

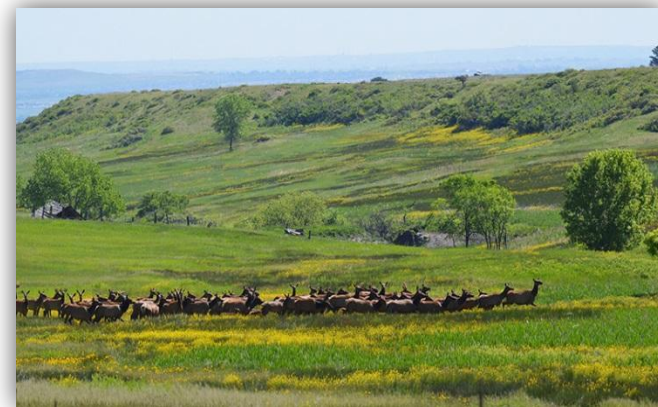
An introduction to Rocky Flats

May 17, 2018

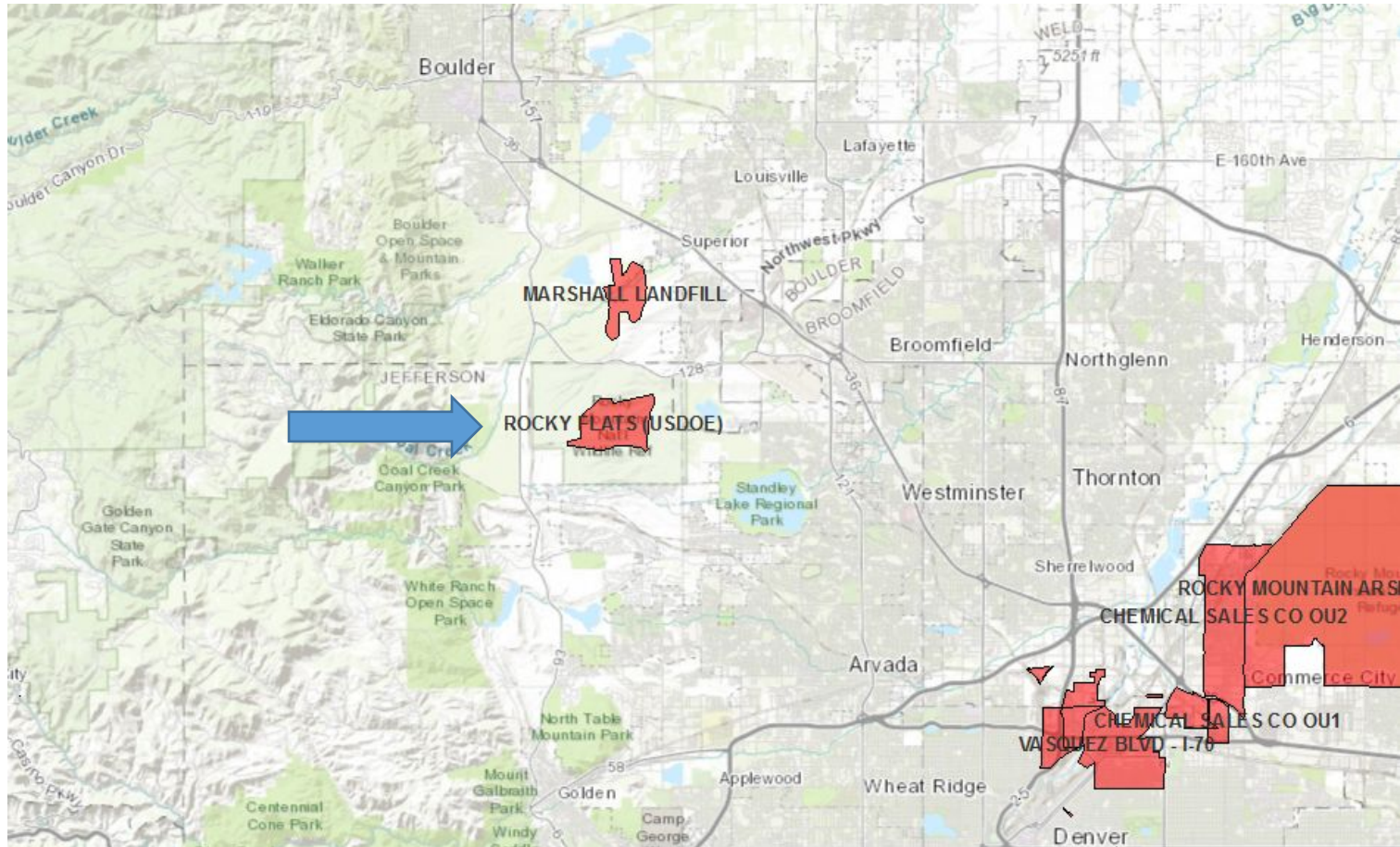
Jefferson Parkway
Citizen Advisory Group

Colorado Department of Public Health and
Environment (CDPHE)

www.colorado.gov/cdphe/hm



Rocky Flats

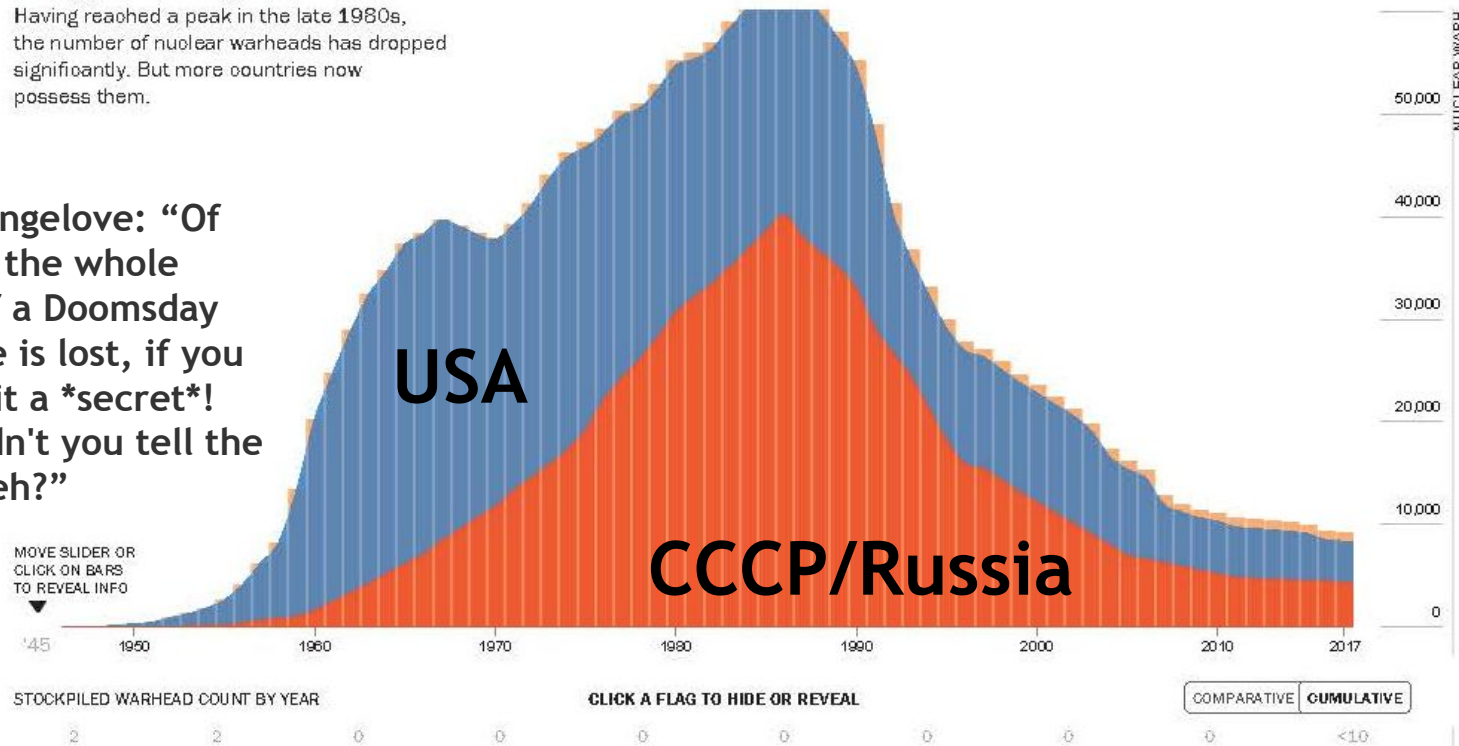


Global warhead count vs. USA vs. Russia

Rising, then Pulling Back from a Peak

Having reached a peak in the late 1980s, the number of nuclear warheads has dropped significantly. But more countries now possess them.

Dr. Strangelove: “Of course, the whole point of a Doomsday Machine is lost, if you *keep* it a *secret*! Why didn't you tell the world, eh?”



Global US Russia United Kingdom France China Israel India Pakistan North Korea

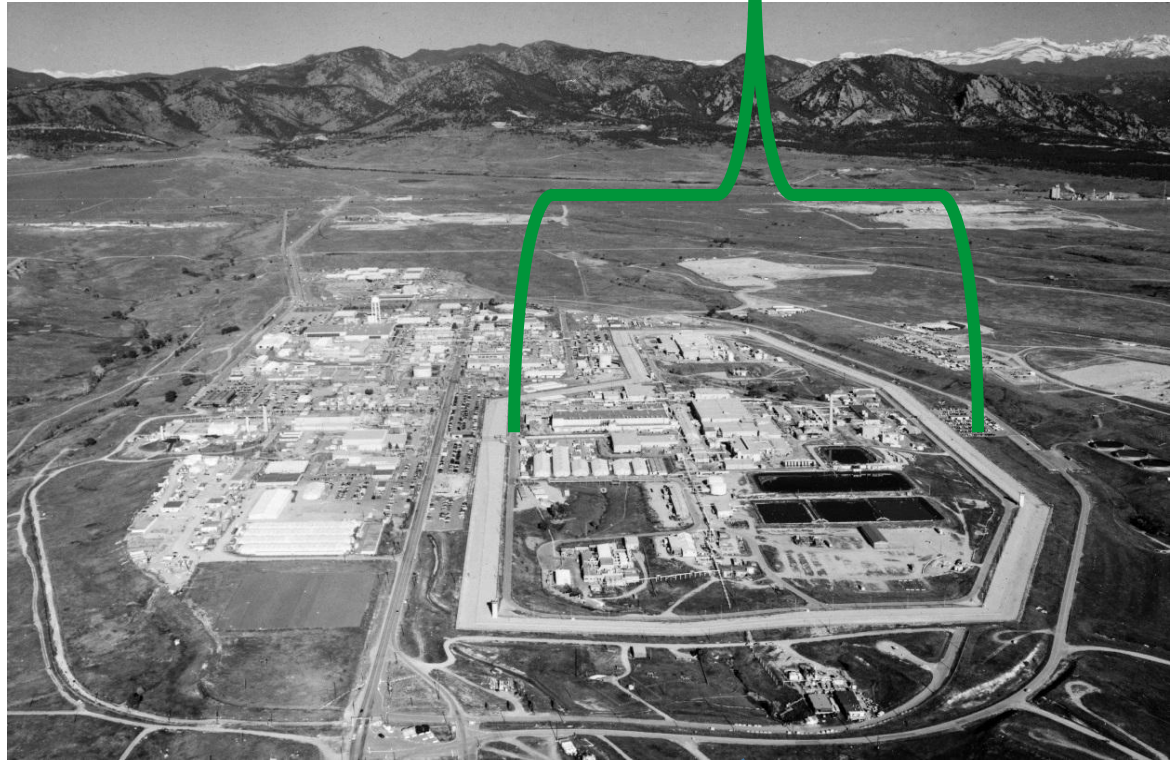
Source: *The Bulletin of the Atomic Scientists'* Nuclear Notebook, written by Hans M. Kristensen and Robert S. Norris, Federation of American Scientists



Plutonium puck



Plutonium pit production
for nuclear weapons



"Protected area"
high security zone



903 Pad



Timeline - Rocky Flats Plant

- 1946/1954: Atomic Energy Act
- 1951: Plant construction
- 1952-1989: Plant produces plutonium triggers during the Cold War; environmental releases on and offsite; two major fires
- 1976: Resource Conservation and Recovery Act (RCRA) - “cradle to grave” regulation of hazardous waste
- 1980: Comprehensive Environmental Response and Liability Act (CERCLA) - “Superfund”
- 1982: EPA issues first guidelines for implementing CERCLA
- 1983: EPA’s first National Priorities List (NPL)
- 1986: CERCLA “SARA” Amendments, added Section 120
 - Requires federal facilities to comply in same manner as other entities, and
 - Federal facilities on the NPL must have interagency agreement with EPA (and the state, if state so desires)
- 1986: interagency compliance agreement
- 1988: Plant operations slow
- 1989: EPA/FBI raid; Rocky Flats added to EPA’s National Priorities List

Timeline – CERCLA cleanup

- 1991: new interagency agreement reflecting the change to a CERCLA cleanup
- 1992: operator gets \$18.5M fine for environmental crimes
- Early 1990s: state and federal environmental battles, unanswered questions get answered - e.g. **Federal Facilities Act**, amended RCRA to waive immunity from state penalties for federal violations of state hazardous waste laws
- 1990s-2005: physical investigation, sampling, and cleanup of Rocky Flats
- 1996: Rocky Flats Cleanup Agreement (RFCA)
- 2001: Congress passes the **Rocky Flats National Wildlife Refuge Act**
- 2006: site remedy selected, see CAD/ROD
 - **Central Operable Unit (COU)**
 - **Peripheral Operable Unit (POU)**
-Refuge and ROW lands

CERCLA cleanup effort during 1990s – 2000s

- 10-year, \$7 billion CERCLA (Superfund) cleanup
- Deactivated, decommissioned and demolished 800+ structures
- 421 potentially contaminated areas investigated
- ~360 areas remediated
- Largest CERCLA cleanup, at the time
- Refuge and offsite areas investigated and sampled
- COCs: arsenic, benzo(a) pyrene, dioxin, plutonium, vanadium
- Activities overseen by DOE, EPA, CDPHE, and DNFSB



Trench 1 removal



903 pad excavation



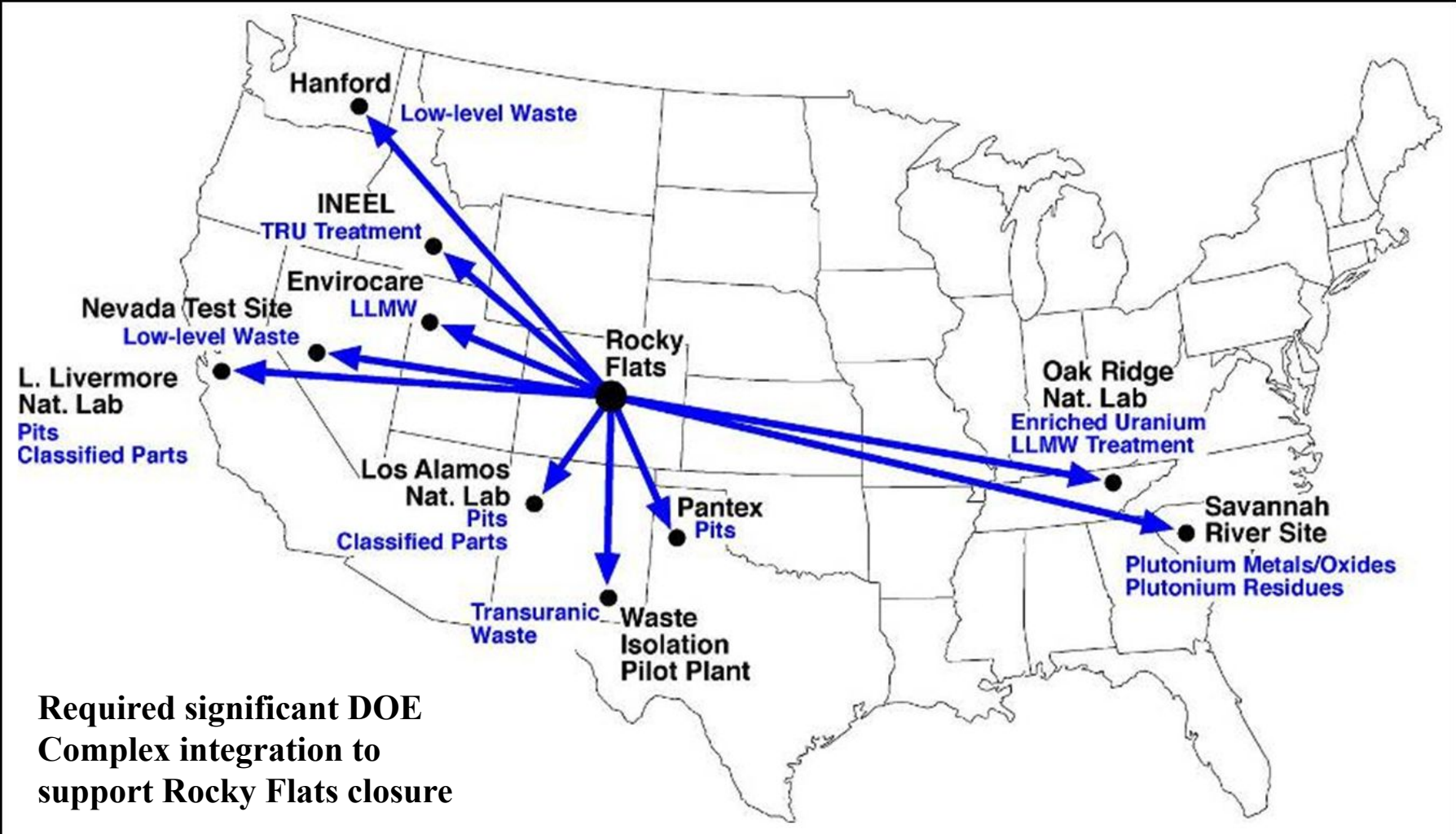
Original
Landfill



B-881 implosion



Special Nuclear Material and Waste Shipping



Required significant DOE
Complex integration to
support Rocky Flats closure

2003

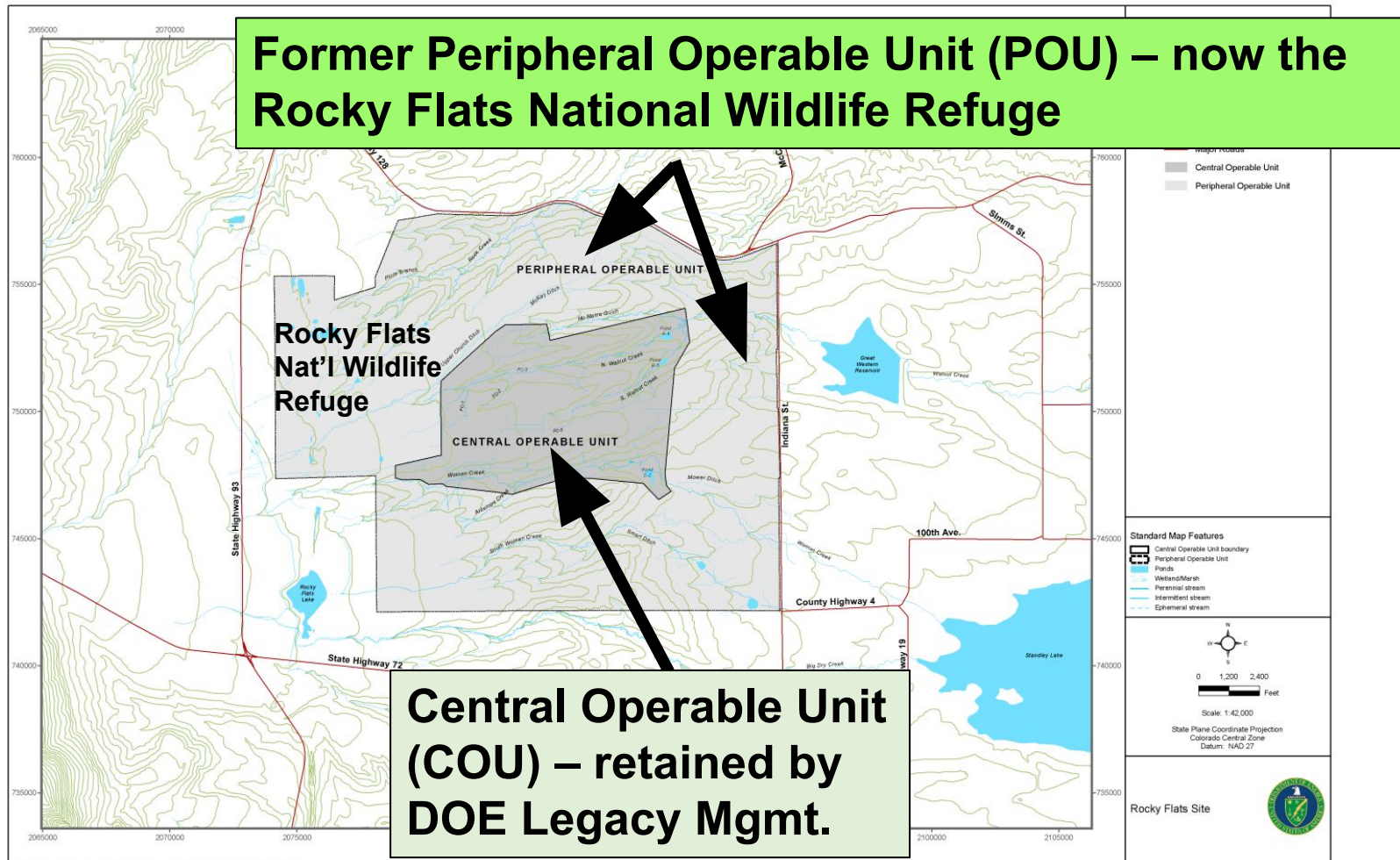


2010



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Rocky Flats TODAY

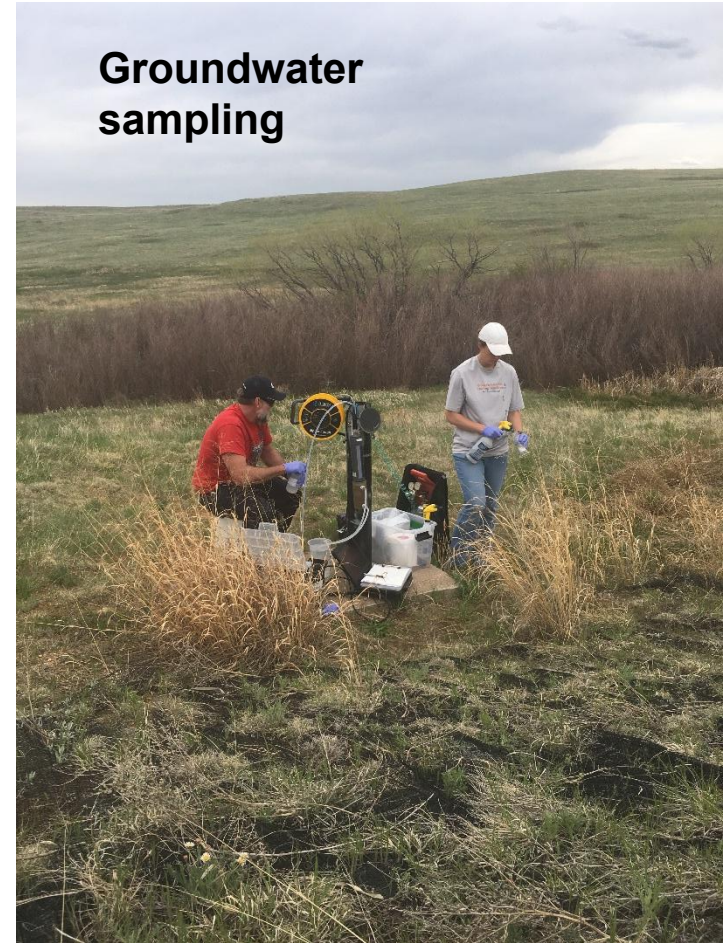




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Timeline - post-closure

- 2006: post-closure agreement, the Rocky Flats Legacy Management Agreement (RFLMA)
- 2007: EPA delists POU from National Priorities List
- 2012, 2017: CERCLA Five-year Reviews conclude the remedy is functioning and protective of human health and the environment
- Ongoing remedy monitoring and maintenance, reviews, site visits, and (3) groundwater treatment systems operating



Groundwater treatment systems



A regulatory analogy...



- Speed limits.
- Numerical standards not unique to Rocky Flats - quantitative regulation of water, air, etc.
- CDPHE regulates based on applicable law, regulations, and guidance.
- Agencies are not the legislature.

What “cleaned-up” means

- Remediation met applicable legal and regulatory requirements.
 - Central Operable Unit was remediated to CERCLA risk range, per regulations.
 - Refuge/ROW was not remediated because detected levels were so low the land did not meet the threshold for action.
 - Environmental regulatory standards are health-based, not background based.

Health-based environmental standards and risk calculations

- EPA's Integrated Risk Information System (IRIS)
 - Looks at toxicology and chemistry regarding various chemicals' human health effects
 - Provides assessments of hazards that are then used in decision-making and site risk assessments nationwide
- Risk assessments - can consider different exposure scenarios, doses, adult and child biology, animal biology, chemical hazards, behaviors, and identifies pathways

Rocky Flats cleanup data and records available online

• Agency records:

- **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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Office of Legacy Management

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LM Home > LM Sites > Colorado

Rocky Flats Site, Colorado
A CERCLA and/or RCRA Site

Remediation at the Rocky Flats Site was conducted in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and/or Resource Conservation and Recovery Act (RCRA) regulations. Responsibility for operation and maintenance of the site was transferred to LM in October 2005 and requires operation and maintenance of remedial action systems, routine inspection and maintenance, records-related activities, and stakeholder support. Jurisdiction of the site was transferred to the Office of Legacy Management in 2008. For more information about the Rocky Flats site, view the [fact sheet](#).

- [Site History](#)
- [Site Documents](#)
- [Community Involvement](#)
- [Contact Us](#)
- [Rocky Flats Benefits Administration](#)
- [Comprehensive Environmental Response, Compensation, and Liability Act \(CERCLA\) Administrative Record Database](#)
- [Rocky Flats Site Mapping and Monitoring \(GEMS\)](#)

There is on and off-site residual contamination

- Residual contamination within regulatory limits.
- Agencies continue to monitor the site and remedy.
- There have never been conditions to justify a CDPHE penalty under RFLMA.



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

Radioactivity levels are well below regulatory standards

Average Residual Plutonium Contamination in Surface Soil:

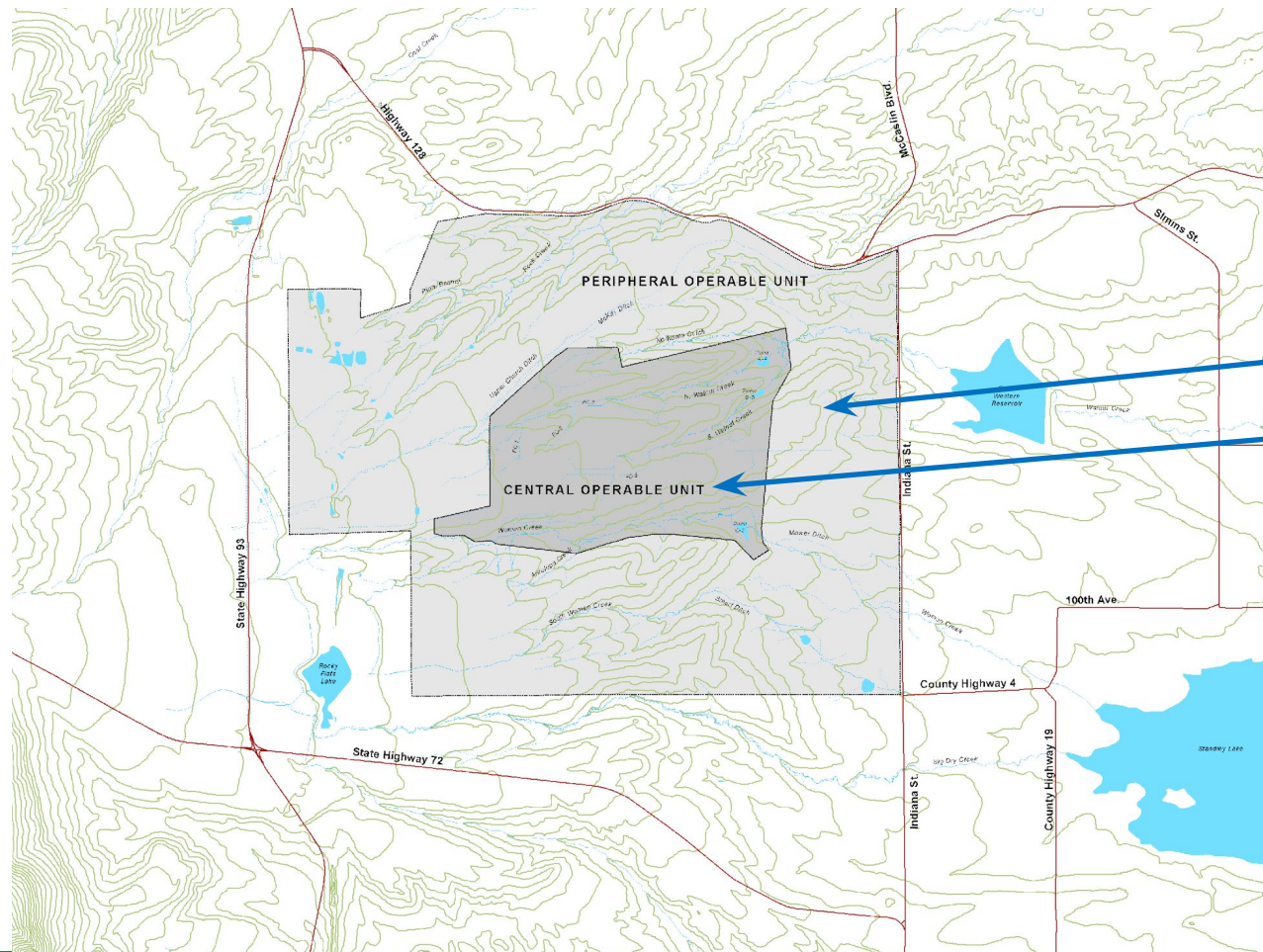
Refuge = 1.1 pCi/g

COU = 2.3 pCi/g



DOSE:
< 1 mrem/year for adult or child

RISK:
< 1 in a million risk of excess cancer



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





Radiation Dose Chart

Airport security scan
 0.005 mrem

Home smoke detector
 0.008 mrem/year

Eating one banana
 0.01 mrem

Rocky Flats radiological
 dose estimate (RI/FS)
 <1 mrem/year

Airplane flight from
 Denver to Juneau, AK
 1 mrem

Off-site dose estimates
 for 903 Pad plutonium
 release at Rocky Flats,
 1965 -1969
 0.91 to 7.2 mrem

Typical medical X-ray
 10 mrem/X-ray

Average Three Mile
 Island dose to the
 public on the day of the
 accident
 <2 to 10.4 mrem/day

Average targeted
 nuclear medicine dose
 400 mrem/year

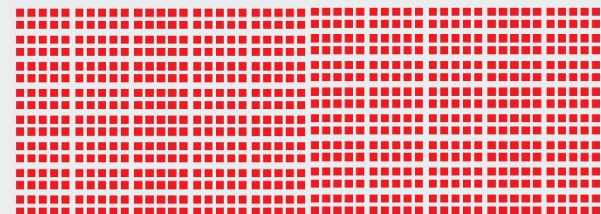
Dose limit for a
 pregnant worker
 500 mrem/pregnancy

Average annual dose for
 an American
 360 to 600 mrem/year

Full body CT scan
 1,000 mrem

Annual nuclear worker
 dose limit
 5,000 mrem/year

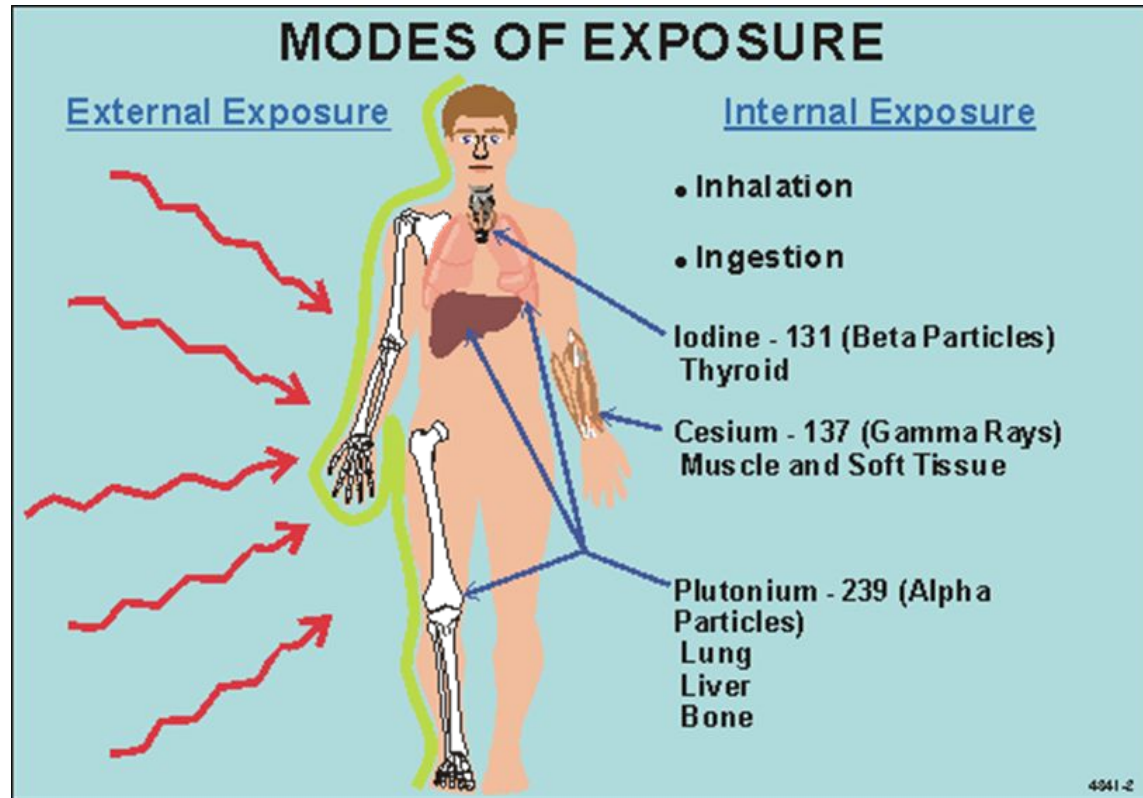
Dose at which there is a
 link to cancer
 10,000 mrem



Chernobyl accident, high dose
 >80,000 mrem

Exposure Pathways

1. Inhalation
2. Ingestion
3. Dermal absorption
4. Injection
5. External irradiation



Exposure Pathways

Wildlife Refuge Worker:

- staff a visitor center,
- monitor and maintain the trail system,
- dig fence posts,
- track the on-site wildlife populations.
- 230 days/year; 18.7 years



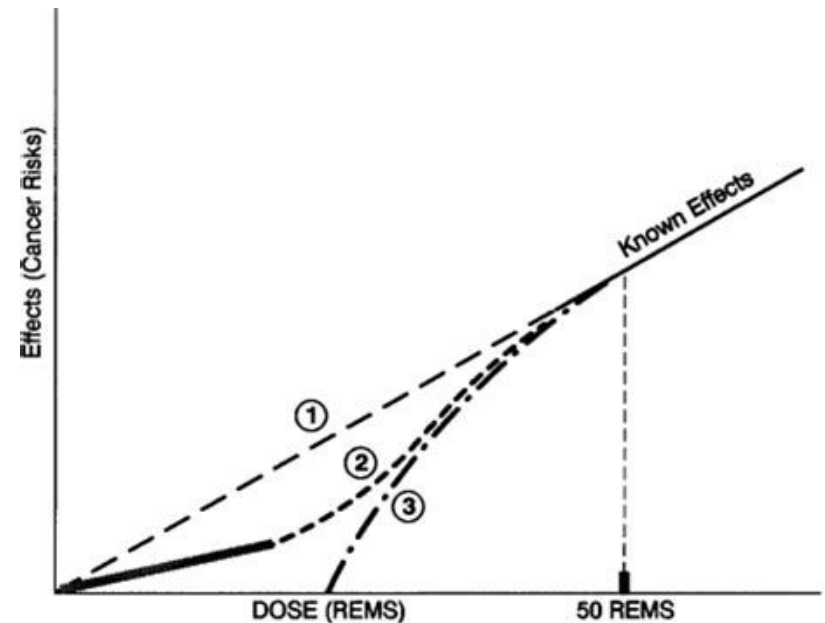
Wildlife Refuge Visitor:

- Hike, Bike, birdwatch
- 100 visits/year
- 2½ hours/visit
- 24 years (adult) + 6 years (child)
- Soil ingestion rate = 60 mg/day



What's the impact of a small amount of ionizing radiation?

- Cancer possible, not probable - small risk
- Regulations provide limits below which, risk/dose is negligible
- Linear no-threshold dose model



Note: in rems, not mrems

Can inhaling even one particle of plutonium cause cancer?

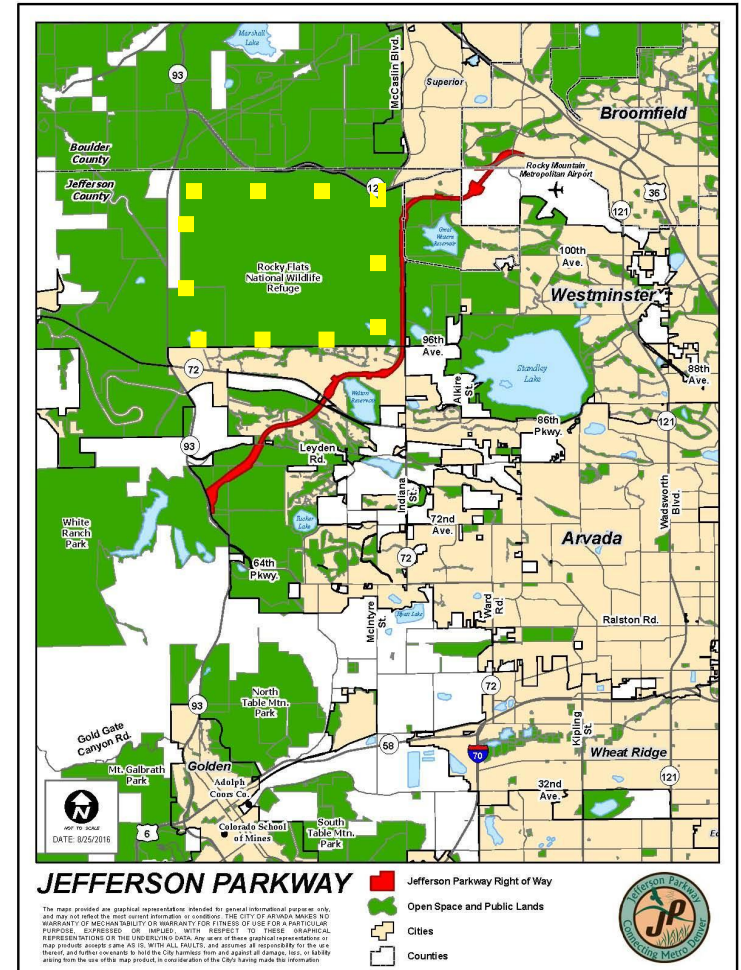
- The risk is not zero, but it is very small
- Plutonium is a global contaminant; it is everywhere
- Principle of toxicology: “The poison is in the dose.”
 - “Millions of dust particles contaminated with PuO_2 must be inhaled in order for significant radiation doses...”²

Rocky Flats is very well-studied

- CERCLA environmental investigation
- General process used at other CERCLA sites
- Informed decisions based on data collected, employee interviews, records, and process knowledge
- Thousands of samples collected on and offsite:
 - Air
 - Soil
 - Groundwater (1,289 monitoring wells)
 - Surface water
 - Sediment

Would Parkway construction release harmful levels of plutonium?

- 300-foot ROW along Indiana granted in the Refuge Act
- Environmental investigation concluded both the Refuge area and off-site areas are **suitable for unlimited use and unrestricted exposure**



Right-of-way sampling

- Lots of soil samples
- Maximum ROW plutonium concentration = **8.8 pCi/g**
- Average ROW plutonium concentration = **1.4 pCi/g**
- Third-party sampling east of ROW agree with DOE sampling results

300 feet west of Indiana St.



Federal and state standards for airborne radionuclides

FEDERAL STANDARDS

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

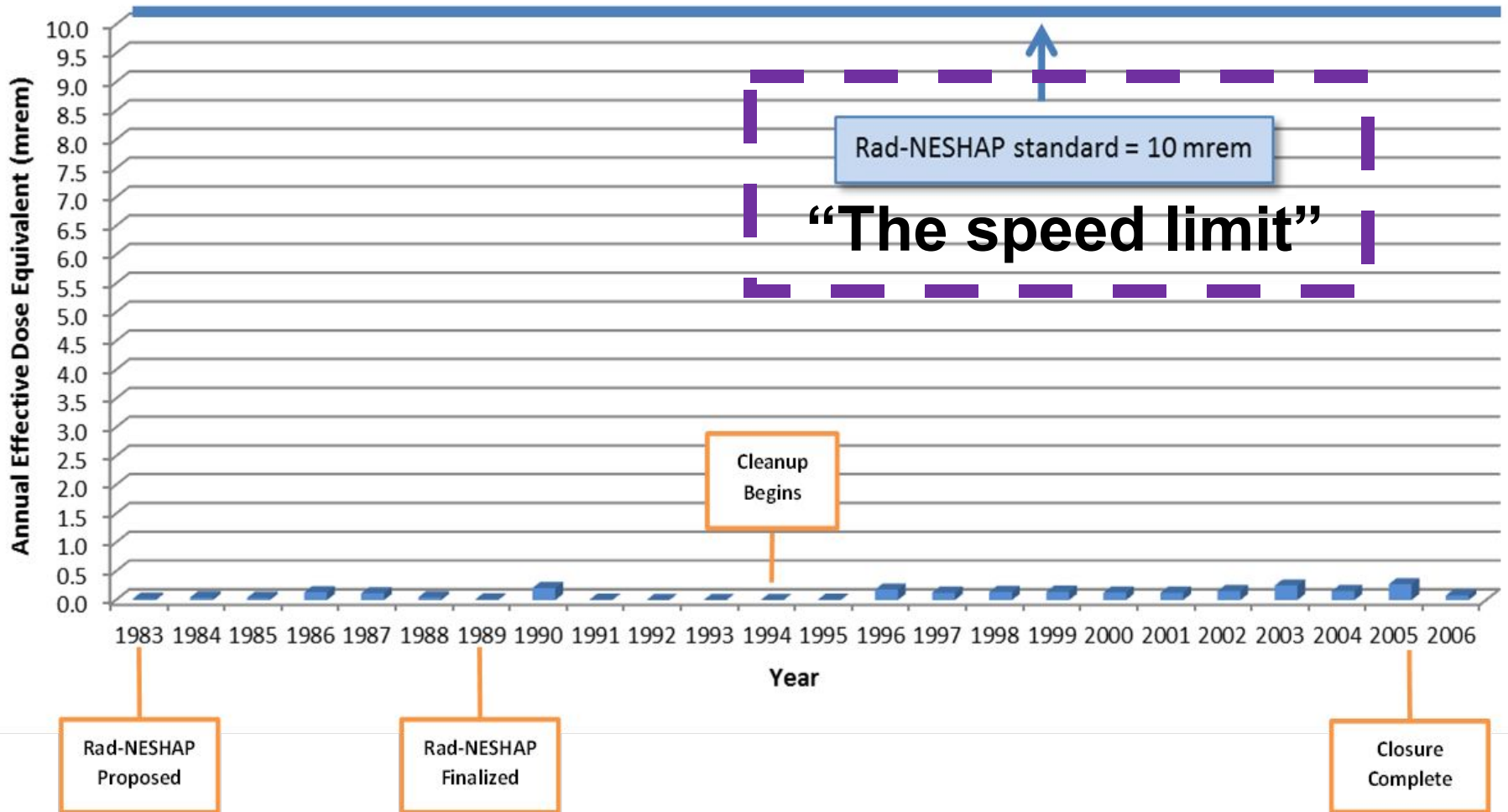
10 millirem/year dose limit for radionuclide air emissions

STATE STANDARDS

Colorado radiation standard limits public to a total annual dose above back-ground of **25 millirem/year**

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

Maximum Off-Site Dose Through the Air Pathway



Rocky Flats Health Studies

ATSDR Public Health Assessment

- 2005 - the Agency for Toxic Substances Disease Registry (Atlanta, GA) conducted an independent public health assessment for Rocky Flats
 - ATSDR is charged with assessing potential public health impacts for Superfund sites, nationwide.
 - “Overall, ATSDR did not identify any environmental exposures at levels of public health concern for past and current exposures...”
 - During plant operation, “residents who lived near Rocky Flats Plant were exposed to site-related contaminants, but not at levels associated with adverse health effects.”
 - Community, EPA, state and local health agencies consulted.
 - Public comment period.

Historical Public Exposure Studies

- CDPHE-administered studies during 1990s with oversight by 12-member Health Advisory Panel appointed by then-Governor Romer.
- Focused on estimating increased cancer risk for residents around Rocky Flats from 1952 to 1989.
- Peer review
- About 50 public meetings
- Laborer living near Indiana and 64th Avenue - median increased cancer risk of about 2.5 in 1,000,000.

Three CO Cancer Registry studies

- CDPHE houses the **Colorado Central Cancer Registry**
 - Registers cancers diagnosed in Colorado residents
 - Individual patient information, confidential
 - ~20,000 cancer cases per year
- 1998 - Registry examined cancer incidence data, 1980-1989
 - Neighborhoods around Rocky Flats vs. Metro Denver area
 - 10 cancers specifically tied to plutonium exposure and other cancers of concern (e.g. lung, brain)
 - Health Advisory Panel oversight
- 2016 - same 10 cancers as original study, 1990-2014
- 2017 - supplement to 2016 study
 - Added thyroid and rare cancers

CDPHE cancer incidence study conclusions

Questions?

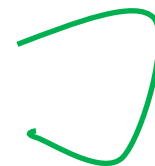
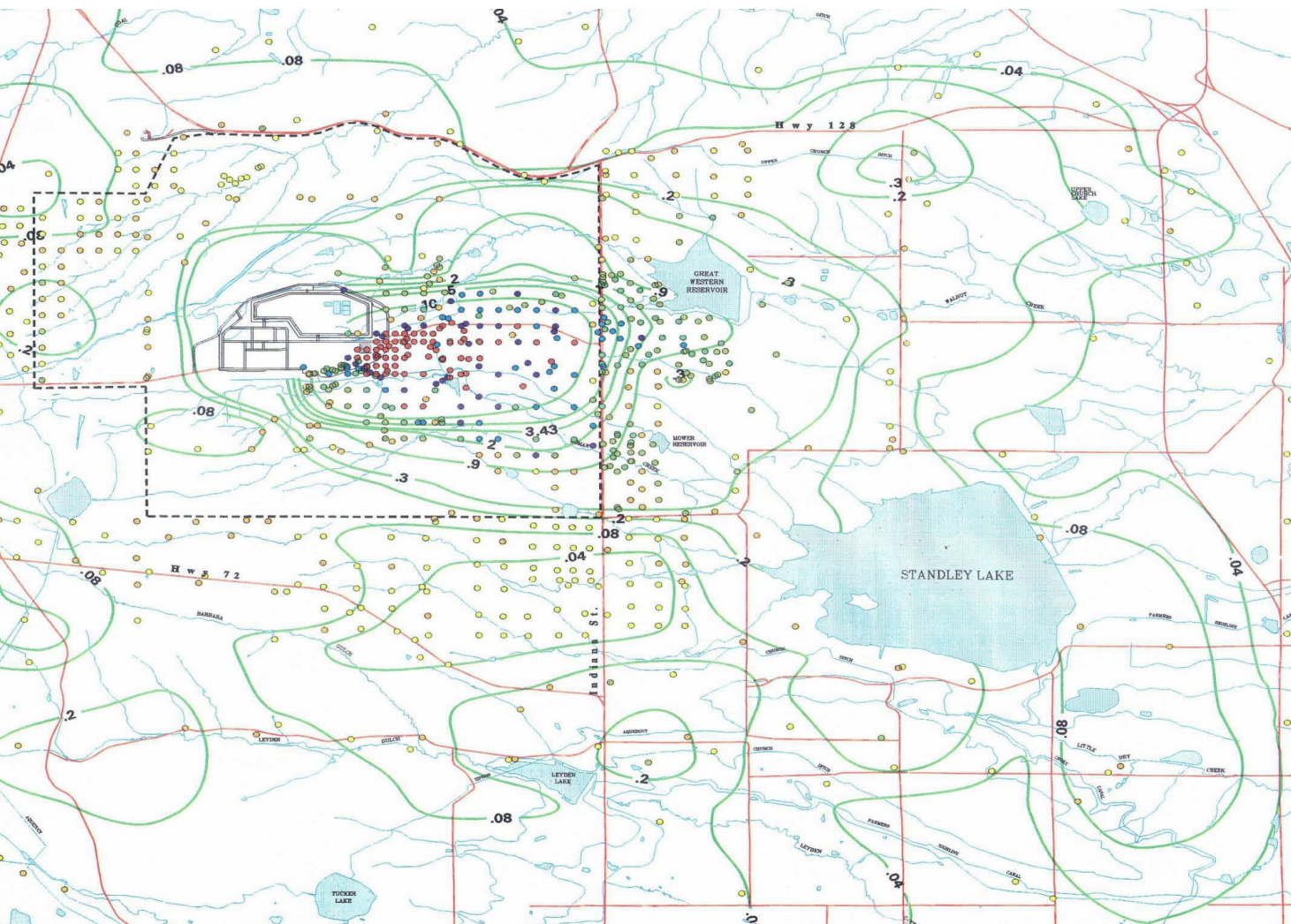
- Environment and cleanup - Carl Spreng and Lindsay Masters, carl.spreng@state.co.us and lindsay.masters@state.co.us
- CDPHE cancer incidence studies - Mike Van Dyke, mike.vandyke@state.co.us



Offsite Contamination

Surface Soil Sampling Locations

Pu-239/240 in pCi/g



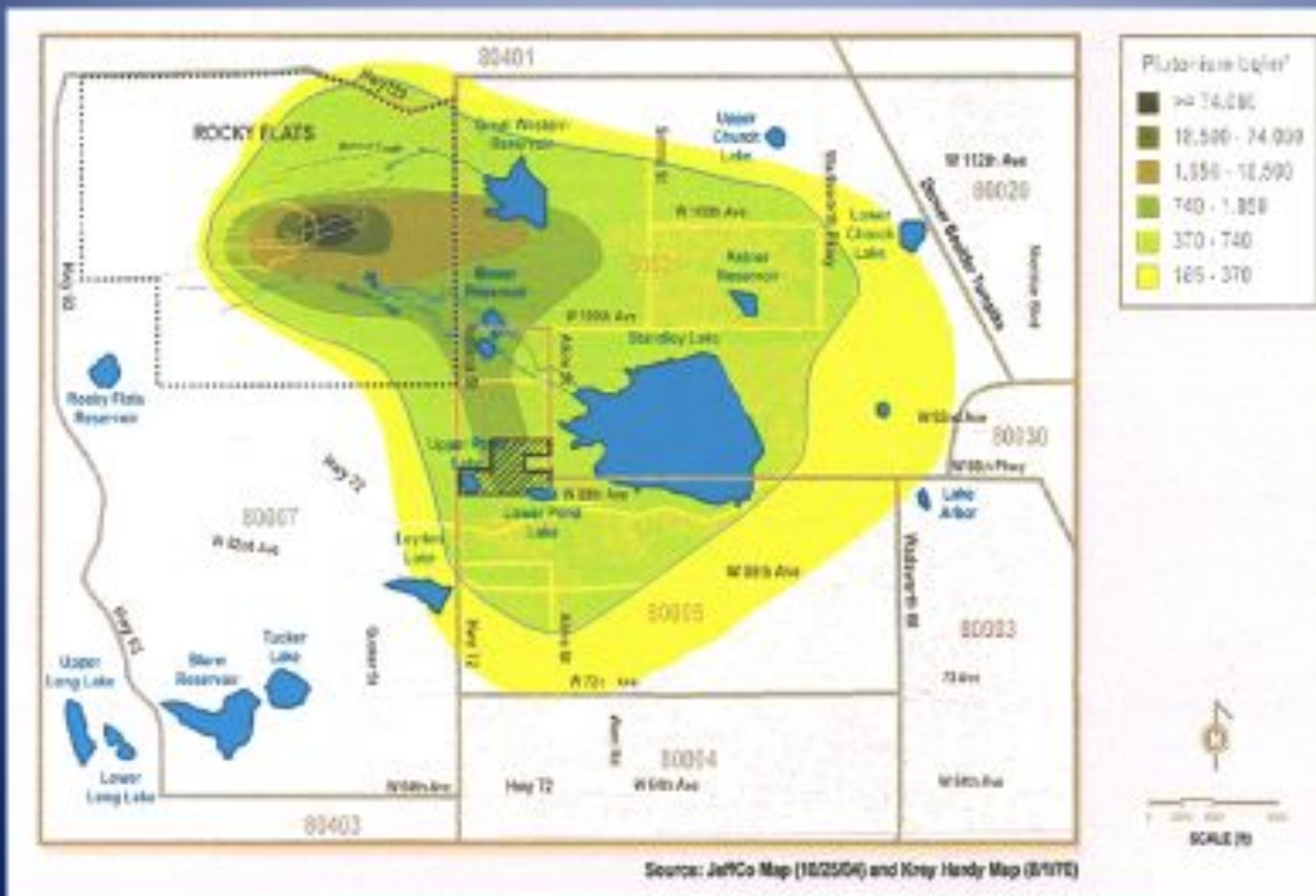
**Pu isopleths
(pCi/g)**

**Plotted from about
750 sample points
(pre-cleanup)**



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Krey & Hardy Study (1970)



pCi/g
>200
50 - 200
5 - 50
2 - 5
1 - 2
0.5 - 1

- Data do not meet EPA useability criteria.
- Data included multiple analyses by various labs.
- Data is pre-remediation.

CERCLA Risk Range



