & E Tree	74	0.001520	0.000530
12/28/2009	Dummerston State Garage	75	0.001610	0.000520
12/28/2009	Guilford Town Garage	76	0.011000	0.001200
12/28/2009	Power Line River Crossing	77	0.000693	0.000444
12/28/2009	Renauld Brothers	78	0.013900	0.001300
12/28/2009	Vernon Elementary School	79	0.000564	0.000425
12/28/2009	Wilmington State Garage	80	0.000615	0.000404
12/28/2009	Windham County Court	81	0.011600	0.001100

Figure 2. 2009 Mean Beta Radioactivity in Air Around VYNPS

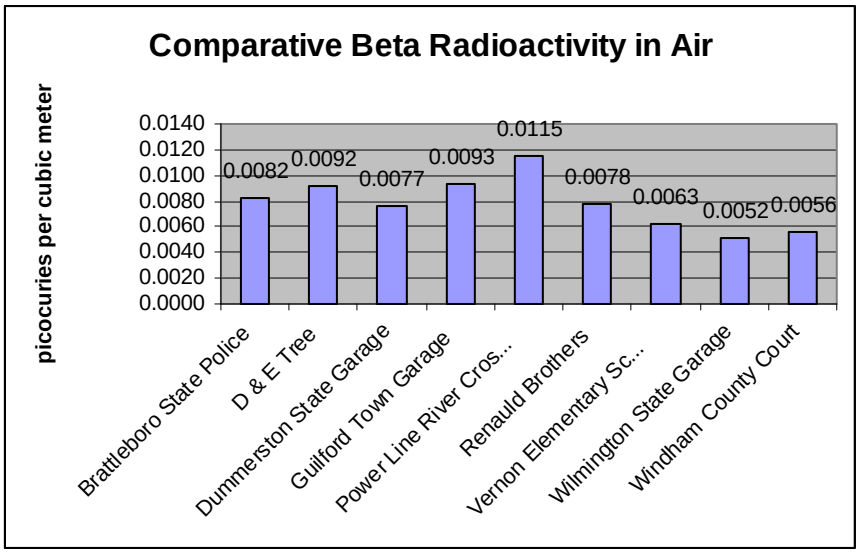


Table 9. 2009 Air Sample Radioactive Iodine-131 Results

Sample Date	Sample Location	Map ID No.	Results pCi/m^3
1/29/2009	Brattleboro State Police	73	< LOD
1/29/2009	D & E Tree	74	< LOD
1/29/2009	Dummerston State Garage	75	< LOD
1/29/2009	Guilford Town Garage	76	< LOD
1/29/2009	Power Line River Crossing	77	< LOD
1/29/2009	Renauld Brothers	78	< LOD
1/29/2009	Vernon Elementary School	79	< LOD
1/29/2009	Wilmington State Garage	80	< LOD
1/29/2009	Windham County Court	81	< LOD
3/6/2009	Brattleboro State Police	73	< LOD
3/6/2009	D & E Tree	74	< LOD
3/6/2009	Dummerston State Garage	75	< LOD
3/6/2009	Guilford Town Garage	76	< LOD
3/6/2009	Power Line River Crossing	77	< LOD
3/6/2009	Renauld Brothers	78	< LOD
3/6/2009	Vernon Elementary School	79	< LOD
3/6/2009	Wilmington State Garage	80	< LOD
3/6/2009	Windham County Court	81	< LOD
3/30/2009	Brattleboro State Police	73	< LOD
3/30/2009	D & E Tree	74	< LOD
3/30/2009	Dummerston State Garage	75	< LOD
3/30/2009	Guilford Town Garage	76	< LOD
3/30/2009	Power Line River Crossing	77	< LOD
3/30/2009	Renauld Brothers	78	< LOD
3/30/2009	Vernon Elementary School	79	< LOD
3/30/2009	Wilmington State Garage	80	< LOD
3/30/2009	Windham County Court	81	< LOD
5/13/2009	Brattleboro State Police	73	< LOD
5/13/2009	D & E Tree	74	< LOD
5/13/2009	Dummerston State Garage	75	< LOD
5/13/2009	Guilford Town Garage	76	< LOD
5/13/2009	Power Line River Crossing	77	< LOD
5/13/2009	Renauld Brothers	78	< LOD
5/13/2009	Vernon Elementary School	79	< LOD
5/13/2009	Wilmington State Garage	80	< LOD
5/13/2009	Windham County Court	81	< LOD

LOD = Limit of Detection of 0.003 picocuries per cubic meter (pCi/m^3)

Table 9. 2009 Air Sample Radioactive Iodine-131 Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/m^3
6/25/2009	Brattleboro State Police	73	< LOD
6/25/2009	D & E Tree	74	< LOD
6/25/2009	Dummerston State Garage	75	< LOD
6/25/2009	Guilford Town Garage	76	< LOD
6/25/2009	Power Line River Crossing	77	< LOD
6/25/2009	Renauld Brothers	78	< LOD
6/25/2009	Vernon Elementary School	79	< LOD
6/25/2009	Wilmington State Garage	80	< LOD
7/22/2009	Windham County Court	81	< LOD
7/22/2009	Brattleboro State Police	73	< LOD
7/22/2009	D & E Tree	74	< LOD
7/22/2009	Dummerston State Garage	75	< LOD
7/22/2009	Guilford Town Garage	76	< LOD
7/22/2009	Power Line River Crossing	77	< LOD
7/22/2009	Renauld Brothers	78	< LOD
7/22/2009	Vernon Elementary School	79	< LOD
7/22/2009	Wilmington State Garage	80	< LOD
7/22/2009	Windham County Court	81	< LOD
8/24/2009	Brattleboro State Police	73	< LOD
8/24/2009	D & E Tree	74	< LOD
8/24/2009	Dummerston State Garage	75	< LOD
8/24/2009	Guilford Town Garage	76	< LOD
8/24/2009	Power Line River Crossing	77	< LOD
8/24/2009	Renauld Brothers	78	< LOD
8/24/2009	Vernon Elementary School	79	< LOD
8/24/2009	Wilmington State Garage	80	< LOD
8/24/2009	Windham County Court	81	< LOD
9/23/2009	Brattleboro State Police	73	< LOD
9/23/2009	D & E Tree	74	< LOD
9/23/2009	Dummerston State Garage	75	< LOD
9/23/2009	Guilford Town Garage	76	< LOD
9/23/2009	Power Line River Crossing	77	< LOD
9/23/2009	Renauld Brothers	78	< LOD
9/23/2009	Vernon Elementary School	79	< LOD
9/23/2009	Wilmington State Garage	80	< LOD
9/23/2009	Windham County Court	81	< LOD

LOD = Limit of Detection of 0.003 picocuries per cubic meter (pCi/m^3)

Table 9. 2009 Air Sample Radioactive Iodine-131 Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/m^3
10/22/2009	Brattleboro State Police	73	< LOD
10/22/2009	D & E Tree	74	< LOD
10/22/2009	Dummerston State Garage	75	< LOD
10/22/2009	Guilford Town Garage	76	< LOD
10/22/2009	Power Line River Crossing	77	< LOD
10/22/2009	Renauld Brothers	78	< LOD
10/22/2009	Vernon Elementary School	79	< LOD
10/22/2009	Wilmington State Garage	80	< LOD
10/22/2009	Windham County Court	81	< LOD
11/23/2009	Brattleboro State Police	73	< LOD
11/23/2009	D & E Tree	74	< LOD
11/23/2009	Dummerston State Garage	75	< LOD
11/23/2009	Guilford Town Garage	76	< LOD
11/23/2009	Power Line River Crossing	77	< LOD
11/23/2009	Renauld Brothers	78	< LOD
11/23/2009	Vernon Elementary School	79	< LOD
11/23/2009	Wilmington State Garage	80	< LOD
11/23/2009	Windham County Court	81	< LOD
12/28/2009	Brattleboro State Police	73	< LOD
12/28/2009	D & E Tree	74	< LOD
12/28/2009	Dummerston State Garage	75	< LOD
12/28/2009	Guilford Town Garage	76	< LOD
12/28/2009	Power Line River Crossing	77	< LOD
12/28/2009	Renauld Brothers	78	< LOD
12/28/2009	Vernon Elementary School	79	< LOD
12/28/2009	Wilmington State Garage	80	< LOD
12/28/2009	Windham County Court	81	< LOD

LOD = Limit of Detection of 0.003 picocuries per cubic meter (pCi/m^3)

Table 10. 2009 Air Sample Gamma Radioactivity Results

Sample Date	Sample Location	Map ID No.	Results pCi/m^3
1/29/2009	Brattleboro State Police	73	Natural
1/29/2009	D & E Tree	74	Natural
1/29/2009	Dummerston State Garage	75	Natural
1/29/2009	Guilford Town Garage	76	Natural
1/29/2009	Power Line River Crossing	77	Natural
1/29/2009	Renauld Brothers	78	Natural
1/29/2009	Vernon Elementary School	79	Natural
1/29/2009	Wilmington State Garage	80	Natural
1/29/2009	Windham County Court	81	Natural
3/6/2009	Brattleboro State Police	73	Natural
3/6/2009	D & E Tree	74	Natural
3/6/2009	Dummerston State Garage	75	Natural
3/6/2009	Guilford Town Garage	76	Natural
3/6/2009	Power Line River Crossing	77	Natural
3/6/2009	Renauld Brothers	78	Natural
3/6/2009	Vernon Elementary School	79	Natural
3/6/2009	Wilmington State Garage	80	Natural
3/6/2009	Windham County Court	81	Natural
3/30/2009	Brattleboro State Police	73	Natural
3/30/2009	D & E Tree	74	Natural
3/30/2009	Dummerston State Garage	75	Natural
3/30/2009	Guilford Town Garage	76	Natural
3/30/2009	Power Line River Crossing	77	Natural
3/30/2009	Renauld Brothers	78	Natural
3/30/2009	Vernon Elementary School	79	Natural
3/30/2009	Wilmington State Garage	80	Natural
3/30/2009	Windham County Court	81	Natural
5/13/2009	Brattleboro State Police	73	Natural
5/13/2009	D & E Tree	74	Natural
5/13/2009	Dummerston State Garage	75	Natural
5/13/2009	Guilford Town Garage	76	Natural
5/13/2009	Power Line River Crossing	77	Natural
5/13/2009	Renauld Brothers	78	Natural
5/13/2009	Vernon Elementary School	79	Natural
5/13/2009	Wilmington State Garage	80	Natural
5/13/2009	Windham County Court	81	Natural

Table 10. 2009 Air Sample Gamma Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/m^3
6/25/2009	Brattleboro State Police	73	Natural
6/25/2009	D & E Tree	74	Natural
6/25/2009	Dummerston State Garage	75	Natural
6/25/2009	Guilford Town Garage	76	Natural
6/25/2009	Power Line River Crossing	77	Natural
6/25/2009	Renauld Brothers	78	Natural
6/25/2009	Vernon Elementary School	79	Natural
6/25/2009	Wilmington State Garage	80	Natural
7/22/2009	Windham County Court	81	Natural
7/22/2009	Brattleboro State Police	73	Natural
7/22/2009	D & E Tree	74	Natural
7/22/2009	Dummerston State Garage	75	Natural
7/22/2009	Guilford Town Garage	76	Natural
7/22/2009	Power Line River Crossing	77	Natural
7/22/2009	Renauld Brothers	78	Natural
7/22/2009	Vernon Elementary School	79	Natural
7/22/2009	Wilmington State Garage	80	Natural
7/22/2009	Windham County Court	81	Natural
8/24/2009	Brattleboro State Police	73	Natural
8/24/2009	D & E Tree	74	Natural
8/24/2009	Dummerston State Garage	75	Natural
8/24/2009	Guilford Town Garage	76	Natural
8/24/2009	Power Line River Crossing	77	Natural
8/24/2009	Renauld Brothers	78	Natural
8/24/2009	Vernon Elementary School	79	Natural
8/24/2009	Wilmington State Garage	80	Natural
8/24/2009	Windham County Court	81	Natural
9/23/2009	Brattleboro State Police	73	Natural
9/23/2009	D & E Tree	74	Natural
9/23/2009	Dummerston State Garage	75	Natural
9/23/2009	Guilford Town Garage	76	Natural
9/23/2009	Power Line River Crossing	77	Natural
9/23/2009	Renauld Brothers	78	Natural
9/23/2009	Vernon Elementary School	79	Natural
9/23/2009	Wilmington State Garage	80	Natural
9/23/2009	Windham County Court	81	Natural

Table 10. 2009 Air Sample Gamma Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/m^3
10/22/2009	Brattleboro State Police	73	Natural
10/22/2009	D & E Tree	74	Natural
10/22/2009	Dummerston State Garage	75	Natural
10/22/2009	Guilford Town Garage	76	Natural
10/22/2009	Power Line River Crossing	77	Natural
10/22/2009	Renauld Brothers	78	Natural
10/22/2009	Vernon Elementary School	79	Natural
10/22/2009	Wilmington State Garage	80	Natural
10/22/2009	Windham County Court	81	Natural
11/23/2009	Brattleboro State Police	73	Natural
11/23/2009	D & E Tree	74	Natural
11/23/2009	Dummerston State Garage	75	Natural
11/23/2009	Guilford Town Garage	76	Natural
11/23/2009	Power Line River Crossing	77	Natural
11/23/2009	Renauld Brothers	78	Natural
11/23/2009	Vernon Elementary School	79	Natural
11/23/2009	Wilmington State Garage	80	Natural
11/23/2009	Windham County Court	81	Natural
12/28/2009	Brattleboro State Police	73	Natural
12/28/2009	D & E Tree	74	Natural
12/28/2009	Dummerston State Garage	75	Natural
12/28/2009	Guilford Town Garage	76	Natural
12/28/2009	Power Line River Crossing	77	Natural
12/28/2009	Renauld Brothers	78	Natural
12/28/2009	Vernon Elementary School	79	Natural
12/28/2009	Wilmington State Garage	80	Natural
12/28/2009	Windham County Court	81	Natural

Table 11. 2009 Air Sample Quarterly Composite Results

Sample Date	Sample Location	Results pCi	Error pCi	Sample Comment
4/15/2009	All 9 Vermont Yankee Filters for Quarter 1	5730	460	Be-7
7/18/2009	All 9 Vermont Yankee Filters for Quarter 2	6140	540	Be-7
11/13/2009	All 9 Vermont Yankee Filters for Quarter 3	6490	510	Be-7
1/13/2009	All 9 Vermont Yankee Filters for Quarter 4	5830	290	Be-7

Table 12. Common Natural Gamma Radiation Emitters

	Actinium-228	Beryllium-7
Bismuth-212	Bismuth-214	Lead-210
Lead-212	Lead-214	Polonium-210
Potassium-40	Radium-224	Radium-226
Radium-228	Thallium-208	Thorium-228
Thorium-229	Thorium-230	Thorium-231
Thorium-232	Thorium-234	Uranium-233
Uranium-234	Uranium-235	Uranium-238

Table 13. Nuclear Facility Gamma Radiation Emitters

Antimony-124	Antimony-126	Barium-140/Lanthanum-140
Cerium-144/Promethium-144	Cesium-134	Cesium-136
Cesium-137	Chromium-51	Cobalt-56
Cobalt-58	Cobalt-60	Iodine-131
Iodine-132	Iodine-133	Iodine-135
Krypton-85	Krypton-88	Manganese-54
Neptunium-239	Plutonium-239	Plutonium-240
Ruthenium-103	Strontium-85	Strontium-89
Tellurium-132	Xenon-133	Xenon-133m
Xenon-135	Zinc-65	Zirconium-95/Niobium-95

Water Sampling Results

Water is sampled each month at 10 locations. Six are sample locations in the Connecticut River. Of these six Connecticut River locations, two samples are taken monthly in the pool where the station discharges cooling water, two are taken monthly downstream from the station in the pool just below the Vernon dam, and two are taken from the river upstream from the station in Brattleboro. The remaining four sample locations include one representing the Brattleboro municipal water supply, and one each from drinking water wells that serve the Miller and Blodgett Farms in Vernon and the Vernon Elementary School. Results are in Tables 14, 15, 16, and 17.

Each of the water samples undergoes four different analyses. The first three analyses are like those for the air samples: analysis for alpha radioactivity, analysis for beta radioactivity, and analysis for radionuclides by gamma spectroscopy. The fourth analysis is unique to water samples. It is an analysis for tritium, the common name for the radioisotope hydrogen-3. Gamma and tritium analyses of groundwater samples from Vermont Yankee's on-site groundwater monitoring wells have been included since the 2008 report.

The concerns about alpha, beta and gamma radiation were discussed earlier. Tritium is a source of very weak beta radiation. Tritium is created when water passes through the reactor core. The reactor coolant water at Vermont Yankee, as is the case at all nuclear power stations, becomes tritiated as the hydrogen atoms in water molecules are activated by neutron radiation in the reactor core. Tritiated water may leave the power station-site in the same ways that non-radioactive water leaves the station – in the air, in groundwater and through discharges into surface waters like the Connecticut River. Unmonitored tritium releases from nuclear facilities have always been a source of concern. Tritium monitoring by the Health Department may help identify releases if they develop.

In January 2010, tritium contamination of on-site groundwater was verified at Vermont Yankee. For the purposes of this report, groundwater is defined as water above bedrock,

while drinking water is below bedrock. To date, no on-site or off-site drinking water or Connecticut River water has been sampled and found to have tritium contamination above the lower limit of detection. Only groundwater within a relatively narrow plume on Vermont Yankee property has been found to be contaminated with tritium.

Map 10 shows the routine water sample locations around the Vermont Yankee site. Tables 14, 15, 16 and 17 present the water sample results. The tables list the map identification numbers so the locations can be seen on Map 10. Sample locations 84A and 86 are in the Connecticut River downstream. These are labeled in Tables 14 to 17 as Connecticut River, Station 3-3 and Connecticut River Downstream. Sample locations 84B and 84D are in the basin where Vermont Yankee Nuclear Power Station discharges water from the station into the Connecticut River. The tables identify them as Connecticut River, Station 3-4 and Discharge Forebay. Samples 84C and 87 are in the Connecticut River upstream of the station. They are identified as Connecticut River, Station 3-8 and Connecticut River Upstream in Tables 14, 15, 16 and 17. Connecticut River Station 3-8 is where Route 9 crosses the Connecticut River north of Brattleboro. The sample for the Connecticut River Upstream is taken where Route 119 crosses the Connecticut River near downtown Brattleboro.

In addition to showing the individual analysis results over the course of 2009, the mean results of each of the samples at the 10 water sample locations are plotted. Figures 4 and 5 allow comparisons of the mean alpha and mean beta radioactivity results for the 10 locations.

Alpha Radioactivity Analyses

The alpha radioactivity measured in all samples is within the historical range for alpha radioactivity. In particular, alpha radioactivity measurements around Vermont Yankee over the past 38 years of operations and environmental surveillance have ranged from below the limit of detection for alpha radioactivity up to 15 picocuries per liter (pCi). The 2009 results for all samples ranged from -1.33 to 11.3 pCi/L and are shown in Table 14.

The mean results, shown in Figure 4, indicate the Blodgett Farm and the Vernon Elementary School have the highest natural alpha emitters in their water. This has been the case for many years. Past Health Department water samples analyzed for natural radioactivity indicate radioisotopes of radium and uranium are likely responsible for the higher alpha and beta radioactivity at the Blodgett Farm and the Vernon Elementary School.

The mean Connecticut River upstream sample results, having a range of -0.954 to 1.862 picocuries per liter (pCi/L) at the 95 percent confidence level, may be useful as an indicator of background. These results can be compared to results of water samples taken in the Connecticut River near the Vermont Yankee Nuclear Power Station discharge area, and downstream in the Connecticut River. The upstream samples are taken near Brattleboro. Considering the results with uncertainty at the 95 percent confidence level, there is no statistical difference between water samples in the discharge basin and downstream from Vermont Yankee Nuclear Power Station, compared to water samples upstream from Vermont Yankee. The samples more likely to be affected by Vermont Yankee Nuclear Power Station operations, near the discharge and downstream from the station discharge, have mean sample results in the range of -1.107 to 2.097 pCi/L and -0.953 to 2.046 pCi/L, respectively.

Beta Radioactivity Analysis

The beta radioactivity analysis results are found in Table 15. The results were all well within the historical range of less than the calculated limit of detection and 15 picocuries per liter. Specifically, the measurements in Table 15 range from -1.81 to 9.55 picocuries per liter. Taking the mean results for each of the sample sites and plotting them gives us the graph in Figure 5. In this graph, some of the characteristic results observed in the alpha radioactivity analyses are also seen with beta radioactivity. Specifically, the river water samples contain significantly less radioactivity compared to the groundwater samples. Also like the alpha radioactivity sample results, the samples from the Connecticut River near the Vermont Yankee Nuclear Power Station discharge area and

downstream of the station, ranging from -1.887 to 3.432 pCi/L and from -0.916 to 3.087 pCi/L, respectively, are not significantly different from the samples taken from the Connecticut River upstream from the power station, where the sample means ranged between -1.923 and 4.675 pCi/L.

One difference between the alpha and beta radioactivity measurements is what is seen in the well water drinking water measurements. While the Blodgett Farm and the Vernon Elementary School alpha radioactivity samples were significantly higher than the Miller Farm alpha radioactivity results, the beta radioactivity measurements for the three sites fed by well water are not significantly different. The elevated beta radioactivity at Miller Farm is not coincident with elevated alpha radioactivity, and this characteristic is thought to be due to the different geological attributes at each of the sites causing the expression of certain natural radioactive materials and not others.

Gamma Spectroscopy

Gamma spectroscopy is a technique that allows for the identification and quantification of radioactive material that emits gamma radiation. Most of the water samples, 83 of them, were found to be less than the calculated limit of detection. Gamma radiation-emitting radioactive materials were identified in the remaining 29 samples, but all were naturally occurring radioactive materials. All but one of those samples with detectable gamma radiation from naturally occurring radionuclides are drinking water samples where the drinking water source is a deep well – the Blodgett and Miller Farms and Vernon Elementary School. The gamma spectroscopy results for the water samples are found in Table 16. The calculated limits of detection for water samples are listed in Table 19. The commonly identified natural radioactive materials that emit gamma radiation are listed in Table 12.

Off-site Tritium Measurement Results

For 2009, no tritium radioactivity above the laboratory instrumentation limit of detection of approximately 300 pCi/L was identified in any of the off-site drinking water, surface water or municipal water samples obtained by the Health Department. The range of results was from -554 to197 pCi/L. Again, the locations sampled include three private drinking water wells near Vermont Yankee, the municipal water supply in Brattleboro, and the Connecticut River where the station discharges cooling water in the Vernon Pool, downstream from the Vernon Dam and upstream in the Brattleboro area. All of the tritium analysis results are presented in Table 17.

On-site Groundwater Well Sample Results

Groundwater analysis has been conducted for years by Vermont Yankee to ascertain whether drinking water or river water could become contaminated by station operations. Most samples have been obtained from wells near leach fields to verify compliance with Vermont Department of Environmental Conservation permits. In November 2007, Vermont Yankee added three wells between station structures and the Connecticut River specifically to monitor groundwater for tritium and other radioactive materials. These three wells, GZ-1, GZ-3 and GZ-5, were sampled to assist with the detection of leaks from the station's systems into the environment. This was part of Vermont Yankee's effort to meet the voluntary elements of the Nuclear Energy Institute's Groundwater Protection Initiative. This initiative was sponsored by the Institute in response to the discovery of leaks at several nuclear power staions in the U.S. starting in 2005.

The Health Department started getting field duplicate samples, sometimes referred to as split samples, from the three groundwater protection monitoring wells, GZ-1, GZ-3 and GZ-5, and four other wells used to monitor a septage spreading field at the south end of the site in October 2008. These spreading field samples are designated GW0201, GW0202, GW0203 and GW0204. The field duplicates were obtained from the same locations and at the same times as samples for Vermont Yankee were obtained, so they are meant to be nearly identical samples. All of the Health Department's samples were

shipped directly to the Health Department Laboratory for analysis. Each year, a Health Department representative witnesses the sampling of these wells to verify the work was done in accordance with industry best practices.

For four calendar quarters starting in October 2008, samples obtained from these seven wells were analyzed and found to have no tritium above the lower limit of detection of 300 pCi/L. They were also analyzed by gamma spectroscopy for other radioactive materials, and none indicated any radioactive materials related to operations at Vermont Yankee. One of the samples for the last quarter of 2009, for groundwater monitoring well GZ-3, resulted in tritium activity measured at 569 $\pm$ 171 pCi/L. This November 17, 2009 sample and other samples obtained by Vermont Yankee led to an extensive investigation for the sources of the tritium and other radioactive materials that leaked from Vermont Yankee systems into the environment. Table 18 lists these results.

Figure 3

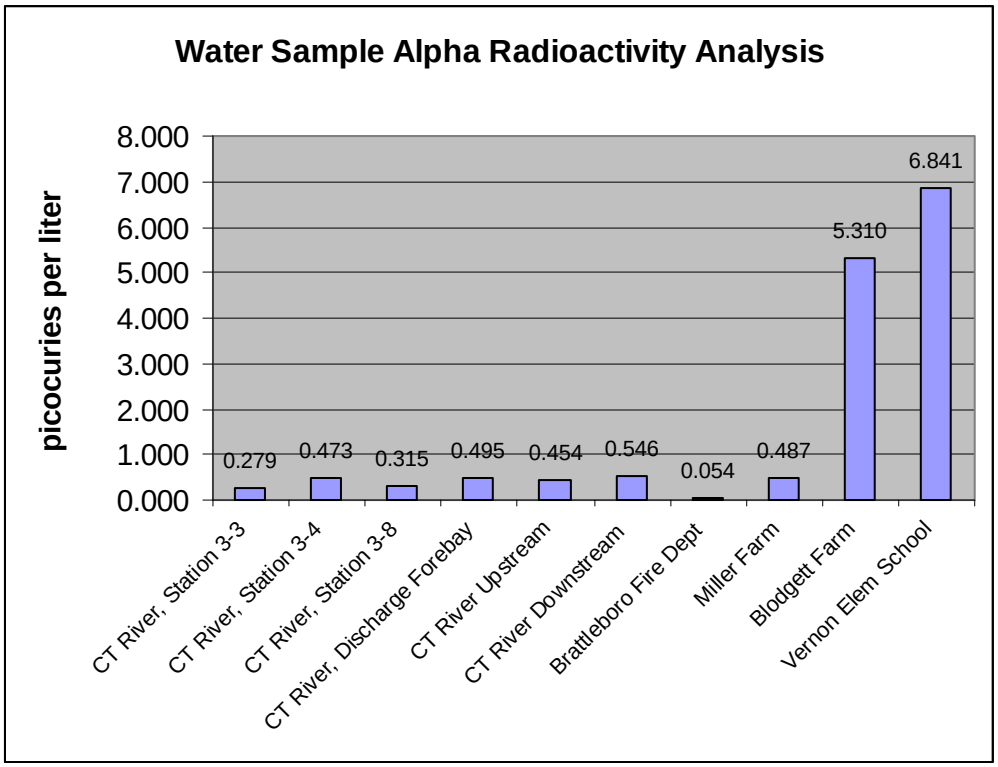
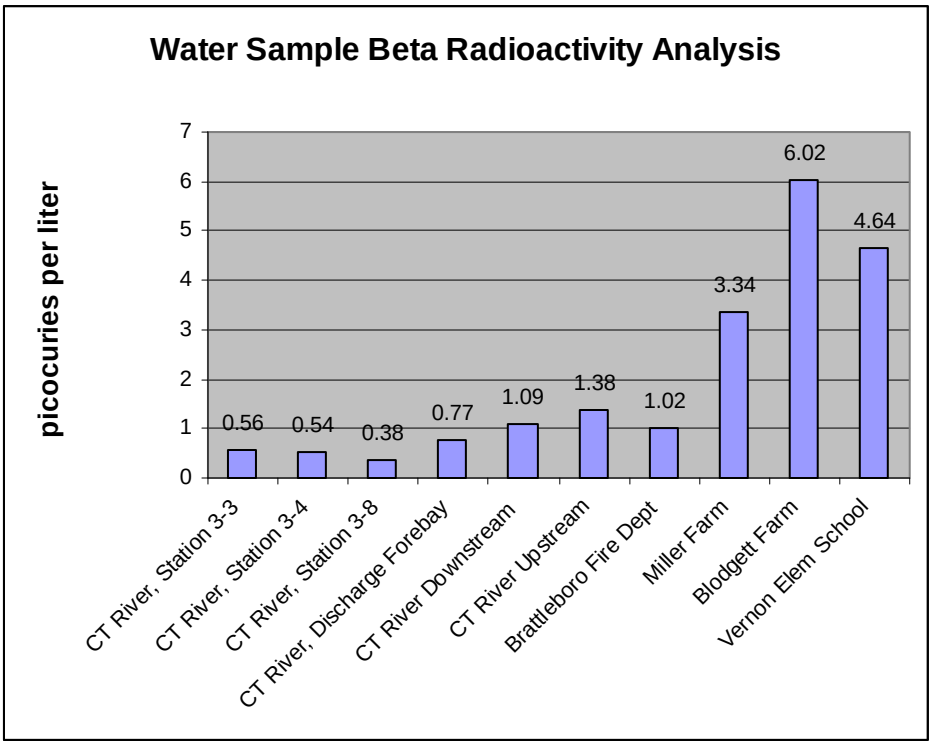

Water Sample Alpha Radioactivity Analysis
picocuries per liter
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
0.279
0.473
0.315
0.495
0.454
0.546
0.054
0.487
5.310
6.841
CT River, Station 3-3
CT River, Station 3-4
CT River, Station 3-8
CT River, Discharge Forebay
CT River Upstream
CT River Downstream
Brattleboro Fire Dept
Miller Farm
Blodgett Farm
Vernon Elem School

Figure 4


Water Sample Beta Radioactivity Analysis
picocuries per liter
0
1
2
3
4
5
6
7
0.56
0.54
0.38
0.77
1.09
1.38
1.02
3.34
6.02
4.64
CT River, Station 3-3
CT River, Station 3-4
CT River, Station 3-8
CT River, Discharge Forebay
CT River Downstream
CT River Upstream
Brattleboro Fire Dept
Miller Farm
Blodgett Farm
Vernon Elem School

Map 9

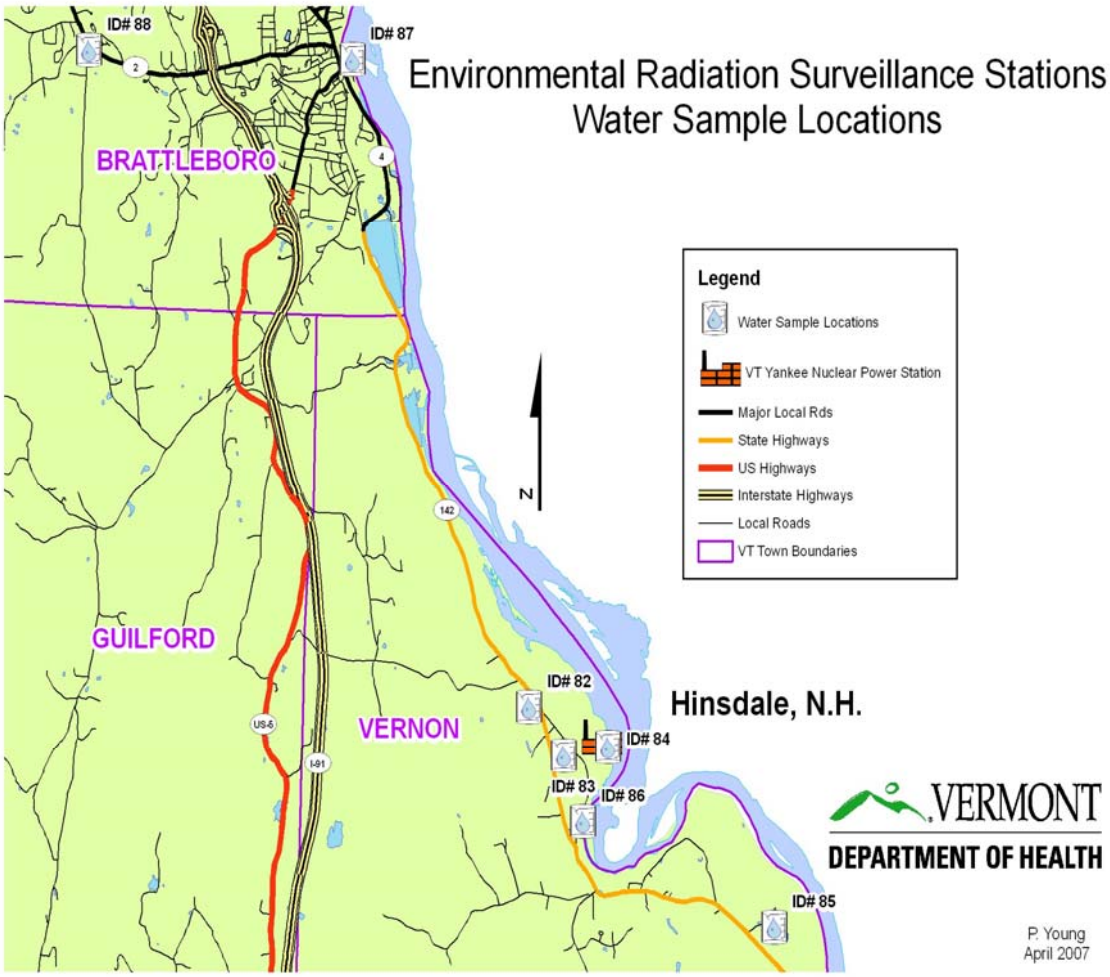

Environmental Radiation Surveillance Stations
Water Sample Locations
ID# 88
ID# 87
BRATTLEBORO
GUILFORD
VERNON
ID# 82
ID# 84
ID# 83
ID# 86
ID# 85
Hinsdale, N.H.
N
Legend
Water Sample Locations
VT Yankee Nuclear Power Station
Major Local Rds
State Highways
US Highways
Interstate Highways
Local Roads
VT Town Boundaries
VERMONT
DEPARTMENT OF HEALTH
P. Young
April 2007

Table 14. 2009 Water Sample Alpha Radioactivity Results

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L	Analysis Method
1/14/2009	3-3	84A	1.35	1.31	EPA 900
1/14/2009	3-4	84B	1.08	1.29	EPA 900
1/14/2009	3-8	84C	0	0.41	EPA 900
1/14/2009	Discharge Forebay	84D	0.89	1.4	EPA 900
1/29/2009	Vernon Elem School	83	6.75	1.25	EERF 00-02
1/29/2009	Brattleboro Fire Dept	88	-0.15	0.68	EPA 900
1/29/2009	Conn River Downstream	86	1.58	1.29	EPA 900
1/29/2009	Blodgett Farm	85	4.66	1.13	EERF 00-02
1/29/2009	Miller Farm	82	0.42	0.82	EERF 00-02
2/16/2009	3-3	84A	-0.26	1.33	EPA 900
2/16/2009	3-4	84B	1.33	1.46	EPA 900
2/16/2009	3-8	84C	-0.09	0.47	EPA 900
2/16/2009	Discharge Forebay	84D	0	1.38	EPA 900
3/6/2009	Blodgett Farm	85	5.72	1.18	EERF 00-02
3/6/2009	Brattleboro Fire Dept	88	0.15	0.7	EPA 900
3/6/2009	Conn River Downstream	86	0.26	1.38	EPA 900
3/6/2009	Conn River Upstream	87	-0.26	1.34	EPA 900
3/6/2009	Miller Farm	82	1.84	0.92	EERF 00-02
3/6/2009	Vernon Elem School	83	5.79	1.18	EERF 00-02
3/16/2009	3-3	84A	0.27	1.36	EPA 900
3/16/2009	3-4	84B	0.6	0.8	EPA 900
3/16/2009	3-8	84C	0.42	0.56	EPA 900
3/16/2009	Discharge Forebay	84D	0	0.76	EPA 900
3/30/2009	Blodgett Farm	85	5.58	1.14	EERF 00-02
3/30/2009	Brattleboro Fire Dept	88	0.32	0.81	EPA 900
3/30/2009	Conn River Downstream	86	0.62	1.32	EPA 900
3/30/2009	Conn River Upstream	87	0.54	0.58	EPA 900
3/30/2009	Miller Farm	82	0.66	0.79	EERF 00-02
3/30/2009	Vernon Elem School	83	5.58	1.14	EERF 00-02
4/15/2009	3-3	84A	0	0.84	EPA 900
4/15/2009	3-4	84B	-0.26	1.45	EPA 900
4/15/2009	3-8	84C	0	0.56	EPA 900
4/15/2009	Discharge Forebay	84D	0.45	0.87	EPA 900

Table 14. 2009 Water Sample Alpha Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L	Analysis Method
5/13/2009	Blodgett Farm	85	4.18	1.05	EERF 00-02
5/13/2009	Brattleboro Fire Dept	88	0.45	0.88	EPA 900
5/13/2009	Conn River Downstream	86	0.14	0.83	EPA 900
5/13/2009	Conn River Upstream	87	0.74	0.88	EPA 900
5/13/2009	Miller Farm	82	0.46	0.77	EERF 00-02
5/13/2009	Vernon Elem School	83	5.24	1.12	EERF 00-02
5/14/2009	3-3	84A	0.15	0.87	EPA 900
5/14/2009	3-4	84B	0.45	0.87	EPA 900
5/14/2009	3-8	84C	0.27	0.77	EPA 900
5/14/2009	Discharge Forebay	84D	0.59	0.87	EPA 900
6/15/2009	3-3	84A	0.76	0.85	EPA 900
6/15/2009	3-4	84B	-0.26	1.34	EPA 900
6/15/2009	3-8	84C	1.32	1.48	EPA 900
6/15/2009	Discharge Forebay	84D	1.33	1.49	EPA 900
6/25/2009	Blodgett Farm	85	4.89	1.11	EERF 00-02
6/25/2009	Brattleboro Fire Dept	88	0.15	0.83	EPA 900
6/25/2009	Conn River Downstream	86	0	0.84	EPA 900
6/25/2009	Conn River Upstream	87	-0.31	1.63	EPA 900
6/25/2009	Miller Farm	82	0	0.74	EERF 00-02
6/25/2009	Vernon Elem School	83	4.48	1.08	EERF 00-02
7/16/2009	3-3	84A	0.31	0.81	EPA 900
7/16/2009	3-4	84B	0.3	0.78	EPA 900
7/16/2009	3-8	84C	0.45	0.79	EPA 900
7/16/2009	Discharge Forebay	84D	1.22	0.84	EPA 900
7/22/2009	Blodgett Farm	85	4.53	1.04	EERF 00-02
7/22/2009	Brattleboro Fire Dept	88	-0.32	1.61	EPA 900
7/22/2009	Conn River Downstream	86	0.27	1.38	EPA 900
7/22/2009	Conn River Upstream	87	1.44	1.54	EPA 900
7/22/2009	Miller Farm	82	0.42	0.71	EERF 00-02
7/22/2009	Vernon Elem School	83	7.74	1.24	EERF 00-02
8/13/2009	3-3	84A	0.52	1.28	EPA 900
8/13/2009	3-4	84B	1.1	1.38	EPA 900
8/13/2009	3-8	84C	0.83	1.37	EPA 900
8/13/2009	Discharge Forebay	84D	-0.27	1.28	EPA 900
8/24/2009	Blodgett Farm	85	5.11	1.05	EERF 00-02
8/24/2009	Brattleboro Fire Dept	88	0	1.36	EPA 900
8/24/2009	Conn River Downstream	86	0.28	0.68	EPA 900
8/24/2009	Conn River Upstream	87	0.87	1.45	EPA 900
8/24/2009	Miller Farm	82	0.42	0.67	EERF 00-02
8/24/2009	Vernon Elem School	83	11.3	1.4	EERF 00-02

Table 14. 2009 Water Sample Alpha Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L	Analysis Method
9/15/2009	3-3	84A	-0.52	1.51	EPA 900
9/15/2009	3-4	84B	-0.29	1.68	EPA 900
9/15/2009	3-8	84C	-0.27	1.56	EPA 900
9/15/2009	Discharge Forebay	84D	1.08	1.68	EPA 900
9/23/2009	Blodgett Farm	85	7.17	1.26	EERF 00-02
9/23/2009	Brattleboro Fire Dept	88	0	1.54	EPA 900
9/23/2009	Conn River Downstream	86	0.56	1.69	EPA 900
9/23/2009	Conn River Upstream	87	-0.27	1.58	EPA 900
9/23/2009	Miller Farm	82	-0.14	0.74	EERF 00-02
9/23/2009	Vernon Elem School	83	6.46	1.22	EERF 00-02
10/15/2009	3-3	84A	-0.28	1.56	EPA 900
10/15/2009	3-4	84B	0	1.5	EPA 900
10/15/2009	3-8	84C	-0.27	1.48	EPA 900
10/15/2009	Discharge Forebay	84D	-1.33	1.43	EPA 900
10/22/2009	Blodgett Farm	85	6.16	1.19	EERF 00-02
10/22/2009	Brattleboro Fire Dept	88	-1.08	1.46	EPA 900
10/22/2009	Conn River Downstream	86	-0.79	1.44	EPA 900
10/22/2009	Conn River Upstream	87	-0.88	1.61	EPA 900
10/22/2009	Miller Farm	82	0.57	0.79	EERF 00-02
10/22/2009	Vernon Elem School	83	6.65	1.22	EERF 00-02
11/13/2009	3-3	84A	0.3	0.79	EPA 900
11/13/2009	3-4	84B	0.26	1.35	EPA 900
11/13/2009	3-8	84C	0.66	0.71	EPA 900
11/13/2009	Discharge Forebay	84D	1.06	1.41	EPA 900
11/23/2009	Brattleboro Fire Dept	85	0	0.78	EPA 900
11/23/2009	Conn River Downstream	88	1.35	0.84	EPA 900
11/23/2009	Conn River Upstream	86	1.37	1.47	EPA 900
11/23/2009	Miller Farm	87	0.64	0.73	EERF 00-02
11/23/2009	Vernon Elem School	82	8.35	1.28	EERF 00-02
12/14/2009	3-3	83	0.75	0.74	EPA 900
12/14/2009	3-4	84A	1.37	0.8	EPA 900
12/14/2009	3-8	84B	0.46	0.39	EPA 900
12/14/2009	Discharge Forebay	84C	0.92	0.77	EPA 900
12/28/2009	Blodgett Farm	84D	5.1	1.1	EERF 00-02
12/28/2009	Brattleboro Fire Dept	85	1.07	1.31	EPA 900
12/28/2009	Conn River Downstream	88	1.74	0.85	EPA 900
12/28/2009	Conn River Upstream	86	1.3	1.6	EPA 900
12/28/2009	Miller Farm	87	0.07	0.72	EERF 00-02
12/28/2009	Vernon Elem School	82	6.91	1.21	EERF 00-02

Table 15. 2009 Water Sample Beta Radioactivity Results

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L	Analysis Method
1/14/2009	3-3	84A	0.15	1.99	EPA 900
1/14/2009	3-4	84B	-1.08	1.96	EPA 900
1/14/2009	3-8	84C	0.34	0.41	EPA 900
1/14/2009	Discharge Forebay	84D	0.31	2	EPA 900
1/29/2009	Vernon Elem School	83	4.35	2..11	EPA 900
1/29/2009	Brattleboro Fire Dept	88	0.39	1.01	EPA 900
1/29/2009	Conn River Downstream	86	1.39	2.03	EPA 900
1/29/2009	Blodgett Farm	85	6.23	2.16	EPA 900
1/29/2009	Miller Farm	82	3.11	2.08	EPA 900
2/16/2009	3-3	84A	0.62	2.01	EPA 900
2/16/2009	3-4	84B	-86	168	EPA 900
2/16/2009	3-8	84C	0	0.67	EPA 900
2/16/2009	Discharge Forebay	84D	-0.47	1.99	EPA 900
3/6/2009	Blodgett Farm	85	5.81	2.16	EPA 900
3/6/2009	Brattleboro Fire Dept	88	0.7	1.02	EPA 900
3/6/2009	Conn River Downstream	86	-0.78	1.98	EPA 900
3/6/2009	Conn River Upstream	87	-0.16	1.99	EPA 900
3/6/2009	Miller Farm	82	4.4	2.12	EPA 900
3/6/2009	Vernon Elem School	83	4.07	2.11	EPA 900
3/16/2009	3-3	84A	-0.46	1.83	EPA 900
3/16/2009	3-4	84B	0.7	0.94	EPA 900
3/16/2009	3-8	84C	0.83	0.63	EPA 900
3/16/2009	Discharge Forebay	84D	0.85	0.94	EPA 900
3/30/2009	Blodgett Farm	85	4.99	1.96	EPA 900
3/30/2009	Brattleboro Fire Dept	88	0.85	0.94	EPA 900
3/30/2009	Conn River Downstream	86	1.2	0.95	EPA 900
3/30/2009	Conn River Upstream	87	1.14	0.64	EPA 900
3/30/2009	Miller Farm	82	2.65	1.91	EPA 900
3/30/2009	Vernon Elem School	83	4.35	1.95	EPA 900
4/15/2009	3-3	84A	0.62	1.02	EPA 900
4/15/2009	3-4	84B	-1.09	1.98	EPA 900
4/15/2009	3-8	84C	0	0.67	EPA 900
4/15/2009	Discharge Forebay	84D	0.55	1.02	EPA 900

Table 15. 2009 Water Sample Beta Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L	Analysis Method
5/13/2009	Blodgett Farm	85	4.38	2.13	EPA 900
5/13/2009	Brattleboro Fire Dept	88	0.08	1.01	EPA 900
5/13/2009	Conn River Downstream	86	1.01	1.03	EPA 900
5/13/2009	Conn River Upstream	87	1.01	1.03	EPA 900
5/13/2009	Miller Farm	82	1.25	2.05	EPA 900
5/13/2009	Vernon Elem School	83	3.75	2.11	EPA 900
5/14/2009	3-3	84A	1.4	1.04	EPA 900
5/14/2009	3-4	84B	1.01	1.03	EPA 900
5/14/2009	3-8	84C	-0.16	1	EPA 900
5/14/2009	Discharge Forebay	84D	0.55	1.02	EPA 900
6/15/2009	3-3	84A	1.76	0.88	EPA 900
6/15/2009	3-4	84B	2.59	1.74	EPA 900
6/15/2009	3-8	84C	1.98	1.72	EPA 900
6/15/2009	Discharge Forebay	84D	2.6	1.74	EPA 900
6/25/2009	Blodgett Farm	85	6.75	1.85	EPA 900
6/25/2009	Brattleboro Fire Dept	88	1.99	0.89	EPA 900
6/25/2009	Conn River Downstream	86	2.07	0.89	EPA 900
6/25/2009	Conn River Upstream	87	3.37	1.76	EPA 900
6/25/2009	Miller Farm	82	4.44	1.79	EPA 900
6/25/2009	Vernon Elem School	83	5.21	1.81	EPA 900
7/16/2009	3-3	84A	-0.15	0.9	EPA 900
7/16/2009	3-4	84B	-0.15	0.9	EPA 900
7/16/2009	3-8	84C	-0.23	0.9	EPA 900
7/16/2009	Discharge Forebay	84D	-0.38	0.9	EPA 900
7/22/2009	Blodgett Farm	85	3.18	1.9	EPA 900
7/22/2009	Brattleboro Fire Dept	88	0.23	0.91	EPA 900
7/22/2009	Conn River Downstream	86	-0.45	1.8	EPA 900
7/22/2009	Conn River Upstream	87	-1.81	1.77	EPA 900
7/22/2009	Miller Farm	82	0.6	1.83	EPA 900
7/22/2009	Vernon Elem School	83	1.06	1.84	EPA 900
8/13/2009	3-3	84A	-0.61	1.78	EPA 900
8/13/2009	3-4	84B	0.31	1.81	EPA 900
8/13/2009	3-8	84C	-1.07	1.77	EPA 900
8/13/2009	Discharge Forebay	84D	0.61	1.81	EPA 900
8/24/2009	Blodgett Farm	85	4.48	1.91	EPA 900
8/24/2009	Brattleboro Fire Dept	88	-1.38	1.77	EPA 900
8/24/2009	Conn River Downstream	86	-0.31	1.79	EPA 900
8/24/2009	Conn River Upstream	87	0.92	1.82	EPA 900
8/24/2009	Miller Farm	82	4.79	1.92	EPA 900
8/24/2009	Vernon Elem School	83	9.55	2.02	EPA 900

Table 15. 2009 Water Sample Beta Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L	Analysis Method
9/15/2009	3-3	84A	1.02	1.7	EPA 900
9/15/2009	3-4	84B	1.17	1.7	EPA 900
9/15/2009	3-8	84C	1.75	1.72	EPA 900
9/15/2009	Discharge Forebay	84D	1.02	1.7	EPA 900
9/23/2009	Blodgett Farm	85	7.77	1.86	EPA 900
9/23/2009	Brattleboro Fire Dept	88	1.02	1.7	EPA 900
9/23/2009	Conn River Downstream	86	2.48	1.74	EPA 900
9/23/2009	Conn River Upstream	87	2.63	1.74	EPA 900
9/23/2009	Miller Farm	82	3.95	1.77	EPA 900
9/23/2009	Vernon Elem School	83	5.27	1.8	EPA 900
10/15/2009	3-3	84A	0.3	1.73	EPA 900
10/15/2009	3-4	84B	2.37	1.78	EPA 900
10/15/2009	3-8	84C	-0.15	1.72	EPA 900
10/15/2009	Discharge Forebay	84D	1.04	1.74	EPA 900
10/22/2009	Blodgett Farm	85	9.22	1.94	EPA 900
10/22/2009	Brattleboro Fire Dept	88	3.41	1.8	EPA 900
10/22/2009	Conn River Downstream	86	2.66	1.78	EPA 900
10/22/2009	Conn River Upstream	87	2.52	1.78	EPA 900
10/22/2009	Miller Farm	82	3.12	1.8	EPA 900
10/22/2009	Vernon Elem School	83	4.9	1.84	EPA 900
11/13/2009	3-3	84A	0.3	0.79	EPA 900
11/13/2009	3-4	84B	0.28	1.63	EPA 900
11/13/2009	3-8	84C	0.78	0.83	EPA 900
11/13/2009	Discharge Forebay	84D	1.06	1.41	EPA 900
11/23/2009	Brattleboro Fire Dept	85	1.43	0.85	EPA 900
11/23/2009	Conn River Downstream	88	1.14	0.84	EPA 900
11/23/2009	Conn River Upstream	86	1.99	1.68	EPA 900
11/23/2009	Miller Farm	87	3.42	1.72	EPA 900
11/23/2009	Vernon Elem School	82	4.71	1.75	EPA 900
12/14/2009	3-3	83	1.76	0.93	EPA 900
12/14/2009	3-4	84A	1.3	0.92	EPA 900
12/14/2009	3-8	84B	0.5	0.46	EPA 900
12/14/2009	Discharge Forebay	84C	1.53	0.93	EPA 900
12/28/2009	Blodgett Farm	84D	7.38	1.96	EPA 900
12/28/2009	Brattleboro Fire Dept	85	2.45	1.83	EPA 900
12/28/2009	Conn River Downstream	88	1.53	0.93	EPA 900
12/28/2009	Conn River Upstream	86	2.15	1.83	EPA 900
12/28/2009	Miller Farm	87	5.06	1.9	EPA 900
12/28/2009	Vernon Elem School	82	3.83	1.87	EPA 900

Table 16. 2009 Water Sample Gamma Radioactivity Results

Sample Date	Sample Location	Map ID No.	Results pCi/L
1/14/2009	3-3	84A	< LLD
1/14/2009	3-4	84B	< LLD
1/14/2009	3-8	84C	< LLD
1/14/2009	Discharge Forebay	84D	< LLD
1/29/2009	Vernon Elem School	83	< LLD
1/29/2009	Brattleboro Fire Dept	88	< LLD
1/29/2009	Conn River Downstream	86	< LLD
1/29/2009	Blodgett Farm	85	Natural
1/29/2009	Miller Farm	82	< LLD
2/16/2009	3-3	84A	< LLD
2/16/2009	3-4	84B	< LLD
2/16/2009	3-8	84C	< LLD
2/16/2009	Discharge Forebay	84D	< LLD
3/6/2009	Blodgett Farm	83	Natural
3/6/2009	Brattleboro Fire Dept	88	< LLD
3/6/2009	Conn River Downstream	86	< LLD
3/6/2009	Conn River Upstream	87	< LLD
3/6/2009	Miller Farm	82	Natural
3/6/2009	Vernon Elem School	83	Natural
3/16/2009	3-3	84A	< LLD
3/16/2009	3-4	84B	< LLD
3/16/2009	3-8	84C	< LLD
3/16/2009	Discharge Forebay	84D	< LLD
3/30/2009	Blodgett Farm	83	Natural
3/30/2009	Brattleboro Fire Dept	88	< LLD
3/30/2009	Conn River Downstream	86	< LLD
3/30/2009	Conn River Upstream	87	< LLD
3/30/2009	Miller Farm	82	Natural
3/30/2009	Vernon Elem School	83	Natural
4/15/2009	3-3	84A	< LLD
4/15/2009	3-4	84B	< LLD
4/15/2009	3-8	84C	< LLD
4/15/2009	Discharge Forebay	84D	< LLD

LLD: lower limits of detection

Table 16. 2009 Water Sample Gamma Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/L
5/13/2009	Blodgett Farm	85	Natural
5/13/2009	Brattleboro Fire Dept	88	< LLD
5/13/2009	Conn River Downstream	86	< LLD
5/13/2009	Conn River Upstream	87	< LLD
5/13/2009	Miller Farm	82	Natural
5/13/2009	Vernon Elem School	83	Natural
5/14/2009	3-3	84A	< LLD
5/14/2009	3-4	84B	< LLD
5/14/2009	3-8	84C	< LLD
5/14/2009	Discharge Forebay	84D	< LLD
6/15/2009	3-3	84A	< LLD
6/15/2009	3-4	84B	< LLD
6/15/2009	3-8	84C	< LLD
6/15/2009	Discharge Forebay	84D	< LLD
6/25/2009	Blodgett Farm	85	Natural
6/25/2009	Brattleboro Fire Dept	88	< LLD
6/25/2009	Conn River Downstream	86	< LLD
6/25/2009	Conn River Upstream	87	< LLD
6/25/2009	Miller Farm	82	Natural
6/25/2009	Vernon Elem School	83	< LLD
7/16/2009	3-3	84A	< LLD
7/16/2009	3-4	84B	< LLD
7/16/2009	3-8	84C	< LLD
7/16/2009	Discharge Forebay	84D	< LLD
7/22/2009	Blodgett Farm	85	Natural
7/22/2009	Brattleboro Fire Dept	88	< LLD
7/22/2009	Conn River Downstream	86	< LLD
7/22/2009	Conn River Upstream	87	< LLD
7/22/2009	Miller Farm	82	Natural
7/22/2009	Vernon Elem School	83	< LLD
8/13/2009	3-3	84A	< LLD
8/13/2009	3-4	84B	< LLD
8/13/2009	3-8	84C	< LLD
8/13/2009	Discharge Forebay	84D	< LLD
8/24/2009	Blodgett Farm	85	Natural
8/24/2009	Brattleboro Fire Dept	88	< LLD
8/24/2009	Conn River Downstream	86	Natural
8/24/2009	Conn River Upstream	87	< LLD
8/24/2009	Miller Farm	82	Natural
8/24/2009	Vernon Elem School	83	Natural

LLD: lower limits of detection

Table 16. 2009 Water Sample Gamma Radioactivity Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/L
9/15/2009	3-3	84A	< LLD
9/15/2009	3-4	84B	< LLD
9/15/2009	3-8	84C	< LLD
9/15/2009	Discharge Forebay	84D	< LLD
9/23/2009	Blodgett Farm	85	Natural
9/23/2009	Brattleboro Fire Dept	88	< LLD
9/23/2009	Conn River Downstream	86	< LLD
9/23/2009	Conn River Upstream	87	< LLD
9/23/2009	Miller Farm	82	Natural
9/23/2009	Vernon Elem School	83	Natural
10/15/2009	3-3	84A	< LLD
10/15/2009	3-4	84B	< LLD
10/15/2009	3-8	84C	< LLD
10/15/2009	Discharge Forebay	84D	< LLD
10/22/2009	Blodgett Farm	85	Natural
10/22/2009	Brattleboro Fire Dept	88	< LLD
10/22/2009	Conn River Downstream	86	< LLD
10/22/2009	Conn River Upstream	87	< LLD
10/22/2009	Miller Farm	82	Natural
10/22/2009	Vernon Elem School	83	Natural
11/13/2009	3-3	84A	< LLD
11/13/2009	3-4	84B	< LLD
11/13/2009	3-8	84C	< LLD
11/13/2009	Discharge Forebay	84D	< LLD
11/23/2009	Brattleboro Fire Dept	85	< LLD
11/23/2009	Conn River Downstream	88	< LLD
11/23/2009	Conn River Upstream	86	< LLD
11/23/2009	Miller Farm	87	Natural
11/23/2009	Vernon Elem School	82	Natural
12/14/2009	3-3	83	< LLD
12/14/2009	3-4	84A	< LLD
12/14/2009	3-8	84B	< LLD
12/14/2009	Discharge Forebay	84C	< LLD
12/28/2009	Blodgett Farm	84D	Natural
12/28/2009	Brattleboro Fire Dept	85	< LLD
12/28/2009	Conn River Downstream	88	< LLD
12/28/2009	Conn River Upstream	86	< LLD
12/28/2009	Miller Farm	87	Natural
12/28/2009	Vernon Elem School	82	Natural
9/15/2009	3-3	83	< LLD

LLD: lower limits of detection

Table 17. 2009 Water Sample Tritium Results

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L
1/14/2009	3-3	84A	112	170
1/14/2009	3-4	84B	24	169
1/14/2009	3-8	84C	106	170
1/14/2009	Discharge Forebay	84D	160	170
1/29/2009	Vernon Elem School	83	9	169
1/29/2009	Brattleboro Fire Dept	88	95	169
1/29/2009	Conn River Downstream	86	108	170
1/29/2009	Blodgett Farm	85	32	169
1/29/2009	Miller Farm	82	60	169
2/16/2009	3-3	84A	-75	168
2/16/2009	3-4	84B	-86	168
2/16/2009	3-8	84C	80	170
2/16/2009	Discharge Forebay	84D	-22	169
3/6/2009	Blodgett Farm	85	170	122
3/6/2009	Brattleboro Fire Dept	88	86	170
3/6/2009	Conn River Downstream	86	106	170
3/6/2009	Conn River Upstream	87	-37	169
3/6/2009	Miller Farm	82	37	170
3/6/2009	Vernon Elem School	83	-24	169
3/16/2009	3-3	84A	-67	171
3/16/2009	3-4	84B	-84	171
3/16/2009	3-8	84C	-188	170
3/16/2009	Discharge Forebay	84D	-261	169
3/30/2009	Blodgett Farm	85	-65	171
3/30/2009	Brattleboro Fire Dept	88	0.32	0.81
3/30/2009	Conn River Downstream	86	-157	170
3/30/2009	Conn River Upstream	87	-97	171
3/30/2009	Miller Farm	82	-127	171
3/30/2009	Vernon Elem School	83	-84	171
4/15/2009	3-3	84A	197	172
4/15/2009	3-4	84B	71	171
4/15/2009	3-8	84C	22	170
4/15/2009	Discharge Forebay	84D	69	171

Table 17. 2009 Water Sample Tritium Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L
5/13/2009	Blodgett Farm	85	45	170
5/13/2009	Brattleboro Fire Dept	88	-13	170
5/13/2009	Conn River Downstream	86	106	171
5/13/2009	Conn River Upstream	87	-26	170
5/13/2009	Miller Farm	82	173	172
5/13/2009	Vernon Elem School	83	162	171
5/14/2009	3-3	84A	65	170
5/14/2009	3-4	84B	117	171
5/14/2009	3-8	84C	13	170
5/14/2009	Discharge Forebay	84D	-43	169
6/15/2009	3-3	84A	-444	167
6/15/2009	3-4	84B	-554	166
6/15/2009	3-8	84C	-347	168
6/15/2009	Discharge Forebay	84D	-353	168
6/25/2009	Blodgett Farm	85	-181	170
6/25/2009	Brattleboro Fire Dept	88	-381	168
6/25/2009	Conn River Downstream	86	-452	167
6/25/2009	Conn River Upstream	87	-448	167
6/25/2009	Miller Farm	82	-424	168
6/25/2009	Vernon Elem School	83	-368	168
7/16/2009	3-3	84A	-13	177
7/16/2009	3-4	84B	-47	177
7/16/2009	3-8	84C	-19	177
7/16/2009	Discharge Forebay	84D	-19	177
7/22/2009	Blodgett Farm	85	30	177
7/22/2009	Brattleboro Fire Dept	88	30	177
7/22/2009	Conn River Downstream	86	-15	177
7/22/2009	Conn River Upstream	87	-9	177
7/22/2009	Miller Farm	82	52	177
7/22/2009	Vernon Elem School	83	6	177
8/13/2009	3-3	84A	52	165
8/13/2009	3-4	84B	2	165
8/13/2009	3-8	84C	-15	165
8/13/2009	Discharge Forebay	84D	4	165
8/24/2009	Blodgett Farm	85	4	165
8/24/2009	Brattleboro Fire Dept	88	-87	164
8/24/2009	Conn River Downstream	86	87	166
8/24/2009	Conn River Upstream	87	-24	165
8/24/2009	Miller Farm	82	-39	164
8/24/2009	Vernon Elem School	83	7	165

Table 17. 2009 Water Sample Tritium Results (continued)

Sample Date	Sample Location	Map ID No.	Results pCi/L	Error pCi/L
9/15/2009	3-3	84A	-35	162
9/15/2009	3-4	84B	-48	162
9/15/2009	3-8	84C	-78	162
9/15/2009	Discharge Forebay	84D	-97	161
9/23/2009	Blodgett Farm	85	-99	161
9/23/2009	Brattleboro Fire Dept	88	-121	161
9/23/2009	Conn River Downstream	86	4	162
9/23/2009	Conn River Upstream	87	-6	162
9/23/2009	Miller Farm	82	82	163
9/23/2009	Vernon Elem School	83	-28	162
10/15/2009	3-3	84A	-45	161
10/15/2009	3-4	84B	-43	161
10/15/2009	3-8	84C	67	162
10/15/2009	Discharge Forebay	84D	-95	160
10/22/2009	Blodgett Farm	85	73	162
10/22/2009	Brattleboro Fire Dept	88	-162	160
10/22/2009	Conn River Downstream	86	-19	161
10/22/2009	Conn River Upstream	87	0	161
10/22/2009	Miller Farm	82	-101	160
10/22/2009	Vernon Elem School	83	32	132
11/13/2009	3-3	84A	11	166
11/13/2009	3-4	84B	-9	166
11/13/2009	3-8	84C	-17	165
11/13/2009	Discharge Forebay	84D	90	167
11/23/2009	Brattleboro Fire Dept	85	69	166
11/23/2009	Conn River Downstream	88	-127	164
11/23/2009	Conn River Upstream	86	-71	165
11/23/2009	Miller Farm	87	179	167
11/23/2009	Vernon Elem School	82	26	166
12/14/2009	3-3	83	140	165
12/14/2009	3-4	84A	48	164
12/14/2009	3-8	84B	19	163
12/14/2009	Discharge Forebay	84C	-19	163
12/28/2009	Blodgett Farm	84D	41	164
12/28/2009	Brattleboro Fire Dept	85	76	164
12/28/2009	Conn River Downstream	88	101	164
12/28/2009	Conn River Upstream	86	56	164
12/28/2009	Miller Farm	87	86	164
12/28/2009	Vernon Elem School	82	177	165
9/15/2009	3-3	83	-35	162

Table 18. On-Site Groundwater Sample Analysis Results

Sample Date	Sample Location	Results pCi/L Gamma	Results pCi/L Tritium	Error +/- pCi/L Tritium
3/16/2009	Well GW0201	Naturally Occurring Radionuclides	-11	172
3/16/2009	Well GW0202	Naturally Occurring Radionuclides	172	174
3/16/2009	Well GW0203	Naturally Occurring Radionuclides	127	174
3/16/2009	Well GW0204	Naturally Occurring Radionuclides	80	173
3/16/2009	Well GZ-1	Naturally Occurring Radionuclides	218	175
3/16/2009	Well GZ-3	Naturally Occurring Radionuclides	190	174
3/16/2009	Well GZ-5	Naturally Occurring Radionuclides	-26	172
8/26/2009	Well GW0201	Naturally Occurring Radionuclides	97	206
8/26/2009	Well GW0202	Less Than the LLD	-67	204
8/26/2009	Well GW0203	Naturally Occurring Radionuclides	-46	204
8/26/2009	Well GW0204	Naturally Occurring Radionuclides	51	205
8/26/2009	Well GZ-1	Naturally Occurring Radionuclides	-8	204
8/26/2009	Well GZ-3	Naturally Occurring Radionuclides	62	205
8/26/2009	Well GZ-5	Less Than the LLD	143	206
11/17/2009	Well GW0201	Naturally Occurring Radionuclides	-30	165
11/17/2009	Well GW0202	Naturally Occurring Radionuclides	-136	164
11/17/2009	Well GW0203	Naturally Occurring Radionuclides	39	165
11/17/2009	Well GW0204	Naturally Occurring Radionuclides	-43	165
11/17/2009	Well GZ-1	Naturally Occurring Radionuclides	37	165
11/17/2009	**Well GZ-3**	**Naturally Occurring Radionuclides**	**569**	**171**
11/17/2009	Well GZ-5	Naturally Occurring Radionuclides	19	165

11/17/2009 sample of groundwater monitoring well GZ-3 found to be greater than the lower limit of detection of 300 pCi/L. This well was determined by follow-up samples in January 2010 to be positive for tritium contamination of the on-site groundwater.

Food Chain Sampling Results

Monitoring of the food chain involves direct monitoring of some foods such as milk, cultivated vegetation and fish. It also involves monitoring of the soil and sediment that support land and aquatic species, and natural vegetation like grass, ferns, and fungi that serve as feed to land animals.

Milk Sample Results for 2009

Cow's raw milk is sampled monthly from two farms in Vernon. One farm is about one-half mile north of Vermont Yankee Nuclear Power Station, and the other is about three miles south of the power station. Map 12 shows the location of these two dairy farms.

Milk is analyzed for all gamma radiation-emitting radioactive materials, and a separate assessment for iodine-131 is conducted. Table 20 shows the iodine-131 results. The analyses found no iodine-131 greater than the calculated limit of detection, which is 3.0 picocuries per liter (pCi/L).

As recorded in Table 21, the gamma spectroscopy of milk also revealed no nuclear facility-generated radioactive materials in excess of the counting system's limits of detection. The calculated limits of detection for radioactive materials in milk are listed in Table 19.

The one radioactive material that was detected above its calculated limit of detection was potassium-40, a primordial radioactive material. Primordial radioactive materials are those created with the formation of the earth and other cosmic features. Potassium-40 has a half-life of 1,280,000,000 years. The gamma spectroscopy results are presented in Table 21. The potassium-40 results for all milk samples, ranging from 1280 to 1480 pCi/L, fall within the historical range for potassium-40 of 1,200 to 2,000 pCi/L.

Vegetation Sample Results for 2009

A variety of natural and cultivated plants are sampled to verify that no Vermont Yankee Nuclear Power Station radioactive materials are accumulating in the human and animal food chains. Vegetation samples taken in the immediate vicinity of Vermont Yankee at the Vernon Elementary School and on the Connecticut River just downstream from the Vernon Dam were analyzed by gamma spectroscopy, as was a sample from the Vermont State Police post in West Brattleboro. None of the sample results were outside of the historical range for vegetation samples that have been reported from the vicinity of Vermont Yankee and elsewhere in Vermont in other years. The historical range for gamma radioactivity in vegetation varies for the specific kind of plant, but generally the range is from the calculated limit of detection to 20,400 picocuries per kilogram (pCi/kg). The specific values for 2009 are found in Table 23 and range from 649 – 1120 pCi/kg for the cosmogenic radionuclide beryllium-7 and from 4340 – 5970 pCi/kg for the primordial radionuclide potassium-40.

The gamma radioactivity results in picocuries per kilogram for the 2009 vegetation samples are shown in Figures 6 and 7. Figure 6 shows the beryllium-7 results, while Figure 7 shows the potassium-40 results. These radioactive materials, potassium-40 and beryllium-7, are naturally occurring radioactive materials, and these concentrations are within the historical range for vegetation samples, which has been as high as 20,400 picocuries per kilogram.

Soil Sample Results for 2009

Soil samples were also collected in the same manner as the vegetation samples – at the Vernon Elementary School, along the banks of the Connecticut River downstream from the Vernon Dam, which is downstream from Vermont Yankee, and at the Vermont State Police Barracks in West Brattleboro. The table of soil sample results is Table 24. All sample results were within the historical range of less than the calculated limit of detection to 500 picocuries per kilogram for cesium-137, and from 7,000 to 20,000

picocuries per kilogram for potassium-40. The potassium-40 results ranged from 7,840 to 14,200 pCi/kg. The one positive result for cesium-137 was 109 pCi/kg.

While potassium-40 is a purely natural radionuclide, cesium-137 exists only due to human activity. Figure 8 shows the one sample with cesium-137 activity and Figure 9 shows the three samples with potassium-40. Cesium-137 may be found throughout Vermont and the United States. Like cesium-137 findings elsewhere, the positive cesium-137 results around Vermont Yankee is explained by residual radioactivity from above ground nuclear weapons testing fallout, and from fallout from the plume that sent radioactivity around the world for several weeks following the nuclear reactor explosion and fire at Chernobyl in the former Soviet Union.

Sediment Sample Results for 2009

Sediment samples are taken from the bottom of the Connecticut River by an environmental contractor. The samples in this report are analyzed by the Health Department Laboratory. The sediment samples are taken from four areas of the Connecticut River. The first is near the North Storm Drain. This is an area where radioactive sedimentary contaminants from Vermont Yankee Nuclear Power Station were discovered in 1997, and it is an area just east of the station's stack. Sample locations S-1, S-2, T-1, T-2, T-3, U-1, U-2, U-3, U-4, V-3, V-4, V-5, W-4, W-5 and X-5 are from this North Storm Drain area. These sample locations are shown in an illustration included as Figure 10.

The reason the sediments in this North Storm Drain area are particularly studied is because of cobalt-60 contamination that washed down a storm drain near the Turbine Building in 1997. This contamination from the Turbine Building was determined to have come from the building ventilation system. The system was modified to prevent recurrence. Vermont Yankee and the Health Department have been monitoring the North Storm Drain area for cobalt-60 and other station-related radioactive materials ever since. Cobalt-60 was last detected in a sediment sample obtained and analyzed in 2004.

The second location is in the pool upstream from the Vernon Dam, near the primary station discharge at the south end of the station property near the cooling towers. In Table 25, the samples for location 3-4 are from this part of the Connecticut River. The third location, 3-3, is south of the Vernon Dam in the pool created downstream from the hydroelectric facility there. The final sample location, 3-8, is well upstream of the station where the Route 9 highway bridge crosses the Connecticut River north of Brattleboro.

Two sets of samples are obtained, one set in the spring and one set in the fall. A sediment sample is taken with a mass ranging from 0.75 to 1.25 kilograms. At the Health Department Laboratory, the sample is dried, weighed on a top-loaded balance and placed in a 500 milliliter high density polyethylene bottle. The sample is counted on the gamma spectrometer system using a reverse germanium detector. A normal spectrum will include naturally occurring, primordial radioactive materials such as potassium-40, cosmogenic, naturally occurring radioactive materials such as beryllium-7, and archival cesium-137 from past atmospheric nuclear weapons testing and the releases from Chernobyl. North Storm Drain samples in the past included trace amounts of cobalt-60. Like cesium-137, cobalt-60 is radioactive material of only human origin.

For 2009, primordial potassium-40 is within the historical range of 6,000 – 26,000 pCi/kg at 9,780 – 21,100 pCi/kg. Cosmogenic beryllium-7 activity ranged from 516 – 2,150 pCi/kg, also within the historical range for beryllium-7 of less than the lower limit of detection to 3,000 pCi/kg. The archival cesium-137 is within the historical range of the calculated limit of detection to 500 pCi/kg at 43.5 – 173 pCi/kg. There were no other radioactive materials in excess of the counting system's calculated limits of detection including cobalt-60. The calculated limits of detection for sediment are the same as those for soil, and shown in Table 22. The potassium-40 results are graphed in Figure 11, while the results for cesium-137 are graphed in Figure 12.

Fish Sample Results for 2009

Table 26 presents the results of gamma spectroscopy of fish samples. The fish were obtained from the Connecticut River by an environmental contractor. The fish samples were analyzed by the Health Department Laboratory. Table 26 shows that the only results in excess of the counting system's calculated limits of detection were for naturally occurring, cosmogenic potassium-40 and for cesium-137. Potassium-40 in 2009, ranging from 2,090 to 2,810 pCi/kg falls within the historical range for these samples: 1,000 – 5,000 pCi/kg. The cesium-137 results were also within the historical range of less than the lower limit of detection to 100 pCi/kg at 10.2 and 10.4 pCi/kg. This cesium-137 is thought to be from atmospheric fallout from nuclear weapons testing in past decades and the nuclear accident at Chernobyl in 1986.

Location 3-4 in the table above corresponds with the Vernon Pond, the basin formed by the Vernon Dam on the Connecticut River just downstream from Vermont Yankee Nuclear Power Station. Location 3-8 is near the Route 9 highway bridge north of Brattleboro. The fish that had detectable cesium-137 levels was caught in the Vernon Pond. All fish, from north of Brattleboro and from the Vernon Pond tested positive for potassium-40. Fish are captured by an electroshock method. The fish are frozen whole, weighed and chopped or blended for loading into a reentrant beaker. The total sample of about one kilogram is then analyzed with a gamma spectrometer system using a reverse electrode germanium detector.

Table 19. Gamma Spectroscopy Calculated Limits of Detection for Milk, Water, Vegetation and Fish Samples

Radioactive material	Calculated Limit of Detection
Cadmium-109	46 pCi/L or pCi/kg
Cobalt-57	2 pCi/L or pCi/kg
Cerium-139	2 pCi/L or pCi/kg
Mercury-203	2 pCi/L or pCi/kg
Tin-113	3 pCi/L or pCi/kg
Cesium-137	3 pCi/L or pCi/kg
Yttrium-88	2 & 3 pCi/L or pCi/kg
Cobalt-60	2 & 2 pCi/L or pCi/kg
Beryllium-7	20 pCi/L or pCi/kg
Potassium-40	42 pCi/L or pCi/kg
Barium-133	3 pCi/L or pCi/kg
Cesium-134	3 pCi/L or pCi/kg
Iodine-131	3 pCi/L or pCi/kg
Zinc-65	5 pCi/L or pCi/kg
Manganese-54	3. pCi/L or pCi/kg
Silver-110m	3 pCi/L or pCi/kg
Cerium-144	15 pCi/L or pCi/kg
Cerium-141	4 pCi/L or pCi/kg
Chromium-51	20 pCi/L or pCi/kg
Antimony-126	2. pCi/L or pCi/kg
Ruthenium-103	2 pCi/L or pCi/kg
Strontium-90	3 pCi/L or pCi/kg
Antimony-124	3 pCi/L or pCi/kg
Ruthenium-106	25 pCi/L or pCi/kg
Cesium-136	3 pCi/L or pCi/kg
Cobalt-58	2 pCi/L or pCi/kg

Map 10

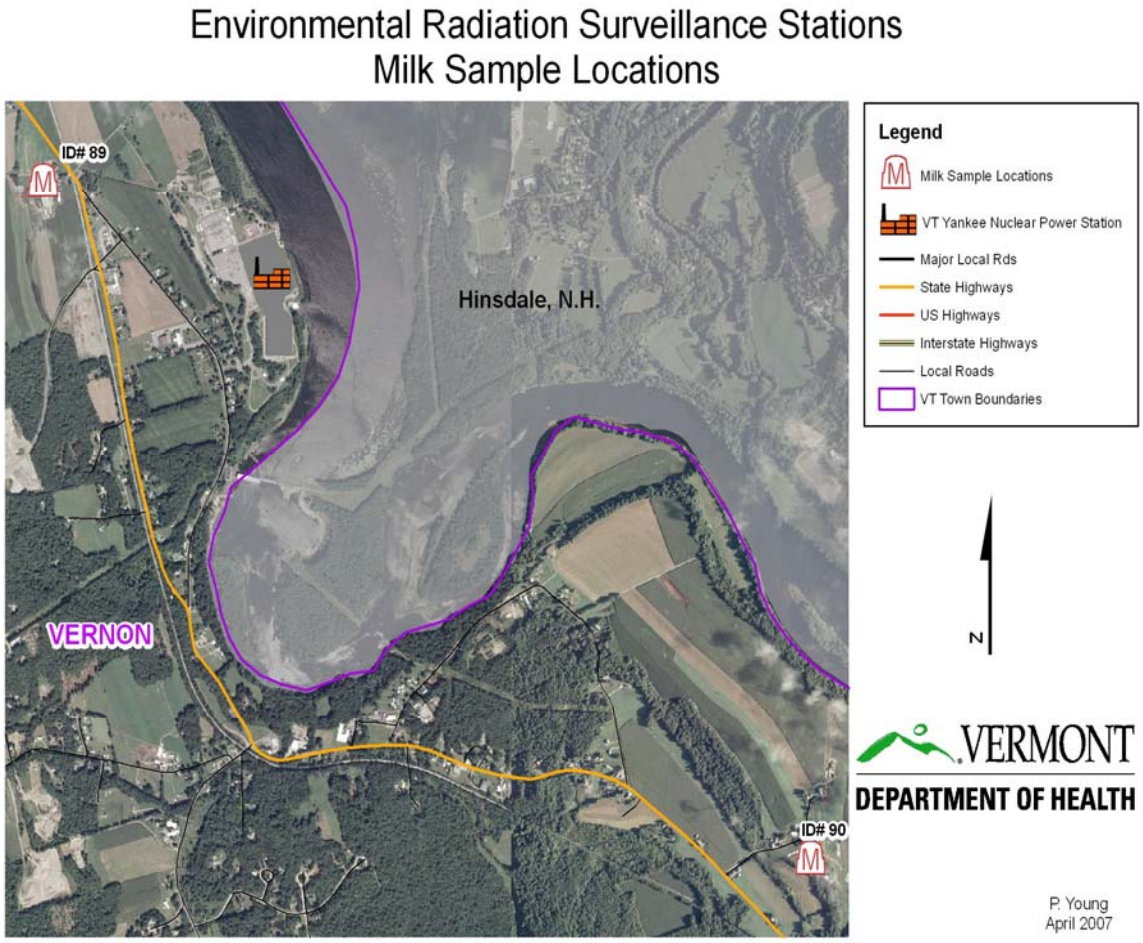

Environmental Radiation Surveillance Stations
Milk Sample Locations
ID# 89
Hinsdale, N.H.
VERNON
ID# 90
Legend
Milk Sample Locations
VT Yankee Nuclear Power Station
Major Local Rds
State Highways
US Highways
Interstate Highways
Local Roads
VT Town Boundaries
N
VERMONT
DEPARTMENT OF HEALTH
P. Young
April 2007

Table 20. 2009 Milk Sample Iodine-131 Results

Sample Date	Sample Location	Map ID No.	Results Nuclides	Results pCi/L
1/29/2009	Blodgett Farm	90	I-131	< LOD
1/29/2009	Miller Farm	89	I-131	< LOD
3/6/2009	Blodgett Farm	90	I-131	< LOD
3/6/2009	Miller Farm	89	I-131	< LOD
3/30/2009	Blodgett Farm	90	I-131	< LOD
3/30/2009	Miller Farm	89	I-131	< LOD
5/18/2009	Blodgett Farm	90	I-131	< LOD
5/18/2009	Miller Farm	89	I-131	< LOD
6/25/2009	Blodgett Farm	90	I-131	< LOD
6/25/2009	Miller Farm	89	I-131	< LOD
7/22/2009	Blodgett Farm	90	I-131	< LOD
7/22/2009	Miller Farm	89	I-131	< LOD
8/24/2009	Blodgett Farm	90	I-131	< LOD
8/24/2009	Miller Farm	89	I-131	< LOD
9/23/2009	Blodgett Farm	90	I-131	< LOD
9/23/2009	Miller Farm	89	I-131	< LOD
10/22/2009	Blodgett Farm	90	I-131	< LOD
10/22/2009	Miller Farm	89	I-131	< LOD
11/23/2009	Blodgett Farm	90	I-131	< LOD
11/23/2009	Miller Farm	89	I-131	< LOD
12/28/2009	Blodgett Farm	90	I-131	< LOD
12/28/2009	Miller Farm	89	I-131	< LOD

LOD = Limit of Detection of 3 picocuries per liter (pCi/L)

Table 21. 2009 Milk Sample Gamma Radioactivity Results

Sample Date	Sample Location	Map ID No.	Results Nuclides	Results pCi/L	Error pCi/L
1/29/2009	Blodgett Farm	90	K-40	1370	100
1/29/2009	Miller Farm	89	K-40	1460	100
3/6/2009	Blodgett Farm	90	K-40	1390	230
3/6/2009	Miller Farm	89	K-40	1280	220
3/30/2009	Blodgett Farm	90	K-40	1350	230
3/30/2009	Miller Farm	89	K-40	1360	230
5/18/2009	Blodgett Farm	90	K-40	1470	250
5/18/2009	Miller Farm	89	K-40	1410	240
6/25/2009	Blodgett Farm	90	K-40	1360	230
6/25/2009	Miller Farm	89	K-40	1400	240
7/22/2009	Blodgett Farm	90	K-40	1430	240
7/22/2009	Miller Farm	89	K-40	1350	230
8/24/2009	Blodgett Farm	90	K-40	1430	240
8/24/2009	Miller Farm	89	K-40	1460	250
9/23/2009	Blodgett Farm	90	K-40	1400	240
9/23/2009	Miller Farm	89	K-40	1440	240
10/22/2009	Blodgett Farm	90	K-40	1410	240
10/22/2009	Miller Farm	89	K-40	1400	240
11/23/2009	Blodgett Farm	90	K-40	1380	230
11/23/2009	Miller Farm	89	K-40	1390	240
12/28/2009	Blodgett Farm	90	K-40	1480	250
12/28/2009	Miller Farm	89	K-40	1440	240

Table 22. Calculated Limits of Detection for Soil and Sediment Samples

Radioactive material	Calculated Limit of Detection
Cadmium-109	272 pCi/kg
Cobalt-57	11 pCi/kg
Cerium-139	13 pCi/kg
Mercury-203	15 pCi/kg
Tin-113	21 pCi/kg
Cesium-137	17 pCi/kg
Yttrium-88	19 & 13 pCi/kg
Cobalt-60	17 pCi/kg
Beryllium-7	1278 pCi/kg
Potassium-40	274 pCi/kg
Barium-133	20 pCi/kg
Cesium-134	17 pCi/kg
Iodine-131	16 pCi/kg
Zinc-65	35 pCi/kg
Manganese-54	18 pCi/kg
Silver-110m	16 pCi/kg
Cerium-144	88 pCi/kg
Cerium-141	21 pCi/kg
Chromium-51	124 pCi/kg
Antimony-126	15. pCi/kg
Ruthenium-103	15 pCi/kg
Strontium-90	18 pCi/kg
Antimony-124	17 pCi/kg
Ruthenium-106	159 pCi/kg
Cesium-136	16 pCi/kg
Cobalt-58	17 pCi/kg

Table 23. 2009 Vegetation Gamma Radioactivity Results

Sample Date	Sample Location	Results pCi/kg	Error pCi/kg	Results Nuclides	Comment	Comment
6/25/2009	Connecticut River Downstream	4850	860	K-40	Grass	Natural
6/25/2009	Connecticut River Downstream	694	138	Be-7	Grass	Natural
6/25/2009	Vermont State Police Brattleboro	5970	1020	K-40	Grass	Natural
6/25/2009	Vermont State Police Brattleboro	649	137	Be-7	Grass	Natural
6/25/2009	Vernon Elementary School	4340	770	K-40	Grass	Natural
6/25/2009	Vernon Elementary School	1120	160	Be-7	Grass	Natural

Figure 5

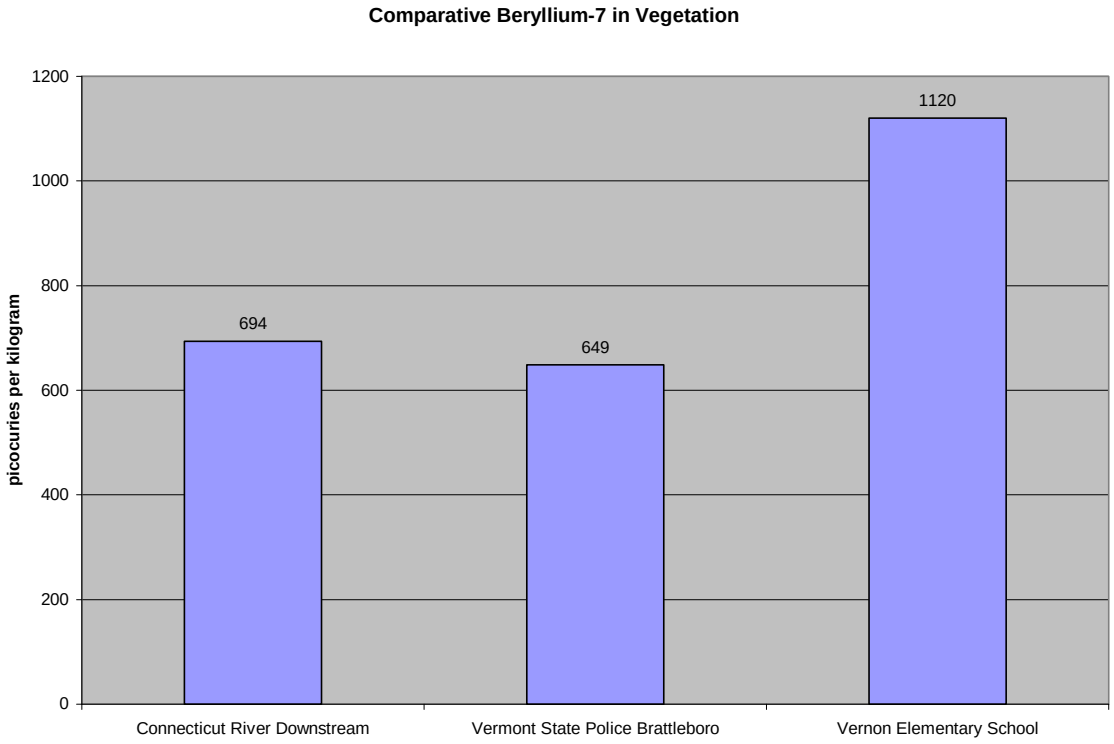

Comparative Beryllium-7 in Vegetation
picocuries per kilogram
1200
1000
800
600
400
200
0
694
649
1120
Connecticut River Downstream
Vermont State Police Brattleboro
Vernon Elementary School

Figure 6

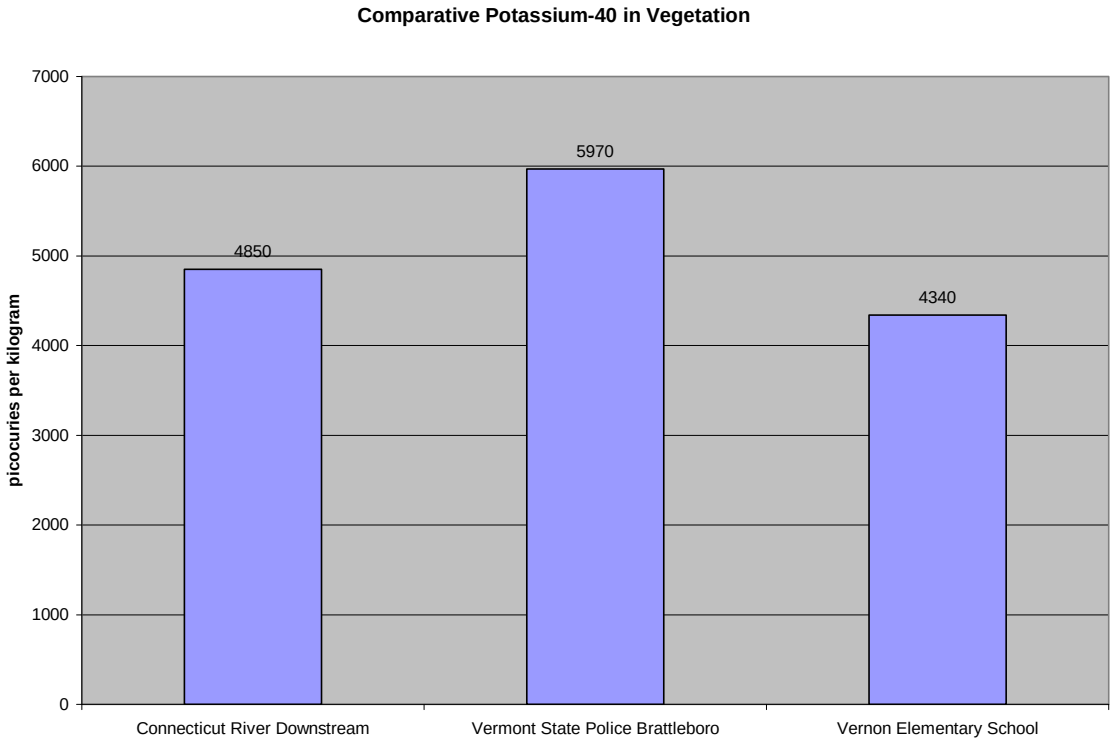

Comparative Potassium-40 in Vegetation
picocuries per kilogram
7000
6000
5000
4000
3000
2000
1000
0
4850
5970
4340
Connecticut River Downstream
Vermont State Police Brattleboro
Vernon Elementary School

Table 24. 2009 Soil Sample Gamma Radioactivity Results

Sample Date	Sample Location	Results pCi/kg	Error pCi/kg	Results Nuclides	Comment
6/25/2009	Vernon Elementary School	14200	2300	K-40	Natural
6/25/2009	Vermont State Police Brattleboro	9950	1670	K-40	Natural
6/25/2009	Vermont State Police Brattleboro	109	25	Cs-137	Fallout
6/25/2009	Connecticut River Downstream	7940	1330	K-40	Natural

Figure 7

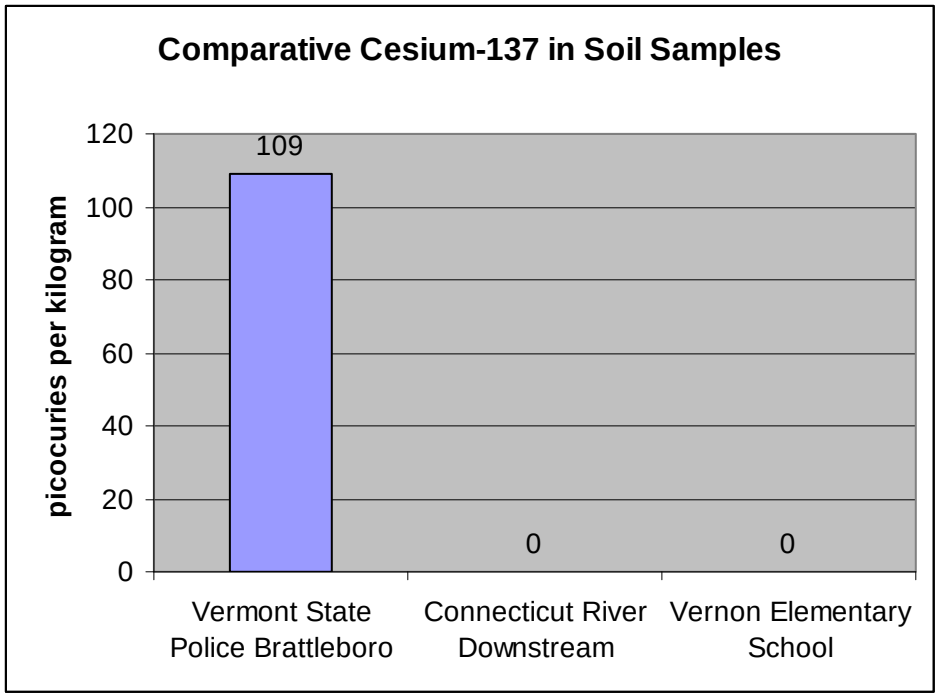

Comparative Cesium-137 in Soil Samples
picocuries per kilogram
120
100
80
60
40
20
0
109
0
0
Vermont State Police Brattleboro
Connecticut River Downstream
Vernon Elementary School

Figure 8

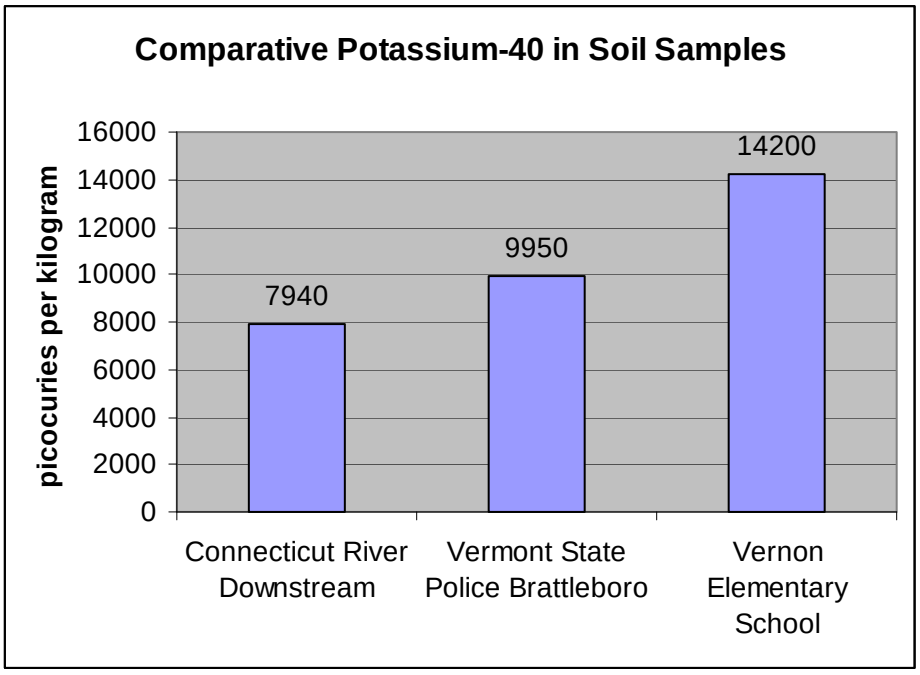

Comparative Potassium-40 in Soil Samples
picocuries per kilogram
16000
14000
12000
10000
8000
6000
4000
2000
0
7940
9950
14200
Connecticut River Downstream
Vermont State Police Brattleboro
Vernon Elementary School

Figure 9. Sediment Sample Locations

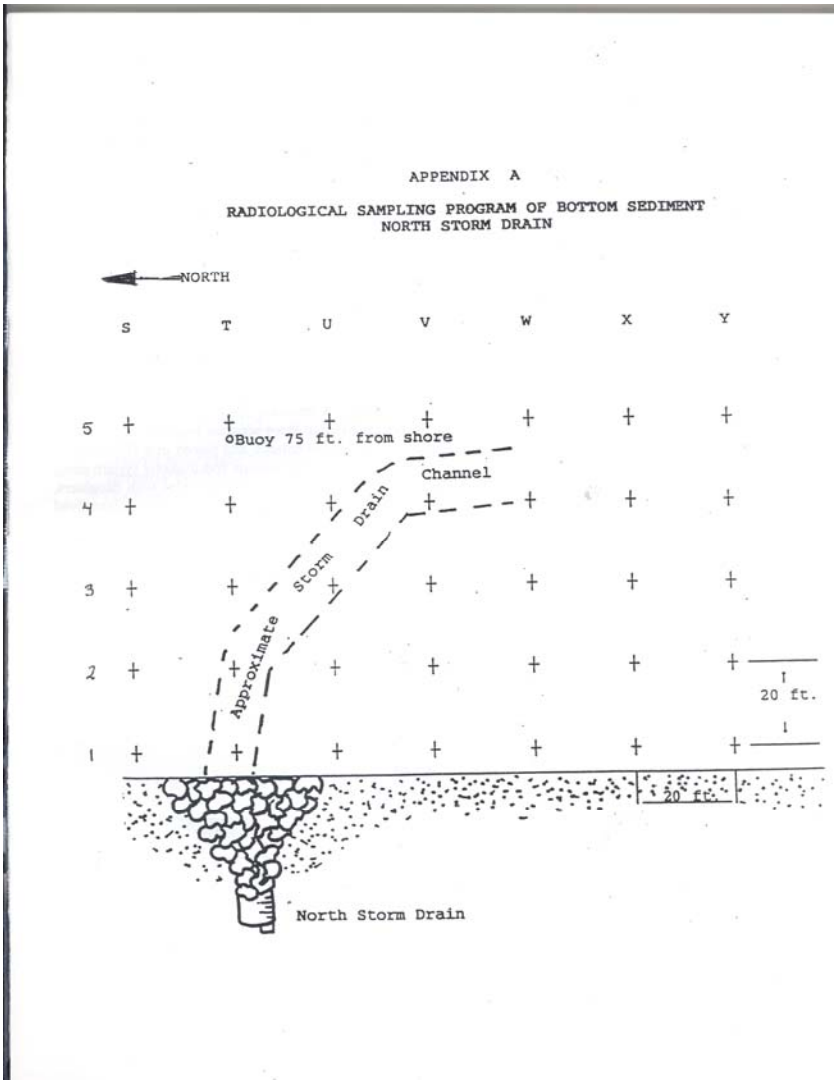


Figure 10

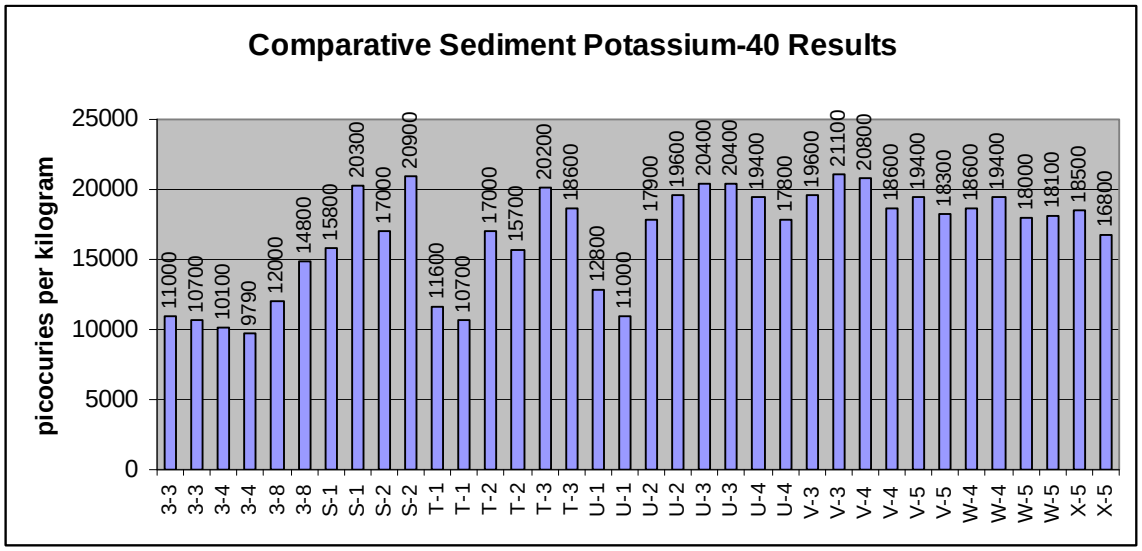

Comparative Sediment Potassium-40 Results
picocuries per kilogram
25000
20000
15000
10000
5000
0
3-3 11000
3-3 10700
3-4 10100
3-4 9790
3-8 12000
3-8 14800
S-1 15800
S-1 20300
S-2 17000
S-2 20900
T-1 11600
T-1 10700
T-2 17000
T-2 15700
T-3 20200
T-3 18600
U-1 12800
U-1 11000
U-2 17900
U-2 19600
U-3 20400
U-3 20400
U-4 19400
U-4 17800
V-3 19600
V-3 21100
V-4 20800
V-4 18600
V-5 19400
V-5 18300
W-4 18600
W-4 19400
W-5 18000
W-5 18100
X-5 18500
X-5 16800

Figure 11

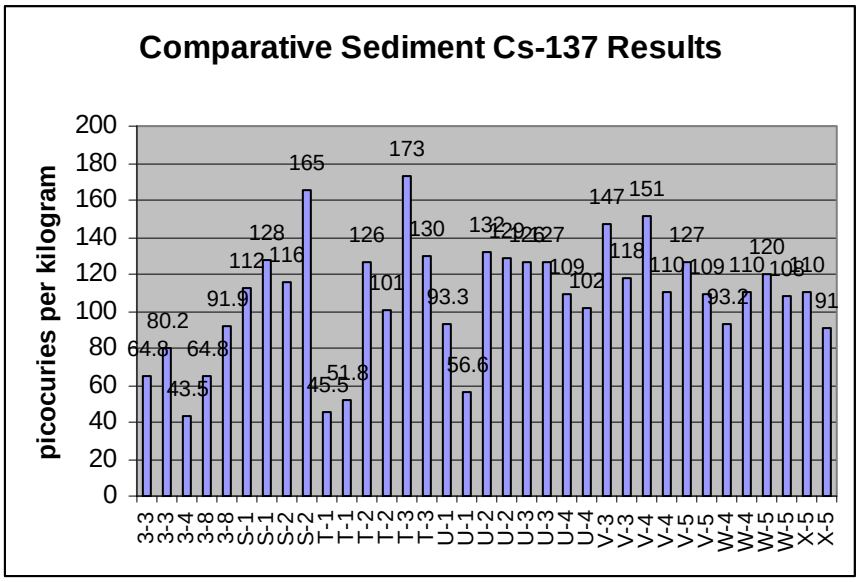

Comparative Sediment Cs-137 Results
picocuries per kilogram
200
180
160
140
120
100
80
60
40
20
0
64.8
80.2
43.5
64.8
91.9
112
128
116
165
45.5
51.8
126
101
173
130
93.3
56.6
132
129
126
127
109
102
147
118
151
110
127
109
93.2
110
120
108
110
91
3-3
3-3
3-4
3-8
3-8
S-1
S-1
S-2
S-2
T-1
T-1
T-2
T-2
T-3
T-3
U-1
U-1
U-2
U-2
U-3
U-3
U-4
U-4
V-3
V-3
V-4
V-4
V-5
V-5
W-4
W-4
W-5
W-5
X-5
X-5

Table 25. 2009 Sediment Sample Gamma Radioactivity Results

Sample Date	Sample Location	Results Nuclides	Results pCi/kg	Error pCi/kg	Comment
5/11/2009	3-4	K-40	10100	1700	Natural
5/11/2009	3-4	Cs-137	43.5	17.9	
5/11/2009	3-8	K-40	12000	2000	Natural
5/11/2009	3-8	Cs-137	64.8	24.2	
5/11/2009	3-3	K-40	11000	1800	Natural
5/11/2009	3-3	Cs-137	64.8	23.2	
5/27/2009	U-3	K-40	20400	3300	Natural
5/27/2009	U-3	Cs-137	126	32	
5/27/2009	V-3	K-40	19600	3200	Natural
5/27/2009	V-3	Cs-137	147	40	
5/27/2009	U-4	K-40	19400	3200	Natural
5/27/2009	U-4	Cs-137	109	32	
5/27/2009	V-5	K-40	19400	3200	Natural
5/27/2009	V-5	Cs-137	127	34	
5/27/2009	W-5	K-40	18000	3000	Natural
5/27/2009	W-5	Cs-137	120	34	
5/27/2009	W-4	K-40	18600	3100	Natural
5/27/2009	W-4	Cs-137	93.2	36.7	
5/27/2009	T-3	K-40	20200	3300	Natural
5/27/2009	T-3	Cs-137	173	36	
5/27/2009	X-5	K-40	18500	3000	Natural
5/27/2009	X-5	Cs-137	110	38	
5/27/2009	T-2	K-40	17000	2800	Natural
5/27/2009	T-2	Cs-137	126	35	
5/27/2009	U-1	K-40	12800	2100	Natural
5/27/2009	U-1	Cs-137	93.3	23.3	
5/27/2009	T-1	K-40	11600	1900	Natural
5/27/2009	T-1	Cs-137	45.5	18.4	
5/27/2009	V-4	K-40	20800	3400	Natural
5/27/2009	V-4	Cs-137	151	38	
5/27/2009	U-2	K-40	17900	3000	Natural
5/27/2009	U-2	Cs-137	132	34	
5/27/2009	S-1	K-40	15800	2600	Natural
5/27/2009	S-1	Cs-137	112	31	
5/27/2009	S-2	K-40	17000	2800	Natural
5/27/2009	S-2	Cs-137	116	35	

Table 25. 2009 Sediment Sample Gamma Radioactivity Results (continued)

Sample Date	Sample Location	Results Nuclides	Results pCi/kg	Error pCi/kg	Comment
10/22/2009	3-8	K-40	14800	2500	Natural
10/22/2009	3-8	Cs-137	91.9	35.3	
10/22/2009	3-8	Be-7	1420	400	Natural
10/22/2009	3-3	K-40	10700	1800	Natural
10/22/2009	3-3	Cs-137	80.2	20.6	
10/22/2009	3-4	K-40	9790	1620	Natural
10/22/2009	X-5	K-40	16800	2700	Natural
10/22/2009	X-5	Cs-137	91	27.6	
10/22/2009	W-5	K-40	18100	3000	Natural
10/22/2009	W-5	Cs-137	108	30	
10/22/2009	W-4	K-40	19400	3200	Natural
10/22/2009	W-4	Cs-137	110	34	
10/22/2009	V-5	K-40	18300	3000	Natural
10/22/2009	V-5	Cs-137	109	29	
10/22/2009	V-4	K-40	18600	3000	Natural
10/22/2009	V-4	Cs-137	110	28	
10/22/2009	V-3	K-40	21100	3400	Natural
10/22/2009	V-3	Cs-137	118	37	
10/22/2009	U-4	K-40	17800	2900	Natural
10/22/2009	U-4	Cs-137	102	30	
10/22/2009	U-3	K-40	20400	1900	Natural
10/22/2009	U-3	Cs-137	127	39	
10/22/2009	U-2	K-40	19600	3200	Natural
10/22/2009	U-2	Cs-137	129	35	
10/22/2009	U-1	K-40	11000	1800	Natural
10/22/2009	U-1	Cs-137	56.6	22	
10/22/2009	U-1	Be-7	2150	420	Natural
10/22/2009	T-3	K-40	18600	3000	Natural
10/22/2009	T-3	Cs-137	130	36	
10/22/2009	T-2	K-40	15700	2600	Natural
10/22/2009	T-2	Cs-137	101	30	
10/22/2009	T-1	K-40	10700	1800	Natural
10/22/2009	T-1	Cs-137	51.8	17.2	
10/22/2009	T-1	Be-7	516	266	Natural
10/22/2009	S-2	K-40	20900	3400	Natural
10/22/2009	S-2	Cs-137	165	36	

Table 26. 2009 Fish Sample Gamma Radioactivity Results

Sample Date	Sample Location	Results pCi/kg	Error pCi/kg	Results Nuclides
5/12/2009	3-4	2090	350	K-40
5/12/2009	3-4	10.2	3.8	Cs-137
5/12/2009	3-8	2100	370	K-40
10/22/2009	3-4	2570	450	K-40
10/22/2009	3-4	10.4	6.6	Cs-137
10/30/2009	3-8	2810	480	K-40

List of Tables, Figures and Maps

Tables

Figures

Maps