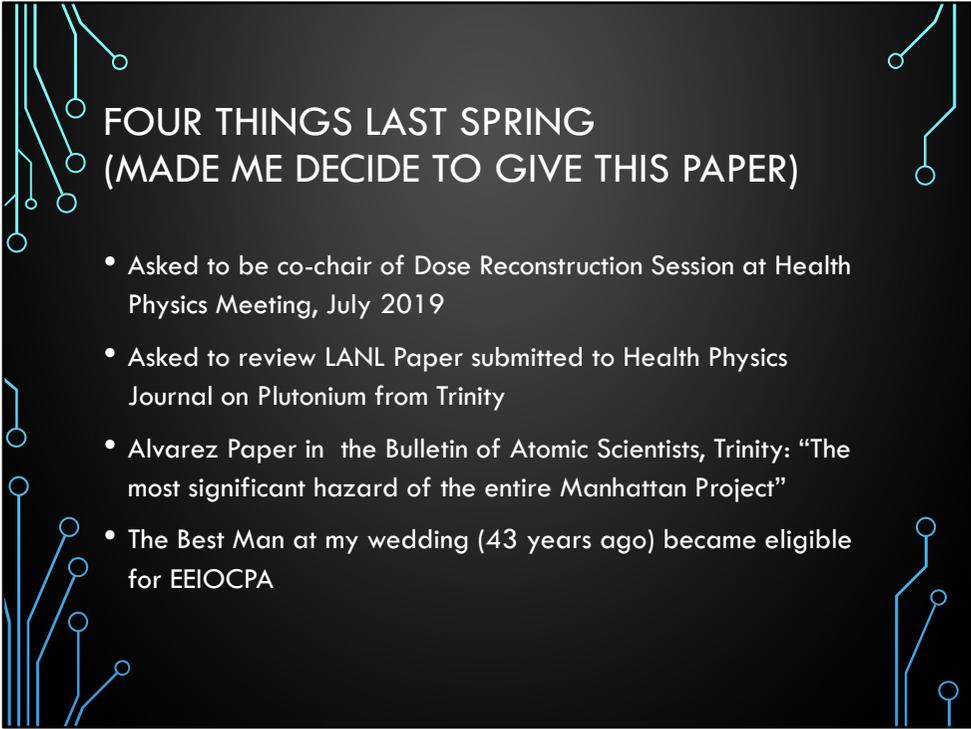


The Trinity test in 1945 was similar to what might occur with a dirty bomb. A small fraction of the plutonium was used in the explosion. The device was detonated at low altitude, on a 100-foot steel tower. As a result, the fireball contacted the soil. Because of the low altitude, fallout exhibited a “skip distance” with little fallout near the test site. Although there were plans for evacuation, radio communication was lost as the survey teams traveled out to follow the overhead plume. Thus, the command center was unsure whether the criteria had been met (15R/hr; 75R/2 weeks) and failed to order the evacuation. The population in New Mexico was ten times closer than those downwind from the NTS. Cattle on the Chupadera Mesa received 20,000 R skin exposure from the fallout. Potential doses to downwinders will be summarized, along with one person’s personal experience.

The author worked on the Los Alamos Historical Document Retrieval and Assessment Project (LAHDRA) was conducted by the Centers for Disease Control and Prevention (CDC). The final report was issued in 2010 after a 10 year review of LANL records dealing with releases of radioactive or toxic materials and is available at: (<https://wwwn.cdc.gov/LAHDRA/>).

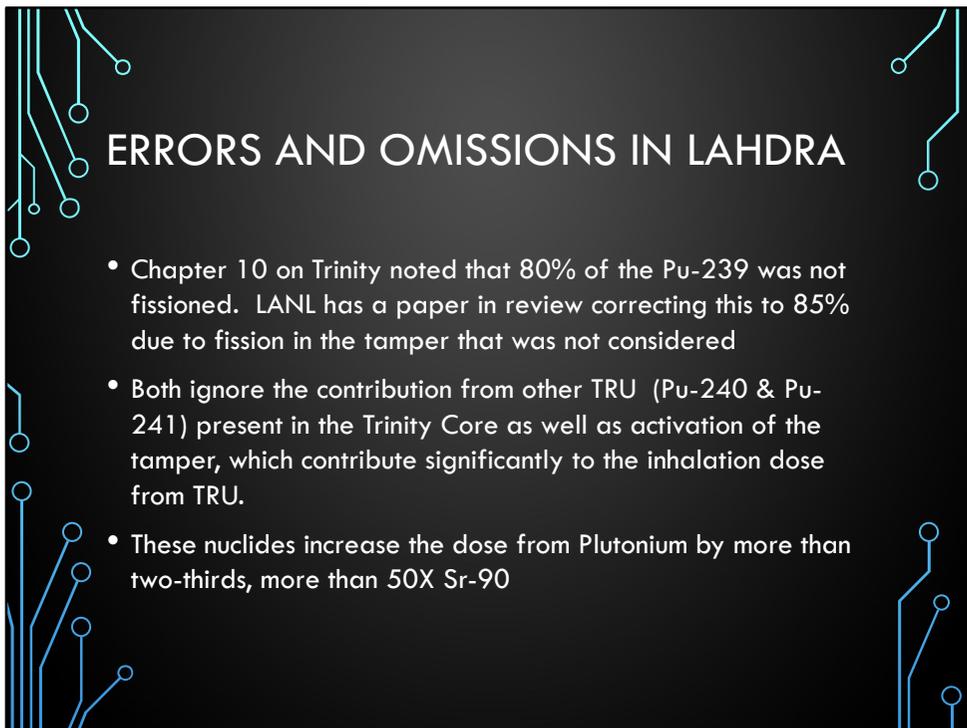
The actual historical documents are also available in pdf format elsewhere on the CDC website and hard copies with a searchable database were provided to the University of New Mexico Library in Albuquerque, NM.



FOUR THINGS LAST SPRING (MADE ME DECIDE TO GIVE THIS PAPER)

- Asked to be co-chair of Dose Reconstruction Session at Health Physics Meeting, July 2019
- Asked to review LANL Paper submitted to Health Physics Journal on Plutonium from Trinity
- Alvarez Paper in the Bulletin of Atomic Scientists, Trinity: “The most significant hazard of the entire Manhattan Project”
- The Best Man at my wedding (43 years ago) became eligible for EEIOCPA

These will be discussed in the next few slides.



ERRORS AND OMISSIONS IN LAHDRA

- Chapter 10 on Trinity noted that 80% of the Pu-239 was not fissioned. LANL has a paper in review correcting this to 85% due to fission in the tamper that was not considered
- Both ignore the contribution from other TRU (Pu-240 & Pu-241) present in the Trinity Core as well as activation of the tamper, which contribute significantly to the inhalation dose from TRU.
- These nuclides increase the dose from Plutonium by more than two-thirds, more than 50X Sr-90

In the 1977 book, *The Effects of Nuclear Weapons* (available as a download at: <https://www.osti.gov/biblio/6852629-effects-nuclear-weapons-third-edition>) page 407, paragraph 9.43 notes that:

“At one time it was suggested that the explosion of a sufficiently large number of nuclear weapons might result in such an extensive distribution of the plutonium as to represent a worldwide hazard. It is now realized that the fission products—the radioisotope strontium-90 in particular—are a more serious hazard than plutonium is likely to be. Further, any steps taken to minimize the danger from fission products, which are much easier to detect, will automatically reduce the hazard from the plutonium.”

While true for modern weapons, the Trinity type solid pit released far more plutonium than newer weapons which use a hollow pit. When this statement is incorrectly applied to Trinity, it lends itself to a false narrative. Five of the first six atomic bombs were solid pit, and three of those were exploded near the earth surface or under water. A solid pit was never used again. Trinity (July 16, 1945, Alamogordo, New Mexico) the Baker shot (July 25, 1946, Bikini Atoll) and Joe-1 (Aug. 29, 1949, Semipalatinsk Test Site, Kazakhstan) all experienced significant plutonium releases that were unappreciated beforehand.

When one considers the other transuranic nuclides such as Pu-240 and Pu-241 from both the pit itself as well as activation of transuranics in both the pit and tamper, the inhalation dose from plutonium is more than 50 times greater than strontium-90.

TUCKER AND ALVAREZ PAPER

- Alvarez and Tucker worked in Hazel O'Leary's (DOE Secretary) office in the 1990's on the Human Radiation Experiments Initiative
- Tucker was intrigued by correspondence from the 1940s in which NM based doctors inquired whether a spike of infant mortality following Trinity could be related to the fallout
- The response from the Manhattan Engineering District was "no", however the data from NM was not requested till months later
- LAHDRA never encountered these documents!

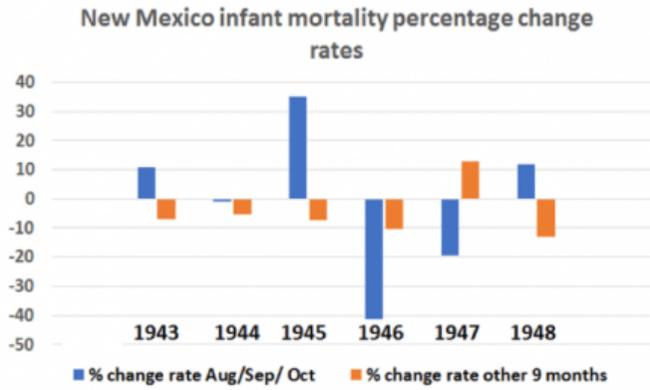
This publication is available at: <https://thebulletin.org/2019/07/trinity-the-most-significant-hazard-of-the-entire-manhattan-project/>

If the shocking assertions in this paper are confirmed, infants died as a result of the Trinity test. Infant mortality has steadily declined with advances in medical care over the years. Tucker and Alvarez show an apparent 3 to 4 fold increase in infant mortality in the 3 months following Trinity, as shown in the next slide taken from their work.

Narratives about the effects of Trinity on downwinders are often minimized. If this is confirmed, this clearly demonstrates that many elements of that narrative are false.

I was a team member of the Los Alamos Document Retrieval and Assessment Project (LAHDRA) which reviewed and coordinated declassification and public release of many LANL documents dealing with chemical and radioactive material releases from LANL that lead to offsite consequences. During the course of that project, files from the Legal Department were reviewed by title only, because of concerns by the University of California that information unrelated to releases might be released that was privileged and confidential for the University. If the documents located by Tucker and Alvarez (released by DOE during the Human Radiation Experiments project during the 1990s) are located in the LANL Legal files, this raises concerns that other information might have been missed as well.

ALVAREZ PAPER



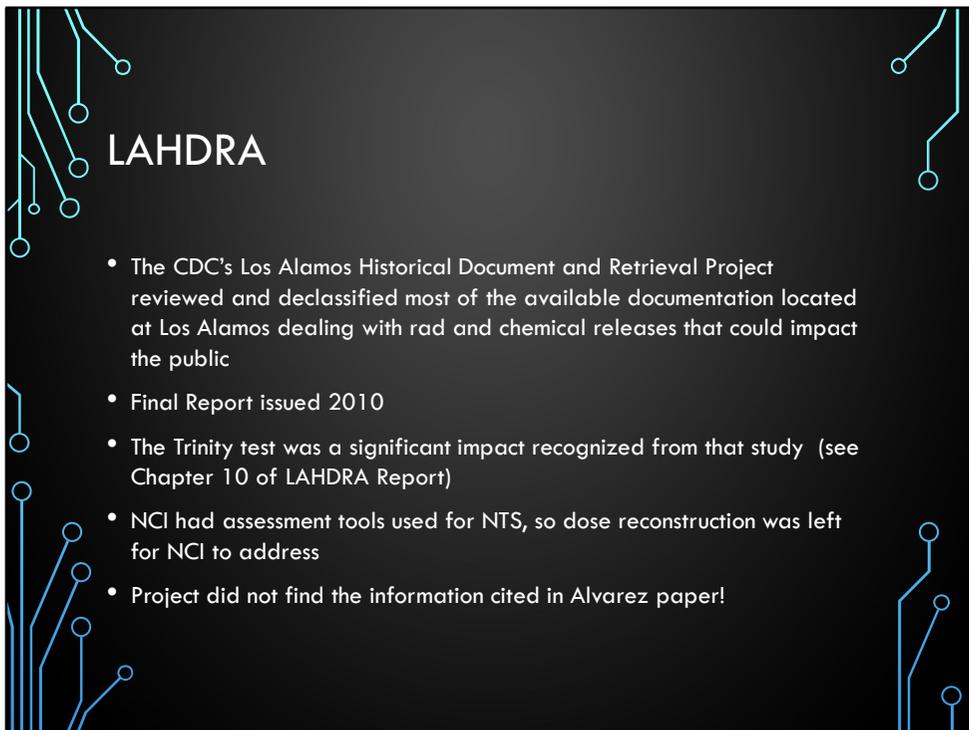
Source: New Mexico Department of Health, Bureau of Vital Records and Health Statistics

Note the increase in Blue in 1945, followed by declines in subsequent years.

EEOICPA (AND MY BEST MAN)

- Compensation of \$150,000 and payment of medical expenses from the date a claim is filed is available to:
 - Employees of the Department of Energy (DOE), its contractors or subcontractors, and atomic weapons employers with radiation-induced cancer if:
 - the employee developed cancer after working at a covered facility of the Department of Energy, its contractors and subcontractors; and
 - *the employee's cancer is determined at least as likely as not* related to that employment in accordance with guidelines issued by the Department of Health and Human Services, or
 - the employee is determined to be a member of the Special Exposure Cohort (SEC)....

This slide summarizes the requirements and benefits to workers who are covered under The Energy Employees Occupational Illness Compensation Program Act (*EEOICPA*).

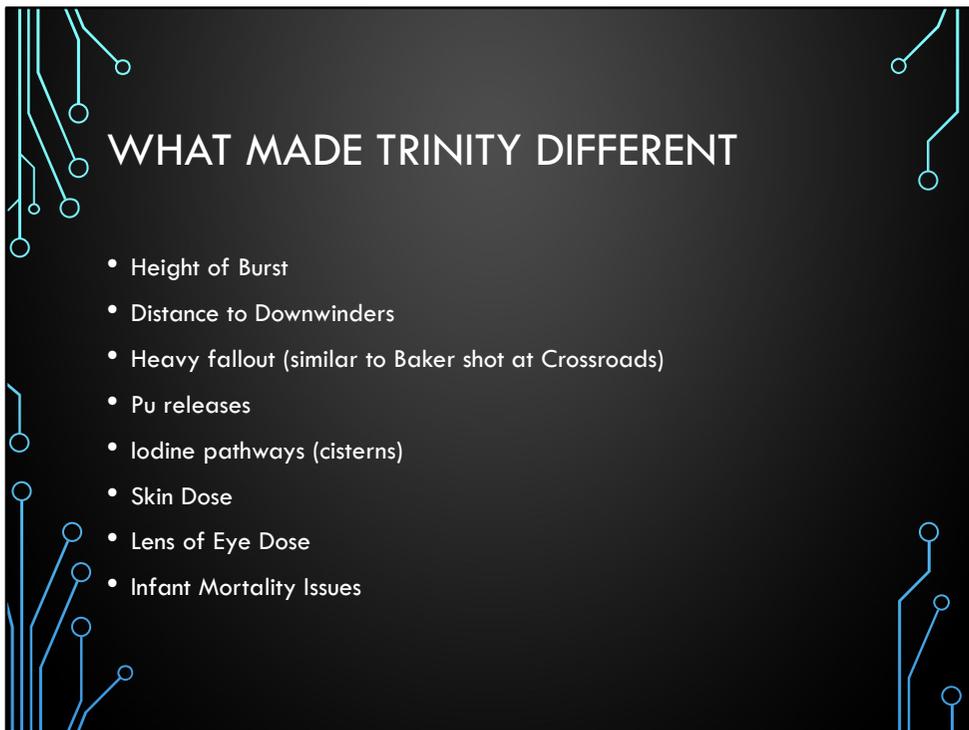
The slide features a black background with light blue circuit-like lines and nodes. The title 'LAHDRA' is positioned at the top left. A bulleted list of five items is centered on the slide.

LAHDRA

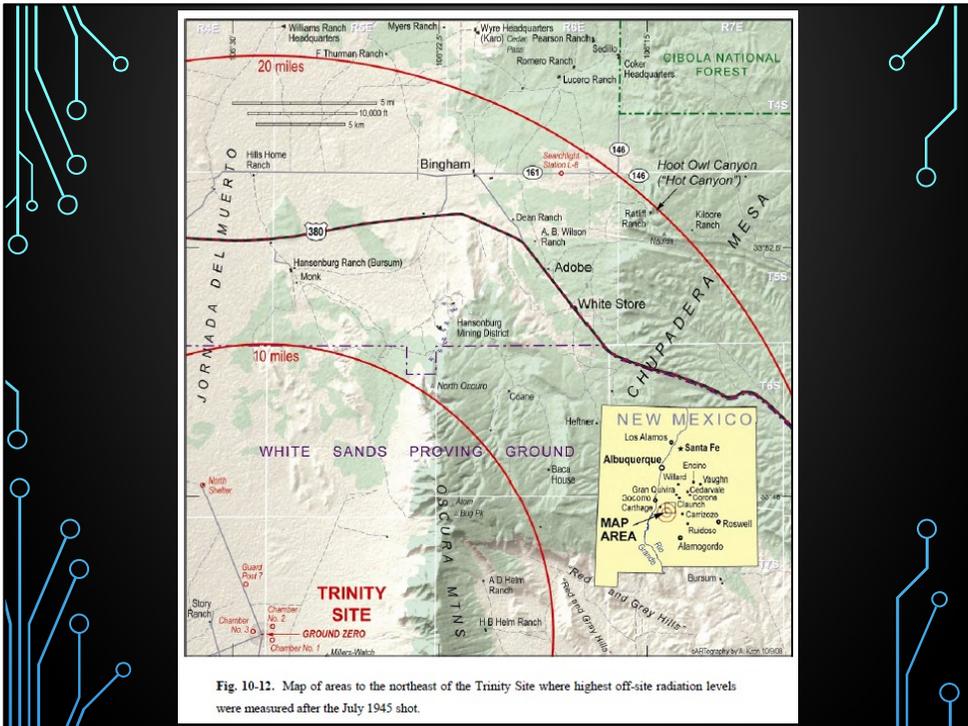
- The CDC's Los Alamos Historical Document and Retrieval Project reviewed and declassified most of the available documentation located at Los Alamos dealing with rad and chemical releases that could impact the public
- Final Report issued 2010
- The Trinity test was a significant impact recognized from that study (see Chapter 10 of LAHDRA Report)
- NCI had assessment tools used for NTS, so dose reconstruction was left for NCI to address
- Project did not find the information cited in Alvarez paper!

The Los Alamos Historical Document Retrieval and Assessment Project (LAHDRA) was conducted by the Centers for Disease Control and Prevention (CDC). The final report was issued in 2010 after a 10 year review of LANL records dealing with releases of radioactive or toxic materials and is available at: (<https://wwwn.cdc.gov/LAHDRA/>).

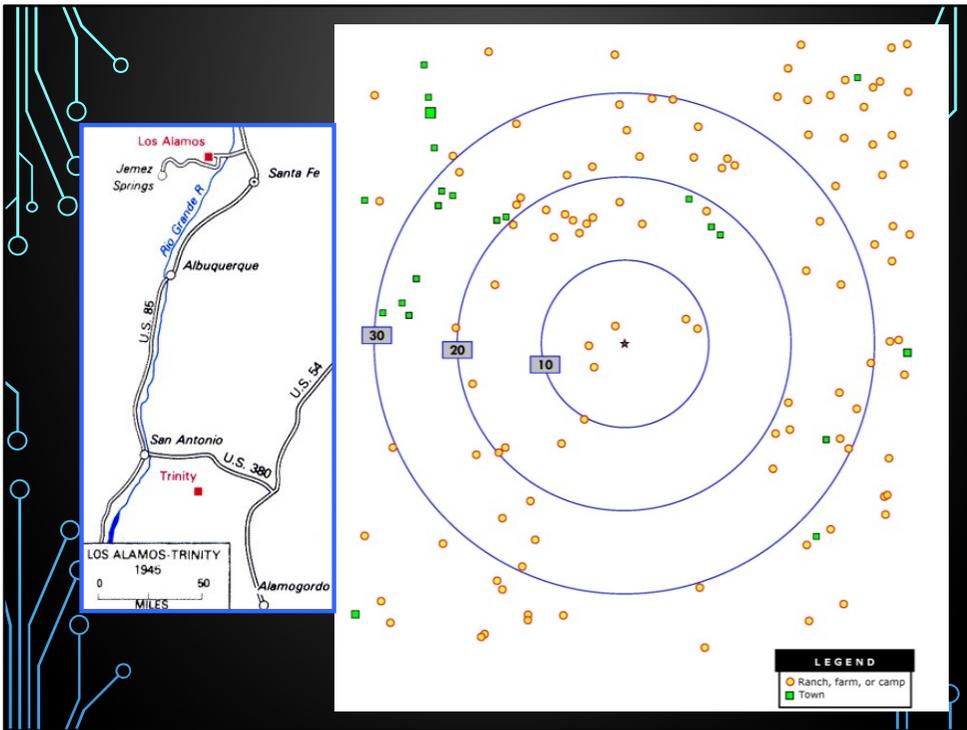
The actual historical documents are also available in pdf format elsewhere on the CDC website and hard copies with a searchable database were provided to the University of New Mexico Library in Albuquerque, NM.



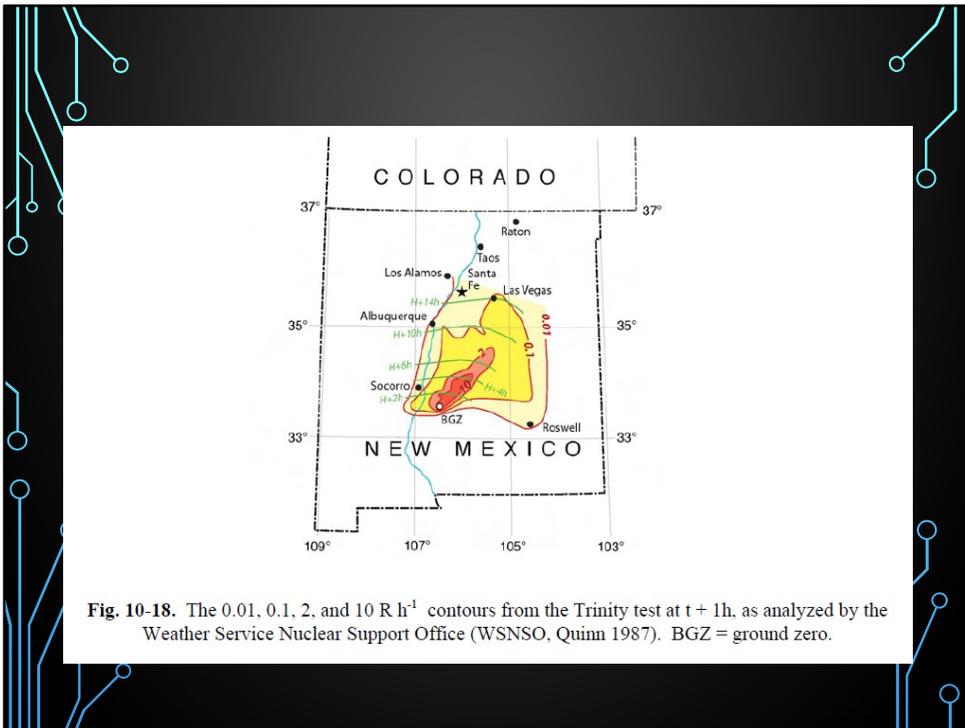
A discussion of these points can be found in Chapter 10 of the LAHDRA Final Report (2010) and are further discussed in the following slides.



This image taken from the LAHDRA report shows the test site for Trinity, along with 10 and 20 mile radii to the Northeast, the predominant direction of travel for early fallout. The towns of Bingham, Adobe and White Store lie between 10 and 20 miles from ground zero. Also shown on the map is the location of the Searchlight 8 Team, who were monitoring fallout in the area (see LAHDRA report for more information.)



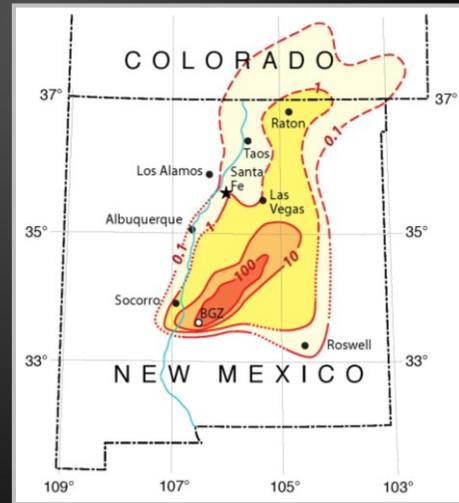
This figure is also taken from the LAHDRA report and shows towns as well as ranches, farms and camps out to over 30 miles from ground zero. The information was taken from USGS maps, and does not include all ranches and camps. As discussed in the LAHDRA report, Los Alamos was surprised the day after the test to find the Ratliff family in the area that came to be known as “hot canyon” a play on words from the name “Hoot Owl” Canyon. About 4 towns and 50 ranches or farms are located in the area to the northeast, where the highest levels of fallout occurred.



This fallout map is also taken from the LAHDRA report and shows data prepared by the WSNSO as reported by Quinn in 1987. At one hour after the test, dose rates down wind exceeded 10 R/hr. The effects of nuclear weapons characterizes this as early fallout. The downwinders from the Nevada Test Site in Utah who were compensated for their exposure to fallout with the 1990 Radiation Exposure Compensation Act (RECA) did not encounter early fallout. While there is no clear distinction between early and delayed fallout, 24 hours is often used to separate effects of fallout. The LAHDRA Report summarizes LANL estimates of exposure following Trinity and include an estimate of 140 R to downwinders from early fallout. This is external gamma radiation only, and does not include beta radiation exposure or internal exposure from inhalation or ingestion of radioactive material.

FALLOUT FROM THE TRINITY TEST

- Mapped based on field measurements
- Limited by primitive nature of portable instruments
- Measured across the country (Kodak had film darkened when Trinity fallout was incorporated into cardboard for boxes)
- Unfissioned Pu was not well measured until years later



mR/h at t + 12 h

Based on Cederwall and Petersen 1990

Fallout from the Trinity Test has been plotted to a certain extent based on the field measurements made by the 5 monitoring teams, but it has not been studied to the extent done for later tests done at the Nevada Test Site.

The figure here shows the Trinity fallout pattern as exposure rate, (in milliRoentgens per hour at t + 12 hours) based on Weather Service Nuclear Support Office analysis reported by Quinn in 1987 and extended with Livermore Lab modeling as reported by Cederwall and Peterson in 1990. The data presented lacks fine structure one would expect from elevation changes in terrain.

But these representations are limited by the primitive nature of the portable instruments that were available at the time. The measurements were also limited by the large area to be monitored and conditions, including gravel roads that were used to access locations within the area.

And it has been noted that the monitoring that was conducted in the days after the Trinity blast did not measure the unused plutonium that was deposited in the environment.

We know that fallout was measured across the country— it was found in cardboard used by Kodak after they observed spotting on their film and traced it back to contamination in cardboard caused by an Indiana paper mill's use of river water that had been contaminated by the Trinity fallout.

THE RATE OF DECAY OF FISSION PRODUCTS
K. WAY AND E. P. WIGNER
PHYS. REV. 73, 1318 – PUBLISHED 1 JUNE 1948

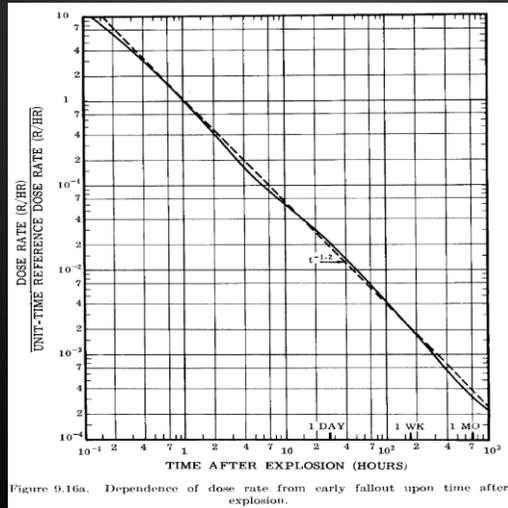
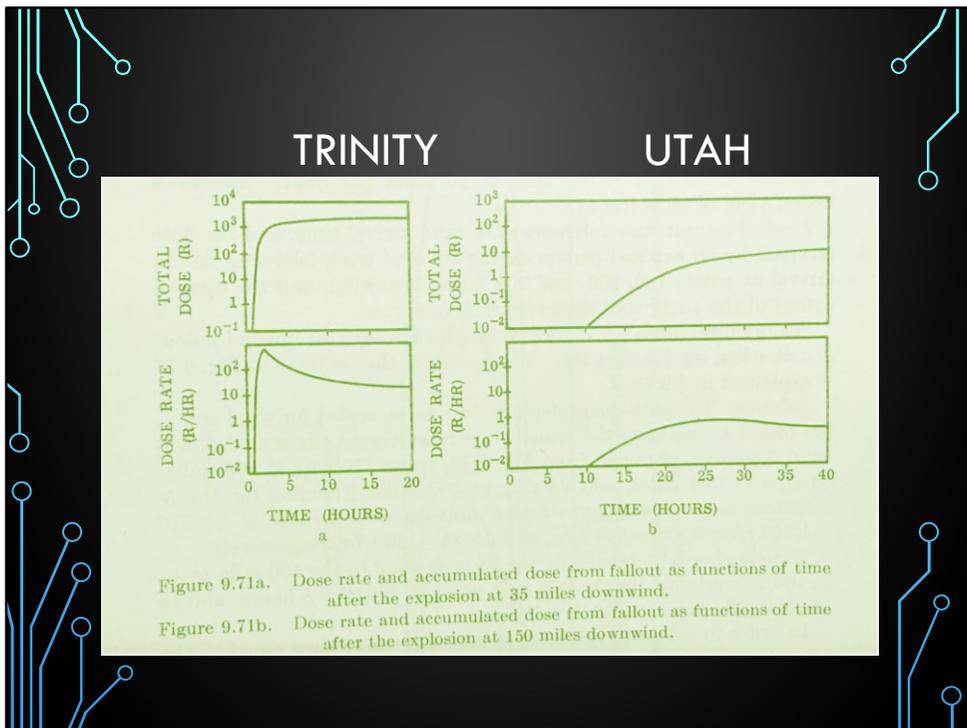


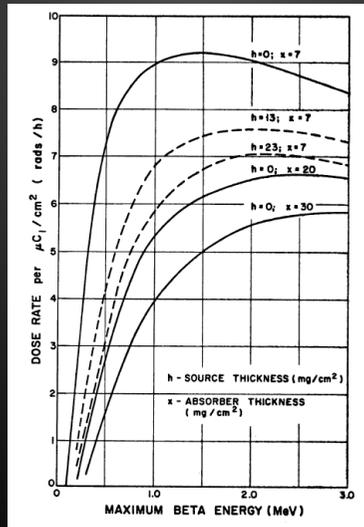
Figure 9.16a. Dependence of dose rate from early fallout upon time after explosion.

This graph is from *The Effects of Nuclear Weapons*, and shows the famous Way-Wigner power rule that radioactive material and radiation exhibit from fallout. The rule is often stated simply that radiation levels drop by a factor of ten for every factor of seven in time. Thus, the one hour dose rate shown in an earlier figure would be down by a factor of 10 in 7 hours, and down by a factor of 100 in 49 hours (roughly 2 days) and down by a factor of 1,000 in a little over 2 weeks. In 1945 and 1946, this was not completely understood. Sailors participating in Operation Crossroads at Bikini in 1946 incorrectly believed that their efforts to decontaminate the ships after the Baker shot (second in the series) were succeeding. It was just the natural decay of early fission products and not their cleanup. It took 2 weeks to convince Admiral Blandy that the third shot should be cancelled because of the plutonium that was not decaying.



This figure from the Effects of Nuclear Weapons shows the dose rate (lower curves) and total dose (upper curves) from fallout from an atomic bomb at 35 and 150 miles from ground zero. This nearly represents the differences between downwinders at Trinity versus those in Utah from NTS testing. With early fallout, the dose rate rises in an hour and climbs rapidly resulting in a total dose in excess of 100 R. With delayed fallout, the arrival time of the fallout is delayed perhaps to 10 hours or more. The Way-Wigner curve on the previous slide shows rapid decay of early fallout, and the figures above shows dose rates are upwards of 1,000 times lower as is the total dose. Delayed fallout as experienced by Utah downwinders did not significantly contribute to their radiation dose. Utah downwinders dose was dominated by ingested radioactive material, primarily from radioactive iodine from the cow-grass-milk pathway. Trinity downwinders also experienced that, in addition to the gamma radiation whole body exposure from early fallout shown above.

LA-4558-MS (J. W. HEALY, 1971) SURFACE CONTAMINATION: DECISION LEVELS



There are easy methods to convert radioactivity per unit surface area to dose rate or dose rate to surface activity. These curves are from a LANL report by Jack Healy and show that for a skin thickness of $7 \text{ mg}/\text{cm}^2$ (areal thickness is the actual thickness times the density) and for various overlying materials like clothing, dose rates of 7 rads per hour from beta radiation occur at surface concentrations of about 1 microcurie per square centimeter.

As reported in the final LAHDRA report, cattle (also described as range cows) received from 4,000 to 50,000 rads that burned their dorsal back. If one assumes one cow received 21,000 rads and uses a conversion factor of 7 rads per hour per microcurie per square centimeter, one obtains a integrated exposure to 3,000 microcuries per square centimeter – hour. Integrating the Way-Wigner curve is used to convert microcuries per square centimeter – hours to microcuries per square centimeter (areal density), as discussed on the next slide.

WHAT DO THE LAST 3 SLIDES MEAN

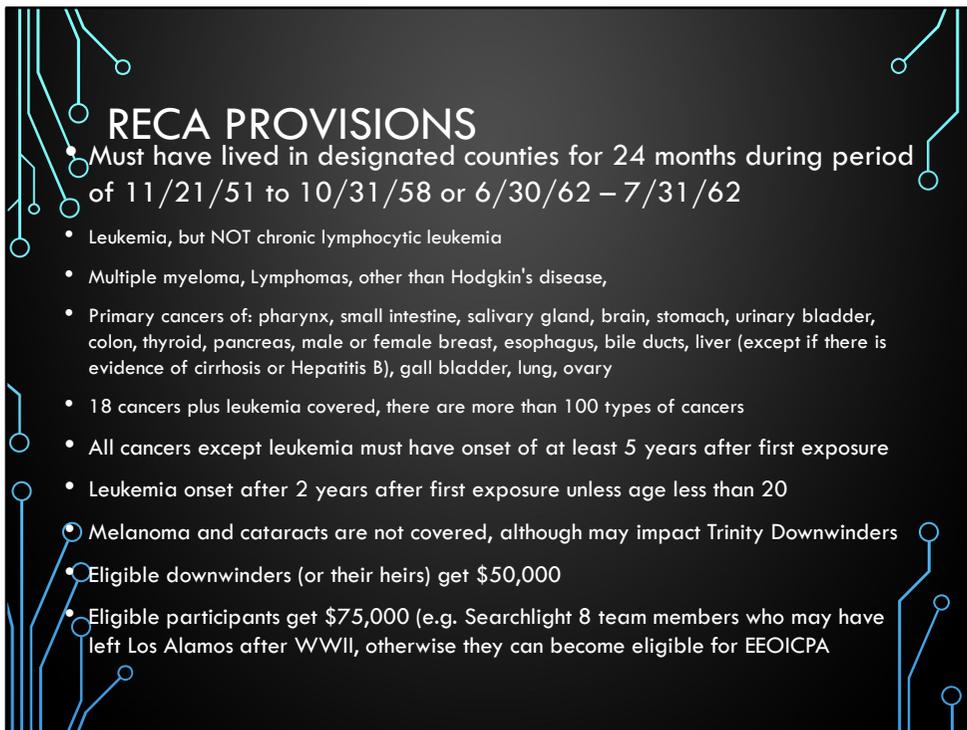
- If one looks at the H+1 dose estimate, and uses Healy's graph of 7 rads/hr per $\mu\text{Ci}/\text{cm}^2$
- Deposition exceeded 10 millicuries per square meter
- This is more than 10,000 times higher than typical US fallout data collected in the 1950s and 1960s
- The cattle Los Alamos bought provide crude measurements of fallout in their pasture
- This is higher than Utah downwinders

The deposition on this slide reflects the average. Civil defense rules from the Effects of Nuclear Weapons indicate the 1 hour dose rate shown on an earlier slide would be equivalent to curies per square meter, which includes the shorter lived fission products.



Fig. 10-20. A system for collection of water off the roof of a residence on the Black Hills Ranch, formerly the Nalda Ranch, east-northeast of the Trinity Site. The cistern to the left, which was damaged by the Trinity blast then repaired, is still in use today.

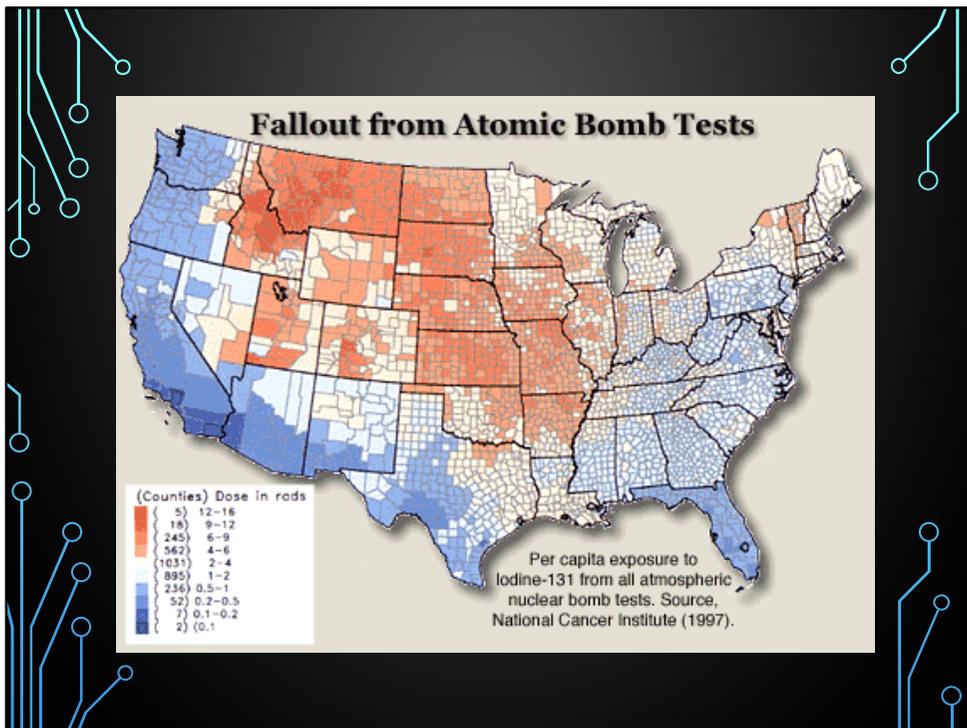
As the photo from the LAHDRA report shows, most rural ranches and farms in southern New Mexico used cisterns for collecting rain water for uses such as drinking and cooking. With a nominal roof area of 100 square meters, fallout depositions of soluble fission products likely exceeded a curie. The soluble components of fallout (such as radioactive iodine) were swept into the cistern and ingested as the cistern water was used. This created unique pathways for exposure to radioactive fallout that were not considered in the case of Utah downwinders from NTS. In addition to the “cow-grass-milk” pathway used for assessing Utah downwinder exposures, a “mom-cistern-milk” pathway provided concentration of iodine in addition to other nuclides in fallout. (Radioactive iodine is used for treatment of thyroid disease because the iodine concentrates in tissues such as the thyroid but also in the breast of lactating mothers, where it can be consumed by infants.) Neither pathway have ever been assessed for Trinity downwinders!



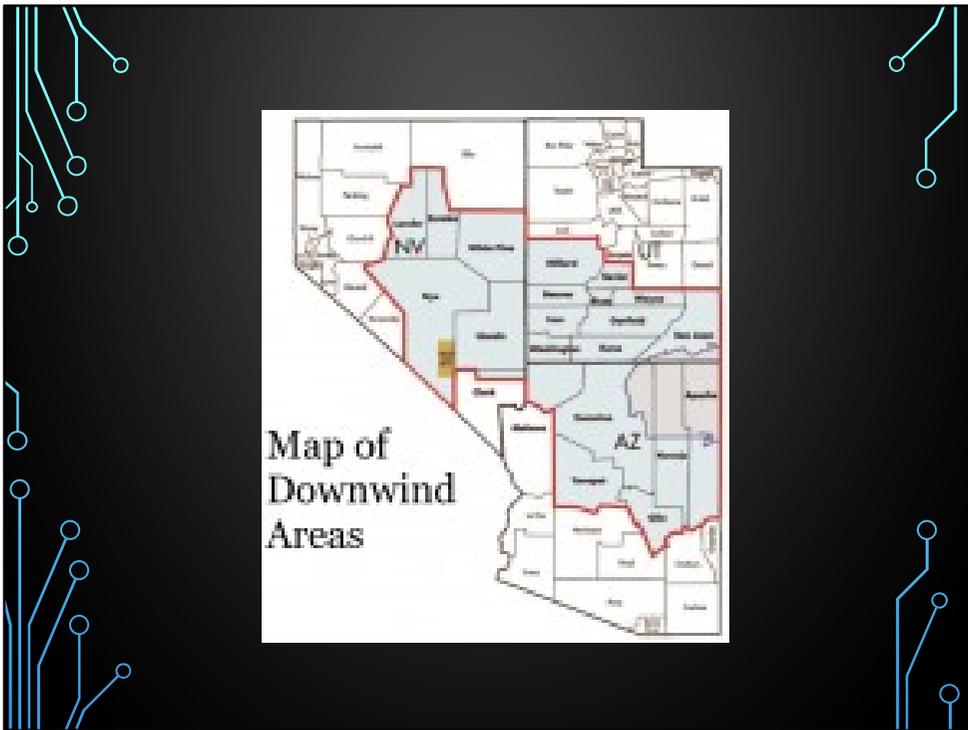
RECA PROVISIONS

- Must have lived in designated counties for 24 months during period of 11/21/51 to 10/31/58 or 6/30/62 – 7/31/62
 - Leukemia, but NOT chronic lymphocytic leukemia
 - Multiple myeloma, Lymphomas, other than Hodgkin's disease,
 - Primary cancers of: pharynx, small intestine, salivary gland, brain, stomach, urinary bladder, colon, thyroid, pancreas, male or female breast, esophagus, bile ducts, liver (except if there is evidence of cirrhosis or Hepatitis B), gall bladder, lung, ovary
 - 18 cancers plus leukemia covered, there are more than 100 types of cancers
 - All cancers except leukemia must have onset of at least 5 years after first exposure
 - Leukemia onset after 2 years after first exposure unless age less than 20
- Melanoma and cataracts are not covered, although may impact Trinity Downwinders
- Eligible downwinders (or their heirs) get \$50,000
- Eligible participants get \$75,000 (e.g. Searchlight 8 team members who may have left Los Alamos after WWII, otherwise they can become eligible for EEOICPA)

This summarizes the RECA act as applied to Utah downwinders. Participants in the Trinity test or the roughly 1,000 visitors (primarily scientists who were involved with the bomb project) received up to 15 R as reported by Maag and Rohrer (The Trinity Project 1945 – 1946, DNA). These individuals (should they have been diagnosed with a radiosensitive cancer) would be eligible for the generous provisions of the EEOICPA discussed earlier.



This shows the NCI study of fallout from what is asserted to be “all atmospheric nuclear bomb tests”. The study depended heavily on US Public Health Service measurements none of which were made in 1945 for Trinity. This continues a false narrative in which exposures to Trinity fallout are ignored.



This shows the areas of Utah and other states where individuals who meet program requirements can receive compensation to help pay for their cancer treatment.

CANCER IN JAPANESE SURVIVORS

Table 1. Number of persons, Cancer Deaths, and Non-cancer Deaths for Different Dose Groups in the Life Span Study

	DS86 Weighted Colon Dose, mSv							
	Total	0-50	50-100	100-200	200-500	500-1,000	1,000-2,000	>2,000
No. Subjects	86,572	37,458	31,650	5,732	6,332	3,299	1,613	488
Cancer Deaths	9,335	3,833	3,277	668	763	438	274	82
Non-cancer Deaths	31,881	13,832	11,633	2,163	2,423	1,161	506	163
Trinity External Dose		YES	YES	YES	YES	YES	YES	NO
UTAH Iodine Dose		YES	NO	NO	NO	NO	NO	NO

This table shows data from the Life Span Study of survivors of the bombings in Japan from 2006 (see https://en.wikipedia.org/wiki/Epidemiology_data_for_low-linear_energy_transfer_radiation). It is often said that the downwinder populations did not receive doses as high as the Japanese survivors. Of the 86,572 survivors who volunteered to participate in a life-long study of health effects, only 488 received radiation doses greater than that of Trinity downwinders. In contrast, the 2005 report of the National Research Council to the US Congress reported that the maximum dose to Utah downwinders would be less than 25 rads to their thyroid. To compare with total body radiation received downwind of Trinity, that value must be multiplied by an organ weighting factor of 0.04, resulting in a risk estimate for Utah downwinders of less than 1 rem reflecting the equivalent risk of a whole body exposure. Exposures above 100 mSv but less than 2,000 mSv were received by about 17,000 Japanese survivors. These individuals are the “gold standard” for radiation protection in that they exhibit observable excess cancers which rise with their dose. It is unfortunate that Trinity downwinders were not studied in a similar manner since their exposures and cancers would add useful information about the effects of radiation to that obtained from Japanese survivors. It is not at all certain that such a study would be possible 75 years after the Trinity test.

COMPARISON OF COMPENSATION PROGRAMS

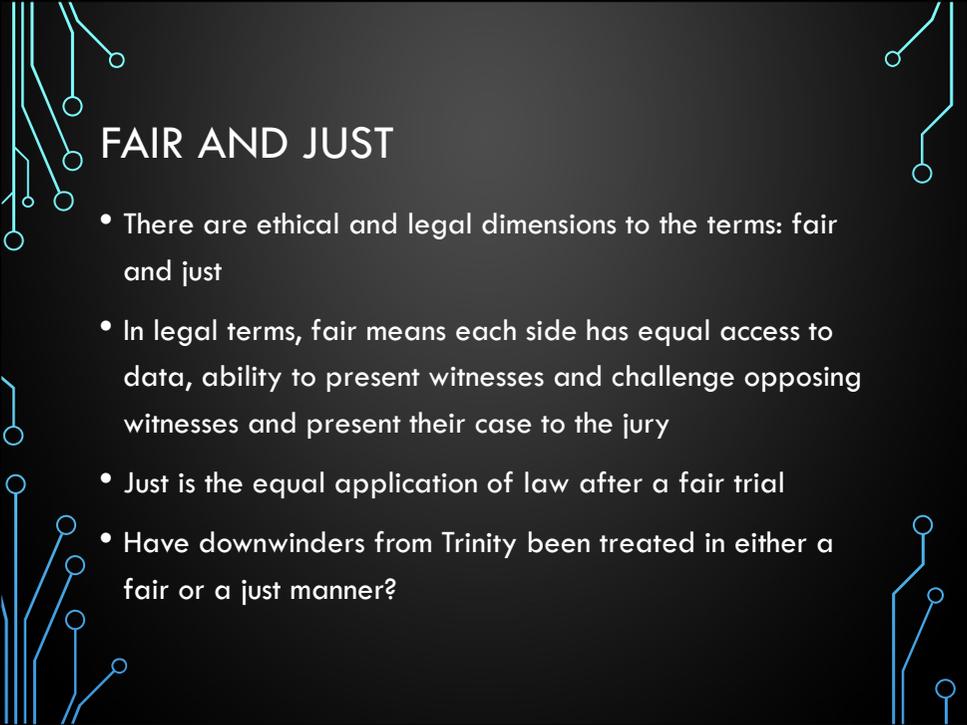
Program	Participants	Cost of Programs	
		Payments	Payments
EEOICPA	122,290	\$11,768,656,689	\$150,000 plus free medical care
Marshall Islands	167	\$2,000,000,000	\$15,000 per year
RECA	34,372	\$2,243,205,380	\$50,000
Trinity	?	\$0	?

This table summarizes the various compensation programs resulting from the US development and testing of nuclear weapons. The data is current as of 2019, and was obtained from internet searches of the programs or other sources.

BARBARA KENT

- One story of many
- Age 14 at Dance Camp near Ruidoso with 12 girls
- When fallout came, girls used it as pancake makeup
- Her hair turned white around face, and her parents allowed her to dye her hair at age 14
- Likely dose to hair follicles between 100 and 500 rads beta plus gamma.

Barbara Kent's story has been told in other venues. The author talked with Barbara about a year ago. This provides another case where downwinder symptoms could, in principle, be used to establish the radiation dose they were exposed to.



FAIR AND JUST

- There are ethical and legal dimensions to the terms: fair and just
- In legal terms, fair means each side has equal access to data, ability to present witnesses and challenge opposing witnesses and present their case to the jury
- Just is the equal application of law after a fair trial
- Have downwinders from Trinity been treated in either a fair or a just manner?

ADVICE TO CONGRESS ON EXPANDING RECA & IMPORTANT DATES

• 2005 National Research Council:

- Assessment of the Scientific Information for the Radiation Exposure Screening and Education Program
 - Chapter 5 used national fallout data and NCI model to argue no addition to impacted counties for compensation was needed
 - Trinity fallout was a decade before the national fallout data programs (1956, 45 stations; 1962, 62 stations for entire US)
 - Pu inhalation was not considered, as well as LAHDRA suggestions of cisterns
 - Infant mortality not considered

• June/2019 Congressional Research Service:

- The Radiation Exposure Compensation Act (RECA): Compensation Related to Exposure to Radiation from Atomic Weapons Testing and Uranium Mining
 - A disability expert concluded because of the 2005 NRC report, no action needed

• Spring, 2020 NCI report on Trinity due to be published

- RECA sunset provision, ends in 2022