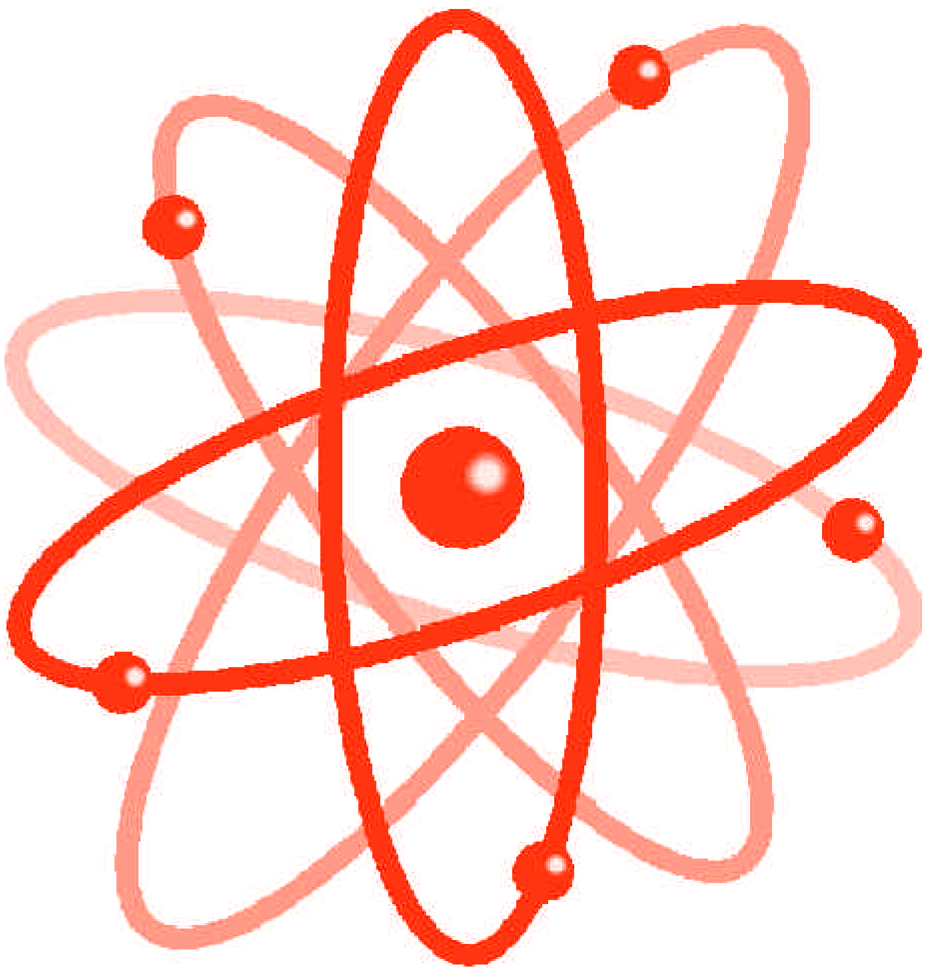
Materials for January 27, 2016 Meeting with the Office of Information and Regulatory Affairs/ White House Office of Management and Budget Regarding Proposals to Allow Radioactivity in Drinking Water Hundreds of Times Higher than Safe Drinking Water Act Maximum Contaminant Levels

Contents

Longstanding EPA Maximum Contaminant Levels (MCLs) for Radionuclides Pursuant to the Safe Drinking Water Act

United States Environmental Protection Agency

Radionuclides in Drinking Water: A Small Entity Compliance Guide



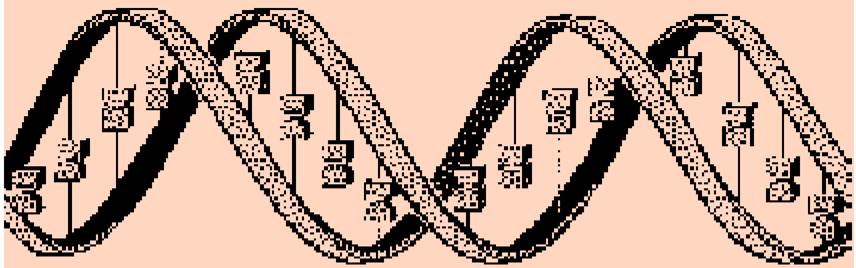
2. Which Radionuclides Does EPA Regulate in Drinking Water?

Some elements, either found in nature or man-made, are unstable and emit particles or waves of high energy from the nucleus or other parts of the atom.

There are three basic kinds of high-energy radiation: alpha, beta, and gamma (included in a broader group called photons). Many radioactive elements called "radionuclides" (pronounced "radio-noo-clydes") emit more than one kind of radiation, but are classified by their most important kind.

How Radionuclides Affect Peoples' Health

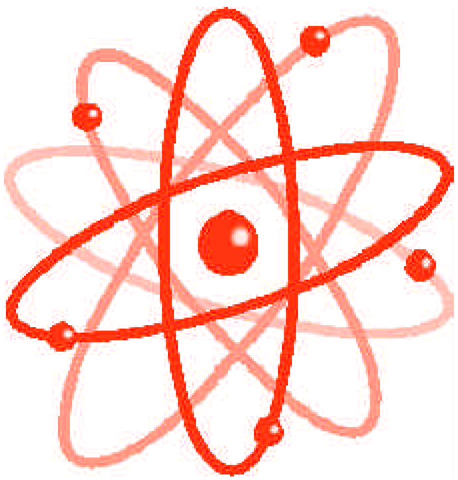
Exposure to radioactivity may be harmful to chemical reactions important to living cells in your body. Radiation pulls electrons off atoms in the cells (ionizes them) and may prevent the cell from functioning properly. It may lead to the cell's death, to the cell's inability to repair itself, or to the cell's uncontrolled growth (cancer). For example, ionizing radiation can damage DNA, which carries the genetic information in a cell. Damage to DNA may change the cell's genetic code, resulting in the mutation of one or more genes contained in the DNA. These mutations can cause cells to malfunction or lead to cancer. These mutations may also be passed on to children.



EPA has limits in drinking water called maximum contaminant levels (MCLs) for four groupings of radionuclides:

- One MCL is a limitation on two kinds (or "isotopes") of radium: radium-226 (Ra-226), which mostly emits alpha radiation, Ra-228, which mostly emits beta radiation.
- Another MCL limits radiation from a group of 179 man-made beta and photon emitters. Only systems which have been designated by your State as vulnerable or contaminated by this class of radionuclides must monitor. See section 7.
- The third MCL is for "gross alpha" which includes all alpha emitters except uranium and radon.
- Fourth is a new MCL for uranium isotopes U-234, U-235 and U-238, which mostly emit alpha radation. This last MCL is actually concerned primarily about limiting the toxic effects of uranium as a heavy metal as much as its effect as a radionuclide.

The MCLs are concerned with the health effects from radiation inside the body after drinking the radionuclides. However, many radionuclides classified as “alpha emitters’ or “beta emitters” also emit gamma radiation, which can penetrate the body from outside, affecting workers during storage or disposal of wastes.



Radionuclide Maximum Contaminant Levels	
Beta/photon emitters*	4 mrem/year
Gross alpha particle	15 pCi/L
Radium-226 and Radium-228	5 pCi/L
Uranium	30 µg/L
*A total of 179 individual beta particle and photon emitters may be used to calculate compliance with the MCL.	

Derived Concentrations (pCi/l) of Beta and Photon Emitters in Drinking Water

Yielding a Dose of 4 mrem/yr to the Total Body or to any Critical Organ as defined in NBS Handbook 69

Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l
H-3	20,000	Ni-65	300	Nb-95	300	Sb-124	60	Nd-147	200	Os-191	600
Be-7	6,000	Cu-64	900	Nb-97	3,000	Sb-125	300	Nd-149	900	Os-191m	9,000
C-14	2,000	Zn-65	300	Mo-99	600	Te-125m	600	Pm-147	600	Os-193	200
F-18	2,000	Zn-69	6,000	Tc-96	300	Te-127	900	Pm-149	100	Ir-190	600
Na-22	400	Zn-69m	200	Tc-96m	30,000	Te-127m	200	Sm-151	1,000	Ir-192	100
Na-24	600	Ga-72	100	Tc-97	6,000	Te-129	2,000	Sm-153	200	Ir-194	90
Si-31	3,000	Ge-71	6,000	Tc-97m	1,000	Te-129m	90	Eu-152	200	Pt-191	300
P-32	30	As-73	1,000	Tc-99	900	Te-131m	200	Eu-154	60	Pt-193	3,000
S-35 inorg	500	As-74	100	Tc-99m	20,000	Te-132	90	Eu-155	600	Pt-193m	3,000
Cl-36	700	As-76	60	Ru-97	1,000	I-126	3	Gd-153	600	Pt-197	300
Cl-38	1,000	As-77	200	Ru-103	200	I-129	1	Gd-159	200	Pt-197m	3,000
K-42	900	Se-75	900	Ru-105	200	I-131	3	Tb-160	100	Au-196	600
Ca-45	10	Br-82	100	Ru-106	30	I-132	90	Dy-165	1,000	Au-198	100
Ca-47	80	Rb-86	600	Rh-103m	30,000	I-133	10	Dy-166	100	Au-199	600
Sc-46	100	Rb-87	300	Rh-105	300	I-134	100	Ho-166	90	Hg-197	900
Sc-47	300	Sr-85 m	20,000	Pd-103	900	I-135	30	Er-169	300	Hg-197m	600
Sc-48	80	Sr-85	900	Pd-109	300	Cs-131	20,000	Er-171	300	Hg-203	60
V-48	90	Sr-89	20	Ag-105	300	Cs-134	80	Tm-170	100	Tl-200	1,000
Cr-51	6,000	Sr-90	8	Ag-110m	90	Cs-134m	20,000	Tm-171	1,000	Tl-201	900
Mn-52	90	Sr-91	200	Ag-111	100	Cs-135	900	Yb-175	300	Tl-202	300
Mn-54	300	Sr-92	200	Cd-109	600	Cs-136	800	Lu-177	300	Tl-204	300
Mn-56	300	Y-90	60	Cd-115	90	Cs-137	200	Hf-181	200	Pb-203	1,000
Fe-55	2,000	Y-91	90	Cd-115m	90	Ba-131	600	Ta-182	100	Bi-206	100
Fe-59	200	Y-91m	9,000	In-113m	3,000	Ba-140	90	W-181	1,000	Bi-207	200
Co-57	1,000	Y-92	200	In-114m	60	La-140	60	W-185	300	Pa-230	600
Co-58	300	Y-93	90	In-115	300	Ce-141	300	W-187	200	Pa-233	300
Co-58m	9000	Zr-93	2,000	In-115m	1,000	Ce-143	100	Re-186	300	Np-239	300
Co-60	100	Zr-95	200	Sn-113	300	Ce-144	30	Re-187	9,000	Pu-241	300
Ni-59	300	Zr-97	60	Sn-125	60	Pr-142	90	Re-188	200	Bk-249	2,000
Ni-63	50	Nb-93m	1,000	Sb-122	90	Pr-143	100	Os-185	200		

List of Man-made and Naturally-Occurring Radionuclides addressed by 15 pCi/L gross alpha particle activity MCL standard

Nd-144	Ra-219	U-235 **
Sm-147	Ra-223	U-236 **
Sm-148	Ra-224	U-238 **
Po-208	Ra-226*	Pa-231
Bi-210	Rn-220	Pu-236
Bi-211	Fr-221	Pu-238
Bi-212	Fr-223	Pu 239
Bi-213	Ac-225	Pu-240
Bi-214	Ac-227	Pu-241
Po-210	Th-227	Pu-242
Po-212	Th-228	Np-237
Po-213	Th-229	Am-241
Po-214	Th-230	Cm-242
Po-215	Th-232	Cm-244
Po-216	U-230**	Cm-245
Po-218	U-232**	Cm-248
At-217	U-233**	Bk-248
At-218	U-234**	Cf-250
Tl-217		

Source: EPA OSWER Directive 9283.1-14, November 6, 2001

* Combined Ra-226 + Ra-226 now is not to exceed 5 pCi/L

** Uranium MCL is now 30 micrograms/L

This list includes only those radionuclides with half lives exceeding 4 days.

Revisions to the Protective Action Guides Manual for Radiological Incidents

Review Draft

This equation simplifies the removal of radiation from a water supply following a contaminating incident. For example, if a radiological incident results in the contamination of the water in a reservoir, then the radionuclide concentration will decline with the effective half-life of the radionuclide in the reservoir.

The assumed water intake rate, *I*, is another variable that will influence the DRLs. The water intake rate is assumed to be 2.0 L/d (0.528 gal/d), which represents the water intake of the upper 90th percentile of the U.S. population. The larger the assumed daily water consumption, the lower the DRLs. The DRLs are also affected by the assumed exposure time, *T*. In this analysis, *T* is assumed to be 1 year. Effectively, the longer the assumed exposure time, the lower the DRLs. The first year is used since the Intermediate Phase of a radiological incident response may last weeks to months, depending on the severity of the incident. Projected Intermediate Phase doses are usually calculated assuming a one-year exposure.

The 1-year exposure period assures that protective actions would be in place long enough for water monitoring to reveal a decline in the concentrations of radionuclides in the drinking water supply and/or other variables affecting the potential radiation dose to members of the community. Using a 1-year basis for the DRLs also reduces the uncertainty due to the inability to predict the temporal variations in rain storm events over a shorter period.

4.4 Derived Response Levels for Radionuclides in Drinking Water

The final step in developing the drinking water PAG was to calculate DRLs. These levels will allow emergency response personnel to determine whether the radionuclide concentrations in water are likely to exceed the drinking water PAG of 0.5 rem (5 mSv).

Table 5-3 in ICRP 1984 presents the DRLs for the air exposure pathway. For inhalation, even relatively short-lived radionuclides are of concern due to the short time from a release to an exposure via the airborne pathways .For the drinking water pathway, there is substantial delay between the contaminating event and exposure. For example, the typical turnover rate of a reservoir is 1 year. Accordingly, the list of radionuclides for the drinking water PAG was constructed from the list in Table 5-3 in ICRP 1984 by deleting the radionuclides with half-lives less than 1 day. This option was selected for the drinking water PAG because it includes a comprehensive list of potentially important radionuclides and is consistent with the approach used in developing the implementation guidance for the air exposure PAGs. Table 4-1 provides the actual list of these radionuclides and their associated DRLs. The "Without Radioactive Decay" column should be used when the situation indicates a radionuclide concentration may not decrease via radioactive decay due to being in secular equilibrium with a parent radionuclide and/or the source is continuously contaminating the water source.

4.5 Applying the Generic Derived Response Levels

EPA derived generic DRLs to assist in planning and, in the event of a radiological emergency, quick and effective execution of protective actions. Although event-specific DRLs would reduce some of the uncertainty associated with generic DRLs, it would require real-time analysis that might be difficult to obtain or cause a delay in taking action if time-sequenced data needed to be gathered. However, incident-specific DRLs may be developed; the generic values included in this Manual are only intended to act as a guide for decision-making.

DRLs can be used to trigger and guide the response to an incident that results in, or that could result in, the contamination of drinking water supplies. For example, action might be taken to protect water supplies as soon as notification of a radiological release is received. Data can then be obtained from monitoring programs, and field measurement programs can be expanded to include drinking water samples. Such programs could include sampling and analysis of water upstream and downstream of a water supply system and in storage within the supply system.

Comparison of these data to the DRLs in Table 4-1 can inform judgments regarding the need to implement protective actions. Once it is determined that the potential exists for the PAG to be exceeded, actions can be initiated or revised based on the results of comparison of environmental data to Table 4-1. It is important to remember that such actions are likely to be event-specific. However, consideration of various strategies during emergency planning will allow quick and effective decisions to be made in the case of an actual incident.

Developing a reasonably accurate model for predicting the movement of radionuclides from a watershed to their ultimate fate in a reservoir or other water body is a very difficult problem. The uncertainty of precipitation events represents a major obstacle to credibly predicting this movement. Rain may fall in almost any pattern of frequency and intensity. This leads to great uncertainty in predicting the magnitude of dilution in streams and lakes, the lateral movement of a contaminant due to erosion, or the vertical movement of a contaminant due to percolation in a watershed. Therefore, decisions on protective action must be based on measurements rather than calculations alone. A radiological environmental surveillance program in place to collect up-to-date information concerning the concentrations of radionuclides in water supplies is vital.

4.6 Derived Response Levels for Multiple Radionuclides

In the case that multiple radionuclides are found in the water supply, divide the actual concentration of each radionuclide in water by its DRL of 0.5 rem (5 mSv). This gives a fraction of the allowed amount in water for each radionuclide. If the sum of the fractions is 1 or less, the total of the radionuclides is less than the PAG of 0.5 rem. (See the fractions rule, as follows):

$$F = \sum_{i}^{n} \frac{C_i}{DRL_i}$$

Where:

F	=	the sum of fractions
C_i	=	the concentration of radionuclide, i, in the water supply (pCi/L)
DRL_i	=	the Derived Response Level for the i^{th} radionuclide (pCi/L)

For example, assume that as a result of a nuclear power plant accident, a water supply is contaminated with 100,000 pCi/L of I-131, 12,000 pCi/L of Cs-137, and 3,500 pCi/L of Sr-90.

The DRLs in Table 4-1 for radioactive decay only are 267,000; 13,800; and 6,730 respectively. The sum of fractions rule would result in the following:

$$F = 100{,}000/267{,}000 + 12{,}000/13{,}800 + 3{,}500/6{,}730 = 0.37 + 0.87 + 0.52 = 1.76$$

Based on this, the radionuclide contamination levels exceed the DRL for this combination of radionuclides, assuming depletion by radioactive decay only. As such, actions to protect drinking water would be recommended.

If F is greater than one, the DRL is exceeded. Intervention is recommended until such time that the radionuclide concentrations decline below the DRL and that decision makers are certain that the radionuclide concentrations will not increase above the DRL in the future.

Table 4-1. Derived Response Levels (DRLs) Associated with a Committed Effective Dose (CED) of 0.5 rem Resulting from 1 Year of Ingestion

			Normalized mrem per pCi/L (CED)		DRLs (pCi/L)	
Radionuclide	Radioactive Decay Constant 1/d	DCF mrem/μCi	Without Radioactive Decay	With Radioactive Decay Only	Without Radioactive Decay	With Radioactive Decay Only
H-3	1.54E-04	1.55E-01	1.13E-04	1.10E-04	4.42E+06	4.54E+06
C-14	3.31E-07	2.15E+00	1.57E-03	1.57E-03	3.19E+05	3.19E+05
Na-22	7.29E-04	1.18E+01	8.61E-03	7.56E-03	5.80E+04	6.61E+04
P-32	4.85E-02	8.88E+00	6.48E-03	3.66E-04	7.71E+04	1.37E+06
P-33	2.73E-02	9.10E-01	6.64E-04	6.67E-05	7.53E+05	7.50E+06
S-35	7.93E-03	2.87E+00	2.10E-03	6.84E-04	2.39E+05	7.31E+05
Cl-36	6.30E-09	3.44E+00	2.51E-03	2.51E-03	1.99E+05	1.99E+05
K-40	1.48E-12	2.28E+01	1.66E-02	1.66E-02	3.00E+04	3.00E+04
Ca-45	4.25E-03	2.63E+00	1.92E-03	9.75E-04	2.60E+05	5.13E+05
Sc-46	8.27E-03	5.48E+00	4.00E-03	1.26E-03	1.25E+05	3.97E+05
Ti-44	3.16E-05	2.15E+01	1.57E-02	1.56E-02	3.19E+04	3.20E+04
V-48	4.27E-02	7.33E+00	5.35E-03	3.43E-04	9.34E+04	1.46E+06

Table 4-1. Derived Response Levels (DRLs) Associated with a Committed Effective Dose (CED) of 0.5 rem Resulting from 1 Year of Ingestion

			Normalized mrem per pCi/L (CED)		DRLs (pCi/L)	
Radionuclide	Radioactive Decay Constant 1/d	DCF mrem/μCi	Without Radioactive Decay	With Radioactive Decay Only	Without Radioactive Decay	With Radioactive Decay Only
Cr-51	2.50E-02	1.43E-01	1.04E-04	1.14E-05	4.79E+06	4.37E+07
Mn-54	2.22E-03	2.67E+00	1.95E-03	1.34E-03	2.57E+05	3.74E+05
Fe-55	7.03E-04	1.23E+00	8.98E-04	7.92E-04	5.57E+05	6.31E+05
Fe-59	1.56E-02	6.62E+00	4.83E-03	8.46E-04	1.03E+05	5.91E+05
Co-58	9.79E-03	2.77E+00	2.02E-03	5.50E-04	2.47E+05	9.09E+05
Co-60	3.60E-04	1.27E+01	9.27E-03	8.69E-03	5.39E+04	5.76E+04
Ni-63	1.98E-05	5.63E-01	4.11E-04	4.10E-04	1.22E+06	1.22E+06
Zn-65	2.84E-03	1.46E+01	1.07E-02	6.64E-03	4.69E+04	7.54E+04
Ge-68	2.41E-03	4.77E+00	3.48E-03	2.32E-03	1.44E+05	2.16E+05
Se-75	5.79E-03	9.66E+00	7.05E-03	2.93E-03	7.09E+04	1.70E+05
Rb-86	3.71E-02	1.04E+01	7.59E-03	5.61E-04	6.59E+04	8.92E+05
Sr-89	1.37E-02	9.51E+00	6.94E-03	1.38E-03	7.20E+04	3.63E+05
Sr-90	6.52E-05	1.03E+02	7.52E-02	7.43E-02	6.65E+03	6.73E+03
Y-90	2.60E-01	9.96E+00	7.27E-03	7.66E-05	6.88E+04	6.53E+06
Y-91	1.18E-02	8.77E+00	6.40E-03	1.47E-03	7.81E+04	3.41E+05
Zr-93	1.24E-09	4.11E+00	3.00E-03	3.00E-03	1.67E+05	1.67E+05
Zr-95	1.08E-02	3.56E+00	2.60E-03	6.46E-04	1.92E+05	7.73E+05
Nb-94	9.35E-08	6.44E+00	4.70E-03	4.70E-03	1.06E+05	1.06E+05
Nb-95	1.97E-02	2.18E+00	1.59E-03	2.21E-04	3.14E+05	2.26E+06
Mo-99	2.52E-01	2.24E+00	1.64E-03	1.78E-05	3.06E+05	2.81E+07
Tc-99	8.91E-09	2.38E+00	1.74E-03	1.74E-03	2.88E+05	2.88E+05
Ru-103	1.76E-02	2.72E+00	1.99E-03	3.09E-04	2.52E+05	1.62E+06
Ru/Rh-106	1.88E-03	2.59E+01	1.89E-02	1.37E-02	2.64E+04	3.65E+04
Ag-110m	2.77E-03	1.03E+01	7.52E-03	4.73E-03	6.65E+04	1.06E+05
Cd-109	1.49E-03	7.40E+00	5.40E-03	4.17E-03	9.26E+04	1.20E+05
Cd-113m	1.40E-04	8.51E+01	6.21E-02	6.06E-02	8.05E+03	8.26E+03
In-114m	1.40E-02	1.51E+01	1.10E-02	2.14E-03	4.54E+04	2.33E+05
Sn-113	6.02E-03	2.73E+00	1.99E-03	8.06E-04	2.51E+05	6.20E+05
Sn-123	5.36E-03	7.77E+00	5.67E-03	2.49E-03	8.82E+04	2.01E+05
Sn-125	7.19E-02	1.14E+01	8.32E-03	3.17E-04	6.01E+04	1.58E+06
Sn-126	8.25E-09	1.77E+01	1.29E-02	1.29E-02	3.87E+04	3.87E+04
Sb-124	1.15E-02	9.40E+00	6.86E-03	1.61E-03	7.29E+04	3.11E+05
Sb-126	5.59E-02	9.10E+00	6.64E-03	3.26E-04	7.53E+04	1.54E+06
Sb-127	1.80E-01	6.18E+00	4.51E-03	6.87E-05	1.11E+05	7.28E+06
Te-127	1.78E+00	6.25E-01	4.56E-04	7.02E-07	1.10E+06	7.12E+08
Te-129	1.43E+01	2.33E-01	1.70E-04	3.26E-08	2.94E+06	1.53E+10
Te-129m	2.06E-02	1.10E+01	8.03E-03	1.07E-03	6.23E+04	4.68E+05
Te-131m	5.55E-01	7.22E+00	5.27E-03	2.60E-05	9.49E+04	1.92E+07
Te/I-132	2.13E-01	1.41E+01	1.03E-02	1.32E-04	4.86E+04	3.78E+06
I-125	1.15E-02	5.70E+01	4.16E-02	9.76E-03	1.20E+04	5.12E+04
I-129	1.21E-10	3.92E+02	2.86E-01	2.86E-01	1.75E+03	1.75E+03
I-131	8.62E-02	8.07E+01	5.89E-02	1.87E-03	8.49E+03	2.67E+05
Cs-134	9.20E-04	7.11E+01	5.19E-02	4.41E-02	9.63E+03	1.13E+04
Cs-136	5.29E-02	1.14E+01	8.32E-03	4.31E-04	6.01E+04	1.16E+06
Cs/Ba-137	6.33E-05	5.03E+01	3.67E-02	3.63E-02	1.36E+04	1.38E+04
Ba-133	1.77E-04	5.66E+00	4.13E-03	4.00E-03	1.21E+05	1.25E+05

Table 4-1. Derived Response Levels (DRLs) Associated with a Committed Effective Dose (CED) of 0.5 rem Resulting from 1 Year of Ingestion

			Normalized mrem per pCi/L (CED)		DRLs (pCi/L)	
Radionuclide	Radioactive Decay Constant 1/d	DCF mrem/μCi	Without Radioactive Decay	With Radioactive Decay Only	Without Radioactive Decay	With Radioactive Decay Only
Ba-140	5.44E-02	9.62E+00	7.02E-03	3.54E-04	7.12E+04	1.41E+06
La-140	4.13E-01	7.48E+00	5.46E-03	3.62E-05	9.16E+04	1.38E+07
Ce-141	2.13E-02	2.63E+00	1.92E-03	2.47E-04	2.60E+05	2.03E+06
Ce-143	5.04E-01	4.15E+00	3.03E-03	1.65E-05	1.65E+05	3.04E+07
Ce/Pr-144	2.44E-03	1.94E+01	1.42E-02	9.38E-03	3.53E+04	5.33E+04
Nd-147	6.31E-02	4.00E+00	2.92E-03	1.27E-04	1.71E+05	3.94E+06
Pm-145	1.07E-04	4.29E-01	3.13E-04	3.07E-04	1.60E+06	1.63E+06
Pm-147	7.23E-04	9.66E-01	7.05E-04	6.20E-04	7.09E+05	8.07E+05
Pm-149	3.13E-01	3.68E+00	2.69E-03	2.35E-05	1.86E+05	2.13E+07
Pm-151	5.86E-01	2.71E+00	1.98E-03	9.25E-06	2.53E+05	5.41E+07
Sm-151	2.11E-05	3.63E-01	2.65E-04	2.64E-04	1.89E+06	1.89E+06
Eu-152	1.42E-04	5.07E+00	3.70E-03	3.61E-03	1.35E+05	1.39E+05
Eu-154	2.16E-04	7.55E+00	5.51E-03	5.30E-03	9.07E+04	9.43E+04
Eu-155	3.83E-04	1.21E+00	8.83E-04	8.24E-04	5.66E+05	6.07E+05
Gd-153	2.86E-03	1.03E+00	7.52E-04	4.67E-04	6.65E+05	1.07E+06
Tb-160	9.59E-03	5.96E+00	4.35E-03	1.21E-03	1.15E+05	4.15E+05
Ho-166m	1.58E-06	7.33E+00	5.35E-03	5.35E-03	9.34E+04	9.35E+04
Tm-170	5.39E-03	4.89E+00	3.57E-03	1.56E-03	1.40E+05	3.20E+05
Yb-169	2.17E-02	2.63E+00	1.92E-03	2.42E-04	2.60E+05	2.06E+06
Hf-181	1.63E-02	4.15E+00	3.03E-03	5.08E-04	1.65E+05	9.84E+05
Ta-182	6.03E-03	5.70E+00	4.16E-03	1.68E-03	1.20E+05	2.97E+05
W-187	6.96E-01	2.33E+00	1.70E-03	6.70E-06	2.94E+05	7.47E+07
Ir-192	9.36E-03	5.07E+00	3.70E-03	1.05E-03	1.35E+05	4.77E+05
Au-198	2.57E-01	3.81E+00	2.78E-03	2.96E-05	1.80E+05	1.69E+07
Hg-203	1.49E-02	7.07E+00	5.16E-03	9.45E-04	9.69E+04	5.29E+05
Tl-204	5.02E-04	4.40E+00	3.21E-03	2.93E-03	1.56E+05	1.70E+05
Pb-210	8.51E-05	2.58E+03	1.88E+00	1.85E+00	2.65E+02	2.70E+02
Bi-207	4.99E-05	4.70E+00	3.43E-03	3.40E-03	1.46E+05	1.47E+05
Bi-210	1.38E-01	4.85E+00	3.54E-03	7.03E-05	1.41E+05	7.11E+06
Po-210	5.01E-03	4.48E+03	3.27E+00	1.50E+00	1.53E+02	3.33E+02
Ra-226	1.19E-06	1.04E+03	7.59E-01	7.59E-01	6.59E+02	6.59E+02
Ac-227	8.72E-05	1.19E+03	8.69E-01	8.55E-01	5.76E+02	5.85E+02
Th-227	3.70E-02	3.34E+01	2.44E-02	1.81E-03	2.05E+04	2.77E+05
U-235	2.70E-12	1.73E+02	1.26E-01	1.26E-01	3.96E+03	3.96E+03
U-238	4.25E-13	1.65E+02	1.20E-01	1.20E-01	4.15E+03	4.15E+03
Np-237	8.87E-10	3.96E+02	2.89E-01	2.89E-01	1.73E+03	1.73E+03
Np-239	2.94E-01	2.95E+00	2.15E-03	2.01E-05	2.32E+05	2.49E+07
Pu-236	6.66E-04	3.22E+02	2.35E-01	2.09E-01	2.13E+03	2.40E+03
Pu-238	2.16E-05	8.44E+02	6.16E-01	6.14E-01	8.12E+02	8.15E+02
Pu-239	7.89E-08	9.29E+02	6.78E-01	6.78E-01	7.37E+02	7.37E+02
Pu-240	2.90E-07	9.29E+02	6.78E-01	6.78E-01	7.37E+02	7.37E+02
Pu-241	1.32E-04	1.76E+01	1.28E-02	1.25E-02	3.89E+04	3.99E+04
Pu-242	5.04E-09	8.81E+02	6.43E-01	6.43E-01	7.77E+02	7.77E+02
Am-241	4.39E-06	7.55E+02	5.51E-01	5.51E-01	9.07E+02	9.08E+02
Am-242m	1.25E-05	7.07E+02	5.16E-01	5.15E-01	9.69E+02	9.71E+02
Am-243	2.57E-07	7.51E+02	5.48E-01	5.48E-01	9.12E+02	9.12E+02

Table 4-1. Derived Response Levels (DRLs) Associated with a Committed Effective Dose (CED) of 0.5 rem Resulting from 1 Year of Ingestion

			Normalized mrem per pCi/L (CED)		DRLs (pCi/L)	
Radionuclide	Radioactive Decay Constant 1/d	DCF mrem/μCi	Without Radioactive Decay	With Radioactive Decay Only	Without Radioactive Decay	With Radioactive Decay Only
Cm-242	4.26E-03	4.33E+01	3.16E-02	1.60E-02	1.58E+04	3.12E+04
Cm-243	6.66E-05	5.51E+02	4.02E-01	3.97E-01	1.24E+03	1.26E+03
Cm-244	1.05E-04	4.55E+02	3.32E-01	3.26E-01	1.51E+03	1.53E+03
Cm-245	2.23E-07	7.70E+02	5.62E-01	5.62E-01	8.90E+02	8.90E+02
Cm-246	4.01E-07	7.66E+02	5.59E-01	5.59E-01	8.94E+02	8.94E+02
Cf-252	7.19E-04	3.52E+02	2.57E-01	2.26E-01	1.95E+03	2.21E+03

By How Much Would Radioactivity in Drinking Water Be Allowed to Exceed EPA's Safe Drinking Water Act Maximum Concentration Levels Without Actions Being Taken to Protect the Public if Options Floated by EPA in 2013 Were Adopted

Charts Showing How Much the 2009 Proposed PAGs Would Have Exceeded Current Safe Drinking Water Act Maximum Contaminant Levels

PROPOSED RELAXATION OF EPA DRINKING WATER STANDARDS

Proposed Protective Action Guide [PAG] vs. Current Maximum Concentration Level [MCL]

Radionuclide	PROPOSED PAG (w/o Decay)*	CURRENT Maximum Concentration Level (MCL)*	RATIO (Factor by which permissible concentration of radioactivity in drinking water is proposed to increase)
H-3	4,420,000	20,000	**221**
C-14	319,000	2,000	**160**
Na-22	58,000	400	**145**
P-32	77,100	30	**2,570**
S-35	239,000	500	**478**
Cl-36	199,000	700	**284**
Ca-45	260,000	10	**26,000**
Sc-46	125,000	100	**1,250**
V-48	93,400	90	**1,040**
Cr-51	4,790,000	6,000	**798**
Mn-54	257,000	300	**857**
Fe-55	557,000	2,000	**279**
Fe-59	103,000	200	**515**
Co-58	247,000	300	**823**
Co-60	53,900	100	**539**
Ni-63	1,220,000	50	**24,400**
Zn-65	46,900	300	**156**
Se-75	70,900	900	**78**
Rb-86	65,900	600	**110**
Sr-89	72,000	20	**3,600**
Sr-90	6,650	8	**831**
Y-90	68,800	60	**1,150**
Y-91	78,100	90	**868**
Zr-93	167,000	2,000	**84**
Zr-95	192,000	200	**960**
Nb-95	314,000	300	**1,050**
Mo-99	306,000	600	**510**
Tc-99	288,000	900	**320**
Ru-103	252,000	200	**1,260**
Ag-110m	66,500	90	**739**
Cd-109	92,600	600	**154**
In-114m	45,400	60	**757**
Sn-113	251,000	300	**837**
Sn-125	60,100	60	**1,000**
Sb-124	72,900	60	**1,220**
Te-127	1,100,000	900	**1,220**

*Units = picoCuries per Liter (pCi/L)

PROPOSED RELAXATION OF EPA DRINKING WATER STANDARDS

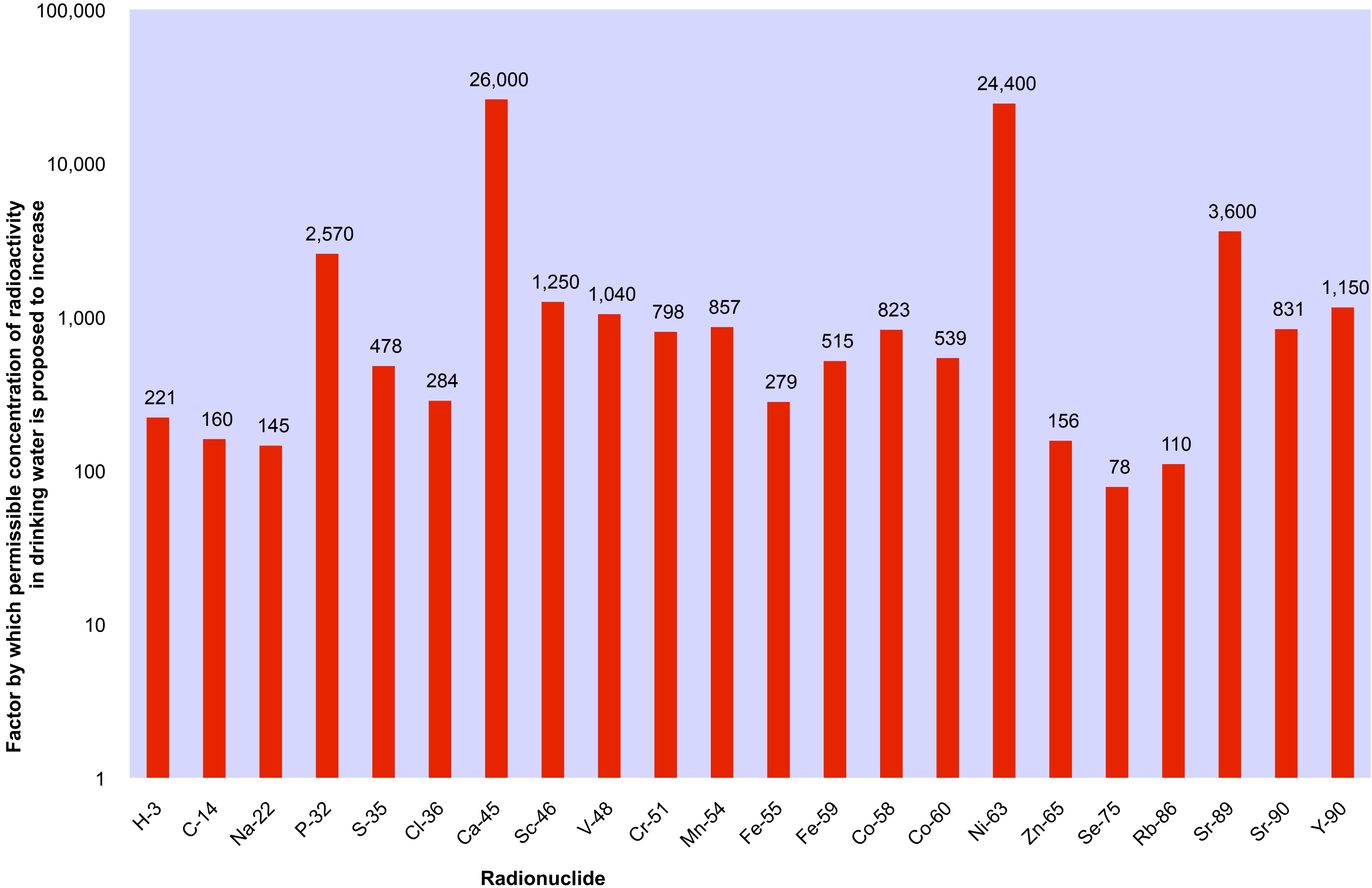
Proposed Protective Action Guide [PAG]
vs. Current Maximum Concentration Level [MCL]

Radionuclide	PROPOSED PAG (w/o Decay)*	CURRENT Maximum Concentration Level (MCL)*	RATIO (Factor by which permissible concentration of radioactivity in drinking water is proposed to increase)
Te-129	2,940,000	2,000	**1,470**
Te-129m	62,300	90	**692**
Te-132	48,600	90	**540**
I-132	48,600	90	**540**
I-129	1,750	1	**1,750**
I-131	8,490	3	**2,830**
Cs-136	60,100	800	**75**
Cs-137	13,600	200	**68**
Ba-140	71,200	90	**791**
La-140	91,600	60	**1,530**
Ce-141	260,000	300	**867**
Ce-143	165,000	100	**1,650**
Ce-144	35,300	30	**1,180**
Nd-147	171,000	200	**855**
Pm-149	186,000	100	**1,860**
Sm-151	1,890,000	1,000	**1,890**
Eu-152	135,000	200	**675**
Eu-154	90,700	60	**1,510**
Eu-155	566,000	600	**943**
Gd-153	665,000	600	**1,110**
Tb-160	115,000	100	**1,150**
Tm-170	140,000	100	**1,400**
Hf-181	165,000	200	**825**
Ta-182	120,000	100	**1,200**
W-187	294,000	200	**1,470**
Ir-192	135,000	100	**1,350**
Au-198	116,900,000	100	**1,170,000**
Hg-203	96,900	60	**1,620**
Tl-204	156,000	300	**520**
Bi-207	146,000	200	**730**

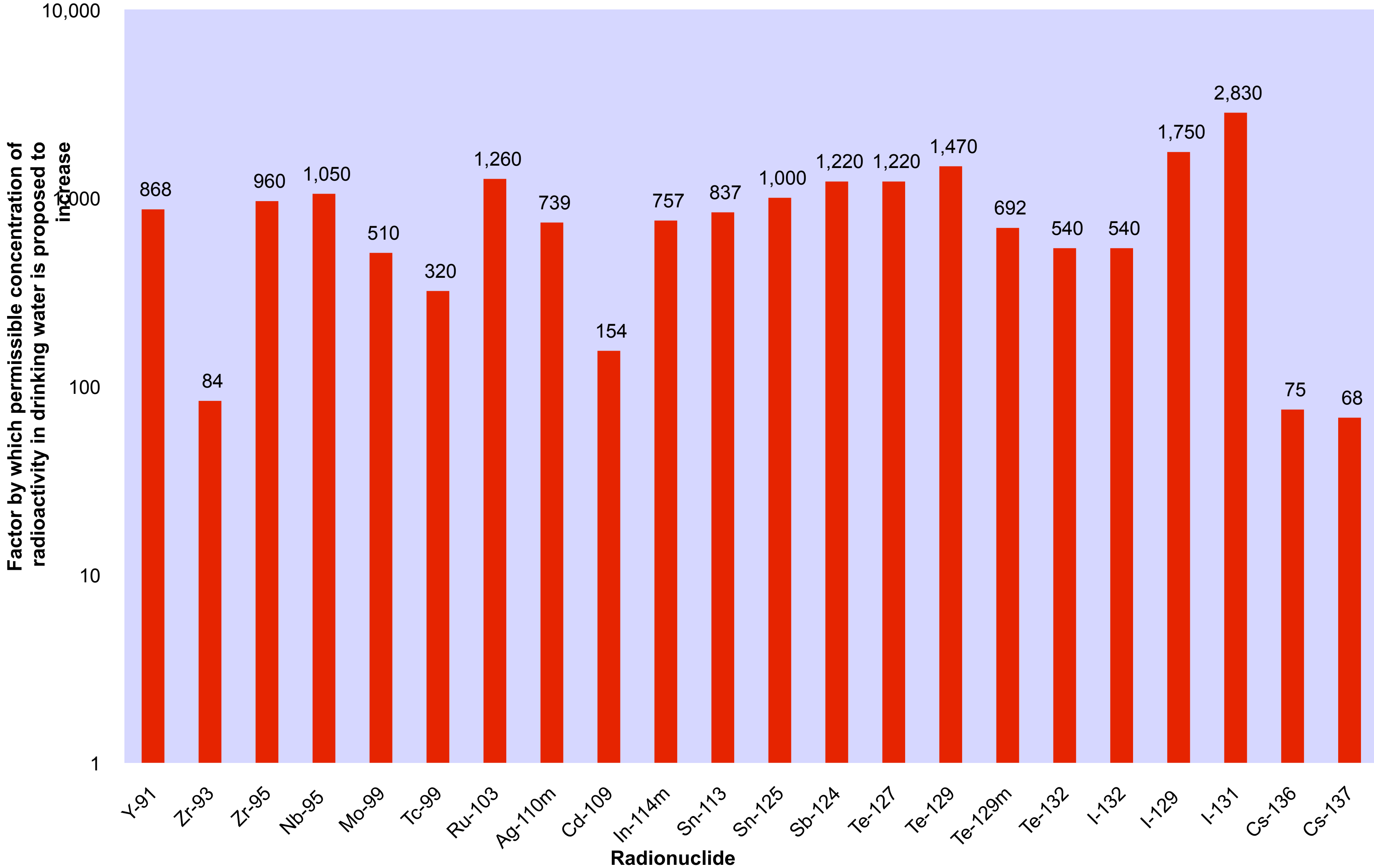
*Units = picoCuries per Liter (pCi/L)

Factor by which Allowable Radioactivity in Drinking Water is Proposed to Increase

Proposed PAG (w/o Decay) vs. Current Maximum Concentration Level (MCL)



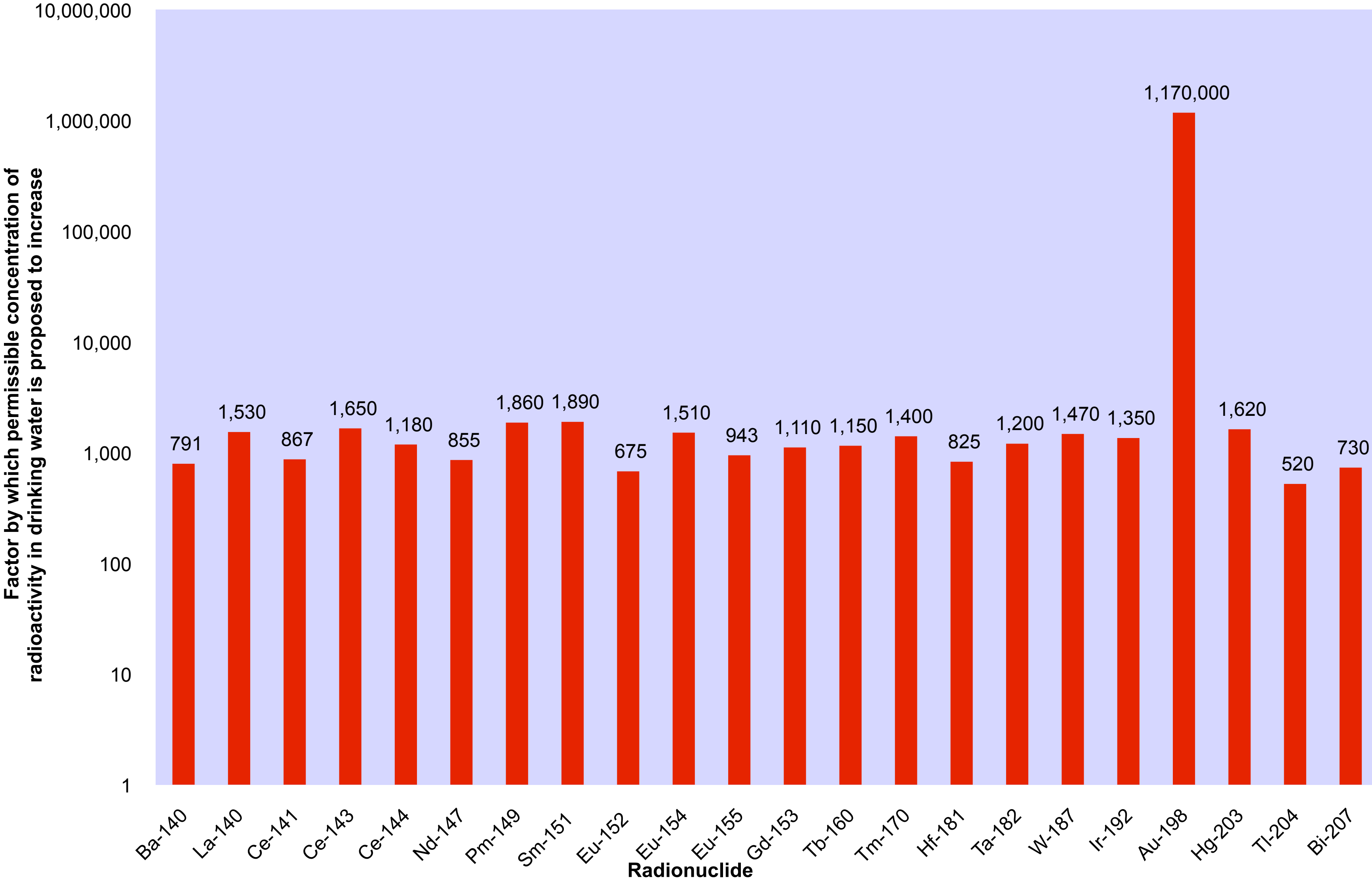
Factor by which Allowable Radioactivity in Drinking Water is Proposed to Increase
Proposed PAG (w/o Decay) vs. Current Maximum Concentration Level (MCL)



Page 2 of 3

Factor by which Allowable Radioactivity in Drinking Water is Proposed to Increase

Proposed PAG (w/o Decay) vs. Current Maximum Concentration Level (MCL)



Internal EPA Analysis of the Water PAG Proposal by EPA's Stuart Walker on Behalf of EPA Office of Superfund Remediation and Technological Innovation May 15, 2007

Obtained by Public Employees for Environmental Responsibility (PEER) under the Freedom of Information Act

Explanation of "3 Tables Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10^{-4} Concentrations"

There are 3 Lotus 123 Tables provided. They are sorted by:

1. Radionclide, in the order provided in the draft PAGs chapter
2. Risk, in order of the DRL posing the highest multiple of a 1 x 10-4 cancer incidence risk
3. MCLs, in order of the DRL posing the greatest multiple of the MCL

Rationale for Tables 2 and 3:

The CERCLA document most analogous to this PAG would be the "Final Guidance on Numeric Removal Action Levels for Contaminated Drinking Water Sites" OSWER 9360.1-02, October 25, 1993, which discusses when short-term risks from contaminated drinking water wells are high enough to warrant providing alternative (replacement) drinking water supplies. For class A carcinogens that do not have DWELs or longer-term HA's, like radionuclides, this guidance says to provide drinking water if the concentrations are above 1 x 10^{-4} lifetime risk (using OW methodology of 70 year exposure), or the MCL, if the MCL is greater than 1 x 10^{-4} lifetime risk.

Following are explanations of the information in the 3 tables.

Radionuclide column:

- Lists of radionuclides taken from Table 4.2 in draft Chapter 4 on drinking water PAGs.

- Radionuclides that are bolded and their rows are shaded were considered radionuclides of most concern for RDDs, INDs, or nuclear accidents in writeups from ORIA and Army Corps of Engineers.

- Tables that were put in the same row in Table 4.2 (e.g., Ru/Rh-106) have been broken out to facilitate comparisons between DRLs and 1 x 10^{-4} risk levels.

DRLs with Rad Decay column:

- Taken from Table 4.2. These were the most stringent DRLs listed and were used for comparison purposes since the other DRLs used assumptions that would not factor into CERCLA decisions about when to provide drinking water (e.g., assuming levels will decay or dilute over the year so use a level averaged over the year).

1x10-4 using OW Methods column:

- For those radionuclides that **do** have a value listed in the column "OW risk associated with MCL", these values are based on the rounded off values in the "OW risk..." column then a hand calculation on the value in the "MCLs" column to approximate the concentration that corresponds to a 1 x 10^{-4} cancer incidence risk using OW methodology. Note, OW staff did not create 1 x 10^{-4} concentrations for these radionuclides.

- For those radionuclides that **do not** have a value listed in the column "OW risk associated with MCL", these values are from OW.

MCLs Column:

- MCLs from OW implementation guide.

- Uranium MCLs are in terms of mass (micrograms per liter), not activity (picoCuries per liter). The 30 micrograms per liter MCL for the uranium element was converted to an activity for each isotope. The UMTRCA groundwater standard of 30 pCi/l for U-234 and U-238 combined was listed here for U-234 since it is a potential ARAR at CERCLA sites.

OW Risk Associated with MCL

- Provided in NODA for MCLs and/or regulatory support document. Note that some MCLs that are in OW implementation guide did not appear in the support documents, which is why SF rather than OW risk is provided.

1x10-4 using SF & 70 yrs

- Risk estimate developed using CERCLA rad PRG calculator, by changing "Tap water" exposure scenario defaults as follows: time of exposure from 30 years to 70 years; target risk from $1x10^{-6}$ to $1x10^{-4}$.

Comparison of DRL to OW/SF 10-4:

- Shows by a factor of #, how much DRL is greater than 1x10-4 risk level concentration.

- What this means
  - if value is 70, then **1 year** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
  - if value is 840, then **1 month** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
  - if value is 25,550, then **1 day** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
  - if value is 127,750, then drinking **1 glass** of water (12 ounces) at DRL value will equal amount of exposure of drinking water with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)

Comparison of DRL to MCL

- Shows by a factor of #, how much DRL is greater than MCL concentration.

- What this means
  - if value is 70, then **1 year** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
  - if value is 840, then **1 month** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
  - if value is 25,550, then **1 day** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
  - if value is 127,750, then drinking **1 glass** of water (12 ounces) at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years).
    - For example, drinking a very small glass of water of approximately 4ounces with Bi-210 at the DRL concentration would result in an exposure that corresponds to drinking liters of water per day for 70 years at the MCL level.

Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by Radionuclide

Radionuclide	DRLs without Rad Decay	Concentrations in pCi/L 1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison shows DRL is X times 10-4 or MCL value Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
H-3	**10,700,000**	**50,000**	**20,000**	**4x10-5**		**214**	**535**
C-14	1,210,000	2,000	2,000	1x10-4		605	605
Na-22	246,000	400	400	1x10-4		615	615
P-32	1,640,000	300	30	1x10-5		5,467	54,667
P-33	10,000,000				2,080	4,808	
S-35	9,900,000	6,250	500	8x10-6		1,584	19,800
Cl-36	877,000	875	700	8x10-5		1,002	1,253
K-40	134,000				83	1,614	
Ca-45	1,120,000	1,110	10	9x10-7		1,009	112,000
Sc-46	712,000	500	100	2x10-5		1,424	7,120
Ti-44	111,000				80	1,388	
V-48	1,540,000				249	6,185	
Cr-51	58,100,000	19,800	6,000	3x10-5		2,934	9,683
Mn-54	1,090,000	1,500	300	2x10-5		727	3,633
Fe-55	**4,420,000**	**2,800**	**2,000**	**7x10-5**		**1,579**	**2,210**
Fe-59	8,200	400	200	5x10-5		21	41
Co-58	1,640,000	33	300	9x10-4		49,200	5,467
Co-60	**97,300**	**200**	**100**	**5x10-5**		**487**	**973**
Ni-63	4,460,000	5,000	50	1x10-6		892	89,200
Zn-65	229,000	300	300	1x10-4		763	763
Ge-68	2,820,000				293	9,625	
Se-75	281,000	300	900	3x10-4		937	312
Rb-86	1,250,000	300	600	2x10-4		4,167	2,083
Sr-89	643,000	1,000	20	2x10-6		643	32,150
Sr-90	**18,200**	**40**	**8**	**2x10-5**		**455**	**2,275**
Y-90	6,140,000	198	60	3x10-5		31,010	102,333
Y-91	577,000	225	90	4x10-5		2,564	6,411
Zr-93	1,660,000	2,200	2,000	9x10-5		755	830
Zr-95	1,110,000	660	200	3x10-5		1,682	5,550
Nb-94	357,000				613	582	
Nb-95	1,590,000				1,940	820	
Mo-99	21,600,000	1,500	600	4x10-5		14,400	36,000
Tc-99	**1,690,000**	**1,260**	**900**	**7x10-5**		**1,341**	**1,878**
Ru-103	**3,820,000**	**1,000**	**200**	**2x10-5**		**3,820**	**19,100**
Ru-106	**111,000**	**75**	**30**	**4x10-5**		**1,480**	**3,700**
Rh-106	**111,000**						
Ag-110m	291,000	297	90	3x10-5		980	3,233
Cd-109	222,000	600	600	1x10-4		370	370
Cd-113m	16,100				71	227	
In-114m	352,000	150	60	4x10-5		2,347	5,867
Sn-113	1,290,000	750	300	4x10-5		1,720	4,300
Sn-123	459,000				340	1,350	
Sn-125	1,710,000	198	60	3x10-5		8,636	28,500
Sn-126	156,000				80	1,950	
Sb-124	559,000	300	60	2x10-5		1,863	9,317
Sb-126	1,650,000				184	8,967	

Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by Radionuclide

Radionuclide	DRLs without Rad Decay	Concentrations in pCi/L: 1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison shows DRL is X times 10-4 or MCL value: Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
Sb-127	7,080,000				202	35,050	
Te-127	490,000	2,970	900	3x10-5		165	544
Te-129	313,000,000	20,000	2,000	1x10-5		15,650	156,500
Te-129m	702,000	225	90	4x10-5		3,120	7,800
Te-131m	15,400,000		200		247	62,348	77,000
Te-132	5,850,000		90		120	48,750	65,000
I-132	5,850,000	4,500	90	2x10-6		1,300	65,000
I-125	144,000				80	1,800	
I-129	90,900	25	1	4x10-6		3,636	90,900
I-131	450,000	75	3	4x10-6		6,000	150,000
Cs-134	37,900	0	80	3x10-2		142,125	474
Cs-136	1,430,000	400	800	2x10-4		3,575	1,788
Cs-137	51,200	100	200	2x10-4		512	256
Ba-137	51,200						
Ba-133	760,000				300	2,533	
Ba-140	1,680,000	225	90	4x10-5		7,467	18,667
La-140	12,500,000	300	60	2x10-5		41,667	208,333
Ce-141	2,660,000	750	300	4x10-5		3,547	8,867
Ce-143	27,800,000	500	100	2x10-5		55,600	278,000
Ce-144	148,000	99	30	3x10-5		1,495	4,933
Pr-144	148,000				25,200	6	
Nd-147	4,130,000	500	200	4x10-5		8,260	20,650
Pm-145	5,460,000				3,650	1,496	
Pm-147	2,720,000		600		1,210	2,248	4,533
Pm-149	20,000,000	500	100	2x10-5		40,000	200,000
Pm-151	50,000,000				453	110,375	
Sm-151	6,540,000	5,000	1,000	2x10-5		1,308	6,540
Eu-152	394,000	2,000	200	1x10-5		197	1,970
Eu-154	273,000	99	60	6x10-5		2,758	4,550
Eu-155	1,750,000	1,980	600	3x10-5		884	2,917
Gd-153	2,690,000	1,980	600	3x10-5		1,359	4,483
Tb-160	728,000	330	100	3x10-5		2,206	7,280
Ho-166m	314,000				254	1,236	
Tm-170	725,000	330	100	3x10-5		2,197	7,250
Yb-169	2,660,000				510	5,216	
Hf-181	1,380,000	500	200	4x10-5		2,760	6,900
Ta-182	614,000	500	100	2x10-5		1,228	6,140
W-187	62,700,000	1,000	200	2x10-5		62,700	313,500
Ir-192	847,000	500	100	2x10-5		1,694	8,470
Au-198	16,100,000	500	100	2x10-5		32,200	161,000
Hg-203	566,000	990	60	6x10-4		572	9,433
Tl-204	782,000	600	300	5x10-5		1,303	2,607
Pb-210	476				2	238	
Bi-207	467,000	660	200	3x10-5		708	2,335
Bi-210	5,850,000	219	15			26,712	390,000
Po-210	1,970	1	15			1,791	131

Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by Radionuclide

	Concentrations in pCi/L					Comparison shows DRL is X times 10-4 or MCL value	
Radionuclide	DRLs without Rad Decay	1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
Ra-226	1,950	5	5	1x10-4		390	390
Ac-227	183				10	18	
Th-227	309,000	41	15			7,537	20,600
Th-228	6,940	18	15			386	463
Th-230	4,630	21	15			220	309
Th-232	942	19	15			50	63
Pa-231	231	8	15			29	15
U-232	1,960		640,000,000		7	280	0
U-233	8,770		290,000		28	313	0
U-234	9,090		190,000		29	313	0
U-234	9,090	UMTRCA GW	30		29	313	303
U-235	9,420		65		29	325	145
U-238	10,200		10		32	319	1,020
Np-237	578	32	15			18	39
Np-239	22,700,000		300		397	57,179	75,667
Pu-236	2,250	26	15			87	150
Pu-238	796				16	50	
Pu-239	727				15	48	
Pu-240	727				15	48	
Pu-241	37,900		300		1,160	33	126
Pu-242	749				16	47	
Am-241	707	19	15			37	47
Am-242m	728				29	25	
Am-243	706	19	15			37	47
Cm-242	32,500	51	15			637	2,167
Cm-243	1,020	21	15			49	68
Cm-244	1,280	23	15			56	85
Cm-245	688	19	15			36	46
Cm-246	688	19	15			36	46
Cf-252	2,460	39	15			63	164

Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by OW/SF 1x10-4 Cancer Incidence Risk

Radionuclide	DRLs without Rad Decay	Concentrations in pCi/L 1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison shows DRL is X times 10-4 or MCL value Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
Cs-134	37,900	0	80	3x10-2		142,125	474
Pm-151	50,000,000				453	110,375	
W-187	62,700,000	1,000	200	2x10-5		62,700	313,500
Te-131m	15,400,000		200		247	62,348	77,000
Np-239	22,700,000		300		397	57,179	75,667
Ce-143	27,800,000	500	100	2x10-5		55,600	278,000
Co-58	1,640,000	33	300	9x10-4		49,200	5,467
Te-132	5,850,000		90		120	48,750	65,000
La-140	12,500,000	300	60	2x10-5		41,667	208,333
Pm-149	20,000,000	500	100	2x10-5		40,000	200,000
Sb-127	7,080,000				202	35,050	
Au-198	16,100,000	500	100	2x10-5		32,200	161,000
Y-90	6,140,000	198	60	3x10-5		31,010	102,333
Bi-210	5,850,000	219	15			26,712	390,000
Te-129	313,000,000	20,000	2,000	1x10-5		15,650	156,500
Mo-99	21,600,000	1,500	600	4x10-5		14,400	36,000
Ge-68	2,820,000				293	9,625	
Sb-126	1,650,000				184	8,967	
Sn-125	1,710,000	198	60	3x10-5		8,636	28,500
Nd-147	4,130,000	500	200	4x10-5		8,260	20,650
Th-227	309,000	41	15			7,537	20,600
Ba-140	1,680,000	225	90	4x10-5		7,467	18,667
V-48	1,540,000				249	6,185	
I-131	450,000	75	3	4x10-6		6,000	150,000
P-32	1,640,000	300	30	1x10-5		5,467	54,667
Yb-169	2,660,000				510	5,216	
P-33	10,000,000				2,080	4,808	
Rb-86	1,250,000	300	600	2x10-4		4,167	2,083
Ru-103	3,820,000	1,000	200	2x10-5		3,820	19,100
I-129	90,900	25	1	4x10-6		3,636	90,900
Cs-136	1,430,000	400	800	2x10-4		3,575	1,788
Ce-141	2,660,000	750	300	4x10-5		3,547	8,867
Te-129m	702,000	225	90	4x10-5		3,120	7,800
Cr-51	58,100,000	19,800	6,000	3x10-5		2,934	9,683
Hf-181	1,380,000	500	200	4x10-5		2,760	6,900
Eu-154	273,000	99	60	6x10-5		2,758	4,550
Y-91	577,000	225	90	4x10-5		2,564	6,411
Ba-133	760,000				300	2,533	
In-114m	352,000	150	60	4x10-5		2,347	5,867
Pm-147	2,720,000		600		1,210	2,248	4,533
Tb-160	728,000	330	100	3x10-5		2,206	7,280
Tm-170	725,000	330	100	3x10-5		2,197	7,250
Sn-126	156,000				80	1,950	
Sb-124	559,000	300	60	2x10-5		1,863	9,317
I-125	144,000				80	1,800	
Po-210	1,970	1	15			1,791	131

Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by OW/SF 1x10-4 Cancer Incidence Risk

	Concentrations in pCi/L					Comparison shows DRL is X times 10-4 or MCL value	
Radionuclide	DRLs without Rad Decay	1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
Sn-113	1,290,000	750	300	4x10-5		1,720	4,300
Ir-192	847,000	500	100	2x10-5		1,694	8,470
Zr-95	1,110,000	660	200	3x10-5		1,682	5,550
K-40	134,000				83	1,614	
S-35	9,900,000	6,250	500	8x10-6		1,584	19,800
Fe-55	4,420,000	2,800	2,000	7x10-5		1,579	2,210
Pm-145	5,460,000				3,650	1,496	
Ce-144	148,000	99	30	3x10-5		1,495	4,933
Ru-106	111,000	75	30	4x10-5		1,480	3,700
Sc-46	712,000	500	100	2x10-5		1,424	7,120
Ti-44	111,000				80	1,388	
Gd-153	2,690,000	1,980	600	3x10-5		1,359	4,483
Sn-123	459,000				340	1,350	
Tc-99	1,690,000	1,260	900	7x10-5		1,341	1,878
Sm-151	6,540,000	5,000	1,000	2x10-5		1,308	6,540
Tl-204	782,000	600	300	5x10-5		1,303	2,607
I-132	5,850,000	4,500	90	2x10-6		1,300	65,000
Ho-166m	314,000				254	1,236	
Ta-182	614,000	500	100	2x10-5		1,228	6,140
Ca-45	1,120,000	1,110	10	9x10-7		1,009	112,000
Cl-36	877,000	875	700	8x10-5		1,002	1,253
Ag-110m	291,000	297	90	3x10-5		980	3,233
Se-75	281,000	300	900	3x10-4		937	312
Ni-63	4,460,000	5,000	50	1x10-6		892	89,200
Eu-155	1,750,000	1,980	600	3x10-5		884	2,917
Nb-95	1,590,000				1,940	820	
Zn-65	229,000	300	300	1x10-4		763	763
Zr-93	1,660,000	2,200	2,000	9x10-5		755	830
Mn-54	1,090,000	1,500	300	2x10-5		727	3,633
Bi-207	467,000	660	200	3x10-5		708	2,335
Sr-89	643,000	1,000	20	2x10-6		643	32,150
Cm-242	32,500	51	15			637	2,167
Na-22	246,000	400	400	1x10-4		615	615
C-14	1,210,000	2,000	2,000	1x10-4		605	605
Nb-94	357,000				613	582	
Hg-203	566,000	990	60	6x10-4		572	9,433
Cs-137	51,200	100	200	2x10-4		512	256
Co-60	97,300	200	100	5x10-5		487	973
Sr-90	18,200	40	8	2x10-5		455	2,275
Ra-226	1,950	5	5	1x10-4		390	390
Th-228	6,940	18	15			386	463
Cd-109	222,000	600	600	1x10-4		370	370
U-235	9,420		65		29	325	145
U-238	10,200		10		32	319	1,020
U-234	9,090	UMTRCA GW	30		29	313	303
U-234	9,090		190,000		29	313	0

Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by OW/SF 1x10-4 Cancer Incidence Risk

	Concentrations in pCi/L					Comparison shows DRL is X times 10-4 or MCL value	
Radionuclide	**DRLs without Rad Decay**	**1x10-4 using OW Methods**	**MCLs**	**OW Risk Associated with MCL**	**1x10-4 using SF & 70yrs**	**Comparison of DRL to OW/SF 10-4**	**Comparison of DRL to MCL**
U-233	8,770		290,000		28	313	0
U-232	1,960		640,000,000		7	280	0
Pb-210	476				2	238	
Cd-113m	16,100				71	227	
Th-230	4,630	21	15			220	309
H-3	**10,700,000**	**50,000**	**20,000**	**4x10-5**		**214**	**535**
Eu-152	394,000	2,000	200	1x10-5		197	1,970
Te-127	490,000	2,970	900	3x10-5		165	544
Pu-236	2,250	26	15			87	150
Cf-252	2,460	39	15			63	164
Cm-244	1,280	23	15			56	85
Pu-238	**796**				**16**	**50**	
Th-232	942	19	15			50	63
Cm-243	1,020	21	15			49	68
Pu-239	**727**				**15**	**48**	
Pu-240	**727**				**15**	**48**	
Pu-242	**749**				**16**	**47**	
Am-241	**707**	**19**	**15**			**37**	**47**
Am-243	706	19	15			37	47
Cm-246	688	19	15			36	46
Cm-245	688	19	15			36	46
Pu-241	**37,900**		**300**		**1,160**	**33**	**126**
Pa-231	231	8	15			29	15
Am-242m	728				29	25	
Fe-59	8,200	400	200	5x10-5		21	.41
Ac-227	183				10	18	
Np-237	578	32	15			18	39
Pr-144	148,000				25,200	6	
Rh-106	**111,000**						
Ba-137	**51,200**						

Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by MCL

Radionuclide	DRLs without Rad Decay	1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
	Concentrations in pCi/L					Comparison shows DRL is X times 10-4 or MCL value	
Bi-210	5,850,000	219	15			26,712	390,000
W-187	62,700,000	1,000	200	2x10-5		62,700	313,500
Ce-143	27,800,000	500	100	2x10-5		55,600	278,000
La-140	12,500,000	300	60	2x10-5		41,667	208,333
Pm-149	20,000,000	500	100	2x10-5		40,000	200,000
Au-198	16,100,000	500	100	2x10-5		32,200	161,000
Te-129	313,000,000	20,000	2,000	1x10-5		15,650	156,500
I-131	450,000	75	3	4x10-6		6,000	150,000
Ca-45	1,120,000	1,110	10	9x10-7		1,009	112,000
Y-90	6,140,000	198	60	3x10-5		31,010	102,333
I-129	90,900	25	1	4x10-6		3,636	90,900
Ni-63	4,460,000	5,000	50	1x10-6		892	89,200
Te-131m	15,400,000		200		247	62,348	77,000
Np-239	22,700,000		300		397	57,179	75,667
I-132	5,850,000	4,500	90	2x10-6		1,300	65,000
Te-132	5,850,000		90		120	48,750	65,000
P-32	1,640,000	300	30	1x10-5		5,467	54,667
Mo-99	21,600,000	1,500	600	4x10-5		14,400	36,000
Sr-89	643,000	1,000	20	2x10-6		643	32,150
Sn-125	1,710,000	198	60	3x10-5		8,636	28,500
Nd-147	4,130,000	500	200	4x10-5		8,260	20,650
Th-227	309,000	41	15			7,537	20,600
S-35	9,900,000	6,250	500	8x10-6		1,584	19,800
Ru-103	3,820,000	1,000	200	2x10-5		3,820	19,100
Ba-140	1,680,000	225	90	4x10-5		7,467	18,667
Cr-51	58,100,000	19,800	6,000	3x10-5		2,934	9,683
Hg-203	566,000	990	60	6x10-4		572	9,433
Sb-124	559,000	300	60	2x10-5		1,863	9,317
Ce-141	2,660,000	750	300	4x10-5		3,547	8,867
Ir-192	847,000	500	100	2x10-5		1,694	8,470
Te-129m	702,000	225	90	4x10-5		3,120	7,800
Tb-160	728,000	330	100	3x10-5		2,206	7,280
Tm-170	725,000	330	100	3x10-5		2,197	7,250
Sc-46	712,000	500	100	2x10-5		1,424	7,120
Hf-181	1,380,000	500	200	4x10-5		2,760	6,900
Sm-151	6,540,000	5,000	1,000	2x10-5		1,308	6,540
Y-91	577,000	225	90	4x10-5		2,564	6,411
Ta-182	614,000	500	100	2x10-5		1,228	6,140
In-114m	352,000	150	60	4x10-5		2,347	5,867
Zr-95	1,110,000	660	200	3x10-5		1,682	5,550
Co-58	1,640,000	33	300	9x10-4		49,200	5,467
Ce-144	148,000	99	30	3x10-5		1,495	4,933
Eu-154	273,000	99	60	6x10-5		2,758	4,550
Pm-147	2,720,000		600		1,210	2,248	4,533
Gd-153	2,690,000	1,980	600	3x10-5		1,359	4,483
Sn-113	1,290,000	750	300	4x10-5		1,720	4,300

Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by MCL

Radionuclide	DRLs without Rad Decay	1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
	Concentrations in pCi/L					Comparison shows DRL is X times 10-4 or MCL value	
Ru-106	111,000	75	30	4x10-5		1,480	3,700
Mn-54	1,090,000	1,500	300	2x10-5		727	3,633
Ag-110m	291,000	297	90	3x10-5		980	3,233
Eu-155	1,750,000	1,980	600	3x10-5		884	2,917
Tl-204	782,000	600	300	5x10-5		1,303	2,607
Bi-207	467,000	660	200	3x10-5		708	2,335
Sr-90	18,200	40	8	2x10-5		455	2,275
Fe-55	4,420,000	2,800	2,000	7x10-5		1,579	2,210
Cm-242	32,500	51	15			637	2,167
Rb-86	1,250,000	300	600	2x10-4		4,167	2,083
Eu-152	394,000	2,000	200	1x10-5		197	1,970
Tc-99	1,690,000	1,260	900	7x10-5		1,341	1,878
Cs-136	1,430,000	400	800	2x10-4		3,575	1,788
Cl-36	877,000	875	700	8x10-5		1,002	1,253
U-238	10,200		10		32	319	1,020
Co-60	97,300	200	100	5x10-5		487	973
Zr-93	1,660,000	2,200	2,000	9x10-5		755	830
Zn-65	229,000	300	300	1x10-4		763	763
Na-22	246,000	400	400	1x10-4		615	615
C-14	1,210,000	2,000	2,000	1x10-4		605	605
Te-127	490,000	2,970	900	3x10-5		165	544
H-3	10,700,000	50,000	20,000	4x10-5		214	535
Cs-134	37,900	0	80	3x10-2		142,125	474
Th-228	6,940	18	15			386	463
Ra-226	1,950	5	5	1x10-4		390	390
Cd-109	222,000	600	600	1x10-4		370	370
Se-75	281,000	300	900	3x10-4		937	312
Th-230	4,630	21	15			220	309
U-234	9,090	UMTRCA GW	30		29	313	303
Cs-137	51,200	100	200	2x10-4		512	256
Cf-252	2,460	39	15			63	164
Pu-236	2,250	26	15			87	150
U-235	9,420		65		29	325	145
Po-210	1,970	1	15			1,791	131
Pu-241	37,900		300		1,160	33	126
Cm-244	1,280	23	15			56	85
Cm-243	1,020	21	15			49	68
Th-232	942	19	15			50	63
Am-241	707	19	15			37	47
Am-243	706	19	15			37	47
Cm-246	688	19	15			36	46
Cm-245	688	19	15			36	46
Fe-59	8,200	400	200	5x10-5		21	41
Np-237	578	32	15			18	39
Pa-231	231	8	15			29	15
U-234	9,090		190,000		29	313	0

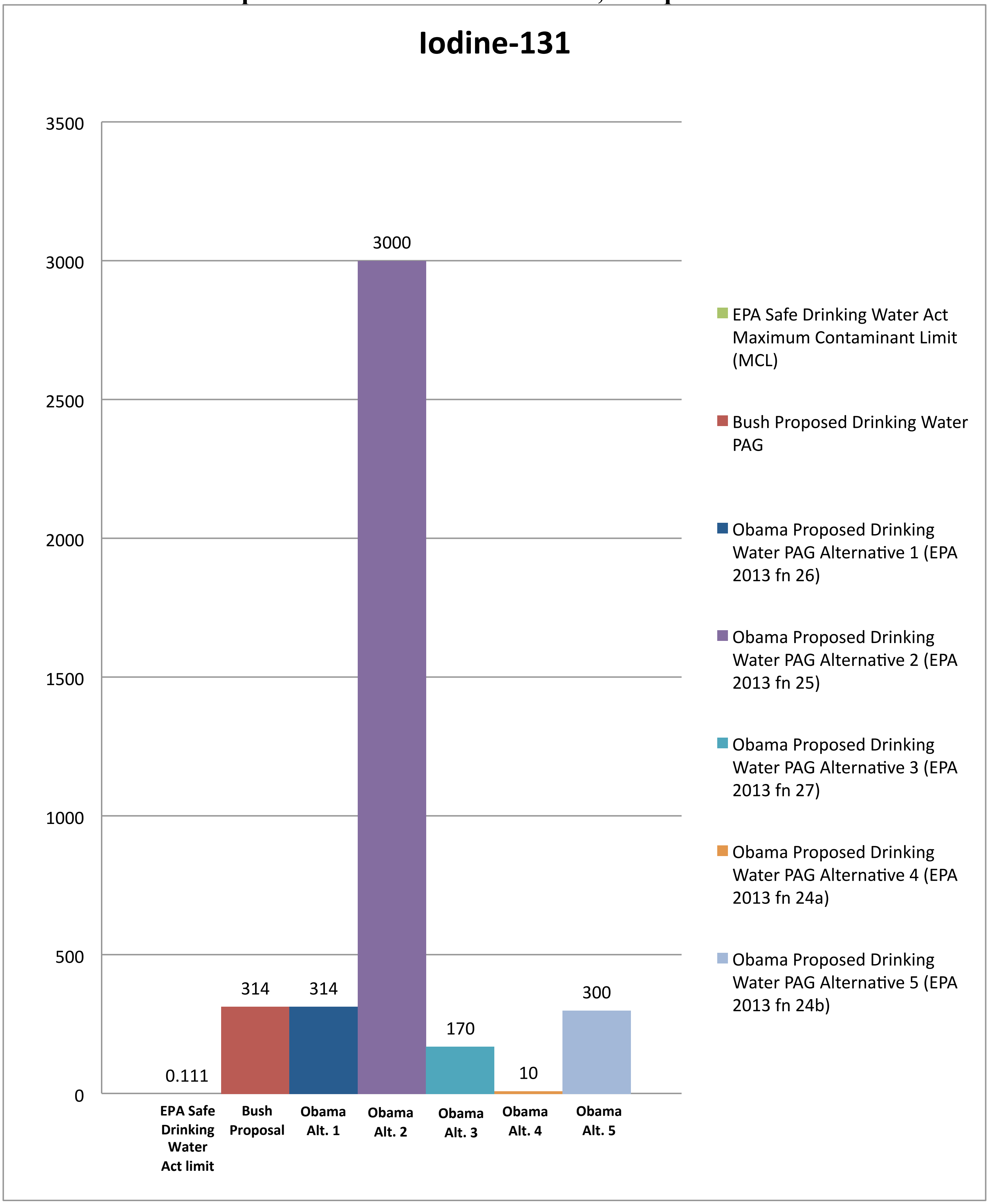
Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations

Sorted by MCL

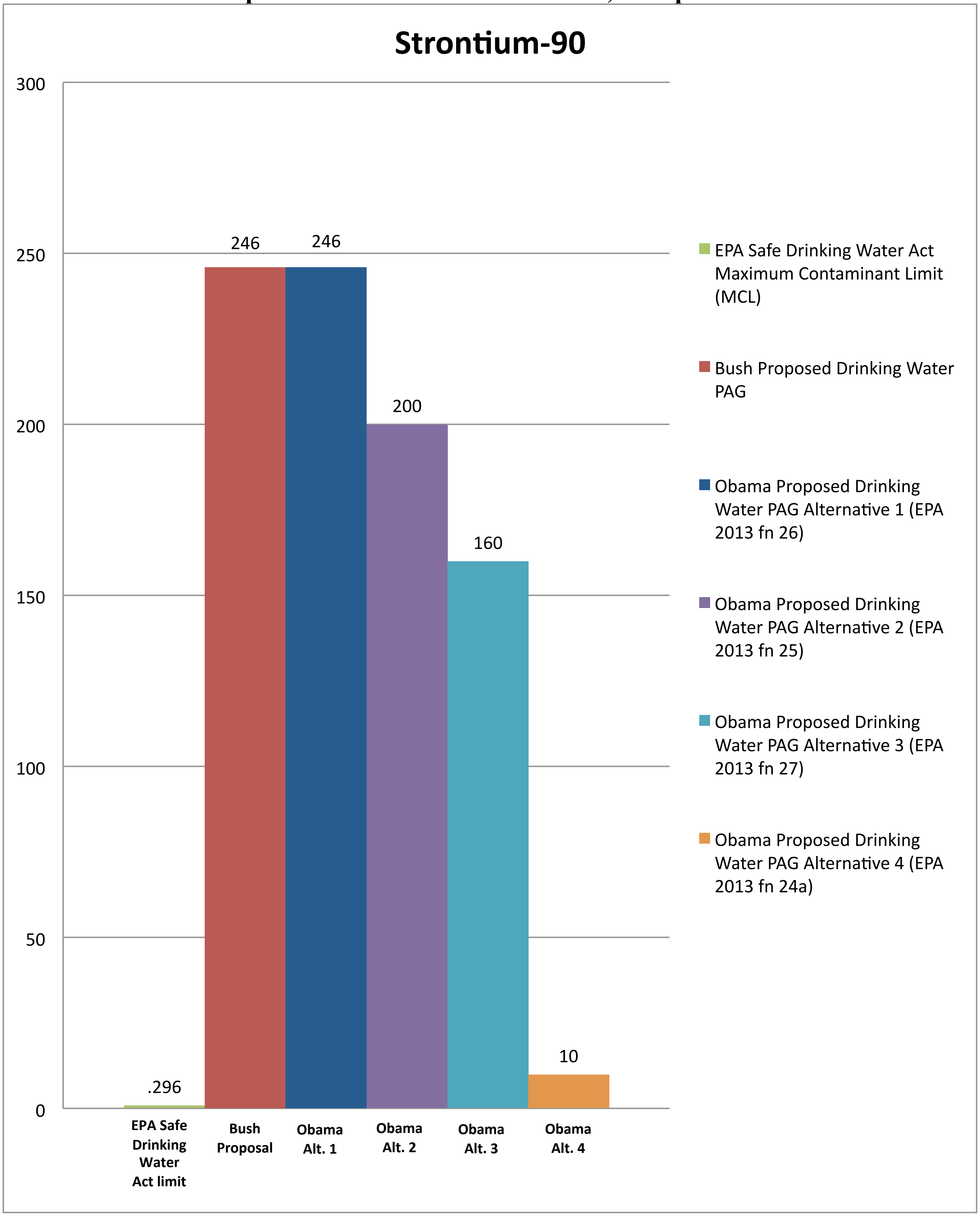
Radionuclide	DRLs without Rad Decay	Concentrations in pCi/L 1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison shows DRL is X times 10-4 or MCL value Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
U-233	8,770		290,000		28	313	0
U-232	1,960		640,000,000		7	280	0
Pu-242	749				16	47	
Am-242m	728				29	25	
Pu-238	796				16	50	
Pu-239	727				15	48	
Pr-144	148,000				25,200	6	
Ac-227	183				10	18	
Pu-240	727				15	48	
Rh-106	**111,000**						
Cd-113m	16,100				71	227	
Sb-127	7,080,000				202	35,050	
Sn-126	156,000				80	1,950	
Nb-95	1,590,000				1,940	820	
Pm-151	50,000,000				453	110,375	
Sn-123	459,000				340	1,350	
Ti-44	111,000				80	1,388	
Pm-145	5,460,000				3,650	1,496	
K-40	134,000				83	1,614	
I-125	144,000				80	1,800	
Nb-94	357,000				613	582	
Ge-68	2,820,000				293	9,625	
Ba-133	760,000				300	2,533	
P-33	10,000,000				2,080	4,808	
Yb-169	2,660,000				510	5,216	
V-48	1,540,000				249	6,185	
Pb-210	476				2	238	
Ho-166m	314,000				254	1,236	
Sb-126	1,650,000				184	8,967	
Ba-137	51,200						

By How Much Would Radioactivity in Drinking Water Be Allowed to Exceed EPA's Safe Drinking Water Act Maximum Concentration Levels Without Actions Being Taken to Protect the Public if Options Floated by EPA in 2013 Were Adopted

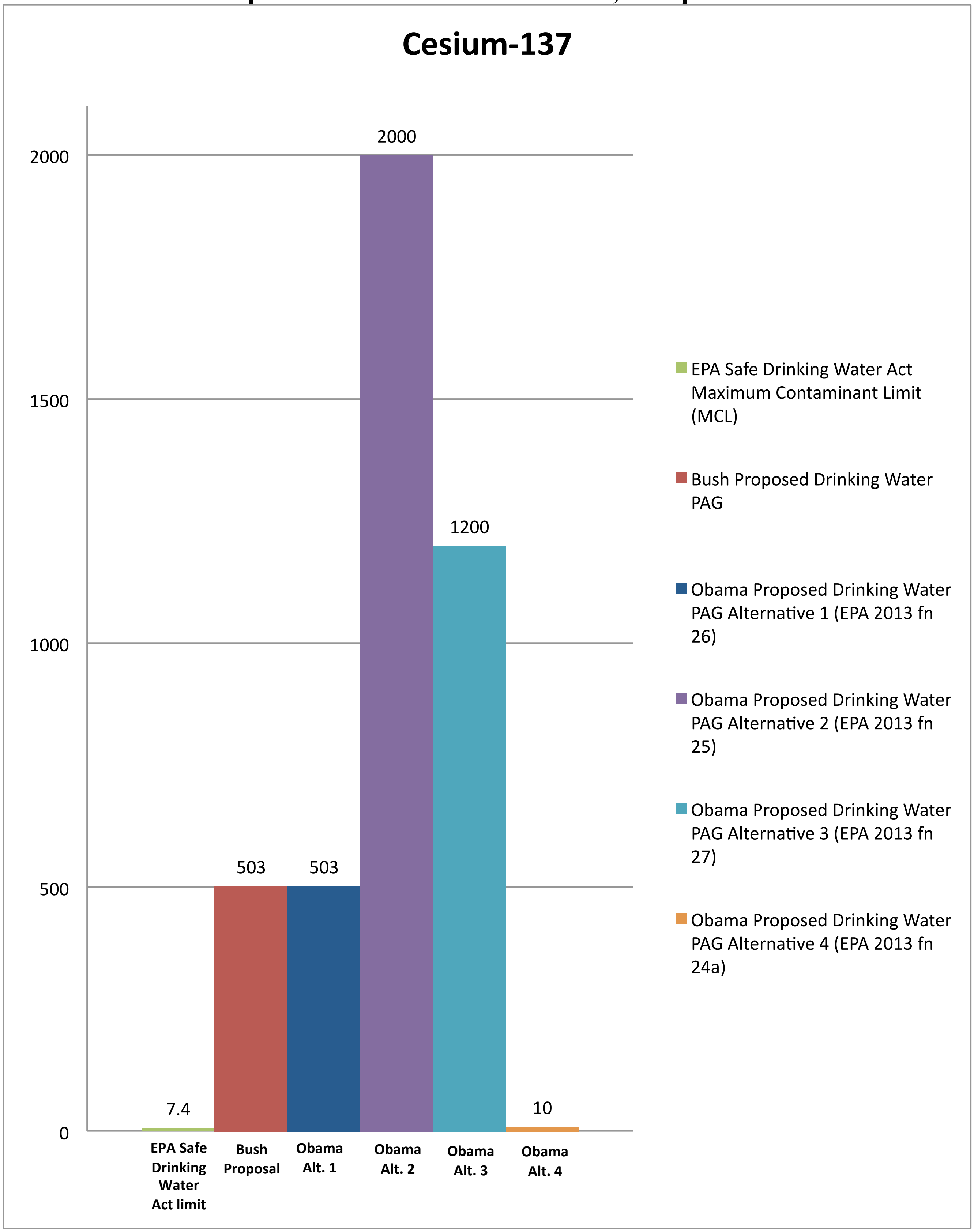
Allowable Radionuclide Concentrations in Water Under the EPA's Safe Drinking Water Act Limits Compared with Alternatives Identified in Proposed Protective Action Guides, in Bq/L



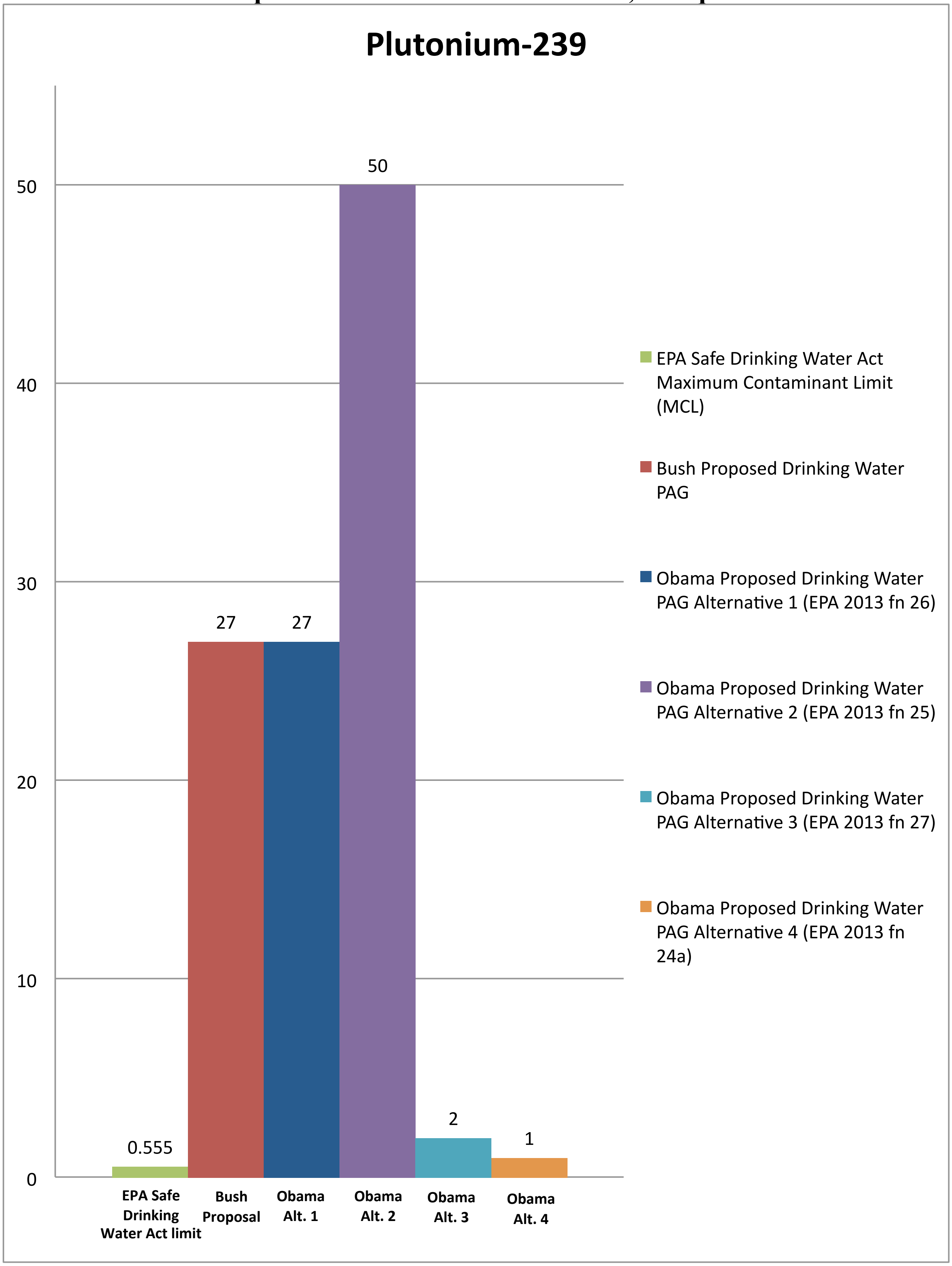
Allowable Radionuclide Concentrations in Water Under the EPA's Safe Drinking Water Act Limits Compared with Alternatives Identified in Proposed Protective Action Guides, in Bq/L



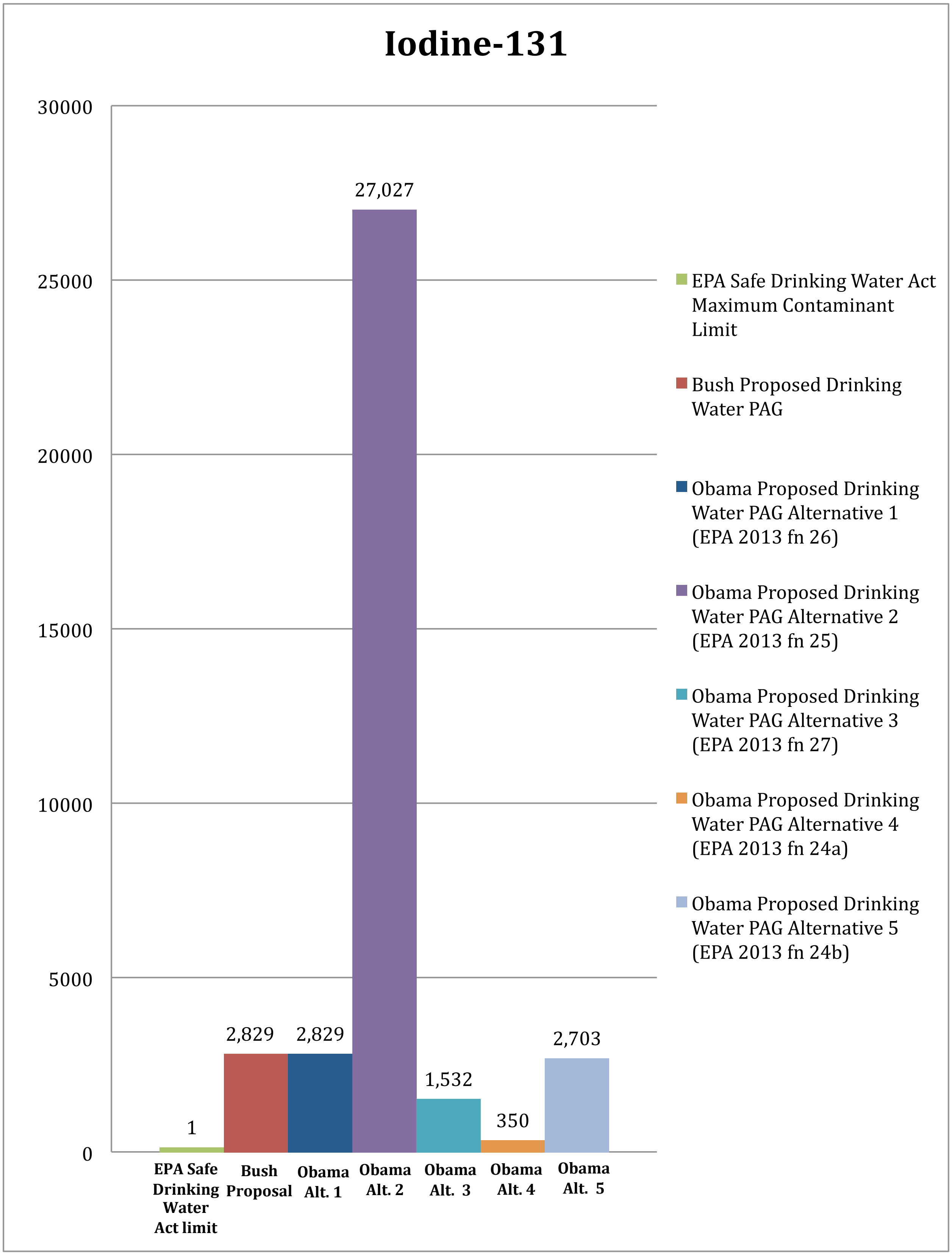
Allowable Radionuclide Concentrations in Water Under the EPA's Safe Drinking Water Act Limits Compared with Alternatives Identified in Proposed Protective Action Guides, in Bq/L



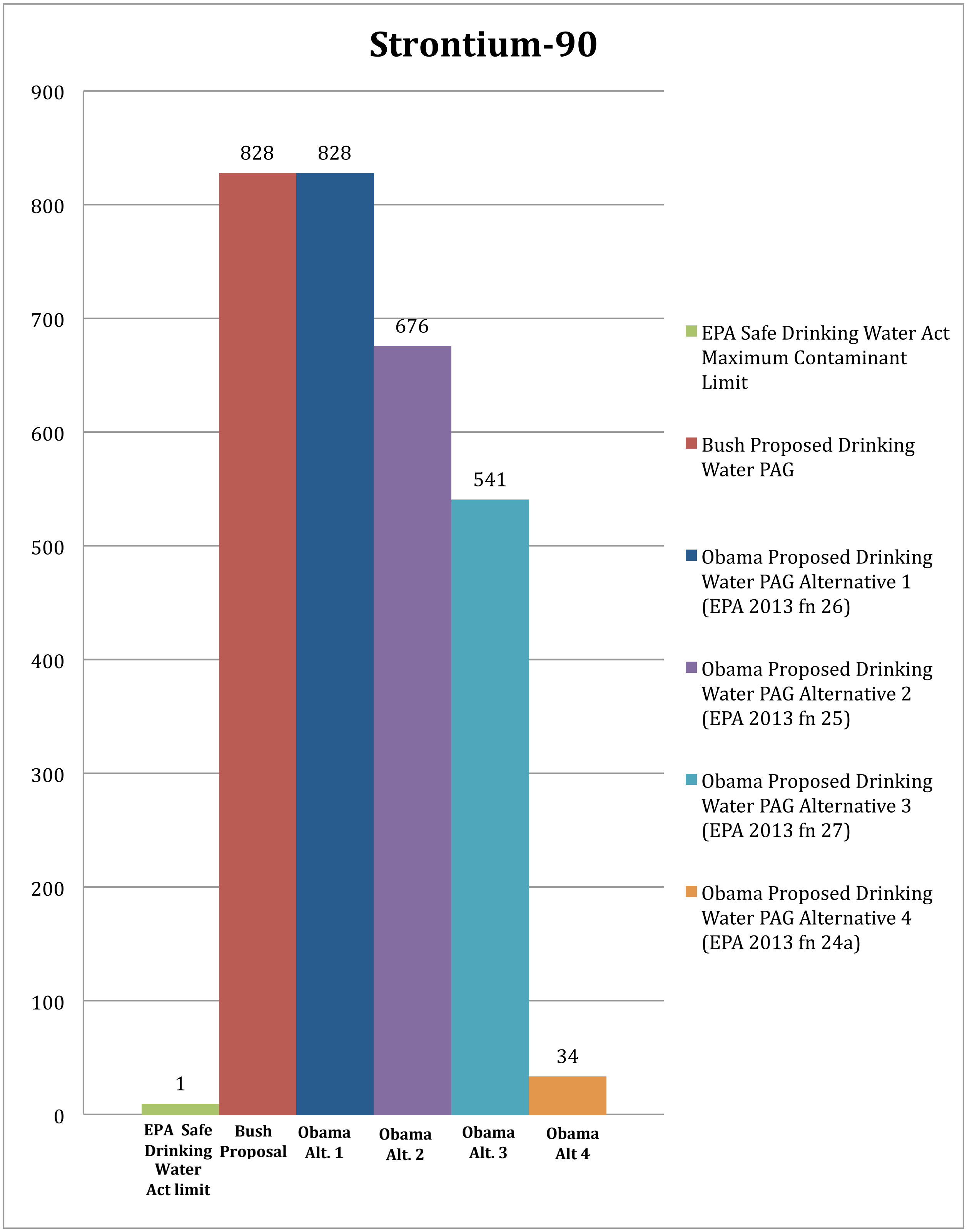
Allowable Radionuclide Concentrations in Water Under the EPA's Safe Drinking Water Act Limits Compared with Alternatives Identified in Proposed Protective Action Guides, in Bq/L



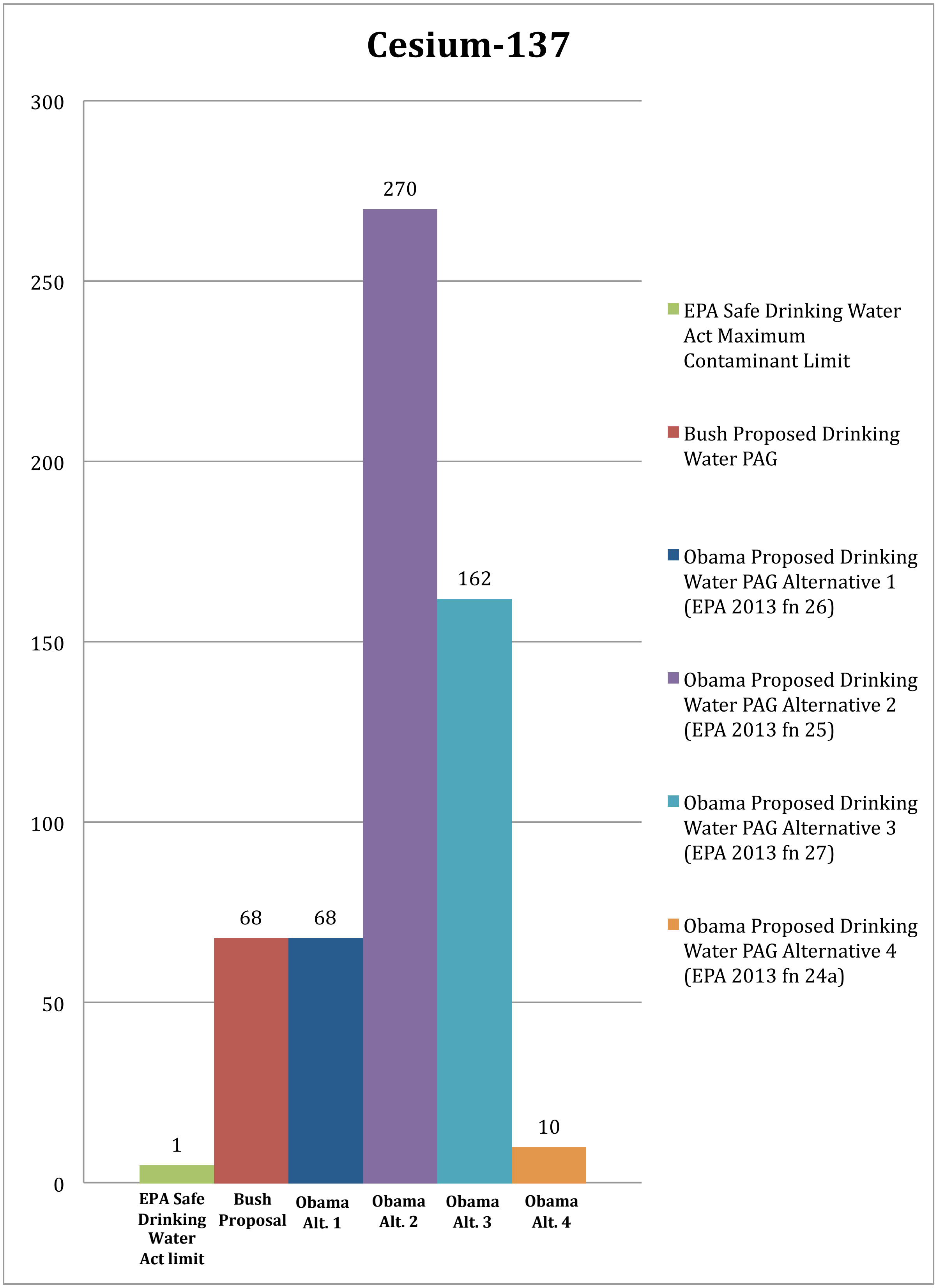
Factors by Which Radionuclide Concentrations in Drinking Water Would Exceed EPA's Safe Drinking Water Act Levels if the Alternatives Identified in 2013 Proposed Protective Actions Guides Were Adopted



Factors by Which Radionuclide Concentrations in Drinking Water Would Exceed EPA's Safe Drinking Water Act Levels if the Alternatives Identified in 2013 Proposed Protective Actions Guides Were Adopted



Factors by Which Radionuclide Concentrations in Drinking Water Would Exceed EPA's Safe Drinking Water Act Levels if the Alternatives Identified in 2013 Proposed Protective Actions Guides Were Adopted



Factors by Which Radionuclide Concentrations in Drinking Water Would Exceed EPA's Safe Drinking Water Act Levels if the Alternatives Identified in 2013 Proposed Protective Actions Guides Were Adopted