

"Institutional controls" means a mechanism used to limit human activities at or near a contaminated site, or to ensure the effectiveness of the remedial action over time, when contaminants remain at a site in levels or concentrations above the applicable remediation standard that would allow unrestricted use of that property. Institutional controls under this subchapter may include, without limitation, structure, land and natural resource use restrictions, well restriction areas, classification exception areas, deed notices, and declarations of environmental restrictions.

"Intake dose" means the annual radiation dose to a person from all potential intake pathways (exclusive of radon inhalation), including the ingestion of water, direct ingestion of soil, intake of foods, and the inhalation of resuspended particulate matter (in committed effective dose equivalent).

"Limited restricted-use remedial action" means any remedial action that requires the continued use of institutional controls but does not require the use of an engineering control.

"Natural background radionuclide concentration" means the average value of a particular radionuclide concentration in soils measured in areas in the vicinity of the site, in an area that has not been influenced by localized human activities, including the site's prior or current operations.

"Quality factor" means the factor by which absorbed doses are multiplied to obtain a quantity that expresses the effectiveness of the absorbed dose on a common scale for all types of ionizing radiation.

"Radioactive contamination or radioactive contaminant" means the collective amount of radiation emitted from one or more radionuclides in the soil at concentrations above natural background levels.

"Radioactive materials" means any material, solid, liquid, or gas, that emits radiation spontaneously.

"Radionuclide" means a type of atom that spontaneously undergoes radioactive decay.

"Regional natural background variation" means the best Department estimate, based on available data, of a region's naturally experienced variation in radiation dose from mean levels that are commonly and consistently experienced by persons in the State.

"Remedial action" means those actions taken at a site, or offsite if a radioactive contaminant has migrated or is migrating there from a radioactively contaminated site as may be required by the Department, including, without limitation, removal, treatment, containment, transportation, securing, or other engineering or treatment measures, whether to an unrestricted use or otherwise, designed to ensure that any discharged radioactive contaminant at the site, or that has migrated or is migrating from the site, is remediated in compliance with the applicable remediation standards in this subchapter.

"Remediation" or "remediate" means all necessary actions to investigate and cleanup or respond to any known, suspected, or threatened discharge of radioactive contaminants, including, as necessary, the preliminary assessment, site investigation, remedial investigation, and remedial action.

"Remediation standards" means the combination of numeric standards that establish a level or concentration, and narrative standards, to which radioactive contaminants must be treated, removed or otherwise cleaned for soil, ground water or surface water, as provided by the Department pursuant to N.J.S.A. 58:10B-12, in order to meet the health risk or environmental standards.

"Residual radionuclides" means the concentration of radionuclides remaining after the remediation is successfully completed, excluding background.

"Restricted use remedial action" means any remedial action that requires the continued use of engineering and institutional controls in order to meet the established health risk or environmental standards.

"Technologically enhanced naturally occurring radioactive materials" means any naturally occurring radioactive materials whose radionuclide concentrations or potential for human exposure have been increased by any human activities.

"Total effective dose equivalent" means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

"Uncontaminated surface soil" means soil whose average natural background radionuclide total concentrations are less than the limits for residual radionuclides, and cannot exceed the background established for the site by more than two standard deviations.

"Unrestricted use remedial action" means any remedial action that does not require the continued use of engineering or institutional controls in order to meet the established standards.

"Vertical extent" means the average depth, measured in feet, of the post-remediation radioactive contamination over an affected area.

7:28-12.4 General requirements

(a) Any person conducting remediation pursuant to this subchapter shall comply with the requirements of N.J.A.C. 7:26E, Technical Requirements for Site Remediation, excluding those sections related to sampling, surveying, and background investigations. Sampling, surveying and laboratory requirements shall be in accordance with N.J.A.C. 7:28-12.5.

(b) Compliance with this subchapter shall not relieve any person from complying with more stringent cleanup standards or provisions imposed by any other applicable statute, rule or regulation.

7:28-12.5 Sampling, surveying and laboratory requirements

(a) Facilities licensed under 10 C.F.R. Part 50 that have Nuclear Regulatory Commission-approved quality assurance plans are exempt from the requirements of this section. Otherwise, in addition to the requirements in N.J.A.C. 7:26E Appendix A IV.1, persons responsible for conducting remediations shall include the following in the radionuclide analysis reports:

1. Report final results as a value plus or minus the associated error for each sample;
2. Report data as calculated, and not report "less than" values for any sample;
3. Report minimum detectable activities;
4. Calculate results for single sample and composites to the sample collection period mid point;
5. Provide a quantitation report; and
6. Provide copies of the instrument run logs.

(b) If available, persons responsible for conducting remediations shall provide:

1. The Gamma Spectroscopy Report which includes sample specific header information, peak search, peak identification, background subtraction, activity, and minimum detectable activity;
2. The Gross Beta calculation worksheets and computer generated result forms;
3. Radiochemical Iodine calculation worksheets and computer generated result forms;
4. Liquid Scintillation calculation worksheets and computer-generated result forms; and
5. Gross Alpha and Gross Beta, radium-226, uranium, and strontium-89 and 90 calculation worksheets and computer-generated result forms.

(c) For radionuclides, analytical methods contained in the following publications, incorporated herein by reference, or equivalents as approved by the Department, shall be used for determining radionuclide concentrations and/or radiation levels:

1. U.S. Environmental Protection Agency; "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA 600/4-80-32, as amended and supplemented. This document may be obtained from the USEPA National Air and Radiation Environmental Laboratory, 540 S. Morris Ave., Montgomery, AL 36115-2601;

2. U.S. Department Of Energy; "Environmental Measurements Laboratory—Procedures Manual," HASL-300, 27th Ed., Vol. 1, as amended and supplemented. This document may be obtained from the US Department of Energy, Environmental Measurements Laboratory, 201 Varick St., 5th Floor, New York, NY 10014-4811; and/or

3. U.S. Environmental Protection Agency Eastern Environmental Radiation Facility; "Radiochemistry Procedures Manual," EPA 520/5-84-006, as amended and supplemented. This document may be obtained from the address in (c)1 above.

(d) Any laboratory providing radiological analysis for soil shall be certified pursuant to N.J.A.C. 7:18 for radionuclide analysis in water and, in addition, shall have participated in and passed a soil intercomparison analysis administered by either the International Atomic Energy Agency or the U.S. Department of Energy's Environmental Measurements Laboratory within the year preceding the radiological analysis for the methods of interest.

(e) Sampling and surveying for radioactive contamination shall be done in accordance with the protocol specified in that version of the Department of Environmental Protection's Field Sampling Procedure Manual's section on Radiological Assessment, incorporated herein by reference, in effect at the time of sampling and surveying which may be obtained by calling the Bureau of Environmental Radiation at (609) 984-5400 or from the Radiation Protection Program's web site at <http://www.state.nj.us/dep/rpp/index.htm>.

7:28-12.6 Remedial action selection

Remedial action selection for all sites contaminated with radioactive material shall be in accordance with N.J.A.C. 7:26E-5.

7:28-12.7 Remedial action requirements

The remedial action requirements for all sites contaminated with radioactive material shall be in accordance with N.J.A.C. 7:26E-6, with the exception of N.J.A.C. 7:26E-6.4, Post-remedial action requirements. Post-remedial sampling shall be conducted in accordance with the guidance provided in that version of the Department of Environmental Protection's Field Sampling Procedure Manual's section on Radiological Assessment, in effect at the time of the post-remedial sampling.

7:28-12.8 Radiation dose standards applicable to remediation of radioactive contamination of all real property

(a) Sites shall be remediated so that the incremental radiation dose to any person from any residual radioactive contamination at the site above that due to natural background radionuclide concentration, under either an unrestricted use remedial action, limited restricted use remedial action, or a restricted use remedial action, shall be as specified below:

1. For the sum of annual external gamma radiation dose (in effective dose equivalent) and intake dose (in committed effective dose equivalent), including the groundwater pathway: 15 millirem (0.15 milliSievert) total annual effective dose equivalent (15 mrem/yr TEDE).

2. For radon-222: three picocuries per liter (pCi/L) of radon gas (111 Bq/m³).

3. Radioactively contaminated ground water shall be remediated to comply with the New Jersey Groundwater Quality Standards rules, N.J.A.C. 7:9-6.

7:28-12.9 Minimum remediation standards for radionuclide contamination of soil

(a) For radioactive contamination in soils, the requirements of N.J.A.C. 7:28-12.8 shall be considered to be met for a specific radionuclide if:

1. Where only one radionuclide adds to the radioactive contamination of the site, the incremental concentration of the radionuclide above the natural background radionuclide concentration does not exceed the value in Table 1A, 1B (for unrestricted use), 2A, 2B (for limited restricted use), 3A, or 3B (for restricted use) below;

Table 1A Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Unrestricted Use Standards for Radioactive Contamination (pCi/g)⁽¹⁾

Radionuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	54	35	26	20	17	14	12	11	10
U234 ⁽²⁾	62	37	26	21	17	14	12	11	10
Ra226 ⁽³⁾	3	2	2	2	2	2	2	2	2
U235 ⁽²⁾	29	22	17	14	12	10	9	8	7
Ac227	3	2	2	2	2	2	2	2	2
Th232	2	2	2	2	2	2	1	1	1

Table 1B Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Unrestricted Use Standards for Radioactive Contamination (Bq/g)⁽¹⁾

Radionuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	2.02	1.29	0.94	0.75	0.62	0.53	0.46	0.41	0.36
U234 ⁽²⁾	2.29	1.36	0.98	0.76	0.62	0.53	0.46	0.41	0.36
Ra226 ⁽³⁾	0.10	0.08	0.08	0.08	0.07	0.07	0.07	0.06	0.06
U235 ⁽²⁾	1.07	0.08	0.63	0.52	0.44	0.38	0.34	0.30	0.27
Ac227	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07
Th232	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05

Table 2A Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Limited Restricted Use Standards for Radioactive Contamination (pCi/g)⁽¹⁾

Radionuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	64	41	30	24	20	17	15	13	12
U234 ⁽²⁾	69	42	30	24	19	16	14	13	11
Ra226 ⁽³⁾	5	4	3	3	2	2	2	2	2
U235 ⁽²⁾	37	27	22	18	15	13	11	10	9
Ac227	5	5	5	5	5	5	5	4	4
Th232	3	3	3	3	3	3	3	3	3

Table 2B Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Limited Restricted Use Standards for Radioactive Contamination (Bq/g)⁽¹⁾

Radionuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	2.37	1.52	1.12	0.88	0.73	0.62	0.54	0.48	0.43
U234 ⁽²⁾	2.56	1.56	1.12	0.88	0.72	0.61	0.53	0.47	0.42
Ra226 ⁽³⁾	0.19	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
U235 ⁽²⁾	1.38	1.01	0.80	0.65	0.55	0.48	0.42	0.38	0.34
Ac227	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Th232	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.10	0.10

Table 3A Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Restricted Use Standards for Radioactive Contamination (pCi/g)⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)		Feet of Vertical Extent of Residual Radionuclides (VE)								
		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	USS 1	82	46	32	24	20	17	15	13	12
	USS 2	83	46	32	25	20	17	15	13	12
	USS 3	83	46	33	25	20	17	15	13	12

U234 ⁽²⁾	USS 4	83	47	33	25	20	17	15	13	12
	USS 5	85	47	33	25	21	18	15	13	12
	USS 1	81	45	31	24	19	16	14	13	11
	USS 2	81	45	31	24	20	17	14	13	11
	USS 3	81	45	32	24	20	17	14	13	11
Ra226 ⁽³⁾	USS 4	81	46	32	24	20	17	15	13	11
	USS 5	83	46	32	25	20	17	15	13	12
	USS 1	7	4	3	3	2	2	2	2	2
	USS 2	7	4	3	3	2	2	2	2	2
	USS 3	7	4	3	3	2	2	2	2	2
U235 ⁽²⁾	USS 4	7	4	3	3	2	2	2	2	2
	USS 5	7	4	3	3	2	2	2	2	2
	USS 1	62	35	25	19	16	13	11	10	9
	USS 2	67	37	25	20	16	13	12	10	9
	USS 3	67	37	26	20	16	14	12	11	10
Ac227	USS 4	67	37	26	20	16	14	12	11	10
	USS 5	68	37	26	20	17	14	13	11	10
	USS 1	17	9	6	5	5	5	5	4	4
	USS 2	18	10	7	7	6	5	5	5	5
	USS 3	18	10	10	8	6	6	6	6	6
Th232	USS 4	18	15	10	8	8	8	8	8	8
	USS 5	26	15	10	10	10	10	10	10	10
	USS 1	15	9	7	5	4	3	3	3	3
	USS 2	21	10	7	5	4	3	3	3	3
	USS 3	21	10	7	5	4	4	4	4	4
	USS 4	21	10	7	5	5	5	5	5	5
	USS 5	21	10	7	6	6	6	6	6	6

Table 3B Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Restricted Use Standards for Radioactive Contamination (Bq/g)⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)	Feet of Vertical Extent of Residual Radionuclides (VE)									
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9	
U238 ⁽²⁾	USS 1	3.03	1.70	1.18	0.90	0.74	0.63	0.54	0.48	0.43
	USS 2	3.08	1.71	1.18	0.92	0.75	0.63	0.55	0.48	0.43
	USS 3	3.09	1.71	1.21	0.92	0.75	0.63	0.55	0.49	0.44
	USS 4	3.09	1.74	1.21	0.92	0.75	0.64	0.56	0.49	0.44
	USS 5	3.14	1.74	1.21	0.93	0.77	0.65	0.56	0.50	0.44
U234 ⁽²⁾	USS 1	2.98	1.66	1.15	0.88	0.72	0.61	0.53	0.47	0.42
	USS 2	2.98	1.66	1.15	0.89	0.73	0.61	0.53	0.47	0.42
	USS 3	2.98	1.66	1.17	0.90	0.73	0.62	0.54	0.47	0.42
	USS 4	2.98	1.70	1.18	0.90	0.74	0.62	0.54	0.47	0.42
	USS 5	3.05	1.70	1.18	0.91	0.74	0.63	0.54	0.48	0.43
Ra226 ⁽³⁾	USS 1	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 2	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 3	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 4	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 5	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
U235 ⁽²⁾	USS 1	2.30	1.30	0.91	0.70	0.59	0.49	0.42	0.38	0.34
	USS 2	2.47	1.36	0.94	0.73	0.59	0.49	0.43	0.39	0.35
	USS 3	2.48	1.36	0.95	0.73	0.59	0.50	0.44	0.40	0.36
	USS 4	2.49	1.38	0.95	0.73	0.60	0.52	0.45	0.41	0.37
	USS 5	2.51	1.38	0.95	0.74	0.62	0.53	0.47	0.42	0.37
Ac227	USS 1	0.62	0.34	0.24	0.18	0.18	0.18	0.17	0.17	0.17
	USS 2	0.66	0.36	0.24	0.24	0.23	0.20	0.19	0.19	0.19
	USS 3	0.66	0.36	0.36	0.29	0.23	0.23	0.23	0.23	0.23
	USS 4	0.66	0.54	0.37	0.29	0.28	0.28	0.28	0.28	0.28
	USS 5	0.97	0.54	0.37	0.36	0.36	0.36	0.36	0.36	0.36
Th232	USS 1	0.56	0.35	0.25	0.19	0.15	0.13	0.11	0.10	0.10
	USS 2	0.77	0.39	0.26	0.19	0.15	0.13	0.12	0.12	0.12
	USS 3	0.77	0.39	0.26	0.19	0.15	0.14	0.14	0.14	0.14
	USS 4	0.77	0.39	0.26	0.19	0.17	0.17	0.17	0.17	0.17
	USS 5	0.77	0.39	0.26	0.22	0.22	0.22	0.22	0.22	0.22

¹ The allowed Incremental Concentrations are added to the natural background radionuclide concentration to obtain the absolute value of the allowed radionuclide concentration following site remediation.

² These allowable concentrations may however, further be limited by the chemical toxicity of uranium. Applicants should inquire with NJDEP's Site Remediation Program for the additional applicable chemical cleanup standards for uranium.

³ When more than one nuclide is present, use the Radium-226 Table in Appendix A, incorporated herein by reference, for applying the sum of the fractions rule. Then use whatever number is more restrictive for radium-226, the value in Tables 1A through 3B or the value derived by using the sum of the fractions rule.

	USS 2	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 3	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 4	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 5	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
U235(2)	USS 1	2.30	1.18*	0.89*	0.70	0.59	0.49	0.42	0.38	0.34
	USS 2	2.47	1.36	0.94	0.73	0.59	0.49	0.43	0.39	0.35
	USS 3	2.48	1.36	0.95	0.73	0.59	0.50	0.44	0.40	0.36
	USS 4	2.49	1.38	0.95	0.73	0.60	0.52	0.45	0.41	0.37
	USS 5	2.51	1.38	0.95	0.74	0.62	0.53	0.47	0.42	0.37
Ac227	USS 1	0.33	0.26*	0.24	0.18	0.18	0.18	0.17	0.17	0.17
	USS 2	0.52*	0.36	0.24	0.24	0.23	0.20	0.19	0.19	0.19
	USS 3	0.66	0.36	0.36	0.29	0.23	0.23	0.23	0.23	0.23
	USS 4	0.66	0.54	0.37	0.29	0.28	0.26*	0.26*	0.26*	0.26*
	USS 5	0.97	0.54	0.37	0.36	0.33*	0.28*	0.28*	0.26*	0.26*
Th232	USS 1	0.26*	0.18*	0.18*	0.15*	0.15	0.13	0.11	0.10	0.10
	USS 2	0.37*	0.26*	0.22*	0.19	0.15	0.13	0.12	0.12	0.12
	USS 3	0.52*	0.30*	0.26	0.19	0.15	0.14	0.14	0.14	0.14
	USS 4	0.63*	0.39	0.26	0.19	0.17	0.17	0.17	0.17	0.17
	USS 5	0.74*	0.39	0.26	0.22	0.22	0.22	0.22	0.17*	0.17*

(1) The allowed Incremental Concentrations are added to the natural background radionuclide concentration to obtain the absolute value of the allowed radionuclide concentration before mixing.

(2) These allowable concentrations may however, further be limited by the chemical toxicity of uranium. Applicants should inquire with NJDEP's Site Remediation Program for the additional applicable chemical cleanup standards for uranium.

(3) When more than one nuclide is present, use the Radium-226 Table in Appendix B, incorporated herein by reference, for applying the sum of the fractions rule. Then use whatever number is more restrictive for radium-226, the value in Tables 4A through 5B or the value derived using the sum of the fractions rule.

* Values were back-calculated to ensure 15 mrem/yr TEDE after mixing.

2. After it is established that the concentrations in Table 4A, 4B, 5A, or 5B above are met, the layer of residual radionuclides shall be mixed thoroughly with the layer of uncontaminated surface soil to achieve a uniform concentration, as outlined in Chapter 12 of the Department's Field Sampling Procedures Manual, throughout the soil column;

3. Where more than one radionuclide contaminant is present at the site, their concentrations meet the sum of the fractions as described below:

$$\text{Sum of } \frac{CA_i}{C_i} \leq 1$$

where:

CA_i = the incremental concentration of radionuclide i at the site, and

C_i = the incremental allowed concentration of radionuclide i from Table 4A, 4B, 5A, or 5B above, if it were the only remaining radionuclide at the site; and

4. The requirements in (a)3 above shall be met.

7:28-12.10 Petition for alternative remediation standards for radioactive contamination

(a) In lieu of using the minimum remediation standards for radioactive contamination of soil found at N.J.A.C. 7:28-12.9, a person may petition the Department for an alternative soil standard for radioactive contamination. Such an alternate soil cleanup standard:

1. Shall not result in incremental doses, for sum of annual external radiation dose and intake dose, exceeding 15 mrem/yr (0.15 mSv/yr) total effective dose equivalent;

2. Shall not result in incremental concentrations exceeding three pCi/L (111 Bq/m³) of radon in indoor air in the lowest level of the building; and

3. Shall not result in radionuclide in groundwater levels exceeding those in the New Jersey Groundwater Quality Standards in N.J.A.C. 7:9-6.

(b) The Department shall not consider a petition for an alternative soil standard for radionuclides that is supported by increasing, in any manner, the allowed incremental background dose value of 15 mrem/yr (0.15 mSv/yr) or the allowed incremental radon in air concentration of three pCi/L (111 Bq/m³), or varying the parameters listed in Tables 6 or 7 below.

Table 6

Parameter	Unrestricted	Limited or Restricted
Indoor onsite breathing rate (m ³ /hr)	0.63	1.4
Outdoor onsite breathing rate (m ³ /hr)	1.40	1.4
Soil ingestion rate (g/yr)	70	12.5
Homegrown crop ingestion rate (g/yr)	17,136	0
Drinking water consumption rate(l/yr)	700	700
Shielding factor through basement or slab	0.20	0.20
Shielding factor through wall	0.80	0.80
Shielding factor outside	1.00	1.00

Table 7 Soil to Vegetation Transfer Factors

Element	pCi/g plant (wet) to pCi/g soil (dry)
Th	1E-3
Ra	4E-2
Pb	1E-2
Po	1E-3
U	2.5E-3
Ac	2.5E-3
Pa	1E-2
Bi	1E-1

(c) The Department shall consider petitions only in cases where site-specific or waste specific factors, and/or site design features are used in performing the dose assessment, which are different than those used by the Department in establishing the soil concentrations in N.J.A.C. 7:28-12.9. Factors which the Department shall consider in a petition for an alternate soil standard include, but are not limited to:

1. The chemical or physical state of the radioactive material;
2. Site-specific soil characteristics, depth to groundwater and other geological and hydrogeological characteristics which may substantially change the potential dose from radionuclides, as compared to the values listed in Tables 8 and 9 below.

Table 8 Generic Site Input Parameters for Groundwater Pathway Analysis

Dimensions of contaminated zone, LxW (m)	100 × 100
Percolation rate (vertical Darcy velocity, m/yr)	0.5
Volumetric water content in contaminated zone (m ³ /m ³)	0.35
Volumetric water content in unsaturated zone (m ³ /m ³)	0.2
Bulk density of contaminated zone (g/m ³)	1.6
Bulk density of saturated zone (g/m ³)	1.6
Unsaturated zone thickness (distance from bottom of source to aquifer, m)	0.5
Porosity of aquifer	0.45
Longitudinal dispersivity in aquifer (m)	9
Transverse dispersivity in aquifer (m)	4
Pore velocity in aquifer (m/yr)	4
Well screen thickness (mixing depth, m)	10

Table 9 Sorption Coefficients used for Groundwater Pathway Analysis

Isotopes	Kd (mg/L)
uranium	35
thorium	3,200
radium	500
lead	270
proactinium	550
actinium	450

3. Use of caps, covers, sealants, geotextile membranes, limits on the vertical extent of radioactive contamination remaining on site and/or other engineering or institutional controls that reduce potential exposures to radioactive materials; and

4. Changes in indoor and outdoor occupancy times, which are justified by land uses other than residential or commercial.

(d) A petition for an alternate soil standard shall include an analysis demonstrating how and why the difference in factors such as those in Tables 8 and 9 above and/or indoor and outdoor occupancy times will result in substantially different soil standards than those in N.J.A.C. 7:28-12.9.

(e) Regardless of the factors used by the petitioner, the Department shall not approve alternative standard petitions that include institutional and engineering controls where failure of those controls, not including the failure of a radon remediation system, would result in more than 100 mrem (one mSv) total annual effective dose equivalent.

(f) In the event the Department determines that sufficient evidence exists to support consideration of an alternative soil standard, the petitioner shall submit a written analysis which demonstrates compliance with the dose limits in N.J.A.C. 7:28-12.9 including:

1. The remedial action informational requirements of N.J.A.C. 7:26E-6; and
2. A dose assessment analysis, including:
 - i. An estimate of the radiation doses received by a post-remediation on-site resident for an unrestricted use remedial action, or by a resident or an employee (of a proposed commercial use facility) for a limited restricted use remedial action;
 - ii. A presentation of all equations or other mathematical techniques used, either directly or embodied in a computer model, to predict the movement of radionuclides and/or their resulting radiation dose;
 - iii. Groundwater radionuclide concentration calculations which shall be extended for a period of 1,000 years;
 - iv. A presentation of all numerical input parameters to equations or computer models, the range of values for those parameters, including reference sources, the value selected for use and the basis for that selection;
 - v. A presentation of other relevant factors and assumptions used in the analyses, such as site-specific geology, land use, etc.;
 - vi. An analysis of which input parameters, when varied, would most significantly affect radiation dose results, commonly referred to as a sensitivity analysis; and

vii. An analysis of both continued use of existing structures and future use scenarios. Future use scenarios shall include, if applicable, the construction of buildings for either unrestricted use remedial actions or limited restricted use remedial actions, including excavations for basements and/or footings.

(g) Engineering controls or institutional controls may be incorporated as part of a petition for an alternative remediation standard provided that these controls will be durable and implemented for an appropriate period of time to achieve their intended purpose.

(h) Computer models acceptable to the Department may be used by the petitioner for an alternative soil standard to confirm that the requirements of N.J.A.C. 7:28-12.9 have been and will continue to be met.

7:28-12.11 Requirements pertaining to engineering or institutional controls

(a) All remediation proposals shall designate the intended use(s) of the property. Such intended use(s) shall be restricted as necessary to prevent future exposure, and shall otherwise be consistent with current and projected State and local zoning designations or land uses. For sites not remediated to the unrestricted use standards in N.J.A.C. 7:28-12.9, the Department shall define the nature and duration of all appropriate engineering or institutional controls necessary to meet the standards in N.J.A.C. 7:28-12.9 or 12.10(a), based upon the particular conditions of the site.

(b) In order for any remediation under this subchapter requiring engineering controls or institutional controls to meet the standards in N.J.A.C. 7:28-12.9 or 12.10(a), the person responsible for conducting the remediation shall, in addition to meeting the provisions of N.J.S.A. 58:10B-13:

1. Implement all necessary actions, as determined by the Department, to assure that such engineering or institutional controls are being implemented and maintained for an appropriate period of time; and
2. Provide for the costs of implementing and maintaining the requisite active engineered or institutional controls for an appropriate period of time.

7:28-12.12 Requirements pertaining to a change in land use

(a) Any subsequent proposed use of a property that is different from the intended use (other than unrestricted use

remedial actions) described in the original remediation proposal shall require a prior review and prior approval by the Department. To initiate this review, 90 calendar days prior to a proposed change in land use, the person proposing such use shall prepare and submit to the Department, at the Bureau of Environmental Radiation, PO Box 415, Trenton, NJ 08625-0415, and to each affected municipality, a brief written description of the new proposed use as compared to the intended use upon which the original remediation was based including all planned soil excavations, and any additional remedial actions to be implemented.

(b) If the Department determines that the proposed new use may cause the dose limitations of N.J.A.C. 7:28-12.8 to be exceeded, the person requesting the use change shall be required to prepare and submit to the Department's Bureau of Environmental Radiation, PO Box 415, Trenton, NJ 08625-0415, a dose assessment analysis, containing the information required under N.J.A.C. 7:28-12.10(f)2, (g), and (h), to ascertain whether the dose limitation requirements of N.J.A.C. 7:28-12.8 will be met for the proposed new use.

(c) In preparing the dose assessment analysis, the person may incorporate into the new use plan new remedial measures such as different radionuclide in soil concentrations, or radioactive contamination vertical extents, and/or new engineering or institutional controls, provided that for engineering or institutional controls, the person responsible for conducting the remediation provides for the cost of implementing and maintaining them as specified in N.J.A.C. 7:28-12.11(c)3.

7:28-12.13 Requirements pertaining to the final status survey

The final status survey is performed to demonstrate that a site meets the remediation standards. It shall be done in accordance with that version of the Department of Environmental Protection's Field Sampling Manual's section on Radiological Assessment, which is incorporated herein by reference, in effect at the time of the survey which may be obtained by calling the Bureau of Environmental Radiation at (609) 984-5400 or from the Radiation Protection Program's web site at <http://www.state.nj.us/dep/rpp/index.htm>. Chapter 12 of the Department's Field Sampling Procedures Manual follows the methodology provided in MARSSIM with some modifications.

APPENDIX A

Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Nuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Ra226									
Unrestricted Use Standards	3	2	2	2	2	2	2	2	2

Ra226 Limited Restricted Use Standards	5	5	5	5	5	5	5	4	4
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Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)	Feet of Vertical Extent of Residual Radionuclide (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Ra226 Restricted Use Standards									
USS 1	22	15	10	8	6	5	5	4	4
USS 2	28	15	10	8	6	5	5	5	5
USS 3	28	15	10	8	6	6	6	6	6
USS 4	28	15	10	8	7	7	7	7	7
USS 5	28	15	10	9	9	9	9	9	9

Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Nuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Ra226 Unrestricted Use Standards	0.13	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08
Ra226 Limited Restricted Use Standards	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.15	0.15

Allowed Incremental Derived Concentration Guideline Levels (Bq/g) for the Gamma and Intake Pathways⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)	Feet of Vertical Extent of Residual Radionuclide (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Ra226 Restricted Use Standards									
USS 1	0.81	0.55	0.37	0.30	0.22	0.18	0.18	0.15	0.15
USS 2	1.04	0.56	0.37	0.30	0.22	0.18	0.18	0.18	0.18
USS 3	1.04	0.56	0.37	0.30	0.22	0.22	0.22	0.22	0.22
USS 4	1.04	0.56	0.37	0.30	0.26	0.26	0.26	0.26	0.26
USS 5	1.04	0.56	0.37	0.33	0.33	0.33	0.33	0.33	0.33

(1) These Ra226 concentration numbers may be used only when more than one radionuclide is present for the sum of the fractions rule at N.J.A.C. 7:28-12.9(b).

APPENDIX B

Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)	Feet of Vertical Extent of Residual Radionuclide (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Ra226 Unrestricted Use									
USS 1	5*	3*	3	3	3	3	2	2	2
USS 2	7*	4*	4*	3*	3	3	2	2	2
Pre-mixing Values									
USS 3	7	5*	4*	4	3	3	3	3	3
USS 4	11	7*	5*	4	3	3	3	3	3
USS 5	13*	8	6	4	4	4	4	4	4
Ra226 Limited Restricted Use									
USS 1	11*	8*	7*	7*	6*	6*	5*	5*	5*
USS 2	16*	11*	9*	8*	7*	6*	6*	5*	5*
USS 3	21*	13*	10*	9*	7*	6*	6*	6*	6*
Pre-mixing Values									
USS 4	26*	16*	12*	9*	8*	7*	7*	6*	6*
USS 5	31*	18*	11*	10*	9*	8*	7*	7*	7*

* Back-calculated to ensure 15 mrem/yr TEDE after mixing

Allowed Incremental Derived Concentration Guideline Levels (Bq/g) for the Gamma and Intake Pathways⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)	Feet of Vertical Extent of Residual Radionuclide (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Ra226 Unrestricted									
USS 1	0.18*	0.12*	0.12*	0.12*	0.12	0.10	0.09	0.08	0.08