PLUTONIUM AND PEOPLE DON'T MIX

A Guide to Rocky Flats, Colorado's Defunct Nuclear Bomb Factory

by LeRoy Moore, PhD

Rocky Flats Nuclear Guardianship
Rocky Mountain Peace & Justice Center

July 20, 2017

Facts by our side are never sudden
Until they look around
And then they scare us like a spectre
Protruding from the ground

-- Emily Dickenson

TABLE OF CONTENTS

GLOSSARY

AEC
Bq
CDH
CDPHE
CERCLA
DOE
EPA
FACA
pCi/g
Pu
RCRA
RFCA

PERSPECTIVE

When I arrived in Colorado in 1974 to teach at the University of Denver I had never heard of the Rocky Flats nuclear bomb plant near Denver. But I was concerned about nuclear weapons. I had been teaching at graduate and undergraduate levels for a decade. Since about 1969 I had alerted students to the fact that the human presence on this planet could end soon due to three threats of our own making: 1) nuclear holocaust, 2) ecological disaster, and 3) authoritarian governance. Any one of these could end our time on this planet. I hoped that students aware of these threats could do something about them. I often told them: "This is your homework – for the rest of your life. If the human race is to survive, we'll have to change our ways. You can help this happen."

I had been in Denver several years when in 1978 a small group of people who opposed nuclear weapons sat on the railway tracks leading in to the Rocky Flats plant. They caught my attention. I realized that Rocky Flats epitomized in a concentrated way all three of the fundamental threats to which I was alerting students, and its product was the extremity of violence, while those on the tracks were committed to nonviolence, as was I.[1] Soon I left the academic world and joined those on the tracks. The blockade lasted from April 1978 until April 1979 – "a year of disobedience."[2] I believe it is the longest sustained nonviolent civil disobedience in U.S. history. When those on the tracks were arrested and removed, they were quickly replaced by others, sometimes by people new to the occupation. When I was on the tracks, I was arrested and put on trial in federal court. This was an eye-opening experience in itself on how injustice trumps justice.[3]

Having left the academic for the activist world, I quickly learned more about the global threat of the bombs made at Rocky Flats and the local hazard of radioactive plutonium released into the environment from this facility. And I gained increased awareness that making these bombs requires a secretive, centralized, authoritarian command structure that undermines democracy across the board. The Manhattan Project that designed and built the bombs used against Japan in 1945 was totally secret. It established a pattern of invoking a veil of security to hide details about harm to people and the environment. This pattern prevailed afterward in all aspects of the nuclear weapons enterprise. Getting reliable information on matters like radiation releases has been difficult to impossible. When production ended at Rocky Flats after the FBI raided the plant in 1989, evidence of law-breaking gathered by the FBI was sealed by court order, so it was not available to the public or elected officials. Standards for permissible exposure to radiation for plant workers and the public were set with no participation of those likely to be exposed. As will be shown in the text, though the period of the Superfund "cleanup" of the contaminated site had more public participation than any other time, major "cleanup" decisions were made behind closed doors. This pattern of secrecy has not ended.

Production of nuclear weapons began at Rocky Flats in 1952. For thirty-seven years it was the only plant in the country producing the fissile plutonium bomb cores for the U.S. arsenal. But the plant also created a tradition of risk for people in the area – about which some learned only gradually. The risk did not end with the termination of production. Next came what the Department of Energy (DOE) called the "risk-based cleanup" of the site. It lasted 15 years and at completion left a legacy of risk in the form of an unknown quantity of highly toxic radioactive plutonium in the environment.

Denver-area people inherited the crisis of a local hazard forever. Crisis is danger. But it can also be a turning point, a change for the better. This work explores both aspects of the Rocky Flats

---

[1] See APPENDIX A, Gift of Nonviolence.

[2] Joseph Daniel et al., *A Year of Disobedience* (Boulder: Daniel Publications, 1979); Daniel et al., *A Year of Disobedience and a Criticality of Conscience* (Boulder: Story Arts Media, 2013).

[3] See APPENDIX B, for a brief account of my revealing experience in court.

crisis, the danger and the opportunity.

After learning about Rocky Flats in 1978, I joined others seeking a permanent halt to bomb-building at the plant, a goal achieved in 1992 when the plant's mission changed from production to cleanup. Then for fifteen years I served on oversight and advisory bodies focused on the Superfund "cleanup" of the Rocky Flats site. When the "cleanup" was done the Department of Energy (DOE) transferred about three-fourths of the 10 square-mile site to U.S. Fish & Wildlife Service to run as a national wildlife refuge, while it retained for its Legacy Management program 2.1 square miles in the central more contaminated part of the site.

For four years beginning in 2000 I had the unusual fortune of being a member of two committees of the National Council on Radiation Protection and Measurements (NCRP), the principal U.S. body that researches radiation health effects and makes recommendations regarding standards for permissible exposure. This gave me a close look at the little-known world of those who decide how much radiation exposure the rest of us may legally experience. And in the first decade of the 21st century for three years I served on the board of the Alliance for Nuclear Accountability, a national network of grassroots groups located near nuclear weapons facilities across the country. I am not a technical specialist; everything that I know about Rocky Flats and the nuclear weapons enterprise I have learned with the help of others. What is presented here draws on this experience.

It is not widely known that a few of the Manhattan Project scientists who created the first atomic bombs opposed using them on a human population because doing so would commit the war crime of killing innocent people indiscriminately. These scientists lobbied unsuccessfully for these weapons to be demonstrated over the ocean rather than dropped on a living city. Further, after the bombs were actually used at Hiroshima and Nagasaki, they called for nuclear weapons to be outlawed, with the material used to make them controlled by a non-government body. They realized that in a nuclear war there could be no winners, only losers, because these weapons threaten both a global nuclear holocaust and an environmental calamity from which recovery would be impossible. Convinced that nuclear weapons had made war obsolete, they called themselves "nuclear pacifists" – total opponents of war. Continued production of nuclear weapons cannot be justified. I agree with these original nuclear pacifists. Nuclear weapons must be abolished. They are illegal and immoral. Made by humans, they can be unmade by humans.

At its founding, the U.S.A. presented a democratic hope to the world. This would necessitate openness in governance and a promise to overcome exclusion. But, as stated earlier, the Bomb is an enemy of democracy. One of the government's first acts after creation of the Manhattan Project in 1942 was to assume "total control over the mining, milling, refining, and use of uranium,"[4] a material essential for nuclear bombs. In the same year physician William C. Hueper, head of the environmental cancer section of the National Cancer Institute, was blocked by superiors from publishing data about dangers of mining uranium because "it was not in the public interest."[5] After World War II, in the case of Rocky Flats, "Colorado's top elected officials were not informed that the plant would be built until the decision had already been made."[6] The U.S. commitment to nuclear weapons has undermined our democracy. How we deal with the nuclear issue will reveal our character as a people.

---

[4] Robert Alvarez, "Uranium Mining and the U.S. Nuclear Weapons Program" (2013) http://blogs.fas.org/pir/2013/11/uranium-mining-u-s-nuclear-weapons-probram/

[5] Ibid.

[6] Howard Holme, Pre-Trial Statement, Good vs. Church, Church vs. Dow and Rockwell (Civil Actions Nos. 75-M-1111, 75-M-1162, 75-M-1296), U.S. District Court for the District of Colorado, 1978, p. 8

Unacknowledged victims of lethal contaminants released from Rocky Flats live near the site as well as in areas some distance away (see chapter 10). Also unacknowledged are the many that allow such harm to happen. This includes both passive citizens and officials who whitewash the truth about harm to the public. Some of these officials realize that decades of radioactive releases have caused serious damage. But they remain silent and instead speak of "safe levels" of radiation exposure and assure us that there is "no immediate danger." Among officials from the DOE, the EPA and the Colorado Department of Public Health and Environment, fidelity to the party line trumps truth, a point that will be repeatedly referred to in the following pages.

In the past, some supported our nation's nuclear weapons enterprise, in part because of the belief that we needed the Bomb to defeat the Communists, in part to reinforce Rocky Flats as the biggest local employer, and in part because of the mantra that a government industry would never do harm. We may then have been ignorant of the well-established science that any dose of ionizing radiation can cause harm.[7] Proclamations about safe levels of risk are based on official standards whose premise is that low-dose exposures are acceptable. If such assertions are repeated enough, people doubt their own misgivings. The official line prevails, and, at Rocky Flats and elsewhere in the nuclear weapons complex, no actual studies of human health need be undertaken.

Most people do not mean to give themselves over to a deleterious system. Yet those who set standards for permissible exposure, who regulate the industry, who vote in Congress to sustain the nuclear weapons enterprise, or who design and implement the "cleanup" of contaminated sites like Rocky Flats – all these people urge populations to agree that it's acceptable to live in places of questionable safety. Rocky Flats is a striking example of what social theorist Ulrich Beck called a "risk society," a modern form of human organization that makes harm inescapable. Standards for permissible exposure to toxins "may indeed prevent the very worst from happening, but they are at the same time 'blank checks' to poison nature and humankind a bit" – all in the name of safety, security and economy. In Beck's memorable words, "Whoever limits pollution has also concurred in it."[8]

It is crucially important to have a critical history of the Rocky Flats site. All of us, especially those new to the area, need to know this history, not because of the past but because of the future. Familiarity with the story will enable us to understand that contamination rooted in policies and practices of a bygone day is still very much with us. There is a tradition of risk, all encompassing risk, that is inescapable. If you live here for a period and are exposed probably without your knowledge to toxins in the Rocky Flats environment, even if you move far away, the tradition of risk will go with you. It may affect you personally, or it may show up in your offspring.

The first two chapters of this work deal with background information on radiation health effects and the unusual danger of plutonium-239, the primary material used in bomb-making at the plant and the contaminant of principal concern. The very brief third chapter explains that those who picked Rocky Flats as the location for a nuclear bomb plant made a fatal mistake. Chapter 4 deals with the period of public ignorance about Rocky Flats, when the most dangerous fires and accidents occurred at the plant without public knowledge. The dawning of public awareness and the rapid rise of resistance to plant operations is examined in chapter 5. Chapter 6 covers the brief period from the 1989 FBI raid on Rocky Flats to collect evidence of environmental law-breaking at the plant to the

---

[7] Categorically affirmed by the National Academy of Sciences, *Health Risks from Exposure to Low Levels of Ionizing Radiation, BEIR VII* (Biological Effects of Ionizing Radiation), (Washington: National Research Council, 2006). Hereafter referred to as *BEIR VII*. See also *BEIR V* (1999).

[8] Ulrich Beck, *Risk Society: Towards a New Modernity,* translated by Mark Ritter (London: Sage Publications, 1992), p. 64.

1992 change of the plant's mission from production to cleanup. The compromised "cleanup" is covered in chapter 7. Issues of the Rocky Flats National Wildlife Refuge and the Department of Energy's retention of the more contaminated central area of the site are dealt with in chapters 8 and 9. Chapter 10 discusses environmental and public health conditions that give the living a permanent responsibility to future generations; it explores how Nuclear Guardianship enables people to fulfill this responsibility. All looks to the future.

Spokespersons for the government agencies responsible for the inadequate "cleanup" at Rocky Flats regard their work as a model for "cleanup" at other DOE sites, even though Rocky Flats was not cleaned to the maximum extent possible using current technology. It was "cleaned" instead to the level required by law. Those who did the "cleanup" knew they were leaving an uncertain amount of plutonium in the environment on the site. According to the official way of assessing harm, the risk is small. They expect people in the area to accept contaminants left in the soil without complaint. When they say there is no longer any reason to be concerned about the site, they foster denial. Denial is encouraged. It makes risk tolerable. This work is intended to awaken people, to end their denial, to make them aware. Only a people who are aware and informed can protect themselves and others from exposure to toxins in the environment, The stakes are high. Again, all looks to the future.

1. BACKGROUND: RADIATION HEALTH EFFECTS AND EXPOSURE STANDARDS

Introduction: Soon after I learned about Rocky Flats I participated in a seminar on radiation convened by John (Jock) Cobb of the faculty of the University of Colorado medical school. He was a remarkable individual who gave freely of himself and his knowledge to anyone curious about Rocky Flats. In his seminar I was amazed at the technical complexity of radiation. I asked myself: What have you gotten into now? This chapter provides basic information about radiation, its health effects and standards for permissible exposure, information pertinent for everything that follows.

Ionizing radiation, the problem: The radiation encountered at Rocky Flats is ionizing radiation. It can alter the electrical charge of atoms and molecules within cells in the body, creating health problems. Do not confuse it with non-ionizing radiation, like that from a microwave oven or high voltage power lines. When radiation is mentioned in these pages, ionizing radiation is what is meant.

Main types of ionizing radiation: The four main type are distinguished by their penetrating ability, or alternately by the material that blocks them and prevents penetration (see Figure 1.1):

- *Neutron* radiation is the most penetrating of all forms of radiation. Neutrons are emitted in large numbers by nuclear fission or nuclear fusion (the splitting or fusing of atoms).
- *Gamma rays* and *x-rays* are strongly penetrating. They pass through most substances, including the body, but can be stopped by lead. A large dose of either can be harmful, even fatal, because it may kill enough cells to disrupt or destroy one's health. But because it passes through the body, at lower doses it may do little or no harm; it may kill cells directly hit, but they will be discarded. Americium-241, often in the Rocky Flats environment because it is a daughter product of plutonium-241, emits gamma radiation.
- *Beta particles* are less penetrating than gamma rays, more penetrating than alpha particles. A metal shield will prevent beta from penetrating an organism. Tritium is a beta emitter.
- *Alpha particles*, heavier and weaker than other forms of radiation, are the least penetrating. Because they cannot penetrate skin or a sheet of paper, they can be harmful only if inhaled or taken into the body through an open wound. Ingested alpha will likely be excreted. Alpha particles lodged in the body can be far more damaging than other types of radiation, because for as long as they remain in the body, which may be for the remainder of one's life, they continually irradiate surrounding tissue, damaging cells. A concentration of damaged cells may eventually lead to cancer or other ailments. Plutonium-239, the contaminant of principal concern at Rocky Flats, is an alpha emitter, as is radium (which appears in nature).

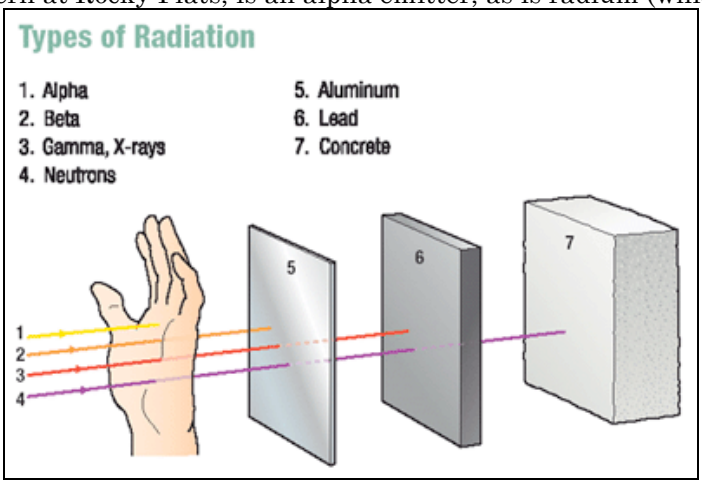


Figure 1.1: Types of radiation and what blocks each type. For example, the alpha radiation emitted by plutonium cannot penetrate human skin. It cannot enter the body from outside it, and it cannot leave the body from within. Image from Nuclear Waste Management Organization.

Isotopes: A given chemical element, such as plutonium, may have several forms, which are called isotopes. All isotopes of the element have an equal number of protons but a different number of neutrons in their nuclei; their chemical properties are identical but they differ in relative atomic mass. A specific isotope is identified by a number after the name, such as uranium-238 or plutonium-239. Since almost all plutonium used to make bombs at Rocky Flats is plutonium-239, when I refer to plutonium in this text the reference is to plutonium-239. When I refer to a different isotope, the number of that particular isotope will appear, an example being "plutonium-238."

Radioactivity and half-life: Radioactive materials are by nature unstable. The nucleus of the material breaks down, or disintegrates, in an attempt to reach a stable or non-radioactive state. As it disintegrates, energy is released in the form of radioactivity, and the material is transformed into other elements. The speed at which this radioactive decay or disintegration occurs is calculated in terms of "half-life." "Half-life" is the time required for a radioactive substance to decay to half its original radioactivity (see Figure 1.2).

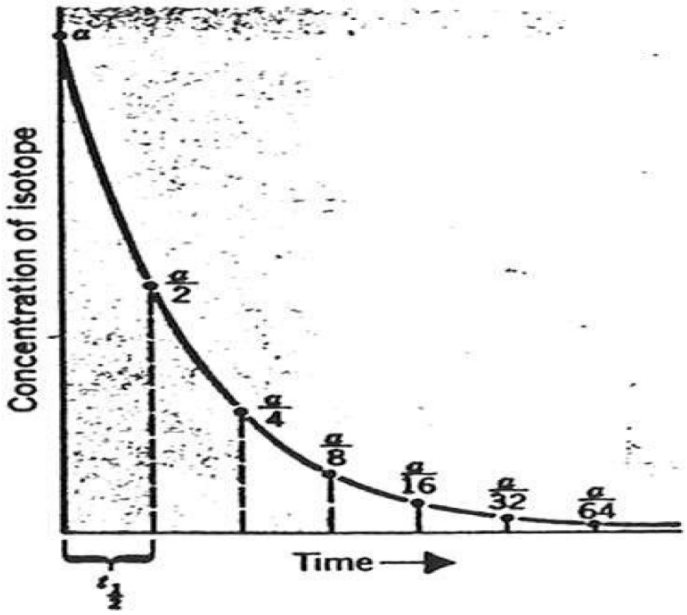


Figure 1.2: Half-life is the time required for a specific radioactive material to become half as radioactive as at the beginning of the period. After passage of a second period of identical length the radioactivity of the material will have decreased by another half. The process continues until no more radiation is being released and the once-radioactive material has become stable. A radioactive material will pass through more than ten half-lives before it is stable or no longer radioactive.

Radionuclides found in nature generally have a very long half-life, and they are still decaying. Uranium-238, a natural element, has a half-life of 4.5 billion years. This means that after 4.5 million years, the uranium will be half as radioactive as it was at the beginning of the period. Plutonium exists in only minuscule amounts in nature; all plutonium at Rocky Flats was produced in reactors. The half-life of plutonium-239 is 24,110 years. After this long the alpha radiation being emitted is half what it was at the beginning. After another 24,110 years the radioactivity is reduced to 1/4; after passage of two half-lives 1/8 is still radioactive. And so on. After 241,100 years – 10 half-lives – the plutonium is still radioactive. It remains radioactive for almost half-a-million years. This is the principal contaminant in the environment on and off the Rocky Flats site.

Terminology for measurement of radiation: Terms used for the measurement of radiation vary, depending on whether one refers to a) the radiation emitted from a radioactive source, b) the radiation absorbed by an exposed person, c) adverse health effects that a person exposed to radiation

may suffer, or d) estimating harm from exposure to different types of radiation.[1] There are two main systems of terminology, the System Internationale (SI) that emerged from the metric system and the conventional system more widely used in the USA. The following provides terms from both.

- **Measuring emitted radiation**: Emitted radiation is measured in terms of its activity (radioactivity) rather than the mass of the emitting material. The activity is the number of disintegrations the material undergoes in a given period of time. The conventional term for measuring this activity for any radioactive material is a **curie (Ci)**, named for Marie Curie. One curie is the amount of any radioactive material that undergoes 37 billion disintegrations per second, which is the intensity of the radioactivity of one gram of radium. There are numerous subdivisions of a curie, such as nanocurie (1/billionth of a curie) and picocurie (1/trillionth of a curie). The SI term is **becquerel (Bq)**. One becquerel is the amount of any radioactive element that undergoes one disintegration per second. Clearly a curie is a large quantity of material, while a becquerel of the same material is a small amount. Regarding plutonium-239, 16.3 grams (0.57 lbs.) produces one curie of radiation. One Bq of plutonium is equal to 27 picocuries (one picocurie = 1/trillionth of a curie, or 0.027 disintegrations per second).
- **Measuring absorbed radiation**: When a person is exposed to radiation, energy is deposited in tissues of the body. The amount of energy deposited per unit of weight of human tissue is called the absorbed dose. Absorbed dose is measured using the conventional term **rad (radiation absorbed dose)** or the SI term **Gray (Gy).** One Gy = 100 rad. Gy is now often used instead of rad.
- **Measuring possible adverse health effects of radiation exposure**: The risk that a person may suffer adverse health effects from radiation exposure is measured using the conventional unit **rem (roentgen equivalent man)** or the SI unit **Sv (sievert).** Roentgen, a German physicist, discovered X-rays. His name was attached to an imprecise unit indicative of radiation health effects, imprecise because radiation health effects cannot be accurately measured; they can at most be estimated.
- **Measuring harm (relative biological effect or RBE) due to different types of radiation**: To account for the large range of uncertainty regarding possible harm from exposure to different types of radiation, specialists use the concept of **relative biological effect (RBE)** or **Quality factor (Q)** – also called the **radiation weighting factor (W_R).** There is a difference between the amount of energy absorbed by the radiated organism (rad) and the damage that may result (rem). To determine a person's biological risk, scientists have assigned a number to each type of ionizing radiation (alpha particles, beta particles, gamma rays, and x-rays) depending on that type's ability to transfer damaging energy to the cells of the body. This number is the RBE or Q. To estimate one's risk in rems, the dose in rads is multiplied by the RBE or Q. Thus, rems = rads x RBE. The RBE for plutonium will be discussed more fully below.

All this is a bit overwhelming. I tell myself not be cowed or discouraged by these terms. Only one constantly immersed in this language is likely to become conversant in its use. I try to use the terms accurately. Generally, I avoid this level of detail unless it is essential. Some of these terms, such as RBE and picocuries, show up in the following pages because they figure prominently in discussions of plutonium at Rocky Flats. They'll be explained.

Standards for permissible exposure to radiation: A U.S. body of technical specialists, now called the National Committee on Radiation Protection and Measurements (NCRP), proposed the first radiation exposure standards in 1934. According to Catherine Caufield, who has examined the history, these first standards "rested on scientifically shaky ground – on studies too short to detect long-term effects; on inadequate samples; on ill defined and inconsistent units of measurement; on untested assumptions" – problems that, she says, have continued to characterize most efforts to set

[1] For clear explanations of these technical topics, see www.rense.com/general93/uner.htm and www.bt.cdc.gov/radiation/measurement.asp

exposure limits.[2] Standards did not become legally binding until 1957, when the Atomic Energy Commission (AEC), which was responsible for both the nuclear weapons and nuclear power programs in the U.S., wanted officially established standards, so they couldn't be changed at the whim of the NCRP.[3] Today the NCRP continues to produce studies on radiation health effects and to make recommendations for exposure standards. The International Commission on Radiological Protection (ICRP) does similar work at the international level. Also working at the global level is the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

A variety of U.S. agencies currently establish and enforce radiation standards. For the nuclear weapons industry, two sets of standards apply, one for employees in the plants and another for the general public. Standards for the latter are enforced by the EPA and state agencies, such as the Colorado Department of Public Health and the Environment (CDPHE). The DOE enforces standards for workers. All these agencies rely on recommendations from NCRP, ICRP and other bodies, such as the National Academy of Sciences (especially its *BEIR* studies [Biological Effect of Ionizing Radiation]).

The following shows how official radiation standards have changed over time·, generally in the direction of being more protective as more is learned about radiation health effects.[4]

Workers	Permitted maximum exposure
1934	30 rem per year
1950	15 rem per year
1956	5 rem per year
1987	1.5 rem per year (adopted for Britain, not the U.S.)
1990	2 rem per year (60% reduction from the 1956 standard, recommended by ICRP but not adopted for U.S. by DOE as of January 2015)
Public	
1949	0.3 rem per year (1% of worker limit)
1953	1.5 rem per year (10% of worker limit)
1956	0.5 rem per year (10% of worker limit)
1990	0.1 rem per year (5% of worker limit; recommended by ICRP and adopted in the U.S.)

The standard for permissible radiation exposure for U.S. nuclear workers (enforced by the DOE and its predecessor agencies) was set at 5 rem per year in 1956. As of March 2015 it has not been changed. In adhering to this standard, DOE rejects ICRP's 1990 recommendation of a 60% reduction from 5 to 2 rem per year. Just how much radioactive substance will result in a 5-rem dose varies drastically. The radiation emitted, the retention time, the material's RBE as well as its tendency to accumulate in certain parts of the body are all important factors.

Controversy: Can "hormesis" save money? In the mid-1990s then-Senator Peter Dominici from New Mexico, a powerful supporter of the nuclear enterprise, wanted proof that exposure to radiation at low doses is not harmful. He evidently believed in "hormesis," the idea that low-dose radiation exposure, far from being harmful, is in fact beneficial – that a little radiation will actually make you healthier. He thought the U.S. was spending too much needlessly protecting people from harmless low-dose exposure and that the cost of the impending cleanup of DOE sites (like Rocky Flats at the time) could be greatly reduced if existing radiation exposure standards were relaxed. Over a period of several years he supported three major efforts that together should achieve what he sought. First,

[2] Caufield, *Multiple Exposures: Chronicles of the Radiation Age* (NY: Harper & Row, 1989), p. 21.
[3] Ibid., p. 73.
[4] Ibid., p. 249.

he asked the Government Accountability Office (GAO) to produce a report on radiation exposure standards, expecting it to demonstrate that present standards should be relaxed. Second, in 1997 he got Congress to create and fund the ten-year DOE Low Dose Radiation Research Program. He believed scientists funded by research grants from the program would show that low-dose radiation exposure is not harmful. Third, he wanted the National Academy of Sciences (NAS) to do another in its series of highly influential *BEIR* (Biological Effects of Ionizing Radiation) studies, this one on low-dose exposure, expecting it to confirm hormesis. Once he had results from these three endeavors, Domenici thought getting current radiation exposure standards relaxed would be simple. His effort was ambitious, but it was also controversial. And in the end he failed.

I played an active role in trying to make sure each of these three endeavors included a broad enough representation of points of view that Domenici's very one-sided approach to radiation standards would not prevail. But there was no way to get the GAO, which produces reports for Congress, to produce a balanced report when it was requested by a prominent senator, so Domenici got from the GAO essentially what he wanted. Actually, the body of their report showed a lack of agreement among radiation health specialists, while its conclusion claimed a consensus for the view that existing standards were overly protective and that relaxing them would do no harm and would save money in cleaning up DOE sites.[5] The report displays a division of consciousness not unusual in official circles, especially regarding protection from radiation exposure – a division between the view that any exposure is harmful and, alternately, that a little exposure can't hurt. Oddly, though the GAO claimed consensus for its conclusion, it provided no references to studies that supposedly supported its view. I asked GAO for a list of the studies they had reviewed. When I finally received a long list I corresponded with key individuals to find out if they really agreed with the GAO "consensus." Across the board, the people I contacted said two things: first, GAO never asked for their views, and, second, they were not part of the GAO "consensus." I later published an article in the *Bulletin of the Atomic Scientists* on the range of efforts to relax radiation exposure standards, including an extensive account of the GAO report. I suggest that people curious about this issue read the article, because it provides a readable primer on the complex issue of setting standards. It is available on line.[6]

Regarding the DOE low-dose research program, I attended a report session in Washington. S Scientists whose research was paid for by DOE grants did not meet Domenici's expectation. Many of them criticized current radiation standards not for being overly protective but for being not protective enough. And of the two dozen or so research projects reported on, the one researcher who sought explicitly to prove hormesis admitted in public that his effort failed.

Finally, the *BEIR* study sought by Domenici was delayed for a couple of years, because the committee named by the NAS to produce the report at first included individuals who favored hormesis or displayed a conflict of interest. Activists, including myself, visited the NAS office in Washington two or three times in our eventually successful effort to persuade NAS officials to remove several biased individuals from the committee and to appoint in their places other more neutral parties. When finally released in 2006 the report, called *BEIR VII*, was a ringing affirmation that any exposure to ionizing radiation is potentially harmful[7] Or, in other words, there is no such thing as a safe dose of ionizing radiation. Official standards for permissible exposure at best limit the radiation to which people can be exposed. They do not guarantee protection. Though *BEIR VII* says that any dose of radiation is potentially harmful, existing standards allow some exposure and thus

---

[5] *Radiation Protection Standards: Scientific Basis Inconclusive* (GAO, 2000).
[6] "Lowering the Bar," *Bulletin of the Atomic Scientists* (May-June 2002), pp. 28-37. On line at http://www.rockyflatsnuclearguardianship.org/wp-content/uploads/2013/07/Lowering-the-Bar_Bulletin-May-02.pdf
[7] National Academy of Sciences, *Health Risks from Exposure to Low Levels of Ionizing Radiation*, *BEIR VII*, (Washington: National Research Council, 2006).

also some harm. This permits a harmful industry to operate. Though official standards do limit risk they also perpetuate and even sponsor it. The permissive nature of this practice at Rocky Flats has given to Denver-area people a tradition of risk. Where there is risk, there will be harm.

Karl Morgan: Which approach to low-dose radiation exposure is most protective? Here I will include one small portion of my above-mentioned article because it makes clear that how you view low-dose radiation exposure affects your whole understanding of radiation and its health effects. In 1943, as part of the Manhattan Project, Karl Z. Morgan accepted the task of determining how much ionizing radiation nuclear weapons workers could be exposed to without danger to their health. He was dubbed the "father of health physics," a wholly new discipline of specialists who knew radiation was dangerous and sought to protect the health of workers. At the time, he said, "We all had, all of us, a serious misconception, in that we adhered universally . . . to the so-called 'threshold hypothesis,' meaning that if a dose were low enough, cell repair would take place . . . and there would be no resultant damage. In other words, we believed there was a safe level of radiation." By 1949, however, "The majority of us realized that there really wasn't a so-called safe level of exposure." Convinced that risk increased in exact proportion to dose, those responsible for radiation safety rejected the threshold model in favor of the "linear no-threshold" or "LNT" hypothesis.

Morgan headed the newly conceived Health Physics Division at the Oak Ridge National Laboratory from its creation in 1943 until his retirement in 1972. He was very influential in both the ICRP and the U.S. NCRP (see pp. 11-12), the principal bodies that study radiation health effects and recommend standards for permissible exposure to radiation. Both bodies adopted the LNT approach for calculating risk, making it the orthodoxy of the nuclear establishment. It simplifies the range of exceedingly diverse and complex data regarding radiation effects long-term malignancy, in utero processes, effects among different sub-populations, genetic change, repair actions, and so on. The LNT approach was first applied to radiation exposure standards as a result of Hermann Muller's discovery in the 1920s of genetic mutations in fruit flies exposed to radiation, work for which he received the 1946 Nobel Prize in medicine.

Morgan eventually rejected the LNT in favor of the more stringent "supralinear" approach, because he had become convinced that it "fits the data more appropriately." He explained: "Down at the very low doses you actually get more cancers per person-rem than you do at the high doses. Now, I'm not saying that you get more cancers at these low doses than at high doses. I'm saying that damage per unit dose is greater at these levels. And that's true in part because the high levels will more often kill cells outright, whereas low levels of exposure tend to injure cells rather than kill them, and it is the surviving, injured cells that are the cause for concern." Over time, a damaged cell may become cancerous: "It divides, it divides again and again, and, on the average, if it's leading to a solid tumor, after 30 years it will be large enough that it will be recognized as a malignancy"[8] (see Figure 1.3).

Morgan understood that if low-dose exposure was more dangerous than previously realized, more stringent protective measures were needed. But once he rejected the LNT orthodoxy in favor of the supralinear approach, he had moved beyond the establishment paradigm, and the industry ostracized him. Recognized as the "father of health physics" until his death in 1999 he led an active campaign against exposure to low-dose radiation, testifying as an expert witness in various lawsuits, helping win key cases. One case he deemed significant, *Silkwood v. Kerr-McGee Corporation* in 1979, about the death of Karen Silkwood, showed that "there is no such thing as a 'safe dose' of radiation."[9]

---

[8] Morgan, quoted in Robert Del Tredici, *At Work in the Fields of the Bomb* (NY: Harper & Row, 1987), pp. 133–34.

[9] Karl Z. Morgan and Ken M. Peterson, *The Angry Genie: One Man's Walk through the Nuclear Age* (Norman: University of Oklahoma Press, 1999), p. 145.

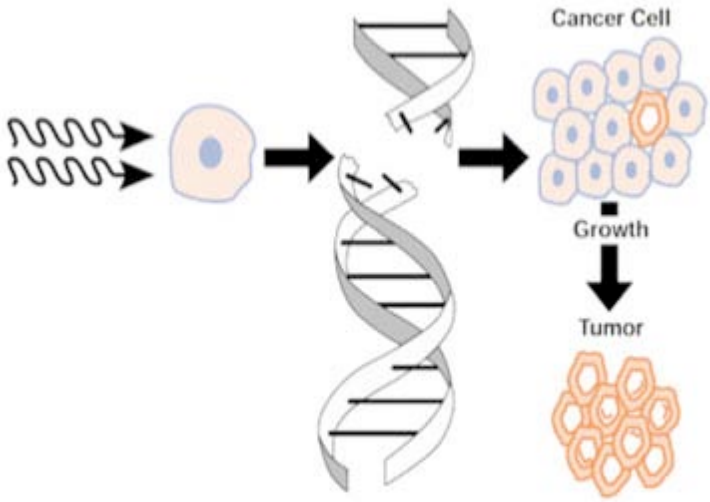


Figure 1. Development of cancer from mutation produced by ionizing radiation.

Figure 1.3: Low-dose Radiation Exposure and Cancer. This image shows what Morgan described, that a low dose of radiation attacks cells in the body, severing the DNA and resulting in a damaged cell that over time is multiplied until there are enough damaged cells to form a cancerous tumor. A higher dose of radiation would kill cells rather than damaging them, and it is replication of damaged cells that leads to a cancer.

The favored *Linear No-Threshold (LNT)* approach of the nuclear establishment, with its recognition that any exposure to radiation is potentially harmful, is a middling way between the *threshold* view that there is a level of exposure below which harm does not occur and the *supralinear* view that low dose radiation is more harmful per unit dose than higher levels of exposure. *Hormesis*, a close cousin of the threshold view, assumes that a little radiation below the threshold is good for you. Each of these views has supporters. The key question is what is best for the public health, including offspring and future generations. The answer is simple: That is best which is most protective. Obviously, this is the supralinear approach, with its recognition that any exposure can be harmful and its concern to protect people from harmful effects from low-dose exposure. If people are protected at this level, they are protected at all levels of exposure (see Figure 1.4)

The "Petkau Effect," another way of explaining greater harm from very low-dose exposure: In 1972 Canadian researcher Abram Petkau showed that repeated exposure to very low doses of radiation wreaks far more harm than one-time exposure to higher doses allowed by official standards. Karl Morgan explained that cancer could result from low doses injuring rather than killing cells. Petkau gave another explanation, namely, that prolonged low-dose exposure destroys the protective membrane of cells, producing multitudes of "free radicals" that themselves create havoc among cells, destroying health in the process. His explanation is called "Petkau effect."[10]

[10] Ralph Graeub, *The Petkau Effect: The Devastating Effect of Nuclear Radiation on Human Health and the Environment* (NY: Four Walls Eight Windows, 1994). See also http://www.nuclearreader.info/chapter3.html

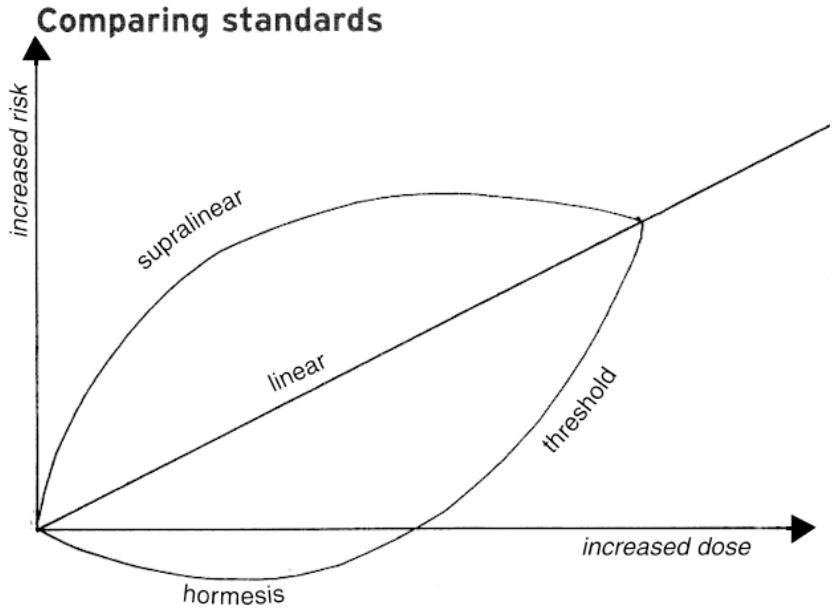


Figure 1.4: Approaches to Radiation Protection. This diagram shows the major approaches to understanding the relation between dose and risk of harm. A) The *linear* approach, favored within the nuclear establishment, assumes an equivalence between dose and health effect. B) The *threshold* approach assumes there is a level of exposure below which harm will not occur; harm begins at the threshold and increases as the dose increases. C) *Hormesis* is a threshold approach with the addition that exposure below the threshold has a beneficial effect. D) The *supralinear* approach assumes that very low-dose exposure is more harmful per unit dose than higher levels of exposure.

Affected populations excluded from the standard-setting process: Nuclear workers and people who live or work in the vicinity of a nuclear plant are excluded from the task of setting standards for radiation exposure likely to affect them. All such standards are developed by a self-selected scientific elite without any direct input from affected populations, much less their consent. When I was serving on an NCRP committee, two colleagues and I urged the NCRP at their 2004 annual meeting in Washington to include affected parties in the task of studying radiation health effects and setting standards.[11] They rejected our appeal. In the realm of standards for permissible exposure to radiation, the earthly fate of people continues to be decided not by those affected but by a group that functions like a self-appointed medieval priesthood.[12]

Protecting those who least need to be protected: The whole edifice of standards for permissible exposure to radiation rests on the dubious foundation of cancer incidence among survivors of the Hiroshima and Nagasaki bombings. There are several problems with relying on this data. First, the data used in the study was compiled not immediately after the bombing but five years later. Second, U.S. medical personnel who were part of the military occupiers from the country that had dropped the bombs did the initial work; only later were Japanese specialists directly involved. Third, the data is full of uncertainty because much of it relies on interviews of survivors rather than direct medical observation; also, by the time interviews were first done many survivors had died. Fourth, exposure from the bombs was mainly to external gamma rays rather then the far more dangerous internal alpha particles (see p. 9); to this day, standards for internal radiation are not based directly on data from alpha exposure but are extrapolated from standards set for external

[11] Lisa Ledwidge, LeRoy Moore and Lisa Crawford, "Stakeholder Perspectives on Radiation Protection," *Health Physics*, vol. 87, no. 3 (Sept. 2004).
[12] See Rosalie Bertell,"Critique of ICRP structure and membership" (1993), http://www.ratical.org/radiation/inetSeries/wwc2_10.txt

radiation exposure. Finally, perhaps most important, survivors, whose data provides the foundation for the study, belong to the strongest, healthiest, most robust part of the population; those who died first from the exposure included the ill, the old, the very young and those with a genetic susceptibility. Basing exposure standards on what happens to survivors protects the strong more than the weak.[13] A better foundation for setting standards would be data on nuclear workers.[14]

Protecting "reference man": Existing radiation standards, including those applicable for the Rocky Flats "cleanup," were calculated to protect "reference man," that is, a Caucasian male age 20 to 30, 5 feet 7 inches tall, weighing about 154 pounds and living in a moderate climate.[15] Clearly, protecting "reference man" does not protect the most vulnerable.

Women and infants, the most vulnerable, the least protected: Standards for radiation exposure ignore the disproportionately greater harm to both women and infants. Mary Olson, who has written an essay that highlights this issue, points out that the *BEIR VII* study of 2006 recognized the problem but did not highlight it.[16]

Scientific uncertainty: A National Academy of Sciences report in December 2008 harshly criticized the EPA for the way it deals with scientific uncertainty in calculating risk. Too often the EPA treats uncertainty as indicating a problem that can be ignored rather than dealt with. "There's almost an incentive to having scientific uncertainty," observed one scientist.[17] Too little is known, the report says, about variability in human susceptibility as well as cumulative effects of exposure to radioactive and chemical toxins in combination. The report calls for greater transparency and stakeholder involvement in the risk assessment process.[18] Because cleanup standards for Rocky Flats were established with the public playing more a spectator role than the role of genuine participants, affected populations near Rocky Flats must live with the results of approaches the scientific establishment now criticizes. For more details on this, see chapter 7.

Genetic specialist warns about the long-term effect of radiation exposure: Herman Muller received the 1946 Nobel Prize in medicine for his discovery of genetic mutations in fruit flies exposed to radiation. Toward the end of his life he published an article on the genetic effect to humans of radiation exposure. Though birth defects may occur, far more serious is the cumulative effect "over a virtually unlimited period." The damaged gene will "be passed along in inheritance . . . before it happens to turn the scales against the individual carrying it. When it does so, it will cause the extinction of its own line of descent," because some person in the chain of the harmed gene burden will lose the ability to reproduce, resulting in "genetic death . . . The losses are spread out over centuries, even millennia, with only a few thousand genetic deaths resulting from them in any one generation." The total damage to posterity will be massive. "Therefore the hereditary damage should be the chief touchstone in the setting of 'permissible' or 'acceptable' dose limits . . . We must learn, through experience, to tackle our problems of today that affect tomorrow in a truly responsible way –

---

[13] David Richardson, "Lessons from Hiroshima and Nagasaki: The most exposed and most vulnerable," *Bulletin of the Atomic Scientists*, vol. 68, no. 3 (May-June 2012), pp. 29-35. http://bos.sagepub.com/content/68/3/10.full.pdf+html

[14] Steve Wing, David Richardson and Alice Stewart, "The Relevance of Occupational Epidemiology to Radiation Protection Standards," *New Solutions*, vol. 9, no. 2 (1999).

[15] Arjun Makhijani et al., "Healthy from the Start," *Science for Democratic Action*, vol. 14, no.4 (Feb. 2007). http://ieer.org/projects/healthy-from-the-start/

[16] Mary Olson, "Atomic radiation is more harmful to women," Nuclear Information and Resource Service, October 2011. http://www.nirs.org/radiation/radhealth/radiationwomen.pdf

[17] Cornelia Dean, "Panel Seeks Changes in EPA Reviews," *New York Times*, December 3, 2008.

[18] Board on Environmental Studies and Toxicology, National Academy of Sciences, *Science and Decisions: Advancing Risk Assessment* (Washington, DC: National Research Council, 2008). See http://www.nap.edu/catalog.php?record_id=12209.

one that our successors will thank us for."[19]

"Genetic uncertainty problem" for wildlife: Reminiscent of Muller, genetic specialist Diethard Tautz says that effects of radiation exposure on a given species of wildlife may not be readily apparent in the individuals of that species until the passage of several generations. He calls this a "genetic uncertainty problem."[20] His work suggests that wildlife at Rocky Flats could in the long term be hurt by conditions at the site. Such harm would not be confined to the site. Some observers have taken a very sanguine approach to reports that plutonium has been found in the bodies of deer killed near Rocky Flats. Ecologist K. Shawn Smallwood, who in 1996 studied wildlife at Rocky Flats, "found it remarkable that no genetic studies" had been done there or at other nuclear sites.[21]

Concerns to remember regarding radiation exposure standards:

- Don't deny the adverse effect of radiation exposure because you can't see, feel, hear, taste, or smell radioactivity.
- Remember that "there is no way of inactivating radioactivity or shortening its active period. There is no practical method of preventing its spread in the atmosphere . . . once it has escaped from containment."[22]
- Ask regarding "permissible" radiation exposure standards, who gives permission?
- Remember that the government and industry brought radiation to you, not the reverse. The people are not the source of such exposure.
- Remember that the only justification for standards for radiation exposure is to protect you and others, secondarily to protect the industry.
- Do what you can to protect the most vulnerable from the lowest exposure to human-produced radiation; doing this protects all.

Radiation standards: A prediction

Standards for permissible exposure
to radiation
fail to protect sufficiently.
They are a dam that holds back
a flood of illness and death
but lets pass
an "insignificant" trickle
of the diseased and damned.
These standards are a damn dam
that lets a harmful enterprise thrive.
Today's trickle is a warning:
In time, the dam will break
in a flood of illness and death.

---

[19] Herman J. Muller, "Radiation and Heredity," *American Journal of Public Health Nations Health*, vol. 54, January 1964. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1254569/?page=9
[20] Tautz, "Genetic Uncertainty Problem," *Trends in Genetics*, vol. 16, November 2000, pp. 475-477.
[21] Smallwood et al., "Animal Burrowing Attributes Affecting Hazardous Waste Management," *Environmental Management*, vol. 22, no. 6, 1998, p. 834.
[22] John F. Loutit, *Irradiation of Mice and Men* (Chicago: University of Chicago Press, 1967), p. vii.

2. THE PECULIAR DANGER OF PLUTONIUM

Toxic: Physicist Glenn T. Seaborg at the University of California in Berkeley discovered plutonium in 1940. He called it "fiendishly toxic, even in small amounts."[23] The fact that plutonium could fission (its atoms would divide) and also had a long half-life, made it suitable for building bombs. Plutonium is exceedingly rare in nature. In 1956 a small quantity that was the byproduct of the natural fissioning of uranium was discovered in the central African state of Gabon. The plutonium used at Rocky Flats was produced in reactors at either DOE's Hanford facility in Washington State or its Savannah River Site in South Carolina. We humans have brought large quantities of plutonium into the world and we are now responsible for it.

Long-term danger: Plutonium-239, the principal material used at Rocky Flats to produce the fissile "pit" (actually a bomb) at the core of nuclear warheads, has a half-life of 24,110 years. Physicist Fritjof Capra of the University of California in Berkeley says this material should be isolated from the environment for half-a-million years (see Figure 2.1). At Rocky Flats plutonium was not isolated from the environment but was repeatedly deposited there. Those responsible for the Superfund "cleanup" knowingly left behind an unknown amount, the main source of problems today. Tiny particles left in the environment make Rocky Flats a local hazard forever.

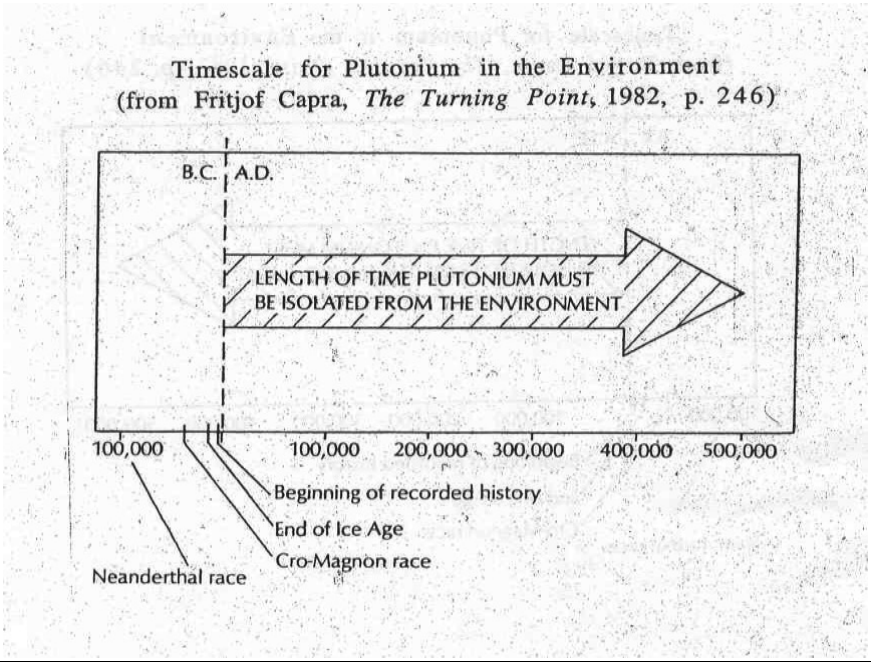


Figure 2.1: Fritjof Capra's timescale for plutonium in the environment. His diagram provides a look at the nuclear age and plutonium in relation to time.

Potentially lethal if internalized: The alpha radiation emitted by plutonium cannot penetrate skin like x-rays or gamma radiation (see p. 9). But tiny particles inhaled, ingested, or taken into the body through an open wound may lodge in the lungs, liver, surface or marrow of bone, the gonads or elsewhere. For as long as plutonium resides in the body it continually bombards the immediately surrounding tissue with radiation, typically for the rest of one's life (see Figure 2.2). The result may be cancer, genetic harm, or a compromised immune system, making one vulnerable to other illnesses. The latent period for cancer is likely to be 20 to 30 years.

[23] Jeremy Bernstein, *Plutonium* (2007), p. 105.

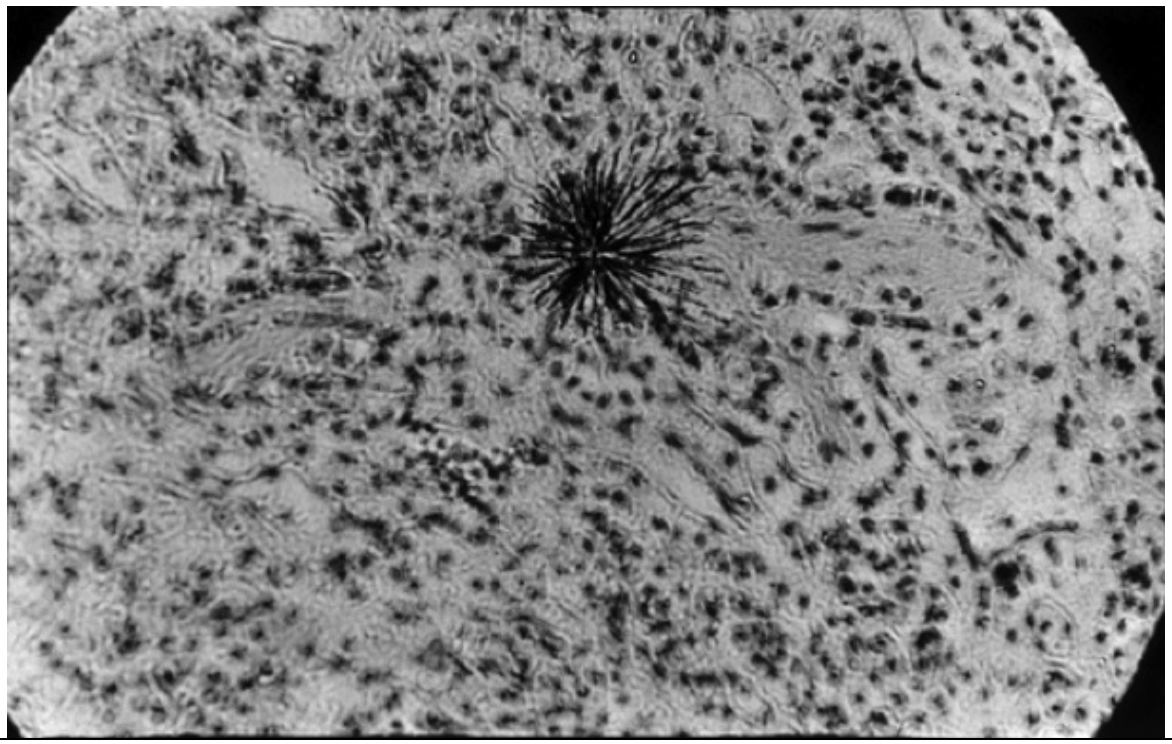


Figure 2.2: Plutonium in lung. "The black star in the middle of this picture shows the tracks made by alpha rays emitted from a particle of plutonium-239 in the lung tissue of an ape. The alpha rays do not travel very far, but once inside the body, they can penetrate more than 10,000 cells within their range. This set of alpha tracks (magnified 500 times) occurred over a 48-hour period."[24]

Hazardous in very small amounts: Plutonium particles of 10 or less microns can be inhaled. The average diameter of human hair is about 50 microns. Meteorologist W. Gale Biggs concluded that most airborne particles at Rocky Flats were probably smaller than 0.01 microns.[25] Particles too small to see are not too small to do harm.

More harmful than other forms of radiation: Plutonium's RBE: Exposure to internal alpha emitters like plutonium is much more harmful than exposure to an equivalent dose from penetrating gamma or x-ray radiation. In an attempt to account for the difference, those who set standards for permissible exposure refer to the "relative biological effect" (RBE) – or "weighting factor" – for alpha emitters (see p. 11). Plutonium's RBE is important for two reasons. First, plutonium is harmful only if taken inside the body, but once lodged there it continually irradiates nearby tissue, probably for the rest of one's life, making it far more dangerous than larger doses of radiation that enter the body and pass through. Second, plutonium's tendency to concentrate in certain organs (predominantly lung, bone and liver) and then to cluster within these organs makes it far more damaging than if it were evenly distributed throughout an organ. It sometimes concentrates in the brain or the gonads. In the gonads, it may affect offspring, as reported by Muller (see pp. 17-18). There are no known circumstances in which plutonium is distributed uniformly in a particular organ or throughout the body (see Figures 2.3 and 2.4).

[24] Robert Del Tredici, *At Work in the Fields of the Bomb* (NY: Harper & Row, 1987), plate 39.
[25] Biggs, "Airborne Emissions and Monitoring of Plutonium from Rocky Flats," March 17, 2011 http://www.rockyflatsnuclearguardianship.org/#!academic-information/zoom/c1arf/image_17gh

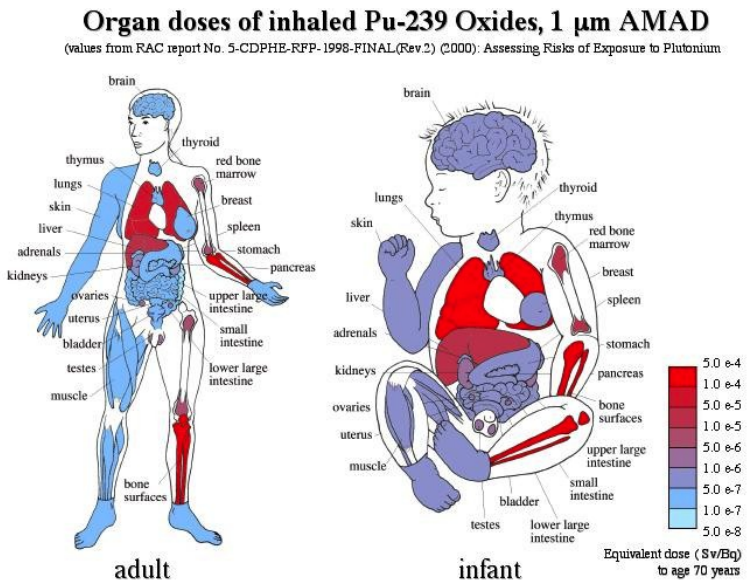


Figure 2.3: Where plutonium is likely to settle in the body if inhaled.

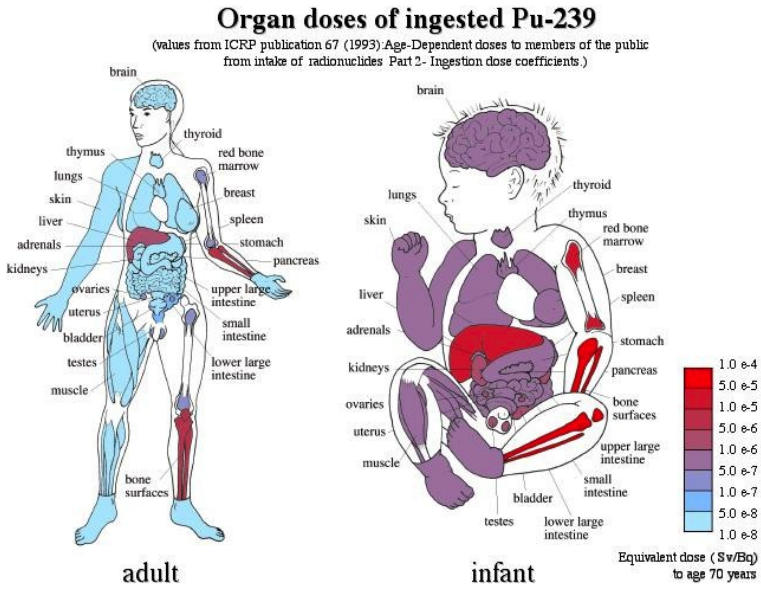


Figure 2.4: Where plutonium may settle in the body if ingested. If ingested, the plutonium is likely to be excreted and thus to be far less harmful than inhaled plutonium.

Though the ICRP said in 1980 that the RBE for plutonium should be 85,[26] to calculate radiation exposure standards it uses 20 as the plutonium RBE, because 20 is the average RBE. This means that those doing calculations to set radiation exposure standards assume the damage caused

[26] ICRP, *Biological Effects of Inhaled Radionuclides, Publication No. 31* (Oxford, England: Permagon Press, 1980).

by plutonium exposure is 20 times as severe as the damage caused by external exposure to uranium, a radionuclide where rads equals rems and the RBE is 0. This averaging approach disregards the harm that may result from plutonium exposure to certain organs of the body or to given individuals; it does not protect the most vulnerable members of the population. For example, a 1979 study concluded that for chromosomal (genetic) changes induced by plutonium exposure, the RBE should be 278.[27] And the RBE for bone cancer ranges as high as 320.[28] The agencies responsible for the Rocky Flats "cleanup" followed the ICRP in using an RBE of 20 to establish the radiation exposure standards for the cleanup. The averaging approach customarily employed by those who set exposure standards disregards the enormous variations in human susceptibility. Further, British researchers concluded in 1997 that the RBE for genetic effects from plutonium exposure is essentially "infinite," because the extent of potential harm to the gene pool is incalculable.[29] This review shows that the prevailing way of using the average RBE for plutonium in setting standards for permissible exposure fails by design to protect the most vulnerable. Look again at the dire predictions of Herman Muller, foremost student of genetic effects of exposure to ionizing radiation (see pp. 17-18).

Harm from a single particle: Tom K. Hei and colleagues at Columbia University demonstrated that a single plutonium alpha particle induces mutations in mammal cells. Cells receiving very low doses were more likely to be damaged than destroyed. Replication of these damaged cells constitutes genetic harm, and more such harm per unit dose occurs at very low doses than would occur with higher dose exposures. "These data provide direct evidence that a single alpha particle traversing a nucleus will have a high probability of resulting in a mutation and highlight the need for radiation protection at low doses." In a follow-up study, they found that "a single alpha particle can induce mutations and chromosome aberrations in [adjacent or bystander] cells that received no direct radiation exposure to their DNA"[30] – that is, cells not directly hit by radiation but harmed anyway.

Hot particles: The previous paragraph deals with what others call a "hot particle," that is, a tiny (10 or less microns) particle of plutonium or other alpha emitter that is highly radioactive and can be inhaled or otherwise internalized. Lodged within the body, it constantly irradiates a small area of nearby tissue for an indeterminate period, very likely for all of one's life after the initial exposure. As noted above (pp. 16-17), official radiation protection standards are based on external radiation that hits the whole body once, distributes radiation more or less evenly and is then gone. A hot particle, even one giving off much less radiation, can be far more harmful because of its concentrated irradiation of a small area long-term. The concept, while demonstrated often, is controversial. Efforts to get hot particles considered in establishment of radiation exposure standards have not succeeded.[31]

Excess cancers among Rocky Flats workers exposed to purportedly safe levels: In 1987 Gregg S. Wilkinson of DOE's Los Alamos Lab published results of his study showing that some exposed Rocky Flats workers with internal plutonium deposits as low as 5% of DOE's purportedly safe permissible lifetime body burden developed a variety of cancers in excess of what was normal for

---

[27] R. J. DuFrain et al., "Human Cyclogenetic Dosimetry: A Dose-Response Relationship for Alpha Particle Radiation from 241 Am," *Health Physics*, vol . 37 (1979), pp. 279-289.
[28] Helen A. Grogan et al, *Assessing Risk of Exposure to Plutonium* (Risk Assessment Corp., Feb. 2000), pp. 6.27-6.39.
[29] M. A. Khadim et al, *Nature*, vol. 355, no. 20 (Feb. 1992), pp. 738-740.
[30] Hei et al., *Proceedings of the National Academy of Sciences*, vol. 94 (Apr. 1997), pp. 3765-3770; and vol. 98 (4 Dec. 2001), pp. 14410-14415. They reinforced what Karl Morgan had said (see above, p. 14).
[31] Thomas B. Cochran and Arthur R. Tamplin, *Radiation Standards for Hot Particles: A Report on the Inadequacy of Existing Radiation Protection Standards Related to Internal Exposure of Man to Insoluble Particles of Plutonium and Other Alpha-Emitting Hot Particles* (Washington, DC: Natural Resources Defense Council, February 14, 1974). For this and other writings on hot particles, see http://www.nrdc.org/nuclear/cochran/cochranpubs.asp

workers who had not been exposed.[32] Prior to publication, Wilkinson was told to change his results "to please the customer," that is, the DOE. When he published his findings without change he was isolated, deprived of work and soon forced out of his job. I have yet to meet a Rocky Flats worker familiar with thus study. Officials at the plant did not inform the workers, though the study was about them. For a fuller account of his work and the treatment he received, see Appendix C.

The entire Rocky Flats site contaminated: Historically, while some areas at Rocky Flats were more heavily contaminated than others, plutonium particles released in fires, accidents, and routine operations were laid down across the whole of the site. Soil sampling done at predominantly upwind locations by Harvey Nichols, retired biology professor of the University of Colorado,[33] supports this conclusion. His work will be discussed in more detail later.

Inadequacy of the Rocky Flats cleanup: Plutonium left in the Rocky Flats environment is in the form of very fine particles that can be inhaled. The government agencies responsible for the cleanup made no effort to clean the site to the maximum extent possible. They knowingly left an unknown quantity of plutonium in the environment. There is no guarantee that plutonium left behind will remain safely in place or even on the site. This topic will be addressed more fully in chapter 7.

Concluding words about plutonium: The trouble with plutonium begins if it enters one's body, most likely by inhalation. You probably won't know it happened. But if you get a bit of plutonium inside – not much, just a bit – you may be forever changed, no longer the person you were, because now you're being constantly irradiated somewhere in the recesses of your being – in one of your lungs, in the marrow of a bone or on its surface, in your liver, maybe even in your brain or gonads. It's working on you, and you're not the same. The plutonium is dangerous not briefly, not for a few weeks or a number of years, but for the rest of your life and perhaps in your offspring. Your health may later be ruined. Future generations may be affected. We humans have brought this about.

The DOE, the EPA, the CDPHE – they and all the corporations that ever operated the Rocky Flats plant – tell us: It's OK. They're infected with the twin conceits of denial and risk – risk from a teasing permissible exposure, and denial backed by a pile of reports and records.

[32] Wilkinson et al., "Mortality among Plutonium and Other Radiation Workers at a Plutonium Weapons Facility," *American Journal of Epidemiology* (1987), vol. 125, no. 2, pp. 231-250.
[33] http://wwwrockyflatsnuclearguardianship.org/#!presentation-by-harvey-nichols/c1m2k

3. Fateful Mistake: Locating a Nuclear Bomb Plant at Rocky Flats

After the end of World War II and, as a crucial step in beginning the Cold War, President Harry Truman decided that the U.S. would mass-produce nuclear weapons. Manhattan Project veteran Danish physicist Niels Bohr said that doing this would require turning the whole country into one vast factory. This is exactly what happened. Rocky Flats, to be located 16 miles northwest of central Denver (see Figure 3.1), would be one of a dozen large plants deployed across the country, each focused on producing either material for the bomb or specific parts.

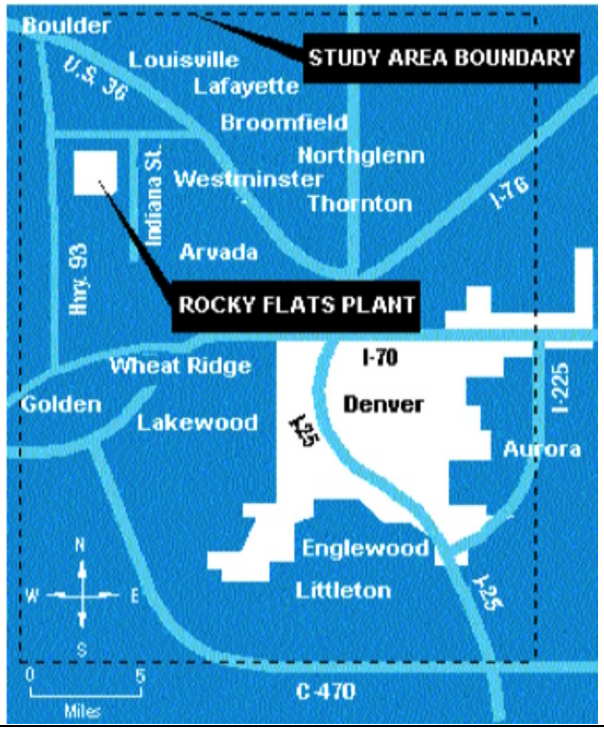


Figure 3.1: Location of the Rocky Flats plant. From *Summary of Findings: Historical Pubic Exposure Studies on Rocky Flats*, Colorado Department of Public Health and Environment (August 1999). Plutonium released from Rocky Flats was carried by the wind well beyond the "study area" outlined on this map.

The Atomic Energy Commission (AEC), predecessor to the Department of Energy (DOE), assigned Cleveland-based Austin Company the task of choosing a site for "Project Apple" (AEC's name for what became the Rocky Flats plant).[34] The selection process included only negligible study of dangers at the Rocky Flats site, nothing, for instance, about earthquake danger. Austin's crucial mistake was to locate the plant where it should never have been located, a blunder that would prove fateful for the public. The company took wind readings not at Rocky Flats but 20 miles away on the east side of Denver at the now closed Stapleton Airport, where prevailing winds are from the south. By contrast, at Rocky Flats prevailing winds blow steadily, sometimes severely, from the mountains toward the east and southeast, across the suburbs of Arvada, Westminster, Broomfield and others toward central Denver (see Figure 3.2). Seasonal Chinook winds, clocked in excess of 140 mph, are

[34] For more detail on Project Apple and the decision to locate the plant at Rocky Flats, see Len Ackland, *Making a Real Killing: Rocky Flats and the Nuclear West* (Albuquerque: University of New Mexico Press, 1999), chap. 3; *Citizen's Guide to Rocky Flats* (1992), p. 3, on line at http://www.rockyflatsnuclearguardianship.org/#!citizens-guide-to-rocky-flats/c1hm8; and Kristen Iversen, *Full Body Burden: Growing Up in the Nuclear Shadow of Rocky Flats* (New York: Crown Publishing Group, 2012), pp. 4-8.

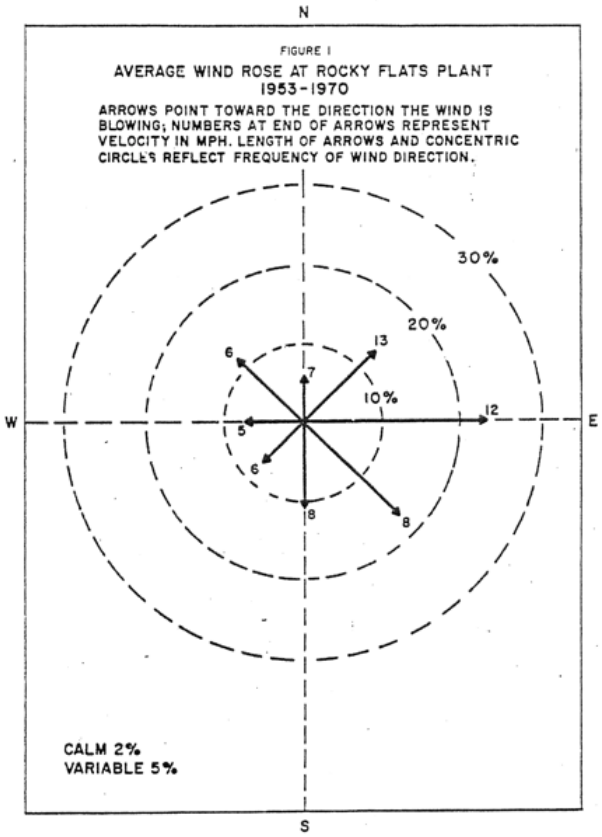


Figure 3.2: Wind Rose at the Rocky Flats plant, showing force and direction of the wind that at the site blows half of the time toward the east, southeast, and northeast. Strongest winds are also in these directions. From P. W. Krey and E. P. Hardy, "Plutonium in Soil Around the Rocky Flats Plant," HASL 235 Report (NY: AEC Health and Safety Laboratory, 1970), p. 5.

known to snap telephone poles and overturn vehicles in the Rocky Flats area (see Figure 3.3). With Rocky Flats as the site, radioactive contaminants released from the plant, most notably plutonium, would be distributed by the wind across heavily populated parts of the Denver metro area.

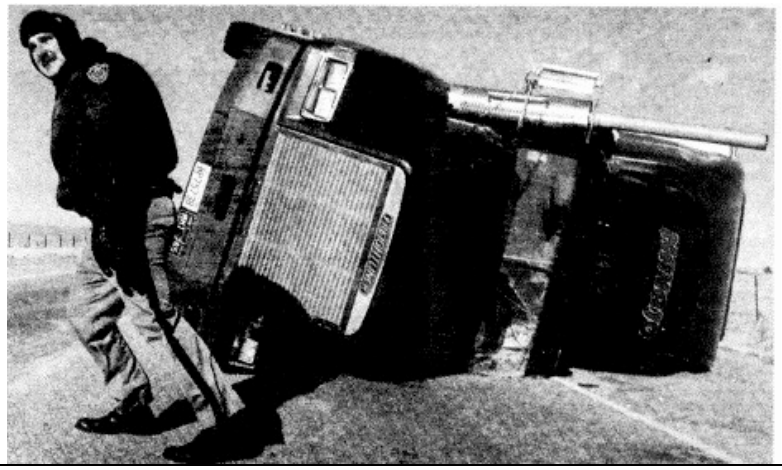


Figure 3.3: A windy day along Colo. Hwy. 93 near the West Gate (main entrance) of Rocky Flats, December 14, 1990. Photo by Jay Koetzer, *Rocky Mountain News*.

4. UNIMPEDED AND UNWATCHED OPERATIONS AT ROCKY FLATS (1952-1970)

This chapter is concerned with the first 18 years of operations at Rocky Flats, a period distinguished by the fact that the public was little aware of what was done at Rocky Flats and thus was almost wholly devoid of curiosity about the place. Also, there was no regulation; the AEC regulated itself. Activities at the plant therefore were, as the chapter title says, "unimpeded and unwatched." Francis "Heinie" Langell, manager of Rocky Flats for Dow Chemical from 1951 when construction began at the site until he retired in 1961, spoke in 1992 of early days at the plant. Reporters and the public, he recalled, "didn't bother us. They didn't try to jump the fence and see what was inside. . . . They didn't try to get us to talk about things we weren't supposed to. . . . They cooperated beautifully with us."[1]

Principal product of Rocky Flats: The plant began operations in 1952 as the government's only site for the production of fissile plutonium components for nuclear weapons. Though the bombs were originally made mainly of enriched uranium, plutonium use increased. By 1960 Rocky Flats was making only plutonium "pits," the hollow plutonium sphere that forms the explosive core of a nuclear warhead (see Figure 4.1) . The plant also reprocessed plutonium that had been recovered either from scrap or from returned pits. Rocky Flats also made non-nuclear bomb parts from beryllium, stainless steel and depleted uranium. Numerous potentially toxic materials were used at the site.[2]

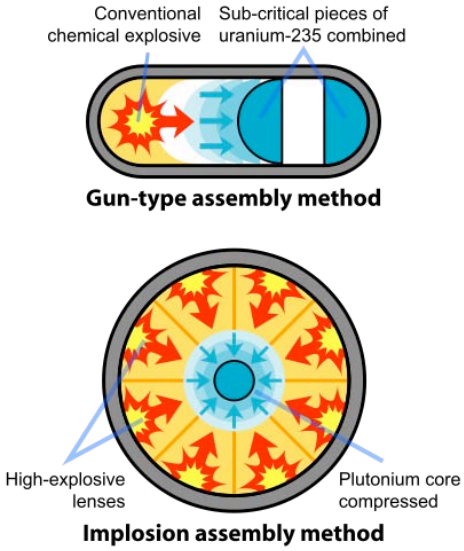


Figure 4.1: Two types of atom bombs. The bomb used against Hiroshima on August 6, 1945, was a uranium gun-type bomb in which a mass of sub-critical uranium-235 (blue mass on left) was fired into another like mass (blue mass on right), causing the uranium to fission or go critical. The bomb used against Nagasaki on August 9, 1945, was an implosion-type bomb in which conventional explosive imploded a sphere of plutonium (blue) causing it to fission or go critical. Plutonium bombs were more efficient, in that they could produce a bigger bang with less material. Each plutonium pit was in fact an atom bomb. Image from Wikimedia Commons.

The contaminant of principal concern at the site, both now and for the long-term future, is plutonium. Most plutonium at Rocky Flats is plutonium-239, the form or "isotope" used in weapons.

---

[1] Julie Hutchinson, "Early Manager Reflects Workers' Loyalty," *Boulder Daily Camera*, February 2, 1992.

[2] ChemRisk, Task 2 Report: Selection of the Chemicals and Radionuclides of Concern (CDH, June 1991).

Considerable quantities of this highly toxic material were released into the environment as minute particles. An unknown quantity remains in the soil. In this paper plutonium-239 is referred to simply as plutonium. And plutonium is the principal focus.

In its 37 years of production the plant produced about 70,000 plutonium pits, each in fact being an atomic bomb like the plutonium bomb that destroyed Nagasaki on August 9, 1945 (see **Figures 4.2 and 4.3).** Many of the pits made at Rocky Flats were "triggers" for thermonuclear or

Figure 4.2: Nagasaki, Japan, before it was destroyed with a U.S. atomic bomb on August 9, 1945.

Figure 4.3: Nagasaki after it was bombed with one plutonium bomb on August 9, 1945.

hydrogen bombs. An H-bomb undergoes a series of three explosions. First, a conventional explosion implodes the plutonium sphere until its atoms fission (second explosion), raising the temperature to equal the sun's surface, triggering the fusion of hydrogen atoms (third explosion). The fusion explosion of hydrogen atoms is far more powerful than the fission explosion of an atom bomb. Even

today (August 2015), the pit in every warhead in the U.S. arsenal, except for no more than 30 produced at Los Alamos, was made at Rocky Flats.

A self-regulating entity: From the beginning the nuclear weapons industry has been self-regulating. The primary difference between the Manhattan Project of World War II and the post-war nuclear weapons industry in the U.S. was the shift of control from the U.S. Army to a civilian agency, the Atomic Energy Commission (AEC). The Atomic Energy Act, enacted in 1946, ensured that no other government agency could interfere with this industry. The Environmental Protection Agency did not then exist, and no agency of state governments where nuclear weapons plants were located had any say over activities at such plants. In Colorado, the Colorado Department of Health (CDH) was, as will be shown below, sometimes aware of misdeeds and problems at Rocky Flats, but it had absolutely no jurisdiction over anything that happened there, including issues of public health. CDH officials generally remained quiet about the plant, even when they knew about likely harm to the public. One of the realities of Rocky Flats history is the gradual, if stormy, growth, first, of questions from the public, the media, and outside agencies, and, later, of external regulatory authority, mainly on toxins and public health. This change accompanied the public awareness and resistance that occurred after 1970, the topic of chapter 5.

Plutonium is handled in "gloveboxes": Special precautions were taken to protect plutonium workers at the plant. They worked with plutonium in "gloveboxes," that is, in large cabinets with portholes for viewing the material inside the box from the outside. To work with material inside the box a worker inserted his or her hands into lead lined gloves that protruded into the box. The gloves protected the worker from exposure. Because plutonium is pyrophoric – that is, capable of spontaneous combustion if exposed to oxygen – the gloveboxes are oxygen-free and filled mainly with nitrogen. All workers who processed plutonium worked at gloveboxes. (See Figures 4.4 and 4.5)

Figure 4.4: Worker on the outside of a glovebox looking in where, with his hands inserted in lead-lined gloves, he holds a plutonium "puck" that will be shaped into a pit.

Figure 4.5: Workers at a line of gloveboxes. Plutonium is moved from box to box along an assembly line.

Edward Martell and the fire on Mother's Day 1969: The lack of public attention to Rocky Flats ended abruptly after a major fire at the plant on Mother's Day, May 11, 1969.[3] This was by no means the first big fire or major release of plutonium to the environment from Rocky Flats, but it was the first incident of this sort to receive attention of knowledgeable outsiders, most notably of Edward A. Martell, a radiochemist with Boulder's National Center for Atmospheric Research (NCAR).[4] He had worked with the army on nuclear weapons tests in the South Pacific after World War II. He was a specialist without peer in the field of radiation health effects. He was also familiar with Rocky Flats.

Martell feared the fire had released plutonium particles that could harm people downwind of the site. So he asked AEC and Dow officials to sample for plutonium in off-site soil. When they declined, he and Stuart Poet, a colleague, collected samples themselves. Just as he expected, they found plutonium in off-site areas. The largest deposits they found were at separate locations about two miles east and southeast of the plant. Each contained 8.20 picocuries of plutonium per gram of soil (8.20 pCi/g), a quantity 210 times the 0.04 picocuries per gram (pCi/g) now accepted as the average local plutonium deposits from atmospheric explosions of nuclear bombs. In Chapter 2, I pointed out that a picocurie is a measure of radiation.

Naturally occurring plutonium is exceedingly rare; a very small amount has been found at only one location, in Gabon in Africa. Martell knew that until quite recently plutonium as a human-made product did not exist. But now in the nuclear age the whole planet had been covered with a

---

[3] Details of the fire are reported by Ackland, *Making a Real Killing*, pp. 152-159; Iversen, *Full Boby Burden*, chap. 1; and Moore, *Citizen's Guide*, pp. 27-28m ion line at http://www.rockyflatsnuclearguardianship.org/#!citizens-guide-to-rocky-flats/c1hm8 .

[4] On Martell's role in relation to Rocky Flats, see Moore, "Democracy and Public Health at Rocky Flats," on line at http://media.wix.com/ugd/cff93e_5d3b6b6a12204505a3bc0fd2e2f504eb.pdf .

thin blanket of plutonium, released as fallout from atmospheric nuclear bomb detonations. He knew that some people who inhaled or otherwise internalized a tiny amount of fallout plutonium would years later become ill, and some would die. He was one of the few scientists to publicize this; another was the dissident Soviet nuclear physicist Andrei Sakharov, then under house arrest in the USSR for publishing such information. People were dying from plutonium, without being aware of its existence. And now, Martell worried, there may be more such people in the Denver area.

In February 1970 Martell and Poet, assuming that the plutonium they found came from the 1969 fire, reported the findings of their off-site sampling to authorities from the AEC, Dow Chemical and the Colorado Department of Health (CDH). AEC and Dow officials told them that the plutonium had been contained in the building where the fire occurred and thus that what they found most likely came either from a fire that happened on September 11, 1957, or from leaks from thousands of drums of plutonium-laced liquid waste that had been stored outside in the plant's 903 area from 1954 until 1968. These two events, the 1957 fire and the 903-area leaks, they were told, were the sources of the largest plutonium releases from Rocky Flats since operations began in 1952. This information was new. Neither of these events had been previously revealed to the public. Both are discussed below.

The Mother's Day 1969 fire at Rocky Flats was the most expensive industrial accident in the U.S. up to that time (see Figures 4.6 and 4.7). In 1969 dollars, it cost taxpayers approximately $45 million for repairs, plus another $22 million for plutonium loss (an estimated one metric ton, or 2,240 pounds). Air Force General Edward Giller, testifying about the fire to Congress on behalf of the AEC, insisted again that no plutonium had escaped to the external environment. But he added ominously that had the roof of Building 776 where the fire occurred ruptured, the City of Denver would almost certainly have had to be evacuated and the nuclear industry would have been thoroughly discredited

Figure 4.6: A glovebox area in Building 776, totally destroyed in the May 11, 1969, fire, the most expensive industrial fire to date in U.S. history, costing close to $50 million, not including the one metric ton (2,240 lbs.) of plutonium burned in the fire.

in the eyes of the public.[5] Despite the oft-repeated claim of no plutonium release from this fire, attorney Howard Holme in his research on behalf of plaintiffs in the "Church case," a lawsuit brought by landowners charging that Rocky Flats devalued their property (see below, p. 51), uncovered reports that the Mother's Day fire released an unknown amount of plutonium to the external environment. He also found that monitoring devices were destroyed in the fire, and some filters meant to protect the public were breached.[6]

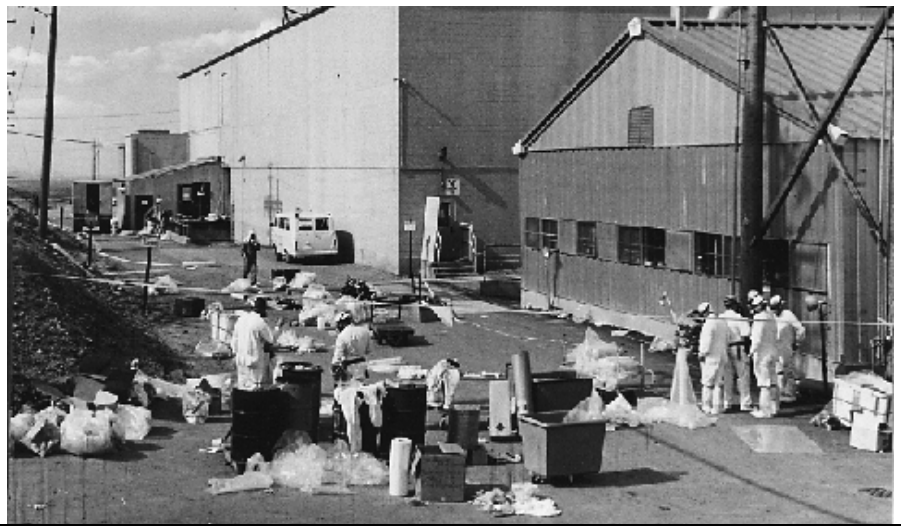


Figure 4.7: Cleaning up after 1969 the fire. AEC and Dow officials said plutonium was contained within the building where the fire occurred, that only an insignificant amount was released outside, mainly tracked out on the shoes of those who had fought the fire.

Martell penalized for seeking the truth about Rocky Flats: At the February 1970 meeting where Martell presented to government officials the results of the soil sampling he and Poet had done, a high-ranking AEC official inquired about the work of Martell and his colleagues. On learning that Martell heads a research lab at the National Center for Atmospheric Research (NCAR), a non-government entity supported by the National Science Foundation, this man said he would "bring this matter up with the appropriate officials of . . . the National Science Foundation." He said he had "a personal hangup about one federal agency engaging in activities critical of another federal agency."[7] Martell's research group was soon dissolved and he lost funding for his lab. Though he was one of the foremost specialists on radiation health effects anywhere, his ability to do original research was now hampered. Not long after his death in 1995 one of his NCAR associates told me that but for the strong support of his NCAR colleagues Martell would have lost his job.[8] As we shall see, he was not the only independent scientist to pay a high price for challenging the official line about Rocky Flats.

Turning point: Martell reveals to the public the danger of Rocky Flats: At a news conference on February 14, 1970, Martell informed the Denver-area public that Rocky Flats was a nuclear weapons production plant that had endangered the public health by contaminating the environment with radioactive and toxic materials. He referred not only to the Mother's Day 1969 fire but also the much worse 1957 fire and the fiasco of plutonium blowing off the site from where leaking barrels had been stored outdoors in the 903 area (both discussed below). Rocky Flats spokespersons were saying that naturally occurring radiation is around us all the time, especially in

[5] Ackland, *Making a Real Killing*, pp. 158-159; for a vivid account, see his Virtual Exhibit on the 1969 fire at http://www.colorado.edu/journalism/cej/exhibit/ .
[6] Holme, *Pre-Trial Statement* (1978), pp. 24, 402.
[7] P. Metzger, *The Atomic Establishment* (NY: Simon and Schuster, 1972), p. 259.
[8] Neldor Medrud, Interviewed by Moore, June 3, 2005.

the high altitude of Colorado, and that it is harmless. Likewise, they said, what has been released from Rocky Flats is also harmless. Martell by contrast issued a stern warning: "The radioactivity from plutonium oxide dust particles (such as those produced in the May 11, 1969, fire) is millions of times more intense than that from naturally occurring radioactive dust particles of the same size. Only minute amounts in the lung are sufficient to cause cancer."[9]

CDH knew about the 1957 fire and the 903 releases but did not inform the public: Until recently I thought CDH knew nothing of the danger posed by Rocky Flats, that they learned about it from Martell's 1970 revelations. But on June 21, 2012, retired Rocky Flats worker Burt Kelchner, who came to Rocky Flats from Los Alamos and began working at the plant in 1952, told me that CDH people, including their nuclear specialist Al Hazle, had long known what was happening at Rocky Flats. They were well aware, he said, of both the 1957 fire and the leaking drums at the 903 area, both unknown to the public until 1970. They learned of the Rocky Flats danger not from personnel at CDH, a state agency responsible for the public health, but from Martell, an independent scientist. At the February 1970 news conference, he asked: "Is it the responsibility of citizens to demonstrate that a definite health hazard results from a given pollutant, or is it the responsibility of the polluter to demonstrate that there is no hazard?" He might have added: "Isn't it the duty of the state Health Department to inform the public when their health is endangered?" The public would not forget Martell and his concern. Had there been no Mother's Day 1969 fire, the public may never have heard from him and it might be much longer before the danger posed by the Rocky Flats plant became known.

The 1957 fire, largest release of plutonium, public not notified: One of the most important revelations to come after Martell's soil sampling was the tale of what happened on the night of September 11, 1957, barely four years after production began at Rocky Flats (see Figure 4.8). A

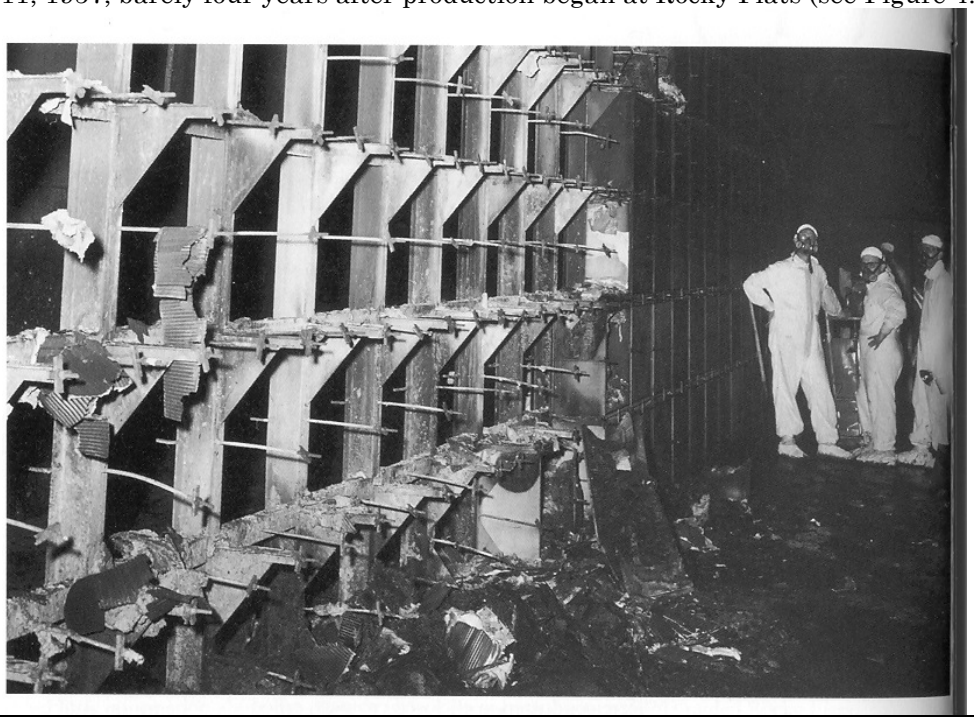


Figure 4.8: Exhausted firefighters stand next to the 8' high bank of filters destroyed by the fire and explosion in Building 771 on September 11, 1957. Each 2' X 2' filter was 6 inches thick. The filters were intended to protect the public by capturing plutonium particles in smoke leaving Building 771. With the filters gone there was no protection. Production resumed before all filters were replaced.

[9] Martell, "Plutonium Contamination in the Denver Area," Press Release (February 24, 1970), p. 1.

catastrophic fire and explosion erupted in Building 771, the plant's principal plutonium processing facility. As noted above, plutonium, being pyrophoric, can ignite spontaneously in the presence of oxygen. On that night in 1957 enough oxygen evidently made its way into a leaky glovebox to ignite plutonium that was there. Once ignited, plutonium burns at very high temperature and is difficult to extinguish. At the time alarms and detection devices either didn't exist in Building 771 or weren't operating. The fire was discovered by security personnel at 10:10 PM. When carbon dioxide efforts failed to quench the fire, they turned ventilation fans on high, but this spread the fire rather than put it out. The bank of 620 filters meant to protect the public by trapping plutonium particles caught fire. At 10:39 PM an explosion occurred in the filter ducts, strong enough to blast open all the doors at one end of the hall and destroy most of the filters, releasing to the external environment all the plutonium lodged on them. They had not been changed since their installation in 1954. They burned for 13 hours, releasing 20 to 500 pounds of plutonium. An additional 14.3 kilograms (17.2 pounds) of plutonium, enough to make three bombs, could not later be accounted for and presumably burned. The 150-foot stack through which smoke had poured was contaminated and partially burned. During the fire a plume of plutonium-laden smoke moved across the Denver area (see Figure 4.9).

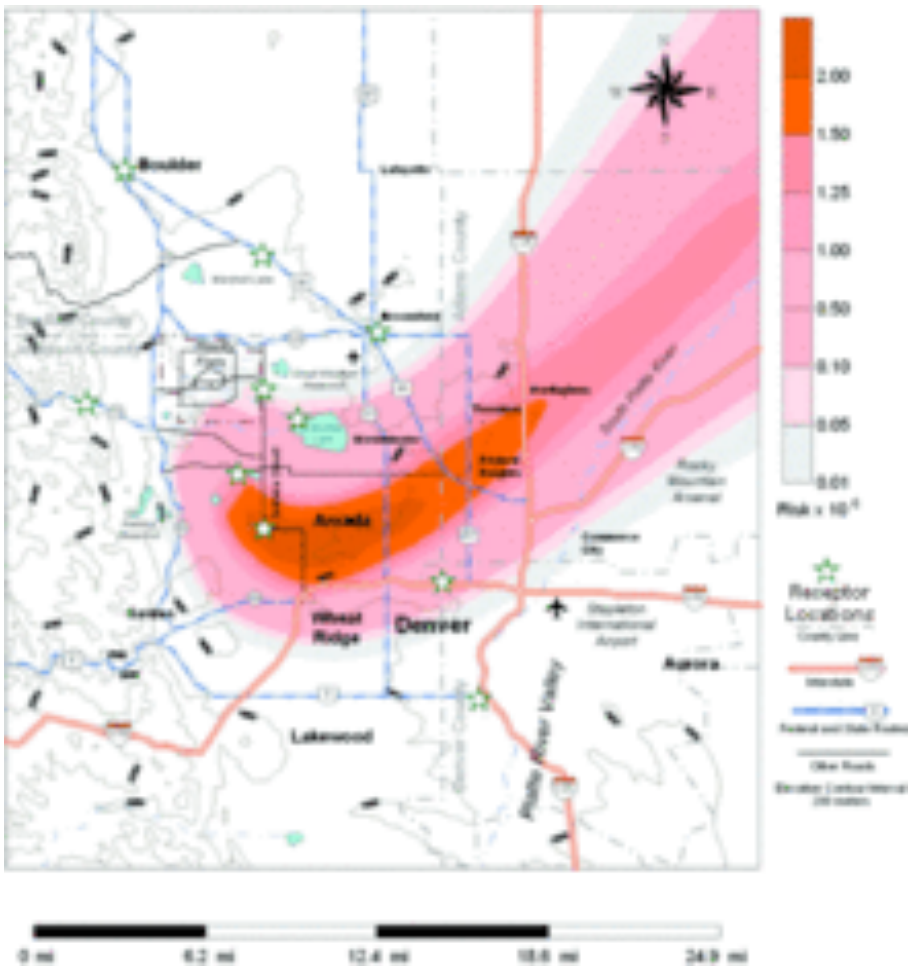


Figure 4.9: Map of the trajectory of the plutonium-laden plume from the September 11, 1957, fire, largest single release of plutonium in the plant's history. The plume moved south and southeast toward Denver, then northeast up the Platte River valley, carrying plutonium far beyond the area shown on the map. From *Summary of Findings: Historical Pubic Exposure Studies on Rocky Flats*, CDPHE (August 1999).

AEC officers told the press this was a $50,000 fire and that it caused "no spread of radioactive contamination of any consequence."[10] In fact, the fire's cost was $818,000.[11] Attorney Howard Holme later said, "It appears to be the single largest release of plutonium in the plant's history. . . . Little environmental monitoring was available during the fire and little monitoring was done to attempt to locate the plutonium released in the fire."[12] No warning was given to local schools, neighboring cities, County commissioners, or health agencies. Nothing was done to protect the public. Officials did not reactivate smokestack monitors until eight days after the fire. The first day they were turned on, the guidelines for stack emissions were exceeded by 16,000 times. According to Carl Johnson, MD, Director of the Jefferson County Health Department, "The guidelines for a 50 year release were exceeded in a single day."[13] Limited production resumed in Building 771 three days after the fire, though the destroyed filters had not yet been replaced. Effluents through the stack remained high in radioactive content until all filters were finally changed in February 1959.[14]

The leaking plutonium at the 903 area: No story about irresponsible handling of nuclear waste is so well known as the one of thousands of barrels of plutonium-laced waste stored outdoors in the plant's 903 area for more than a decade (see Figure 4.10)**.** Exposed to wind, rain, snow and heat,

Figure 4.10: Drums of plutonium-laden waste were stored outdoors in the 903 area from 1954 until 1968. Some corroded and leaked. This area was a principal source of plutonium particles released off-site to the east and southeast. After the drums were removed, the storage area of about 260,000 square feet – bigger than four football fields – was paved with asphalt and named the "903 Pad."

[10] "Atomic Plant Fire Causes $50,000 loss," *Denver Post*, September 12, 1957; "$50,000 Blaze Hits Atom Plant at Rocky Flats," *Rocky Mountain News*, September 13, 1957.
[11] Holme, *Pre-Trial Statement* (1978), pp. 295, 322.
[12] Ibid., pp. 21, 23.
[13] Johnson, "Comments on the 1957 Fire at the Rocky Flats Plant," Reported to the Conference on the Relation of Environmental Pollution to the Cancer Problem in Colorado, American Medical Center Cancer Research Center, Lakewood, CO, September 26, 1980.
[14] Holme, *Pre-Trial Statement* (1978), pp. 324, 323.

many of these barrels corroded and leaked plutonium into the environment. Dow knew as early as 1959 that some of these drums were leaking. Its corrective actions of rust retardant and a rabbit-proof fence had little positive effect. In the late 1960s, Dow finally removed the barrels and plowed the contaminated soil under. Plowing, however, freed plutonium particles and made them more readily available to high winds that distributed them widely, especially off the site to the east and southeast.[15] AEC officials, referring to "trace amounts" of plutonium, said they "present no risks to the health of employees of the plant or to citizens in the surrounding area."[16] People in affected areas disagreed. Under the leadership of landowner Marcus Church they would later bring a lawsuit against operators of the plant (for discussion of the Church case, see p. 51).

Conclusion: A period of public ignorance: The preceding pages of this chapter refer to the three largest releases of plutonium from Rocky Flats – the 1957 fire, the 903 Pad fiasco, and the 1969 fire. They all happened when Dow Chemical managed the plant. In this period there were also numerous other releases, including routine releases of tiny plutonium particles through filters that were supposed to protect the public. Routine releases will be discussed in more detail in chapter 5. Most of the contamination released from Rocky Flats occurred when operations at the plant were unimpeded and unwatched. ChemRisk later produced a figure that shows vividly the year-by-year plutonium emissions from Rocky Flats during the early period of the plant's history (see Figure 4.11).

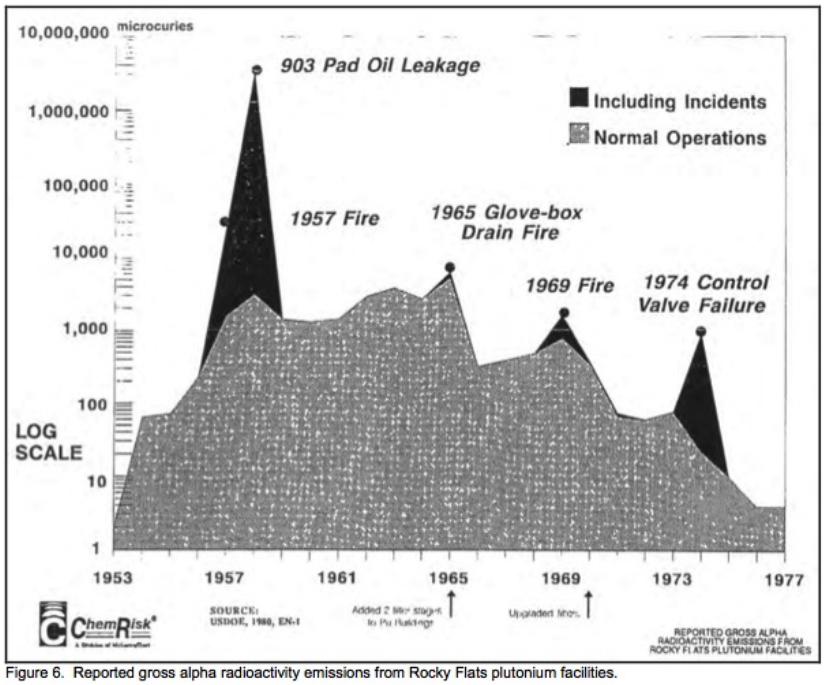


Figure 6. Reported gross alpha radioactivity emissions from Rocky Flats plutonium facilities.

Figure 4.11: Estimated plutonium emissions from Rocky Flats, 1953 to 1977. The image shows annual emissions, not what accumulated in the environment. Note the very high releases from "normal operations" (grey shading). Emissions dropped rapidly following the 1969 fire and stayed relatively low after Rockwell took over from Dow in 1975. ChemRisk, *Rocky Flats History: Rocky Flats Toxicologic Review and Dose Reconstruction*, Task 3-4 (CDPHE, Phase 1, February 1992).

[15] Holme, *Pre-Trial Statement* (1978), pp. 53, 98-101; Moore, *Citizen's Guide*, pp. 29-36; Ackland, *Making a Real Killing*, chap 7; and Iversen, *Full Body Burden*, chap. 2.
[16] "AEC Statement," attached to Martell et al., "Fire Damage," *Environment* (May 1970), 12, 4, p. 20.

5. PUBLIC AWARENESS AND RESISTANCE TO ROCKY FLATS (1970-1989)

Introduction: As noted earlier, the Denver-area public was mostly ignorant about Rocky Flats until Edward Martell and Stuart Poet found plutonium in the off-site environment after the Mother's Day, 1969, fire and informed the public that Rocky Flats was a nuclear weapons plant that had endangered them ever since it began operations in 1952 by releasing lethal toxins. This chapter focuses on the two decades from the 1969 fire till the 1989 FBI raid and "temporary" halt to production later that year, a "temporary" halt that became permanent. These two decades were marked by heightened public awareness, new information becoming available and a very rapid growth of opposition to Rocky Flats. In this period both the EPA and the state began regulation at the plant. In 1992 the plant's mission was changed from production to cleanup..

AEC scientists map plutonium contamination: After Martell's revelations in 1970, AEC brought their own scientists to Colorado to sample the off-site environment either to refute or to confirm what Martell had reported. The visiting scientists, P. W. Krey and E. P. Hardy of AEC's Health and Safety Laboratory in New York City, more than confirmed the accuracy of Martell and Poet's work. In 1970 they produced a long report that included a map with odd-shaped "isopleths" showing relative concentrations of wind-blown plutonium released from Rocky Flats and deposited in soil on and off the plant site (see Figure 5.1).

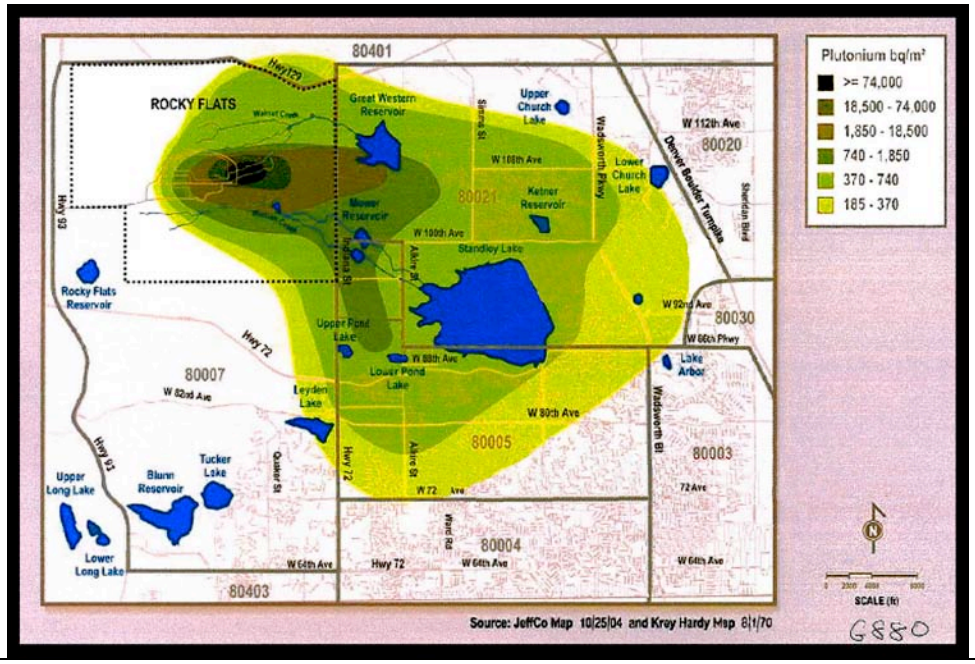


Figure 5.1: 1970 map by AEC scientists P. W. Krey and E. P. Hardy of plutonium contamination at Rocky Flats. The amoeba-like isopleths show distribution of windblown plutonium in becquerels per square meter (bq/m^2). One becquerel = one disintegration (release of radiation) per second. From Krey and Hardy, "Plutonium in Soil Around the Rocky Flats Plant," HASL 235 Report (1970). The map shows an area of about 30 square miles off the Rocky Flats site that is contaminated with plutonium released from the plant. This color adaptation of the original black-and-white map was used to delineate the area of the class of affected property owners seeking compensation for damage to their property in the Cook v. Dow & Rockwell lawsuit heard in Denver federal court. This case will be discussed later.

Krey: Plutonium deposited throughout the Denver metro area: Martell was the first of a number of independent scientists to play a major role in bringing public attention to Rocky Flats. Before telling more about him and the contributions of others, I'll mention another crucial finding of

AEC scientists Krey and Hardy. When they produced their 1970 map of plutonium contamination on and near the Rocky Flats site (Figure 5.1), they didn't just sample close to Rocky Flats. They took 25 soil samples across the Denver metro area in an effort to find out how much plutonium had been released from Rocky Flats and where it had gone. Krey published the results in *Health Physics* in 1976. His article included a map, again with isopleths showing relative concentrations of wind-blown plutonium (see Figure 5.2). Plutonium quantities decreased in samples further out from the plant site until finally deposits from Rocky Flats could not be distinguished from background. Krey's map shows that plutonium released from Rocky Flats was deposited across all of the City of Denver. The quantity of plutonium in off-site soil found by Martell and Poet after the 1969 fire and soon after by Krey and Hardy was at that time regarded as disturbing by Martell and others.

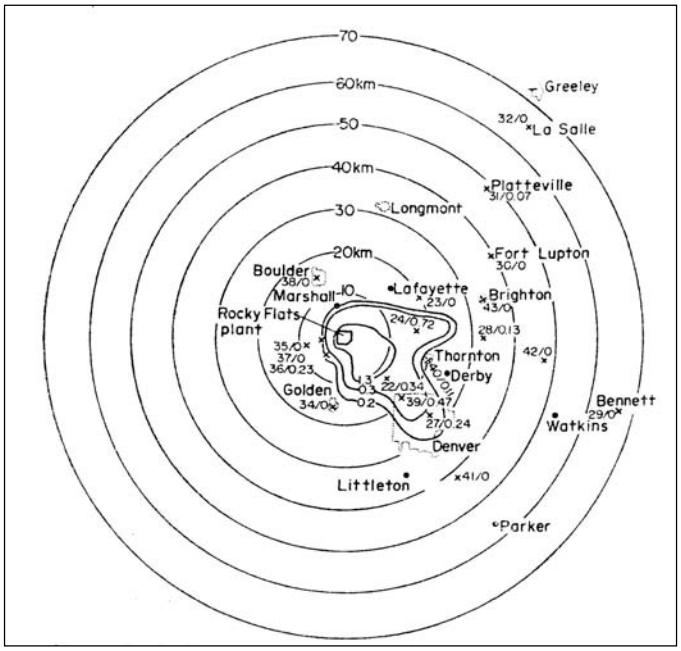


Figure 5.2: Plutonium released from Rocky Flats in soil in the Denver metro area. Each X on this map designates a soil sampling site. The first of the pair of numbers adjacent to the sampling site represents the site number. The second (following the slash) represents the Rocky Flats plutonium in millicuries per square kilometer (mCi/km^2) measured at that site (one millicurie is 1/1000th of a curie). The outlines of the isopleths reflect the concentration contours of Rocky Flats plutonium in the soil expressed as mCi/km^2. The concentric circles show distances from the center of the Rocky Flats plant in kilometers (1 km = 0.62 mile). P. W. Krey, "Remote plutonium contamination and total inventories from Rocky Flats," *Health Physics*, 1976, vol. 30, p. 210.

The State of Colorado sets a meaningless standard for plutonium in soil: In response to all these revelations about plutonium released from the plant into off-site areas, Colorado was the first state with a DOE nuclear weapons plant to set a standard for plutonium permitted in off-site soil. In January 1973 Colorado stated that land where plutonium contamination exceeds 0.2 disintegrations per minute per gram of soil (dpm/g) is "unfit for residential use, subdivision development, or commercial and industrial uses."[1] But this strict rule did not last. Less than two months later the state increased by tenfold the amount of plutonium to which exposure was allowed, from 0.2 dpm./g to 2.0 dpm/g. And it lifted its prohibition against residential, commercial, or industrial uses in areas where contamination did not meet the new standard; hereafter it would merely require "special

[1] R. L. Cleere, "Public notice of plutonium contamination in the area of the Dow Chemical Rocky Flats Plant," Signed R. L. Cleere, Executive Director, CDH, January 24, 1973.

techniques" for construction in these areas, such as plowing plutonium under.[2] Thus, the standard was completely gutted of its original provisions for public health. In 1975, Martell criticized the state standard for being at least 20 times too high and not protective of public health.[3] Nonetheless, the revised standard remains in effect today, allowing residential development very near the site. To the state government, economic growth is more important than protecting public health.

Tripling the size of the Rocky Flats site to create a buffer zone: In February 1974, eleven months after establishment of the state's 2.0 dpm/g standard for plutonium in off-site soil, the AEC more than tripled the size of the Rocky Flats site by adding 4,550 acres, mainly on the downwind, down gradient east side where the boundary was moved out to Indiana St. This meant that most land where the plutonium contamination was too high to meet the state's 2.0 dpm/g standard was now incorporated within the Rocky Flats property on federal land where the state's standard did not apply and could not be enforced.

The state's misleading soil sampling practice: In enforcing its new standard for plutonium in soil in areas east of the enlarged site, CDH employed from the outset a sampling method that thwarted its ability to locate places where the plutonium concentration exceeded the standard. Rather than analyzing specific samples for their radiation content, CDH divided the area to be sampled into large sectors, then calculated the average plutonium concentration in each sector by compositing all the soil collected from twenty-five samples taken from within that sector.[4] This approach may show average distribution in large areas, but it dilutes particular points where readings are high by averaging them with lower ones, making identification of hot spots impossible.

CDH's soil sampling also misrepresented reality in that over time its samples were collected to increasingly greater depth. This diluted the material measured and gave the impression that the quantity of plutonium in the soil was steadily decreasing. An internal study criticized this practice and showed that plutonium concentrations in soil around Rocky Flats had changed little from 1970 until 1991.[5] For public health assessments, CDH eventually adopted the practice of compositing samples taken from the top quarter-inch of soil within a given area, continuing in shallow surface soil the method criticized in the previous paragraph. The words of German analyst Ulrich Beck are apt: "Whoever limits pollution has also concurred in it." Standards for "permissible" exposure "may indeed prevent the very worst from happening," he continues, "but they are at the same time 'blank checks' to poison nature and humankind a bit."[6]

Martell and the public: Rocky Flats a local hazard and a global threat: Martell's revelations after the 1969 fire sparked public awareness and action. "Nobody knew anything about Rocky Flats until his study," said Judy Danielson, a physical therapist. She used Martell's work to organize people to go door-to-door in areas east of Rocky Flats asking residents if they could collect a scoop of dirt from their yards to test for radiation content. They labeled these samples with names and addresses and took them to public meetings of candidates for Congress in 1972, asking those running for office to get the samples analyzed and to explain what they'd do about Rocky Flats.[7] This attracted media attention and helped make Rocky Flats an issue that candidates for public office could not ignore.

---

[2] "Amendment to the State of Colorado Rules and Regulations Pertaining to Radiation Control, Subpart RH 4.21.1," Adopted Colorado State Board of Health, March 21, 1973.
[3] Martell, "Basic considerations in the assessment of the cancer risks and standards for internal alpha emitters," at the public hearings on plutonium standards, US EPA, Denver 1975, pp. 17, 20.
[4] Jonathan Love, "Rocky Flats Soil Plutonium $^{239+240}$Survey from 1970 to 1991," Denver: CDH, 1994.
[5] Richard H. Jones and Yiming Zhang, "Spatial and temporal analysis of the Rocky Flats soil plutonium data," Denver: CDH, September 19, 1994.
[6] Beck, *Risk Society: Towards a new modernity*, trans. Mark Ritter (London: Sage, 1992), p. 64.
[7] Ackland, *Making a Real Killing*, p. 169.

In 1974, Danielson, a Quaker, and Pam Solo, a nun from the socially active Sisters of Loretto, were hired to share a staff position at the Denver office of the American Friends Service Committee. Their focus: nuclear weapons production at Rocky Flats. Thus began what by the end of the decade had blossomed into a national and global movement of resistance to nuclear weapons. The Rocky Flats Action Group, an umbrella body that grew out of the AFSC activities, labeled Rocky Flats a "local hazard and a global threat." The "local hazard" was the public health and environmental danger Martell had exposed, the "global threat" the possible nuclear holocaust that haunted him. Observing bomb tests in the South Pacific as an Army radiation health specialist made him, he said, "quite a pacifist. If you appreciate the effects of thermonuclear explosions, you aren't going to be disposed toward the military and wars as the means of settling national affairs."[8] The Rocky Flats movement thus articulated and elaborated Martell's twin concerns (see Figure 5.3).

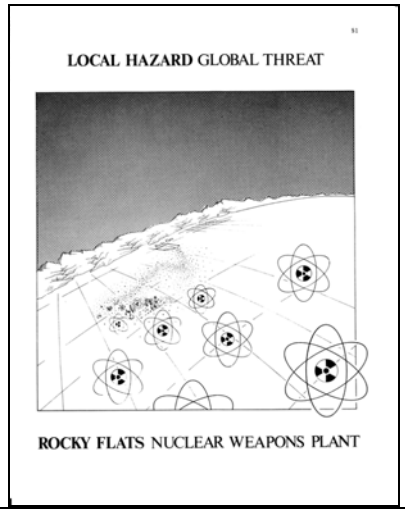


Figure 5.3: In 1977 the Rocky Flats Action Group published this 20-page booklet. It was packed with most of what was then publically known about Rocky Flats.

The Lamm-Wirth Task Force calls for shutdown of Rocky Flats: Pressure from those energized by Martell led to the creation in late 1974 of the Lamm-Wirth Task Force on Rocky Flats by newly elected Governor Dick Lamm and Congressman Tim Wirth, whose district included Rocky Flats. The Task Force Final Report issued in 1975 recommended that Rocky Flats be closed and its work be relocated.[9] This recommendation would not be forgotten.

The Rocky Flats Monitoring Committee: One recommendation of the Lamm-Wirth Task Force was creation of a citizen oversight group. Thus, in 1976 the government created the Rocky Flats Monitoring Committee, probably the first citizen oversight group for a nuclear weapons facility anywhere. Pam Solo, the only "adversary" appointed to this body, reported that they met on a regular basis, toured the Rocky Flats buildings, saw everything, were 'dazzled" with technology, and were treated like VIPs. "The language and euphemisms that they used – a nuclear excursion, as though it was a trip up the Colorado River. You kind of kill off the language." She pressed them: "The Task Force says shut it down and convert it. How are we going to move on this? They would all look at me like I had pulled their pants down." Those meetings, she said, left her "totally numb and sick."[10] The group's funding ended in 1981.

Martell on the danger of plutonium's alpha radiation: Martell emphasized that plutonium alpha particles taken into the body do not distribute uniformly in an organ, as assumed by those

[8] Ibid., p. 162.
[9] *Lamm-Wirth Task Force on Rocky Flats: Final Report*, October 1975.
[10] Pam Solo, Interviewed by Moore, Newton, MA, September 23. 1996.

"who persist in using the average whole organ dose as the measure of cancer risk" for setting exposure standards. Instead, within the body, alpha particles clump in "hotspots" where their energy is concentrated at levels 100 to 1000 times their average organ concentrations, a fact ignored by most of those who set standards. Also, in the process known as "alpha recoil," alpha particles subdivide into a cloud of smaller particles, thereby enhancing and intensifying the potential for harm to surrounding cells, possibly inducing cancer or creating conditions for other ailments.[11] He noted that "plutonium in fallout from nuclear tests is now present at measurable levels in all human organs." While the amount is small, it "will certainly contribute to the initiation and progression of malignancy in the general population," particularly when radiation from other sources is added.[12]

Martell calls attention to the commonly ignored danger of naturally occurring radiation: Martell estimated that 80 percent of all cancers are radiation induced, most of them "attributable to lifetime exposures to natural background radiation."[13] Those who ignore the adverse role of naturally occurring radiation, he noted, find it easy to allow additional exposure from human-made sources. Internal alpha emitters, from natural as well as unnatural sources, "may be the principal agent of radiation-induced cancer" as well as the major contributing factor in arteriosclerosis and resultant cardiovascular disease.[14] The record from Rocky Flats and other plutonium-processing sites suggests increased incidence of coronaries among plutonium workers.[15]

Martell calls for independent studies of radiation health effects: In February 1995 Martell wrote to then-Energy Secretary Hazel O'Leary urging a full-scale study of plutonium health effects, especially to protect workers. Such a study, he said, must not, as in the past, be "controlled by a vested-interest establishment that has contrived to minimize or ignore adverse effects of all sources of human exposure to ionizing radiation."[16] O'Leary did not reply.

A few weeks before his July 12, 1995, death, Martell, with a sarcastic twist, told close friend chemist Niels Schonbeck that he had failed to realize that "the point was, if there's something disturbing going on, look the other way." He, clearly, was not one who looked the other way. Later, with sadness, he said, "I worry about all future generations, because we're not studying radiation-induced health effects, not objectively, not thoroughly."[17]

Rocky Flats and animals: Alerted by Martell's report, some local farmers, ranchers and pet owners who lived near Rocky Flats worried that their animals may have been exposed to radiation, because some had weird abnormalities. Bini Abbott, who ran a ranch for abandoned and abused horses about a mile-and-a-half downwind of the plant, had so many horses with health problems that she began to freeze some of their body parts for later examination[18] (see Figure 5.4). Loyd Mixon, a local farmer with numerous deformed animals, created quite a stir when he took "Scooter," a pig with no hind feet and misshapen ears, to a meeting of the Lamm-Wirth Task Force in 1974[19] (see Figure 5.5). As if items like these were not enough, the EPA reported in December 1974 that cattle in a pasture just east of Rocky Flats had more plutonium in their lungs than cattle grazing on the

---

[11] Martell, *Natural Radionuclides and Life* (unpublished manuscript), chap. 4.
[12] Ibid., chap. 7, pp. 7-8.
[13] Ibid., chap. 7, p. 11.
[14] Martell, "Tobacco radioactivity and cancer in smokers." *American Scientist*, July-August 1975, vol 63, pp. 409-410.
[15] Martell, interviewed by Robert Del Tredici, July 22, 1982.
[16] Martell to Energy Secretary Hazel O'Leary, February 9, 1994.
[17] Martell, interviewed by Niels Schonbeck for the Rocky Flats Health Advisory Panel, February 21, 1995.
[18] Ackland, *Making a Real Killing*, pp. 166-167; Iversen, *Full Body Burden*, pp. 65-66.
[19] Ackland, *Making a Real Killing*, pp. 183; Iversen, *Full Body Burden*, pp. 123, 138.

Nevada Test Site where the U.S. had exploded hundreds of nuclear bombs during the 1950s and 1960s[20] (see Figure 5.6). Animals at Rocky Flats will be discussed more fully below.

Figure 5.4. A windy day at Bini Abbott's horse ranch, about a mile-and-a-half downwind of the Rocky Flats plant, which is up the hill beyond the horses, hidden by flying dust. Photo by John Till, 1999.

Figure 5.5: Farmer Loyd Mixon, who lived downwind of Rocky Flats, and deformed pig "Scooter."

[20] Iverson, *Full Body Burden*, p. 113.

Figure 5.6: Cows grazing just east and downwind of the Rocky Flats plant. Photo by John Till, 1999.

More bad news: Tritium found in Great Western Reservoir: Throughout the early 1970s Rocky Flats was in the news often, and the news was not good. On April 24, 1973, Al Hazle of CDH discovered tritium in the water of Great Western Reservoir, a lake just east of the Rocky Flats boundary that was the source of Broomfield's drinking water (for the location of Great Western Reservoir, see Figure 5.1 on p. 36). Tritium is a radioactive form of hydrogen used in thermonuclear bombs but supposedly not present at Rocky Flats. In the form of "tritiated water" it cannot be separated from the water and thus is readily internalized. Once in the body it can prove harmful, because, with a half-life of only 12.3 years, it emits radiation rapidly. CDH did not tell the public about finding tritium, but it informed the AEC. Behind the scenes for several months the AEC and Dow, without doing any analysis of the reservoir, denied that Rocky Flats was the source of the tritium. In September, the governor publicly disclosed the fact that there was tritium in the Great Western Reservoir, creating quite a stir.

After the governor's revelation, the AEC finally conducted an investigation and announced that its own Livermore Laboratory in California had accidentally sent tritium to Rocky Flats. This made the tritium incident a full-fledged scandal. Not only were people drinking a radioactive substance but those in charge didn't seem to know where it came from and what was happening. With all this attention, CDH said the tritium is harmless. Martell strongly disagreed. Things moved slowly. A quarter-century later, in 1998, Broomfield finally got a new source of drinking water, paid for by AEC's successor, the Department of Energy, without DOE admitting that tritium endangered anyone's health.[21] Despite the denials from Rocky Flats, Edward Putzier, a health physicist at the plant, wrote in a 1982 paper that some Rocky Flats glove boxes contained "massive amounts" of tritium,[22] suggesting even greater official ignorance at Rocky Flats – or denial or outright lying.

Changing of the guard at Rocky Flats: Writer Len Ackland says, "The tritium fiasco was the last straw for Dow Chemical at Rocky Flats." The company had lost favor with the public – with all the reports about accidents, fires, spills and releases – but now even some in the workforce and in Congress were critical,[23] In 1998, I interviewed for the Rocky Flats oral history collection Jim Kelly, former president of the United Steelworkers Local 8031, the principal union at Rocky Flats. He told me about his testimony before a Congressional committee about Dow's poor safety record not in the community but with employees, workers at the plant. He thought this hearing was a tipping point

[21] Ackland, *Making a Real Killing*, pp. 171-173, 176; Iversen, *Full Body Burden*, pp. 96, 100-101
[22] Putzier, "The Past Thirty Years at Rocky Flats," November 1982.
[23] Ackland, *Making a Real Killing*, p. 176.

for the company.[24] Dow soon announced it would not seek renewal of its contract at Rocky Flats. In November 1974, AEC replaced Dow with Rockwell. Less than two months later, in January 1975, AEC itself was divided into two parts, the Nuclear Regulatory Commission, responsible for nuclear power, and the Energy Research and Development Administration (ERDA), in charge of weapons. Two years later ERDA was renamed the Department of Energy (DOE). One complaint about the AEC was that it was self-regulating. This continued with DOE.

Biology Professor Harvey Nichols hired to sample airborne plutonium, becomes major critic of Rocky Flats: In 1975 the ERDA hired British-born Dr. Harvey Nichols, a specialist in aerial transport of pollen, to study airborne particles at Rocky Flats. At the time he did not know that the plant produced the fissile plutonium cores for warheads. In 1975-76 he took snow samples across the whole of the roughly ten square-mile Rocky Flats site. All his samples were radioactively "hot," even those from areas predominantly upwind. He estimated that about 14 million radioactive particles per acre were deposited on the site in less than two days of snowfall.

To determine what kind of radiation was being emitted, he brought particles present in the snow into contact with radiation-sensitive film. The particles etched fission tracks and "star bursts" on the film, indicating alpha radiation emitted by plutonium. This meant that tiny plutonium particles released from the tall smokestack at Rocky Flats (see Figure 5.7) and floating in the air had, in Nichols words, "been scavenged from the air by the falling snow." He concluded that routine operations at the plant were constantly dusting the Rocky Flats site with "up to tens of billions of plutonium particles per acre."[25] This constant dusting, of course, included the "buffer zone," land that is now the Rocky Flats National Wildlife Refuge.

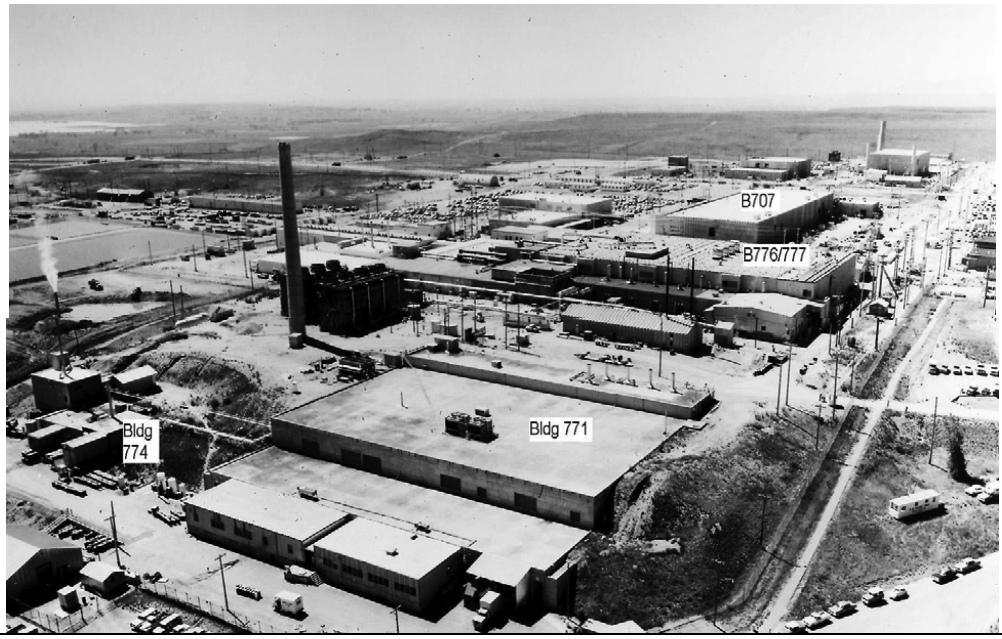


Figure 5.7: Photo from 1969 showing the 150-foot tall stack. Nichols realized that plutonium was being routinely released from this stack. In the picture one can see the three plutonium processing buildings (771, 776/777, and 707). The view is southeast. Standley Lake is visible in the upper left. Missing is the high-security barrier erected around the plutonium area in the early 1980s.

[24] Kelly, Maria Rogers Oral History Program, http://oralhistory.boulderlibrary.org/interview/ohxxxx/
[25] Nichols, Final Report on ERDA Contract EY-76-S-02-2736 and personal communications dated November 21, 2003, and October 15, 2009. See also Nichols, Rocky Flats: A Detective Story at http://www.rockyflatsnuclearguardianship.org/#!presentation-by-harvey-nichols/c1m2k

Years later, in response to Nichols' questioning at a hearing on Rocky Flats before the Colorado State legislature, officials from Rockwell International, the company that ran the plant, admitted that plant operations routinely released plutonium particles to the environment. A 1992 report by ChemRisk contains a graphic image (see Figure 4.11, p. 35) that shows the magnitude of these routine releases during production years at the plant. Far more plutonium was actually released in day-to-day operations than in the extreme events of the 1957 fire, the 1969 fire and the leaks at the 903 drum storage area.

Nichols disagrees with government agencies about contamination of the buffer zone: Nichols is convinced that the tiny plutonium particles released from Rocky Flats are still present in the soil of the buffer zone, now the Rocky Flats National Wildlife Refuge. But the government agencies responsible for the Superfund "cleanup" of the site did no remediation in the buffer zone, because in their view this part of the site contained little contamination. The method they used to characterize the area (locate, measure and map contamination) is called "kriging." This commonly used method estimates contaminant concentration in a given area by averaging a few surface soil samples collected within a large plot – say, 5 plutonium samples averaged from a plot of 25 or more acres. It may miss or average away hot spots. In the buffer zone it showed plutonium contamination to be either non-existent or insignificant. Nichols trusts results of his own sampling more than the kriging reports. He says most of the tiny plutonium particles released into the buffer zone soil either blew away to another location or remain – not necessarily on the surface, likely percolated down a bit, but still there.

Nichols says airborne plutonium was inadequately monitored around the perimeter of the Rocky Flats site: By the late 1970s DOE, EPA and CDH were periodically reporting to the public results of air monitoring around the perimeter of the Rocky Flats site (see Figure 5.8). Their reports routinely showed little or no plutonium leaving the site. As soon as Nichols, who is very experienced with air monitoring, saw the equipment being used at Rocky Flats, he called it laughable. To do an effective job, air monitors must have maximum intake of airborne particles, but this was not possible with the monitors at Rocky Flats. They did not pivot into the wind, did not compensate for changes in wind speed, and were roofed in a way that prevented intake of many particles.[26] As a result, the periodic reports of Rocky Flats air-monitoring data misrepresented reality and were more "a program to reassure the public rather than the sound, unimpeachable scientific endeavor that was actually needed."[27] With airborne plutonium poorly monitored at the perimeter of the site, Nichols thought multitudes of tiny particles had been distributed off the site as well as on, a fact already demonstrated by Martell as well as AEC scientists Krey and Hardy and, as will be shown shortly, by Carl Johnson, MD, Director of the Jefferson County Health Department.

Meteorologist W. Gale Biggs also found that airborne plutonium was poorly monitored: In the 1980s then-Governor Roy Romer appointed meteorologist W. Gale Biggs to assess air-monitoring of plutonium releases at Rocky Flats. Among the things he learned are these:

- The majority of emissions (60-99%) are "fugitive" emissions – that is, plutonium from the soil picked up by the wind and carried elsewhere. This is what happened with the 903 leaks.
- Plutonium particles in fugitive emissions can be either small or large.
- The average size of particles in ductwork in plant buildings is very small, 0.045 microns.
- The average size of a human hair is about 50 microns.

---

[26] Nichols, "Pollen and spores as vectors of radionuclide particles at the Rocky Flats facility, Colorado," First Progress Report for US ERDA under Contract No. E (11-1) - 2736, October 15, 1975; and "Some aspects of Organic and Inorganic Particulate Transport at Rocky Flats," Final Report for US ERDA on Contract EY-76-S-02-2736, prepared for US ERDA in 1977.

[27] Nichols, Assessment of the Official Air Sampling Equipment at Rocky Flats (February 18, 2012). On line at http://media.wix.com/ugd/cff93e_eef7aa6815f245e18c1357249382ed97.pdf

- Particles released from the stack (such as those Nichols found in snow) are tiny – probably smaller than 0.01 microns – because they have passed through several banks of filters.
- After emission from the stack, some small particles attach to larger airborne particles, such as pollen or organic matter, the size of which may range from about 15 to several hundred microns.
- Larger particles drop to the ground before they reach air monitors around the perimeter of the site and thus are not monitored. Some of these were deposited in the buffer zone,
- Smaller particles that reach the monitors can pass through them without being monitored.
- Thus the air monitors fail to monitor much of the emitted airborne plutonium.
- Small particles probably travel some distance before settling.
- The population was exposed to airborne plutonium before it settled.
- By means of the "alpha-recoil effect," a process that continues indefinitely, radiation decay of plutonium generates enough energy to blast a piece of plutonium off the particle.
- Due to alpha recoil, particles decrease in size and increase in number. Most of these tiny particles can pass through the filters of the monitors and thus are not measured. They can be readily picked up by wind and more readily inhaled.[28]
- For all the reasons cited, the amount of plutonium emitted was not measured and could not be known.
- Though the most dangerous exposure is from airborne pathways, we cannot estimate the extent of the health problem because we do not know the emissions.

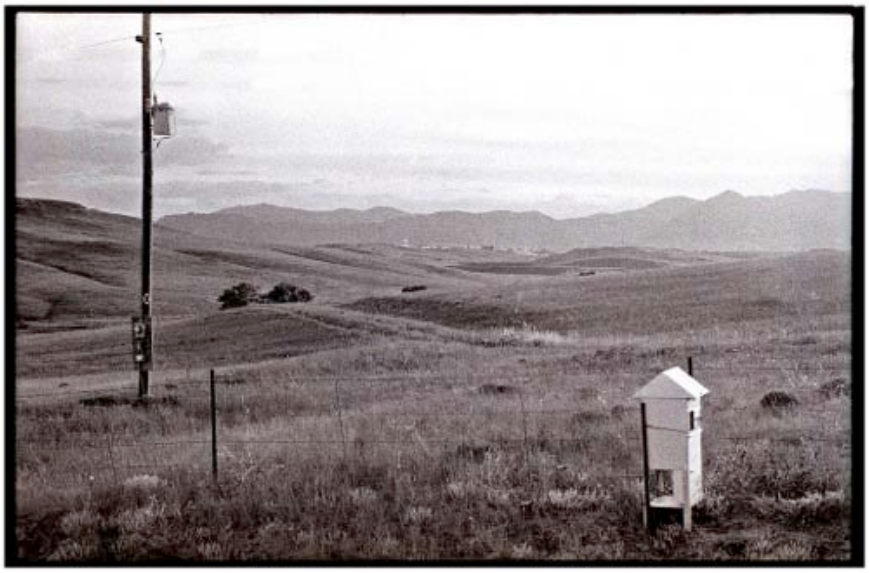


Figure 5.8: Air monitor along the eastern boundary of the Rocky Flats site. Such monitors, according to Nichols were inadequate. The plant's water tower and tops of buildings are visible about 2 miles away up the hill in the center of the picture. Photo by Robert Del Tredici.

Innovation: Carl Jonson samples plutonium in dust: In 1974 Carl J. Johnson, MD, was named Director of the Health Department in Jefferson County, where Rocky Flats is located. A short time later a County Commissioner asked him whether the Commissioners should allow a residential development on land just east of Rocky Flats. The CDH had already approved the project, despite having found plutonium in surface soil there up to seven times the state standard for plutonium in soil (see pp. 37-38); they would require plowing prior to construction. In response, Johnson and two colleagues from the U.S. Geological Survey (USGS) in Littleton sampled the area, using probably for

[28] Biggs, Airborne Emissions and Monitoring of Plutonium from Rocky Flats (March 17, 2011). http://www.rockyflatsnuclearguardianship.org/#!academic-information/zoom/c1arf/image_17gh

the first time anywhere the innovative method of sampling only respirable or breathable dust. Samples taken at 25 locations showed plutonium concentrations, on average, 44 times greater than what had been measured at the same locations in previous whole-soil sampling by CDH. Several readings exceeded previous ones by 100 times or more, one by 285 times.[29] In September 1975, when the County Commissioners saw the results, they vetoed residential development on the land in question. This triggered a lawsuit against Rocky Flats by Marcus Church, owner of the land, a matter to be examined later (see pp. 51-52). When Johnson and his colleagues published their results, they explained that they sampled dust because it is only the "very small particles" of dust on the surface of soil that can be picked up by wind and made available for inhalation, the worst way to be exposed to plutonium.[30] Their article continues to be cited by those who do this unique type of sampling, But ERDA, Rockwell, CDH and EPA, all of which had supported Johnson and his colleagues on their original sampling, suddenly backed off and became negative about Johnson and his work. Martell, on the other hand, applauded the sampling of breathable dust as a stroke of genius and the most realistic way to sample for plutonium.[31]

Johnson proposes that the state adopt dust sampling for plutonium: In October 1975 Johnson formally proposed that, for purposes of assessing health risk of plutonium exposure in off-site areas, the state set a new standard based on plutonium in respirable dust on the surface of soil. "The coarser materials which are not inhaled and retained," he pointed out, "have no bearing on the actual hazard to health and serve only to dilute the amount of radioactivity found by analysis, and may yield a spurious low concentration of plutonium that is misleading."[32] CDH did not welcome this proposal. To resolve the issue, the Colorado Land Use Commission brought in Karl Z. Morgan, fabled "father of health physics" and former chair of the internal dose committee of both the National Council on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP) and recently retired from DOE's Oak Ridge Lab. Morgan was asked whether for assessing the public health risk from plutonium in surface soil it was better to follow Johnson in using dust samples or CDH in collecting whole-soil samples. Morgan sided with Johnson. Colorado officials, having gotten from Morgan the advice they sought, chose to ignore it. Shortly after his visit, Morgan wrote Johnson: "The situation is much worse than I had suspected. . . . I am amazed that the State of Colorado . . . has not been out front from the beginning, collecting this type of data, pointing out the environmental hazard and doing all it could to ameliorate the problem."[33]

Johnson and the criticality question: In environmental sampling done near the Rocky Flats site Johnson found cesium-137, a radioactive material never used at the plant. For him its presence suggested the likelihood of "a significant fission reaction," or "criticality," of plutonium at the plant. A criticality is a run-away chain reaction of fissionable material that happens spontaneously and instantly releases a blast of neutron radiation likely to be fatal to anyone nearby. Three employees at the Los Alamos Lab in New Mexico lost their lives due to criticalities there. If there was ever a criticality at Rocky Flats, other fission byproducts, such as strontium-90 and iodine-131, should also be present. Johnson asked plant officials to sample soil for these materials and to do a review of

---

[29] Johnson, "Survey of land proposed for residential development east of Rocky Flats, for plutonium 239 contamination of respirable dust on the surface of the soil," Report to the Jefferson County Commissioners and the Colorado State Health Department (September 12, 1975).

[30] Johnson, R. R. Tidball, and R. C. Severson, "Plutonium hazard in respirable dust on the surface soil." *SCIENCE* (August 1976), vol. 193, pp. 488-490.

[31] For an account of Johnson's Rocky Flats work, see Moore, "Democracy and Public Health at Rocky Flats," in Dianne Quigley et al., *Tortured Science* (Amityville, NY: Baywood, 2012), pp. 76-92; on line at http://media.wix.com/ugd/cff93e_c22798032f2e468f9af7d9ccb317169f.pdf .

[32] Johnson, "Remarks to the State Board of Health concerning a proposed new interim standard for contamination of soil with plutonium" (January 21, 1976).

[33] Morgan to Johnson, January 30, 1976.

"incidents" at the plant "to determine the source of the cesium."[34] When he learned that an explosion had accompanied the 1957 fire – the blast that blew doors open – he suspected it was a criticality. He saw official reports of elevated levels of strontium as well as cesium in soil at the site. But all his queries regarding criticalities were ignored.

Former Rocky Flats engineer James S. Stone, who blew the whistle to the FBI on problems at the plant, insisted that there had been several criticality events there.[35] Strontium as a contested issue reappeared in January 2005 when former FBI agent Jon Lipsky who had led the June 1989 FBI raid of Rocky Flats, announced at a news conference in Denver that he had seen documentation of high levels of strontium contamination at the site.[36] Whether there's ever been a criticality at Rocky Flats remains a matter of controversy. The standard line is that no criticality has happened at Rocky Flats. It is well known that there was a Criticality Lab at the plant, where experiments were performed. It seems reasonable to assume that criticalities occurred on purpose at the lab and that their byproducts were released into the environment, but so far this is only speculation. In July 2015 Robert E. Rothe, who operated the Criticality Lab, confirmed that criticalities had occurred repeatedly, sometimes for extended periods. He says nothing about disposal of radioactive byproducts.[37]

Johnson asks: Is it safe to live near Rocky Flats? Ever since 1970 when Martell alerted people to the danger of plutonium in the environment in off-site areas, some have wondered whether it is safe to live in the contaminated area. Johnson responded to this question quite directly by examining the incidence of cancer among people living in areas known to be contaminated with plutonium. He focused on Anglos in 1969-71 because cancer data was available for this period and the population near Rocky Flats was overwhelmingly Anglo. He mapped three isopleths in the metro area showing wind-blown concentration of plutonium from Rocky Flats, then looked at the incidence of cancer within each area and compared it to cancer incidence in the surrounding non-contaminated area. His isopleths were similar to those of Krey's 1976 map (see Figure 5.2, p. 37) but were based on more samples from a smaller area. Johnson's map shows that in the most contaminated Area I nearest Rocky Flats there was 16% more cancer than in the non-contaminated Area IV, 12% more cancer in Area II which reached into the heart of Denver, and 6% more cancer in Area III which stretched to the far side of Denver (see Figure 5.9). Overall, he "found a higher incidence of all cancer in areas contaminated with plutonium, compared to the unexposed area."[38]

DOE effort to refute Johnson's cancer incidence study failed: DOE paid Kenneth S. Crump, one of its own scientists, to refute Johnson's cancer-incidence study. When he used the same data that Johnson used, he got the same results. When he examined data from a decade later (1979 -81), he found a reduced cancer incidence in Area I nearest Rocky Flats, with the highest incidence in Area II, the urban core. He advanced the thesis that cancer incidence in both cases had nothing to do with Rocky Flats but was due to the "urban effect" measured by distance from the State Capitol building in Denver. He asserted that there was no evidence of "a relation between environmental exposure to plutonium from Rocky Flats and cancer incidence."[39]

---

[34] Johnson, Report to the Jefferson County Board of Health (March 31, 1977).
[35] Rocky Flats Oral History Program Boulder Public Library, James S. Stone, 0H1302-2.
[36] See McKinley and Balkany, A*mbushed Grand Jury*, pp. 122, 187, 194-196.
[37] Rothe, Comments on the June 9, 2015, NIOSH White Paper, July 10, 2015; received by email from Jon Lipsky, July 14, 2015. NIOSH is the National Institute for Occupational Safety and Health.
[38] Johnson, "Cancer incidence in an area contaminated with radionuclides near a nuclear installation," *AMBIO* (October 1981), vol. 10, 4, p. 178.
[39] Crump et al., 1987 "Cancer incidence patterns in the Denver Metropolitan Area in relation to the Rocky Flats Plant," *American Journal of Epidemiology* (1987), vol. 126(1), pp. 127-135. See also Crump et al., "Statistical analyses of cancer incidence patterns in the Denver metropolitan area in

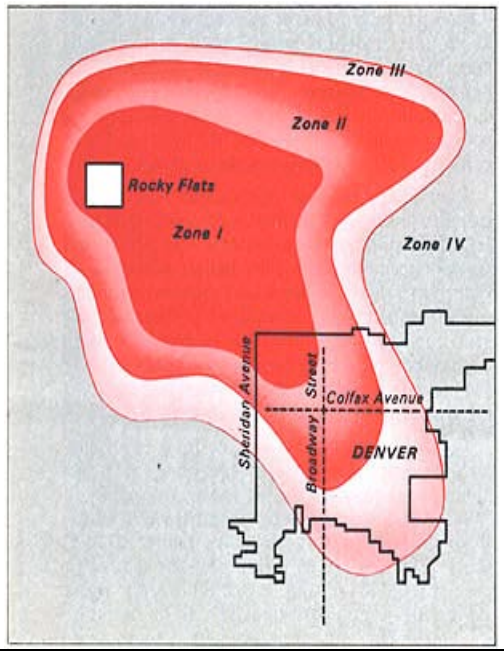


Figure 5.9: Jonson's map, as produced in color by John Craig Freeman. Areas I, II and III on the map are contaminated with plutonium released from Rocky Flats. In the non-contaminated Area IV cancer incidence is roughly equal to the rest of Colorado. See the text above for the cancer incidence in the three contaminated areas. From Johnson, "Cancer Incidence in an Area Contaminated with Radionuclides Near a Nuclear Installation," *AMBIO* (October 1981), vol. 10, no. 4, p. 177.

Johnson, in a published response, pointed out that Crump was able to claim a lower percentage of cancer for areas near Rocky Flats only by setting aside his own isopleth approach in favor of dividing the Denver region into six equal pie-shape sectors centered on and radiating out from the State Capitol building in downtown Denver. When Crump analyzed cancer incidence in each of these six sectors, he concluded that the incidence of cancer in the sector that included Rocky Flats was not appreciably different from its incidence the other sectors. But, Johnson, in a published reply, pointed out, the sector that included Rocky Flats also included the upwind non-contaminated City of Boulder (1970 population 66,870). Adding Boulder's population results in greatly undercounting the percentage of cancer incidence related to Rocky Flats (see Figure 5.10).

When Crump used Johnson's isopleth approach he got the same results as Johnson for 1969-71, while for 1979-81 Crump found, as noted, a decline of cancer incidence in the area nearest Rocky Flats. Johnson attributed this reduction to the very large in-migration into his Area I during the 1970s, significantly lessening the percentage of people in the contaminated area counted in Johnson's original study.[40] Despite this careful rebuttal, DOE and other agencies ignored what Johnson wrote and continued to tout the Crump study as definitive. And those simply eager to dismiss Johnson ignored him and cited Crump. Richard W. Clapp, one of the country's foremost epidemiologists, said he'd never heard of something called "the urban effect" having anything to do with cancer incidence anywhere. He contacted Crump and sought an explanation, but Crump was unable to give one. In Clapp's view, Crump's attempt to refute Johnson is a failure.[41]

---

relation to the Rocky Flats plant," Report for DOE contract #DE AC04-76EV01013, Subcontract 8115006, Lovelace Inhalation Toxicology Research Institute, Albuquerque, NM (August 20, 1984).

[40] Johnson, "Cancer incidence patterns in the Denver Metropolitan Area in relation to the Rocky Flats Plant," *American Journal of Epidemiology* (1987), vol. 126 (1), p. 153.

[41] Clapp, Report submitted 13 November 1996 for plaintiff's counsel in *Cook vs. Dow Chemical and Rockwell International*, United States District Court, District of Colorado.

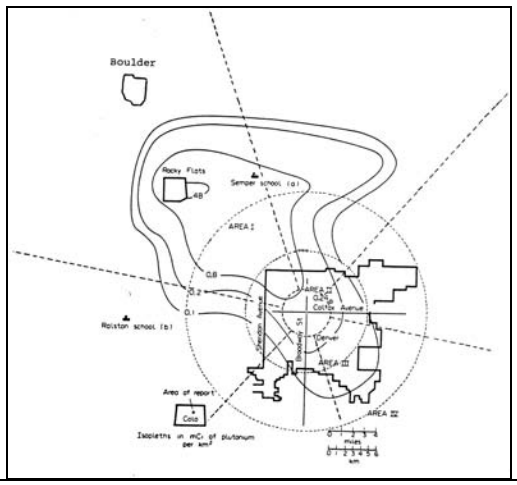


Figure 5.10: Crump divided the Denver area into six sectors radiating outward from the State Capitol Building, then analyzed data from these sectors to demonstrate the "urban effect" on cancer incidence patterns. The figure above superimposes Crump's sectors on Johnson's map. Note that the non-contaminated City of Boulder is included in the sector that contains Rocky Flats. Adding Boulder to the sector that includes Rocky Flats results in gross undercounting of cancer incidence attributed to Rocky Flats. This image is from an unpublished paper by Johnson, "Rocky Flats Revisited: Follow-up Studies," April 1988, page 15.

Johnson loses his job when real estate interests gain control of County Commissioners: Johnson's article clearly disturbed people associated with the nuclear establishment. But it also troubled those involved in development in the burgeoning suburbs moving closer to the Rocky Flats site (see Figure 5.11). After a realtor was elected as a Jefferson County Commissioner in 1981, a changed county Board of Health, appointed by the Commissioners, voted three-to-two to give Johnson the choice of being fired (and losing all accrued benefits) or of resigning immediately. He resigned.[42] This happened five months before publication of his cancer incidence study in *AMBIO*, journal of the Royal Swedish Academy of Science. On hearing of Johnson's dismissal, Martell called him the "only man in the Denver public health community who is concerned about public health."[43]

Figure 5.11: This 1999 photo by John Till shows residential development encroaching on the Rocky Flats site from the northeast.

[42] The author was present at this meeting, which happened in Golden on May 15, 1981.
[43] Martell quoted in Timothy Lange, "They Fired Dr. Johnson," *Westword*, May 28, 1981.

Federal government's Rocky Flats Advisory Notice: The question about living near Rocky Flats caught the attention of the U.S. Department of Housing and Urban Development. In March 1979 the agency required anyone seeking federal mortgage insurance on property bought within ten miles of the Rocky Flats plant to sign the "Rocky Flats Advisory Notice" (see Figure 5.12). The notice

ROCKY FLATS ADVISORY NOTICE

Figure 5.12: Rocky Flats Advisory Notice. My text explains that this rule had a short life.

referred to "varying amounts of plutonium contamination of the soil" and to an "Emergency Response Plan" that would be implemented in the event of "an accidental release of radioactive materials" from Rocky Flats. The notice had a very brief life. Shortly after Ronald Reagan took office in January 1981, the Advisory Notice requirement was eliminated.

The Advisory Notice also had an absurd side, in that it required signatures from people who purchased property that was not contaminated. In fact, most land encompassed within a 10-mile circle around Rocky Flats would not be contaminated. The 20-kg (12-mile) concentric circle around Rocky Flats on Krey's map (see Figure 5.2, p. 37) is not much larger than a 10-mile circle; most of the land within the 20-kg circle according to Krey is well outside the contaminated area. Plutonium released from Rocky Flats was deposited not in concentric circles around Rocky Flats but in places where the wind carried it, as shown by Krey and Hardy's as well as Johnson's isopleths.

Church lawsuit by landowners claiming harm to their property and its bearing on Johnson: With his sampling of dust in 1975, Johnson had stopped residential development on land east of Rocky Flats (see pp. 47-49). In response Marcus Church and other landowners filed a lawsuit against Dow and Rockwell, operators of the plant, arguing that contamination from Rocky Flats had devalued their property. They sought $23 million for damages. Years passed before the "Church case," as it was known, came up. Finally, in December 1984 it was settled without a trial. The

plaintiffs (landowners) were paid $9 million, and it was mandated that the contested land could be used only for open space or an industrial park.

DOE and the contractors also gained control of all internal documents reviewed in this case and had the court lock them away, a step that "effectively seals off information about contamination from journalists, scientists, or concerned citizens"[44] – a measure repeated, as we shall see, in the case brought after the 1989 FBI raid of Rocky Flats to collect evidence of criminal activity at the plant (see chap. 6). After settlement of the Church case, referring to the long latency period for cancers caused by exposure to plutonium, Johnson told journalists, "Officials have permitted excessive plutonium exposures knowing that they will be through with their careers and retired before the evidence is apparent."[45]

Johnson and the Church case: Confirmation and exclusion: Though the settlement of the Church case confirmed Johnson's position that housing should not be allowed on the contaminated land, in other respects the case played out in ways not favorable to him. First, in his words, there was "a court hearing staged for the judge and the press by the attorneys and witnesses for the defendants. Nothing was to be heard from the experts for the plaintiffs [including Johnson], and there was to be no cross examination of defendants' witnesses."[46] This is injustice as theater.

With Johnson effectively gagged, CDH head Stanley W. Ferguson, citing Crump, pointedly dismissed Johnson's cancer incidence study, then stated the position of CDH: "There is no scientifically valid evidence of the creation or intensification of any health effects as the result of the existence and operations of the Rocky Flats Plant, or by the existence of any materials from the Rocky Flats Plant on soils outside of the plant."[47] Also, reversing their earlier statement that plutonium on Church land exceeded the state's standard for plutonium in soil by up to seven times, CDH now gave Church and other landowners a certificate stating that plutonium contamination on their land did not exceed the standard. By contrast, in testimony Johnson was not allowed to give, he declared that "radioactive emissions from the Rocky Flats Plant have caused an excess of cancer in the exposed areas."[48] The media ignored Johnson and quoted Ferguson.

New rules for the game: Risk assessment and cost-benefit analysis: In the 1970s and 80s, at just the time Martell and Johnson were most active in efforts to protect public health, others were developing the tools of risk assessment and cost-benefit analysis. These tools enable U.S. decision-makers to deal with threats to public health and environmental integrity without unduly impeding harmful enterprises like the nuclear industry. Incorporation of these tools into the decision-making process is based on the assumption that scientists can understand the impact of human activities on ecological and human systems well enough to predict harm and to estimate risk. The resultant risk-based regulatory regime that now prevails in the U.S. puts a price on human health and ecological well being without really knowing what that price is. It presupposes that some level of harm is acceptable without asking those affected whether it is acceptable to them. If Peter's health is robbed to pay Paul for making bombs, decision makers believe the benefit of what Paul does is worth the cost of slighting Peter. Abstract and abstruse formulations of risk are employed to consign Peter and others to disease, deformity, and premature death, whether soon or in the unknown long term.

---

[44] Iversen, *Full Body Burden*, p. 199.
[45] Johnson, Two Landmark Radiation Cases, p. 14.
[46] Ibid., p. 200.
[47] Affidavit of S. W. Ferguson in the U.S. District Court for the District of Colorado, Civil Action No. 75-1162, February 15, 1985.
[48] Johnson, "The public health impact of the Rocky Flats nuclear weapons plant in the Denver Area: A case history with recommendations' (no date).

Dose reconstruction: Substitute for a government funded health study for off-site people: The goal of the Rocky Flats dose reconstruction study which began in 1990.was to determine the history of contaminant releases from the plant and to estimate doses that off-site people may have received in order to decide whether further study was warranted. It was funded by DOE and managed by CDH, which during the study changed its name to the Colorado Department of Public Health and Environment (CDPHE). Colorado Governor Roy Romer appointed a 12-member Health Advisory Panel to oversee the study. It included, besides prominent scientists and local people, two officials from CDH (one would chair the panel) and one each from DOE and Centers for Disease Control. A panel with one-fourth of its members from state and federal agencies would not stray far from the risk assessment orthodoxy that typically informs studies of this sort.

The nine-year study (1990-1999) estimated that total offsite plutonium releases for the production years, 1952-1989, ranged from 4.8 to 51.3 curies.[49] One curie is the quantity of any radioactive material that undergoes 37 billion disintegrations or releases of radiation per second. Thus, according to their estimate, plutonium released from Rocky Flats to the offsite environment emits between 176.6 billion and 1.9 trillion bursts of alpha radiation each second. After 24,110 years (the half-life of plutonium-239), the number of alpha bursts per second will be reduced by half. The material remains in the environment in the form of particles too small to see, but not too small to be inhaled or otherwise taken into the body, where it may harm one's health.

Periodic meetings to involve the public in the dose reconstruction study were sometimes informative, often tedious, occasionally contentious. Technical specialists and the engaged public interacted intensely in efforts to reconstruct major accidents and contaminant releases. But when it came to estimating risk, the abstractions of the "experts" left me and I suspect others with the sense of being reduced to a spectator. The study's final report session felt something like a triumphal celebration, as if those affected were expected to rejoice at learning that, though as much as 51.3 curies of plutonium may have been released offsite, risks were inconsequential and further studies were not warranted. I could imagine those alpha particles surrounding us and ticking away. It was a bit unnerving.

The CDPHE calls the dose reconstruction study a "health study," but it was no such thing. Indeed, it concluded that an actual health study was not warranted. The only situation in which a dose reconstruction study would point to the need for direct health study would be where there is an undeniable correspondence between known large releases of a particular contaminant and its known physical effects. An example is large releases of radioactive iodine from DOE's Hanford facility matched by the high incidence in the area of childhood thyroid cancer, a cancer attributed solely to the presence of iodine in a single organ.[50] Plutonium released from Rocky Flats can certainly cause cancer in exposed people, but any cancer caused by plutonium can also have other causes.

The CDPHE has generally interpreted the study as providing scientific confirmation of the absence of adverse health effects. Unknown to outsiders, some members of the Health Advisory Panel wanted additional research on plutonium in water as it affects downstream communities, a proposal vetoed by the panel's CDPHE chair. Others thought the final report should emphasize in the strongest manner possible that the Denver-area population had been subject to the risk of a major cataclysm due to careless operation of the plant. Specifically, had the 1969 fire breached the roof of the building where it raged, Denver almost certainly would have faced evacuation. Because the final report downplayed this matter, a prestigious independent scientist who was a very active

[49] Summary of Findings, Historical Public Exposures Studies on Rocky Flats (Denver: Health Advisory Panel and CDPHE., August 1999).

[50] Tim Connor, *Burdens of proof: Science and public accountability in the field of environmental epidemiology, with a focus on low dose radiation community health studies* (Columbia, SC: Energy Research Foundation, 1997).

member of the panel, David Albright, president of the Institute for Science and International Security, refused to sign the final report.[51]

The study concluded that the largest single plutonium release was from the 1957 fire and that the person likely to have received the highest exposure was a laborer working outdoors in the direct path of the plume of plutonium-laden smoke from that fire (see Figures 4.8 and 4.9, pp. 32 and 33). The researchers produced a dose calculator that could be used by anyone present in the Denver area at the time of the fire to estimate their dose according to their location. By the time the calculator was finished, however, the CDPHE chair had dissolved the oversight panel by the simple expedient of convening no more meetings. The calculator thus was never made available, and affected people were denied the chance to learn of the dose they may have received back in 1957.

Needed studies that never happened: Despite the conclusion that there is no need for further health studies, others have strongly disagreed. Here are notable examples:

- In 1982, Martell said that the plutonium in the soil east of Rocky Flats "involves risks that are sufficiently serious that only epidemiological studies of the next several generations of people living in that area can really find out what is going on."[52]
- In 1996, nurses at the University of Colorado medical center conducted a community needs assessment and concluded that community-based epidemiological studies should occur in areas affected by Rocky Flats.[53] For anyone who wonders, an epidemiological study is not a direct health study. Instead, it is a statistical analysis, like Carl Johnson's cancer incidence study in which he compared the number of cancers within a specific geographical areawith the plutonium contamination in that same area. He provided what is sometimes called "circumstantial evidence" of the cause of the cancers.
- In 1996, Boston University epidemiologist Richard W. Clapp performed a small epidemiological study in which he found excessive incidence of lung and bone cancers in areas near Rocky Flats. He concluded that "the most recent data are indicative of an ongoing health effect and support the need for surveillance of the incidence of cancer and other diseases on a continuing basis in the exposed communities."[54] He, like Martell, thought only epidemiological studies repeated over several generations in the contaminated area would help us "really find out what is going on."

The programs that Clapp, Martel and the nurses proposed have never taken place. Indeed, there has never been any direct health study or medical monitoring of people who live in areas contaminated with plutonium released from Rocky Flats. Hence, no one really knows the actual health effects of living in such areas.

The kind of public health analysis that should have happened for people in the vicinity of Rocky Flats: The Fernald Medical Monitoring Program established at DOE's Fernald uranium processing facility near Cincinnati, Ohio, was created as a result of a class action lawsuit. From 1990 to 2008 this program provided comprehensive health monitoring for 9,782 individuals. DOE paid for monitoring and diagnosis, not for treatment. Having one's heath monitored relieved some individuals of worry, while for others it provided an early warning of problems in need of attention.[55] A program of this sort should have been set up by the federal government for all DOE nuclear weapons facilities. One of the administrators of the Fernald Program told me that soon after the program was

---

[51] Personal communication with David Albright, Washington, DC, March 30, 2004.
[52] Martell, Interviewed by Robert Del Tredici, 1982.
[53] N. J. Brown et al, *Rocky Flats community needs assessment report* (Denver: UCHSC School of Nursing, 1996), p, 46.
[54] Clapp, Report submitted 13 November 1996 for plaintiff's counsel in *Cook vs. Dow Chemical and Rockwell International*, United States District Court, District of Colorado.
[55] See http://www.eh.uc.edu/fmmp/ and http://cctst.uc.edu/sites/default/files/files/Slides%20Pinney%202011-01-27.pdf

created DOE officials decided that nothing like this would be allowed at any other DOE site. One of the original goals of Cook v. Rockwell & Dow, the class action lawsuit brought as a result of the FBI raid on Rocky Flats in 1989, was to see a similar health monitoring program set up for people who lived in areas known to be contaminated with plutonium released from Rocky Flats. The judge disallowed this public health aspect of the case before it went to trial and restricted the case solely to harm to property. People around Rocky Flats would have benefitted from a medical monitoring program like the one at Fernald, and we all would have had much more information about health effects from exposure to plutonium and other toxins released from Rocky Flats. It was not to be.

Kristen Iversen, author of *Full Body Burden: Growing Up in the Nuclear Shadow of Rocky Flats* (NY: Crown, 2013), now has a web site that presents accounts of people who grew up or lived near the Rocky Flats plant. Many of these stories are about health problems people believe are related to Rocky Flats. See Rocky Flats Stories at http://www.kristeniversen.com/rocky-flats-stories . Perhaps at some point in the future this anecdotal record can be used to get medical monitoring of .the sort done at Fernald and recommended for Rocky Flats by Richard W. Clapp (see preceding).

CDPHE says cancer incidence near Rocky Flats is about the same as anywhere else in the metro area: In 1998 CDPHE dismissed Johnson's concern with a report claiming that those living near Rocky Flats have no higher incidence of cancer than people elsewhere in the metro area.[56] But, like Crump's study, this one distorts reality by mixing populations exposed to plutonium with populations not exposed. In a letter to attorney Caron Balkany, co-author of *The Ambushed Grand Jury*, German radiation specialist Bernd Franke sharply criticized this report. "It appears," he wrote, "that the study design was chosen to calm people down, for public relations purposes, rather than for any real scientific reason."[57] Rather than protecting the public, CDPHE's study approves residential development on contaminated land.

Assessing Carl Johnson: The Rocky Flats work for which Johnson was celebrated and vilified and for which he was forced from office was done in the final six years and five months of the seven years and eight months that he served as Director of Public Health for Jefferson County. Since the termination of his very brief tenure, no one remotely like him has occupied an official position related to public health vis-à-vis Rocky Flats — no county or state or federal official. Johnson stands alone as an untiring advocate for people whose health may have been harmed by Rocky Flats, inside or outside the facility. Though he made himself available to concerned individuals and groups (he met with a study group I organized in 1979), the primary arena of his work was with personnel from government agencies, especially DOE and CDH. His Rocky Flats work is densely documented in the many articles and reports he prepared as well as in his voluminous correspondence.[58]

By the time Johnson died on December 29, 1988, he was a much-published, internationally respected researcher and specialist on radiation health effects. At the urging of former Interior Secretary Stewart Udall, he did the first-ever study of down-winders from the Nevada Test Site.[59] He was in considerable demand abroad as well as elsewhere in the U.S. But in Colorado he was in eclipse, dismissed by nuclear technocrats as well as by promoters of urban sprawl. The constant criticisms of his cancer incidence study by nuclear establishment figures gave unreflective boosters of urban development a rationale for ignoring his warnings.

---

[56] Colorado Central Cancer Registry, *Ratios o f Cancer Incidence in Ten Areas Around Rocky Flats, Colorado Compared to the Remainder of Metropolitan Denver, 1980-89 with Update for Selected Areas, 1990-95* (Denver: CDPHE, 1998).
[57] Franke to Balkany, December 2, 2002.
[58] The papers of both Johnson and Martell are archived at the University of Colorado, Boulder.
[59] Johnson, "Cancer incidence in an area of radioactive fallout downwind from the Nevada Test Site." *Journal of the American Medical Association* (1984), vol. 251, pp. 230-236.

On December 18, 1988, less than two weeks before he died, Johnson published in the *New York Times* an op-ed called "Rocky Flats: Death, Inc." He recounted his years with Jefferson County, explaining various studies he had done and how, "as a result of the buildup of enormous political pressures by vested interests," he was forced from office. He concluded that if people are "to be properly protected, all studies of nuclear contamination and associated health effects should be conducted primarily by independent scientists who are insulated from cynical retaliation."

The Denver Post published a tribute to the deceased Johnson headlined "Doctor warned of Rocky Flats danger" six days after the FBI raided Rocky Flats on June 6, 1989, to collect evidence of environmental crimes allegedly committed at the facility. The article came close to saying that Carl Johnson was right all along. It quotes an anonymous Rocky Flats insider who said Johnson "wasn't as off-base as we used to say he was." For many, the fact that the FBI was investigating Rocky Flats confirmed that Johnson knew what he was talking about.

Johnson delved into the details of radiation health effects to understand in the most thorough way possible what "proper" protection of public health would entail. He reminds us that any purportedly "safe" dose of radiation may be the one that will tip the scales against us. Our fate may be sealed 20 or 30 years before symptoms appear. He was an exemplar of caution on behalf of the unassuming public. But the rules by which he worked were not the rules by which others played the game. There is a striking difference between public health as service to the public and public health as obeisance to the nuclear industry and the economy of denial.

John (Jock) Cobb, MD, of the University of Colorado Medical School studies Rocky Flats plutonium in bodies of deceased people who were autopsied: It's hard to imagine this happening now, but in the 1970s the EPA-asked Cobb to collect body samples of Colorado people who had died and been autopsied, then to research the collected tissue to see how much Rocky Flats plutonium was deposited in the bodies of these deceased individuals. This would show definitively to what extent people who lived downwind of Rocky Flats had taken into their bodies various quantities of plutonium released from the plant. Having the study sponsored by EPA meant that the DOE would not control the results. It is well known that plutonium deposited in the tissue of lung, liver and bone will continue to irradiate surrounding tissue, typically for the rest of one's life. So EPA asked Cobb to study lung, liver and bone tissues. But he also wanted to study the presence of plutonium in the tissue of the gonads, because this would have a genetic effect that could be passed on to future generations. Such a study was far more complicated than analysis of lung, liver and bone. Moreover, it had never been done by anyone, and Cobb wanted to do it. He told the EPA he'd do the study only if he could add gonads research. EPA approved this. The study began in 1975.

Cobb's team of researchers measured plutonium concentrations in body tissues collected from more than 500 persons who died and were autopsied in Colorado hospitals, several in the Denver-area, one in Pueblo. Researchers routinely sought permission from the closest of kin to take the samples. The study compared those who lived near Rocky Flats with those who lived far from the site. The bodies of all these people contained plutonium from bomb fallout, but those who lived nearer the plant had identifiably Rocky Flats plutonium in tissues of lung, liver and bone, with contents higher the closer the person lived to the plant. Cobb periodically shared study results with DOE and Rockwell officials. They found the results embarrassing, but they couldn't stop the study, because it was funded by the EPA. So they tried to get rid of Cobb, even sought to get him dismissed from the university medical faculty. This failed, because he had tenure.[60]

The study was well underway when Reagan became president in January 1981. Anyone old enough to recall will remember that his administration tried to destroy the EPA. Ann Gorsuch (later

[60] Most of the information in these several paragraphs on Cobb is drawn from the interview with John Cobb, Rocky Flats Oral History project, Maria Rogers Oral History Program, OH1180V.

married and known as Ann Buford and the mother of Supreme Court Justice Neil Gorsuch) was named head of the EPA by Reagan. She terminated the funding for Cobb's study, so it ended before it was completed. Cobb insisted that the data already gathered be made publicly available, but people at EPA resisted. When Cobb persisted, EPA personnel rewrote the report's conclusion to say that Rocky Flats harmed no one. In response Cobb appealed to members of Congress to get the report's original language restored. Finally, the report, more or less in its original language, was made available by the National Technical Information Service.[61] You could get a copy only if you contacted them and paid a fee. Very few people ever saw the report or knew of its existence. Rumors were that Cobb had found nothing worth reporting. But when it appeared the report stated clearly that plutonium from Rocky Flats was present in lungs and liver of people who lived near the plant. Results of the study, if not widely available, at least were formally recorded. The report can be read at Archives of the Atomic West in Norlin Library, University of Colorado in Boulder.

Cobb's plan to study plutonium in the gonads, with an eye on the effect on future generations, did not happen: For Cobb the most important part of the study was not done. His research team had collected tissue from lung, liver and bone, but also from the gonads. "It was my hypothesis," he said in his oral history interview, "that the plutonium was being deposited in the gonads, right where it would be affecting the sperm and causing mutations in the sperm, which would then show up . . . in future generations as . . . childhood cancers, deformities, and all that sort of thing." He was familiar with studies of plutonium in gonads of rats. These studies showed that plutonium was "deposited in the basement membrane" of the gonads "right near where the sperm were being generated. . . . This would be the worst place to have plutonium in your body, and if it was there in significant amounts that would be not only endangering the present but all future generations, because it would be damaging the genes."

The research Cobb was most eager to do had never been done with humans, and, so far as I know, has not yet been done. "It takes a whole lot more finesse," he said, "to find the amount of plutonium in the gonad, which weighs only 5 or 6 grams, maybe, than it does in a lung, which is maybe a thousand grams." So the samples from the gonads "were left for last." One of his colleagues in the study was a man named Wes Erford, who undertook the task of developing a method for measuring the very tiny amounts of plutonium deposited in the gonads. His success in doing this was a major breakthrough for studying the gonads, but it happened just as funding for the study ended. Thus Cobb and his team never got to take advantage of Erford's innovation. With the end of the study, all the gonads samples, which remained unexamined, were "sent to Los Alamos by the EPA." Sending the gonads samples to DOE's Los Alamos Lab of course was done by Reagan's EPA, greatly changed from the original agency that was actually an environmental protection agency.

At Los Alamos the gonads samples sat in a freezer for 20 years. When Shawki Ibrahim of Colorado State University's nuclear research program learned about these samples he asked Los Alamos to send them to CSU. He designed a study that could gain government support. Cobb had intended to find out how much plutonium was in the gonads of individuals and to show on a map where each person lived and how much plutonium was present in that person's gonads. This information would show where genetic problems might appear in later generations, a type of research that, as pointed out earlier, had not previously been done anywhere. Ibrahim's plan, by contrast, "would have negated" what Cobb had hoped to find out. According to Cobb, Ibrahim "was going to take all the gonads [samples] and put them into one big pot and analyze the whole thing and then get a figure from that of how much [plutonium] was in each gonad on average." Ibrahim sought Cobb's blessing for this approach, but Cobb didn't give it, because only separate analysis of individual samples would provide the important results he wanted. Ibrahim's approach would totally destroy the very possibility of learning about the presence of plutonium in the gonads of specific

[61] Cobb et al., "Plutonium Burdens in People Living Around the Rocky Flats Plant," March 1983, EPA-600/4-82-069, Springfield, VA: National Technical Information Service.

persons. Cobb died in 1993. In August 2014, in email exchanges with Ibrahim I learned, first, that the gonads samples were sent from Los Alamos to CSU; and second, that, though the samples were kept securely in a freezer at CSU, they were destroyed by a weekend power outage. Thus ended what could have been a pioneer study of plutonium from Rocky Flats in human gonads.

Controversy over plan to incinerate plutonium waste: In the mid 1980s the DOE and plant operator Rockwell International proposed operating a new incinerator in Building 776 to burn plutonium waste at Rocky Flats. This would dispose of some of the plant's huge backlog of nuclear waste, but it would also release even more plutonium particles into the Denver area. To prevent this, Jan Vittum, who volunteered with the American Friends Service Committee in Denver, in 1987 convened five independent scientists, whom she called "the Boulder scientists" because all but one of them lived in Boulder. The group included Martell, Nichols, Biggs, chemist Niels Schonbeck from Metro State, and engineer Joe Goldfield, who had designed the kind of filters used in the plutonium facilities at Rocky Flats. From their several disciplines, in public meetings and via their writings, they showed that incinerating plutonium at Rocky Flats would be unhealthy for people of the Denver area. By the end of 1987 it appeared that the DOE had vetoed the idea and there'd be no incineration of plutonium. But in fact the idea went underground and shifted to using the older Building 771 incinerator that had burned plutonium previously but now was illegal to operate[62] (see Figure 5.13). A few months later, in June 1989, when the FBI and EPA raided Rocky Flats, running this 771 incinerator became one of the most prominent issues to be investigated. It will be taken up later.

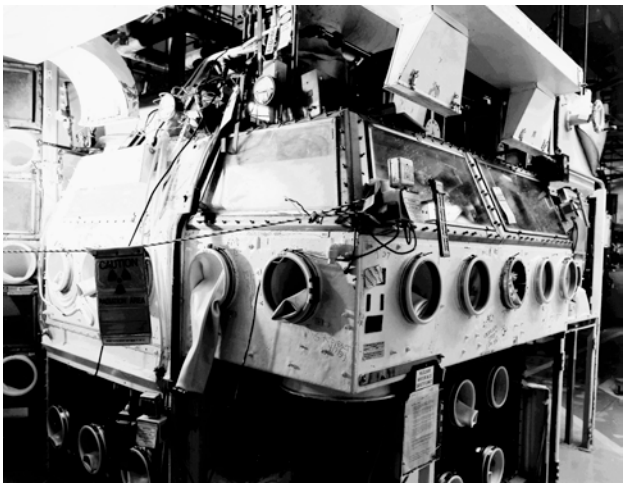


Figure 5:13: Building 771 incinerator. In the late 1980s Rockwell wanted to burn plutonium-contaminated waste in a new incinerator in Building 776. Due to strong public opposition this was not done. The FBI later alleged that the waste instead was illegally burned in the 771 incinerator.

The dawn of organized resistance to Rocky Flats, its distinctiveness and its multiple forms: Resistance to nuclear weapons was initiated by a few scientists of the Manhattan Project who thought nuclear weapons made war obsolete. They called themselves "nuclear pacifists."[63] Atmospheric testing of nuclear weapons attracted more resisters, because of the public health danger of radioactive particles sprinkled across the earth. Resistance to Rocky Flats is distinctive because it was the first organized opposition to a facility that actually produces nuclear weapons. Activists at Rocky Flats created a practice that has been followed elsewhere, in the U.S. and abroad.

[62] On earlier operation of this incinerator, see Ackland, *Making a Real Killing*, p. 288, note 15.
[63] On this activity at Los Alamos, see Rosalie Bertell, *No Immediate Danger? Prognosis for a Radioactive Earth* (Toronto: Women's Press, 1985), pp. 140-43).

In 1974 the American Friends Service Committee (AFSC) in Denver hired Judy Danielson and Pam Solo to share a staff position focused on Rocky Flats. They were the first paid organizers and for quite a while the only ones. The small numbers of participants at the beginning grew quickly to hundreds and thousands, soon gathered into 50 to 60 groups, all seeking the truth about Rocky Flats and spreading the word about what they learned. There were all manner of groups – students, seniors, work colleagues, neighbors, religious groups, artists, musicians, dramatists, businesses, academics, poets. There were dozens of ways of opposing Rocky Flats and the nuclear enterprise – writing, speaking, debating, street theater, marches, music, poetry, art, lobbying, study groups, rallies, as well as educating the public on the nuclear fuel cycle, radiation health effects, nuclear winter, deterrence, the Non-Proliferation Treaty and more. Activities like these burgeoned.

Former school teacher Alex Mayer planted a "peace garden" across the road from the west gate main entrance to Rocky Flats. Often destroyed, he replaced it with new plantings by the next day. The Denver Catholic Worker held a vigil at the west gate every Sunday for ten years. One-day vigils at the west gate were common. Artists hung a giant "Shutdown Rocky Flats" banner from a building near the State Capitol. A street theater group could appear at any time in downtown Denver or elsewhere with a new skit deploring bombs and calling for an end to the arms race.

Taxpayers pay for pollution and Price-Anderson protects polluters: The preceding pages tell of contamination on and off the Rocky Flats site. The government hires and pays for the polluter – with money from taxpayers. The Price Anderson Act, adopted in 1957 and renewed several times since, "indemnifies the nuclear industry against nuclear accidents and exempts corporations from penalties associated with their actions, even in the case of gross corporate negligence. . . . Companies like Dow and Rockwell can pollute without penalty, and the taxpayers bear the cost."[64]

Paying for protest: Paid organizers were actually rare. Most of the groups opposing Rocky Flats went hand to mouth, working things out as they went along. An incredible array of activity was peopled by volunteers with costs covered by people who scrimped, saved and sacrificed, though they were often called "pinkos," told to "get a job" and accused of being paid servants of the Soviets.

Legal rallies and releasing of balloons at Rocky Flats: In the spring of 1978 and 1979 legal rallies were held at Rocky Flats, the first drawing about 5,000 people, the second roughly 12,000. Famous people gave speeches – Pat Schroeder, Daniel Ellsberg, Helen Caldicott, George Wald – and pop musicians performed – Jackson Browne and Bonnie Raitt. A dramatic moment in the 1979 rally was the unleashing of more than 2,000 helium-filled balloons, each with a tag informing the finder that it was released from Rocky Flats and asking that it be mailed back to a Denver address. The idea was to find out where the wind carried plutonium released from Rocky Flats. Tags came back from as far away Illinois, Indiana, Iowa, Kansas and Nebraska (see Figure 5.14).

A symbolic blockade of the railway tracks at Rocky Flats became a real blockade and ruined the chance to make common cause with Rocky Flats workers: In the heady days of the rapidly growing movement of resistance, staff from AFSC and other groups invited people from all across the country to come to Rocky Flats for a big rally on Saturday, April 29, 1978. The rally would demand that Rocky Flats be "economically converted" from making weapons of mass destruction to making something socially useful. T-shirts made for the occasion depict a bomb being turned into a mass-transit train (see Figure 5.15). The rally would be followed by an overnight "symbolic blockade" of the railroad tracks leading in to the plant, the intent being to show that the resisters had the numbers to do a real blockade later if there was no progress on economic conversion of the plant. Police and federal marshals agreed that because the blockade was "symbolic," no arrests would be made. The plan had been carefully vetted not only with management and security officials

[64] Iversen, *Full Body Burden*, pp 123-124. See Moore, *Citizen's Guide*, pp. 4-5.

at the plant but also with leaders of the production workers union, so they would know that no one was trying to deprive them of a job.

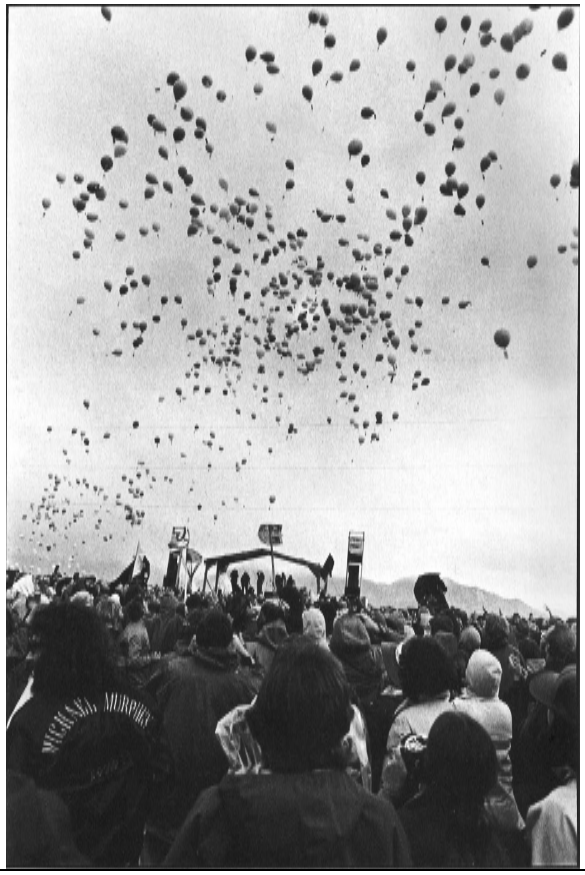


Figure 5.14: Balloons being released from Rocky Flats, April 29, 1979. Photo from Joseph Daniel, *A Year of Disobedience* (Boulder: Daniel Productions, 1979), p. 84.

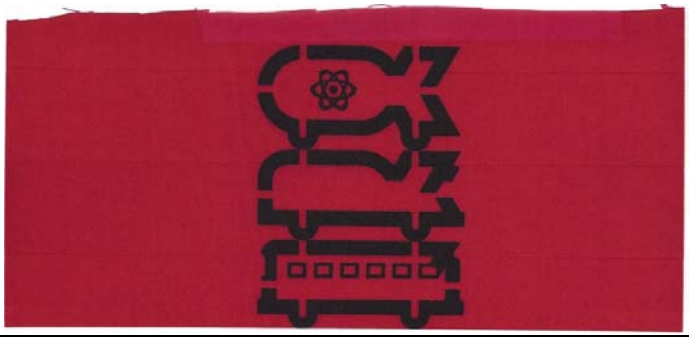


Figure 5.15: Rocky Flats economic conversion. The message on T-shirts in 1979 was to convert the plant from making bombs to making trains for mass transit.

All went according to plan, except that when organizers of the weekend events arrived at Rocky Flats early Sunday morning they learned that 35 individuals who'd spent the night on the tracks – Daniel Ellsberg of Pentagon Papers fame among them – were determined to remain on the tracks. Dubbing themselves the "Rocky Flats Truth Force,"[65] they turned a symbolic blockade into a

[65] Gandhi's term for nonviolence, "satyagraha," translates as the force of truth, or truth force.

real one. The peaceful scenario of the original organizers quickly degenerated into a shouting match between people who opposed Rocky Flats in different ways. The most serious downside was that workers at the plant felt betrayed by those occupying the tracks. Ironically, an event that brought national and international attention to resistance at Rocky Flats wrecked any possibility of making common cause with Rocky Flats workers. At the Fernald and Mound nuclear weapons plants in Ohio, anti-nuclear activists were able to work closely with nuclear workers on public health and environmental issues, but the possibility of doing this at Rocky Flats was ruined.

When those on the tracks were arrested and removed, they were replaced by others. Keeping the tracks occupied became a collective commitment. The blockade continued for a year, probably the longest sustained civil disobedience action in U.S. history (see Figure 5.16). Patrick Malone's teepee

Figure 5.16: First arrest of members of the Rocky Flats Truth Force. When people were removed from the tracks, others soon took their place. Photo from Daniel, *A Year of Disobedience*, p. 55.

on the tracks at Rocky Fats became a highly visible icon inviting people passing by on nearby Highway 93 to visit or to join the occupation (see Figures 5.17 and 5.18).

Figure 5.17: The teepee on the tracks. Photo from Daniel, *A Year of Disobedience*, p. 61.

Figure 5.18: Bearded poet Allen Ginsburg and friends about to be arrested for blocking a train at Rocky Flats. Photo from Daniel, *A Year of Disobedience*, p. 60. Ginsberg's poem, "Plutonian Ode," comes from his time on the tracks. Philip Glass turned the poem into his Symphony No. 6. See http://www.philipglass.com/music/recordings/symphony_6.php.

Civil disobedience preferred by many: The message of civil disobedience: "I break a law of the land in obedience to a higher law, such as, thou shall not kill, and I willingly accept punishment for what I do." Despite the serious loss of not being able to make common cause with workers at the plant, civil disobedience became a preferred option for many who opposed Rocky Flats.

On Nagasaki Day, Sunday, August 9, 1987, several hundred were arrested for civil disobedience, not at the west gate main entrance to Rocky Flats but at the more contaminated east gate. Plant officials forced the activists to go there by closing the west gate. The turnout was large and arrests were delayed because many resisters locked themselves to the fence. Radio broadcasts were soon telling workers not to come in to work that day. Though it was a Sunday, the plant was then operating around the clock seven days each week. This was the only time activists succeeded in shutting down the plant for a day.

Jennifer Haines, who moved from the east coast to Colorado to do something about Rocky Flats, found that solo civil disobedience was her forte. Arrested often, she spent four-and-a-half years in federal penitentiaries, where her life was made difficult because she insisted on using her given name rather than the identifying number assigned to her by the imprisoning government. She tells her impassioned story in *Bread and Water: A Spiritual Journey* (Orbis Books, 1997).

On Ash Wednesday 1983, Sister of Loretto Pat McCormick and Mennonite Mary Sprunger-Froese drove to Rocky Flats in a car that wouldn't go into reverse. At the plant they joined the line of cars taking workers in for the day shift. Though they had no passes, at the security gate they were waved through. On the fence of the high security plutonium processing area they hung crosses and a banner on which they poured blood. They kneeled to pray, and waited – and waited. Eventually a security guard asked, "What are you doing here?" Their answer: "We're commemorating Ash Wednesday." "Oh," he said, "I forgot to go to mass." "This can be your mass," Pat told him. She and Mary were arrested and carted away.

The civil disobedience blockade of the railroad tracks leading into the Rocky Flats plant was the subject of *A Year of Disobedience* (1979), a book of photos by Joseph Daniel. His photos were accompanied by Keith Pope's historical narrative, Daniel Ellsberg's statement at the subsequent trial of the disobedient ones, and Allen Ginsburg's "Plutonian Ode." To celebrate the 35th anniversary of the Rocky Flats Truth Force, Daniel brought out an enlarged edition, called *A Year of Disobedience and a Criticality of Conscience* (2013). The new book contains photos not included in the first one, my summary of the history of resistance to Rocky Flats, an interview with Ellsberg about the current nuclear weapons situation globally, and brief biographies of a few members of the Truth Force.

My personal activity regarding Rocky Flats began with civil disobedience of sitting on the tracks leading in to the plant in April 1979. Getting arrested and put on trial in federal court was an unexpected education. I was arrested as part of an affinity group. The judge in the case asked each of us to write a statement of what we intended to tell the jury. I wrote that I would say that it was the government, not us, who were breaking the law. The government had pledged with Article VI of the Nuclear Nonproliferation Treaty of 1968 **"**to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." According to the Constitution an agreement like this has the force of law. Since the U.S. government has ignored what the Treaty says, it is breaking the law. The judge responded that I was forbidden to say this in the court. This was an education on the injustice of the justice system.

Civil disobedience is not for everyone: Not everyone favored the more confrontational approach of civil disobedience, with the inevitable arrest, trial and possible imprisonment. In fact, the civil disobedience practiced by the Truth Force and others strengthened the political middle of the

movement. It helped legitimize other ways of opposing Rocky Flats, many of them noted above. There was something for everyone. And all these actions fed into the Nuclear Freeze movement of the early 1980s – an appeal that both the U.S. and the USSR engage in a bilateral freeze of the manufacture of nuclear weapons. On June 12, 1982, a million people gathered in New York's Central Park to call for an end to the nuclear arms race.

"We're not breaking the law; the government is": One small group from among the roughly 300 who were arrested at Rocky Flats on August 9, 1987, and Ken Gordon, their pro bono lawyer, deserve to be singled out. When they were put on trial in federal court for their arrest, Gordon persuaded the judge to allow them to be tried not for trespass as charged but under Colorado's "choice of evils" defense. Instead of being tried for having disobeyed the no-trespass law, they chose to argue that it was the government, not them, that broke the law. They were allowed to say what I was forbidden to say a few years earlier. The government's illegal behavior was its failure to abide by its obligation under Article VI of the Nuclear Non-Proliferation Treaty to work in good faith for the total abolition of nuclear weapons. They reminded the court that according to the Constitution international treaties ratified by the government have the force of law. The judge allowed this defense, and the jury, having heard it, found the defendants not guilty as charged. This is the only time in all the many court trials of those arrested for opposing Rocky Flats that any individual or group was acquitted.

Local artist shows the magnitude of the nuclear weapons enterprise: Denver artist Barbara Donachy very effectively addressed the question of how to convey the enormity of the nuclear weapons enterprise. Her *Amber Waves of Grain*, produced in the mid-1980s, vividly depicted the size of the U.S. nuclear arsenal with roughly 31,500 miniature ceramic replicas of nose cones, one for each warhead in the U.S. arsenal at its peak size (see Figure 5.19). For each warhead, of course, Rocky Flats produced the plutonium pit. Her work was exhibited in cities across the country.

Figure 5.19: "Amber Waves of Grain," by Denver artist Barbara Donachy, depicting with miniature ceramic nose cones all the warheads in the U.S. nuclear arsenal, a total of about 31,500. Photo of display at the Boston Science Museum, February 13, 1985. From Robert Del Tredici, *At Work in the Fields of the Bomb* (NY: Harper & Row, 1987), Plate 106.

Encirclement of Rocky Flats: A demonstration of heart and silence, with an afterthought warning: The most beautiful demonstration at Rocky Flats itself was the October 15, 1983, encirclement of the plant by about 17,000 individuals. No speeches by famous people, no rock musicians, no politicians looking for votes, no trespass or civil disobedience, nothing but the sound of the wind and birds and, at a given moment, the playing of taps (see Figure 5.20). As beautiful as this event was, I learned later that Ed Martell, who'd blown the whistle on the public health danger of Rocky Flats, was horrified that wholly innocent people, especially children and women of child-bearing age, were invited to mingle where plutonium had been deposited in the soil.

Figure 5.20: Encirclement of Rocky Flats, October 15, 1983. Photo by Siri Jhoda Singh Khalsa.

Founding of the Rocky Mountain Peace Center: At precisely the time of the encirclement of Rocky Flats, six activists, three men and three women, created the Rocky Mountain Peace Center in Boulder (now the Rocky Mountain Peace and Justice Center). Committed to nonviolent action, from the outset the Peace Center offered civil disobedience and nonviolence training for any who sought it while also encouraging participation in the full range of activities opposing bomb production at Rocky Flats. After production ended at Rocky Flats only half-a-dozen years later, the Peace Center persisted as the key organization seeking the best possible cleanup of the highly contaminated site, a topic to be examined later. In 2010 the Rocky Mountain Peace and Justice Center initiated the Rocky Flats Nuclear Guardianship project, also to be examined later.

***Dark Circle*, award-winning documentary with a focus on Rocky Flats:** In 1982 the film *Dark Circle*, roughly half of which is devoted to Rocky Flats, premiered in Denver, bringing much new attention locally. Directed by Judy Irving, Chris Beaver and Ruth Landy, it explores the link between the nuclear weapons industry and the nuclear power industry. The footage on Rocky Flats is both revealing and disturbing. When the film was banned from PBS, the directors alleged censorship. The film is now available to purchase or rent. I highly recommend seeing it.

Environmental regulation at Rocky Flats? The 1970 passage of the National Environmental Policy Act created the Environmental Protection Agency. Did this mean there would be environmental regulation at sites like Rocky Flats? The DOE and its predecessor agencies, AEC and ERDA, insisted that the Atomic Energy Act exempted the sites of the nuclear weapons complex from such regulation. But they also claimed that they would abide by environmental law by regulating themselves. An example of such self-regulation was the 1980 Rocky Flats Environmental Impact Statement (EIS), a document that essentially declared that there was no reason for concern with environmental contamination and associated problems at the Rocky Flats plant.[66] Despite DOE's views, in 1984 the EPA recognized serious environmental contamination at Rocky Flats when it proposed adding Rocky Flats to the Superfund National Priorities List of the country's most contaminated sites. Rocky Flats was formally added to the list in 1989.

An ugly problem: Regulation of mixed waste at Rocky Flats: Here I refer briefly to only part of the waste problem, since the reader doesn't need all the details of this long and tawdry tale.[67] Earlier we observed two points about waste at Rocky Flats, first, that in regular operations large quantities were routinely produced; second, that neither DOE nor its contractors had any plan for dealing with the waste. In a sense it was ignored until it could be ignored no longer because its quantity was so great and its existence so dangerous. A third closely related problem is that DOE was self-regulating; no other government agency had authority to deal with the waste.

Most waste at Rocky Flats was "mixed waste" – that is, it contained both radioactive and hazardous but non-radioactive materials. The 1976 Resource Conservation and Recovery Act (RCRA) gave EPA and individual states authority to regulate hazardous (non-radioactive) waste. DOE argued that RCRA did not apply at its sites, because most waste at these sites contained radioactive materials. But in 1984 a federal court in Tennessee effectively ended DOE's self-regulation of mixed waste. Authority to regulate such waste was shifted from DOE to EPA and states with laws at least as restrictive as EPA's. In November 1985, however, DOE and Rockwell refused to recognize the jurisdiction of the EPA or CDH over mixed waste at Rocky Flats. CDH threatened to deny Rockwell a permit to store mixed waste. If enforced, this would shut the plant down.

Rocky Flats authorities were so determined not to accept outside regulation that they wanted to oppose it in court. But a very revealing, harshly critical memo from a high-ranking DOE official in Washington ended their opposition. She wrote: "The [RCRA] compliance posture of the Rocky Flats facility makes it a poor candidate for testing fine points of law. . . . We have basically no RCRA groundwater monitoring wells, our permit applications are grossly deficient (some of the waste facilities there are patently 'illegal'). We have serious contamination, and we have extremely limited environmental and waste characterization data for a site of this complexity." She recommended getting an agreement with EPA and CDH, but she wanted the agreement "finessed" with vague and ambiguous language that would give DOE "credibility" and offset the possibility of "citizen suit enforcement."[68] So damning a memo was obviously not intended for the public, but it became available and was widely circulated. DOE, EPA and CDH did reach an agreement that supposedly ensured Rocky Flats' compliance with relevant law. This was less than three years before the FBI raided the plant to investigate violation of federal law, including violation of RCRA.

---

[66] Ackland, *Making Real Killing*, p. 200.

[67] For more detail on waste at Rocky Flats, see Moore et al., *Citizen's Guide to Rocky Flats*, pp . 29-36; on line at http://www.rockyflatsnuclearguardianship.org/citizens-guide-to-rocky-flats?lightbox=image_lcd

[68] DOE, Memorandum EH-1, "Status of Rocky Flats Agreement Negotiations," from Mary L. Walker, Asst. Secty. for Environment, Safety and Health, to S. R Foley, Jr., Asst. Secty. for Defense, July 14, 1986.

Pondcrete: Another waste mess: From the time production began in the 1950s liquid hazardous waste containing low-levels of plutonium and other toxins was stored in five shallow outdoor pools roughly the size of swimming pools. They were called solar evaporation ponds because it was assumed the sun would evaporate the liquid and leave behind a sludge. By the 1980s DOE wanted these ponds shut down, so Rockwell workers put the sludge in large plastic-lined boxes where it was mixed with concrete that they thought would produce solid blocks called "pondcrete" that then could be shipped to the Nevada Test Site for disposal. After sending 3,000 pondcrete blocks to Nevada, the practice suddenly ended. Nevada officials found that pondcrete contained radioactive and non-radioactive materials and thus was mixed waste, regulated by RCRA. The Test Site was not licensed for such material. Then came the real problem. In theory, pondcrete was solid one-ton blocks. But in reality many of the blocks had the consistency not of cement but of mayonnaise. More than 16,500 blocks had been produced. Half or more of them, stored at Rocky Flats, began to sag and leak. A radioactive pudding ran out of the containers over the land and down into the creek beds that drain the site.[69] The pondcrete mess was left for the "cleanup."

No more plutonium waste to Idaho: From 1954 until 1989 waste with a relatively high content of plutonium later called "transuranic" (heavier then uranium) or "TRU-waste" was shipped offsite to DOE's Idaho National Engineering Laboratory (INEL) where it was "temporarily" buried. Shortly after the June 6, 1989, FBI raid on Rocky Flats Colorado Governor Roy Romer reached an agreement with DOE that set a limit of 1,601 cubic yards as the maximum amount of TRU-waste that could be stored onsite. This number did not seem restrictive to DOE at the time, because Rocky Flats was routinely shipping TRU-waste to INEL. But on September 1, 1989, Idaho Governor Cecil Andrus ended 35 years of TRU-waste shipments from Rocky Flats to INEL. At the Idaho border he refused to allow a train carrying Rocky Flats waste to enter the state. He said he was tired of waiting for the DOE to keep its promise to open a permanent TRU-waste disposal site somewhere. The train returned the waste to Rocky Flats and no more was sent to Idaho.[70] Chapter 10 includes further discussion of the Rocky Flats waste sent to Idaho.

Frantic efforts by government officials to find an alternative storage site for the waste proved fruitless. Romer held the line, warning DOE that if they exceeded the TRU-waste limit at Rocky Flats no more waste could be generated – which of course meant the end to production.[71] DOE tried to buy time by installing a new a supercompactor that would compress the waste into a smaller package, about a 50% volume reduction. The supercompactor, however, was damaged during shipment, and production permanently ended before it could be brought on line.

This account provides only a partial view of the complex waste problem in the period just before and after the FBI raid. Everything was complicated by lawsuits and intergovernmental agreements. DOE argued that some of the large volume of material stored at Rocky Flats that had been called TRU-waste should instead be regarded as "residue," because it contained a sizeable volume of plutonium that could be extracted and used again. In a defeat for the DOE, a lawsuit won in 1990 by Sierra Club declared that this material was waste and therefore was subject to RCRA regulation.[72] Eventually, to expedite the "cleanup," even so-called "residues" were handled as waste and were disposed of at WIPP, the Waste Isolation Pilot Plant in New Mexico, which opened in 1999.

Criticality danger: Plutonium in the venting ducts: A scandal that wouldn't go away was the revelation that an unknown quantity of plutonium had accumulated inside the 6,200 feet of venting ducts in the three plutonium processing buildings at Rocky Flats. This threatened a "criticality" – a spontaneous nuclear chain reaction that occurs when a "critical mass" of radioactive material like

---

[69] Ackland, *Making a Real Killing*, pp. 210-211.
[70] Ibid., p. 213
[71] Joan Lowry, "Politicos Deride Plant's N-Waste Plan," *Rocky Mountain News*, October 12, 1989.
[72] Ackland, *Making a Real Killing*, p. 188, note 15.

plutonium accumulates and spontaneously fissions (see pp. 46-47). The splitting atoms release neutrons and other radioactive particles. The worst sort of problem that can happen in a plant like Rocky Flats, a criticality could result in sudden death for anyone nearby. The matter came to light in the summer of 1989 when engineer James Stone blew the whistle on the issue to the FBI. He had badgered DOE and Rockwell on this since 1983, but they had done nothing. Stone believed there had been several previous criticalities at Rocky Flats, a view that countered the official position at Rocky Flats. A 1992 study of Building 771 at the site, written for the cleanup by its nuclear workers, lists a total of 53 *"criticality infractions"* that happened in this one building over the years since production began.[73]

DOE Secretary James Watkins hired a company named Scientech to do a criticality investigation. Had a criticality occurred at Rocky Flats, fission products such as cesium and strontium, not otherwise present at the site, would have been present. Nat Miullo of the EPA found these materials in soil on the plant site and told DOE he believed there had been a criticality. In the 1970s Carl Johnson had also said there'd been a criticality. Scientech found records showing that the problem of plutonium deposits in the ductwork had been recognized as early as 1953, within the first year of operations at the plant. It was due to faulty "pre-filters" or poorly fitting ones; pre-filters were small filters on gloveboxes that trapped plutonium particles and prevented them from escaping into the venting ducts. Workers, frustrated by clogged pre-filters, punched holes in them, allowing plutonium particles to escape into the ductwork to relieve pressure inside gloveboxes so they could continue work. But this of course meant plutonium deposits in the ducts. Were workers paid bonuses that gave them an economic incentive to put production ahead of safety.[74] After all its work, Scientech concluded that there were 62 pounds of plutonium distributed randomly in the ductwork – enough for 10 bombs – a dangerous situation.

Because of the danger posed by plutonium in the ductwork, many in the public expected the DOE to do an Environmental Impact Statement (EIS) on this issue, that is, an official study of alternatives for dealing with the problem – examining possible effects and what the best solution would be. However, DOE and EG&G on May 20, 1991, bypassed this requirement to give themselves a "categorical exclusion" for this project. Despite the fact that the effort to remove plutonium from roughly 6,200 feet of ductwork posed an obvious danger to the public, DOE decided to proceed with the work without an EIS. It thus was good that production ended. We turn now to this topic.

---

[73] "1992 Facility History for Building 771 at the Rocky Flats Plant," Compiled for EM-30 by M. H. Chew and Associates, Inc., April 1992. On line at https://rockyflatsambushedgrandjury.com

[74] For a full discussion of this issue, see Moore, *Citizen's Guide*, pp. 39-41; on line at http://www.rockyflatsnuclearguardianship.org/#!citizens-guide-to-rocky-flats/c1hm8

6. LIMBO: FROM THE FBI RAID TO THE MISSION CHANGE (1989-1992)

Multiple crises: Through the late 1980s it was one crisis after another at Rocky Flats, including a long list of nuclear waste problems: too much of it on site, the Idaho governor refusing to allow more Rocky Flats transuranic waste into his state, failure of plans to incinerate some of the waste, revelation by a whistle blower that plutonium lodged in ventilation ducts threatened a criticality, admission by a DOE official that the plant failed to meet legal requirements for handling mixed waste, efforts to stabilize waste from the solar ponds into a concrete mixture ("pondcrete") instead produced a radioactive sludge that couldn't be moved, acquiring and bringing on site a super-compactor that was too damaged to use, and so on. In addition, EPA and the State of Colorado were now regulating some aspects of Rocky Flats, there was publication of a study showing that Rocky Flats workers exposed to plutonium well below levels deemed safe by the DOE had more cancers than expected, civil disobedience being committed at the drop of a hat, all manner of folks from artists to business leaders opposing Rocky Flats, movies and media examining health problems related to the plant, members of Congress raising pointed questions, and the EPA about toadd Rocky Flats to the Superfund list of the most contaminated sites in the country (it was added on November 21, 1989). And then the FBI raided the plant.

On June 6, 1989, FBI and EPA agents raided Rocky Flats to collect evidence of alleged environmental law-breaking by plant operator Rockwell International: Thus was the first time one federal agency raided another. Among the charges listed in the FBI's affidavit, the one that stood out most to the public, was that the plant was burning waste containing plutonium in an incinerator that was illegal to operate. On September 14, 1989, Rocky Flats workers deliberately exposed co-worker Jacque Brever to plutonium on the job, because she had blown the whistle about the incinerator to the FBI. Activists visited then-Governor Roy Romer to urge him to call for a halt to production at Rocky Flats until it could be demonstrated to be safe. When he declined, I engaged in a water-only fast on the lawn of the State Capitol to reveal his inaction.[1]

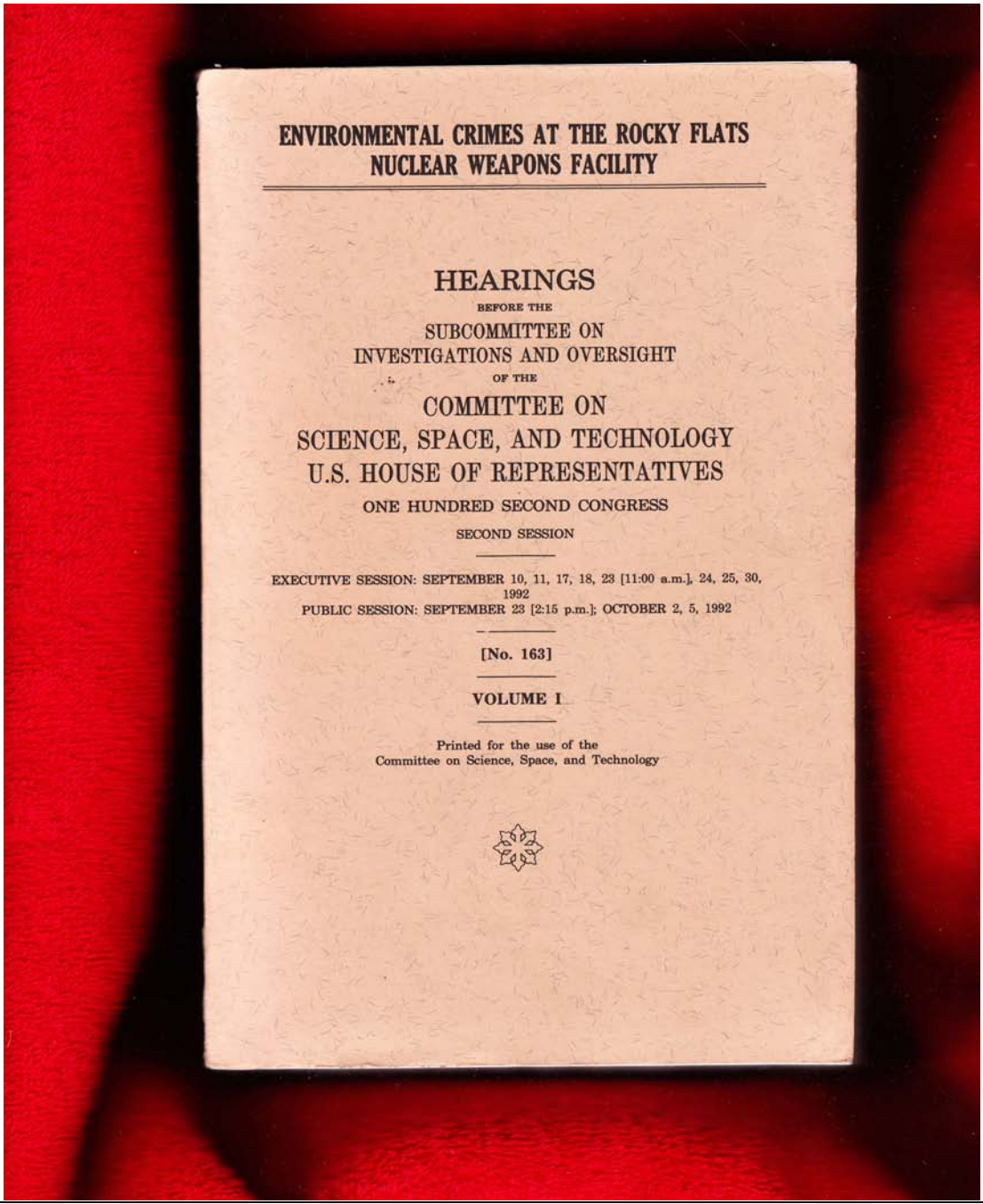
Judge reaches out-of-court settlement with Rockwell but fails to squelch the Rocky Flats Grand Jury which calls Rocky Flats "an ongoing criminal enterprise": On August 1, 1989, a special grand jury was convened by the federal court in Denver to review evidence collected in the FBI raid. The jurors had spent nearly three years at their task when on March 24, 1992, Federal Judge Sherman Finesilver suddenly dismissed the grand jury. But the jurors refused to go home until they completed a report with details from their review of evidence. The judge had earlier told them he expected such a report. Two days after dismissing the grand jury, Finesilver announced that an out-of-court settlement had been reached with Rockwell. Major charges against the company, including illegal operation of the incinerator, were dropped. Rockwell pleaded guilty to several minor charges, was fined $18.5 million (less than its final bonus), and received immunity from further prosecution. The judge sealed 65 cartons of documents from the case – the evidence – in the Denver Federal Courthouse. On September 25, 1992, Finesilver also sealed the report he had received from the grand jury. But on September 30 the Denver weekly *Westword* published an incomplete version of the report that had been leaked. Later the judge released a redacted version. Eventually the full grand jury report was posted on line where it can now be found.[2] The report refers to Rocky Flats as "an ongoing criminal enterprise" and calls for indictment and prosecution of several unnamed Rockwell and DOE officials deemed responsible for what had happened at Rocky Flats.

Jon Lipsky, who led the FBI raid, testifies before Congress: For several days beginning on September 11, 1992, Jon Lipsky, who had led the FBI raid, testified about the investigation before a congressional committee chaired by Rep. Howard Wolpe of Michigan (see Figure 6.1). A 1,737 page record of the hearing, entitled *Environmental Crimes at the Rocky Flats Nuclear Weapons Facility*, was published before the end of the year. Lipsky later stated that the Justice Department told him to lie when he testified before the Congressional committee. He refused to do so.

---

[1] For a brief account of the fast, see APPENDIX C.

[2] http://www.constitution.org/jury/gj/rocky_flats/rocky-flats-grand-jury-report.htm



ENVIRONMENTAL CRIMES AT THE ROCKY FLATS NUCLEAR WEAPONS FACILITY

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
INVESTIGATIONS AND OVERSIGHT

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED SECOND CONGRESS

SECOND SESSION

EXECUTIVE SESSION: SEPTEMBER 10, 11, 17, 18, 23 [11:00 a.m.], 24, 25, 30, 1992
PUBLIC SESSION: SEPTEMBER 23 [2:15 p.m.]; OCTOBER 2, 5, 1992

[No. 163]

VOLUME I

Printed for the use of the
Committee on Science, Space, and Technology

Figure 6.1: *Environmental Crimes at the Rocky Flats Nuclear Weapons Facility*, the record of the Congressional hearing chaired by Rep. Howard Wolpe of Michigan, was published in 1992 in two volumes, totaling 1,737 pages.

The Department of Justice bows to DOE's culture of law breaking: Why did the judge seal the documents that the grand jury had spent nearly three years reviewing? Why was the plant raided in the first place? Do the sealed documents contain information about environmental contamination that should have been reviewed by the EPA and CDPHE, the agencies that regulated the Rocky Flats "cleanup"? That the grand jury opposed the settlement and refused to be dismissed until they wrote a report calling for indictment of several officials indicates that such review should have occurred. Yet the EPA and CDPHE never even tried to review these

documents.[3] Wes McKinley, who was foreman of the grand jury and is forbidden by court order from revealing what he learned about environmental conditions at Rocky Flats, decries the fact that the "cleanup" was finished without the public or the regulators having access to the data sealed in the documents.[4] Likewise, Jon Lipsky, who headed the FBI investigation, felt betrayed by the sealing of the evidence and the failure to prosecute. He described the "cleanup" as "woefully inadequate a farce."[5] Brian Lipsitt, in a remarkable article about the Rockwell settlement written especially for environmental lawyers, shows that the Department of Justice settled the case without indicting key individuals for illegal activity because their illegal acts were part of a "DOE culture" of law-breaking. By letting officials from a powerful federal agency and a major military contractor off the hook, the Department of Justice allowed them to act above the law. Lipsitt praises the grand jury for daring to go public with their rejection of the settlement.[6]

Why did the FBI raid the plant? The answer: To cover up crime: Wes McKinley, foreman of the Rocky Flats Grand Jury, and attorney Caron Balkany together wrote *The Ambushed Grand Jury: How the Justice Department Covered Up Government Nuclear Crimes and How We Caught Them Red Handed*. This book is without question the best source of information on all issues related to the raid and the grand jury. The thesis of the book is that the real purpose of the raid was not to reveal to the public illegal behavior at Rocky Flats but to cover it up (see Figure 6.2). Former Rocky Flats worker Jacque Brever, who blew the whistle on the operation of the incinerator, and former FBI agent Jon Lipsky, who led the FBI raid, agree. Their stories appear in the book. The reader may recall that the case brought by the Church Ranch against Dow and Rockwell was settled out of court in 1984 and that all documents from the case were sealed (see above, p. 51).

Rockwell replaced: In September 1989 Rockwell International told the media that it was impossible to meet DOE's production requirements at Rocky Flats without breaking the law. The very next day Energy Secretary James Watkins announced that Rockwell would be replaced on January 1, 1990, by EG&G, a company well-known to DOE for its operations with the nuclear navy and at other DOE facilities.

Limbo: "Temporary" production halt at Rocky Flats and efforts to resume production: In November 1989 Watkins announced a "temporary" halt to production at Rocky Flats for safety reasons. It was fully expected that in a short time EG&G would have the plant back into full operation. On several occasions in 1990 and 1991 DOE and EG&G officials informed the public that Rocky Flats production would resume on a specific date, only a few days later to announce another postponement. EG&G increased the workforce at Rocky Flats to above 8,500, the largest employment in the plant's history, even though nothing was being produced. Morale among long-term employees at the plant was bad. They complained of being burdened by an abundance of EG&G administrators that were telling them how to improve work that some of them had been doing quite well for two or three decades.

---

[3] Anne Imse, "Rocky Flats Brouhaha," *Rocky Mountain News*, August 20, 2004. For more, see http://www.rockyflatsnuclearguardianship.org/required-reading/rocky-flats-grand-jury-documents/

[4] See Wes McKinley and Caron Balkany, *The Ambushed Grand Jury: How the Justice Department Covered Up Government Nuclear Crimes and How We Caught Them Red Handed* (NY: Apex Press, 2004).

[5] http://www.grist.org/article/little-rockyflats/

[6] Brian Lipsitt, "Rocky Flats: A Plea Bargain in Public View," in Mary Clifford (editor), *Environmental Crime: Enforcement, Policy, and Social Responsibility* (Gaithersburg, MD: Aspen Publishers, 1998), pp. 397-412.

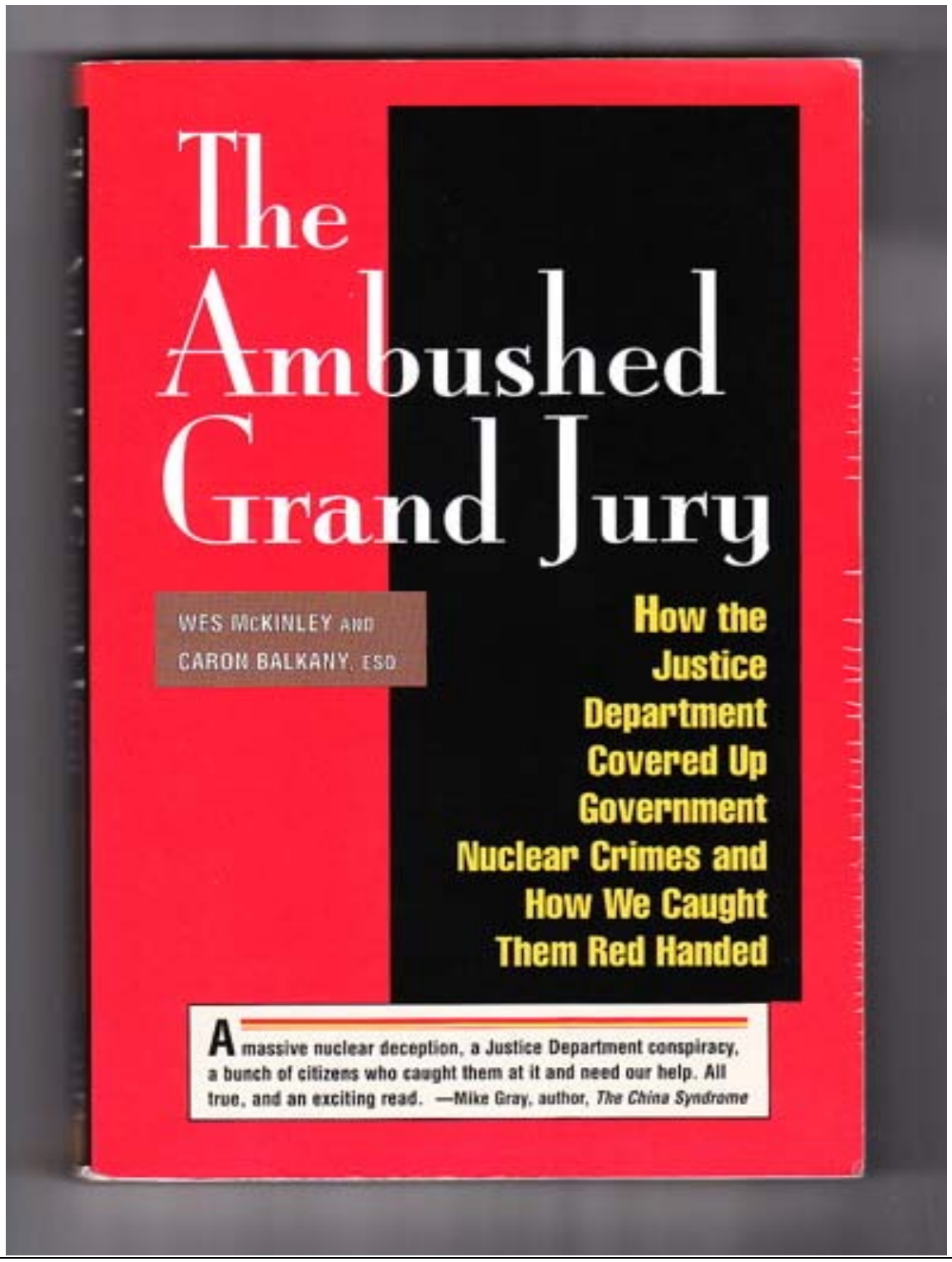


Figure 6.2: *The Ambushed Grand Jury:* (NY: Apex Press, 2004) by Wes McKinley and Caron Balkany is the best source of information on all issues related to the raid and the grand jury.

Whether to resume production: The saga of Building 371: Figuring into the situation regarding the future of the Rocky Flats Plant was the November 1989 breaching of the Berlin Wall and the end of the Cold War with the demise of the Soviet Union on December 26, 1991. Some, especially former Rocky Flats workers, now say

that the plant closed because the Cold War was over and the bombs were no longer needed. But the DOE and others in the government intended to continue making nuclear weapons, and for this they wanted production resumed at Rocky Flats. The clearest evidence of this intent was the official plan to totally renovate one facility, Building 371. The newest, largest, most expensive of the plutonium processing buildings on the site, 371 was originally intended to replace Building 771, the plant's original plutonium processing facility and the location of the 1957 fire, which, unknown to the public, released a vast quantity of plutonium that was deposited across the Denver metro area. Building 371, which cost $225 million (in 1980 dollars), never worked as intended. Parts of it became contaminated soon after it was brought on line in 1981, and so much plutonium was being lost in its complex system of pipes that DOE ordered it shut down in 1984. Thereafter it was used for storage of waste. In 1990 the DOE wanted Congress to appropriate $650 million, almost triple the building's original cost, to renovate it as the "Plutonium Recovery and Modification Plant" (PRMP). Locals who wanted no more of Rocky Flats, including activists steeped in civil disobedience but had never lobbied, were suddenly lobbying Congress not to fund a project that would keep Rocky Flats building bombs far into the future. When the vote in Congress came, Colorado Senator Tim Wirth and Representative David Skaggs (in whose district Rocky Flats was located), along with Representative Pat Schroeder of Denver, took the lead in getting Congress to vote NO. A sound defeat for the DOE, this vote marked the end for Rocky Flats.[7] Secretary of Energy Admiral Watkins was angry. If they don't want Rocky Flats, he said, they won't have it. He ordered all non-nuclear work done at Rocky Flats moved to DOE's Kansas City plant.

Turning point: Rocky Flats mission changed from production to cleanup: In his State of the Union address on January 29, 1992, President George H. W. Bush declared that the U.S. would not continue producing the W88 warhead. Those familiar with Rocky Flats, especially workers inside the plant and activists on the outside, knew this meant no more production at Rocky Flats, since the W88 was the only warhead for which the plant was then scheduled to make plutonium pits. The next day Energy Secretary Watkins announced a change of mission at Rocky Flats from production to cleanup of a contaminated site.[8] Rocky Flats was by now on the Superfund list.

Will there be another Rocky Flats to make pits? With production ended at Rocky Flats, the DOE scrambled to find a new location for manufacturing pits. Despite the end of the Cold War, which had provided the rationale for production of nuclear weapons since the end of World War II, the DOE expected to continue bomb production. Congress supported the effort. Finally, it was decided the replacement for Rocky Flats would be at the Los Alamos Lab, where the first nuclear bombs had been made but which throughout the Cold War had been a design and development facility, not a manufacturing plant. Amidst much controversy over efforts to build a new production facility at the Los Alamos site, they gradually began pit production in a building that dated from the early days of the nuclear age. By February 2015 a total of 30 pits had been made at Los Alamos. Plans call for producing 30 pits annually by 2026 and 80 annually by 2030.[9] Never mind that when it signed the Nuclear Non-Proliferation Treaty in 1968 the U.S. committed to "good faith efforts" to eliminate nuclear weapons. Rocky Flats was shut down but not the manufacture of pits for more warheads.

---

[7] For additional information on Building 371 and the PRMP proposal, see http://leroymoore.wordpress.com/2012/10/31/an-engineers-view-of-building-371-rocky-flats-most-expensive-failure/

[8] Ackland, *Making a Real Killing*. p. 229.

[9] Patrick Malone, "Amid safety concerns at LANL, Udall weighs in on lab's next mission: Pit production," *New Mexican*, February 21, 2015.

7, Part 1. "CLEANUP" AND CLOSURE (1992-2005): FAILURE CLAIMED AS SUCCESS

Preparation for the "cleanup": EG&G had come to Rocky Flats in 1990 to produce bombs, not to clean up a contaminated site. When in 1992 the mission changed from production to cleanup it was assumed that soon EG&G would be replaced by another contractor. On July 1, 1995, EG&G was replaced by Kaiser-Hill, a company specially formed for this task, as a joint venture between two environmental engineering firms, CH2M Hill and ICF Kaiser. The name of the site was changed from Rocky Flats Plant to Rocky Flats Environmental Technology Site. It's not a bad name if it could be true, that is, if technology to remove contamination from the environment could be developed at Rocky Flats, an idea later proposed but regrettably rejected by the DOE.

With the end of production at Rocky Flats some hoped the old culture of secrecy was ended so that citizens now could work directly with their government to deal forthrightly with the contamination left from the production years. Unfortunately, as the following shows, we learned that the old way still prevailed. Also DOE did not act alone. In making the cleanup a new version of an old story, the DOE was joined by EPA and CDPHE, the organizations that regulated the "cleanup." "Cleanup" in fact is not really an appropriate word for what happened at Rocky Flats. For this word implies removal of contaminants, at least to the maximum extent possible, with a parallel effort to eliminate any danger they pose. This did not happen at Rocky Flats. Some prefer the word "remediation," which according to the dictionary means reversing or stopping contamination. This certainly didn't happen at Rocky Flats. So I will use "cleanup" when referring specifically to what happened at Rocky Flats. Enclosing the word in quotation marks signifies that what happened was only a partial "cleanup" and thus hardly deserves this word.

RFLII: Help for displaced workers: One of the concerns arising from the change of mission was taking care of Rocky Flats workers who would lose their jobs. DOE funded the Rocky Flats Local Impacts Initiative (RFLII) to deal with this problem. RFLII provided training and start-up assistance for new businesses, but it was short-lived because the plight of workers proved less severe than expected, thanks to the relatively robust economy of the 1990s in the Denver area.

The Citizens Advisory Board: In 1993, as part of a national trend at DOE sites facing cleanup, the Rocky Flats Citizens Advisory Board (CAB) came into existence. Funded by the DOE and established as a broadly representative body under the Federal Advisory Committee Act (FACA), the group's task was to advise DOE on matters related to the cleanup of Rocky Flats. The group decided that all its recommendations to the DOE would be reached by the process of consensus, meaning each decision would have the support of the whole group rather than a voting majority. This was intended to prevent DOE from using a divide-and-conquer approach with the group. The CAB's work was also member-driven, not staff-driven. Its recommendations thus were stronger and tended to unify the public. RFLII and the CAB were quite influential going into the "cleanup."[1] But RFLII was soon dissolved, and DOE undermined the CAB, a point to be discussed below. I myself was one of the original members of the CAB.

What the public wanted: Cleanup to background: One step that at the time seemed very hopeful was the creation in 1994 of the DOE-funded broadly representative Rocky Flats Future Site Use Working Group. This ad hoc group was given one year to tell the DOE what the public wanted at Rocky Flats. The group consisted of 12 delegates and 12 alternates, each pair representing a particular part of the community – economic, local government, environmental, Rocky Flats workers, residents and land-owners, etc. I and my alternate, a physician, represented peace and health interests. After working together for a year, in June 1995, the group recommended by consensus that Rocky Flats be cleaned "*to average background level for Colorado"* when it is

[1] The CAB replaced the Rocky Flats Environmental Monitoring Council, which had been renamed the Colorado Council on Rocky Flats. Ackland, *Making a Real Killing*, p. 236. Another oversight body, the Rocky Flats Cleanup Commission, funded by an EPA Technical Assistance Grant, was created in 1989 and dissolved in 1994 when funding ended. For a very interesting article on the relation of the CAB to the Cleanup Commission, see http://www.westword.com/1994-10-05/news/melting-down/

technologically and fiscally possible to achieve this in an environmentally sensitive manner. The average background from fallout for plutonium, the contaminant of principal concern, is 0.04 picocuries per gram of soil (0.04 pCi/g). The group recognized that "current laws do not require this level of cleanup," but it expected that "technology will continue to improve," so that "at some time in the future" cleanup to background will become possible. To ensure improvement of technology, the group called for "an earmarked, secure trust fund," and for turning the site into a laboratory for development of technology that did not yet exist. Technology developed locally could be used at plutonium-contaminated sites elsewhere. "We are willing," the report said, "to wait as long as is necessary, but no longer than necessary, to see the site cleaned up, even if that takes many generations to accomplish" (see Figure 7.1).[2]

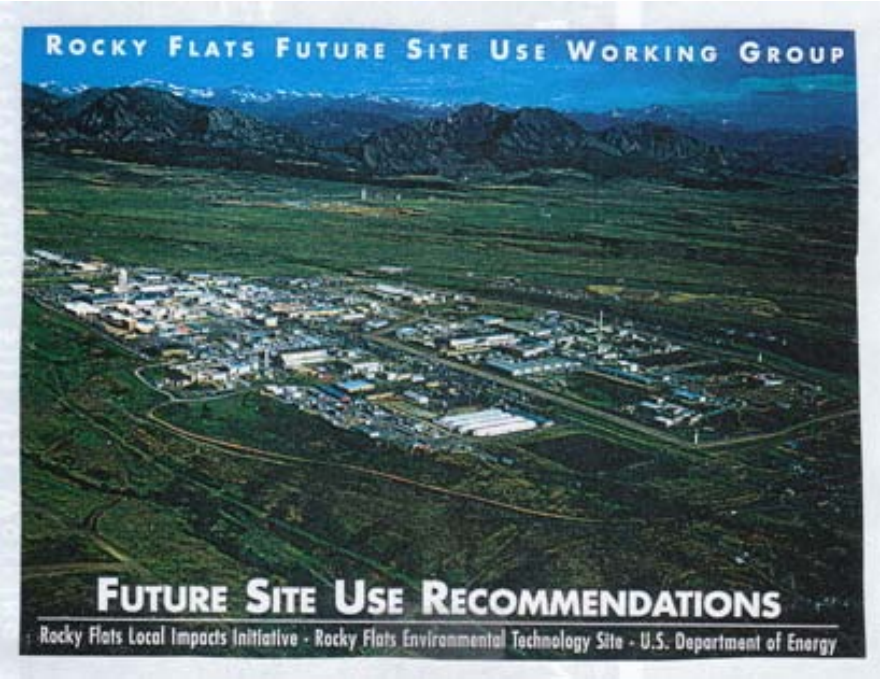


Figure 7.1: In its report published in June 1995 the Rocky Flats Future Site Use Working Group recommended that the ultimate cleanup at Rocky Flats be to average background radiation level.

Proposed cleanup to average background, its difference from natural background, the strong support it had and DOE's rejection: Edward Martell of NCAR often emphasized that all humans on the planet are exposed to natural background radiation – from radioactive materials in soil and air as well as trace amounts in our own bodies. Natural background radiation is higher at higher elevations; in Denver it is about double what it is at sea level. For most people, exposure to natural background will do no harm; for a few it will prove harmful, perhaps even fatal. Fallout from atmospheric nuclear bomb tests, has added additional radioactivity to natural background globally, increasing illness and death. We no longer live in an environment of only natural background radiation. The recommendation of the Future Site Use Working Group that Rocky Flats be cleaned to average background level meant acceptance of naturally occurring background plus the radiation from plutonium that resulted from global fallout – 0.04 picocuries per gram of soil. The group sought eventual removal from the soil of all plutonium deposits above this 0.04 pCi/g level.

The CAB and RFLII, the only Rocky Flats oversight bodies then existing, as well as many individuals and public interest groups endorsed this recommendation, making it without question the single most widely supported cleanup recommendation ever made for Rocky Flats. Despite this overwhelming support, DOE and the agencies regulating the cleanup, EPA and CDPHE, responded to this recommendation with silence, total silence. After waiting more than six months, in January 1996, I published an op-ed saying that the DOE wasn't

[2] *Rocky Flats Future Site Use Working Group Recommendations for Rocky Flats Environmental Technology Site* (July 1995), pp. 17, 18-19.

interested in what the public wanted at Rocky Flats, since it had totally ignored the recommendation it received from the Future Site Use Working Group that it had funded. Only then did the DOE site manager acknowledge receipt of the recommendation, but he dismissed it because the group asked for more than the law required and the site would be cleaned only "to levels prescribed by law."

Confusion regarding what "cleanup" is, what it would cost, and how long it would take: In March 1995 DOE's Office of Environmental Management estimated that all the activities that would have to be dealt with in shutting down the Rocky Flats plant would stretch out to 2060 and cost as much as $36.6 billion. In addition to actual cleanup of soil and water at the site were four non-cleanup activities: 1) relocation of weapons-grade material, 2) removal of bomb-production waste, 3) demolition of buildings, and 4) end site security. While it's a clear misuse of language, the word "cleanup" came to be almost universally used to encompass all the above-mentioned activities. Actual cleanup in fact cost less than each of the other four activities. This was the context for what followed.

On July 1, 1995, EG&G was gone and DOE welcomed Kaiser-Hill as the "cleanup" contractor. In a big public meeting later that month DOE and Kaiser-Hill revealed their "cleanup" plan – to leave most of the contamination in place on the site beneath a cover of rock and soil. They were surprised that the public treated their proposal like a joke.

DOE and Kaiser-Hill held secret meetings with key members of Congress out of which emerged an agreement to do the "cleanup" and closure in less time and for a lower cost. They referred to their new plan as the "accelerated risk-based cleanup."

Secrecy: Cost of the "cleanup" capped and a deadline set for its completion: Out of the secret meetings with Congress came the decision that all work necessary for site closure would be done in ten years for a total cost of $7 billion. Most of this $7 billion paid for the four non-cleanup items mentioned above: 1) relocation of weapons-grade material, 2) removal of bomb-production waste, 3) demolition of buildings, and 4) ending site security. Actual "cleanup" of soil and water was done with what was left -- $473 million, or about 7% of the total. Kaiser-Hill allocated a specific maximum for each of these five areas and specified that any funds saved in one area by doing the job early or below budget could not be used to get a better "cleanup" or to improve work in another area. The $473 million budgeted for actual environmental "cleanup" is the maximum that could be spent for this task. Kaiser-Hill received $560 million for its work, more than was spent on actual "cleanup." It became common by the first years of the 21st century to lump all the above activities together under the term "cleanup" and to say that the "cleanup" cost about $7 billion. Below I will provide detail about the actual "cleanup" but not about the four non-cleanup activities. .

The U.S. government is miserly when it comes to cleaning up its nuclear weapons facilities, by comparison to the $5.5 trillion (in constant 1996 dollars) that it spent between 1940 and 1996 on nuclear weapons and related programs.[3] People subjected to essentially unknown health risks from contaminants released into the environment through the years of production at Rocky Flats now have to deal with the effects of such stinginess. This is a poor precedent, though government officials laud Rocky Flats as setting a precedent for a cheaper "cleanup."

Kaiser-Hill's role: Kaiser-Hill was very good at developing long-range plans that closely linked available funds to actual work. They created a step-by-step sequence for doing the job and finishing it ahead of schedule. Then they bragged that they reduced the cost of "cleanup" from $36 billion to $7 billion and the time for the job from 70 years to 10.[4] In fact, as noted above, only 7% of the $7 billion allocated to close Rocky Flats went to actual environmental "cleanup."

---

[3] Stephen I. Schwartz, ed., *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940* (Washington, D.C.: Brookings Institution Press, 1998), p. 4.

[4] See Kim Cameron and Marc Lavine, *Making the Impossible Possible: Leading Extraordinary Performance: The Rocky Flats Story* (San Francisco: Berret-Koehler, 2006), p. 3.

How clean is clean? What about the official level established in 1996: The Future Site Use Working Group said Rocky Flats should be cleaned to average background, which is 0.04 pCi/g. In the July 1996 *Rocky Flats Cleanup Agreement*, DOE, EPA and CDPHE gave a very different answer. They set the official standard for cleaning plutonium in soil at 651 pCi/g, which is 16,275 times the 0.04 pCi/g Future Site Use Group's recommendation. The agencies adopted the 651 standard with only scant public participation. By coincidence, Assistant Secretary of Energy Al Alm was scheduled to hold a public meeting in Colorado on Environmental Management for DOE, which he managed. Having seen a brief notice in the morning paper that the standard had been set, I arrived early at the place for the Alm meeting and told the person presiding that those present must know the new standard before Mr. Alm spoke. He agreed. The announcement was made. The room exploded with outrage. Mr. Alm saw this.

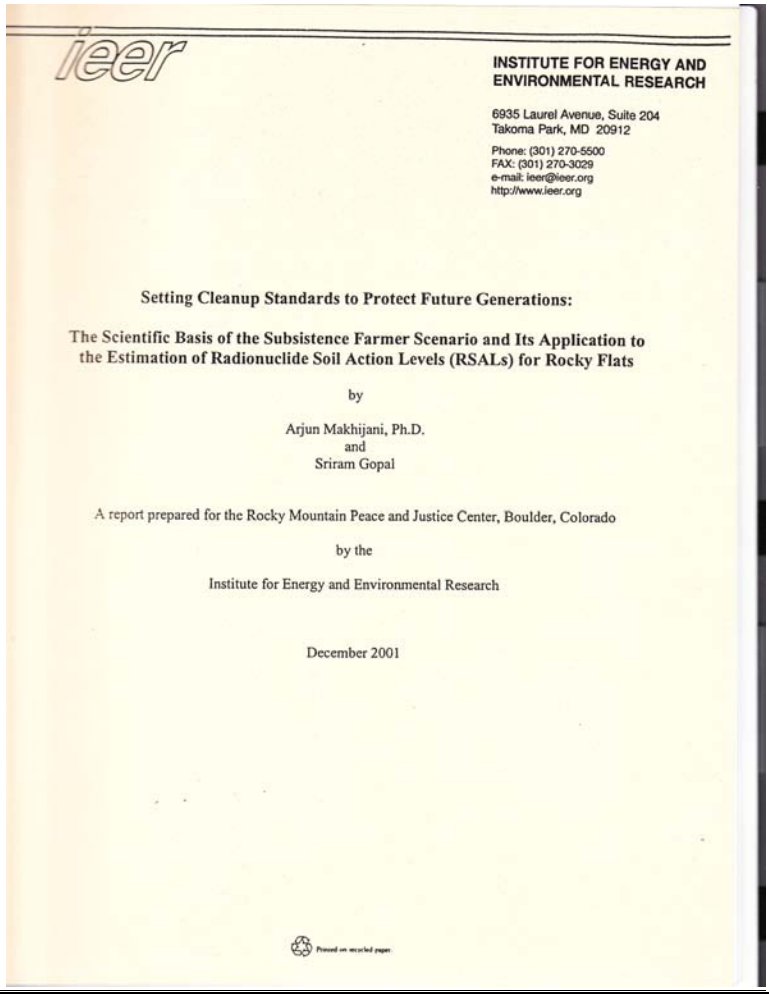
Having seen public anger very directly, Mr. Alm told Rocky Flats officials to commission and fund an independent group of local people to hire specialists to study the Rocky Flats cleanup issue and recommend an appropriate cleanup level for the site. The only limit he placed on the group is that the cleanup level they proposed must allow an annual radiation exposure to any individual of up to 15 millirem (a measure of radiation) for the next 1,000 years. In 1998 the Rocky Flats Radionuclide Soil Action Level Oversight Panel (RSALOP) was formed for this work. Its name indicates its task, a soil action level being the maximum amount of a radioactive material allowed to remain in soil; if the radiation in soil exceeds this specified limit, an "action" is triggered to deal with the contamination, usually by removing it. The new group would challenge the official 651 pCi/g action level. So, what did the group propose?

The action level proposed by the RSALOP: The RSALOP, of which I was a member, hired the Risk Assessment Corp. (RAC) to do the technical research and for about 18 months worked closely with them. In February 2000 RAC issued its *Final Report* on the basis of which the RSALOP recommended that the action level for radionuclides in soil at Rocky Flats be reduced from 651 pCi/g to 35 pCi/g. This was a 99.5% reduction below the level set by DOE and the regulators in 1996, yet still 875 times the 0.04 pCi/g average background level recommended by the Future Site Use Working Group. The 35 pCi/g would allow a maximum annual radiation exposure of 15 millirem, as required by Mr. Alm.[5]

RMPJC proposes a 5 to 10 pCi/g plutonium soil action level to protect future generations: The Rocky Mountain Peace and Justice Center, with which I am affiliated, contracted with Arjun Makhijani and his colleagues at the Institute for Energy and Environmental Research (IEER) to recommend a radionuclide soil action level not constrained by Mr. Alm's specification about allowable exposure. We wanted an action level that provided maximum safety under any conceivable condition. We recognized that due to plutonium's long half-life, plans for the future of the Rocky Flats site must assume that state and federal government agencies on which we now depend will vanish long before plutonium in the environment ceases to be harmful. We asked: What specific humans in the unknown future will be most vulnerable to the plutonium in their environment, about which they are most likely ignorant? Protecting them will protect everyone else. Considering all this, the IEER scientists calculated a radionuclide soil action level for Rocky Flats that would protect a farming family that live all their lives on what is now the Rocky Flats site and eat food produced there and drink local water. Accordingly IEER and RMPJC recommended a cleanup level of 5 to 10 pCi/g (see Figure 7.2). This very conservative recommendation alone was realistic about the future.[6]

[5] Risk Assessment Corporation, *Final Report, Technical Project Summary: Radionuclide Soil Action Level Oversight Panel* (February 2000).

[6] Makhijani and Sriram Gopal, *Setting Cleanup Levels to Protect Future Generations: The Scientific Basis of the Subsistence Farmer Scenario and Its Application to the Estimation of Radionuclide Soil Action Levels (RSALs) for Rocky Flats* (IEER, December 2001). Summary version on line at http://ieer.org/article/science-for-democratic-action/volume-10-number-3/ For full details of the IEER and RMPJC recommendation, see http://www.clarku.edu/mtafund/prodlib/rmpjc/rmpjc_01-015.pdf



ieer

INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH

6935 Laurel Avenue, Suite 204
Takoma Park, MD 20912

Phone: (301) 270-5500
FAX: (301) 270-3029
e-mail: ieer@ieer.org
http://www.ieer.org

Setting Cleanup Standards to Protect Future Generations:

The Scientific Basis of the Subsistence Farmer Scenario and Its Application to the Estimation of Radionuclide Soil Action Levels (RSALs) for Rocky Flats

by

Arjun Makhijani, Ph.D.
and
Sriram Gopal

A report prepared for the Rocky Mountain Peace and Justice Center, Boulder, Colorado

by the

Institute for Energy and Environmental Research

December 2001

Figure 7.2: Booklet recommending plutonium cleanup standard of 5 to 10 picocuries/gram of soil.

What scenario for the future? Superfund law (CERCLA[7]) requires that the cleanup standard for a Superfund site be based, first, on a scenario of the site's future use, and, second, on protecting that scenario's most endangered future user. Those setting the standard thus must identify the future user to be protected. The scenario for the immediately preceding IEER proposal is a family of subsistence farmers who live on the site and eat food grown by themselves. They will be the most vulnerable, long after DOE, EPA and CDPHE disappear. But the agencies responsible for the "cleanup" made a short-term decision that most of the Rocky Flats site would become a wildlife refuge and that the person to be protected would be a wildlife refuge worker. Had the site's future use been designated as housing, farmland or a park, the cleanup would be more thorough and safer – and more expensive. The wildlife refuge designation meant a cheaper "cleanup." Superfund law does not require a cheaper cleanup, but lowering the cost became a fundamental principle – an addiction – in determining the level of "cleanup" to be done at Rocky Flats. A chief driver of the "cleanup" was cost. Not cost to human and animal health and well-being, not cost to the environment, but cost in dollars. It was an economic, not a public health or ecological, decision.

Deciding on the scenario: A fateful decision: In 2003, well before the "cleanup" was completed, U.S. Fish & Wildlife Service (FWS), the agency that would receive much of the Rocky Flats land to operate as a wildlife refuge, decided to allow public recreation at the site, even though 81% of the parties commenting on the FWS plan opposed public access and only 11% explicitly favored it.[8] Many thought allowing site-access to infants

[7] Comprehensive Environmental Response, Compensation, and Liability Act
[8] http://docs.wixstatic.com/ugd/cff93e_a9cff9a4c30b4ac5bbfa27e93b91a9bf.pdf

and children, who of all creatures are the most vulnerable, would be unwise. But the government agencies insisted that, because a wildlife refuge worker would spend more time on the site than anyone else, protecting this person would protect the others. They did not mention that all official exposure standards are calculated to protect "reference man," not women or children or the elderly or infirm. And they had no plan to protect wildlife that live on or visit the site. Nor did they say how they would protect a wildlife refuge worker who just happened to be genetically susceptible to radiation exposure. Undoubtedly there are others who would be far more vulnerable than the typical wildlife refuge worker. Congress passed a bill to make Rocky Flats a wildlife refuge after the "cleanup." In accord with the official orthodoxy, the most vulnerable person would be the wildlife refuge worker. Everything was falling into place.

Proposals that were more protective were rejected as the government agencies coalesced around a proposal of their own: Both the 35 pCi/g recommended in February 2000 by the RSALOP and the 5 to 10 pCi/g proposed in December 2001 by IEER and the Rocky Mountain Peace and Justice Center, like the Future Site Use Group's cleanup-to-background recommendation, were rejected by the government agencies responsible for the "cleanup." At a pubic meeting about the "cleanup" on November 9, 2001, Steve Gunderson, the Rocky Flats point person for CDPHE, said that the agencies designing the "cleanup" were "only looking ahead for the next 100 to 150 years, nothing beyond that."[9] By the time he admitted their very short-term view, the agencies had rejected all the genuinely long-term proposals mentioned above, though formal rejection was not made until November 2002, when DOE, EPA and CDPHE issued for public comment a revised *Rocky Flats Cleanup Agreement* (see Figure 7.3). This document (RFCA) proposed to revise the 651 pCi/g RSAL that had been officially adopted in 1996. The proposed revision will be discussed below. Let it suffice to repeat here that all the above-mentioned rejected recommendations were far more protective than what the agencies were proposed and finally adopted as the official soil action levels. As will be shown, the story was not simply one of making a different calculation. Behind the facade of time-consuming public participation, the government agencies were engaged in secrecy and exclusion of the public. I will discuss this before turning to the details of their new proposal.

Public participation: The hope and the reality: In an attempt to gain the trust of a public alienated by a history of accidents and contamination topped off by the FBI raid, DOE went out of its way to provide opportunity for public participation in the "cleanup." At first, the CAB was quite active. But after getting more from the public than it wanted with the Future Site Use Working Group report in 1995, DOE undermined the very public participation it had sought and marginalized the Citizens Advisory Board. The CAB's sole task was to advise DOE on cleanup; its membership included personnel from local governments, as part of its broadly representative membership. In 1999 DOE created a new group to help oversee the "cleanup," the Rocky Flats Coalition of Local Governments (CLG), a move that undermined the CAB by depriving it of members from local governments. Having two organizations commenting on the "cleanup" allowed DOE to play the game of divide and conquer and more easily ignore the CAB. Also, the CLG was the kind of body from which DOE was more likely to get what it wanted, because representatives of suburban towns near Rocky Flats often favored urban growth and avoided the negativity of attention-getting issues like contamination and protecting public health. At the same time DOE planted some of its own people within the CAB, notably a former employee of DOE's Los Alamos Lab who dismissed conflict-of-interest charges, got himself elected as chair and tried to get the CAB to end its practice of making all recommendations to DOE by consensus.

Public participation became far more difficult as well as frustrating in the summer of 2000 when DOE created the Rocky Flats Cleanup Agreement Focus Group. This group met for 3 to 4 hours twice monthly for two-and-a-half years, focused only on the "cleanup." Unlike the CAB, the agenda for Focus Group meetings was planned not by the participants but by DOE and the regulators. Moreover, while individual participants could express themselves on any issue before the group, unlike the CAB they could make no formal recommendations to the DOE to which the DOE was obliged to respond. But most crucially, the Focus Group was the only place to get details on the "cleanup," participate in discussions and possibly have some influence. If you wanted to be involved with the "cleanup," this was where you had to be. Meetings occurred on Thursday afternoons at a time convenient for government employees paid to attend. People with a daytime job could not participate. Of course the Focus Group, with its long very detailed meetings, increased public participation, but

[9] The meeting was at the Rocky Mountain Peace and Justice Center and included personnel from DOE and EPA.

participation was also diminished, because the public didn't set the agenda and make formal recommendations. The CAB and the CLG continued to meet, but they were now more like sideshows.

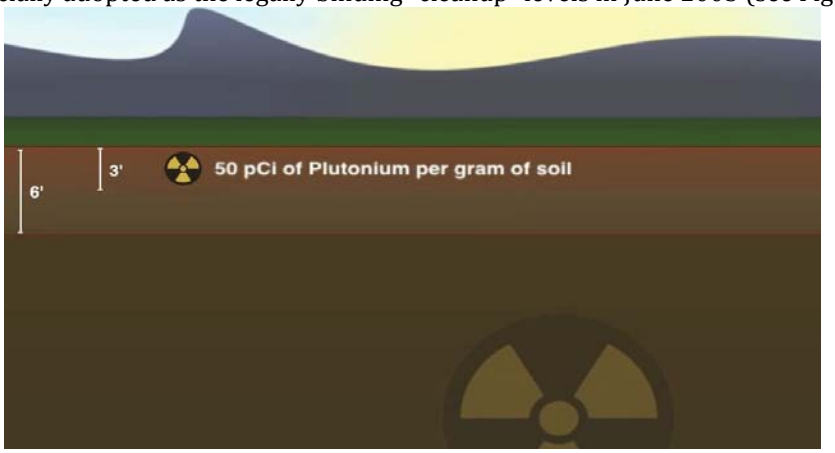
Money, the real driver of the "cleanup": At almost every Focus Group meeting someone would urge DOE to adopt the Future Site Use Working Group's recommendation of cleanup to background. "Tell us the cost for doing this," we said, "and we'll lobby Congress for the funds." It was clear from the looks on the faces of personnel from DOE, EPA and CDPHE that they weren't happy. We had been meeting for well over a year when at a session in June 2001 an irritated DOE official finally made it clear that the better cleanup we sought was not in the cards, because years earlier DOE had made a deal with Congress that put a ceiling on what could be spent on the cleanup and set a deadline for its completion. From what he said, it was obvious, first, that the real driver of the "cleanup" was money, not public health or environmental integrity, and, second, that the public participation to which we were devoting so much time was largely a sham. The official – Joe Legare – who revealed the deal with Congress later said that the effect of his words on those present was "like throwing a dead rat on the table."[10]

Many of us who initially went into the Focus Group with the hope that we'd get to help design the house of "cleanup" found instead that we only got to rearrange the furniture a bit. We had pushed for the best cleanup possible with current technology, plus staying with the job until the site was cleaned to background. But behind closed doors a deal was made from which we were excluded. Whatever DOE did, EPA and CDPHE tagged along. At a large weekend meeting in 2001, an EPA specialist from their lab in Las Vegas said he'd like a word with me. "I've been to many DOE sites around the country," he told me. "Usually on an issue like this, the EPA and state officials meet with local people so they can address DOE with a common voice. But here in Colorado, EPA and state personnel meet with the DOE so they can address the public with a common voice."

New "cleanup" standards: Without any warning Focus Group meetings suddenly came to a dead halt in the summer of 2002 by the simple expedient of not announcing the next session. I awaited such an announcement as weeks passed. DOE, EPA and CDPHE had evidently decided on a new "cleanup" standard and had no more need of us. Several months later, in November 2002, the agencies released for public comment revisions to the *Rocky Flats Cleanup Agreement*, where the agencies proposed to replace the 651 pCi/g standard for plutonium in soil with not one but three standards, as follows:

- Top 3 feet of soil: up to 50 pCi/g of plutonium allowed to remain in soil
- Soil 3 to 6 feet below the surface: 1,000 to 7,000 pCi/g allowed, the amount depending on the size of the contaminated area; a small area may be allowed contamination up to 7,000 pCi/g.
- Soil 6 or more feet below the surface: no limit on the amount of plutonium that may remain

The public comment period straddled the busiest holiday period of the year, embracing Thanksgiving, Christmas and New Years. Under public pressure the comment period was extended two weeks. The above numbers were officially adopted as the legally binding "cleanup" levels in June 2003 (see Figure 7.3 and 7.4).



[10] Theresa Satterfield and Joshua Levin, "Risk Communication, Fugitive Values, and the Problem of Tradeoffs: Diagnosing the Breakdown of Deliberative Processes," *Decision Research* (2002), p. 15.

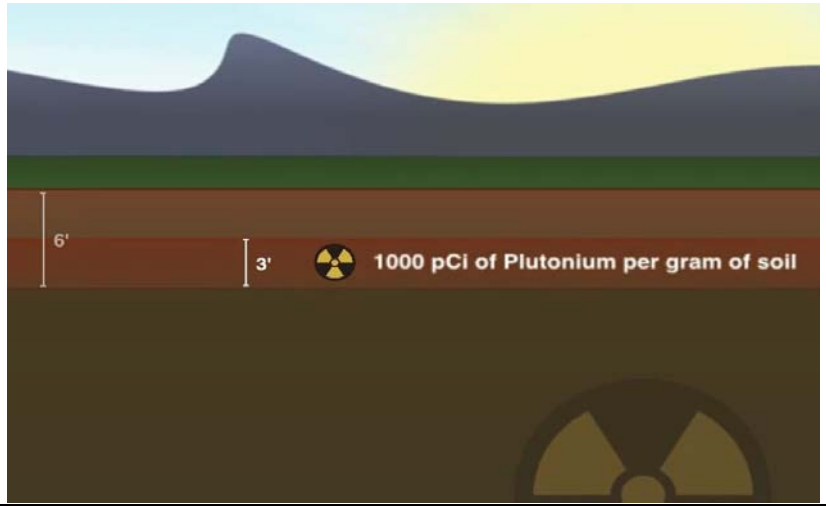


Figure 7.3: These two images, produced by the DOE, show, first, the plutonium "cleanup" standard for the top 3 feet of soil and, second, for soil at a depth of 3 to 6 feet. The latter does not show that in some cases at the 3 to 6 foot depth the standard allowed plutonium contamination up to as much as 7.000 pCi/g of soil. Not mentioned is that soil below 6 feet may contain any quantity of plutonium.

Two crucial facts about the final "cleanup" standards: Cost and lack of public support:
First, "cleaning" the site to the three-level graduated standards adopted for Rocky Fats in 2003 (see p. 80), could be done for the same sum as the rejected 651 pCi/g approach (see p. 76). Thus, the agencies made this change without violating the deal made with Congress. Second, when the proposal for the three-level revised "cleanup" standards was put out for comment, 86% of the parties commenting rejected the proposal and urged the agencies to begin anew.[11] Clearly, informed people wanted a better cleanup, but their concerns were ignored.

[11] http://docs.wixstatic.com/ugd/cff93e_c74ed342de524330a178e1d6fb74f0f5.pdf

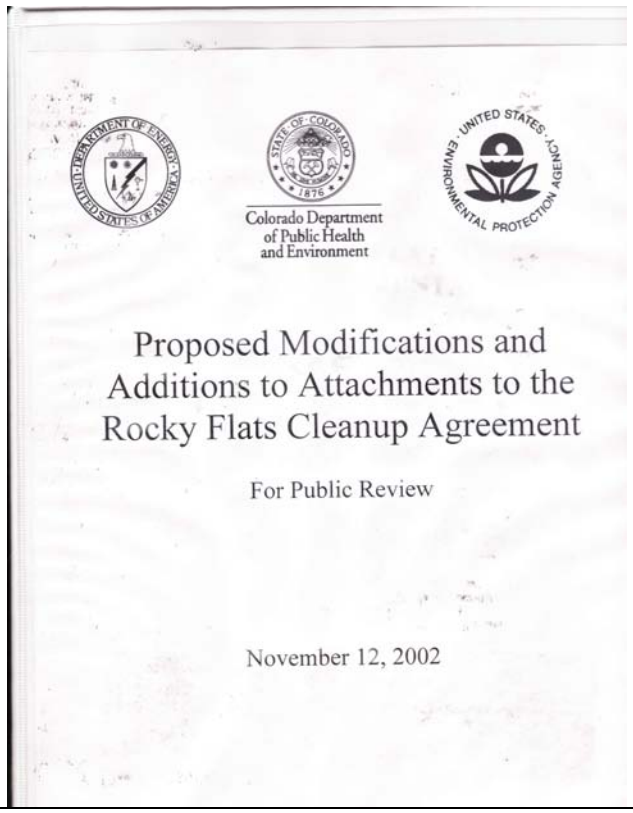


Figure 7.4: In November 2002 DOE, EPA and CDPHE released for comment *Proposed Modifications and Additions to Attachments to the Rocky Flats Cleanup Agreement.* This proposed revision included the three-level plutonium "cleanup" standards that were adopted and made official in June 2003.

Comparison to cleanup standards at other sites: How do the standards adopted for Rocky Flats compare to standards set for cleanup of plutonium-contaminated sites elsewhere? At the following sites, with one exception, standards are lower than the 50 pCi/g for the top 3 feet of soil at Rocky Flats. Also, by contrast to the graduated standards for varying depths adopted for Rocky Flats, the following apply to soil in the environment without respect to depth below the surface.

- 40 pCi/g at the Enewetak Atoll bomb test site (see Figure 7.5)
- 14 pCi/g at the Johnston Atoll bomb test site
- 34 pCi/g for a portion of the DOE's Hanford, WA, site
- 8 pCi/g at Fort Dix, NJ
- 10 pCi/g for a portion of the Livermore National Lab, CA
- 200 pCi/g for a portion of the Nevada Test Site

Comparison to background radiation: For a second perspective, how do the standards cited above compare to background plutonium radiation at Rocky Flats?

- The prevailing view of government agencies is that the average background level for plutonium from global fallout in soil along the Front Range of the Rockies in Colorado is 0.04 pCi/g. The Future Site Use Working Group sought eventual Rocky Flats cleanup to this level.
- The 50 pCi/g allowed to remain in the top 3 feet of soil at the site is 1,250 times the 0.04 pCi/g average background level.
- The 1,000 to 7,000 pCi/g of plutonium allowed at a depth of 3 to 6 feet at the site is 25,000 to 175,000 times the 0.04 pCi/g average background level.
- Below 6 feet at Rocky Flats, there is no limit.

- Plutonium is not a part of natural background radiation. Natural background has been altered globally by the addition of fallout of plutonium and other radionuclides from the human activity of detonating nuclear devices in the atmosphere.

Figure 7.5: Ivy King nuclear test, November 15, 1952, one of 43 nuclear bombs fired at the Enewetak Atoll by the U.S. from 1941 to 1958. Far more contaminated than Rocky Flats, the atoll was cleaned to 40 pCi/g. Enewetak is part of the Republic of the Marshall Islands.

Assessment of public response to the final official "cleanup" standards: By the time the final legally binding "cleanup" standards were adopted by DOE, EPA and CDPHE in June 2003, some of the affected population had more or less willingly gone along with these agencies. The final three-layered standard is better than the old 651 level, because much less plutonium remains in the top 3 feet of soil. But it leaves a dangerous situation, as will be shown below. To call the end result "safe," as many government spokespersons do, is a misuse of language.

7, Part 2. "CLEANUP" AND CLOSURE (1992-2005): FAILURE CLAIMED AS SUCCESS

After the "cleanup," what remains in the depths below 6 feet where no "cleanup" standard applies? At the highly contaminated 903 Pad area, where drums stored outdoors corroded and leaked plutonium into the soil for a decade, those doing the "cleanup" found that plutonium had percolated down to levels considerably below 6 feet. This had not been anticipated. Also, at least 14,700 feet of process waste lines containing plutonium, many below 6 feet, were grouted and left in place. In addition, three large Solar Evaporation Ponds were not dug up and removed but were backfilled with material originally taken from them; their liners, each containing an unknown quantity of plutonium, were left intact. Jack Weaver, who had managed two of the large plutonium processing buildings, thought the whole structure of each building and radioactive material that had leaked into the soil under them should be totally removed, but, he pointed out, the "cleanup" plan only "calls for taking the roof and the walls down to the slab and then pouring a cap over the slab." He said, "There's too much stuff under 771 and even 776 Building that has the potential some day to leach out into the rest of the world. I don't believe that's acceptable."[14] Another former Rocky Flats worker recently told me that the 20 or so "infinity rooms" in these buildings were not cleaned up but were imploded into the basement of the buildings and covered over with soil, so that their highly radioactive remains were left at least 6 feet below the surface. "Infinity rooms" at Rocky Flats were so contaminated with plutonium that the levels of alpha radiation in them were too high for standard monitoring equipment to measure. These rooms were off-limits to workers (see Figure 7.6).

Figure 7.6. Sealed door at one of the "infinity rooms" at Rocky Flats. There were more than 20 of these rooms, the largest 100 yards X 50 yards. Photo by Robert Del Tredici.

Map showing where waste had been deeply buried was ignored in the "cleanup": Former Rocky Flats worker Jerry San Pietro says that he and a fellow-worker were allowed once to see a map that showed where plutonium waste had been buried 20 to 30 feet below the surface at various locations on the site. San Pietro tried to bring attention to what he had seen on this map, because the "cleanup" focused only on what was in the top 6 feet of soil and didn't deal with what the map showed. He was ignored by those doing the "cleanup," including the regulators (EPA and CDPHE), as well as by members of Congress and state officials. Convinced that a great deal of waste remains deeply buried at the site, he calls Rocky Flats "the largest unlicensed nuclear

[14] Ackland, *Making a Real Killing*, p. 242.

burial site in the United States."[15] When he contacted me about this, I made a Freedom of Information Act (FOIA) request for the map he had seen. In response DOE sent not the map he described but one with which I was familiar showing well-known disposal sites. San Pietro thinks the map showing the deep burials by now may have been destroyed.

Concerns about the environmental condition: The previous two sections provided a few examples about plutonium in the Rocky Flats environment at depths below where the "cleanup" standards apply. In what follows I will introduce a range of concerns about plutonium in the soil on and off the site. Already it has been emphasized that plutonium has a half-life of 24,110-years and that it is present in soil as minute particles that can be picked up by wind and made available to be inhaled, the worst way to be exposed to plutonium.

How much plutonium was released to the environment? Varied answers: No one knows how much was released or where it went. Scientists P. W. Krey and E. P. Hardy of the Atomic Energy Commission (AEC), predecessor to DOE, sampled soil throughout the metro area in an effort to find out. In 1976 Krey published a map based on their sampling. The map shows that an estimated 2.6 curies (36 grams or 0.079 pounds) of plutonium released from Rocky Flats was deposited in off-site areas southeast from the plant across most of the City of Denver and east as far as Thornton, with heavier concentrations nearer the plant[16] (see Figure 5.2, p. 37). Martell and Poet, who in 1970 had revealed to the public that plutonium had been released from Rocky Flats, estimated the quantity to be 6.6 Curies (92 grams or 0.203 pounds).[17]

A more comprehensive effort, the Rocky Flats Dose Reconstruction Study, estimated that the total off-site of plutonium releases for 1953-1989 ranged from 0.086 to 0.24 curies (1.2 to 3.4 grams, or (0.0022 to 0.0075 lbs.).[18] Those who did this study did as comprehensive a search for evidence as possible, but in the end they had to rely on data provided by the DOE and this may have been incomplete. Quantities of radioactive materials are indicated in curies or a sub-portion thereof. One curie is the quantity of any radioactive material that undergoes 37 billion disintegrations or releases of radiation per second. Thus, according to the dose reconstruction estimate, the 0.0022 to 0.0075 pounds of plutonium released off site and distributed widely emits between 3.18 billion and 8.88 bbillion bursts of alpha radiation each second. After 24,110 years, the half-life of plutonium-239, the number of alpha bursts per second will be reduced by half. Te particles are too small to see but not to small to be inhaled and to do harm.

Small amount of plutonium, big health problem for a very long time: The foregoing estimates of the quantity of plutonium released from Rocky Flats into the environment are small, ranging from 0.0022 pound to 0.0075 pounds. Why worry about so small a quantity? Because a small amount can be very harmful. According to physicist Fritjof Capra of the University of California at Berkeley, "Plutonium . . . is by far the most dangerous of all nuclear waste products. Less than one-millionth of a gram – an invisible dose – is carcinogenic. One pound, if uniformly distributed, could potentially induce cancer in every person on earth."[19] This toxicity plus plutonium's 24,110-year half-life, make Rocky Flats a local hazard forever.

Energy Secretary Hazel O'Leary reveals that more than a ton of Rocky Flats plutonium is missing: Those who did the dose reconstruction study were not aware of what Energy Secretary Hazel O'Leary would reveal on June 27, 1994. Referring to inventories at Rocky Flats, she revealed that a total of 1.2 metric tons (2,640 pounds) of plutonium had arrived at the plant but could no longer be accounted for. This was enough

---

[15] For San Pietro's story, see Transcript OH1384v in the Rocky Flats Oral History Collection, Maria Rogers Oral History Program at the Carnegie Branch of the Boulder Public Library.
[16] Krey, "Remote Plutonium Contamination and Total Inventories from Rocky Flats," *Health Physics*, vol. 30 (Feb. 1976).
[17] S. E. Poet and Martell, "Plutonium-239 and Americium-241 Contamination in the Denver Area," *Health Physics*, vol. 23 (Oct. 1972.
[18] Summary of Findings, Historical Public Exposures Studies on Rocky Flats, August 1999, Colorado Department of Public Health and Environment (CDPHE).
[19] Capra, *The Turning Point* (1982), pp. 246-47.

plutonium for more than 400 bombs. The official term for this missing plutonium is "MUF," or "material unaccounted for."

Thomas B. Cochran says some of the MUF is in the off-site environment: A nuclear physicist with the Natural Resources Defense Council, Cochran insists that some of this huge quantity of MUF was released to the external environment. In testimony given in the class action lawsuit (Cook v. Dow and Rockwell) brought on behalf of property-holders in areas shown to be contaminated with plutonium released from Rocky Flats (see Figure 7.8), Cochran explained his unsuccessful effort to get the DOE to declassify some of its vast store of documents on the plutonium unaccounted for at Rocky Flats.[20] He said that the plutonium release estimates made by Krey and Hardy and the dose reconstruction study "could be increased by orders of magnitude [ten or more times] and still be consistent with the MUF,"[21] because the quantity is so large.

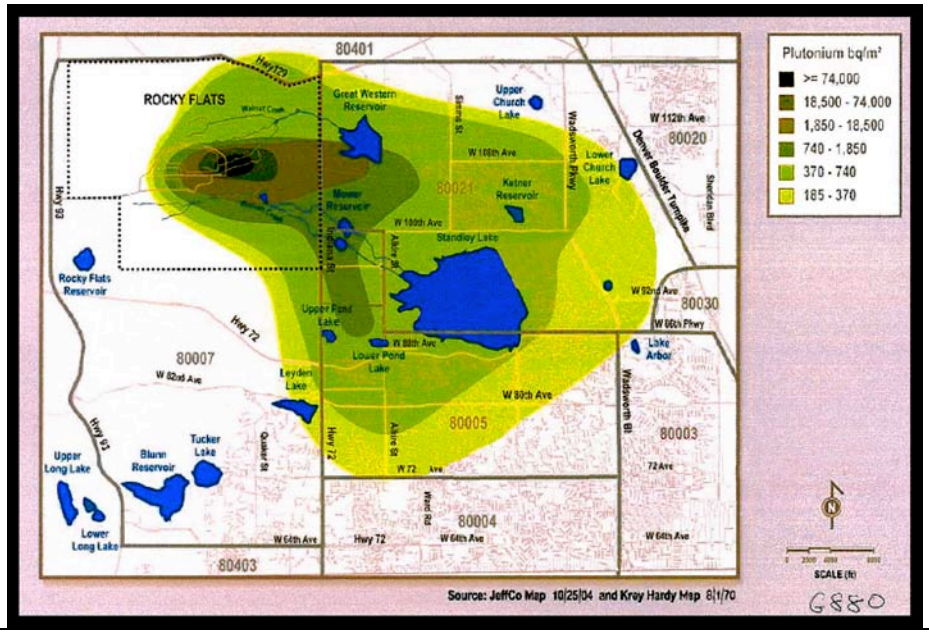


Figure 7.8. Distribution of plutonium contamination from Rocky Flats in becquerels per square meter (one becquerel equals one disintegration or burst of radiation per second). The original version of this map was prepared by P. W. Krey and E. P. Hardy of the AEC's Health and Safety Laboratory, New York City, and published in their 1970 report, "Plutonium in Soil Around the Rocky Flats Plant," HASL 235. The above adaptation of their map was used to delineate the area of the class of affected property owners seeking compensation for damage to their property in the Cook v. Dow & Rockwell lawsuit heard in federal court in Denver and finally settled in 2016.

DOE claims the MUF is in Idaho: In 2012 I received as email a link to *The United States Plutonium Balance, 1944-2009*, June 2012. The text purported to clear up the mystery about the Rocky Flats MUF. It asserts that most of the missing Rocky Flats plutonium went to the Idaho National Lab and was buried there prior to 1970.[22] Up to the time of O'Leary's 1994 announcement about the MUF, DOE's position was that the MUF couldn't be explained because records of early shipments of plutonium-bearing waste from Rocky Flats to Idaho were woefully incomplete. But in 2012 DOE suddenly claimed it knows how much Rocky Flats plutonium

[20] See his extensive testimony in Cook v. Rockwell International, United States District Court, District of Colorado, No. 90-CV-00181, pp. 5230-5655.
[21] Cochran, "Plutonium Inventory Differences at the Rocky Flats Plant and Their Relationship to Environmental Releases," Nov. 22, 1996 http://www.nrdc.org/nuclear/cochran/cochranpubs.asp#pubs
[22] http://nnsa.energy.gov/ourmission/managingthestockpile/plutoniumpits/puinventory Though I received this link out of the blue, and read the claim mentioned above, now the link is invalid. My current copy of *The Plutonium Balance, 1944-2009*, downloaded from the web, says nothing about MUF at Rocky Flats.

was buried in Idaho. This is not credible and will remain not credible until an independent party with unfettered access to all the evidence does an assessment. Can they overcome the following denials?.

Denial 1) **Some MUF was dumped at Lowry Landfill:** A very well documented story by Pulitzer Prize winning journalist Eileen Welsome counters DOE's claim to have found in Idaho the plutonium O'Leary said was lost. In three articles published in *Westword* in April 2001 (see Figure 7.9), Welsome, in tandem with environmentalist Adrienne Anderson, showed that a large quantity of plutonium waste from Rocky Flats was illegally dumped at the Lowry Landfill southeast of Denver.[23] Welsome is quite familiar with plutonium. She received the Pulitzer Prize in 1994 for her *Albuquerque Tribune* articles on an AEC program to determine the health effects of plutonium by injecting it into the bodies of unwilling and unknowing people, most of them "poor, powerless and sick," and several of them black. Her later *The Plutonium Files: America's Secret Medical Experiments in the Cold War* (1999) provides more information on this secret program.

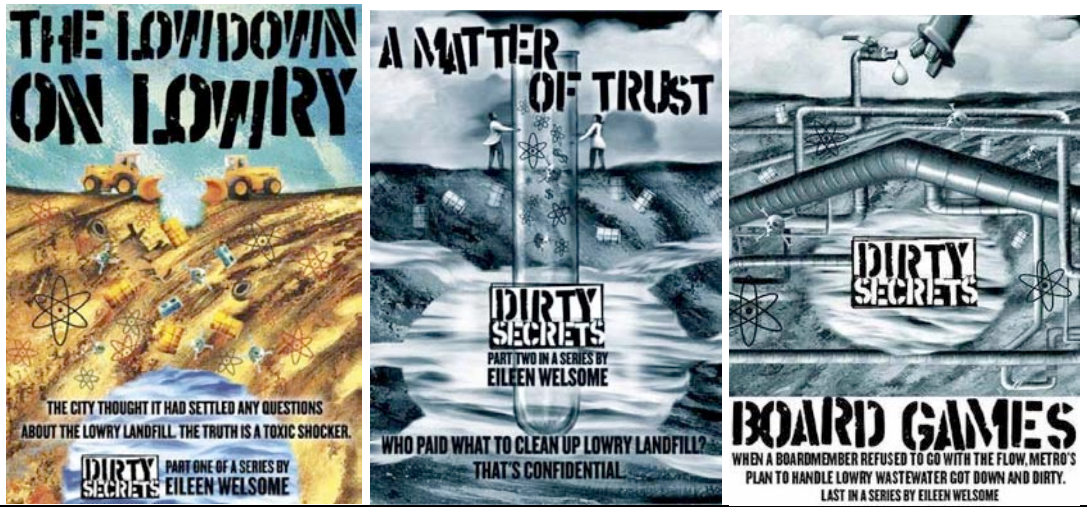


Figure 7.9: On April 12, 16, and 19 of 2001 Eileen Welsome published a series of three carefully documented articles in the Denver weekly *Westword* providing details about the illegal dumping of a large quantity of plutonium from Rocky Flats at the Lowry Landfill southeast of Denver, about 30 miles from Rocky Flats.

The local story she tells is that Rocky Flats plutonium was dumped at the Lowry Landfill from the early 1950s until about 1980 (see Figure 7.10), that is, for all the years of production except for the last decade (1980-89). At the same time, according to Welsome, most of the large corporations in the Denver area and many smaller ones, disposed of many kinds of waste there. After Lowry Landfill was named a Superfund site in 1994, the polluters scrambled to escape high costs for what they had done, while also working behind the scenes and off the record to avoid publicity. A coalition of the larger corporations wanted to make Rocky Flats operators pay a high fee to clean up the radioactive materials. But, with the complicity of the EPA and the City of Denver (which for years owned the site), they reversed themselves, paid fees to get immunity from future charges related to the radionuclides, and worked out a "cleanup" scheme to reduce the quantity of plutonium and other toxins buried at Lowry. Their solution for the plutonium was to move it in liquid form more than 15 miles (as the crow flies) through city sewer lines to the Metro Wastewater Reclamation District plant just south of where the South Platte River flows under Interstate 270 in north Denver. Sewer lines are not authorized to transport radioactive material, so this was – and continues to be – clandestine.

In the summer of 2000 the plutonium-contaminated waste began flowing from the Lowry Superfund site at a rate of 20 to 25 gallons a minute, or about 30,000 gallons per day. This flow of radioactive liquid will continue for 50 years or longer, until the plutonium is no longer at Lowry. Once the plutonium-bearing liquid waste reaches the Wastewater plant it is treated. The cleaner water is released into the South Platte, the

[23] Welsome, "The Lowdown on Lowry," "A Matter of Trust," and "Board Games," *Westword*, April 12, 19 and 26, 2001. On line at http://www.westword.com/authors/eileen-welsome/

heavier plutonium-bearing sludge ("biosolids") is trucked 50 miles east and spread as fertilizer on farmland, and the remaining mildly contaminated water is used to irrigate parks, school yards and parkways in Denver. The large polluters included the two major newspapers, the *Denver Post* and the former *Rocky Mountain News*, neither of which ever carried a story critical of the contamination at Lowry Landfill.

Figure 7.10: Map showing the Lowry Landfill in relation to Rocky Flats.

Not surprisingly, Rocky Flats authorities denied that radionuclides from the plant were ever dumped at Lowry. But according to Welsome, several drivers of tank trucks admitted that they delivered liquid waste from Rocky Flats to Lowry Landfill. Also, police officers said they saw some of the deliveries, and trucking company records confirm that the transport happened. A letter addressed by a coalition of the polluters to EPA shows alarmingly high levels of plutonium and americium at numerous wells drilled at the site. EPA now denies that such a letter exists, but both Welsome and Anderson had copies. The level of denial about what's present at Lowry Landfill is well nigh universal among the polluters. But when denial meets documentation, documentation prevails. Welsome and Anderson provided the documentation. The extent of the denial makes this perhaps the greatest single environmental scandal in Colorado history. Hazel O'Leary's term as Secretary of Energy ended in 1997, well before publication of Welsome's articles.[24]

Denial 2) **Deep burial of plutonium on the Rocky Flats site:** During the Superfund cleanup at Rocky Flats former worker Jerry San Pietro reported that plutonium had been buried on the Rocky Flats site at levels 20 to 30 feet below the surface. What he found should have been reviewed for the cleanup, but it was not. For details, see above, pp. 83-84.

Denial 3: **Evidence collected by the FBI never reviewed:** In the 1989 raid the FBI collected 65 cartons of evidence of environmental crime at the site. This evidence was never reviewed by the agencies that regulated the cleanup – the EPA and CDPHE. For details, see pp. 68 and 90.

Lawsuit brought on behalf of people who live in areas known to be contaminated with plutonium: Shortly after the June 1989 FBI raid of Rocky Flats, a class action lawsuit was filed in Denver federal court against Dow Chemical and Rockwell International, operators of the plant during production years. The suit was brought on behalf of residents of a sector of about 30 square miles shown by AEC scientists P. W. Krey and E. P. Hardy to be contaminated with plutonium released from Rocky Flats (see Figure 7.8, p. 80). As originally filed,

[24] In June 2001, CDPHE and EPA provided an alternate view, on line at https://www.colorado.gov/pacific/sites/default/files/HM_LowryLandfill-Lowry-radionuclides.pdf

the case claimed harm to both the health of residents of the "class area" and their property values. The judge set aside the health aspect and restricted the case to property values. By the time the case was finally tried in the fall of 2005 the "cleanup" was finished. Thus, despite the fact testimony in this case provided much detail regarding how Dow and Rockwell had contaminated the environment, what was revealed in court would have no effect on the "cleanup."

On February 14, 2006, the jury found the corporations guilty[25] and assessed penalties of $554 million (a figure subsequently raised by the judge to just short of $1 billion). This suggests that when uninformed people are presented evidence of the contamination around Rocky Flats and hear as well countervailing arguments, they are likely to conclude, as the jurors in this case did, that the companies that operated Rocky Flats contaminated property and endangered people. The large sum of money, a record-breaking amount, awarded as compensation by the jury to property holders in the class area, has not reached them, because on appeal the verdict was overturned in March 2010, not on grounds of evidence but on procedural issues. In June 2012 the Supreme Court decided not to hear the case and remanded it back to the original court. On June 23, 2015 the Appeals Court for the District of Colorado vacated the March 2010 decision and reestablished the original verdict.[26] As of September 19, 2015, defendants (the corporations) are seeking a Supreme Court review, and attorneys for the plaintiffs are briefing the district court.[27] In May 2016 the case was finally settled. The plaintiffs were awarded compensation of $375 million; payments began in 2017, though many plaintiffs have died.

Failure to create a reliable record of contamination: In addition to the history of contamination at Rocky Flats is the history of failure of DOE, its predecessors and its contractors as well as the EPA and the CDPHE carefully and accurately to document this contamination. A reliable record of contamination at Rocky Flats thus does not exist.[28]

Questions about sampling dust for plutonium at Rocky Flats: The previously reported research of Harvey Nichols and Gale Biggs (see pp. 42-44) showed that most plutonium particles released from Rocky Flats were of such a small size that they could attach to dust motes tiny enough to be carried great distances by wind and be readily inhaled by some unsuspecting person anywhere along the way. Given this reality, Carl Johnson proposed that to protect the health of people in off-site areas the state adopt the method he had pioneered of testing only respirable dust samples for plutonium content (see pp. 45-46). The state rejected his proposal and continued its method of collecting the top quarter-inch of soil, which includes dust but dilutes it by mixing it with other matter that cannot be inhaled. There has never been a program at Rocky Flats either on the site or off for routine collecting of discrete samples of respirable dust and analyzing them for plutonium content. Such sampling would demonstrate the extent to which plutonium is present at the time of the sampling in breathable particles, the most dangerous way for humans to be exposed.

In an effort to refute my remarks about sampling breathable dust, David Abelson and Rik Getty, staff of the Rocky Flats Stewardship Council, searched for examples of dust sampling done at Rocky Flats. In a March 22, 2011, memo to Council members they reported that they had found one example. After a July 2000 lightning-caused fire denuded the soil in an area on the site near the very contaminated 903 Pad, dust was collected with a whiskbroom and a portable wind tunnel. This dust contained very little plutonium. But this was not confirmation that I was wrong to emphasize dust sampling, because this project was a faulty example for two reasons. First, samples weren't taken until six weeks after the fire, by which time any dust in the denuded area would have blown away. Second, the wind tunnel filters captured for analysis only particles that ranged from 10 to 45 microns in size, while, as shown by Gale Biggs (see pp. 44-45), most of the airborne

---

[25] Civil Action No. 90-cv-00181 (JLK), *Cook vs. Dow Chemical & Rockwell International*, U.S. District Court, District of Colorado, 14 February 2006.

[26] Allison Frankel, "10th Circuit in Rocky Flats case: After 25 years, give plaintiffs justice," Reuters, June 24,1015. http://blogs.reuters.com/alison-frankel/2015/06/24/10th-circuit-in-rocky-flats-case-after-25-years-give-plaintiffs-justice/

[27] Email message from Merrill Davidoff, lead attorney for plaintiffs, September 19, 2015.

[28] Professor Michael Ketterer of the Chemistry Dept., Metro State University in Denver, made the case for this on August 4, 2015. See at https://www.youtube.com/watch?v=keZZ1A7-xys

plutonium particles at Rocky Flats would be so small they would pass undetected through these monitoring filters. Besides, this was a one-time event, not an ongoing program where dust sampling is routine. The moral of this story is that you can't find what you don't look for. Or maybe the moral is that you'd best not look for what you don't want to find.

Questionable characterization, using the kriging method: While the failure to determine what's actually present in dust is the bigger problem from a public health standpoint, some of the sampling that was done to characterize the site – that is, locate, measure and map contamination there – was questionable. This is true especially of the "kriging" approach which estimates plutonium concentration in a given area by commingling a few surface soil samples collected from within a large plot to come up with an average concentration for that plot. This method was used to characterize most of the Rocky Flats buffer zone, the part of the site outside the industrial area that today is the Wildlife Refuge. Kriging can miss hot spots or average them away.[29] In addition, for the reasons pointed out earlier, it doesn't take account of the higher toxicity of plutonium present in respirable dust since at Rocky Flats only whole soil samples were used. Also because the measurements are surface ones, kriging misses plutonium deposited on the surface years and decades earlier that has percolated down below the level at which surface samples are taken.

Plutonium that has percolated down can be brought back to the surface by the action of animals, plants, humans, weather or geologic disturbance. It can then be redistributed by wind, perchance to be inhaled by a wholly unsuspecting person. This is a permanent reality at Rocky Flats not detected at all by kriging. The agencies responsible for the Rocky Flats "cleanup," on the basis of results of characterization by kriging, decided that the area that is now the wildlife refuge met their exposure standards and thus required no "cleanup." In 2006 the roughly seven square miles of land transferred by the DOE to FWS to operate as the Rocky Flats National Wildlife Refuge was certified as suitable for any use and was removed from the Superfund list. Inadequate characterization means those responsible for the "cleanup" missed material they supposedly were cleaning up. The following shows other ways their "cleanup" was questionable or faulty.

Evidence from the FBI raid not examined: To summarize a point made previously (see p. 68), the FBI raided Rocky Flats in 1989 to collect evidence of alleged environmental law-breaking by plant operators Dow Chemical and Rockwell International. Federal Judge Sherman Finesilver reached an out-of-court settlement in which he dropped major charges against Rockwell and sealed 65 cartons of documents from the case, documents that should have been reviewed as part of the Rocky Flats "cleanup." Though the documents were made available to the "cleanup" regulators, the EPA and CDPHE, they made no effort to examine them.[30] Above it was noted that *The Ambushed Grand Jury* by Wes McKinley and Caron Balkany argues that the real purpose of the FBI raid was not to reveal environmental law-breaking but to cover it up by collecting and sealing the evidence. The Department of Justice should make the sealed documents available not to the regulators, who have shown themselves to be irresponsible, but to the public.

False data used: In a paper released at a news conference on August 18, 2004, former Rocky Flats worker Jacque Brever, whistleblower to the FBI regarding illegal operation of the incinerator, said that much of the badly contaminated "East Spray Fields" area at Rocky Flats was excluded from the "cleanup" then nearing completion, because the DOE had knowingly given false information about this area to the regulators (see Figure 7.11).[31] According to Brever, the data DOE should have provided was later revealed in publicly available reports from the out-of-court settlement reached with former contractor Rockwell International in the trial triggered by the 1989 FBI raid. Joseph A. Legare of DOE, in a September 1, 2004, letter and paper addressed to Steve Gunderson of CDPHE and Mark Aguilar of EPA, avoided direct response to Brever's

[29] See "Rocky Flats Environmental Technology Site: Independent Review and Technical Evaluation of the Soil Sampling Protocols for Site Characterization and Cleanup Confirmation," a report prepared for the Rocky Mountain Peace and Justice Center by Camp Dresser & McKee, Inc. (August 2005). Available on line at http://www.clarku.edu/research/kaspersonlibrary/mtafund/ and scroll down to Rocky Mountain Peace.
[30] Anne Imse, "Rocky Flats Brouhaha," *Rocky Mountain News*, August 20, 2004.
[31] Brever, "An Analysis of the Department of Energy's Cleanup Plans for Four Areas at Rocky Flats: The Coverup Continues." http://www.utwatch.org/war/jacquebrever_rockyflatscleanup.html

allegation that DOE provided false information about the East Spray Fields to the regulators. Neither correcting nor refuting what she had said, he simply piled the new lie of his denial on top of an old lie.

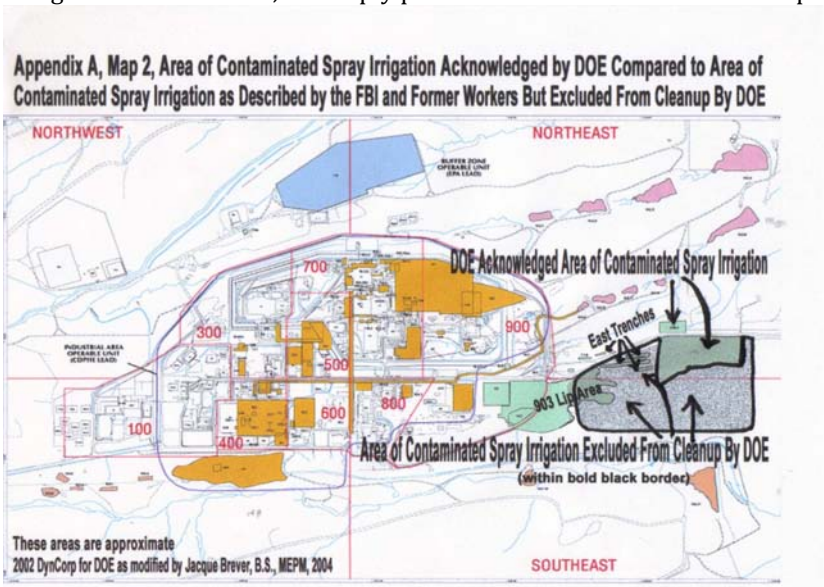


Figure 7.11: Jacque Brever's report shows that for purposes of the site "cleanup," the DOE falsely stated to the EPA and CDPHE that the badly contaminated East Spray Field Area (shown in gray on this map) was not contaminated. This area thus was excluded from the "cleanup."

The "cleanup is based on the false assumption that plutonium in soil at Rocky Flats will not migrate: Those who designed the "cleanup" for Rocky Flats relied on the team of scientists who did a multi-year Actinide Migration Evaluation (AME) at the site and concluded that plutonium in the soil at Rocky Flats remains "relatively immobile."[32] But their results were based primarily on computer modeling rather than on empirical observation. By contrast, environmental engineer M. Iggy Litaor, with instruments he had set up in the field in the unusually wet spring of 1995 detected significant horizontal migration of plutonium in shallow subsurface soil at Rocky Flats. Soon after his stunning real-time discovery, which attracted a great deal of attention because it countered the prevailing Rocky Flats orthodoxy, he was involuntarily terminated by Kaiser-Hill and replaced by the AME team. Back in his native Israel, he tried for about two years with my assistance to get DOE-Rocky Flats to provide him with computerized data he needed to complete a report of his findings. They ignored his request. He thus never published a report documenting what he had found. Absent such documentation in a technical journal, it's as if the movement of plutonium Litaor directly observed in the saturated conditions at Rocky Flats in the spring of 1995 never happened.[33] The Rocky Flats orthodoxy triumphed truth. But studies showing migration of plutonium are abundant.[34]

The AME claim that plutonium will not migrate was refuted by one of its own reports: The AME team's conclusion of inconsequential plutonium migration at Rocky Flats flies in the face of one of their own reports. This report maintains that cleanup of plutonium in the soil at Rocky Flats even to as low as the 10 pCi/g

---

[32] Kaiser-Hill Co., Actinide Migration Evaluation Pathway Analysis Summary Report, ER-108 (April 2004), p. 28.

[33] The author possesses a copy of a preliminary report Litaor prepared about his discovery.

[34] For references on recent findings of plutonium migration in soil at various sites, see Alexander P. Novikov et al., "Colloid Transport of Plutonium in the Far-Field of the Mayak Production Association, Russia," *SCIENCE*, vol. 314 (27 October 2006), notes 6 and 8. Research done by Annie Kersting of DOE's Lawrence Livermore National Laboratory confirms colloidal transport of plutonium. See "Plutonium Hitches a Ride on Subsurface Particles," *Science & Technology Review*, LLNL, Oct./Nov. 2001, pp. 16-18. Also see my "Science compromised in the Cleanup of Rocky Flats," on line at http://media.wix.com/ugd/cff93e_1ae76276c5814bf8aa21dc530da95857.pdf

recommended by the Rocky Mountain Peace and Justice Center (see pp. 76-77), rather than the 50+ actually adopted, would result under conditions of either a 10-year or a 100-year storm in failure at certain downstream areas to meet the Colorado State standard for plutonium in surface water of 0.15 pCi/liter.[35] This contradictory report, though it was part of the AME work, is not cited in the final summary report of the AME project.[36] Twice in 1997, before the wayward AME report was written, the quantity of plutonium in Walnut Creek at the downstream boundary of the Rocky Flats site exceeded the state standard.[37] This occurred on several subsequent occasions not at the site boundary "points of compliance" where the state plutonium-in-water standard must be met. Failures to meet the state standard have happened at upstream "points of evaluation," which have triggered efforts to find the source of the fugitive plutonium. The exact source has never been identified. And the violations have occurred not at the times of severe storms, as predicted in the paper. Recent "exceedances" of the state standard have happened at monitoring location GS10 on South Walnut Creek, a "point of evaluation," not of "compliance." In its January 2014 report, DOE stated: "12 month rolling average for Am-241 and Pu-239 exceeded state standard of 0.15 pCi/L for year ending July 24, 2012."[38] This means that all samples of americium and plutonium collected at GS10 over a period of 12 months were added together and averaged to arrive at the average quantity of plutonium and americium for the year ending on the date given; this average exceeded the state standard. As noted earlier, efforts to find the source have so far not been successful. DOE deals with the problem with engineered controls that divert and dilute the water. Can maintenance of such controls be expected to outlast the plutonium? Can DOE Legacy Management outlast the plutonium?

[35] Kaiser-Hill Co., Report on Soil Erosion and Surface Water Sediment Transport Modeling for the Actinide Migration Evaluation at the Rocky Flats Environmental Technology Site, 00-RF-01823/DOE-00-93258 (August 2000), p. 51.

[36] Kaiser-Hill, *AME Pathway Analysis Summary Report*, ER-108 (April 2004).

[37] J. E. Law, Rocky Mountain Remediation Services, L.L.C., Memo to D. C. Shelton, K-H. Environmental Compliance, dated August 18, 1997, Re: Recent elevated plutonium and americium in water at RFCA point of compliance, Walnut Creek at Indiana Street.

[38] Rocky Flats Site Quarterly Report of Site Surveillance and Maintenance Activities—3rd Quarter, Calendar Year 2013, U.S. Department of Energy, Doc. No. S11334, January 2014.

7, Part 3. "CLEANUP" AND CLOSURE (1992-2005): FAILURE CLAIMED AS SUCCESS

Burrowing animals move plutonium: In an unprecedented 1996 study, ecologist Shawn Smallwood identified 18 species of burrowing animals at Rocky Flats that constantly move soil and any adhering contaminants. They take surface material down and bring buried material up. Major diggers, like pocket gophers, prairie dogs and harvester ants (see Figure 7.12), burrow to depths of 10 to 20 feet and disturb very large areas on the surface, while coyotes, badgers, rabbits, and other animals move additional soil. Plants loosen soil and create passages animals can use. Smallwood estimates that burrowing animals disturb 11 to 12% of surface soil at Rocky Flats in any given year. Undisturbed soils do not exist at the site. Plutonium and americium at Rocky Flats were only partially removed down to a depth of 6 feet and are not removed at all below that level. They are being constantly re-circulated in the environment. What's now buried is likely some day to be brought to the surface for wider dispersal by wind, water, fires or other means. Material brought to the surface in the more contaminated DOE-retained land at the center of the Wildlife Refuge can be redistributed widely within the Refuge and beyond, posing a danger now and in perpetuity. Human and non-human beings will unwittingly take particles into their body

Figure 7.12: Deep diggers among the burrowing animals at Rocky Flats include pocket gophers and harvester ants. According to ecologist Shawn Smallwood they go down 16 to 20 feet and constantly redistribute soil and its contents. In any given year burrowing animals disturb on average 11 to 12% of surface soil at Rocky Flats.

In his research Smallwood of the University of California Davis, went onto the Rocky Flats site on three separate occasions in the summer and fall of 1996, each time accompanied by Rocky Flats personnel. He finished his report before the end of that year and two years later published results in a technical journal.[39] But his findings were totally ignored by officials from DOE, EPA and CDPHE who established the soil remediation standards in the Rocky Flats Cleanup Agreement of June 2003. Regarding burrowing animals, the analysis by these agencies was limited to prairie dog activity in the top 6 feet of soil. But they relied primarily on the conclusion of the Actinide Migration Evaluation scientists that plutonium and americium left in the Rocky Flats soil would remain "relatively immobile." The AME scientists, in their 2004 final report, stated that data on highly mobile species that might transport actinides "are not available and would be difficult and in some cases logistically nearly impossible to obtain."[40] Smallwood's study had been completed eight years earlier.

Earthworms as movers of plutonium: Smallwood did not include earthworms in his study, but they need to be reckoned among the plutonium movers at Rocky Flats (see Figure 7.13). Prof. Tim Seastedt of the Department of Ecology and Evolutionary Biology at the University of Colorado stated what I also heard from

[39] Smallwood et al., "Animal Burrowing Attributes Affecting Hazardous Waste Management," *Environmental Management*, vol. 22, no. 6, 1998, pp. 831–847.
[40] Kaiser-Hill Co., Actinide Migration Evaluation Pathway Analysis Summary Report, ER-108 (April 2004), p.

others: "To my knowledge, there are no density or biomass estimates for earthworms on the Front Range."[41] According to my own estimates, the soil of the full ten square-mile Rocky Flats site likely contains at any given time as many as half-a-billion earthworms.[42] One million earthworms weigh a ton, and in a span of 24 hours "each worm will pass through its body its own weight of soil" and its contents,[43] which at Rocky Flats would sometimes include plutonium. Environmental engineer Iggy Litaor, who paid considerable attention to earthworms during his years at Rocky Flats, says that at the site, though they can burrow much deeper, most of them work the soil to a depth of about 50 centimeters (19.5 inches).[44] Each year they may bring to the surface as much as an inch-thick layer of subsoil.[45] Litaor reported that in the saturated conditions of the spring of 1995, when he detected rapid plutonium migration at the site, earthworms surfaced in huge numbers. Various predators devoured many of them, so that whatever contaminants the worms bore within entered their predators' bodies either to lodge there or to be defecated elsewhere. Untold numbers of the worms dried on the surface and disintegrated into dust that perhaps contained plutonium and americium particles that could be dispersed by wind or other forces. Whenever comparably wet

Figure 7.13: The earthworm population at Rocky Flats, according to my estimate, is about half-a-billion (see footnote 47). They are major movers of soil and its contents. At Rocky Flats this includes plutonium and other contaminants.

conditions recur at Rocky Flats, such as the flood of September 2013, similar activity will recur. But, as noted, earthworms otherwise will be constantly bringing plutonium particles to the surface. Those responsible for the "cleanup" at Rocky Flats paid scant attention to this significant reality.

Uptake of plutonium in grass: An eleven-year study done at DOE's Savannah River Site in South Carolina demonstrates that plutonium in subsurface sediments at that site moved upward from the buried source material. The authors of this study conclude "that the upward movement was largely the result of invading grasses taking up the plutonium and translocating it upward," producing a "measurable accumulation of

[41] Email communication from Tim Seastedt, June 2, 2011.
[42] While earthworm populations per acre "of between one and two million are quite common" (http://journeytoforever.org/farm_library/oliver/balfour_intro.html), poor soil may contain only 250,000 per acre (http://www.experiencefestival). Applying this number to the 6,219 acres of land held by DOE and FWS at Rocky Flats in 2012 suggests a total earthworm population at the site in excess of 1.5 billion. Dropping this number by two-thirds in order to be exceedingly conservative about the high plains environment at the base of the Rockies puts the number of earthworms at the Rocky Flats site at any given time at upwards of half-a-billion.
[43] http://journeytoforever.org/farm_library/oliver/balfour_intro.html
[44] Email communication from M. Iggy Litaor, May 17, 2011.
[45] http://www.ext.colostate.edu/mg/gardennotes/218.html

plutonium on the ground surface."[46] By contrast, the Actinide Migration Evaluation done at Rocky Flats concluded that "uptake into plant . . . tissues is minor."[47] The Rocky Flats site consists for the most part of prairie grassland (see Figure 7.14). If grass at the Savannah River Site brings plutonium up to the surface, should we not expect something similar at Rocky Flats? Very likely the grasses at Rocky Flats have roots that run deeper into the soil than those at Savannah River, due to the drier climate at Rocky Flats. The question whether the grass at Rocky Flats brings plutonium to the surface presents an uncertainty worth detailed exploration. It is prudent to assume that the grass abundant on the Rocky Flats site is constantly bringing to the surface some of the plutonium that is in the environment.

Figure 7.14: Xeric tall-grass prairie at the Rocky Flats National Wildlife Refuge.

Monitoring of windblown particles: If, as indicated above, plutonium particles are likely at any time to be blowing in the wind at Rocky Flats, won't air monitors detect them? The answer is no, because air monitoring no longer occurs at Rocky Flats. But even if it did, the answer would still be no, because the monitors previously used were inadequate and the government reports of airborne monitoring were inaccurate (see pp. 44-45, on the inadequacy of air monitoring).

Aquifers never examined: Beneath much of northern Colorado is the 7,000 square-mile Denver Basin system of four aquifers (see Figure 7.15). Each of these four aquifers lies at a different level within the Denver Basin. They provide water for agricultural and residential use. Rocky Flats is located in northeastern Jefferson County directly over the western edge of the Denver Basin. The official view at Rocky Flats is that the terrain beneath the site is impermeable and thus that the contamination released from the plant into the environment never reached the underlying aquifers. In the September 2007 issue of *Physics Today* chemist Anne Fenerty said that "no independent evaluation has been conducted of the bedrock under the 10-square-mile [Rocky Flats] site, which is in an earthquake zone. It is questionable that an area of this size will have no fractures in the event of an earthquake." Fenerty is not convinced that the aquifers are free of plutonium and other contaminants released from Rocky Flats. But, as she points out, there have been no independent studies of possible Rocky Flats contamination of aquifer water.

---

[46] D. I. Kaplan et al., "Upward Movement of Plutonium to Surface Sediments During an 11-Year Field Study," SRNL-STI-2010-00029, January 25, 2010. http://sti.srs.gov/fulltext/SRNL-STI-2010-00029.pdf

[47] Kaiser-Hill Co., Actinide Migration Evaluation Pathway Analysis Summary Report, ER-108 (April 2004), p. 28; see p. 24.

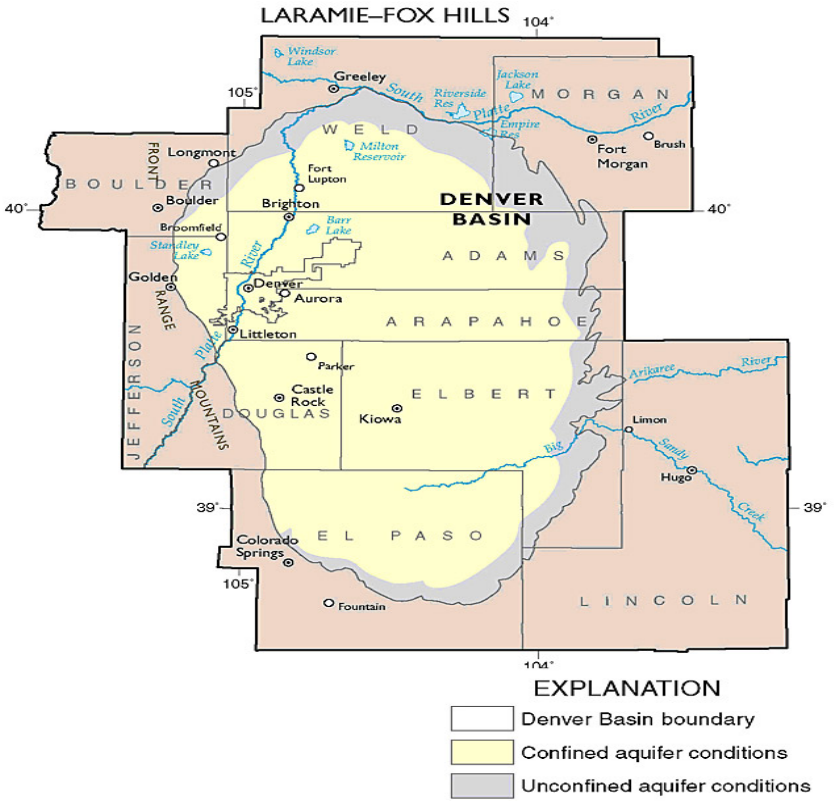


Figure 7.15: Map of the Denver Basin system of aquifers. Rocky Flats is located northwest of Standley Lake between Boulder and Golden, directly above the western edge of the Denver Basin.

The flood of September 2013: What happened in the September 2013 flood, often referred to as a 1,000-year flood? Was plutonium washed off the site? Whether the state's strict standard for plutonium and americium in surface water (0.15 pCi/L) is ever violated is determined by sampling at two specific on-site "points of compliance," one on Walnut Creek, the other on Woman Creek (see Figure 7.16). Was this standard violated during the September 2013 flood? No one knows. Why? Two explanations have been given. DOE site manager Scott Surovchak stated at a public meting in June 2014 that in the midst of the flood it was too dangerous to sample water. He said he went to check the samplers at the height of the flood and was forced to flee to save his life (a worker at the Rocky Flats site later reported that Surovchak was in Florida at the time of the flood, not even present at Rocky Flats). A second explanation, provided in an official DOE report, is that the automatic sampling equipment "was full and did not collect any water for the period 9/11/13 21:49 to 9/13/13 15:30. Therefore, no analytical results are available for this period."[48] September 12 and 13 were the days of peak flooding. A Rocky Flats official said that the more water that was flowing would be beneficial because there would be less plutonium per volume of water.

[48] Rocky Flats Site Quarterly Report of Site Surveillance and Maintenance Activities—3rd Quarter Calendar Year 2013, U.S. Department of Energy, Doc. No. S11334, January 2014, p. 26.

Figure 7.16. The author observes debris from the September 2013 flood in the Walnut Creek channel just east of the Rocky Flats boundary at Indiana St. This photo by Robert Del Tredici was taken in June 2014, nine months after the flood.

Another aspect of sampling during this flood is making measurements of what is called "sheet flooding" – vast sheets of water flowing at a depth of two or three inches or more over broad stretches of land rather than in the stream channels that ordinarily drain the area. The highly specialized equipment designed to measure the flow in sheet flooding was not present at Rocky Flats. Thus, whether plutonium flowed freely in the sheet flooding is not known. Of course such flow affected large areas on site as well as off. If plutonium was released, we do not know where it went, only that its effect will be long-term.

If what happened in September 2013 was not really a catastrophic flood, might we have one?
Meteorologist Gale Biggs wonders if at some unforeseen time there might be a flood like the one that long ago deposited the alluvium that became the area known as Rocky Flats. He imagines a torrent rushing down Coal Creek Canyon and washing before it the whole of the gravelly Rocky Flats formation, carrying the contaminants left there to unknown destinations with unimaginable health and environmental effects. His observation is not far-fetched. Climate warming increases the likelihood that mountain pine forests killed by pine beetles will be ignited by lightning into catastrophic fires that denude mountainsides and prepare the way for massive flash floods in the wake of extreme weather. Those who designed the Rocky Flats "cleanup" made no effort to protect against this sort of environmental devastation.

Risk-based cleanup and the myth that a little exposure is "safe": Rocky Flats is an example of what the DOE calls "risk-based cleanup." The language itself is a tip-off that the "cleanup" is not risk-free. The cleanup standards adopted for Rocky Flats were accompanied by assertions of government officials that the site "cleaned" to these standards is "safe." His or her use of the term "safe" implies that a little radiation can't hurt anyone. The late Edward Martell, the NCAR radiochemist who opened up the public health question for Rocky Flats when he found plutonium in the off-site environment after the 1969 fire, observed that some people get cancer from naturally occurring radiation and some of them die prematurely. He said further that the small exposures resulting from global fallout from nuclear weapons tests have increased disease and death worldwide. The same was said by Andrei Sakharov, the dissident Soviet nuclear scientist, who won the Nobel Prize in 1975 for championing human rights in the Soviet Union. We thus should do our best to eliminate risk or to reduce it to the lowest possible level. The Rocky Flats risk-based cleanup did neither.

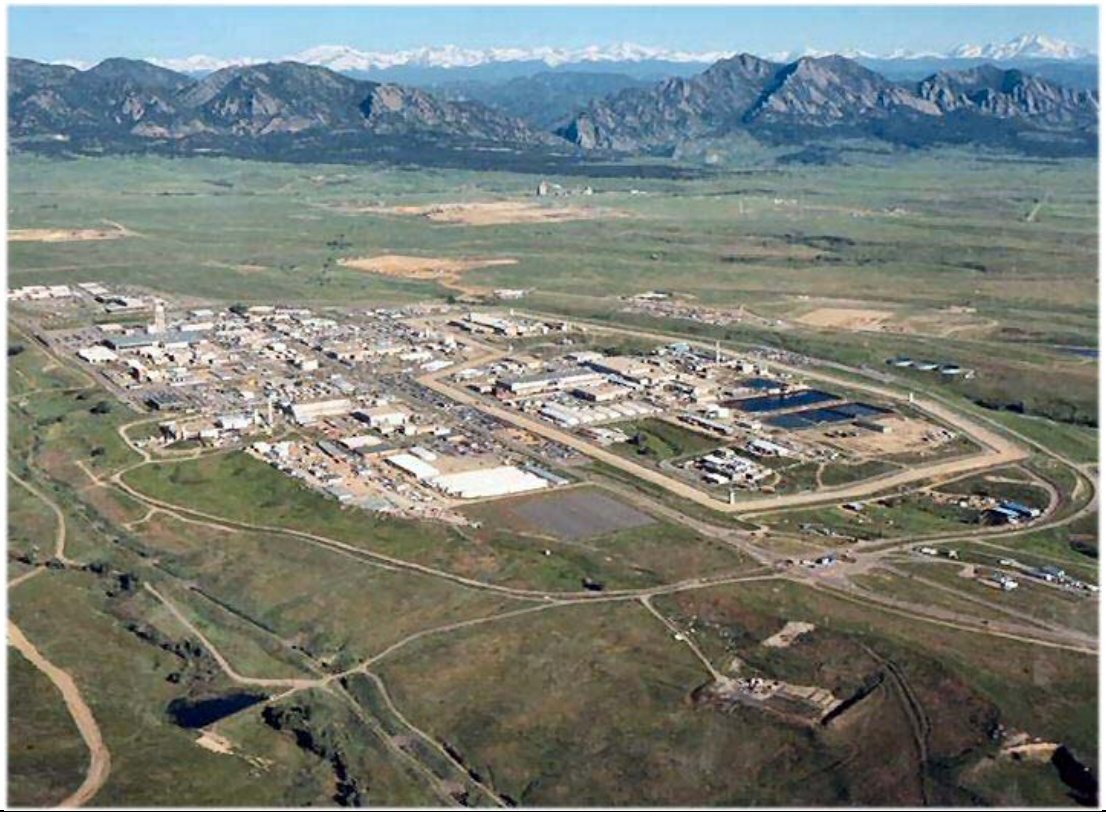
The Precautionary Principle: Over the past three decades people worldwide have formulated the precautionary principle. The best-known U.S. statement was drawn up in the Wingspread Conference on the Precautionary Principle in Racine, WI, in January 1998. The following words from the statement aptly describe the situation at Rocky Flats:

> "We believe existing environmental regulations and other decisions, particularly those based on risk assessment, have failed to protect adequately human health and the environment – the larger system of which humans are but a part.
>
> "We believe there is compelling evidence that damage to humans and the worldwide environment is of such magnitude and seriousness that new principles for conducting human activities are necessary.
>
> "While we realize that human activities may involve hazards, people must proceed more carefully than has been the case in recent history. Corporations, government entities, organizations, communities, scientists and other individuals must adopt a precautionary approach to all human endeavors.
>
> "Therefore, it is necessary to implement the Precautionary Principle: When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof.
>
> "The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action."[49]

The precautionary principle was not followed at Rocky Flats. Though there are very few places in the U.S. where the principle has the force of law as it does in some other countries, the existence of the concept is a reminder that we fall short of the most humane practice regarding public health and environmental integrity. The necessity of applying the Precautionary Principle will be discussed more fully under Nuclear Guardianship.

[49] http://www.p!Unexpected End of Formulasrast.org/precaut.htm

Conclusion: The "cleanup" done at Rocky Flats endangers people of present and future generations. As the foregoing shows, the site was "cleaned" using questionable ways of calculating risk and inadequate or erroneous data about contamination. Though most of the site has legally become a wildlife refuge, it will cease being a wildlife refuge long before plutonium left in the environment ceases to be dangerous. What happens after fences fall and memory fades? From a public health and environmental perspective, the "cleanup" at Rocky Flats was a failure, though DOE touts it as a model to be followed elsewhere and Kaiser-Hill calls it a success.[50] The "cleanup" removed all buildings and structures, but it left a site contaminated essentially forever (see Figures 7.17 and 7.18).



Figures 7.17. The Rocky Flats site at the height of production. What appears to be a road surrounding a portion of the industrial area is actually a high security barrier, to protect the "hot" side of the plant, where plutonium pits were produced. The other "cold" side is where non-nuclear parts made with beryllium and stainless steel were produced. Photo courtesy DOE.

[50] See Kim Cameron and Marc Lavine, *Making the Impossible Possible: Leading Extraordinary Performance, The Rocky Flats Story* (San Francisco: Berrett-Koehler Publishers, Inc., 2006).

 [51]

Figure 7. 18. The Rocky Flats site in 2005, after all structures have been removed. Contamination remains, but it is not visible. Photo courtesy DOE.

8. THE ROCKY FLATS NATIONAL WILDLIFE REFUGE

Background to the Rocky Flats National Wildlife Refuge: I noted in the preceding chapter that DOE, EPA and CDPHE decided to turn most of the Rocky Flats site into a wildlife refuge. "Cleaning" the site to wildlife refuge specifications would be much cheaper than cleaning it for residential or commercial use. Those who made this decision, however, were quite unrealistic. They acted as if protecting a wildlife refuge worker would protect everyone else for as long as plutonium remains dangerous (its half-life is 24,110 years). They rejected the only cleanup proposals that actually provided protection long-term. In keeping with their shortsighted plans, in 2001 Congress passed the Rocky Flats National Wildlife Refuge Act, co-sponsored by then-Senator Wayne Allard and then-Representative Mark Udall. The Act mandated that after completion of the Superfund "cleanup" then underway the DOE would transfer about three-quarters of the Rocky Flats site to U.S. Fish & Wildlife Service (FWS) to manage as the Rocky Flats National Wildlife Refuge.[103]

A mixed blessing: Turning a major portion of the former bomb plant site into a Wildlife Refuge is a mixed blessing. It prevents (for the present at least) residential or commercial development on the site, which is a plus. But at the same time it opened the way to a cheaper and quicker "cleanup" that leaves a legacy of far greater risk than if the site had been cleaned to the maximum extent possible with existing technology. People now and into the long-term future are forced to live with the consequences.

Environmental Impact Statement (EIS) for the future Refuge: In February 2004 FWS issued a Draft EIS for the Wildlife Refuge. It outlined four alternative uses for the Refuge. The most protective of these is "Ecological Restoration," which would limit public access to pre-arranged guided tours on a single 3,700 foot trail in the Rock Creek drainage in the NW portion of the site, upwind of the former industrial production area, main source of plutonium releases. Those who commented on the Draft EIS overwhelmingly favored this alternative. But the option favored by FWS, and eventually adopted by them, allows public access for hiking, biking, horseback riding, limited hunting, photography and wildlife observation. Several miles of trails would be constructed and made available for public use.

The most contentious issue regarding the future Wildlife Refuge was whether or not the Refuge should be opened to the public for recreational activities. Of the 1,280 parties that commented on the EIS, 81% opposed public access, while only 11% explicitly favored it.[104] The principal reason cited for opposing access was the risk of exposure to plutonium and other toxins left in the environment. FWS nevertheless adopted the option that allows maximum public access. By this action FWS guaranteed ongoing conflict with the public. The EIS established the rules that would apply once the "cleanup" was completed and land for the Refuge was transferred from DOE to FWS. After publication of the Final EIS in September 2004, with its declaration that public access to the Refuge would be allowed, I circulated a request for people informed and interested in the matter to send cartoons that might help others understand the meaning of what FWS had just decided. I will include three of these (see Figures 8.1, 8.2 and 8.3).

---

[103] See https://www.google.com/?gws_rd=ssl#q=rocky+flats+national+wildlife+refuge+act

[104] These numbers result from my analysis of *Rocky Flats National Wildlife Refuge, Appendix H, Comments and Responses on the Draft Environmental Impact Statement* (September 2004), on line at http://media.wix.com/ugd/cff93e_a9cff9a4c30b4ac5bbfa27e93b91a9bf.pdf

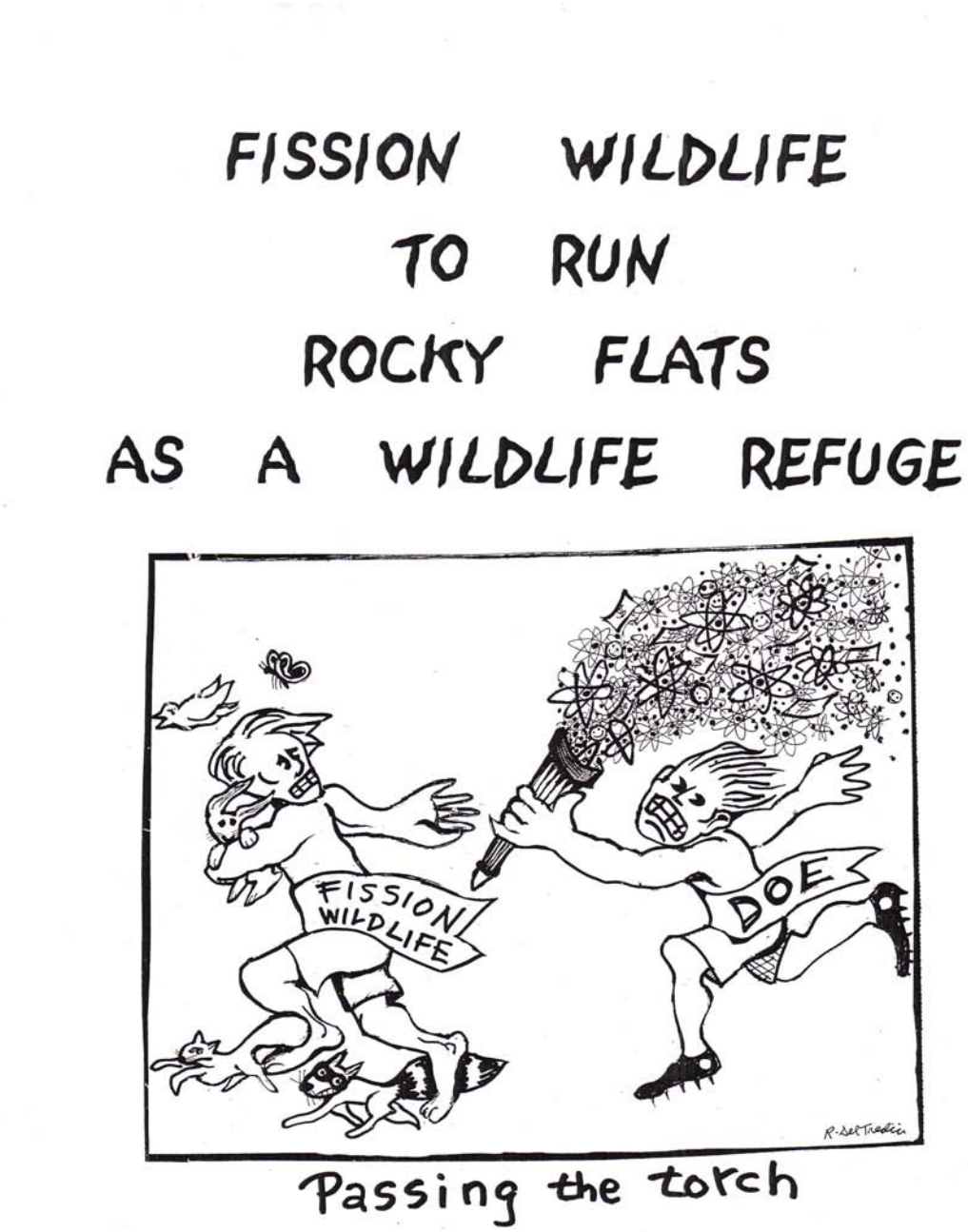


Figure 8.1: DOE passes the radioactive Rocky Flats torch to "Fission Wildlife." Cartoon by Robert Del Tredici. Wildlife is abundant at the site. When the plant was operating, workers often referred to the "hot rabbits" common at the site.

Figure 8.2: FWS will welcome "Kiddie Tours," especially school kids, to the Refuge, once it is opened to the public. Cartoon by Tom Ferguson of Atlanta.

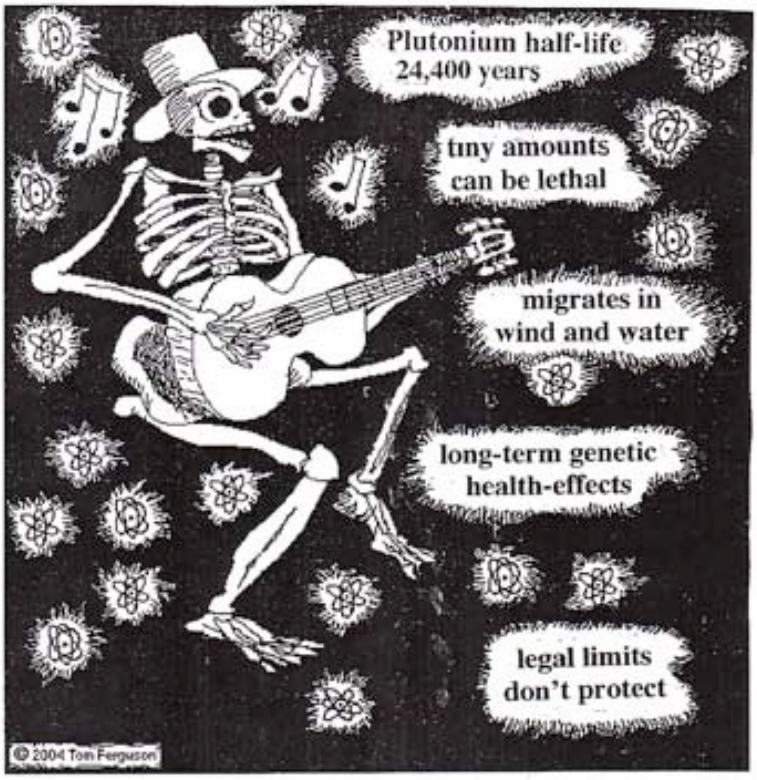


Figure 8.3: This cartoon by Tom Ferguson of Atlanta emphasizes problems with plutonium in the environment of the Rocky Flats National Wildlife Refuge.

Creation of the Rocky Flats National Wildlife Refuge: In 2006, soon after completion of the Superfund "cleanup" of the Rocky Flats site, the DOE transferred almost seven square miles of the nearly ten square mile site to the U.S. Fish & Wildlife Service (FWS) to operate as a Wildlife Refuge (see Figure 8.4). Though FWS decided to open the Refuge for public recreation, as of February 2015 it remains closed to the public because FWS lacks the funds to prepare the site for public access. Opposition to its opening continues. Biologist Harvey Nichols thinks every DOE weapons site that has a Superfund cleanup should be closed to the public for at least 200 years after completion of the cleanup. This would allow time for a fuller assessment of exposure to radiation and chemical toxins in the environment at such sites.

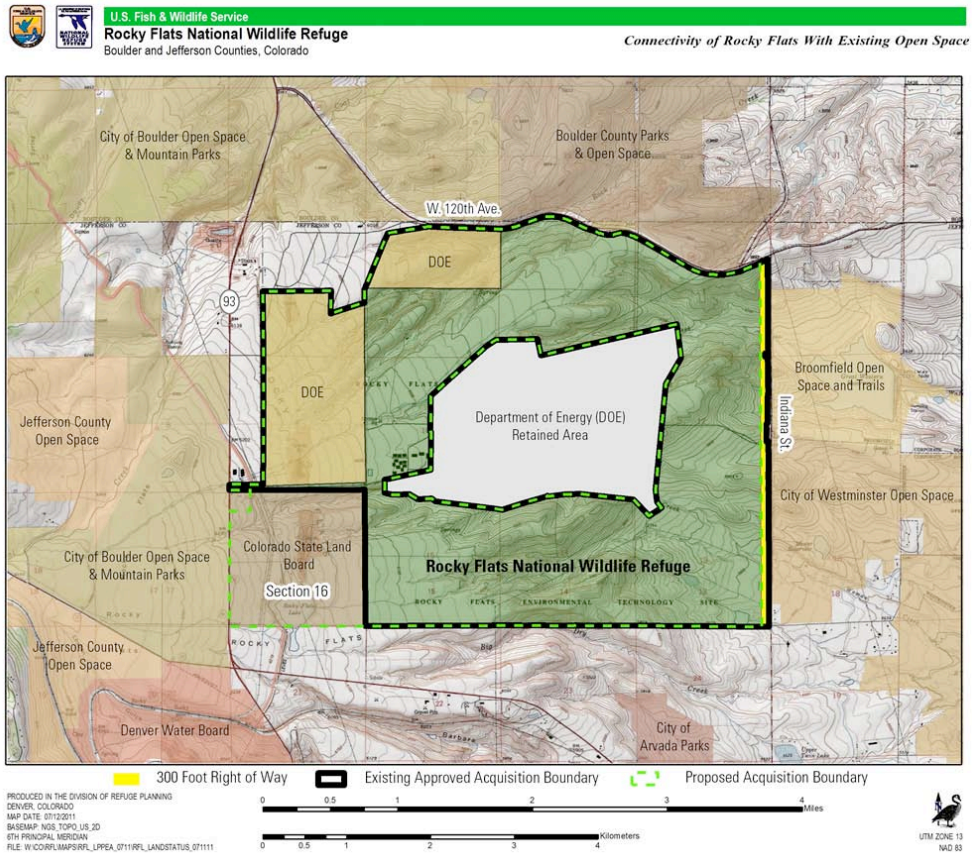


Figure 8.4: The green area on this map is the 4,465-acre (6.98 square-miles) Rocky Flats National Wildlife Refuge managed by FWS. DOE retains 1,309 acres (2.05 square-miles) in the center of the site, essentially the more contaminated former industrial area of the Rocky Flats plant. The DOE land remains on the Superfund list of contaminated sites. Private interests mine gravel in the tan plots; when their mining rights expire, these plots will be transferred to FWS. Section 16 in the SW corner was added to the Wildlife Refuge in December 2011 as part of the deal by which FWS ceded the 300-foot-wide yellow strip of land along the eastern edge of the site for the proposed Jefferson Parkway.

Proposal to provide minimal informed consent for visitors to the Refuge: After the FBI raided the Rocky Flats plant to collect evidence of alleged violation of environmental law a grand jury was convened to review the evidence. Wes McKinley, a Baca County rancher, was elected foreman of the grand jury. In their final report, as noted earlier, the jurors called Rocky Flats "an ongoing criminal enterprise" and sought to indict DOE and Rockwell officials. The judge instead dismissed the grand jury and reached an agreement with

Rockwell that dropped major charges against the company and gave them immunity from further prosecution. McKinley was disturbed. Then FWS declared that they would open the Wildlife Refuge to the public. This was too much. He could imagine people ignorant about Rocky Flats visiting the Refuge and being exposed to plutonium. He decided to get himself elected to the state legislature. Maybe he could do something positive regarding Rocky Flats.

After being elected to represent his district McKinley hit on the idea of requiring the state to post prominent signs at Refuge entries informing people that visiting the Refuge posed a risk of being exposed to radioactive material remaining in the environment. He made several attempts to get such a bill passed in the state legislature before he was term-limited. Several of us, including myself, testified several times at the State Capitol in support of his bill. It was opposed by Carl Spreng of CDPHE as well as by members of the Rocky Flats Stewardship Council tutored by Council Executive Director David Abelson. One year McKinley's bill passed in the House and was headed for the Senate. Then-U.S. Senator Mark Udall, co-author of the act that created the Rocky Flats Refuge, stepped in and told the head of the State Senate not to let this bill get out of committee and onto the floor in the Senate. Udall prevailed, and soon thereafter McKinley's term ended and he left the legislature, having failed to get warning signs at Rocky Flats (see Figure 8.5).

Figure 8.5: This sketch of the Rocky Flats National Wildlife Refuge shows FWS plans for entries and trails. The view looks west from Indiana Street toward Highway 93 that runs from Golden-to-Boulder with the mountains beyond. The Refuge occupies the darker green portion of the site, a total of 4,465 acres (6.98 square miles). The lighter green area in the center of the refuge is the 1,309–acre plot retained by DOE's Legacy Management program; it includes the more contaminated former industrial zone and parts of the site that are subject to ongoing maintenance and engineered controls. Had McKinley's bill passed, warning signs would have been posted at the six site entries indicated on the sketch.

Wes McKinley's unsuccessful effort to get any warning signs at the Refuge does not mean no signs. FWS itself adopted wording for signs that it intends to post. Each sign will acknowledge that during production years "plutonium and other contaminants were released into the environment." The signs will further state that an extensive EPA and CDPHE evaluation of contamination shows the following:

> "The levels of contamination on refuge land are low, meet conservative state and federal cleanup standards, and are similar to adjacent lands. Both EPA and CDPHE have determined that the land is safe for public recreation, refuge workers, and resident wildlife. The refuge workers, the people most exposed to this environment, have a maximum lifetime increased cancer risk of about 2 in a million due to residual contaminants. Environmental health risks to refuge visitors, including children, are far lower than that."[105]

This FWS language downplays danger, claims safety and denies informed consent. I counter it in the foregoing pages by showing, first, that existing radiation exposure standards are inadequately protective; second, that important data about site conditions were not considered in the "cleanup" at Rocky Flats; and, third, that risk is always present at Rocky Flats and that where there is risk there will be some harm.

Testing breathable dust blowing off the Wildlife Refuge for plutonium content: Breathable dust in surface soil has never been routinely tested for its plutonium content on the Rocky Flats site, though Carl Johnson pioneered sampling dust for plutonium in off-site areas in 1975 (see pp. 45-46). He showed that sampling only surface dust isolates the tiny plutonium particles that can be suspended in the air and be inhaled, the worst way to be exposed to plutonium. To protect public health plutonium particles in surface dust need to be isolated and measured, so we at least have a better sense of the danger. The state's method of sampling only whole soil dilutes plutonium content by mixing it with heavier gravel and soil that cannot be suspended by the wind. Breathable particles are the critical part.

In the spring of 2009 I urged FWS, as the government agency now responsible for the Wildlife Refuge, to hire independent scientists to collect samples of breathable dust from the surface soil at various locations on the site and to analyze the samples for plutonium content.[106] I encouraged them to establish a program to do such testing periodically, because plutonium in soil at the site can be randomly made available to strong winds in the area by the actions of animals, plants, water, humans and wind itself. Results from this kind of sampling would show to what extent plutonium is present in breathable particles at the time of sampling. Any plutonium released from the DOE land – 1,309 acres surrounded by the Refuge – could be carried by wind onto the Refuge. The response of FWS was to pass the buck to CDPHE. Hearing nothing from them, I published an op-ed on January 10, 2010, urging CDPHE to establish a permanent program to take discrete samples of breathable dust from surface soil at Rocky Flats and test them for plutonium content.[107]

Four days later, January 14, 2010, Carl Spreng of CDPHE sent an email message rejecting my proposal, because it "doesn't take into account new technologies and methods." But in fact "new technologies and methods" for sampling dust for plutonium were introduced back in 1975 by Carl Johnson who urged the state to adopt his innovative dust sampling method. They turned him down (see pp. 44-45). But now Spreng was defending the state's

---

[105] http://www.fws.gov/rockyflats/Signage/Sign.htm
[106] "Test the respirable dust at Rocky Flats," *Boulder Daily Camera*, June 11, 2009. http://www.dailycamera.com/ci_13124737?IADID=Search-www.dailycamera.com-www.dailycamera.com&IADID=Search-www.dailycamera.com-www.dailycamera.com
[107] "Playing with Plutonium at Rocky Flats," *Boulder Daily Camera*, January 10, 2010. http://www.dailycamera.com/ci_14151325?IADID=Search-www.dailycamera.com-www.dailycamera.com

soil sampling practice as if it was new, though Johnson had found it faulty in 1976. "We continue to be confident," Spreng wrote, "that the refuge is safe for public access." I responded to him on January 20: "Given that the Rocky Flats site was not cleaned to the maximum extent possible with existing technology, and given that an unknown quantity of plutonium in the form of fine particles remains in the soil there and that some of it is likely at any time to be brought to the surface by burrowing animals, and given that the National Academy of Sciences 2006 BEIR VII study (Biological Effects of Ionizing Radiation) concluded that any exposure to ionizing radiation is potentially harmful, calling the Rocky Flats wildlife refuge 'safe' is an extreme statement. Would it not be more accurate to acknowledge that visiting the refuge entails some risk, even if it's a level of risk that government agencies find acceptable?"[108] He did not respond.

A few weeks later we at the Rocky Mountain Peace and Justice Center hired Todd Margulies, a local man experienced in this field, to collect dust samples. On April 14, 2010, he and I collected samples that were sent for analysis to specialist Marco Kaltofen, P.E., of the Boston Chemical Data Corp. in Natick, MA. Two observations. First, we collected no samples on the Rocky Flats site, because we were denied permission to go there. Second, our sampling was done during an exceedingly dry period after several days of very high wind. I assumed the sampling would be a simple matter of picking up loose soil or dust on the leeward or downwind side of slopes, plants, fence posts and the like. I thought our problem would be too many sampling opportunities rather than too few. But as soon as we began to look in obvious places over an area of several dozen acres we discovered that the fabled wind at Rocky Flats had scoured the surface, leaving a hard, dry surface devoid of expected dust and loose soil. John Till of Risk Assessment Corp., who for more than two years did scientific research at Rocky Flats on soil cleanup levels, said that plutonium left in the soil there would eventually blow away. When searching for sampling locations I felt I was seeing the reality of which he spoke.

I spoke to a woman who lives near Rocky Flats about the inability of Todd and me to take dust samples because the wind had removed all dust from the soil. She immediately said, "If you want a little dust that hasn't blown away, look for yucca plants. You'll find the dust you're looking for in a little pocket at the base of these plants. Their lower branches are so close to the ground the wind can't remove dust that settles beneath them." We found yucca plants in abundance on the Westminster open space just across Indiana St. from the Rocky Flats site. We were able to collect dust samples at the base of these plants. The samples contained plutonium that had blown there from the Rocky Flats site just across the street, refuting the CDPHE claim that there is no pathway by which plutonium on the site can reach visitors at the Refuge.

When I speak in public about the plutonium in the environment at Rocky Flats I often tell people there's one sure-fire way to end their worries about plutonium: DON'T BREATHE. Don't breathe, because the worst way to be exposed to plutonium is to inhale a particle or two. They will lodge in your body, I tell people, and as long as they are there – in a lung, your liver, bone, your brain, gonads or elsewhere – they will constantly irradiate surrounding tissue. This may result 20 or 30 years later in cancer, a compromised immune system or genetic damage that can be passed on to offspring. No one wants this. So, don't breathe. If you don't breathe you are much less likely to take plutonium into your body, though it can also be internalized through an open wound, whence it will be transported by the blood to a place where it can take up lodging and do the same harm as from breathing. As long as we're alive we'll breathe, which means that if unseen plutonium particles are wafting on the breeze we are likely to inhale some. And there the problem begins. It isn't absolutely certain that our health will be harmed, but we have entered the land of risk, and

[108] Email message, Moore to Spreng, 1-20-10.

the risk may prove harmful. The winds at Rocky Flats can deliver plutonium to us (see Figure 8.6).

Figure 8:6: June 17, 2010, at the SE corner of Rocky Flats, the day they began moving dirt for construction of houses at Candelas (see pp. 109-113). Dust blows off the Rocky Flats site, its boundary just behind me. I stand on land the Jefferson Parkway will traverse if it is built. Photo by Robert Del Tredici.

The proposed Jefferson Parkway: The Rocky Flats National Wildlife Refuge Act states that a strip of land up to 300 feet wide "along the eastern boundary of Rocky Flats" could be made available "for the sole purpose of transportation improvements along Indiana Street."[109] This strip of land is the route now proposed for the Jefferson Parkway, a privately financed toll road (see Figure 8.7). For 50 years developers and others have dreamed of a highway that would complete the 470 beltway around Denver. The Jefferson Parkway is the latest manifestation of this dream.[110] The proposal to build such a road is very controversial because of concerns that construction of a highway near Rocky Flats would stir up plutonium. Earlier efforts to build a highway in this area repeatedly came to naught. In 1989 construction of a toll highway in the Rocky Flats area was put to a vote; it lost by a 4-to-1 margin.[111]

In 1970 AEC scientists P. W. Krey and E. P. Hardy mapped the distribution of plutonium released from Rocky Flats into the environment on and near the site (see Figure 8.7). Their map is based on their soil sampling at a depth of 20 centimeters (7.9 inches) in downwind areas. The route proposed for the Jefferson Parkway passes through the area they show to be the most heavily contaminated with plutonium. By contrast with Krey and Hardy, maps produced for the "cleanup" completed at Rocky Flats in 2005 show only a scant presence of plutonium along the eastern edge of the site. But these maps are based on sampling only of surface soil, not the deeper sampling that Krey and Hardy had done. Some plutonium in shallow soil when Krey and Hardy did their work in 1970 has undoubtedly long since blown away or has percolated down somewhat so that it is no longer on the surface. Much of the plutonium in what they showed to be high concentrations along Indiana Street should still be there.

---

[109] http://www.rockyflatssc.org/rf_refuge_bill_approved_12_01.pdf See Sec. 3174 (e).
[110] Informative article on the Parkway: Nicolene Durham, "Hot Particle Politics on the Rocky Flats Road," at http://www.theboulderstand.org/2013/07/16/hot-particle-politics-on-the-rocky-flats-highway/
[111] See http://www.mesalek.com/colo/denvers470.html

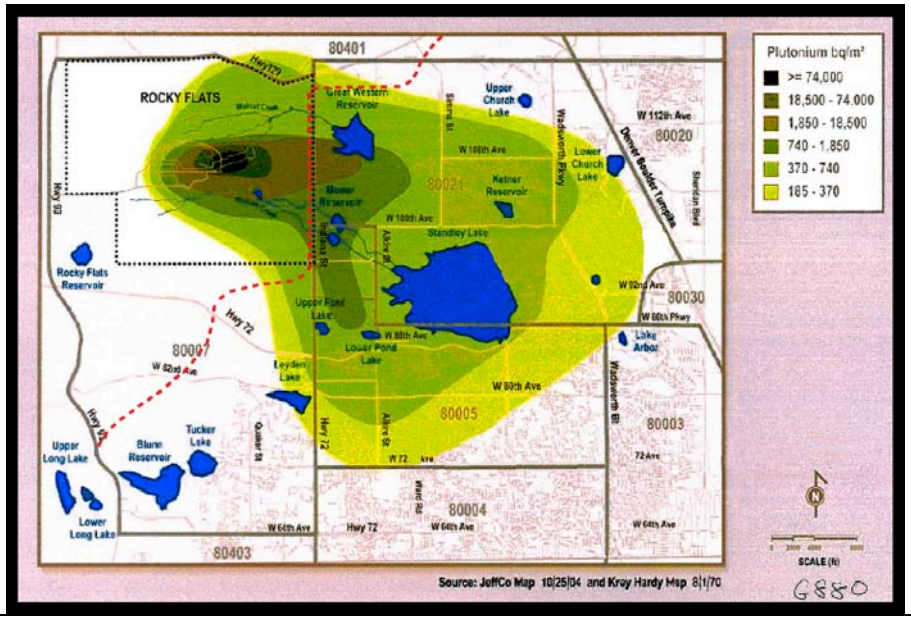


Figure 8.7: This 1970 map by AEC scientists P. W. Krey and E. P. Hardy showing plutonium contamination in soil on and near the Rocky Flats site has appeared earlier in this study. The one addition here is the dotted red line, the route proposed for the Jefferson Parkway. Note that it passes through a highly contaminated area.

In September 2011 the Rocky Mountain Peace & Justice Center commissioned Marco Kaltofen of the Boston Chemical Data Corp. and his colleague Strongbear to collect samples on the route of the proposed Jefferson Parkway. Because U.S. Fish & Wildlife Service denied a request that they be allowed entry onto the Wildlife Refuge, Kaltofen and Strongbear sampled soil along Indiana St. just outside the Refuge fence. They took 19 samples from surface soil plus 3 at a depth of 12 inches and 1 at a depth of 6 inches. They found that plutonium concentrations in their 2011 study area were roughly equivalent to concentrations found in the same location in 1970 by Krey and Hardy. According to Kaltofen, "There was no statistically significant difference between this data set and the 1970 data set. Plutonium losses appear to be approximately equal in magnitude to plutonium inputs [from upwind portions of the site] in the Indiana St. area."[112] In other words, either what he found in 2011 was the same plutonium Krey and Hardy found in 1970 or enough plutonium had blown to Indiana St. from upwind areas of the site to keep the 2011 level roughly equal to that of 1970. In either case, this is not good news.

Things heated up in June 2012 when FWS held a public hearing on whether or not it should do an Environmental Impact Statement (EIS) on the Jefferson Parkway. The National Environmental Policy Act (NEPA) requires that before any agency of the federal government can undertake an action that may adversely affect the environment, it must produce an EIS that includes detailed analysis of likely effects of the contemplated action. In 2004, three years before it gained possession of the land that would become the Rocky Flats National Wildlife Refuge, FWS conducted an EIS on the Refuge, but this EIS totally ignored the question of environmental effects of constructing a highway along Indiana Street.

About 100 people were present at the June 2012 hearing. No one spoke in favor of the highway, and all called for a full-fledged EIS to determine effects on humans and wildlife of building the highway. While waiting to see what FWS would do, things became confusing in

[112] See http://leroymoore.wordpress.com/2012/02/10/pusamplingjeffpkwyrfnwr/

a hurry. The City of Golden and Jefferson County persuaded the City of Boulder and Boulder County to end their long-time opposition to the highway as part of a deal that would allow FWS to make its strip of land available for the highway while adding to the SW corner of the Refuge a square-mile piece of land called Section 16. This enlargement of the Refuge would block further urban sprawl northward along Hwy. 93 toward Boulder, something Boulder City and County both wanted (for the location of Section 16, see Figure 8.4 on p. 103).

In October 2012 FWS, without doing an extensive study, issued a 'Finding of No Significant Impact," vetoing an EIS and giving itself permission to transfer land for the highway. The very next day Golden, Superior and two environmental groups, Rocky Mountain Wild and Wild Earth Guardians, filed suit in federal court to require FWS to do an EIS before transferring land for the Jefferson Parkway. Late in 2012 a federal judge issued the injunction. But he then was told that the deal for FWS to receive Section 16 had a deadline of midnight on the last day of the year. The land transfer would collapse if the deadline was not met. Thus, in the midst of judicial shifting, on December 31, 2010, the judge lifted the injunction. The case never went to trial. The judge apparently acted to meet the deadline. FWS received Section 16 and ceded a 300-foot wide strip of land along Indiana St. to the Jefferson Parkway Public Highway Authority. The Refuge was enlarged to almost 10 square miles.

Though land was transferred, whether the highway will be built is not certain. Some time later, the court ruled in favor of FWS, that there was no requirement for them to do an EIS on the Parkway. But this does not mean the Jefferson Parkway will be built. Several years ago the Denver Regional Council of Local Governments (DRCLOG) agreed to add the Jefferson Parkway to its transport master plan on one condition: No federal or state tax money can be spent to build the road. Recent reports are that investors are not gambling on the possibility of this road. Widespread opposition to the road undoubtedly makes some skittish about investing in it. Meanwhile, the longer the road is delayed the stronger the cultural shift away from private automobiles to public transit.

Residential development near Rocky Flats: Is it wise to live near Rocky Flats? This question was raised by Carl Johnson, MD, Director of Public Health for Jefferson County. He answered with a 1981 study that showed decidedly higher cancer rates among people living in areas contaminated by plutonium released from Rocky Flats (see pp. 47-48). More recently the question has come up for people wondering if they should move into new residential developments near the Rocky Flats site, especially Whisper Creek, immediately SE of the site, and Candelas, where dwellings are being built along the southern edge of the Rocky Flats site (see Figure 8.8).

Michelle Gabrioloff-Parish, a professional woman, mother of two children and wife of a university professor, lives in Superior, about two miles NE of the Rocky Flats site. In recent discussions about the proposed Jefferson Parkway she learned about the history of the plant and the contaminated environment. Then she heard about Candelas, one of largest residential developments in Colorado history, where several thousand dwellings as well as commercial and business facilities and a school are being constructed along the southern edge of the Rocky Flats site. As beautiful as it is, she knew she'd never move her children into such a place. She started the Candelas Glows web site to educate others and to alert them to the dangers of living so close to the site of the former Rocky Flats nuclear bomb plant [113] Soon she had a host of new friends, and they began going to Candelas on weekends with signs and banners and handouts packed with information about why in their view no one should live so close to Rocky Flats. Their visits attract a lot of attention – of the media,

[113] http://candelasglows.com

Figure 8.8: This picture of the Whisper Creek development across Indiana St. immediately SE of the Rocky Flats site dates from June 2011, when construction of houses was underway. Whisper Creek is in an area shown by Krey and Hardy in 1970 to be highly contaminated with plutonium. Photo by Robert Del Tredici.

but also of those who manage the development. The police came. Michelle and her companions were told that as long as they didn't block traffic, stayed on public sidewalks and did not trespass, they would not be bothered. They are very good-natured. Prospective buyers learn from them new information. They undoubtedly are influencing people. Candelas has become much better known as a result of Candelas Glows (see Figures 8.9, 8.10, 8.11 and 8.12).

Figure 8.9: Trail for biking, hiking or horseback riding that runs the whole length of the northern edge of the Candelas development, from Indiana St. on the east to Hwy. 93 on the west, a distance of almost 4 miles. Rocky Flats National Wildlife Refuge is just over the fence to the right. Newly constructed houses are visible to the left of the trail. The trail intersects with two of the planned entries to the Refuge. Photo by Jon Lipsky.

Figure 8.10: The Rocky Flats site NE from the Candelas trail (Figure 8.9), soon after completion of the "cleanup." The cleared ground is the industrial area where structures have been removed and there is not yet any grass cover. The pavement ends at the fence where FWS expects to have a Refuge entry. Photo courtesy of Michelle Gabrioloff-Parish.

Figure 8.11: Michelle Gabrieloff-Parish, founder of Candelas Glows, stands with a horse sculpted by artist Jeff Gipe at the Candelas development near the Rocky Flats National Wildlife Refuge. The horse wears a red hazmat suit and a gas mask. It's a windy day. Photo by Helen H. Richardson of *The Denver Post*.

Figure 8.12: People from Candelas Glows on one of their weekend visits to Candelas. Photo courtesy of Michelle Gabrioloff-Parish.

Michelle Gabrieloff-Parish believes it's unwise to live at Candelas and that it should be shut down. She wants the U.S. Government to purchase the whole Candelas development, all the houses and buildings and all of the land. People should be paid well for the dwellings they moved into, so they can relocate elsewhere. Candelas can become not a place to live but a monument to human folly. Who will implement her idea?

Several times a year I hear from people who wonder if it's wise to live near Rocky Flats. The most valuable exchange I have had on this topic was with a woman who about a year before writing to me had moved with her husband and two-year old daughter into a new house in the Whisper Creek development across Indiana St. and immediately SE of Rocky Flats. She only recently had learned of possible dangers of living in the area. She was expecting another child. Because of the searching quality of her questions, I asked her if I could share our correspondence with others, provided I not use her name or give the location of the house she and her family occupied. She agreed. With her permission I posted a verbatim copy of our very extensive correspondence on my blog. It is a very moving example of thinking in action on the part of herself and her husband. I could not tell them what to do, only what I would do if in their situation. In the end, they sold their house to someone who had grown up near Rocky Flats and had no concerns about it. But most poignant is the exchange she had with her daughter.[114]

In July 2013 Candelas attorney Jonathan G. Pray sent letters to both Michelle Gabrioloff-Parish of Candelas Glows and LeRoy Moore of the Rocky Mountain Peace and Justice Center ordering them to cease and desist making defamatory statements about Candelas or end up in court. Environmental attorney Randall Weiner responded with a letter on behalf of RMPJC. He berated Pray for threatening a SLAPP suit (strategic lawsuit against public participation), a suit filed by a company against citizens engaged in political

[114] See https://leroymoore.wordpress.com/2013/07/18/questions-about-living-near-rocky-flats-2/

activity that threatens the company's interests. He told Mr. Pray RMPJC had made no false statements and had done nothing illegal and that he would be glad to defend the organization in court. He cited evidence that most SLAPP suits are thrown out of court while counter-SLAPPs brought by defendants almost always win, often with staggering fiscal payments.[115] No more was heard from Mr. Pray.

Scandal: FWS plans a "prescribed burn" at the Rocky Flats Wildlife Refuge: No issue has so quickly rallied opposition to FWS as their plan to do a "prescribed" burn of 701 acres at the Refuge near Candelas in the spring of 2015. FWS did not announce that they intended to do the burn. They never held a public meeting to describe their plans. Though the CDPHE approved the burn, they never held a publicly announced meeting on this topic. Further, the EIS done on the Refuge in 2004 does not deal with burning on a radioactive site.

I learned about the proposed burn quite accidently in reading a report of the Rocky Flats Stewardship Council in the fall of 2014. Because of the plutonium in the environment I thought their proposed burn was exceedingly careless and must be stopped. I did something I had never done before, posted a MoveOn petition urging people to sign this statement:

> U.S. Fish & Wildlife Service must cancel the "prescribed burn" planned for the Rocky Flats National Wildlife Refuge in the spring of 2015. Doing the burn will endanger public health by releasing plutonium particles.

Every time someone signed the petition the person's name and any accompanying comments went to David Lucas, head of the Rocky Flats Refuge; James Kurth, then Chief of the National Wildlife Refuge System; as well as Colorado's two Senators and two members of the House of Representatives. Opposition to the burn grew quickly. The Rocky Flats Technical Group of which I am a member got David Lucas to agree to a meeting for January 28, 2015. But at the last moment he canceled after he was told media and a lawyer might be present. The very next day, January 29, FWS canceled the burn. By this time 2,780 people had signed the petition.

Getting the burn canceled was a big boost. A federal agency was paying attention. At the same time, however, they said they were only postponing the burn. They would do burns in the future at Rocky Flats. I published an op-ed on February 20, 2015, emphasizing that the tradition of risk from plutonium exposure that had existed since production began at Rocky Flats in 1952 needed to end, and now is the time to end it. There should be no burns at the site, because any burn would release plutonium. It's not a simple matter of saying no to burns, however. Wildfires of accumulated brush can be caused by lightning or human carelessness, such as a tossed cigarette. Measures to prevent this must be taken.[116]

The plutonium-contaminated Rocky Flats site should have no burns. Invasive vegetation can be targeted with beetles that destroy the ability of these plants to reproduce. Routine mowing or grazing with goats will reduce burnable debris and minimize wildfires from human or natural causes. Affected people and their allies need to work closely with FWS to find solutions that end the risk. We asked for a meeting with FWS to discuss all aspects of troublesome vegetation and preventing burns. FWS did not respond.

Several members of the Rocky Flats Technical Group got a discussion on the proposed burn with the Colorado Air Quality Control Commission. There they were told that

---

[115] For an informative article on this, see http://www.coloradoindependent.com/145376/toxic-suburbia-fantastic-rocky-flats-vistas-plutonium-breezes

[116] http://www.dailycamera.com/guest-opinions/ci_27562074/leroy-moore-burn-canceled-whats-next

before FWS could do a controlled burn at the Wildlife Refuge they would have to request permission and that there would be a public hearing that the Technical Group could attend before any grant for a burn was provided.

Wildlife at the Refuge: In its 2004 Environmental Impact Statement FWS stated that they would allow limited hunting for deer at the Rocky Flats National Wildlife Refuge. Later that year they released results of a deer tissue study done to determine if deer on the Rocky Flats site "are safe for human consumption." The conclusion was that they are "as safe for human consumption as venison taken offsite." With tissue samples collected from 85 deer, 16 had "detectable levels of plutonium, americium, or uranium." All the deer were nevertheless regarded as safe for humans to eat.[117]

Among the abundant wildlife present at the Refuge is one endangered species, the Preble's Meadow Jumping Mouse, which inhabits streams that drain the site (see Figure 8.13). Among animals most likely to be seen, besides deer, are elk (see Figure 8.14). When snow is abundant at higher elevations in the mountains to the west, elk come to lower elevations and often visit the Refuge.

Figure 8.13: The Preble's Meadow Jumping Mouse, listed among the Endangered Species, resides in the Rocky Flats National Wildlife Refuge.

Figure 8.14: Among the many wildlife that visit the Rocky Flats Wildlife Refuge are elk.

[117] http://www.fws.gov/mountain-prairie/pressrel/04-87.htm

Two paragraphs back I mentioned a FWS study to determine whether it is safe for humans to eat deer killed on the Rocky Flats site. How about the health of the animals themselves? Ecologist K. Shawn Smallwood, who studied wildlife at Rocky Flats, pointed out that no wildlife there or at any other DOE site where nuclear waste is present in the environment have been studied to determine the genetic effect of radioactive material on the health of the animals. Given the evidence of contamination and potential danger to exposed wildlife, he and his colleagues "found it remarkable that no genetic studies or rigorous animal population studies have been conducted." The actual environmental impact with regard to "frequency of genetic mutations, birth defects, and mortality" of affected species thus "remains largely unknown."[118]

Genetic specialist Diethard Tautz says that effects of radiation exposure on a given species of wildlife may not be readily apparent in individuals of that species until the passage of several generations. He calls this a "genetic uncertainty problem."[119] This finding suggests that wildlife at Rocky Flats could in the long-term be hurt by conditions at the site, but they are not being watched closely enough for us to know (see Figure 8.15).

Figure 8:15: This image, conceived by John Farrell and designed by Stephanie McMillan, is a good reminder that no genetic studies of wildlife have been done at Rocky Flats. The image was originally made for T-shirts available from Rocky Flats Nuclear Guardianship.

[118] Smallwood et al., "Animal Burrowing Attributes Affecting Hazardous Waste Management," *Environmental Management* (1998), vol. 22, no. 6, p. 834.
[119] Tautz, *Trends in Genetics*, vol. 16 Nov. 2000), pp. 475-477.

Humans at the Refuge: As noted above, FWS plans to allow public access to the Refuge as soon as it has the funds to build the infrastructure of entries and trails. A March 25, 2015, memo from the Rocky Flats Stewardship Council stated that DOE and FWS "are in the early stages of planning a Rocky Flats visitor center. The visitor center will most likely be located on the Rocky Flats National Wildlife Refuge, and will serve both federal agencies." The Visitor Center, apparently to be funded by DOE, is a step toward opening the Refuge to the public. This must not happen, because of the plutonium contamination that remains in soil both at the Refuge and at the 1,309 acres of DOE-retained Superfund site that the Refuge surrounds (see Figures 8.16 and 8.19).

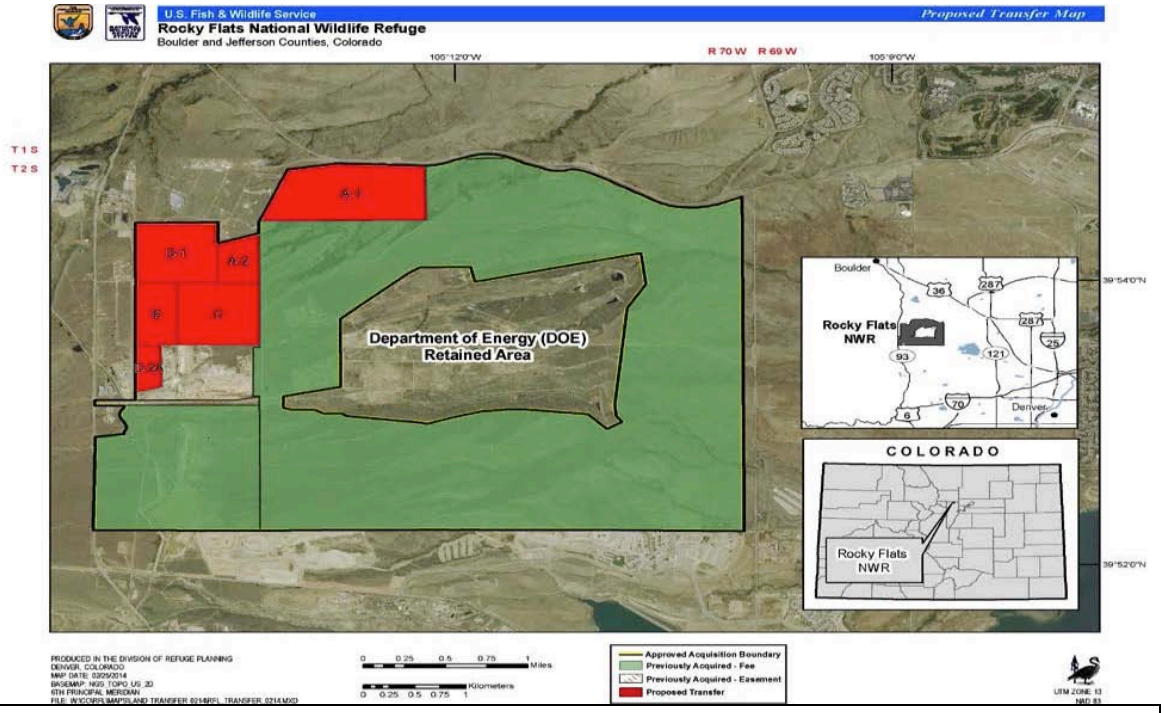


Figure 8.16. The 2015 map shows land that was recently added to the Rocky Flats National Wildlife Refuge. The Refuge now includes the green and red parcels on this map, an area of 9.75 square miles. The Refuge surrounds a plot of 1,309 acres (about 2.05 square miles) retained by the DOE. The DOE land remains on the Superfund list of contaminated sites. The Refuge was removed from the Superfund list when the cleanup was finished.

Congress in 2000 passed legislation to compensate workers whose health was harmed by workplace exposures at Rocky Flats and other DOE nuclear weapons sites. Congress needs to show the same level of care for the wholly innocent unknowing individuals whose health may be harmed if they visit the Rocky Flats National Wildlife Refuge. Potential visitors to the Refuge differ from former Rocky Flats workers in several respects.

- They will not be informed that being at Rocky Flats poses a risk.
- No special measures will be taken to protect them; they will not wear radiation detection equipment as was required of many nuclear workers.
- No record will be kept of their possible exposures.
- Their future health will not be monitored.
- If their health is harmed due to exposure to plutonium or other toxins at Rocky Flats, the source of the problem almost certainly will remain unknown.

- The government will not provide medical care or compensation for their ill fortune.

If public access occurs at the Rocky Flats Wildlife Refuge, FWS will welcome children. Of all potential visitors to the Refuge, a human child is the most vulnerable. Consider:

- A child is more likely than an adult to stir up dust, to eat dirt, to breathe in gasps, or to scrape a knee or an elbow, all ways of taking particles of plutonium into the body.
- Since a child's body is smaller than an adult's, internalized plutonium has much less mass in which to be distributed or to concentrate.
- The alpha radiation emitted within a child's body integrates with that child's growth and tissue development.
- By contrast to either adult humans or other beings, a child's normal life span provides far more time for internalized alpha radiation to harm her or his health.
- U.S. Fish & Wildlife and the Rocky Flats National Wildlife Refuge will disappear long before plutonium in the site environment ceases to be radioactive. It is thus likely after fences fall and memory fades that families with children will live on the site without any knowledge of the invisible danger they face (see Figure 8.17).

On behalf of our own children and of our grandchildren's children's children, the Rocky Flats National Wildlife Refuge must never be opened to the public.

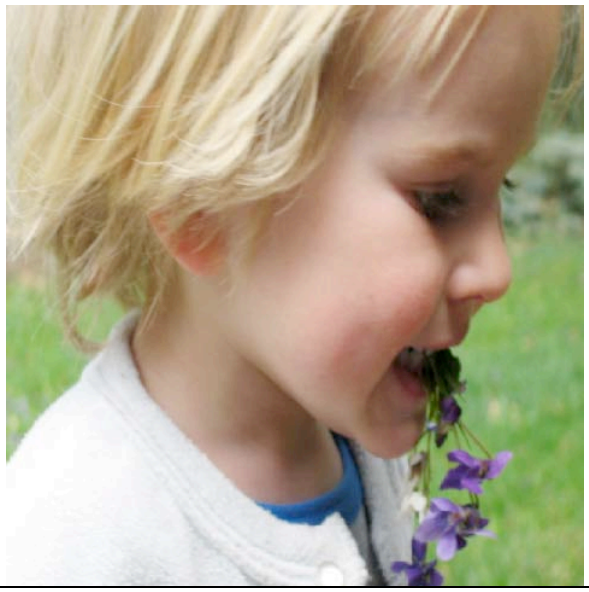


Figure 8.17: Gabriel, grandson of my colleague, Judith Mohling. If the flower he has in his mouth came from Rocky Flats, it could be dusted with plutonium that he could inhale or otherwise take into his young body.

Congress should pass legislation requiring that after cleanup at a DOE Superfund site such as Rocky Flats the site will be designated open space that is closed to the public for not less than 250 years, during which time it will be monitored for toxins and radionuclides in the environment in tandem with ongoing research on human health effects of exposure to said toxins and radionuclides and establishment of standards for protection of those exposed.[120]

In the words of Terry Tempest Williams, "The eyes of the future are looking back at

[120] See Moore, Plutonium at the Rocky Flats National Wildlife Refuge: Who is protected? On line at http://media.wix.com/ugd/cff93e_c1c37cd83365485185dbaab121066e90.pdf

us, and they are praying for us to see beyond our own time."

"Soft opening" of the Refuge: The previous section detailed public health problems people visiting the Refuge would experience. In 2015 FWS initiated what it calls a "soft opening" to the Refuge. Every three months or so FWS will accompany about a dozen individuals to hike from the west entry of the Refuge to the restored remains of Lindsey Ranch along Coal Creek in the northwest portion of the site, a round-trip distance of about five miles through an area contaminated by years of spraying radioactive waste onto the ground as a means for disposal. The soft opening was done with no public discussion, though Daniel Ashe of FWS had promised Rep. Jared Polis at a Congressional hearing that FWS would involve the public.

Rocky Mountain Greenway: In February 2013 then-Secretary of the Interior Ken Salazar announced plans for the Rocky Mountain Greenway, an 80-mile trail for hiking, biking and horseback riding that would connect three National Wildlife Refuges in the Denver area – Rocky Mountain Arsenal, Two Ponds and Rocky Flats – to the Rocky Mountain National Park. According to the original concept, the Greenway would pass near the Rocky Flats National Wildlife Refuge, not through it. But in April 2016 FWS suddenly announced that the Greenway will enter the Rocky Flats Refuge and traverse land known since 1970 to be contaminated with plutonium-239 released into the environment from the now closed Rocky Flats plant. Figure 8.16 shows areas on and off the Rocky Flats site found to be contaminated with plutonium in 1970.

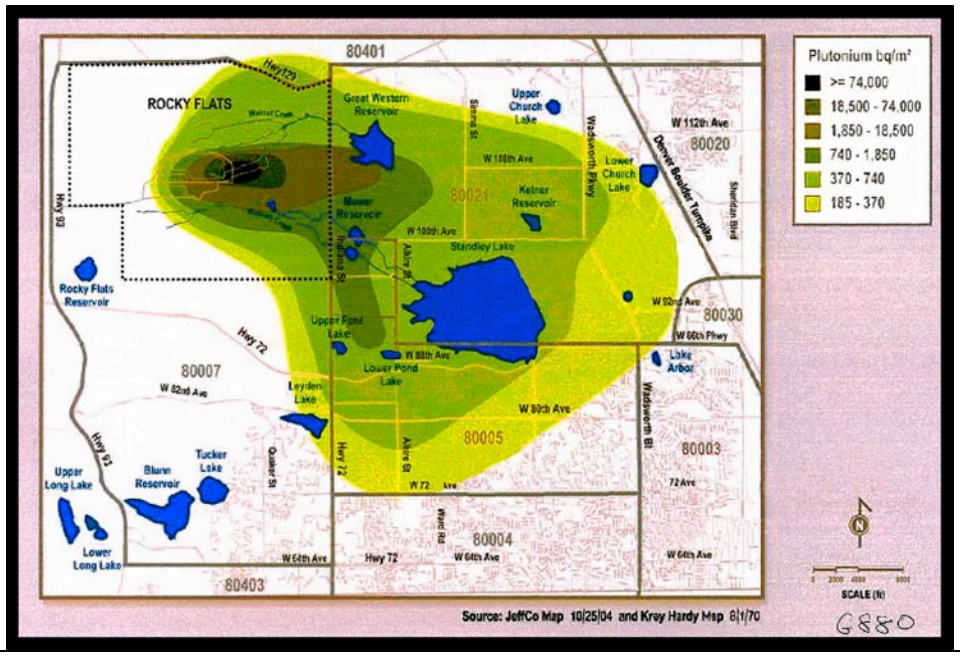


Figure 8.18: Distribution of plutonium contamination from Rocky Flats in becquerels per square meter (one becquerel equals one disintegration or burst of radiation per second). The amoeba-like isopleths show the pattern of windblown plutonium deposits. The original map was done by Atomic Energy Commission scientists, P. W. Krey and E.P. Hardy, "Plutonium in Soil Around the Rocky Flats Plant," HASL 235, 1970.

Figure 8.19 shows the route proposed for the Greenway to enter and traverse part of the Rocky Flats site. Comparing the two maps, it is obvious that if the Greenway follows the route proposed it will pass through land shown in 1970 to be heavily contaminated with plutonium. Is this land still contaminated? In September 2011 Marco Kaltofen of the Boston Chemical Data Corp., under contract with the Rocky Mountain Peace and Justice Center,

sampled soil along the eastern edge of the Rocky Flats site and found the level of plutonium to be about the same as found in the same area by Krey and Hardy in 1970.[121]

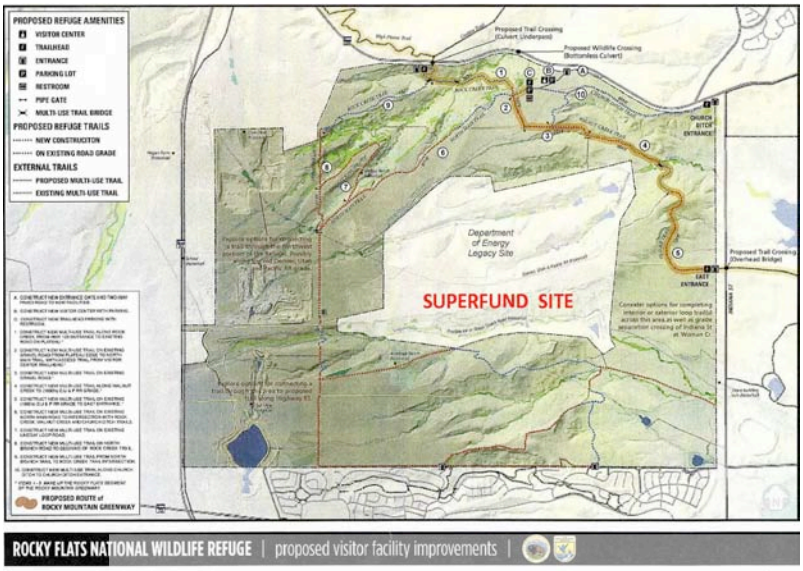


Figure 8.19: Map of the Rocky Flats National Wildlife Refuge with route proposed for the Rocky Mountain Greenway. The Refuge surrounds the more contaminated DOE Superfund site, from which contaminants can be expected to migrate onto Refuge land.

Because plutonium-239 has a half-life of 24,110-years, the area within the Refuge proposed for the Greenway will remain radioactive for more than a quarter-million years. Does this pose a danger to the public?

Is the Refuge Safe? The EPA and CDPHE, the regulators at Rocky Flats, often say that the site is "safe" because official exposure standards are not violated. But the standards of which they speak are not in fact protective, since by their very existence they allow some exposure. The Superfund cleanup done at Rocky Flats was not as thorough as it could have been. A 1995 closed-door deal between Congress and the DOE required that the cleanup be completed within a decade for a fixed sum ($7 billion).[122] Enough contamination remains on the site to ensure exposure.

A 2006 report from the National Academy of Sciences concluded that any exposure to ionizing radiation is potentially harmful.[123] There is no safe exposure. In addition, scientists at Columbia University showed that a single alpha particle from plutonium taken into the body could be harmful, possibly fatal.[124] Once inside the body, the plutonium lodges in a

[121] Marco Kaltofen, MS, PE (Civil, Mass.), Report on the 2011 Rocky Flats sampling and analysis campaign, Boston Chemical Data Corp., January 23, 2012.
[122] Moore, "Rocky Flats: The bait-and-switch cleanup," *Bulletin of the Atomic Scientists*, January-February 2005, pp. 50-57.
http://media.wix.com/ugd/cff93e_7711d2b2a9d84f28ab1986706f1cda75.p
[123] *Health Risks from Exposure to Ionizing Radiation, BEIR VII Phase 2*, Washington: The National Academies Press, 2002, p. 246.
[124] Tom K. Hei et al., "Mutagenic effects of a single and exact number of particles in mammalian cells," *Proceedings of the National Academy of Sciences*, vol. 94 (April 1997), pp. 3765-3770.

specific location and for the rest of one's life bombards nearby cells with radioactive alpha particles.

Hermann Muller received the 1946 Nobel Prize in medicine for his discovery of genetic mutations in fruit flies exposed to radiation. Toward the end of his life he published an article on the genetic effect of radiation exposures in humans. The biggest genetic problems, he said, are the cumulative effects of exposures "over a virtually unlimited period." Adverse health effects may not be readily apparent until the passage of several generations when someone in the genetic chain will suddenly lose the ability to reproduce, resulting in "genetic death." The damage to posterity will be massive. "Therefore the hereditary damage should be the chief touchstone in the setting of 'permissible' or 'acceptable' dose limits."[125] What Muller called for more than a half-century ago has not happened.

According to the latest proposal for the Greenway, local governments are asked to help fund entries of the Greenway into the Refuge. The balance of the cost for the Greenway will be paid with a FLAP (Federal Land Access Program) from the Federal Highway Administration, which will build the Greenway. The map in Figure 8.19 shows that one entry to the Refuge crosses Indiana St. on the eastern edge of the Refuge and the other crosses Highway 128 on the northern edge of the Refuge. Only the Town Council of Superior rejected the plan for the Greenway to go through Rocky Flats. Boulder City Council favored it on the condition that additional soil sampling be done to show that the area is "safe" for the public to visit. All the other governmental entities – the Counties of Boulder, Jefferson and Broomfield, and the cities of Westminster, Golden and Arvada – favored the plan, with the proviso of additional sampling. The Commissioners of Jefferson County, which initiated the effort to get the FLAP grant, agreed that the Rocky Flats Technical Group would be at the table for drawing up protocols for the sampling plan.[126] The Technical Group, a body of individuals deeply experienced with Rocky Flats, came into existence in 2014, when FWS expected to conduct a prescribed burn on the site (see page 113). Its members address the full range of Rocky Flats issues.

On July 8, 2016, several members of the Technical Group met with Elijah Henley, Planning Team Leader on the Greenway for the Federal Highway Administration, to discuss the sampling issue. The following is my summary of the meeting:

1. Mr. Henley favors sampling, but only on the Refuge, not on the DOE Superfund site, which the Technical Group wants, because contaminants there will be released onto the Refuge (see Figure 8.17). He will draft a sampling plan and ask for our comment.

2. He agreed with us that the sampling will be done by an independent party, with the samplers following MARSSIM (Multi-Agency Radiation Survey and Site Investigation Manual) guidelines. MARSSIM was not followed in the Superfund cleanup.

3. Henley did not say who would cover the cost. Also, it's not clear that the sampling will be a permanent periodic process as the Technical Group proposes, with full sampling every five years as well as after any major event, such as a flood or earthquake.

---

[125] Hermann J. Muller, "Radiation and Heredity," *American Journal of Public Health and the Nation's Health*, vol. 54, January 1964.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1254569/?page=9

[126] Members of the Technical Group are Harvey Nichols, Jon Lipsky, Gale Biggs, Anne Fenerty, Michael Ketterer, Mary Harlow, Ted Ziegler and LeRoy Moore.

4. I believe Henley understood the necessity of air sampling, perhaps by sampling respirable dust on the surface of soil, as Carl Johnson had once done (see pages 45-46).

5. I gave him a statement with references showing that existing exposure standards are not protective, yet he insisted that the Refuge sampling will be done to show whether or not the plutonium cleanup standard for the top three feet of soil of 50 picocuries per gram of soil (pCi/g) is met. Jon Lipsky, who did not attend the meeting, said he would challenge this standard, since it was created only for the Superfund cleanup which ended in 2006. Obviously, we will have further discussion on this. Henley said that if the standard he mentioned is not met, the local government entities will not pay for connections to the Refuge.

6. No FLAP money will be spent on Refuge trails, only on the entries across Indiana St. and Highway 128. Henley said all trails on the Refuge, including a portion of the Greenway, will be paid for by FWS.

7. The Technical Group wants the Greenway to bypass Rocky Flats rather than go through the site. Henley later provided sampling protocols without reference to the Technical Group. He added the bypass as an alternative even if the Greenway also passes through the Refuge, which has not yet been determined. As I recall his remarks, people on the trail would see signs giving them the choice of bypassing or going through the Refuge. The route for the bypass would head north along the east end of Great Western Reservoir, cross Highway 128, then head west to connect with Boulder Open Space trail and on north toward Rocky Mountain National Park.

Keep Kids Off Rocky Flats: Questions about the Rocky Mountain Greenway occurred in the midst of varied attempts to settle contentious issues related to the Greenway, the Refuge and the DOE Superfund site. In mid 2016 the Rocky Mountain Peace and Justice Center responded to the Greenway proposal with the Keep Kids Off Rocky Flats (KKORF) campaign. This project began with a petition for people to sign calling on FWS not to encourage school field trips and family picnicking at the Rocky Flats Refuge. Because of the tradition of FWS getting school field trips to bring children to Refuges, KKORF is concentrating on getting the school districts to say they will not sponsor visits to the Refuge from schools in the district. Next, similar requests will be made to specific schools and teachers, then families. The decision to turn the Rocky Wildlife Refuge into a playground was a human decision. Human decisions can be reversed, and this one should be. As of February 2018, six, school boards have agree not to take their students to the Rocky Flats Refuge.

Lawsuit regarding the Refuge: In May 2017 a lawsuit was filed in federal court to require FWS to follow rules of the National Environmental Policy Act (NEPA) before opening the Rocky Flats Wildlife Refuge to the public. Plaintiffs include RMPJC, Candelas Glows, Rocky Flats Right to Know, Rocky Flats Neighborhood Association and Environmental Information Network. The lawsuit seeks to block construction of trails and a Visitor Center until the government completes an up-to-date environmental analysis. FWS has publicly stated that construction will begin in June 2017.

NEPA requires public involvement to review decisions that affect the human environment. Federal agencies must explain the impact of their plans and justify all reasonable alternatives to proposed actions. Boulder attorney Randall Weiner, who is representing the plaintiffs explained, “The purpose of NEPA is to require an analysis of environmental effects before the agency’s actions are irreversible. By avoiding the NEPA mandate, FWS is virtually thumbing its nose at its obligations to consider the risks its plans pose to the public. The agency has waited too long to comply with its NEPA responsibilities.”

The suit also alleges violations of the National Wildlife Refuge Systems Administration Act.[127]

In addition to the lawsuit, attorney Weiner sought an injunction that would immediately halt activity on the Refuge, including receiving money to build the Visitor Center. Attorneys for FWS suddenly countered what FWS had previously said and told the court that no construction would occur at the Refuge until some time in 2018. The judge accepted their argument and rejected the move for an injunction. This is now (July 13, 2017) being appealed.

In addition to these aspects of the case, Refuge Director David Lucas announced in early July 2017 that he had given permission for about 200 prairie dogs now in Longmont to be relocated on the Refuge. This was big news for newspapers and TV. We and other activist groups voiced our opposition, to protect the health of both humans and prairie dogs. We were ready to make this part of our lawsuit, but early on July 13, 2017, Jefferson County officials recommended not to move the prairie dogs to the Refuge. Evidently, County Commissioners have the final say. Efforts are afoot to find another home for the prairie dogs before they are killed by the developer who wants them off his land.

Some of us involved in the lawsuit went to the Boulder Farmers Market on Saturday, July 15, 2017, to talk with people about issues related to the lawsuit. A man who stopped by told me that he had worked on the cleanup at Rocky Flats. "We had to sign a pledge that we wouldn't reveal what we knew." I asked if this meant that there were things DOE didn't want the public to know. He said, "Yes," and walked away.

[127] A copy of the legal complaint is available from randall@randallweiner.com

CHAPTER 9: ROCKY FLATS LEGACY MANAGEMENT

The DOE Superfund Site surrounded by the Wildlife Refuge: On completion of the "cleanup," most of the Rocky Flats property was transferred to U.S. Fish & Wildlife Service (FWS) to manage as the Rocky Flats National Wildlife Refuge, while DOE's Legacy Management Office (LM) retained 1,309 acres (about 2 square miles) of more contaminated land for ongoing monitoring and maintenance. The FWS land was removed from the Superfund list of most contaminated places, but the DOE land remains on the list. DOE and the regulators did a "cleanup" that can meet their target closure date and be financed with the limited sum available. This "cleanup" made LM an absolute necessity.

Another name for LM is long-term stewardship. A National Academy of Sciences report on long-term stewardship published in 2000 concluded that "DOE's preferred solutions reliance on engineered barriers and institutional controls are inherently failure prone."[1] At Rocky Flats, LM relies on dams and fences, that is, on "engineered barriers and institutional controls."

LM at Rocky Flats isn't waiting for these systems to fail; it's rushing the process. I wrote a brief paper for DOE about what's being done regarding surface water leaving the site. Colorado has a strict standard for plutonium (Pu) and americium (Am) in surface water. As it leaves the site on either of the two creeks that drain the site, Pu/Am content in surface water must not exceed 0.15 picocuries per liter (pCi/L), the Colorado standard. The sampling location where the water exits the site is a "point of compliance" (POC). A sampling location upstream is a "point of evaluation" (POE). According to the rules of the game, failure to meet the standard at a POC results in a penalty, while failure at a POE puts DOE on notice to correct the problem. In a three month period in 2011 Pu/Am concentrations exceeded the standard at a specific POE, and this has continued spasmodically since. DOE regards this as a minor problem, because at the exit POC downstream (at the boundary between the DOE site and the Refuge) the water is in compliance.

Things are under control. But are they? During production years a series of dams were constructed on both Walnut and Woman Creeks, the two creeks that drain the Rocky Flats site, in order to impede water flow and allow Pu and Am to sink to the bottom of the resultant holding ponds. By the time water passed through the series of ponds it would meet the Pu/Am standard at the site boundary. In summer 2010, DOE, with the approval of EPA and CDPHE, began breaching the holding pond dams to restore free-flow to the streams. In doing this, DOE ignored a report written in 2001 as part of the study of plutonium migration at the site. This report concluded that even if the site was cleaned to as low as 10 pCi/g recommended by the Rocky Mountain Peace and Justice Center (by contrast to the 50+ actually adopted), there eventually would be a failure at the downstream site boundary to meet the state standard. Moreover, it is impossible to identify the source of the fugitive plutonium, much less to predict when it will show up.[2] In 2012, referencing the information in the two previous paragraphs, I sent DOE a paper entitled, "Is long-term stewardship unraveling at Rocky Flats?" I received no response. To date, in February 2018, the terminal ponds remain in place; they have not been breached, but DOE says it expects to do so soon, perhaps later in 2018.

The legacy of increased alpha radiation: The amount of alpha radiation given off by material in the Rocky Flats environment actually increases with time, thanks to the presence in the original bomb-grade material of a small quantity (0.4%) of plutonium-241.[3] Plutonium-241 has a half-life of 14.3 years. As it decays, it becomes americium-241, an alpha emitter with a half-life of 460 years. In about 75 years, after five half-lives, the alpha activity of the rapidly decaying americium-241 equals

---

[1] National Academy of Sciences, *Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites* (Washington: National Academy Press, 2000), p. 4.
[2] Win Chromec. *Report on Soil Erosion and Surface Water Sediment Transport Modeling for the Actinide Migration Evaluations at the Rocky Flats Environmental Technology Site* (Kaiser-Hill, August, 2000).
[3] Lamm-Wirth Task Force on Rocky Flats, Final Report, October 1975.

half the activity of the plutonium-239 in the original mix of material purified for bomb production.[4] This means that, for a period of time beginning around 2030 and tapering off after 2065 the total alpha radiation emitted by plutonium and americium remaining in the Rocky Flats environment will be at a level 50% higher than this same material emitted when it was first deposited in the environment.

The Rocky Flats precedent: "Risk-based cleanup": The "cleanup" pioneered at Rocky Flats and held out as the model for other sites is what DOE calls a "risk-based cleanup," or "risk-based end state." In sum, this approach entails tailoring cleanup to a legally compliant risk level. The Rocky Flats "cleanup" exposes the wildlife refuge worker to a level of risk that complies with Superfund law. Thus, future use, the cleanup scenario, legal compliance, and limited funding all come together in a "cleanup" called "safe and compliant."

DOE's "risk-based" approach fails to take into account all risks. We must consider unpredictable human or natural actions that may radically alter conditions at a site. A key intent of the "risk-based" approach is to comply with the law, that is, with applicable radiation exposure standards. But standards change from time to time, usually in the direction of greater stringency as more is learned about adverse health effects of radiation exposure.[5] Of course, those who set the exposure standards that now exist did not base their assessment of risk on the more conservative approaches of people like Martell, Sakharov, Hei, Zhou, and others.

Those who set exposure standards calculate risk according to averages rather than according to the danger posed to the most vulnerable members of a population. The risk of harm to everyone who actually gets sick or dies due to an exposure is obviously 100%, while the risk to others is 0%. Calculating risk according to some average thus applies to neither group.

The weakness of the averaging approach for calculating risk is especially evident in the way standards for plutonium exposure are set. If plutonium lodges in the body, the alpha radiation it emits repeatedly bombards surrounding cells. This continuing onslaught makes alpha radiation far more harmful per unit dose than penetrating radiation like gamma or X-rays. To account for the difference, agencies such as the International Commission on Radiological Protection (ICRP) refer to the "relative biological effectiveness" (RBE) of alpha emitters. Assessing the potential harm to different organs and for different disease end-points, ICRP arrived at an average RBE for alpha emitters of 20. This means that on average alpha radiation inside the body is 20 times more harmful than gamma radiation of the same dose. This is a substantial increase, but, because 20 is an average, for some body organs and for certain cancers as well as for some individuals the actual RBE is even higher, sometimes much higher. A detailed report on this issue done as part of the Rocky Flats dose reconstruction study shows that the RBE for plutonium ranges from as low as 1 for leukemia to as high as 375 for some bone cancers with other cancers ranged between.[6] Despite this huge range, ICRP recommends to organizations that set standards for exposure to plutonium that they use 20 as the RBE.[7] This implies that on average exposure to alpha radiation from plutonium is 20 times more risky than exposure to gamma radiation.

The agencies that calculated the Rocky Flats cleanup standards followed the established pattern and used an RBE of 20 for plutonium. By using this number they underestimated the risk of harm that could result from plutonium exposure to certain organs of the body or to given individuals, including of course an individual refuge worker who may be particularly vulnerable without realizing it. Doing more to protect the vulnerable would alter the level of cleanup. Doubling the plutonium RBE

---

[4] S. E. Poet and E. A. Martell, "Plutonium-239 and Americium-241 Contamination in the Denver Area," *Health Physics*, vol. 23, Oct. 1972, p. 545.
[5] Catherine Caufield, *Multiple Exposures: Chronicles of the Radiation Age* (NY: Harper & Row, 1989).
[6] *Risk Assessment Corporation*, Assessing Risks of Exposure to Plutonium, Final Report, CDPHE, Feb. 2000, p. 6-40.
[7] ICRP Publication 26 (Oxford: Pergamon Press, 1977) and ICRP Publication 60 (1990).

to 40 would reduce the surface soil standard by half from 50 to 25 pCi/g. Doubling the RBE again to 80 would drop the surface cleanup level to 12 pCi/g.[8]

There may, however, be much more at stake than protecting a relatively small number of vulnerable individuals. M. A. Kadhim and colleagues working with Eric G. Wright of the Medical Research Council at Harwell, Oxfordshire, England, concluded that the RBE for chromosomal damage resulting from a single plutonium alpha particle traversing a cell is "effectively infinite" due to possible permanent pollution of the human gene pool.[9] Wright calls this "radiation-induced genomic instability." Rob Edwards in an article on this subject quotes Jack Little of the Harvard School of Public Health: "Genomic instability changes our way of thinking about how radiation damages cells and produces mutations." Some researchers think it may offer a "plausible mechanism" for explaining illness other than cancer, illnesses so elusive that epidemiology is "powerless" to detect any relationship between their incidence and exposure to radiation. Keith Baverstock, a senior radiation specialist with the World Health Organization, and Wright believe people "should be more wary of low-level radiation. If genomic instability is causing unpredictable disease, and if some people are genetically predisposed to it, the regulatory system starts to look inadequate."[10]

Even setting aside genomic instability, those who calculate risk for the purpose of establishing standards for permissible exposure are willing to allow fatalities and disabilities. For some anonymous persons, legal compliance may prove a sentence of premature death. In the trenchant words of Ulrich Beck, a foremost European critic of what he calls "risk society," exposure standards "may indeed prevent the very worst from happening, but they are at the same time 'blank checks' to poison nature and humankind a bit."[11]

Risk as defined within the closed culture of the nuclear establishment gets written into law as standards for permissible exposure. The resultant regulations then are enforced as if morality and legality were identical. But the foundational concept of risk itself has been created out of whole cloth without input from affected populations, much less their direct participation in decision-making.[12] The studied indifference to the earthly fate of portions of humankind, to say nothing of other life forms, is startling. Suffice to say that DOE's risk-based approach to cleanup is a human product and that, as such, it needs scrutiny. When it is scrutinized, it doesn't bear up very well.

The Rocky Flats Stewardship Council: For its LM work at the site, DOE established and funds the Rocky Flats Stewardship Council (RFSC). This organization was deliberately created not as a body that balances the full range of views about Rocky Flats but rather to ensure that control rests with representatives of local governments. Besides permanently holding 8 of the 12 seats, they select those who fill the other 4. Generally, the RFSC is a very decent if docile group, united perhaps in a political need not to make waves that could impact negatively on the aura of prosperity important to the burgeoning suburban communities around Rocky Flats. We at the Rocky Mountain Peace and Justice Center have not sought membership because, if admitted, we'd be routinely marginalized.

The RFSC has on occasion taken sides on a divisive issue, the clearest example being its repeated opposition to Wes McKinley's efforts to get signs at the Rocky Flats National Wildlife Refuge informing potential visitors of risk entailed in visiting the refuge (see pp. 104-106). By 2010 the RFSC was advising Fish & Wildlife on language for signs the agency would post at Refuge entries. Any organization that advises a federal agency must comply with the Federal Advisory Committee Act (FACA) requirement that it "be fairly balanced in terms of the points of view represented."[13] Clearly,

---

[8] I owe this insight about the effect of RBE doubling to John Till of Risk Assortment Corporation.
[9] Kadhim et al, 'Transmission of chromosomal instability after plutonium alpha-particle irradiation," *Nature*, 335, 20 Feb. 1992: 738-740.
[10] Rob Edwards, "Radiation Roulette," *New Scientist*, Oct. 11, 1997, pp. 37-40.
[11] Ulrich Beck, *Risk Society: Towards a New Modernity*, trans. Mark Ritter (London: Sage, 1992), p. 64.
[12] Moore, "Lowering the Bar," *Bulletin of the Atomic Scientists*, May-June 2002, 28-36.
[13] http://www.gsa.gov/portal/content/101010

the RFSC did not meet this requirement. I contacted DOE's Office of General Counsel and asked them either to abolish the RFSC for violating FACA or to reconstitute it to conform with the FACA requirement of "fairly balanced" representation. In response, on May 12, 2010, DOE attorney Susan Beard wrote a strongly worded letter to DOE Legacy Management Director David Geiser. She made it very clear that the RFSC is not an advisory body and that it exists solely to convey information back and forth between DOE and the public. Three times in a brief letter she says the RFSC must perform its role of transmitting information "without edit or filter."

When the RFSC was created, then LM Director Michael Owen, in a December 28, 2005, letter to Shaun McGrath, at the time Chair of the Rocky Flats Coalition of Local Governments, vetoed having the RFSC work with U.S. Fish & Wildlife. "We can not direct an organization to work with another federal agency." Clearly, when the RFSC opposed Wes McKinley's efforts to get informed consent signs at the Wildlife Refuge, and when it then advised Fish & Wildlife regarding language for signs the agency would post at the Refuge, the RFSC was out of bounds. Even now, despite Michael Owen's very clear prohibition, the RFSC mission statement posted on its web site declares that the RFSC "also works with the United States Fish and Wildlife Service on issues related to the management of the Rocky Flats National Wildlife Refuge." Raising questions, I learned that the RFSC, in its own view, can do non-DOE work if this work is funded by non-DOE sources. The only non-DOE source of funds is the $1,000 per year paid by each of the eight local government entities that are members of the RFSC. This totals $8,000 per year, a very small amount for giving any kind of advice or time on the RFSC agenda for the FWS Wildlife Refuge manager to make presentations. This is nevertheless being done. In 2017-18, the RFSC changed the language on its web site to make it clear that it will continue to support FWS management of the Refuge.

Rocky Flats Downwinders: At noon on Downwinders Day of Remembrance, January 22, 2016. Tiffany and Nick Hansen gathered a crowd at the steps of the State Capitol in Denver to formally inaugurate the Rocky Flats Downwinders. The project is collecting names and information from anyone who lives or ever lived downwind of Rocky Flats and suspects physical ailment(s) may be due to exposure to plutonium or other toxins released from Rocky Flats. The RF Downwinders contracted first with Professor Carol Jensen of Metro State in Denver, then with Professor Bonnie Kite at the University of Denver to compile a full record of information shared by people. They hope eventually to get federal compensation for those who have been harmed, like that provided downwinders of the Nevada Test Site.

To publicize their effort, on August 28, 2016, they showed the film "Downwinders," followed by a panel discussion with Jon Lipsky, Alesya Casse and LeRoy Moore. The film is about people living downwind of the Nevada Test Site; it gives data regarding the exposure and death from cancer of John Wayne, who acted in a movie filmed in Utah near the Test Site. Compensation has never been available to people downwind of Rocky Flats whose health was harmed by exposure to material released from the plant. Ed Martell, Carl Johnson, Jock Cobb, epidemiologist Richard Clapp of Boston University and nurses from the Colorado Medical School said the health of such people should be monitored. Tiffany and Rick Hansen, with their colleagues and a host of others hope to get compensation from the federal government.

On November 21, 2016, Rick Hansen wrote CDPHE asking for data from the Colorado Central Cancer Registry from 1980 to the present showing the incidence of thyroid cancer and "rare cancers" among people downwind of Rocky Flats versus the general population. A few days later CDPHE published a new study with the a map with shading for the study area (see Figure 8.20). Based on this new study, CDPHE claimed that there is no difference in cancer incidence between people exposed to radiation released from Rocky Flats and people who are not exposed.

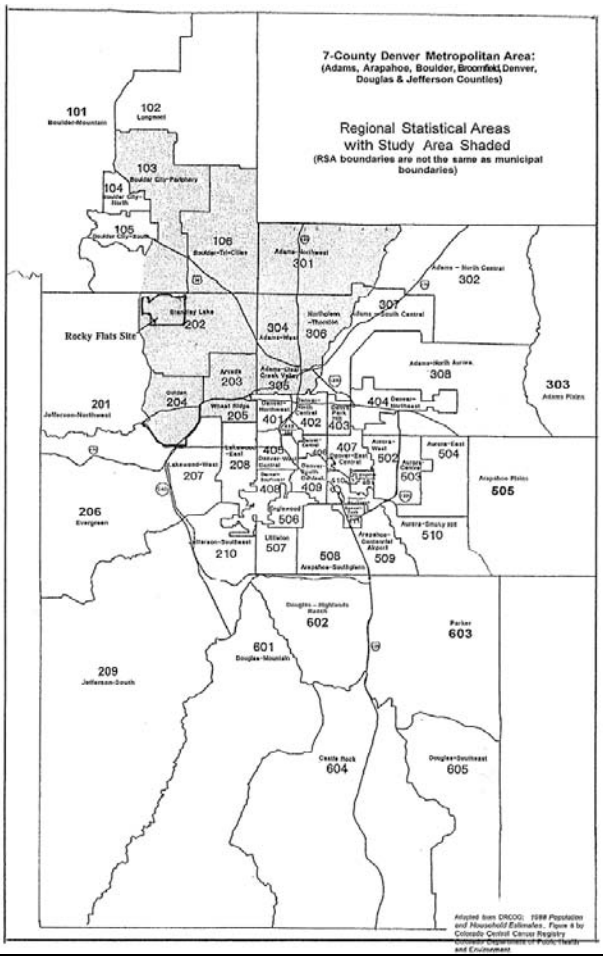


Figure 8.20: CDPHE's map, with shaded study area.

The CDPHE map misrepresents the area of plutonium contamination and thus possible cancer. As noted earlier, in 1970 P. W. Krey of the AEC collected samples throughout the Denver Metro Area to see where plutonium released from Rocky Flats had been deposited. His map shows clearly downwind exposure areas (see Figure 8.21). Note the contrast between where Krey found contamination and the CDPHE shaded study area. The latter includes large non-contaminated spaces and omits large contaminated areas (such as in Denver and nearby suburbs). The CDPHE study greatly diminishes Rocky Flats cancer incidence by including data from non-contaminated regions and excluding data from contaminated areas.

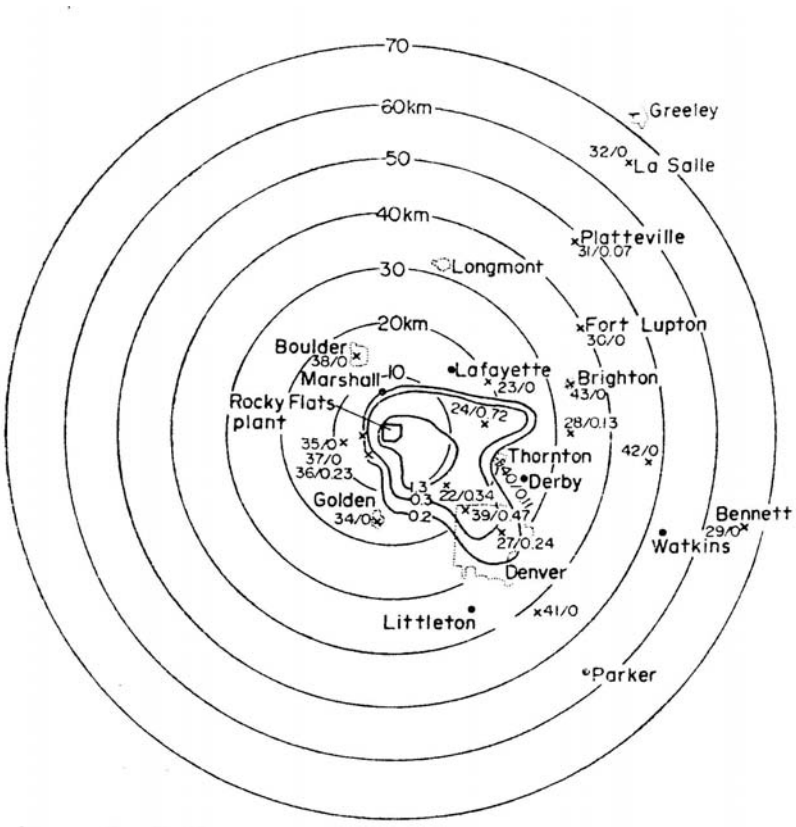


Figure 8.21: Map from Krey, "Remote plutonium contamination and total inventories from Rocky Flats, " *Health Physics*, 1976, vol. 1, pp. 209-214.

Groups working on Rocky Flats and sources of information (as of January 2018)

- Rocky Flats Nuclear Guardianship, a program of the Rocky Mountain Peace and Justice Center, provides the most complete source of Rocky Flats information from past and present. See http://www.rockyflatsnuclearguardianship.org/
- Colorado Coalition for the Prevention of Nuclear War, one of the oldest activist groups in the area, during production year was very active in seeking the shutdown of the plant. Since production ended, the group has sought to end the threat of nuclear war. See http://thecoloradocoalition.org/#
- Environmental Information Network began in the 1990s. It is primarily the work of two sisters, Paula Elofson-Gardine and Susan Eflofson-Hurst. They attracted the attention of the public by finding and making available documents related to Rocky Flats, both the environment and public health concerns. They can be contacted by email at <pjelofson@gmail.com> and <susandhurst@aol.com>
- Rocky Flats Technical Group, a small group of individuals thoroughly familiar with all aspects of Rocky Flats, began in 2014. For details, contact Harvey Nichols at <Harvey.Nichols@colorado.edu>.
- Candelas Glows, an organization founded by Michelle Gabrieloff-Parish, focuses on the very large Candelas Residential Development along the southern edge of the Rocky Flats site. See https://candelasglows.com/
- Rocky Flats Downwinders is detailed above. To learn more or to sign up for the health study, see http://rockyflatsdownwinders.com/
- Rocky Flats Right to Know was created in 2016. For information, contact Bonnie Graham Reed at <bonniestarrysky@comcast.net>.
- Rocky Flats Cold War Museum began in the late 1990s "to document the historical, environmental, and scientific aspects of Rocky Flats, and to educate the public about Rocky Flats,

the Cold War, and their legacies through preservation of key artifacts and development of interpretive and educational programs." Though the museum was originally committed to conveying the full Rocky Flats story, not just the official line, this inclusive understanding has proven difficult. DOE, which should provide taxpayer money to tell the full story, has provided no funds for the Rocky Flats museum. The museums it has supported at other DOE nuclear weapons sites are limited to the party line. The Rocky Flats museum was forced to lay off its director, dispose of many of its artifacts and move into a very small space at the Arvada Center for the Arts and Humanities, 6901 Wadsworth, Arvada. See http://www.rockyflatscoldwarmuseum.org/

- Rocky Flats Oral Histories are part of the Maria Rogers Oral History Program housed in the Carnegie Branch of the Boulder Public Library. The collection contains 230 items. See http://oralhistory.boulderlibrary.org/?s=rocky+Flats
- Bioneers is an annual event in Boulder, affiliated with Bioneers presentations at other locations. The point is to education people who attend on environmental issues the world faces. In February 2018 we gave our third presentation on Rocky Flats. Every year a few people are recruited to work on Rocky Flats, with the Nuclear Guardians or some other group.

CHAPTER 10: NUCLEAR GUARDIANSHIP

Origin of Nuclear Guardianship: In the early 1990s eco-philosopher Joanna Macy of Berkeley, CA, a long-time friend, gathered about her a group of people concerned about all aspects of the nuclear issue. Over the years they produced the following "Ethic of Nuclear Guardianship."

Ethic of Nuclear Guardianship -- Values to Guide Decision-Making on the Management of Radioactive Materials:

1. Each generation shall endeavor to preserve the foundations of life and well-being for those who come after. To produce and abandon substances that damage following generations is morally unacceptable.

2. Given the extreme toxicity and longevity of radioactive materials, their production must cease. The development of safe, renewable energy sources and non-violent means of conflict resolution is essential to the health and survival of life on Earth. Radioactive materials are not to be regarded as an economic or military resource.

3. We accept responsibility for the nuclear materials produced in our lifetimes and those left in our safekeeping.

4. Future generations have the right to know about the nuclear legacy bequeathed to them and to protect themselves from it.

5. Future generations have the right to monitor and repair containers, and to apply such technologies as may be developed to protect the biosphere more effectively. Deep burial of radioactive materials precludes these possibilities and risks uncontrollable contamination to life support systems.

6. Transport of radioactive materials, with its inevitable risks of accidents and spills, should be undertaken only when conditions at the current site pose a greater ecological hazard than transportation.

7. Research and development of technologies for the least hazardous long-term treatment and placement of nuclear materials should receive high priority in funding and public attention.

8. Education of the public about the character, source, and containment of radioactive materials is essential for the health of present and future generations. This education should promote understanding of our relationship to the Earth and to time.

9. The formation of policies governing the management of radioactive materials requires full participation of the public. Free circulation of information and open communication are indispensable for the self-protection of present and future generations.

10. The vigilance necessary for ongoing containment of radioactive materials requires a moral commitment. This commitment is within our capacity, and can be developed and sustained by drawing on the cultural and spiritual resources of our human heritage.

Rocky Flats Nuclear Guardianship: In the summer of 2010 I was invited by Anne Waldman to give a presentation on Rocky Flats for the Summer Writing Program at Naropa University. There was so much interest after the presentation that several things came together. First , the Rocky Mountain Peace and Justice Center (RMPJC) decided that from January to June 2011 it would hold a series of workshops and presentations on Nuclear Guardianship at Naropa University. For the last session in June 2011 Joanna Macy led a Guardianship workshop. Two quick results were, first, RMPJC would turn its long focus on Rocky Flats into the Rocky Flats Nuclear Guardianship (RFNG) and Naropa University would found The Joanna Macy Center as an academic program.

The RFNG meant an explicit commitment to the Guardianship Ethic for our work on Rocky Flats and nuclear weapons. We began a regular schedule of a two-hour meeting every Tuesday at noon, development of a web site focused on Rocky Flats, support of other groups with their own specific approach to Rocky Flats. Out of this came a specific program to Keep Kids Off Rocky Flats (KKORF), beginning with appeals to school boards not to allow their students to go on school field trips to the Rocky Flats National Wildlife Refuge. To date (February 2018) five school boards have made this commitment; none have declined. Of course, we want the Refuge closed, period – not just for the young but for everyone (see pp. 104, 124).

Our other focus at present is to stop construction of the Jefferson Parkway. Earlier it was reported that the Parkway may fail for lock of investors (see pp. 110-112). But if they get the funds and decide to construct the road, this will invite nonviolent civil disobedience. If this happens, we will be ready. We will teach civil disobedience.

Appendix A
The Gift on Nonviolence

In May 1948, on the warm night of the last day of my junior year in high school, when I was 16, I put an end to my father's beating me with a rubber hose. He'd escalated to this weapon for his wholly unjustified punishments some years earlier. On the night in question, as I made my way through the darkened house toward the room I shared with my brother, I sensed my father's presence before seeing him with that garden hose doubled over in his hand. He ordered me to lie down on the bed as I'd always done. It suddenly came to me that I didn't have to take this any longer. My refusal triggered a struggle in which he tried to force me down. I responded by wrapping my arms around his neck and lifting my feet from the floor so that I hung deadweight down the front of his body, absorbing all his energy. Within seconds he went limp with exhaustion, and I removed my arms from around his neck, ending forever his physical violence toward me.

As the years passed I saw a straight line from the violence of my father to the violence of my country, the extremity of the former fortunately no worse that a rubber hose, but of the latter enough nuclear force to end human life on Planet Earth several times over. When in 1978 I learned about Rocky Flats, where the fissile core of every U.S. nuclear warhead was made, I sought with others to stop what was done there. In nonviolence training for my first civil disobedience at Rocky Flats, we did a rol-play called "deadweight" in which you contain a belligerent person's behavior by hanging yourself deadweight down that person's torso. Tears burst from my eyes. Amazingly, what I'd done spontaneously at age 16 was being taught in carefully choreographed nonviolence training.

My father, without knowing he was doing so, had made a gift to me, for he had planted within me the seed of nonviolence and had even brought it to blossom. As for Rocky Flats, an eventual fruit of the flowering of nonviolent resistance was to end production there of nuclear bombs, the extremity of violence.

Appendix B
Plutonium in bodies of workers will shut the industry down

In 1987 Gregg S. Wilkinson of DOE's Los Alamos Lab published results of a study of Rocky Flats workers that presented the first epidemiological findings suggesting that exposure to plutonium produced adverse health effects.[1] Wilkinson divided the 5,413 workers he studied into three groups: the *more exposed* (those with a plutonium body burden of 5 or more nanocuries [nCi]), the *less exposed* (those with a body burden of from 2 to 4.9 nCi), and the *unexposed*. The unexposed workers were the control group to which the exposed workers were compared; that is, workers were compared with their peers in the workplace, not with the population in general. Both the less exposed and more exposed workers by comparison with the non-exposed showed no significant increase in cancers of the liver, bone and lung, organs of the body where plutonium is known to accumulate. But both groups showed surprising increases in a wide range of other cancers. Excess brain cancers were found among both the less exposed and more exposed.

DOE's occupational standard for plutonium is a maximum permissible body burden of 40 nCi. Many of the workers Wilkinson studied had body burdens considerably below this level. Because 2 nCi – a mere 5% of DOE's standard for permissible exposure – was the lowest level his instruments could detect with certainty, Wilkinson classified as unexposed all workers with a body burden of less than 2 nCi. Any cancers among workers burdened at this very low level were not counted as possibly due to occupational exposure. Wilkinson thus thought his study underestimated the true effect of plutonium exposure.

As soon as his results began to be known, his study created a firestorm of controversy within DOE. A physician on the Los Alamos staff told him that his findings, if true, "would shut down the nuclear industry!"[2] His supervisor at Los Alamos urged him to modify his findings prior to publication to please "the customer"[3] that is, DOE. When he published his results without change in the *American Journal of Epidemiology* in 1987, his Los Alamos work was downgraded and subjected to increased levels of internal review, making future research more difficult and publication less likely. In response, he resigned.[4] His colleague George Voelz, one of the eight co-authors of the Wilkinson study, was moved into the position Wilkinson vacated.

In an article published in *Los Alamos Science* in 2000, Voelz presents what purports to be a comprehensive review of what is now known about risk from exposure to plutonium. He refers to Wilkinson's study of Rocky Flats workers, saying that it showed "no evidence of statistically increased rates of lung, liver, and bone cancers."[5] While this is true, Voelz makes no mention of what made the Wilkinson study so controversial in the first place, namely, the finding of elevated levels of other cancers, including brain cancers, among workers with plutonium exposure at very low doses. Voelz' name, by the way, as noted above, appears on the title page of Wilkinson's article as one of the co-authors.

Having heard Wilkinson's Rocky Flats study dismissed as inadequate because he did not consider data on the use of tobacco among the workers he studied, I asked Wilkinson about this. He pointed out, first, that data on tobacco use would be pertinent for lung cancer but not for other cancers. Second, "the potential relationship between smoking, plutonium lung burden and lung cancer should be studied." In fact, while he was at Los Alamos he had drafted a proposal to seek National Cancer Institute funding for research in this area, but DOE officials "would not allow the proposal to be sent to the NCI for review."[6]

---

[1] Gregg S. Wilkinson et al, "Mortality among Plutonium and Other Radiation Workers at a Plutonium Weapons Facility," *American Journal of Epidemiology* 125, 2 (1987): 231-250.
[2] Wilkinson, "Seven years in search of alpha," *Epidemiology*, 10 (1999).
[3] Keith Schneider, "Panel Questions Credibility of Nuclear Health Checks," *New York Times*, February 28, 1990.
[4] Wilkinson, "Seven years in search of alpha," *Epidemiology*, 10 (1999).
[5] George L. Voelz as told to Ileana G. Buican, "Plutonium and Health: How great is the risk?," *Los Alamos Science*, No. 26 (2000), 85.
[6] Wilkinson to Moore, April 26, 2001.

Appendix C
Rocky Flats Fast, 1989

The FBI raided Rocky Flats on June 6, 1989 to collect evidence of environmental law-breaking at the plant. A few days later a small group, myself included, went to Governor Roy Romer with this request: "Tell the DOE to halt production at Rocky Flats until independent investigators verify that the plant can be operated safely. We know you lack the legal authority to close a federal facility," we said, "but as governor you possess an exceptional moral authority. We urge you to use your moral authority to get Rocky Flats closed by July 4."

I left the governor's office that day convinced he would do nothing. But he did do something: He reached an agreement with the DOE to keep the plant operating. This was distressing, because it set a precedent: *Go along with the DOE. Go along to get along.* I could see this happening. Romer was setting a precedent, and I knew other officials would follow his lead. And indeed they did, notably those responsible for the "cleanup."

How should I respond? I decided that if he did not take the action we had requested by July 4, on the very next day, July 5, to highlight his lack of moral nerveI would initiate a water-only fast.

With my close friends the idea of a fast was hotly discussed. I told them it would end only when production ended. It could continue until I died – at age 57. Expecting my death, a Catholic Worker friend made a wooden box to contain my ashes. To be willing to die for a cause is not unusual. I was asking no more of myself than is asked repeatedly of soldiers in our country's military ventures. But some very close to me were angryat any thought of fasting to death. Others wondered: Why Romer? Why not the DOE? or Congress? The answer was simple: Many of us had for years urged the DOE and Congress to close Rocky Flats. Now conditions were ripe for the governor of Colorado to take a stand.

The question of fasting to death was more difficult. I found Mohandas Gandhi persuasive. He fasted to change the behavior not of adversaries but of allies. The one time he fasted to change the behavior of a British Viceroy in India, he quickly realized this was a mistake and ended his fast. To fast to death to change Governor Romer's behavior would likewise be a mistake, for its insistence that he meet our demands would be coercive in an extreme way. So fasting to death was rejected. Instead the fast would end on a specific date. It would begin on July 5, and, unless production at Rocky Flats halted, it would end 35 days later, on August 9, Nagasaki day. It would make no demands. It would simply reveal for all to see our exchange with Governor Romer and his response.

A news conference on July 5 announced the beginning of a 35-day water-only fast to acknowledge the governor's failure to use his moral authority to call for an end to production at Rocky Flats. "The difference between dying from nuclear exposure and dying from nuclear explosion," I commented," is a matter of degree, and the only wayto eliminate either is to eliminate both."

Activists for years had called Rocky Flats a local hazard and a global threat. The hazard would be less if the site were cleaned to the maximum extent possible. This, DOE said in 1995, would take 70 years and cost $36 billion. But later that year DOE decided for a cheaper accelerated "cleanup" and made a closed-door deal with Congress that capped the cost at $7 billion and the time at 10-years. The "cleanup" thus was driven by cost and calendar, not by public health and environmental integrity. When the final proposal for this accelerated "cleanup" was put out for public comment, 86% of the parties commenting rejected it. But officials responsible for the "cleanup" went along with the DOE. Rocky Flats thus is a local hazard forever.

The public aspect of the fast would occur daily from 7 AM till 6 PM at a place on the Capitol lawn, marked by a large banner that declared: "Fast of sadness for Rocky Flats victims." The list of victims included workers exposed to toxins on the job, off-site people endangered by contaminants, those killed or made ill by bombs made at Rocky Flats, the hungry and homeless who suffer the effects of a militarized economy, taxpayers who pay for what they did not choose.

Early on the second morning of the fast I was alone when a car pulled up and Governor Romer stepped out. He came to my side and after a torrent of words said: "You have targeted the wrong

person." "No," I said, "by virtue of the office you hold, you and only you possess the moral authority to persuade the DOE to halt production at Rocky Flats until independent specialists show the plant can be safely operated." At this he turned away. He missed an opportunity and set a precedent.

A lesson I learned from the Vietnamese Buddhist monk Thich Nhat Hanh is, when meditating, to watch my breath. How appropriate, I thought, since the likeliest way to be exposed to plutonium is to breathe in tiny particles. My meditation at the Capitol each day focused on the silent suffering delivered by plutonium particles wafting on the breeze. To fast was to wake up. No more politics of begging for favors.

The public was invited to join the fast – for the sixty minutes of silent meditation at the start of each day, or for a couple of hours or for several days, for conversation, or for silence. People came, some days a few, some days hundreds. On the sixth day of the fast one of Romer's aides said the governor had received hundreds of letters urging him to get Rocky Flats shut down.

But all was not well. One day the governor came out on the Capitol lawn to talk with a large group participating in the fast, and some were hostile. We want him to do the right thing, I thought, but we make it hard for him to hear us, much less heed us. We have a long way to go.

My sign-up book has names from 13 countries and 48 states. Many asked how I got involved with Rocky Flats. In 1974 I arrived in Colorado to teach at the University of Denver. I was not aware of Rocky Flats. But I was concerned that human life on this planet could end due to three fundamental threats of our own making: first, nuclear holocaust; second, ecological disaster; and third, authoritarian and secretive governance. I learned about Rocky Flats in 1978 when people occupied the railroad tracks leading into the plant. I saw immediately that Rocky Flats combined in a concentrated way all three threats to our existence. At this point my life changed forever. I left the academic world and joined people on the tracks in my first act of civil disobedience. From this moment I have devoted myself to stopping Rocky Flats.

The fast was in the papers almost every day. But most persistent was my being asked most mornings to talk on the phone with a radio broadcaster who addressed an audience of commuters in their cars. Besides asking about Rocky Flats, he wanted me to badmouth Governor Romer, but I refused.

When we met with the governor soon after the FBI raid he took great pride in telling us that he and Secretary of Energy James Watkins were about to establish a dose reconstruction study to see how the health of people in off-site areas had been affected by Rocky Flats. The first of three op-eds I published while fasting applauded this move. Only later did I realize that dose reconstruction studies are rarely of any help to the affected public. The study done for Rocky Flats was in fact an expensive diversion that sidestepped the medical monitoring of individuals that should have occurred and did not. To this day there has never been a public study of the specific health of off-site individuals affected by Rocky Flats.

The fast acknowledged that we are responsible for the fate of the generations coming after us. The contamination at Rocky Flats gives rise to a great deal of scientific uncertainty. This calls for caution. The DOE, EPA and Colorado Health call the "cleanup" "risk-based." This means there is a risk. Therefore, to call the site "safe" is wrong. We the people possess the moral authority to deal with Rocky Flats in a much more comprehensive way. It is folly to depend on someone else. The failed "cleanup" is a reminder of this folly.

As for my health, on every day of the fast a physician, the late Paul Klite, checked my health, led me in physical exercises and reported on my condition to Barbara Engel, my partner. Others, too many to mention, helped in various ways. Over the 24 days of having only water and a bit of salt, I never craved food, lost some weight, but in truth never felt better.

The Buddhist monk Sawada Shonin belongs to an order created in Japan after World War II to oppose nuclear weapons. It placed their monks at nuclear weapons production sites in various countries. Sawada was assigned to Rocky Flats. He was traveling when my fast began. I invited him to join the fast when he returned. One afternoon as I sat on the Capitol lawn I saw a distant figure in saffron beating a drum, chanting and marching toward me. It was Sawada. Three days later he proposed that I end my portion of the fast and let him continue it until August 9.

So, on the 24th day I broke my fast and passed to Sawada the responsibility of finishing it 11 days later, on August 9. He was not alone. Forty-five others, most of them local, continued the fast, some for a short time, some till August 9. Thus ended the fast of solidarity with all who suffer because of Rocky Flats. Although the fast ended, the suffering continues.

Appendix D
Fire in 2003, Unknown to the Public

Twice in the month of May 2003 I and about 20 participants in the Rocky Flats Cleanup Agreement (RFCA) Focus Group met with officers of the DOE, EPA and CDPHE to discuss the cleanup underway at Rocky Flats. Those from the Focus Group were highly engaged in issues related to Rocky Flats. We met in Broomfield, maybe five miles from the eastern edge of the Rocky Flats site. Each meeting lasted 2 to 3 hours.

One day that May 2003 a fire broke out in Building 371, the newest, largest, most expensive of the plutonium processing buildings at Rocky Flats. Also, all the plutonium to be shipped off site before the cleanup was finished was stored in 371. Early one day Randy Sullivan, captain of the Rocky Flats Fire Department, suddenly received a radio message that there was a fire in Building 371. Randy knows it has to be a plutonium fire. This is bad news. He soon is in the fire truck that stops in front of the building from which workers are rushing out.

The fire is several stories down, well underground. The air is full of smoke and debris. It is difficult to see. Randy realizes many workers are still in the vicinity of the fire, which he cannot see. Visibility was about 6 inches. Finally he can see the fire at the back of a glovebox. He stays in the building until he's sure the fire is out. Then he leaves and heads for those responsible for decontamination, only to learn that he's so exposed he'll have to be taken to the on-site medical center.

Despite the seriousness of this fire, not a word was said about it to members of the Focus Group by personnel from DOE, EPA and CDPHE. I learned about the fire from reading a draft of Kristen Iversen's new book, *Full Body Burden: Growing Up in the Nuclear Shadow of Rocky Flats*, N.Y.: Crown Publishers, 2012, pp. 289-298.

Appendix E
Superfund and Rocky Flats

Rocky Flats was cleaned for the specific land use of a wildlife refuge. The preference for limiting cleanup to a particular land use seems a far cry from the intent of the original legislation. The initial impetus for Superfund was Love Canal, New York, where contamination from a former industrial site found its way into a school yard and the basements of houses. Hooker Chemical and Plastics Corporation had deeded land to the local school board with a clause stipulating that the site had chemical waste, and the company was assured that no construction would occur where waste had been dumped. But after a few years a school was built on the site and residences were constructed nearby. This striking failure of land use controls provided the impetus for creating the Superfund law.

The original Superfund legislation indicated a clear preference for cleanups that "permanently and significantly reduce the volume, toxicity or mobility of the hazardous substances." To implement the law, EPA, however, had to develop guidelines, primarily the National Oil and Hazardous Substance Contingency Plan (NCP). Along the way, EPA came under intense pressure from polluters, entities of the federal government, and economic development interests to make cleanup guidelines more lax. While the original law referred to cost effectiveness, this concept certainly was not the heart of the law. Yet, in the process of developing guidelines, the closely related concept of cleanup for "reasonably anticipated future use" evolved and took hold. Hence, the cleanup at Rocky Flats, a radioactively polluted site, was guided in large part by a ten page EPA guidance to staff document (OSWER Directive No. 9355.7-04 , Land Use in the CERCLA Remedy Selection Process), drafted in 1995, not subject to any type of public approval.

EPA runs a program known as "Brownfields" which essentially promotes the industrial reuse of contaminated industrial sites. These sites require less cleanup and therefore cleanup that costs less than a cleanup designed to protect a potential resident of the site. This program tends to promote the economic value of the sites, as opposed to emphasizing the health-threatening condition of the sites. It is possible that wildlife refuges will become the Brownfields of large federal facilities.

While in practice Superfund has morphed from a law favoring thorough cleanup to one favoring limited cleanup based on site use, the agencies at Rocky Flats were not required to base plutonium cleanup on the wildlife refuge worker designation. They chose to base their calculations on this designation. Both CDPHE regulations and the Nuclear Regulatory Commission's Decommissioning Rule that apply at Rocky Flats express preference for unrestricted-use cleanups rather than the restricted cleanup happening at Rocky Flats (restricted to a wildlife refuge). Cleaning the site to protect a resident subsistence farmer, as recommended by the Rocky Mountain Peace and Justice Center, would have fulfilled this preference as well as met the original intent of Superfund law.

Appendix F
Plutonium from Rocky Flats to Texas

In January 2018 this link caught my eye: http://www.theirminesourstories.org/?p=671 If you open it you will find a brief article about Asarco's poor environmental practices. Reading the article, suddenly this passage stood out:

> "In the early 1990's, with copper prices falling and many plants shuttered, Asarco contracted with the Department of Defense to accept hazardous waste at its subsidiary, Encycle, in Corpus Christi, Texas. The waste came from DOD facilities at the Rocky Mountain Arsenal and Rocky Flats in Colorado and Tooele, Utah, among others, where napalm, saarin nerve gas, cluster bombs, plutonium and white phosphorous had been produced."

The early 1990s at Rocky Flats would be the period after the FBI raid and the beginning of the "cleanup." The passage says that plutonium "had been produced." This is a mistake; plutonium was processed at Rocky Flats, not produced. The statement suggests that plutonium was sent from Rocky Flats to Encycle, an Asarco subsidiary in Corpus Christi, Texas. This was never publicly revealed by DOE or any of its corporate contractors. Why was this hidden? What else do we not know?