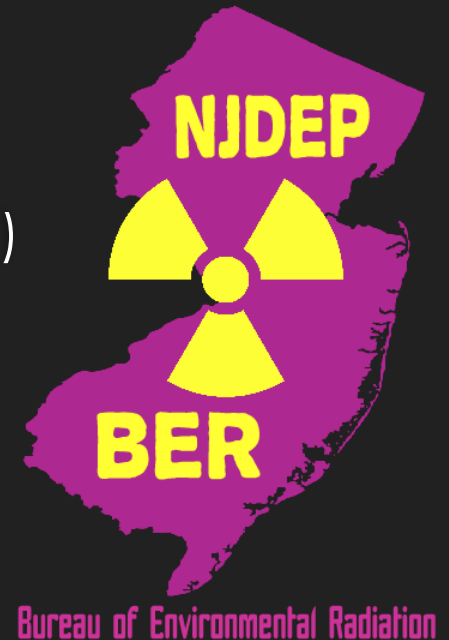


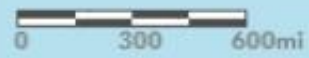
Production and disposition of TENORM waste from water treatment in Southern New Jersey

Ninth International Symposium on Naturally Occurring
Radioactive Material, NORM IX, September 2019

James T. McCullough

New Jersey Department of Environmental Protection (NJDEP)
Bureau of Environmental Radiation





New Jersey

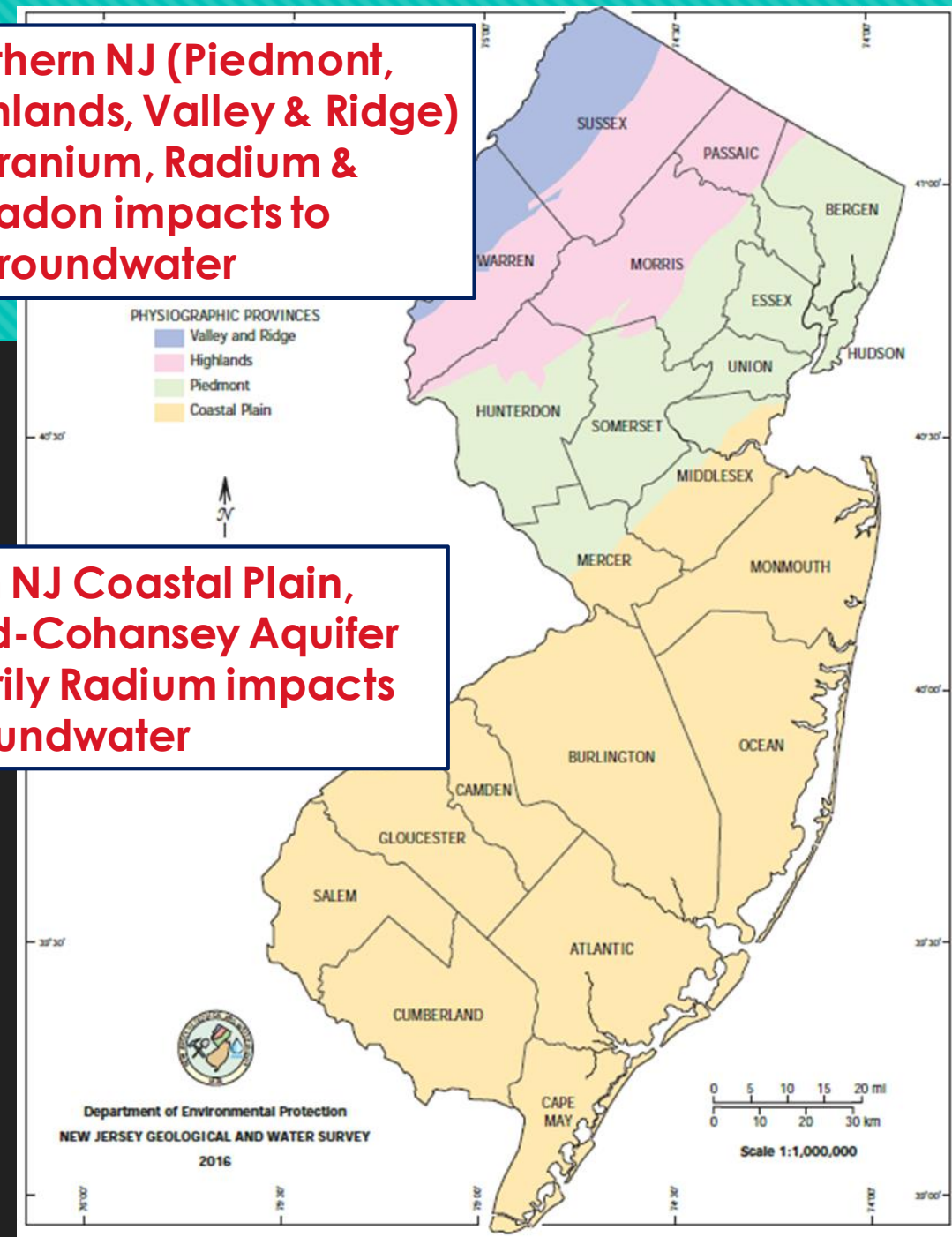
Northern NJ (Piedmont, Highlands, Valley & Ridge)

- Uranium, Radium & Radon impacts to groundwater

- Home to approximately 9,000,000
- Highest population density in USA
- Physiography from South to North:
 - Coastal Plain
 - Piedmont
 - Highlands
 - Valley & Ridge
- Characteristic rocks of certain regions can predict what naturally occurring radionuclides might be present in water based on location.

Southern NJ Coastal Plain, Kirkwood-Cohansey Aquifer

- Primarily Radium impacts to groundwater



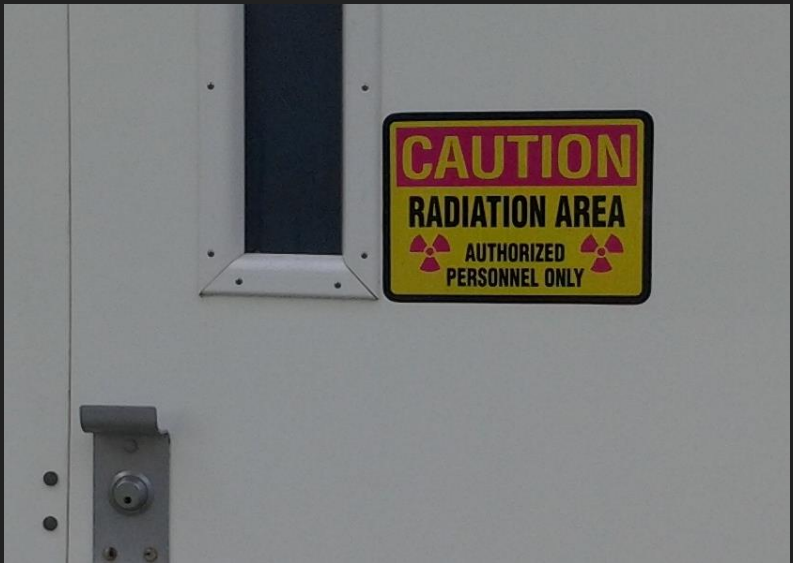
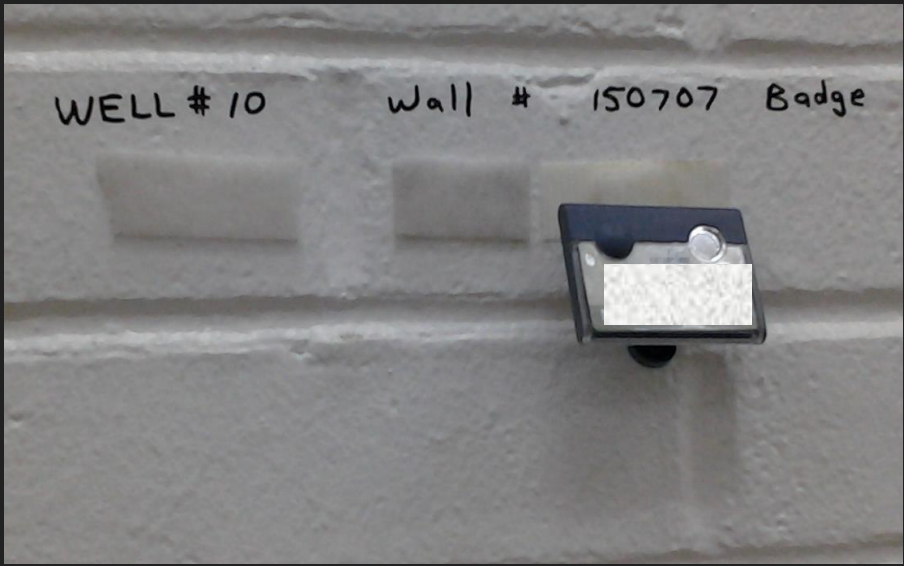
Managing an exceedance

- Consider alternate source water
- Blending source water
- Interconnection - Purchasing water from another area
- Treatment

<https://www.epa.gov/dwreginfo/radionuclides-rule>









Solid Waste Disposal

Generally transferred through a waste broker to a Low-Level Radioactive Waste facility. Activity will vary due to raw water concentrations and usage. A recent media exchange for a small community water system:

Ra-226 & Ra-228 Average Concentration	Total Consignment Activity	Total Volume
828 pCi/g (30,636 Bq/kg)	11.32 mCi (418.8 MBq)	502 ft ³ (14.2 m ³)

Regenerative Media Backwash

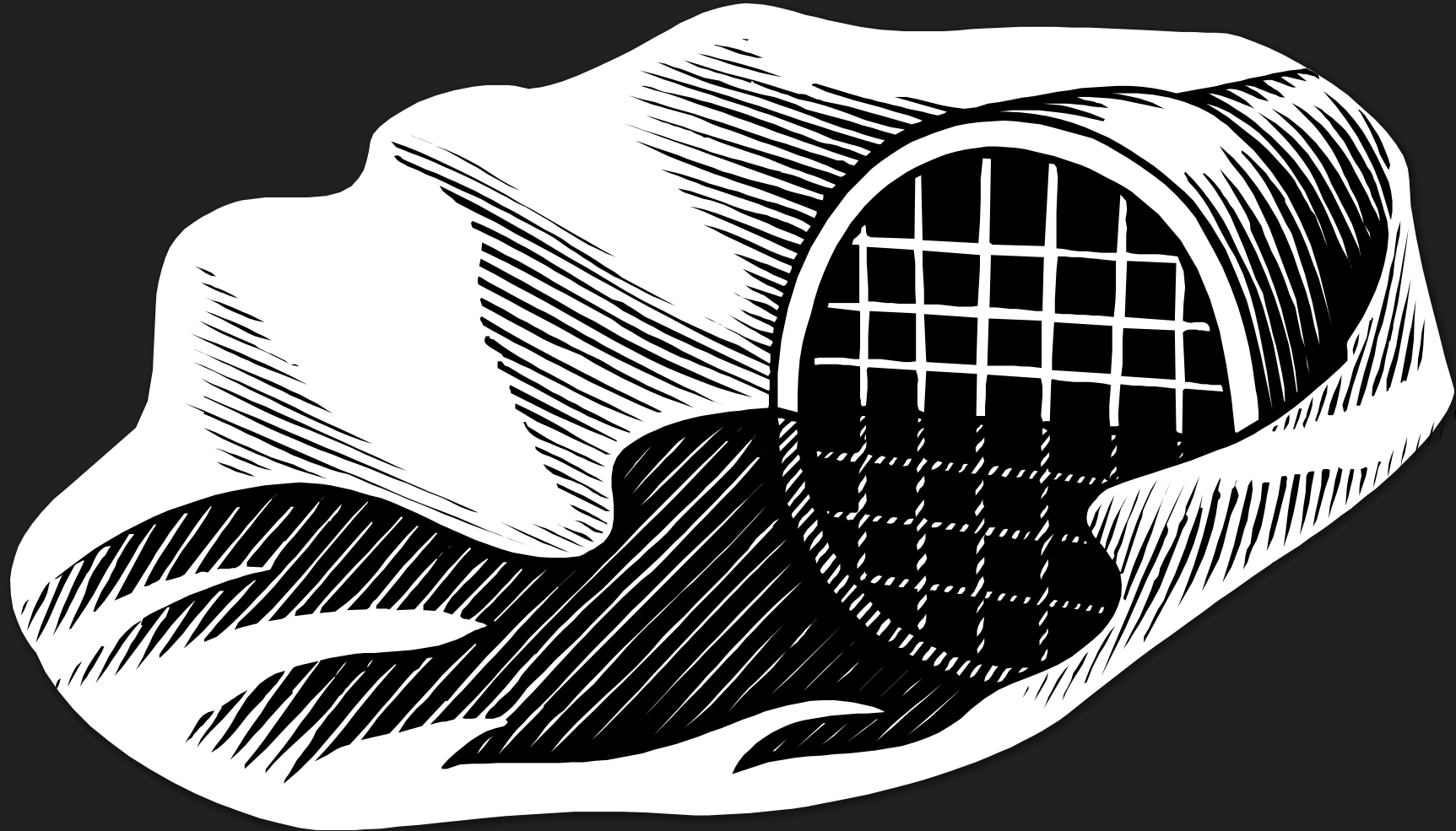
Discharge to Sanitary Sewer limits (N.J.A.C. 7:28-6 (10 CFR 20):

2000 pCi/L (74 Bq/L) Ra-224

600 pCi/L (22.2 Bq/L) Ra-226

600 pCi/L (22.2 Bq/L) Ra-228

So what happens to all that water treatment waste discharged?





Sewage Treatment Plant

ISCORS - Interagency Steering Committee on Radiation Standards

Comprised of several federal agencies to U.S. Environmental Protection Agency

U.S. Environmental Protection Agency (EPA)

U.S. Nuclear Regulatory Commission (NRC)

U.S. Department of Energy (DOE)

U.S. Department of Defense (DOD)

U.S. Department of Health and Human Services (HHS)

The Occupational Safety and Health Administration of the U.S. Department of Labor (DOL – OSHA)

U.S. Department of Transportation (DOT)

U.S. Department of Homeland Security (DHS)

And observer agencies including state radiation control representatives

ISCORS - Sewage Sludge Subcommittee

- Radiological Survey Results and Analysis (ISCORS Technical Report 2003-02)
- Modeling to Assess Radiation Doses (ISCORS Technical Report 2004-03)
- Recommendations on Management of Radioactive Materials in Sewage Sludge and Ash at Publicly Owned Treatment Works (ISCORS Technical Report 2004-04)

**United States
Nuclear
Regulatory
Commission**



**United States
Department
of Energy**



**United States
Environmental
Protection
Agency**



**State of New Jersey
Department of
Environmental
Protection**



**Middlesex County
Utilities
Authority**



**Northeast Ohio
Regional
Sewer District**

New Jersey Study

2001-2005 NJDEP conducted a study of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) in Municipal Sludge

- 29 Municipal Utility Authorities (MUA)
- 4 Septic Systems
- 3 land application sites
- 60 sampling episodes
- 336 sludge/ash samples analyzed
- 32 E-PERMS deployed

New Jersey Study

- Sludge Product Results:
 - Observed Radium concentrations above 95th percentile of the ISCORS national survey
 - Ra-226 range: 0.5 to 24.2 pCi/g (1.9 to 895 Bq/kg)
 - Ra-228 range: 0.5 to 35.1 pCi/g (1.9 to 1300 Bq/kg)
 - Calculated doses above 10 mrem/yr (100 μ Sv/yr) consultation level.





Sludge Product Land Application - Injection



Sludge Product Land Application - Spreading

Summary for Landis Sewerage Authority

(October 2006)

	Sludge Average Activity Concentrations for screening calculations (dry weight)		ISCORS Survey 95 th Percentile	
	pCi/g	Bq/kg	pCi/g	Bq/kg
Radium-226	18.5	6.84×10^2	13	4.8×10^2
Radium-228	13.8	5.11×10^2	5.1	1.9×10^2

Summary for Landis Sewerage Authority

(October 2006)

	Estimated Dose Equivalent	
	millirem per year (mrem/y)	millisieverts per year (mSv/y)
On-Site Resident Scenario (Application for 20 years)	24.1	0.241
On-Site Resident Scenario (Application for 50 years)	51.9	0.519
POTW Facility Worker Scenario	26.4	0.264
Sludge Application Worker Scenario (20 years of application)	4.3	0.043

2006 Study Conclusion

- Radiological levels at treatment plant not an immediate health or safety concern.
- Continued evaluation of land application:
 - Sludge sampled and analyzed quarterly
 - Soil sampled at land application site every five years
 - Implemented by conditions to existing NJPDES (New Jersey Pollutant Discharge Elimination System) Permit

2019 Follow-up to 2006 Report

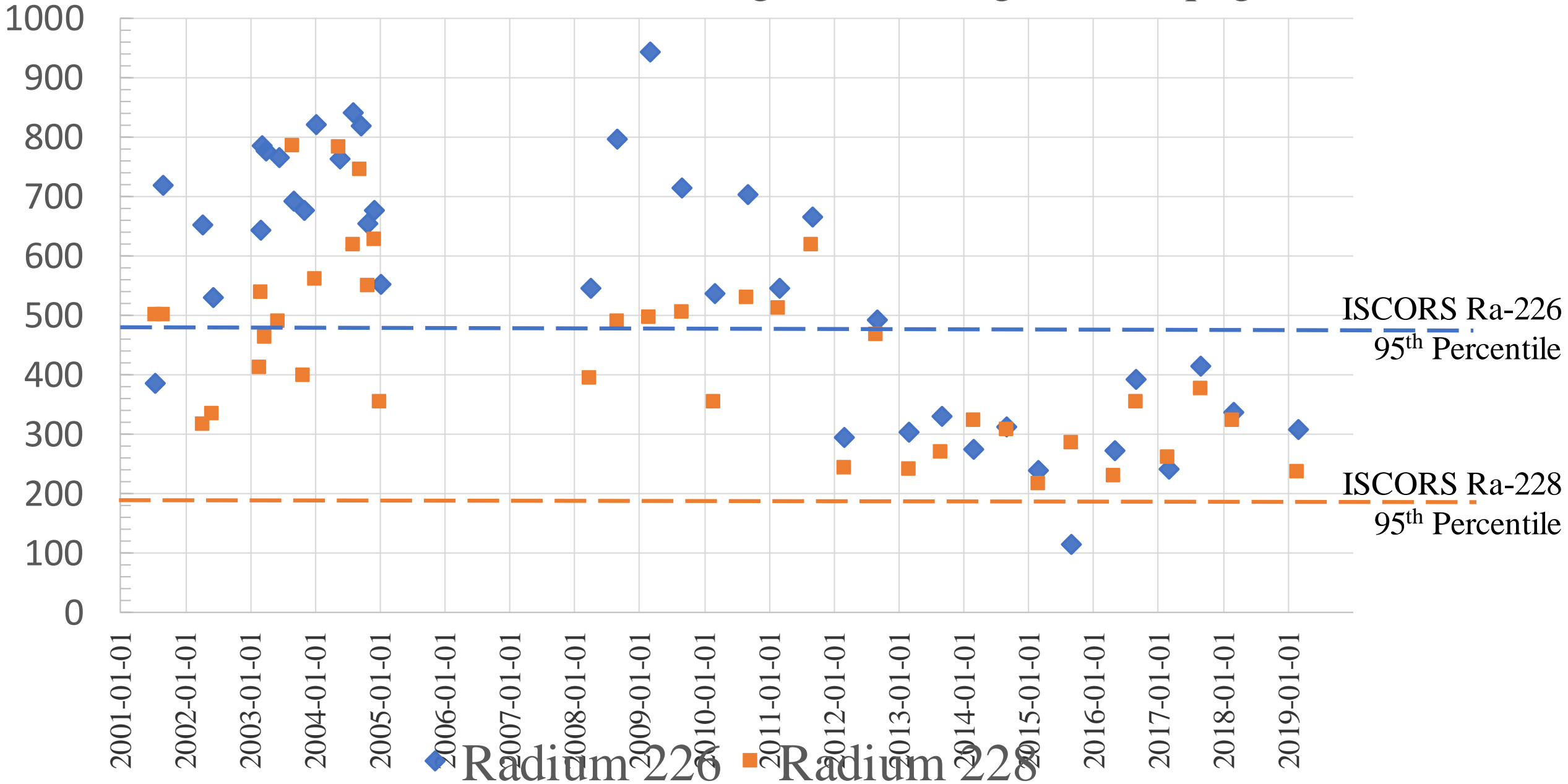
Several rounds of sampling have now been completed under the NJPDES permit conditions. Changes to water treatment technologies may support reduced sampling requirements.

Review NJPDES monitoring results and evaluate:

- Sludge monitoring data
- Land application sites

Consider modifications to permit requirements and/or additional recommendations

Ra-226 and Ra-228 Sludge Monitoring Data (Bq/kg)



2019 Dose Estimate from average sludge concentrations 2000-2018

	Estimated Dose Equivalent millirem per year (mrem/y) [millisieverts per year [mSv/y]		
	2006 initial report	2000-2019 average sludge activity	Last 5 years average sludge activity
On-Site Resident Scenario (Application for 20 years)	24.1 [0.241]	19.6 [0.196]	11.1 [0.111]
On-Site Resident Scenario (Application for 50 years)	51.9 [0.519]	42.1 [0.421]	22.9 [0.229]
POTW Facility Worker Scenario	26.4 [0.264]	21.9 [0.219]	13.0 [0.130]
Sludge Application Worker Scenario (20 years of application)	4.3 [0.043]	3.57 [0.0357]	2.09 [0.0209]

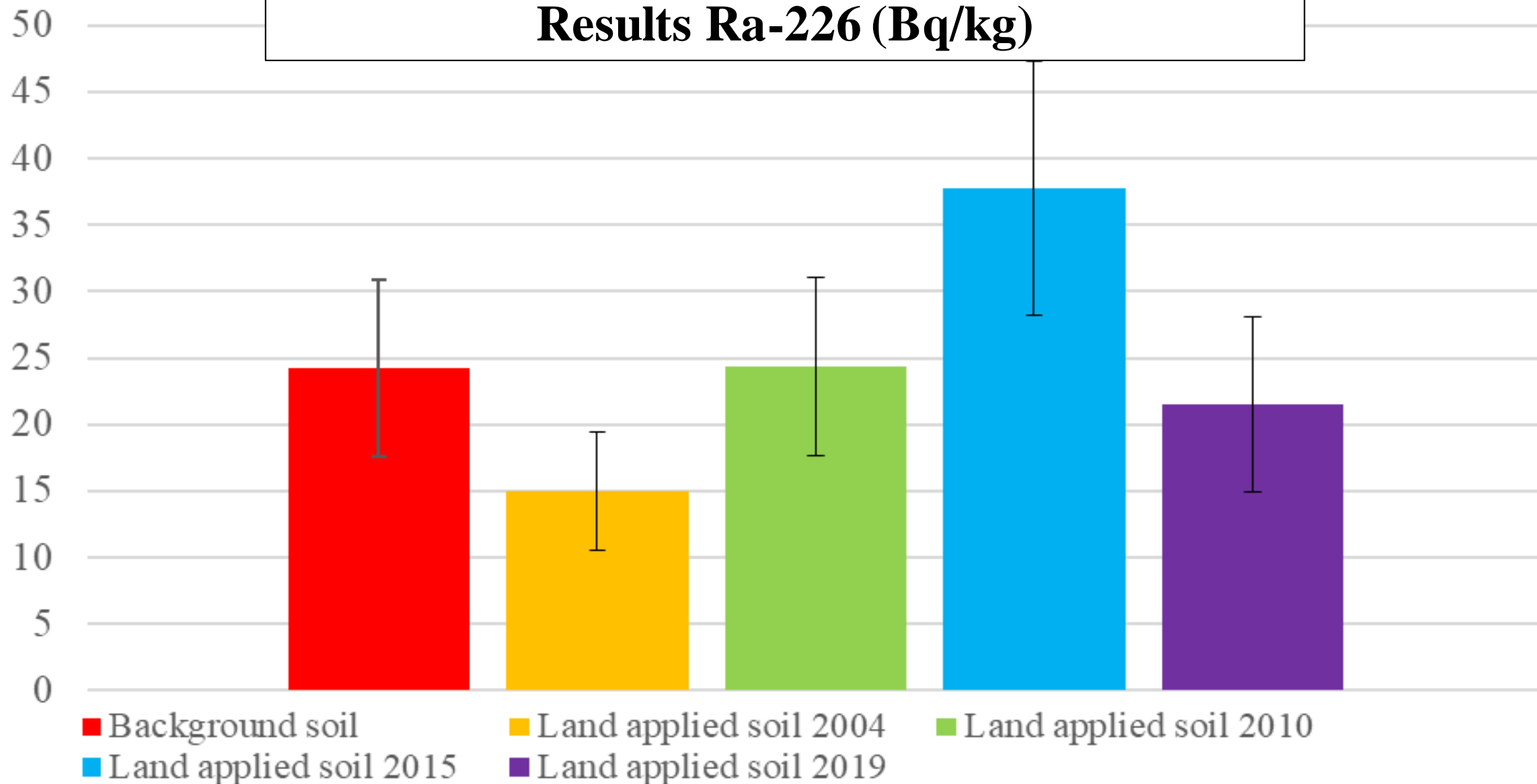
Residuals Transfers to Agricultural Facility

NJPDES permit specifies collecting 10 soil samples every 5 years from a single 19.1 acre field. The entire site is comprised of 40 fields/plots with a total area of approximately 380 acres.

Transfers of sludge product (residuals) to agricultural facility for land application tracked by permit condition.

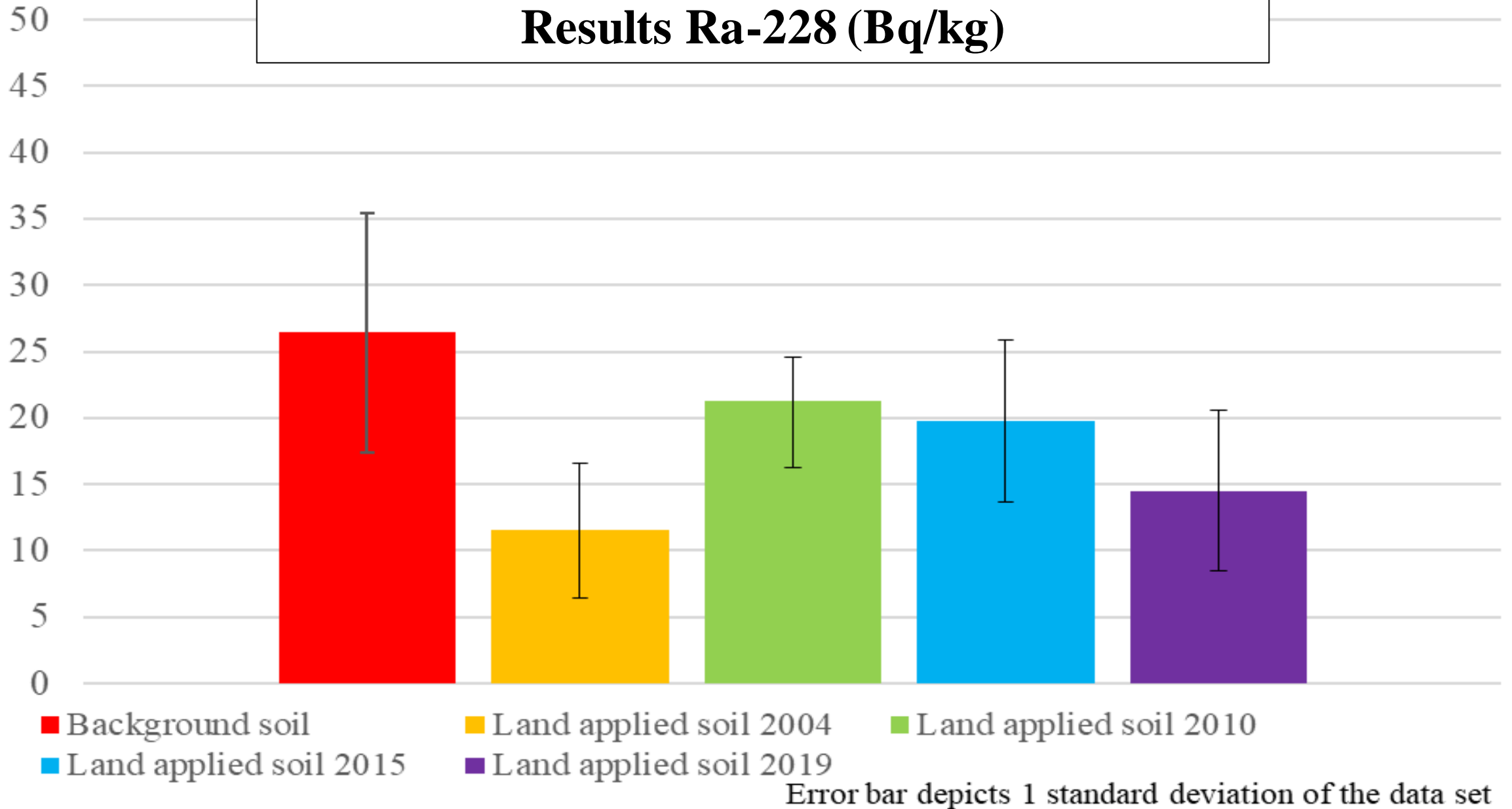
Reporting as DMT/HA (Dry Metric Tons Per Hectare) applied to individual fields, allowing for 2019 sampling to target fields with highest rate of application.

Agricultural Facility Land Application Soil Results Ra-226 (Bq/kg)



Error bars depicts 1 standard deviation of the data set

Agricultural Facility Land Application Soil Results Ra-228 (Bq/kg)



Potential reasons for no significant change to soil concentrations

- Conservative modeling assumptions differed from this case.
 - Application rates were limited by nutrient content in sludge and the needs for particular crops.
 - ISCORS modeling assumption 1 kg/m² application rate.
 - LSA maximum 0.882 kg/m² and mean 0.36 kg/m²
- Other factors may include runoff, crop uptake, or dissolution back into the groundwater, although these were not evaluated specifically by this study.

Findings & Recommendations

- Confirmed that drinking water plant has converted technologies, ceasing discharge of radium backwash.
- Sludge concentrations have fallen, but remain elevated due to other treatment plant inputs.
- Agricultural fields do not show an increase in soil concentration.
- Recommending:
 - Sludge storage tank sampling reduced to biennial (every other year).
 - Consider other potential TENORM inputs for biased sampling.
 - Eliminated additional routine soil sampling.

Thank you to the International Atomic Energy Agency (IAEA) and the Conference of Radiation Control Program Directors (CRCPD) for coordinating the NORM IX Symposium.

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<http://www.nj.gov/dep/aqes/index.html>