



## 4.4 Food and Farm Product Surveillance

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Foodstuffs, including milk, vegetables, fruits, and wine, were collected in 1999 at several locations surrounding the Hanford Site (Figure 4.4.1). Samples were collected primarily from locations in the prevailing downwind directions (south and east of the site) where airborne effluents or fugitive dust from the Hanford Site could be deposited. Samples were also collected in generally upwind directions and at locations somewhat distant from the site to provide information on background radioactivity.

The food and farm product sampling addresses the potential influence of Hanford Site releases in two ways:

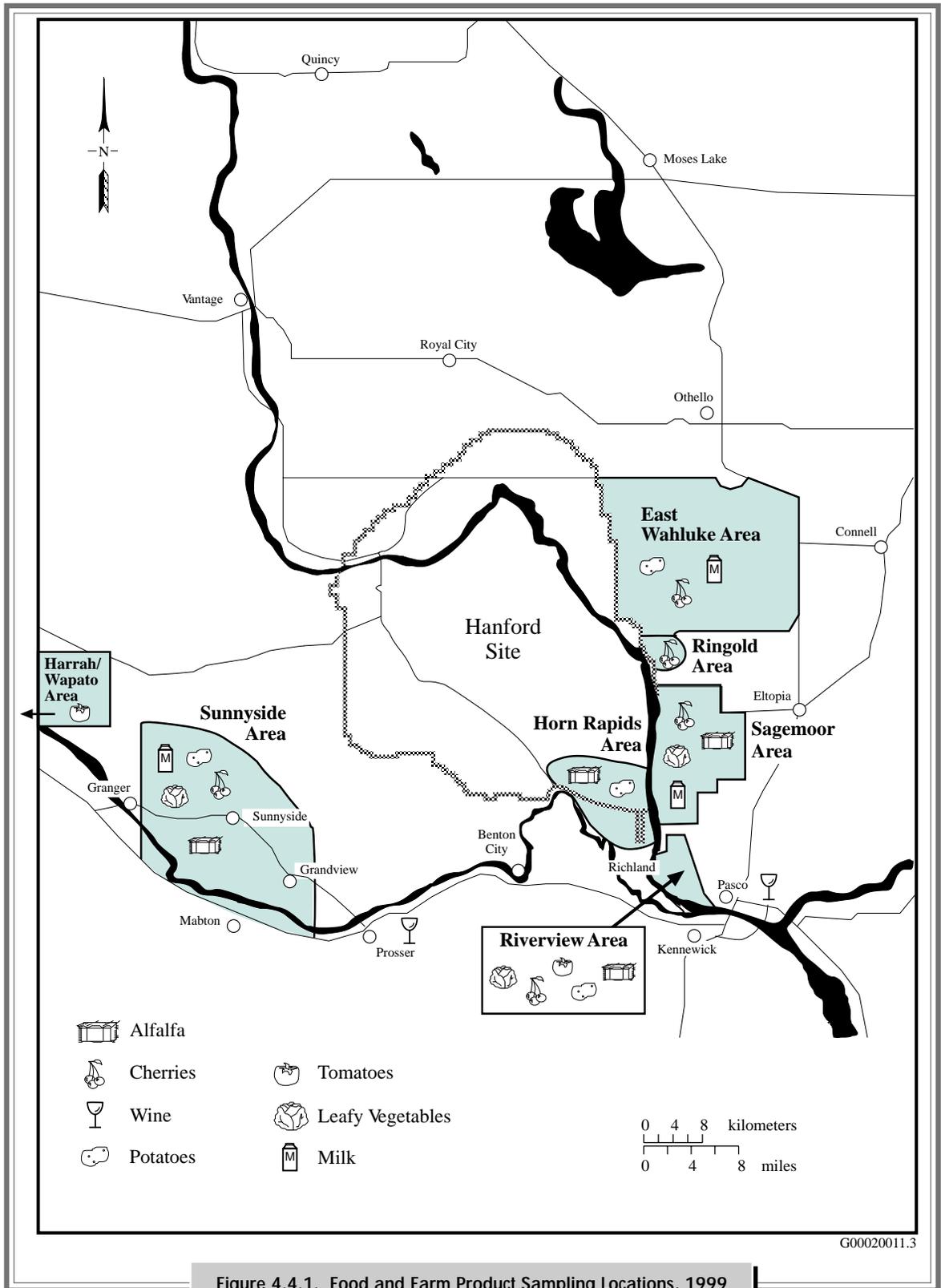
- by comparing results from several downwind locations to those from generally upwind or distant locations
- by comparing results from locations irrigated with Columbia River water withdrawn downstream from the Hanford Site to results from locations irrigated with water from other sources.

In 1996, the food and farm product sampling schedule was modified by establishing a 2- or 3-year rotation for certain farm products. Additionally, analyses for specific radionuclides that historically have not been detected in a food or farm product were discontinued. These changes were adopted because of the emphasis on cleanup of the site. Specific details of the 1999 food and farm product sampling, including sampling locations and radionuclides analyzed, are reported in DOE/RL-91-50, Rev. 2 and PNNL-12103, and are summarized in Table 4.4.1.

Gamma scans (cobalt-60, cesium-137, and other radionuclides; see Appendix E) and strontium-90 analyses were performed routinely for nearly all products. Additionally, milk was analyzed for iodine-129 and tritium; wine was analyzed for tritium. Results for fruits and vegetables are reported in picocuries per gram wet weight. Results for tritium are reported in picocuries per liter of liquid distilled from milk and wine. Most tritium is found as water, and very little tritium is organically bound to other constituents present in food products.

Tritium and iodine-129 from site facilities are released to the atmosphere and to the Columbia River via riverbank springs. Strontium-90 from Hanford is released to the Columbia River through riverbank springs. Cesium-137 is present in atmospheric fallout from weapons testing and is found in Hanford Site radiological waste.

For many radionuclides, concentrations are below levels that can be detected by the analytical laboratory. When this occurs for an entire group of samples, a nominal detection limit is estimated by using two times the total propagated analytical uncertainty (2 sigma). This value from a group of samples is used as an estimate of the lower level of detection for that analyte and particular food product. The total propagated analytical uncertainty includes all sources of analytical error associated with the analysis (e.g., counting errors and errors associated with weight and volumetric measurements). Theoretically, re-analysis of the sample should yield a result that falls within the range of the uncertainty 95% of the time. Results and uncertainties not given in this report may be found in PNNL-13230, APP. 1.



**Figure 4.4.1. Food and Farm Product Sampling Locations, 1999**



**Table 4.4.1. Locations, Sampling Frequencies, and Analyses Performed for Routinely Sampled Food and Farm Products, 1999<sup>(a)</sup>**

<b>Product</b>	<b>Number of Locations</b>		<b>Sampling Frequency<sup>(b)</sup></b>	<b>Number of Locations Analyzed</b>			
	<b>Upwind</b>	<b>Downwind</b>		<b><sup>3</sup>H</b>	<b>Gamma</b>	<b><sup>90</sup>Sr</b>	<b><sup>129</sup>I</b>
Milk	1	2	Q or SA	5	5	5	5
Dairy water	1	2	Q	5	5	0	0
Vegetables	1	2	A	0	4	4	0
Fruit	2	2	A	0	4	4	0
Wine	2	2	A	4	4	0	0

(a) Products may include multiple varieties for each category.

(b) Q = quarterly, SA = semiannually, A = annually.

### 4.4.1 Milk Samples and Analytes of Interest

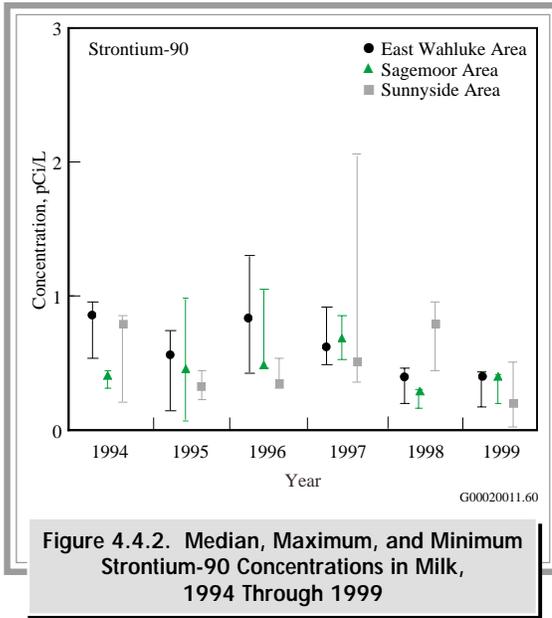
Composite samples of raw, whole milk were collected in 1999 from three dairy farms in the East Wahluke Area and two Sagemoor Area dairy farms. These sampling areas are located near the site perimeter in the prevailing downwind direction (see Figure 4.4.1). Milk samples were also collected from a Sunnyside Area dairy to indicate background radionuclide activities at a generally upwind location.

Samples of milk were analyzed for tritium, strontium-90, iodine-129, and gamma emitters such as cesium-137 because these radionuclides have the potential to move through the air-pasture-cow milk or water-pasture-cow milk food chains to humans. Fallout radionuclides in feed and/or drinking water may be a significant source of radioactivity in milk products; however, measured levels of radionuclides in milk are usually near levels considered to be background. Gamma scans and strontium-90 analyses were conducted quarterly, and iodine-129 analyses were conducted on two semiannual composite samples. Tritium analyses were discontinued in 1995 because tritium activities had dropped below the detection level of standard liquid scintillation counting methods. In 1998, an electrolytic enrichment technique (DOE/RL-91-50, Rev. 2) for measuring

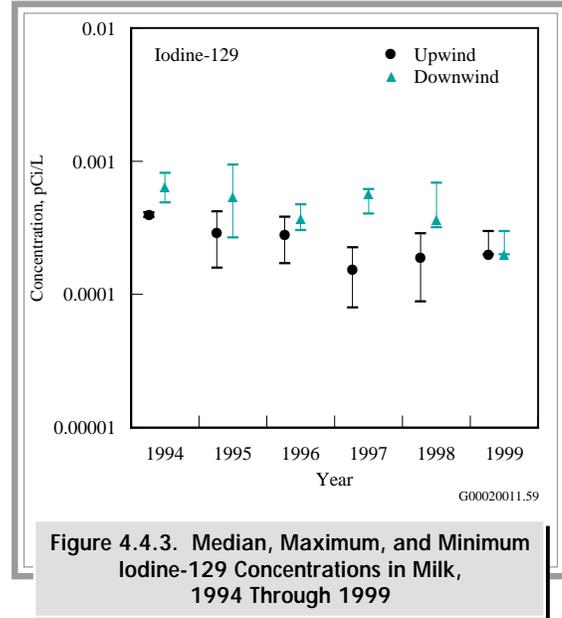
tritium in milk samples was instituted. The electrolytic enrichment technique has a detection limit of ~10 pCi/L of water distilled from milk as compared to ~180 pCi/L for the analytical technique used prior to 1996. Milk samples were not analyzed for tritium in 1996 and 1997.

Strontium-90 was detected in only 1 of 12 (8%) milk samples analyzed in 1999. The one positive result (0.51 pCi/L) was collected near Sunnyside, Washington, and is close to the analytical detection limit (0.35 pCi/L). Results near or below detection are consistent with results observed during the past decade. Median, maximum, and minimum concentrations for samples collected from 1994 through 1999 are shown in Figure 4.4.2. While there is no strontium-90 standard for milk, the drinking water standard (based on a 2-liter per day consumption) is 8 pCi/L (40 CFR 141). The maximum milk consumption rate for estimating dose is ~0.75 liter per day (see Appendix D, Table D.2).

Iodine-129 was quantified for analyses by high-resolution mass spectrometry in six milk samples. In recent years, the levels of iodine-129 in milk collected from generally downwind dairies in the Sagemoor and East Wahluke Areas have persisted at



**Figure 4.4.2. Median, Maximum, and Minimum Strontium-90 Concentrations in Milk, 1994 Through 1999**

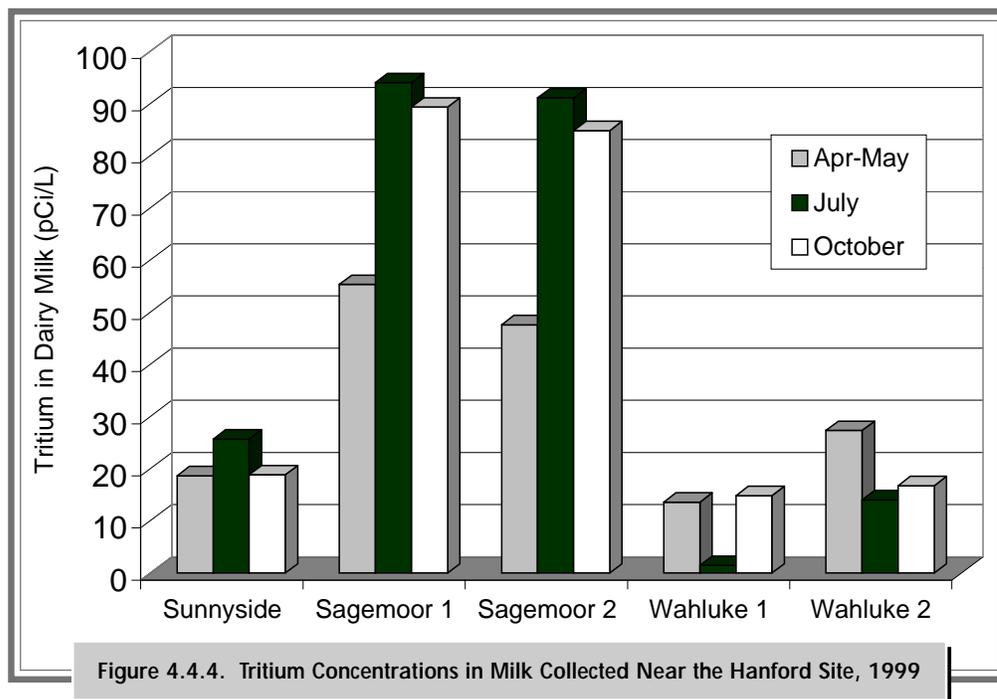


**Figure 4.4.3. Median, Maximum, and Minimum Iodine-129 Concentrations in Milk, 1994 Through 1999**

levels two to four times greater than levels measured upwind in Sunnyside (Figure 4.4.3). Iodine-129 concentrations have declined with the end of nuclear production on the site and contribute less than 1% of the dose to the maximally exposed individual through the consumption of dairy products (see Section 5.0, “Potential Radiological Doses from 1999 Hanford Operations”). While there is no iodine-129 standard for milk, the drinking water standard is 1 pCi/L (EPA-570/9-76-003). No other man-made gamma emitters (including cesium-137) were detectable in 1999 milk samples (PNNL-13230, APP. 1).

Tritium was analyzed by an electrolytic enrichment method in quarterly composite milk samples from the Wahluke, Sagemoor, and Sunnyside Areas (see Figure 4.4.1) in 1999. The results indicate Sagemoor dairies have higher tritium concentrations as compared to both Sunnyside and the Wahluke Areas (Figure 4.4.4). As seen in previous years, the tritium concentration in the first quarter sample was lower than the concentrations in the summer and fall sampling periods. In previous years, Sagemoor Area results were consistently higher than results for both the Wahluke and Sunnyside Areas.

A plausible explanation for this difference may be the drinking water provided to cows at the participating dairies. The dairies in all three areas use well water. The Franklin County aquifers used by the dairies in the Sagemoor and Wahluke Areas have historically been recharged by Columbia River water brought into the areas by the Columbia Basin Irrigation Project. Water for the Columbia Basin Irrigation Project is obtained from the Columbia River upstream of the Grand Coulee Dam. Background tritium levels in Columbia River water in the 1960s ranged from 800 to 5,540 pCi/L. These concentrations were influenced by fallout from world-wide aboveground nuclear weapons testing (Wyerman et al. 1970). Irrigation water from the Columbia River containing these comparatively high tritium levels entered the groundwater aquifers in Franklin County as a result of overapplication and leaking canals. This water remains in the aquifers that provide water for the dairies in Franklin County, particularly those located in low elevation areas. Over the past 30 years, tritium levels have slowly decreased as a result of radiological decay and possible dilution caused by subsequent recharge with less-contaminated irrigation water. Based on a 12.3-year half-life, if we assume an aquifer having



a concentration of 1,000 pCi/L in 1963 (assumes some dilution with natural groundwater), the estimated level after three half-lives in 1999 would be 115 pCi/L.

To help address this question, well water samples were collected in conjunction with the milk samples in 1999. Figure 4.4.5 illustrates a regression analysis of tritium concentrations in dairy water and the corresponding concentrations found in the dairy milk. The ability to predict a tritium concentration in the dairy milk from a known tritium concentration in the dairy water is almost 1 to 1 ( $r^2=0.83$ ).

One well water result from a sample collected in the Wahluke Area in May 1999 was not consistent with this water/milk correlation and may have been the result of analytical error. Information is being gathered on past irrigation practices in the Columbia Basin and the lower Yakima Valley. While the relationships between tritium in milk and groundwater used by the dairies are interesting, the actual levels of tritium in milk make a minor contribution to the dose of those who consume milk (see Section 5.0, "Potential Radiological Doses from 1999 Hanford Operations").

## 4.4.2 Vegetable Samples and Analytes of Interest

Samples of leafy vegetables (i.e., swiss chard and spinach) and vegetables (i.e., tomatoes, asparagus, cucumbers, and potatoes) were obtained during the summer from gardens and farms located within selected sampling areas (see Figure 4.4.1). Leafy vegetables were sampled to monitor for the potential deposition of airborne contaminants. The Riverview Area was sampled because of its exposure

to potentially contaminated irrigation water withdrawn from the Columbia River downstream of the Hanford Site. All vegetable samples were analyzed for gamma-emitting radionuclides and strontium-90.

Measurements of gamma emitters in vegetable and leafy vegetable samples were all less than their respective detection limit (0.02 pCi/g) and were

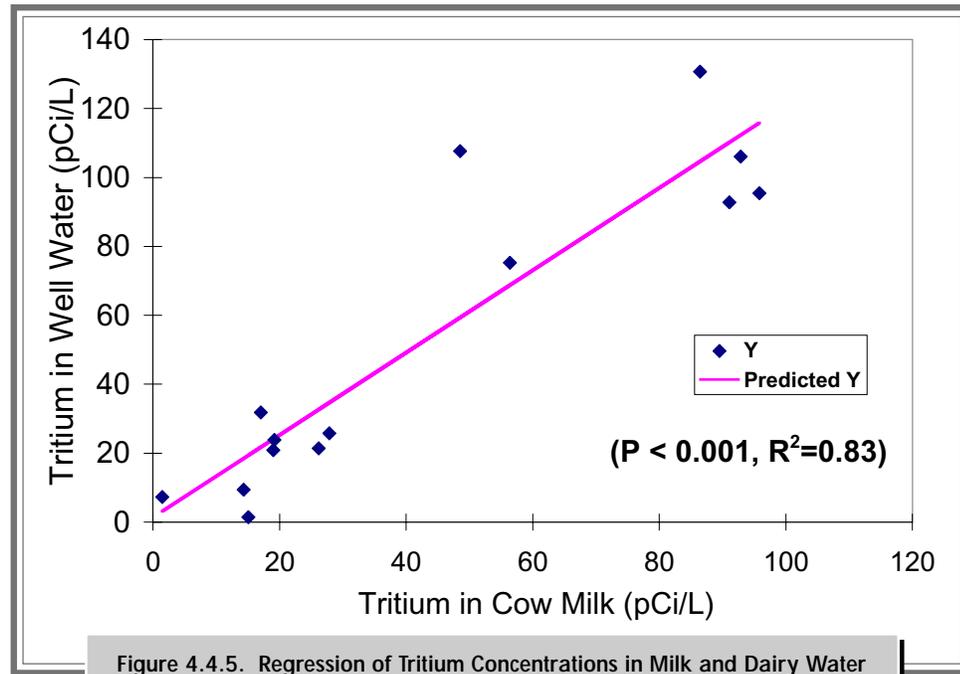


Figure 4.4.5. Regression of Tritium Concentrations in Milk and Dairy Water

consistent with results seen in recent years (PNNL-13230, APP. 1). Strontium-90 was detected in two leafy vegetable samples. The Riverview Area sample ( $0.152 \pm 0.04$  pCi/g wet wt.) had approximately seven times the level of the Sagemoor Area sample ( $0.02 \pm$

$0.006$  pCi/g wet wt.). However, a duplicate Riverview Area sample was submitted for re-analyses and the result was below the analytical detection limit ( $0.05$  pCi/g wet wt.). The Sunnyside Area sample fell below the analytical detection limit ( $0.035$  pCi/g).

### 4.4.3 Fruit Samples and Analytes of Interest

Cherries were collected during harvest from the areas shown in Figure 4.4.1. All cherry samples were analyzed for gamma-emitting radionuclides and strontium-90. Measurable levels of cesium-137, strontium-90, and other man-made gamma-emitting radionuclides were not detected in cherries in 1999.

These results are consistent with measurements in grapes, apples, and melons over recent years (PNL-10575, PNNL-11140, PNNL-11473, PNNL-11796, PNNL-12088). The nominal level of detection for cesium-137 was  $0.01$  pCi/g wet weight.

### 4.4.4 Alfalfa

Alfalfa samples were collected during harvest from the areas shown in Figure 4.4.1. All samples were analyzed for gamma-emitting radionuclides and strontium-90. Measurable levels of cesium-137 and other man-made gamma-emitting radionuclides were not detected in alfalfa in 1999. The nominal

level of detection for cesium-137 in alfalfa was  $0.02$  pCi/g dry wt. Strontium-90 was found above the analytical detection limit ( $0.07$  pCi/g dry wt.) in three of the four samples submitted for analysis in 1999. The highest concentration ( $0.92$  pCi/g dry wt.) was seen in a sample from the Horn Rapids



Area; however, a duplicate analyses of the same batch of alfalfa yielded a concentration of 0.1 pCi/g dry wt. These results were consistent with

measurements in alfalfa over the past 5 years (PNL-10575, PNNL-11140, PNNL-11473, PNNL-11796, PNNL-12088).

### 4.4.5 Wine Samples and Analytes of Interest

Locally produced red and white wines (1999 vintage grapes) were analyzed for gamma-emitting radionuclides and tritium. The wines were made from grapes grown at individual vineyards downwind of the site and at an upwind location in the lower Yakima Valley. Two samples each of red and white wines were obtained from each location and analyzed. An electrolytic enrichment method was used for tritium analysis in water distilled from the wine.

Tritium levels in 1999 wine samples were consistent with past results. Tritium concentrations were higher in Columbia Basin wines when compared to Yakima Valley wines (Figure 4.4.6). Red wine from the Columbia Basin contained nearly twice ( $79.4 \pm 2.4$  pCi/L) the tritium concentration found in white wine ( $38.8 \pm 1.2$  pCi/L) from the same region. Gamma spectroscopy did not indicate the presence of cesium-137 or any other man-made radionuclide in any of the 1999 wine samples. The observed differences between wines and/or regions are likely related to the water sources as discussed with tritium in milk (see Section 4.4.1, "Milk Samples and Analytes of Interest").

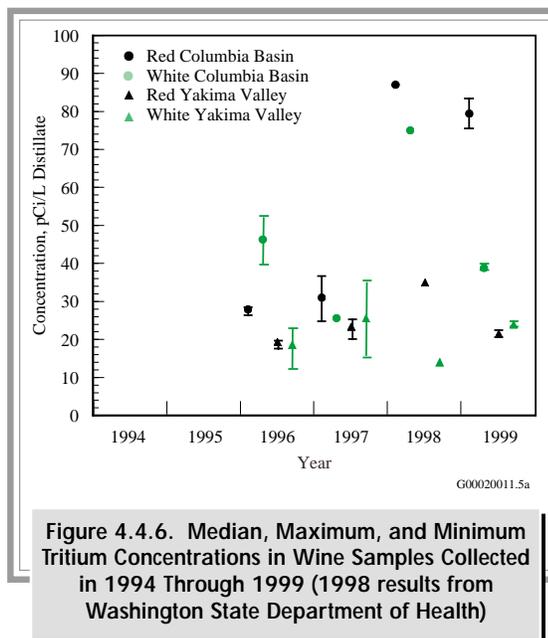


Figure 4.4.6. Median, Maximum, and Minimum Tritium Concentrations in Wine Samples Collected in 1994 Through 1999 (1998 results from Washington State Department of Health)