

Rocky Flats: Myths & Misunderstandings

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Colorado Department of Public
Health and Environment (CDPHE)

www.colorado.gov/cdphe/hm

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This presentation is intended to briefly provide an overview of some Rocky Flats myths and misunderstandings about science, data, the cleanup, risk, and regulatory structure and address frequently asked questions about Rocky Flats. For more information, please visit CDPHE's Rocky Flats website: <https://www.colorado.gov/pacific/cdphe/rocky-flats>.

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First things first: Introductions

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Simpsons image removed prior to presentation distribution.

Some Big Truths - Roadmap

1. Rocky Flats once was highly contaminated
2. Environmental crimes committed during Plant operations
3. Some on and off-site residual contamination remains
4. Will persist a long time

Truth 1: the Rocky Flats Plant was once highly contaminated



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Rocky Flats 903 Pad (U.S. DOE photo)

Truth 2: environmental crimes were committed at the Plant



- Operator pled guilty to environmental crimes
- Federal court
- \$18.5 million criminal penalty

Then, huge Superfund effort



- 10-year, \$7 billion cleanup
- Deactivated, decommissioned and demolished 800+ structures
- 421 potentially contaminated areas investigated
- ~360 areas remediated
- COCs: arsenic, benzo(a) pyrene, dioxin, plutonium, vanadium
- Activities overseen by DOE, EPA, CDPHE, and DNFSB
- ATSDR 2005 public health report

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COCs = contaminants of concern

ATSDR = Agency for Toxic Substances and Disease (part of the Centers for Disease Control and Prevention); ATSDR is charged to assess the presence and nature of health hazards at specific Superfund sites, by conducting public health assessments.

DNFSB = Defense Nuclear Facility Safety Board; independent federal agency, with a focus on public health and safety issues at Department of Energy defense nuclear facilities.

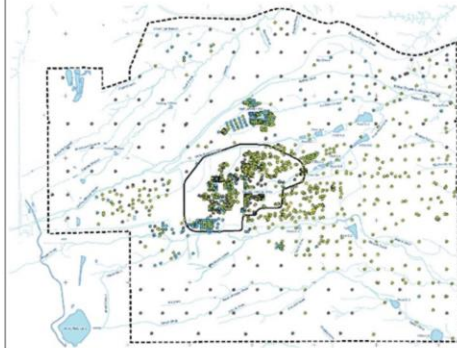
Now

- Rocky Flats Plant gone
- Industrial sources removed
- Superfund risk ranges
- Refuge area delisted
- Regulatory site closure
- Operate & maintain remedy
- Ongoing groundwater and surface water sampling
- Remedy protective of human health and environment



Truth 3: there is on and off-site residual contamination

- Residual contamination at Superfund sites is not unusual.
- Residual contamination within regulatory, health-based limits.
- We continue to monitor the site.



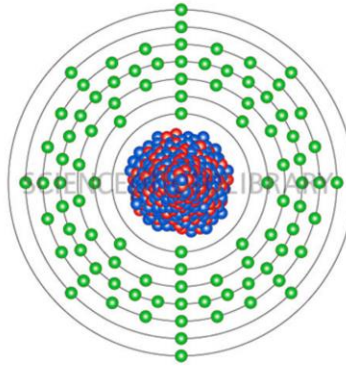
U.S. DOE (2006) RI/FS Report – Americium 241

Contamination documented in RI/FS report and appendices. This figure is from Section 3, showing the nature and extent of Am-241 soil contamination.

RFLMA (Rocky Flats Legacy Management Agreement) is the regulatory framework for remedy implementation and post-closure monitoring.

Truth 4: residual contamination will be there a very long time

- Americium, plutonium, uranium, and metals - thousands of years.
- Chlorinated solvents - decades.
- Therefore -
 - Ongoing monitoring.
 - Operations and maintenance.
 - Groundwater treatment.
 - Five-Year Reviews.
 - State enforcement of institutional controls.



Credit: Plutonium atomic structure image from Science Photo Library, available at <http://www.sciencephoto.com/media/460795/view>

20 Select Rocky Flats Myths and Misunderstandings - Roadmap

1. DOE pays CDPHE
2. Cleanup records and data are secret and unavailable
3. Sealing grand jury records
4. A small dose of ionizing radiation
5. Inhaling even one particle of plutonium
6. Plutonium most dangerous substance known
7. Locations of subsurface contamination
8. Inadequate sampling
9. Parkway construction
10. No airborne radionuclide standards
11. High Volume air samplers
12. Continuous air monitoring
13. Plutonium surface soil action levels
14. Process waste lines
15. Landfills full of toxic materials
16. Wildfire releases of radionuclides
17. Drinking water supplies
18. Missing plutonium
19. Plants and animals are negatively impacted
20. CDPHE is not enforcing regulations following POC exceedances



#1: DOE pays CDPHE for oversight

YES - The “polluter pays principle”

- Why? Efficient and practical AND fair
- Laws and regulations govern CDPHE’s oversight
- CDPHE reports funding to Colorado state legislature
- Federal grants are common practice

APPENDIX A: SITE DESCRIPTIONS

ROCKY FLATS SITE SH 93, JEFFERSON COUNTY

The Rocky Flats site is located approximately 16 miles northwest of downtown Denver, about halfway between the cities of Boulder and Golden. Rocky Flats consisted of 6,241 acres with a central industrialized area of 394 acres where major plant structures were located. Rocky Flats produced components for nuclear weapons for about 40 years. Radionuclides such as plutonium and americium, metals, solvents and other organic compounds are present in soils, building foundations, surface water and groundwater. Releases off-site via surface water constitute the potential exposure route to the public.

Management and Funding: The site was managed by the U.S. Department of Energy (DOE) and operated by contractors. The department and EPA jointly oversaw cleanup of the site under an agreement that divided lead regulatory responsibilities. The department is the post-closure lead regulatory agency and oversees maintenance and environmental monitoring activities and data reporting. The DOE was responsible for all cleanup costs and currently funds the department’s oversight costs through a grant (100 percent federal).

Cleanup Status: Remedial actions were completed on contaminated soil, including source removal from several old disposal trenches and removal of plutonium-contaminated soil at, and around, the 903 Pad drum storage area. Over 800 buildings and structures were remediated by being decontaminated and then either completely removed or demolished with remaining below-grade structures covered by at least three feet of clean fill. Four groundwater treatment systems were installed and two landfills were constructed. The shipment of all weapons grade plutonium from Rocky Flats was completed in July 2003 and physical cleanup work was completed in October 2005. The remedy selected in the record of decision, signed on Sept. 29,

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See RFLMA (December 2012), Part 14, ¶¶73, 74. Picture is an excerpt from the 2016 report to the Colorado General Assembly. States that DOE is responsible for the department’s oversight costs through a grant (100 percent federal). Link to CDPHE’s CERCLA report to the legislature:

https://www.colorado.gov/pacific/sites/default/files/HM_sf-2016-CERCLA-program-report.pdf

The “polluter pays principle” is a fundamental principle of U.S. environmental law, including CERCLA (the Superfund law). It is the commonly accepted practice that those who produce pollution should bear the costs of managing it/damages. CERCLA imposes liability on parties responsible for, in whole or in part, the presence of hazardous substances at a site.

<https://www.epa.gov/enforcement/superfund-liability> Here, DOE is the responsible party for Rocky Flats.

Despite the fact DOE provides funding as required by CERCLA and RFLMA, DOE does not order or mandate CDPHE’s regulatory determinations. CDPHE is an independent state agency, apart from the federal government, and makes its own determinations based on science, law, regulations, and guidance.

#2: cleanup records and data are secret and unavailable to the public

- Wrong
- Government open records laws: FOIA and CORA
- “Sunshine is the best disinfectant”
- Superfund law also requires it!
- On multiple websites
- (Also, please just ask us)

Fact: Rocky Flats cleanup data and records are available

- Agency records are public:

- **DOE** - Administrative Record
<https://www.lm.doe.gov/CERCLA/SiteSelector.aspx>
- **CDPHE** - online Records Center
<https://www.colorado.gov/cdphe/hmwmd-records-review>
- **EPA** - Environmental Information Service Center

- Older records in hard copy



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RI/FS Report:

23-volume report

Database = 6.9 million records for all media

About 1.3 million records are for soil

7,230 surface soil sample locations

15,890 subsurface soil samples

Comprehensive Risk Assessment

Also, in accordance with Title 40 *Code of Federal Regulations* Part 300.810 and the RFCA, DOE established and maintains an Administrative Record for Rocky Flats. The Administrative Record includes the documents that formed the basis for the selection of the final action, or remedy, such as guidance documents, evaluations, and data; notices of public comment periods; public comments; decision documents; and enforcement orders. LM also established and maintains a post-closure Administrative Record file to document ongoing remedy related decisions and activities under RFLMA.

CERCLA administrative record:

https://www.lm.doe.gov/Rocky_Flats/Sites.aspx

#3: sealing grand jury records is evidence of wrongdoing.

- Grand Jury investigates potential criminal conduct.
- Proceedings are generally **secret by law!**
 - Helps protect witnesses.
 - Constitutional protections.
- **Federal Rules of Criminal Procedure, Rule 6.**
FRCP Rule 6(e)(2)(b) states:

“Unless these rules provide otherwise, **the following persons must not disclose a matter occurring before the grand jury** (i) a grand juror; ... (vi) an attorney for the government; or a person to whom disclosure is made...” https://www.law.cornell.edu/rules/frcrmp/rule_6#

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See Cornell’s Legal Information Institute, Federal Rules of Criminal Procedure, available at: https://www.law.cornell.edu/rules/frcrmp/rule_6

For an court’s explanation of Grand Jury secrecy justifications, please see *In the Matter of the Application of WP Company LLC d/b/a The Washington Post for Access to Certain Sealed Court Records* (August 18, 2016), 201 F. Supp. 3d 109, U.S. District Court, District of Columbia. In brief, Grand Jury proceedings are presumptively secret because of due process, reputational, and privacy concerns. See Federal Rule of Criminal Procedure, Rule 6. Grand Jury proceedings are distinct from criminal trials. In addition, there is no First Amendment right of access to grand jury proceedings. Further, federal prosecutors are entrusted with broad authority to compel production of information and formally accuse an individual of criminal wrongdoing. There are risks of misapplication – intentional or inadvertent – of this powerful authority. Court found these concerns outweighed the public interest.

Please check with your attorney if you have legal questions.

Grand jury records would not impact the remedy decision

- 2 separate issues: legal vs. cleanup
- Grand Jury finished before RI/FS data was collected
- Environmental investigation data was collected 1991-2005 - this was used to make cleanup decisions because high quality assurance/quality control standards; earlier data was not collected using the same rigorous QA/QC standards, that's why it was not used
- Regulatory conclusions would not be changed

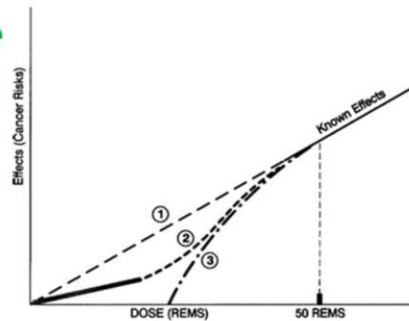
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RI/FS = Remedial Investigation/Feasibility Study

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#4: A small dose of ionizing radiation could be harmful

- Possible, not probable
- Linear no-threshold dose model →
- Regulations provide limits below which, risk/dose is negligible

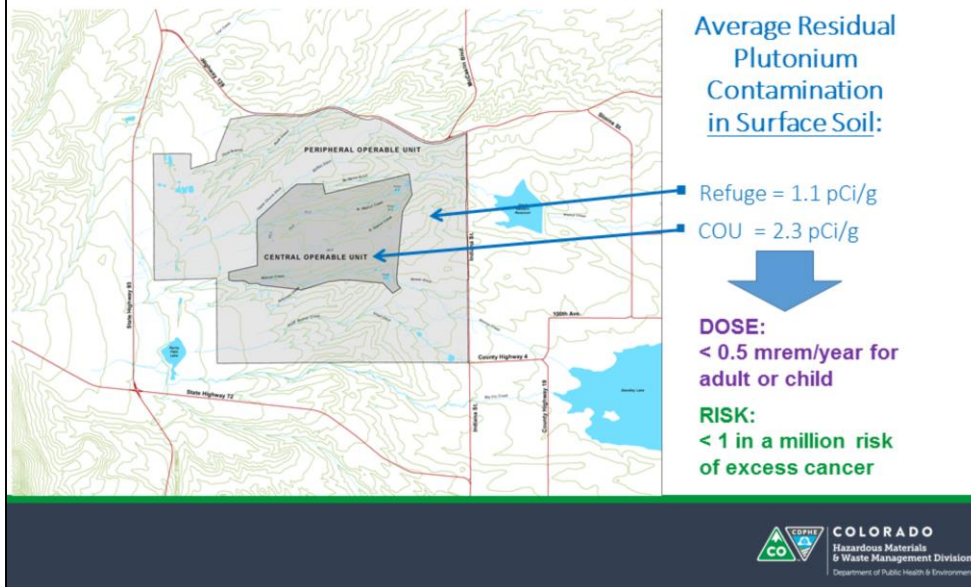


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The **linear no-threshold model** (LNT) assumes that the long term, biological damage caused by ionizing radiation is directly proportional to the dose, that is, it conservatively assumes that any dose, no matter how low, could potentially create the effects that could lead to a cancer. This assumption is based on evidence of health effects at high doses (> 10,000 mrem) even though effects at lower doses have not been observed. State and federal regulations and Superfund guidance, however, establish limits below which radiation doses or cancer risks are so low that they are considered negligible.

“Life developed in a bath of ionizing radiation and solar ultraviolet radiation and created aerobic organisms requiring (a) defenses against the metabolically induced reactive oxygen species, (b) DNA repair, and (c) elimination of damaged cells.” (National Institutes of Health, in Radiology. 2009 Apr; 251(1): 13–22.)

Fact: radioactivity levels are also well below regulatory standards



The average plutonium concentrations in the Refuge and in the Central Operable Unit (COU) are below the State's dose-based standard (25 mrem/year) and the CERCLA risk range (1 in 10,000 to 1 in 1,000,000).

State radioactivity standard

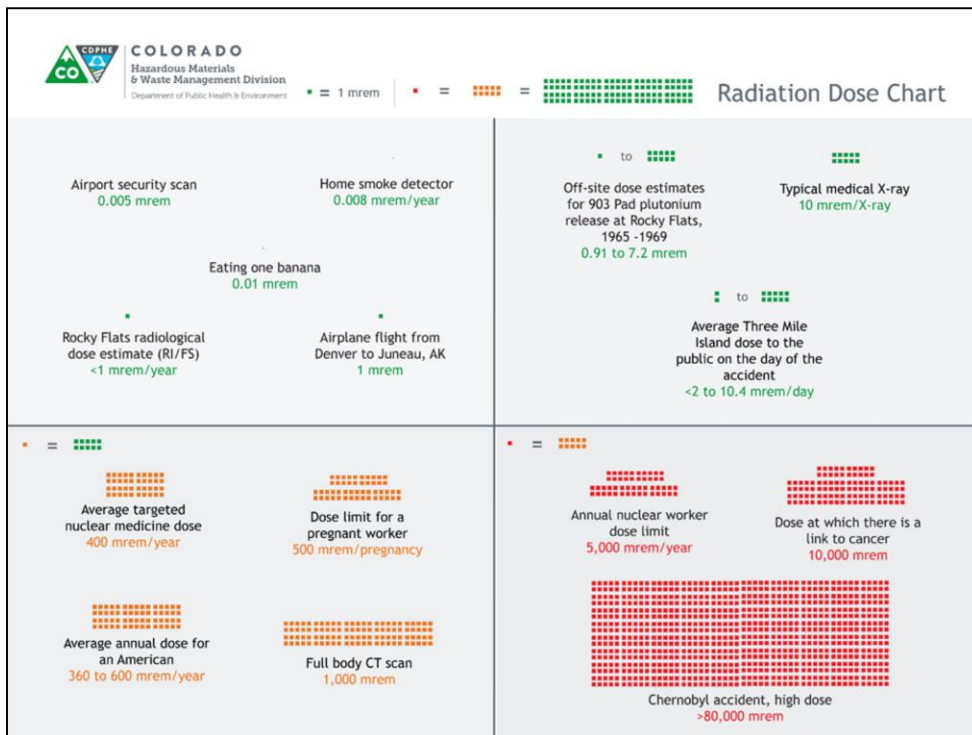
- State dose limit =

25 mrem/year above background

- Calculated doses for plutonium exposure in the most-contaminated area:

- 0.3 mrem/year for an adult refuge worker
- 0.2 mrem/year for a child visitor
- 0.07 mrem/year for an adult visitor

Calculated doses are from Wind Blown Exposure Unit area, the area with the highest plutonium contamination concentrations in surface soil. (Table 17, CAD/ROD, 2006)



Radiation doses from well-known incidents, procedures, and daily-life situations. These reported doses are in terms of **total effective dose equivalent**, which is "the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures)" (U.S. Nuclear Regulatory Commission, <https://www.nrc.gov/docs/ML1126/ML11262A167.pdf>).

A rem (or millirem) is a unit of equivalent absorbed dose of radiation which takes into account the relative biological effectiveness (RBE) of different forms of ionizing radiation, or the varying ways in which they transfer their energy to human tissue (Institute for and Environmental Research, 2018). So radiological doses expressed in millirems account for the effects of different types of radiation, e.g., alpha, beta, gamma, and x-rays.

Radiation dose citations:

- Rocky Flats radiological dose estimate: ES-6, RI/FS: Executive Summary
- Airport scan: http://hps.org/documents/airport_screening_fact_sheet.pdf
- Banana: <http://www.ppe.gla.ac.uk/~protopop/teaching/NPP/P2-NPP.pdf>
- Scans: <https://www.nrc.gov/about-nrc/radiation/around-us/doses-daily-lives.html>
- Units: <https://www.iitk.ac.in/ibc/RadiationUnits.pdf>

<https://www.nrc.gov/images/about-nrc/radiation/factoid2-lrg.gif>

<https://www.nrc.gov/docs/ML1408/ML14084A339.pdf> (10 CFR 20.1208(a) - dose limit for entire pregnancy, so 9 months)

<https://www.nei.org/Master-Document-Folder/Backgrounders/Fact-Sheets/Radiation-and-the-Japanese-Nuclear-Reactors> (typical x-ray is about 10 mrem)

<https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html> (Chernobyl dose)

<https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html> (cancer-linked doses)

<https://ehp.niehs.nih.gov/wp-content/uploads/108/6/ehp.00108545.pdf> (TMI study)

<https://www.iaea.org/sites/default/files/publications/magazines/bulletin/bull21-5/21502795459.pdf>

<https://www.cityofwestminster.us/Portals/1/Documents/Government%20-%20Documents/Departments/Public%20Works%20and%20Utilities/RockyFlatsReviewFullReport.pdf>

<https://www.atsdr.cdc.gov/phs/phs.asp?id=482&tid=86>

<https://drive.google.com/file/d/0B0tmPQ67k3NVSjd4cElxbEZxaGs/view> (historical dose assessment for Rocky Flats)

Average annual radiation dose from medical x-rays is from the U.S. NRC Personal Dose calculator. CT Scans and nuclear medicine exposures may be much higher. An individual x-ray though may have a lower dose, like 10 mrem. This comparison was chosen to compare annual average mrem exposures.

#5: Inhaling even one particle of plutonium can cause cancer

- The risk is not zero, but it is **very small**
- “Millions of dust particles contaminated with PuO₂ must be inhaled in order for significant radiation doses...”
- Note: alpha particle paper conclusions misunderstood

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Research has shown that a person would have to inhale large amounts of plutonium-contaminated dust particles to have a significant radiation exposure.

“Based on our calculations, millions of dust particles contaminated with PuO₂ [plutonium oxide] must be inhaled in order for significant radiation doses to be delivered to key body organs/tissues (bone surface, red marrow, lung, liver)”

Scott, B.R., et al. 1999. *Recommendations for Improving the Interim Radionuclide Soil Action Levels for the Rocky Flats Cleanup Agreement*. Lovelace Respiratory Research Institute. August.

“The largest speck of plutonium that can be readily inhaled is about 3 micrometers in diameter and has a mass of about 0.14 millionths of a milligram. The risk of dying of cancer as a result of inhaling that amount of plutonium is about 0.0000017 (12 cancers per milligram \times 0.00000014 milligrams = 0.0000017 cancers, or 0.00017% additional risk); that is not zero risk, but it is very small.”

Sutcliffe, W.G., et al. 1995. *A Perspective on the Dangers of Plutonium*. Center for Security and Technology Studies, Lawrence Livermore National Laboratory. CSTS-48-95. April.

“Mutagenic effects of a single and an exact number of alpha particles in mammalian cells” (Hei, et al; 1997)

- “It is clear from these data that most of the cells ($\approx 80\%$) survived to form colonies after exposure of their nuclei to a single particle. In fact, more than 10% of the cells survived after nuclear traversal by eight particles.”
- “Our present data provide the first demonstration that a single α particle induces mutations in mammalian cells.”
- “[S]ingle cell irradiation allows a more accurate extrapolation from high to low doses.”
- “...only 20% of the irradiated cells were killed. It is amazing that roughly 10% of cells irradiated with eight α particles were still viable enough to form colonies.”
- Alpha particle beam aimed directed at the nuclei of hamster cells
- Most cells (80%) survived, but with higher rates of mutations

CU/CSU cancer researchers (personal communication to Carl Spreng, 2017):

- The situation in the Hei et al paper does not mirror (and is not designed to mirror) the conditions a multi-celled organism would experience in the real world.
- Even if a mutation was induced by an alpha particle, the majority of mutations are dead ends and do not lead to cancer or even a pre-cancerous condition.
- Cancer is the result of many separate mutations, not just one. Carcinogenesis is a multistage process with sequences of genetic events that can lead to the development of metastatic cancer.

Cell mutations occur thousands of times each day in mammals. These mutations can be caused by an environmental carcinogens (including radiation), by genetics, or just random chance during cell division.

#6: Plutonium is the most dangerous substance known

- Toxicology: “The poison is in the dose.”
- Acute vs. chronic doses
- Plutonium is hazardous, but it is **not** as immediately hazardous to health as many more common chemicals
- Harmful effects from exposure to low doses possible, not probable
- Many carcinogenic substances in environment and products



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Acute: short duration, rapidly progressive, and in need of urgent care.

Chronic: persistent, long lasting, long-term, or recurrent over a relatively long period of time.

Small quantities of other chemicals can be immediately lethal (cyanide, botulism, etc.) including some common household chemicals. **Botulism** produces a neurotoxin which is the most potent toxin known to humankind, natural or synthetic, with a lethal dose of 1.3–2.1 ng/kg (parts per trillion) in humans.

A fundamental principle of toxicology is that the “**poison is in the dose.**” A substance’s potential danger depends not only on what type of chemical it is, but also the amount a person is exposed to and how. For example, a glass of wine is not lethal; however, a number of bottles contain enough alcohol to kill a person.

Less-than-acute doses (chronic) of some substances can eventually cause cancer, like benzene found in gasoline. You may inhale a small amount of this carcinogenic chemical at the pump, but not enough to kill you. Some carcinogens are measured in parts per billion and even parts per trillion.

Both the radiation dose amount and rate are important. Acute doses can lead to Acute Radiation Syndrome (ARS) which can be lethal at very high doses. In the days and weeks after the Chernobyl accident, 29 workers eventually died of ARS.

The main potential health threat from much lower chronic doses of radiation is cancer. The Linear No-Threshold model (see slide #16) is based on a conservative assumption that any dose, no matter how low, could potentially create the effects that could lead to a cancer. State and federal regulations and Superfund guidance, however, establish limits below which radiation doses or cancer risks are so low that they are considered negligible.

#7: locations of subsurface contamination are unknown

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RI/FS CDs need to be requested from DOE. Too much data to PDF. Need Microsoft Access.

Please see the DOE LM Rocky Flats website for contact information.

Apologies to those unfamiliar with the Game of Thrones reference. Copyright HBO, George R.R. Martin, Game of Thrones. Image removed prior to presentation distribution.

Fact: contamination levels and locations are known from data

- CERCLA administrative record
 - RI/FS report (23 volumes)
 - Remaining subsurface features
 - Sampling databases and reports
- Other sampling affirmed
- DOE continues to monitor and report
- EPA and CDPHE continue oversight

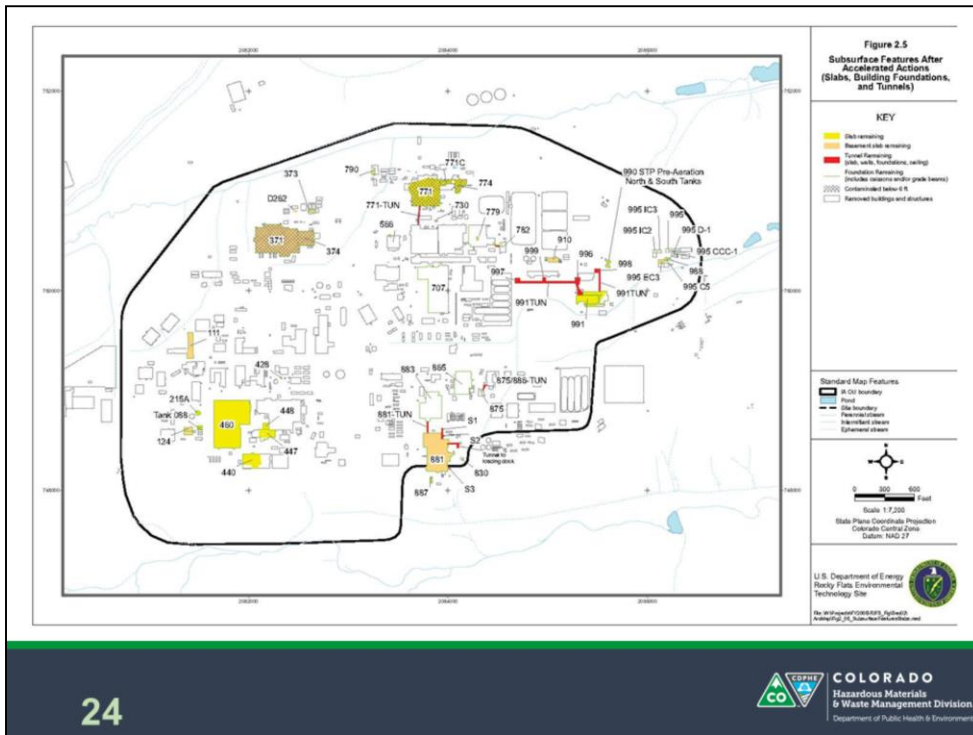


Figure 2.5 (Subsurface Features after Accelerated Actions: Slabs, Building Foundations, and Tunnels) from Rocky Flats RI/FS Report (and Rocky Flats Legacy Management Agreement).

#8: inadequate sampling



- Extensive environmental investigation
- 2,000 waste streams identified by State enforcement
- Based on scientific knowledge and regulatory requirements
- Same general process used at other CERCLA sites
- Thousands of RI/FS samples (air, soil, groundwater, surface water, sediment), 6.9 million data points
- Informed decisions based on data collected, interviews, records, and process knowledge

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RI/FS data may be found/requested here:

https://www.lm.doe.gov/Rocky_Flats/Documents.aspx

Must request CDs and understand databases for large datasets

2,000 waste streams (Dan Miller, CO AGO)

Rocky Flats is well-studied (groundwater example)

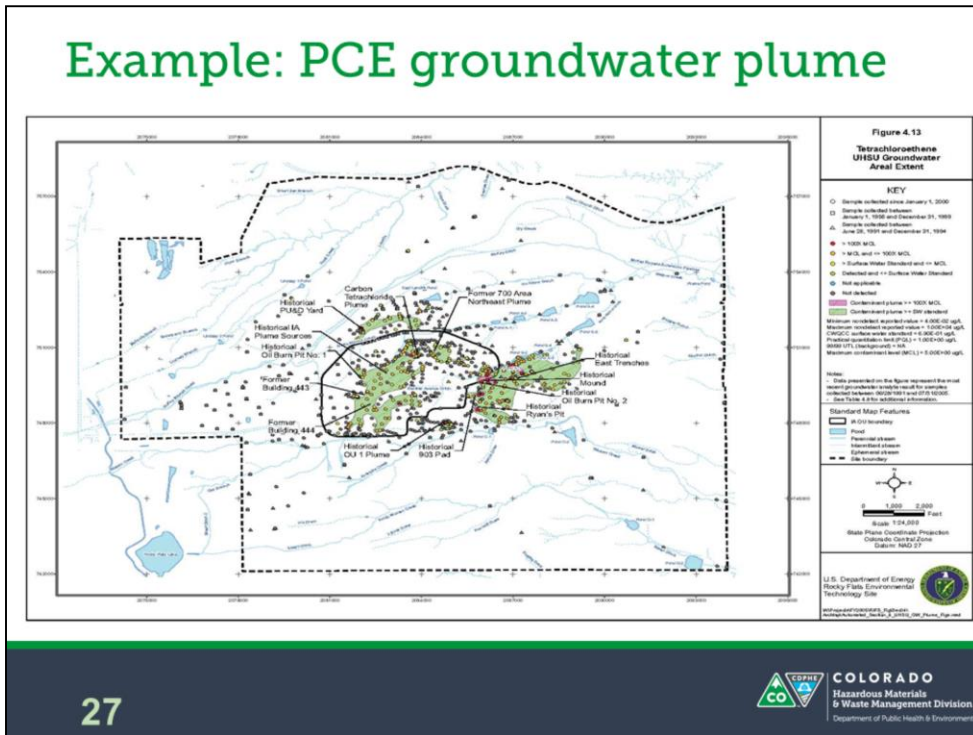
- Hydrogeologic and release information
- Approved sampling procedures and methods
- Evaluation based on data collected June 1991 through July 2005
- Cumulative number of Rocky Flats wells by 2005:
~1,289 groundwater wells
- Ongoing post-closure groundwater monitoring and sampling

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See RI/FS, Section 4 - Nature and Extent of Groundwater Contamination; see Table 4.1 (Summary of RFTEX Well Installations and Sampling Frequencies) CDPHE had dedicated sampler on-site.

Example: PCE groundwater plume



EPA fact sheet on PCE,
[https://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/3dc283e6c5d6056f88257426007417a2/f17f784b5a1b6c3b8825794c006325b3/\\$FILE/Vapor%20Intrusion%20PCE%20Fact%20Sheet_EPA%203_13%20174kb.pdf](https://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/3dc283e6c5d6056f88257426007417a2/f17f784b5a1b6c3b8825794c006325b3/$FILE/Vapor%20Intrusion%20PCE%20Fact%20Sheet_EPA%203_13%20174kb.pdf)

#9: Parkway construction would release harmful levels of plutonium

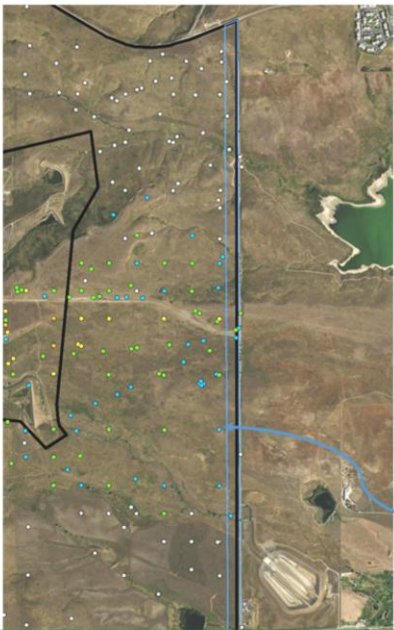
- 300-foot ROW along Indiana granted in 2002 Refuge Act
- RI/FS investigation concluded both the Refuge area and off-site areas are **suitable for unlimited use and unrestricted exposure**
- Levels protective of a refuge worker also protective of a construction worker due to shorter exposure time



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Map from Jefferson Parkway Public Highway Authority (JPPHA),
<https://www.jppha.org/maps/>

Exposure duration: Refuge worker – 18.7 years (chronic); Construction worker -
1 year (sub-chronic)




Right-of-way sampling

- 31 RI/FS samples
- 14 sample locations
- Maximum concentration = 8.8 pCi/g
- Average concentration = 1.4 pCi/g
- Third-party sampling east of ROW agree with DOE sampling results

300 feet west of Indiana St.

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 **COLORADO**
Hazardous Materials
& Waste Management Division
Department of Public Health & Environment

Jefferson Parkway Highway Authority,

https://static1.squarespace.com/static/5982321ecd0f68fa59f9fd97/t/598a29eaff7c50af8e84f796/1502226923316/0816_JeffersonParkwayHighwayAuthority_GreenSpace__1_.pdf

- CDPHE has meet with the Jefferson Parkway Highway Authority.
- Permissible Levels of Radioactive Material in Uncontrolled Areas = 2 disintegrations/minute (approx. 1 pCi/g). Requires consideration of “special construction techniques” as defined by CDPHE’s radiation Control Program [Standards for Protection Against Radiation: 6 CCR 1007-1 Part 4.60.1] (approx. 50 years old)

#10: no standards have been established for airborne radionuclides

FEDERAL STANDARDS

National Emissions Standards for Hazardous Air Pollutants (NESHAPS, part of the Clean Air Act)

10 millirem/year dose limit for radionuclide air emissions

STATE STANDARDS

Colorado radiation standard limits public to a total annual dose above background of 25 millirem/year

Pu-239/240 air emissions limit: 0.02 picocurie per cubic meter of air (average annual emission)

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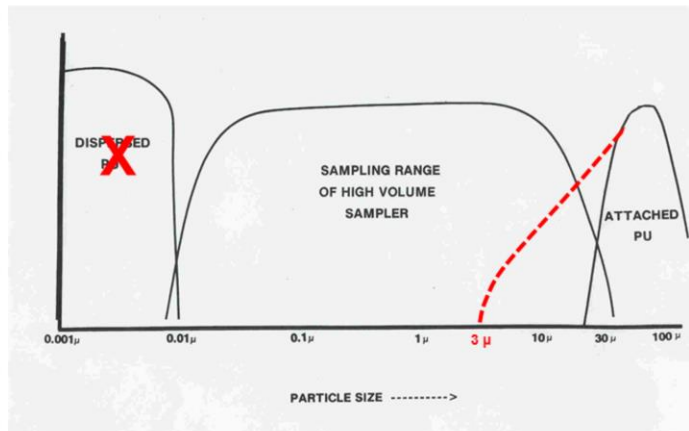


Federal Standard: Rad-NESHAPS: 40 CFR Part 61

State standards:

- 6 CCR 1007-1, Rules and Regulations Pertaining to Radiation Control, Appendix 4B
- 6 CCR 1007-1, Part 4.61.2 - Radiological Criteria For Unrestricted Use.

#11: HiVol air samplers did not capture the right particle size



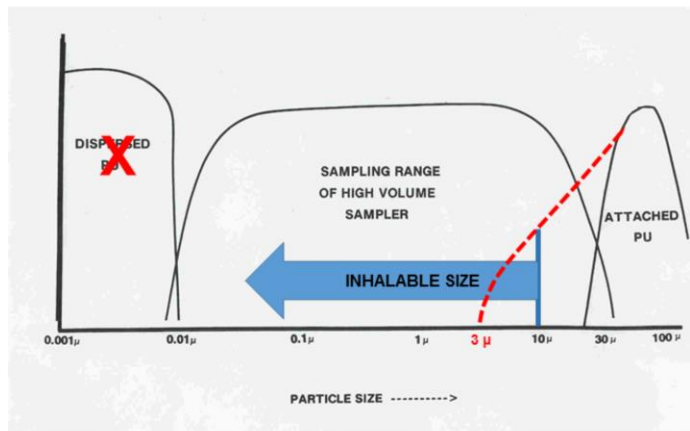
EMISSIONS COMPARED TO SAMPLING RANGE OF HIGH VOLUME MONITOR (original figure, Gale Biggs)

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Inhalation pathway is the most important exposure route, so accurately measuring that pathway is essential.

1. Dispersed Pu is now a non-issue. All primary sources (e.g., stacks) are gone and have not emitted any Pu for about 30 years.
 2. Pu in the environment exists as PuO_2 strongly attached to soil particles that are 3 microns or greater in size.
 3. The respirable portion of particulates is < 10 microns in diameter.
 4. Larger (> 10 microns) particles are screened out in the nose and upper airway and not retained in the body.
- Filters used in air monitors at Rocky Flats were tested and shown to be >99 % efficient in capturing inhalable particles. (1) Testing by manufacturers; (2) Side by side comparisons with CDPHE and reference EPA samplers.



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The “respirable portion” of particulates is < 10 microns in diameter. Larger (> 10 microns) particles are screened out in the nose and upper airway and not retained in the body

- Many research studies conducted at Rocky Flats, including wind tunnel testing by Midwest Research Institute.

#12: continuous air monitoring is still needed

Prior to Cleanup

- Air monitoring conducted for decades
- Annual air emissions and monitoring reports
- Samplers collected both site-derived + naturally-occurring radionuclides
- Small fraction of the national Rad-NESHAP standard detected
- State of Colorado Air Quality Operating Permit

After Cleanup

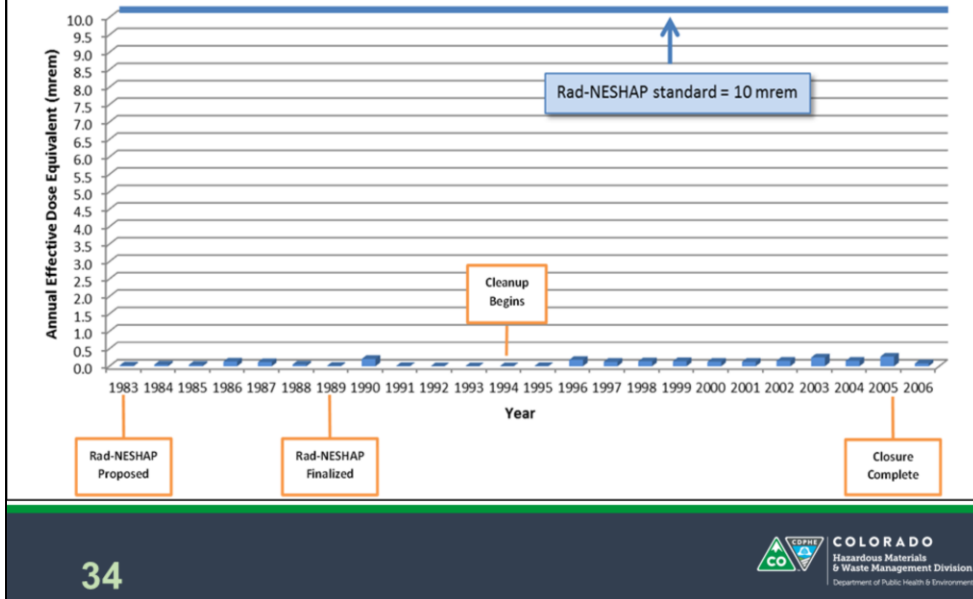
- Sources of airborne contaminants (solvents, radionuclides, etc.) gone
- Monitoring continued briefly to confirm very low contaminant levels
- Air monitoring ceased
- Air Quality Permit terminated
- Potential remains for minor wind erosion of the residual contamination in surface soils

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- DOE maintained networks of air samplers on-site and off-site beginning in the 1950s; two CDPHE programs monitored air particles since 1970; EPA set up mobile air samplers during cleanup.
- Naturally occurring uranium made up the majority of the reported annual measured dose.
- Future air emissions from the site will be less than those in the past.

Maximum Off-Site Dose Through the Air Pathway



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Rad-NESHAP standard = **10 mrem/year**

Maximum airborne radionuclide concentrations no more than 3% of the standard during the entire cleanup phase.

#13: Pu surface soil action levels inadequate

- Action level = trigger! All remedial surface soil action levels set at **1 in 100,000** excess cancer risk
- **Plutonium Soil Action Levels:**
 - **651 pCi/g** = initial action level (1996); dose-based
 - **116 pCi/g** = revised action level (2003); risk-based
 - **50 pCi/g** = final action level (2003); after input from stakeholders
- Residual levels of Pu in COU far below action level following remedial actions = **2.3 pCi/g**
- No remedial actions triggered in Refuge area



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Average concentration of plutonium in Refuge Surface soil is 1.1 pCi/g.

Highest concentration in Refuge samples was 20 pCi/g at one location.

Refuge levels low enough to merit unlimited use/unrestricted exposure and delisting from the Superfund National Priorities List in 2007.

Calculations for Radionuclide Soil Action Levels (RSALs) are in the RSALs Task 3 Report (Document No. SW-A-004689 in Administrative Record)

#14: process waste lines were just left in place and are a continuing source

- Process waste lines were thoroughly characterized
- Most waste lines were removed
- While some waste lines were indeed left in place, lines were purged and plugged with grout.
- Grouting process not unique to Rocky Flats.

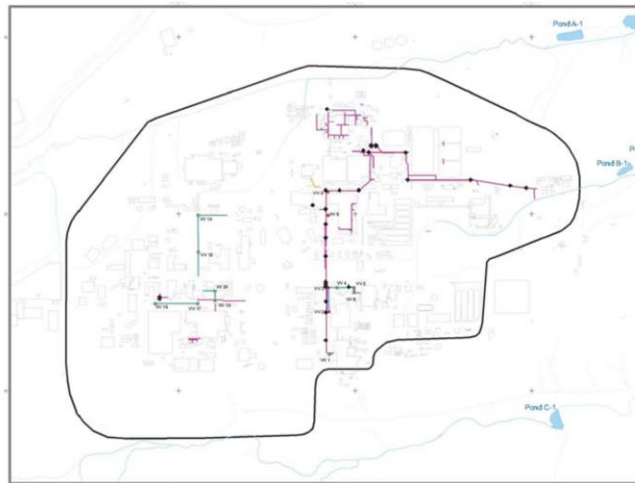


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Photo of apparatus used to grout Original Process Wastes Lines.

Photo of grout, copyright Bob Vila, <https://www.bobvila.com/articles/how-to-grout-tile/#.WkvK-NKnFhE>.

Remaining process waste line locations are documented



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Figure 2.6 (Subsurface Features after Accelerated Actions: Process Waste Lines and Valve Vaults) from Rocky Flats RI/FS Report (and Rocky Flats Legacy Management Agreement).

#15: the landfills (OLF, PLF) are full of toxic materials

- Landfills well-characterized:
 - Surface soil
 - Subsurface soil
 - Groundwater
 - Surface water
- Mostly municipal waste
- Boreholes/pot holes characterized contents
- Some unknowns
- RCRA wells monitor groundwater emanating from landfills



Original Landfill - Surface Soil Samples

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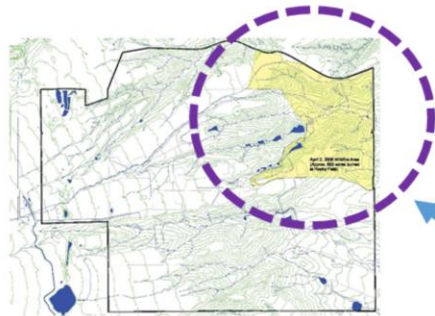
Original Landfill IM/IRA (2005):

Approx. 74,000 cubic yards of sanitary waste and construction debris were disposed prior to 1968.

Waste may have included:

- small amounts of paint, paint thinner, oil, pesticides and cleaners;
- PCBs (e.g., carbonless copy paper, fluorescent light bulbs, etc);
- Metals (Pb, Be, Cr);
- Depleted uranium dumped at OLF in 1965 after it caught fire while being transported. Three actions to recover DU from surface soil;
- Filter backwash from water treatment plant (1955-1964), which treated raw water from the Denver Water Board for use as potable water on site.

#16: wildfires will release harmful levels of radionuclides



Note: parts of WBEU area were included within the burn zone

- Residual plutonium and americium contamination does not have sufficient potential to rise to levels of concern, based on existing regulatory guidance.
- Most recently, fire on April 2, 2006,
 - 39 mph wind gusts.
 - Fire was within both Refuge and COU areas.
- Will be future fires; expect public interest and concern.

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See Assessment of 2006 fire and White Paper on the Radiation Dose Assessment for Firefighters During a Grass Fire. Note: 10 mrem is the annual limit to which a member of the public could be exposed; beyond that and the EPA standard for an airborne radionuclide dose would be exceeded. Exception is if SCA radiological posting limit in surface soil exceeded, for example, 115 pCi Pu-239/gram of soil. Because surface soil is at or below 50 pCi/g soil per RFCA standard, the dose would be less than 1 mrem.

RI/FS, Section 8, Figure A2.13 (Source Areas for Hypothetical Post-Fire Erosion Modeling).

Wildfire effects were also accounted for in the mass loading input parameter in the Action Levels calculations.

April 2006 fire recovery photos

Figure 2. Photos from burned area after 1 day (April 3) and 24 days (April 26).



April, 3, 2006 View NW from near surface water station GS03. April, 26, 2006 View NW from near surface water station GS03.

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Photos from April 2, 2006 fire assessment.

Data from 2000 prescribed burn, during cleanup (50 acres, Buffer Zone)

1. Air sampling of the smoke plume - approximately 0.2 picoCuries of alpha radioactivity per cubic meter of air sampled (pCi/m^3) - for a few hours event
2. Extrapolated dose of 0.2 mrem to someone continually in the smoke plume (for the incident), BUT dosimeters worn by firefighters showed no detectable exposure
3. Temperature monitoring
4. Post-fire portable wind tunnel testing
5. Post-fire soil analysis for actinides

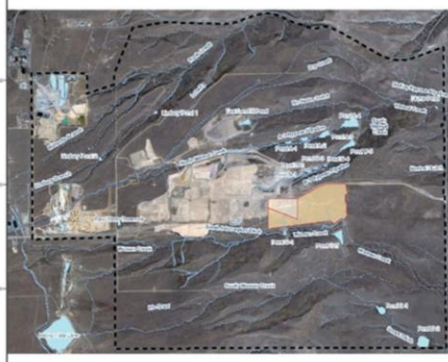


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1. Air samplers were placed at various points around the fire, including in the smoke plume itself.
 3. Wind tunnel set up in the burn site to evaluate what happens when strong winds blow across the burn area. Actinide concentrations in air were increased a factor of 5 compared to unburned scenario, immediately after the fire (pre-recovery).
 5. Dose calculation only theoretical since a person would not have been present as the flame front passed. All alpha activity was assumed to be from plutonium, so the actual dose a co-located individual would have received is less, since most of the activity observed on the filter is from natural radioisotopes. If the 0.2 pCi/m^3 fire value is a 1-day average value, that would equate to an annual average of 0.0005 pCi/m^3 for the fire (0.2 / 365 days), which is well below 0.02 state standard for plutonium.
- Dosimeters worn by firefighters also showed no detectable exposure

Hypothetical post-fire recovery scenario, 903 Pad



Source Areas for Hypothetical Post-Fire Erosion Modeling

- Worst-case scenario was modeled
- Data suggest that radiological hazards are negligible

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See RI/FS, CRA, Section 8 – Attachment 2, Table A2.2

Note: action level calculations included a fire scenario, worst-case, denuding during the spring

Maximum dose would be less than 1 mrem, based on plutonium soil levels

#17: drinking water supplies are being contaminated

- No new releases
- Some plutonium remains from past releases in offsite **sediments**
- Off-site reservoirs well-characterized by RI/FS:
 - Standley Lake
 - Great Western Reservoir
 - Mower Reservoir
- Risk levels below concern for residential exposure

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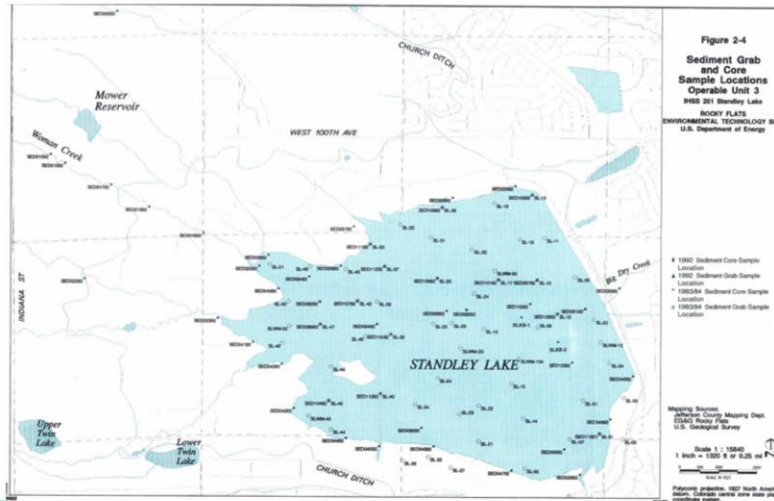
See EPA website regarding the Clear Creek/Central City Superfund Site.

See Facility Investigation/Remedial Investigation Report, Operable Unit 3 (Offsite Areas), June 1996.

Great Western Reservoir Replacement Project funded by a grant from DOE (\$75 M) and the sale of Broomfield's water rights.

Woman Creek Reservoir Authority Reservoir Soil and Sediment Sampling Results (Hydros, May 13, 2014)

Standley Lake studied



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Standley Lake information from Operable Unit 3 RFI/RI Report

OU 3 investigation showed greatest concentration of plutonium in subsurface sediments was 0.38 pCi/g at location SED08392 (center of lake). To compare, the average amount of plutonium in soil in the United States due to nuclear testing fallout ranges between 0.01-0.1 pCi/g. On Colorado's Front Range, background plutonium is about 0.07 pCi/g. The average concentration of uranium in surface soil in the United States is 2.0 pCi/g, but parts of the Colorado Plateau can have much higher radioactivity due to naturally-occurring rock formations.

Great Western Reservoir studied

- Great Western Reservoir also characterized during CERCLA environmental investigation
- 0.0065 mrem per year for a residential exposure scenario.
- ATSDR health assessment looked at potential public health impacts.



A layered system of public protections is in place today.

- On-site COU wells and surface water sampling locations.
- Points of Compliances (POCs)
- Stanley Lake Protection Project -DOE federal grant for Northglenn, Westminster, and Thornton.
- Woman Creek Reservoir blocks potential contamination



Woman Creek & Reservoir

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Cities that received Project funding from DOE were Northglenn, Thornton, and Westminster.

Woman Creek Reservoir Authority manages Woman Creek Reservoir.

ALL MAP LOCATIONS ARE APPROXIMATE; ONLY A GENERALIZED MAP. Map is meant only to illustrate layers of potential sampling checks.

Hydros Consulting report on soil and sediment sampling (2014):

- All maximum observed radionuclide activities and non-radionuclide concentrations were below chronic screening levels (except 3 naturally occurring metals).
- No significant human health risks to on-site workers or nearby residents.

In addition

- Water leaving Rocky Flats COU subject to stricter standards than drinking water for plutonium, uranium, and americium
- DOE grant funded new drinking water supply for Broomfield
- Drinking water suppliers monitor before you drink!



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Image from <https://depositphotos.com/91220032/stock-illustration-faucet-water-vector-cartoon-illustration.html>

#18: plutonium missing from Rocky Flats

ALLEGED: Rocky Flats plutonium was dumped at the Lowry Landfill from the early 1950s until about 1980.

Simply **NO EVIDENCE.**

Lowry Landfill Superfund Site:

- No evidence of man-made radioactive material disposal from Rocky Flats
- 8 main responsible parties in the 2005 Lowry Landfill Consent Decree for Lowry Superfund cleanup; DOE is not among them.
- Monitoring: background levels of Pu and Am

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#19: plants and animals are negatively impacted

- No observed unexpected animal mortality
- Previous surveys of plant and animal diversity and health
- Plant and animal uptake studies
 - USEPA
 - National & international studies
 - Colorado State University
 - RI/FS - Rocky Flats Ecological Risk Assessment
- Samples taken from deer tissue
 - Colorado State Univ. - 1970s-1990s
 - US Fish & Wildlife Service - 2005



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Only 17 of the more than 450 individual isotopic analyses conducted by USFWS on Rocky Flats deer tissue samples measured radionuclide concentrations that could even be detected; only 2 exceeded a 1 in 1 million risk level.

#20: CDPHE is not enforcing regulations following POC exceedances

- RFLMA Attachment 2 flow charts provide procedures - using rolling averages
- **There have never been conditions to justify a CDPHE penalty under RFLMA**
- CDPHE enforces for non-radioactive contaminants and the institutional controls
- EPA has authority to fine DOE for exceedances of radionuclide standards



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Exceedance procedures:

1. Report to agencies and public
2. Develop plan to address occurrence
3. Consult with agencies
4. Implement mitigating actions, if necessary.

Notifications:

- Jan 2017 reportable condition at WALPOC – U at 16.9 µg/L (30-day average).
- Mar 2016 reportable condition at WALPOC – U at 16.9 µg/L (30-day average).
- Dec 2014 reportable condition at WALPOC – U at 17.2 µg/L (12-month average).
- Feb 2014 reportable condition at WALPOC – U at 16.9 µg/L (30-day average).

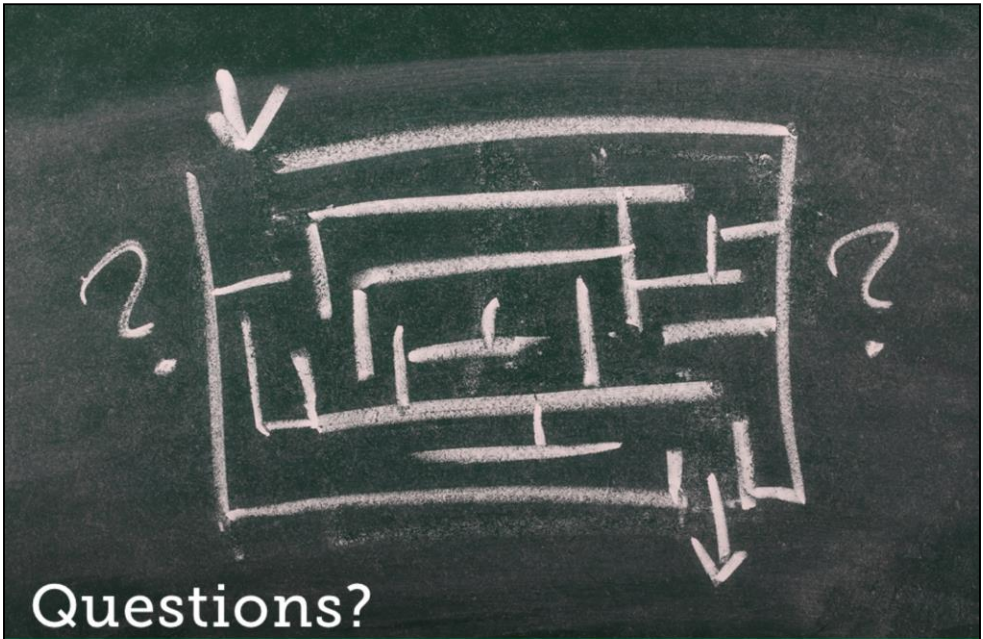
RFLMA Attachment 2, applicable Table 1 Standard for total uranium of 16.8 ug/L.

Compliance with the standard is based on the 12-month rolling average.

Agencies decided that the remedy remains protective:

1. For the 30-day exceedances, the 12-month rolling average uranium concentrations were below the RFLMA standard.

2. High-resolution isotopic uranium analyses for this location show signatures that are between 68 and 87 percent natural uranium.
3. Measured concentrations well below the drinking water standard of 30 $\mu\text{g/L}$.
4. Measured concentrations consistent with anticipated variability.
5. Actions taken: notified parties; consulted and reviewed data; continued upgrades at SPPTS; geochemical evaluation of variability in Walnut Creek.



Questions?

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