General

LIBRARY COPY

Post-Cerro Grande Flood Risk Assessment

13556

Interagency Flood Risk Assessment Team

IFRAT

July 25, 2001

Questions from the Cerro Grande Fire

- Is there an increased risk from flooding after the CGF? If so, what kind of risk?
- What can I do to reduce the risk?
- Is there an increased risk from contaminant runoff from LANL?

What is the IFRAT?

A consortium of state and federal organizations formed to -

- integrate communications among agencies
- provide information on flood-related contamination risks from the Cerro Grande fire

Participating Organizations

- New Mexico Environment Department
- New Mexico Department of Health
- U.S. Department of Energy
- U.S. Environmental Protection Agency
- Los Alamos National Laboratory
- U.S. Forest Service
- U.S. Army Corps of Engineers

IFRAT HISTORY

- Initial planning began just after CGF
- First IFRAT meeting July 7, 2000: Communications, Risk Assessment, Data Collection Subteams formed
- Press Release November 21, 2000
- Public Meeting on December 18, 2000
- Over 20 working meetings to develop risk assessment and recommendations

Cerro Grande Risk Assessment

- Risks from chemicals and radionuclides present in sediment, surface water, ground water from increased runoff due to CGF
- Go through process of risk assessment, then describe results from this risk assessment

Other Assessments Being Conducted

- CDC (acute air exposure)
- ATSDR (acute air exposure)
- RAC
  - Acute air exposure
  - Surface water (flooding)
- San Ildefonso Pueblo Risk Assessment
- Sheet of contacts & websites for other studies and data packages

Assessment Focus

- Residents in canyons draining Cerro Grande Fire area
- Users of Rio Grande and Cochiti Reservoir (fishing, irrigation, recreation)

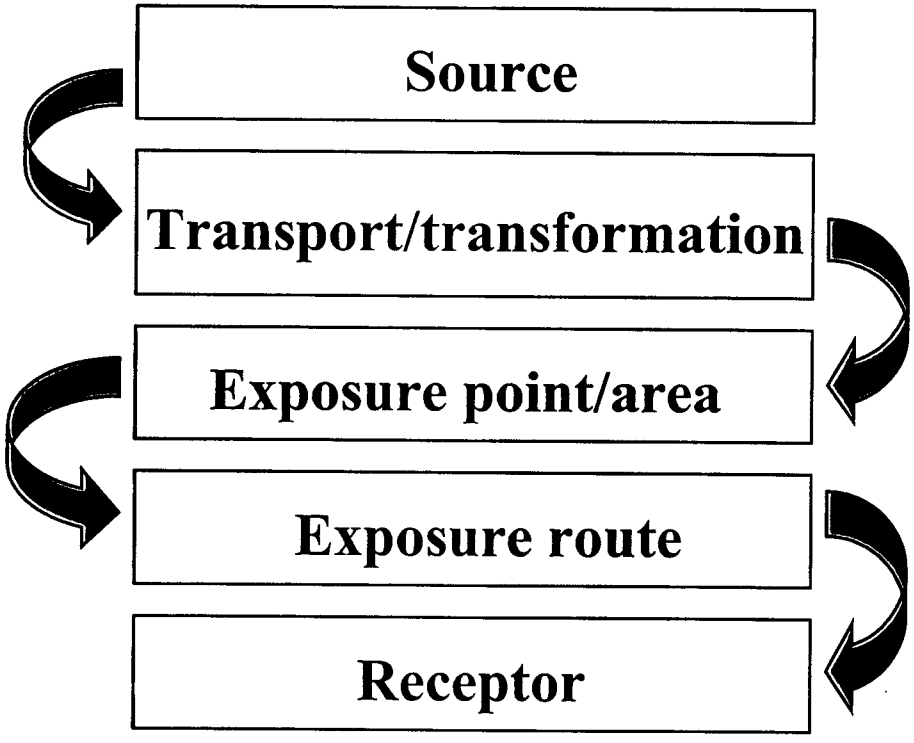
Results Summary

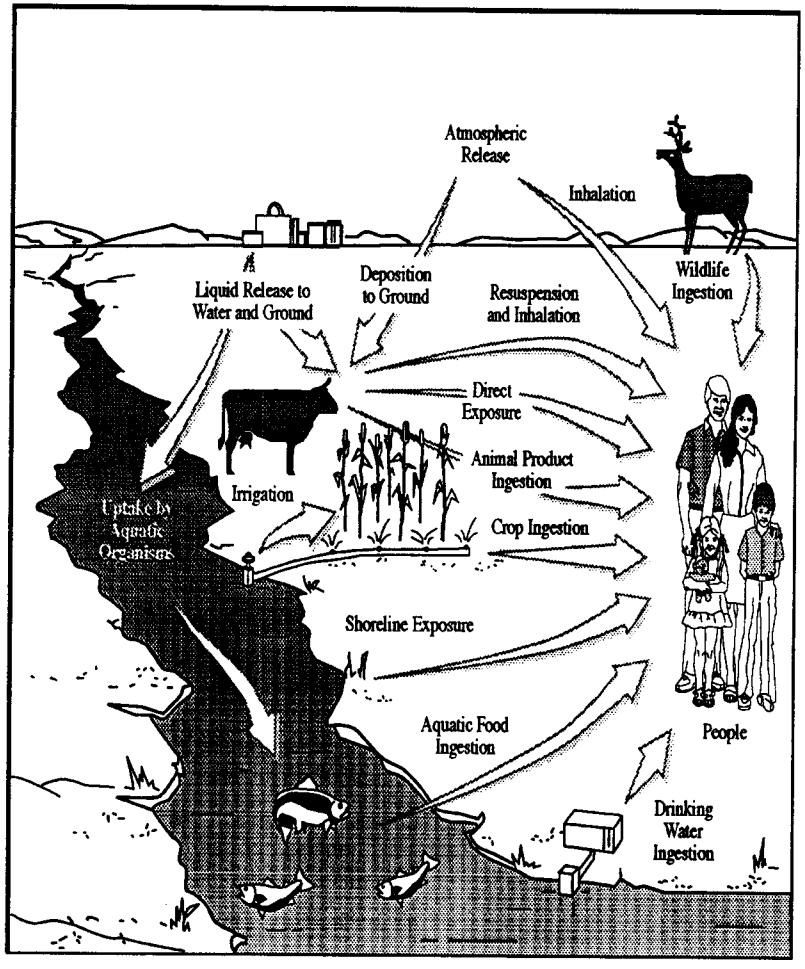
- Sources of concern
- Elevated concentrations of some metals, radionuclides, and organic compounds
- Developed model for assessment
  - Spreadsheet-based
  - Examined canyon resident, river user, lake recreation use
- Little change in overall risk pre- to post-fire

Conceptual Model

- Basis for potential exposure and risk to individuals
- Increased potential for exposure to elevated levels of radionuclides, metals, and organic chemicals
  - Canyons
  - Rio Grande
  - Cochiti Reservoir
  - Downstream
- Potential health risks evaluated for several activities related to use of areas

Conceptual Model





Potential sources of elevated radionuclides, metals, and organic chemicals

- LANL activities (past and present)
- combustion of plant material (global fallout, naturally occurring metals)
- chemicals used to fight the fire
- Los Alamos townsite discharges
- homes and other buildings destroyed by the fire

Potential Transport

- Potentially contaminated media
  - soil/sediment
  - water (surface and groundwater)
  - air (particulates and dust)
- Potential transport mechanisms
  - surface water runoff (stormwater and snowmelt)
  - air deposition
  - leaching

Potential Transport

- Effects of Cerro Grande Fire on migration of material
  - increased potential for runoff (less infiltration)
  - increased potential for erosion from higher flows
  - potential for mobilizing ash, sediments, and other materials that may contain elevated levels of radionuclide, metals, and organic chemicals
  - ash and sediment deposited in lower canyon areas, Rio Grande, Cochiti Reservoir, and locations further downstream (e.g., irrigated fields)
- BMPs installed to inhibit migration of materials (see poster)

Potential Exposure

- Exposure pathways describe how individuals are exposed to water and/or ash/sediment
  - determine potential exposure pathways
  - determine equation for dose for each pathway
  - combine pathways into scenarios such as residential, recreational, or combination depending on individual's activities
- Equation for pathway reflects varying levels of exposure to different receptors (adult and child) to provide range of possible impacts to human health.

Potential exposure pathways

- Drinking groundwater
- Eating crops and livestock
- Eating native plants and wildlife
- inhalation of dust and particulates
- cultural uses of natural resources
- Accidental ingestion of sediment and surface water
- dermal contact with sediment and water
- external irradiation
- consumption of fish from Rio Grande and Cochiti Reservoir

Sampling

- What media were sampled?
  - Ash from burned areas above townsite and from Viveash fire
  - Sediment mixed with varying amounts of ash
  - Stormwater and suspended sediment
  - Shallow alluvial groundwater
  - Rio Grande surface water
  - Cochiti Reservoir surface water
- Poster on sampling

Where were samples collected?

- Canyons above and below Los Alamos National Lab
- Junction of Los Alamos Canyon and Rio Grande River
- Areas along Rio Grande River
- Cochiti Lake
- Maps of locations on poster

What Were Samples Analyzed For?

Type of Samples	Number of Samples	Analyses			
Storm Water	33	√	√	√	√
Surface Water	9	√	√	√	
Ash	21	√	√	√	
Post-Flood Sediment (Muck)	23	√	√	√	√
Alluvial Groundwater	7	√	√	√	
Springs	18	√	√	√	
Fish (Individual and Composite)	15	√	√		

What Were Samples Analyzed For?

[illegible]		Analyses			
Type of Samples	Number of Samples	[illegible]	[illegible]	[illegible]	[illegible]
Storm Water	90	√	√	√	√
Surface Water	120	√	√	√	
Baseline Ash/Muck	21	√	√	√	
Baseline Sediment	130	√	√	√	√
Post-Flood Sediment (Muck)	34	√	√	√	√
Alluvial Groundwater	163	√	√	√	√
Fish (Composite)	36	√	√	√	

Sample Collection

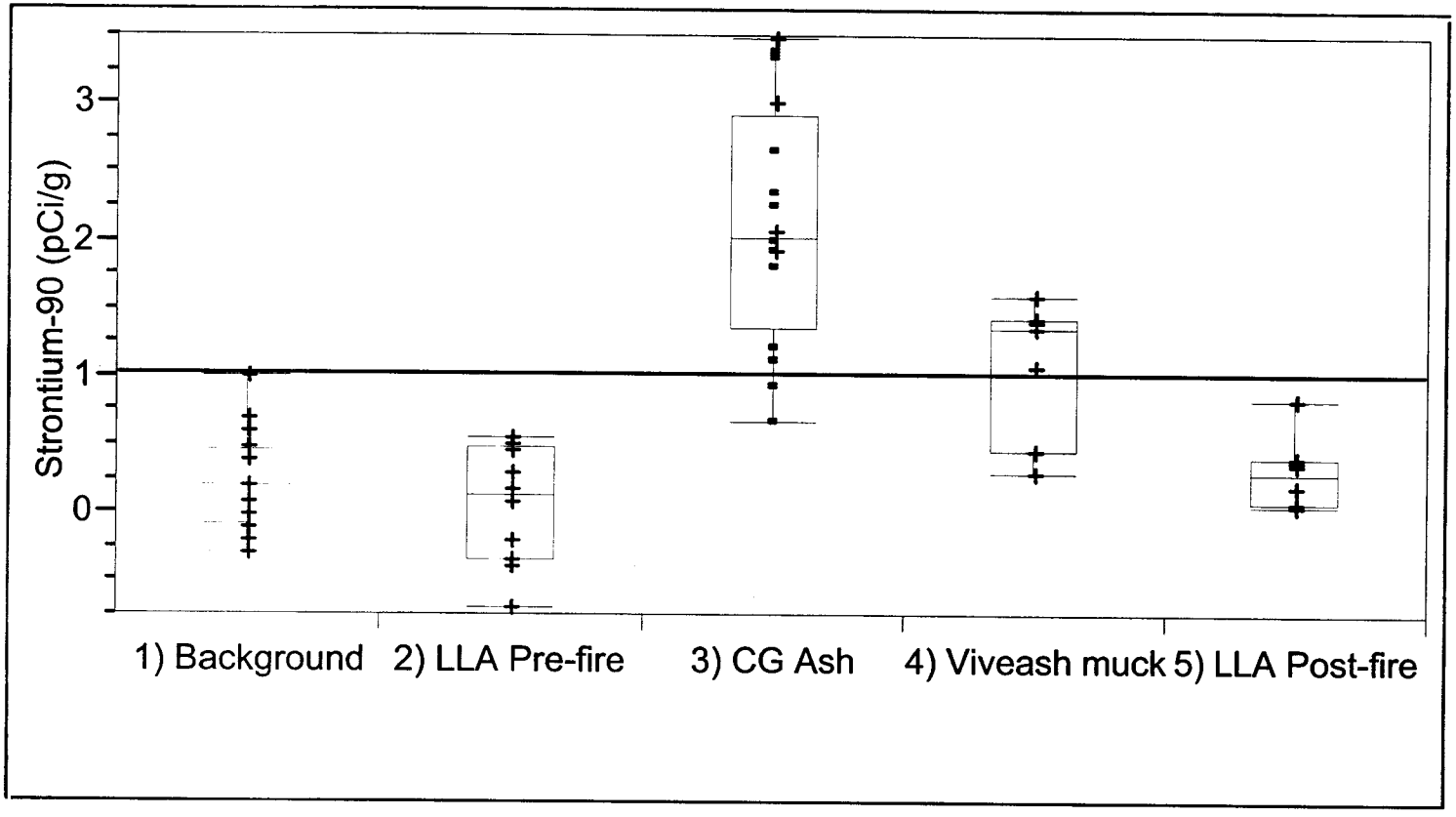
- When were samples collected?
  - June 2000 to March 2001
- Who collected samples?
  - LANL
  - NMED
  - EPA
  - USGS
  - Army Corps of Engineers

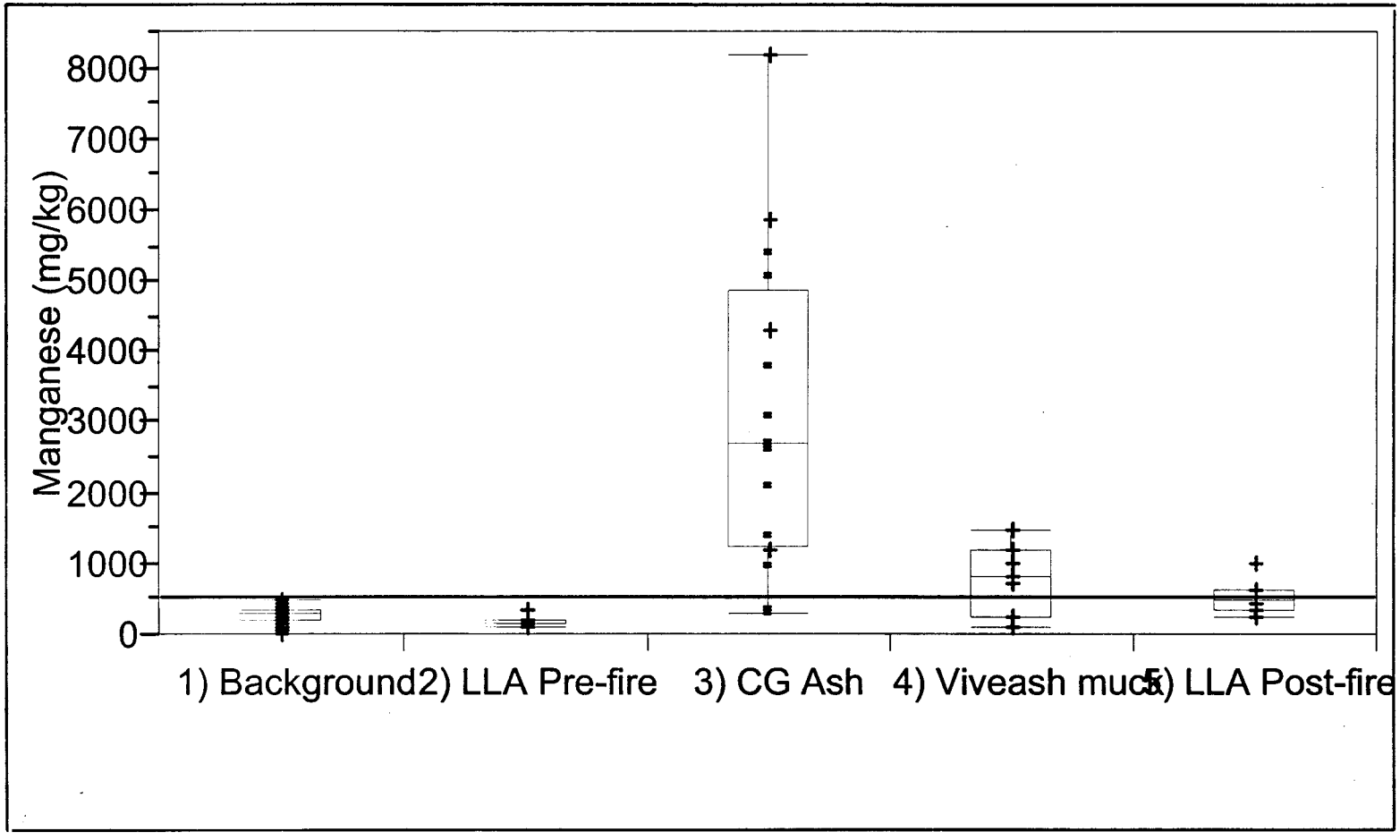
What sample data were used in the assessment?

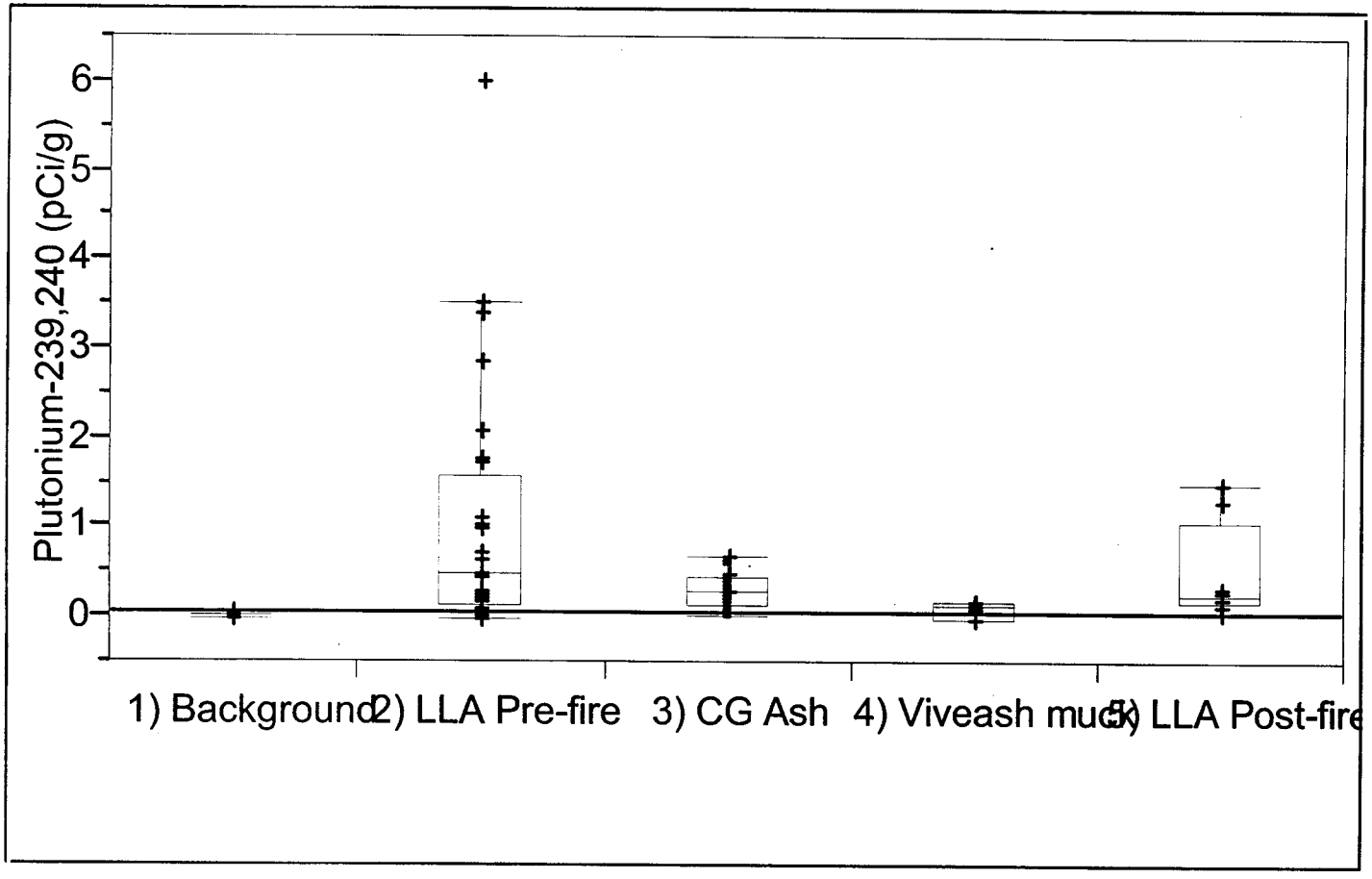
- Cochiti Lake surface water
- Lower LA Canyon sediment
- Shallow alluvial groundwater (Lower LA Canyon)
- Stormwater (for calculated Rio Grande concentrations)
- Fish tissue data

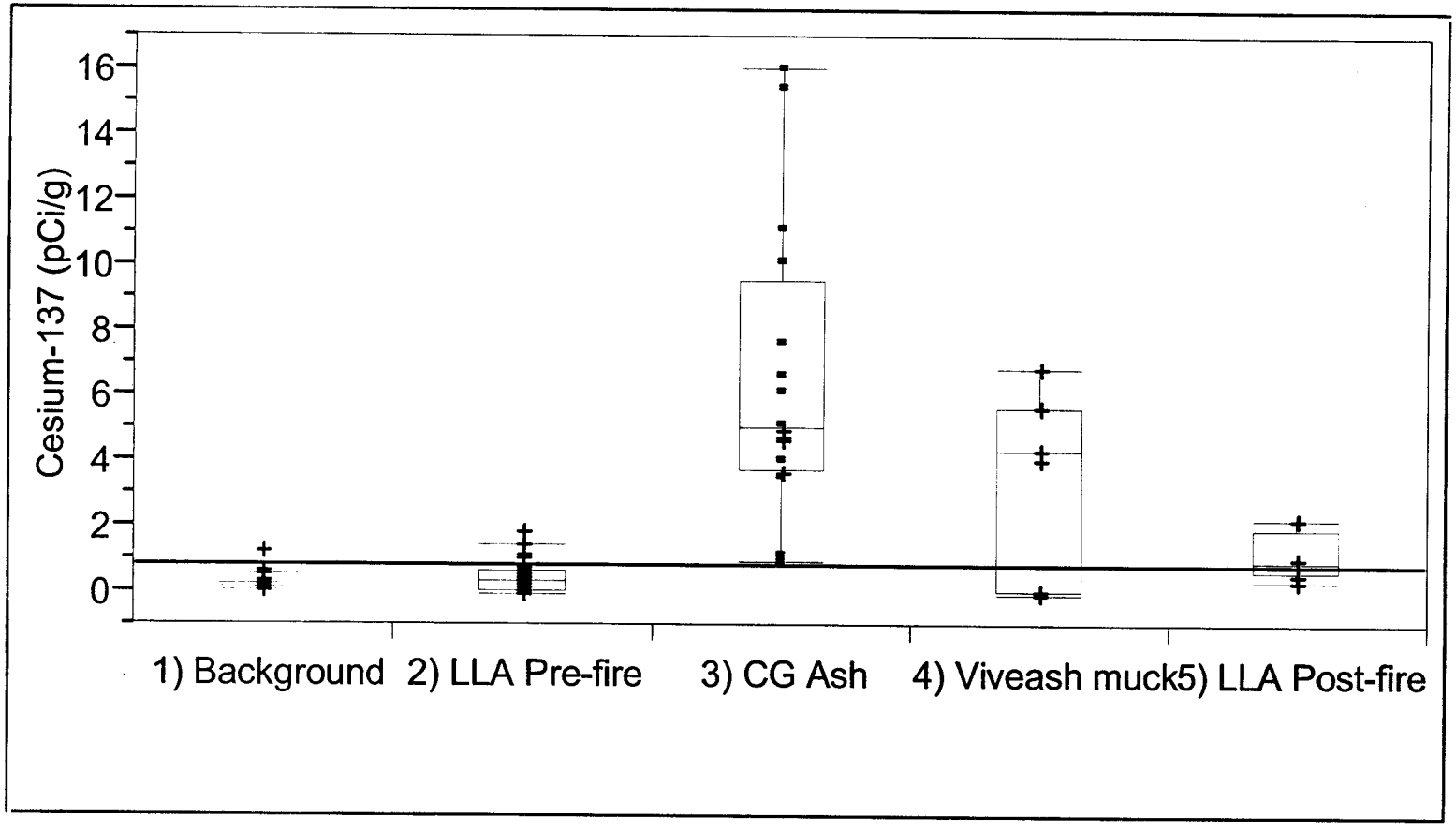
Supplemental Data

- Background values for uranium and thorium data were used in the Lower Los Alamos Canyon resident scenario because they weren't measured in this set because they had shown no elevation in other sampling in Los Alamos canyon
- Dioxin data came from Los Alamos weir (upstream)


Strontium-90 (pCi/g)
3
2
1
0
1) Background
2) LLA Pre-fire
3) CG Ash
4) Viveash muck
5) LLA Post-fire


Manganese (mg/kg)
8000
7000
6000
5000
4000
3000
2000
1000
0
1) Background
2) LLA Pre-fire
3) CG Ash
4) Viveash muck
5) LLA Post-fire


Plutonium-239,240 (pCi/g)
0
1
2
3
4
5
6
1) Background
2) LLA Pre-fire
3) CG Ash
4) Viveash muck
5) LLA Post-fire


Cesium-137 (pCi/g)
16
14
12
10
8
6
4
2
0
1) Background
2) LLA Pre-fire
3) CG Ash
4) Viveash muck
5) LLA Post-fire

Risk Assessment Approach

- What is Risk Assessment?
  - Estimate of the likelihood that the concentrations of chemicals at a site will cause health or environmental problems
  - Based on toxicity
  - Based on exposure
- Used to make decisions about site

Cerro Grande Fire Risk Assessment

- Exposure scenarios include residential, recreational and irrigation activities.
- These scenarios are most likely for the lower canyons areas and downstream locations (e.g., Rio Grande and Cochiti Reservoir).
- Residential exposure most intense so would have highest potential risk.
- Exposed individuals included adult and child.
- Potential risks assessed for reasonable maximum exposures (RME) and central tendency (average) exposures (CTE).
- Provides a range of potential risks in attempt to cover a range of activity and hence exposure of people.

Assumptions Used in Risk Assessment

- concentrations of chemicals in soil and water will remain constant for 30 years
- highest concentrations of chemicals detected were widespread
- individual exposure for 30 years
- residence established on ash/sediment
- plants were grown in ash/sediment only
- animals grazed 50% on plants in ash/sediment
- swimmer/wader exposed to ash laden water during each swim

Exposure pathways assessed

- Ingestion of ash/sediment, shallow groundwater, crops and native plants growing on ash/sediment, livestock and wildlife feeding on plants in ash/sediment, fish from areas receiving ash/sediment laden surface water,
- Inhalation of suspended dust and particulates,
- Dermal contact with ash/sediment and water,
- External irradiation from ash/sediment and water,
- Irrigation of crops with water containing ash/sediment.

Sources of exposure parameters

- EPA exposure factors handbooks, standard default parameters, Risk Assessment Guidance for Superfund (Part A),
- scientific literature,
- professional judgment and common sense.

Exposure Parameters

Exposure Parameters	adult RME	adult CTE	child RME	child CTE
soil ingestion rate (mg soil/day)	200	50	400	100
fraction of soil from contaminated source	1	0.5	1	0.5
surface area for contact (cm2/event)	5800	5000	4700	4300
soil to skin adherence factor (mg/cm2)	0.2	0.07	0.2	0.07
inhalation rate (m3/day)	20	15.2	8.3	8.3
drinking water ingestion rate (l/day)	3	2	1.5	0.74
SA for contact, bathing (cm2)	23000	20000	8450	7310
exposure time for bathing (hours/event)	0.75	0.17	0.75	0.17
homegrown produce ingestion rate (g/kg bw/day)	13.6	1.2	13.6	1.2
fraction plants from contaminated area	1	1	1	1
uptake rate of feed by animal (kg/day)	50	25	50	25
uptake rate of soil by animal (kg/day)	0.5	0.5	0.5	0.5
homegrown meat ingestion rate (g/kg bw/day)	3.4	0.6	3.4	0.6
fraction of meat from contaminated area	1	1	1	1
exposure frequency (days/year)	350	350	350	350
exposure duration (years)	24	9	6	6
body weight (kg)	70	70	15	15
Averaging time (noncarcinogens)	10950	3285	2190	2190
Averaging time (carcinogens)	25550	25550	25550	25550
exposure time swimming/wading (hrs/event)	3	1	3	1
exposure duration (swimming) years	24	9	14	14
exposure frequency for s/w (events/year)	64	32	24	12
water ingestion rate (swimming, l/hr)	0.05	0.05	0.05	0.05
body weight for swimming (kg)	70	70	45	45
Averaging time s/w (noncarcinogens)	10950	3285	5110	5110
LANL specific PEF (m3/kg)	1E+07	1E+07	1E+07	1E+07
fish ingestion rate (kg/yr)	44.1	13.5	9.45	2.9

Risk from Estimated Exposure

- chemical carcinogens and radionuclides
  - EPA target risk range for increased risk of cancer over the background level of occurrence is 10^{-4} (1E-04) to 10^{-6} (1E-06)
  - The upper level of this range (1E-04) corresponds to one excess cancer per 10,000 people exposed.
  - The lower end of this range (1E-06) corresponds to one excess cancer per million people exposed.

- chemical noncarcinogens,
  - Hazard quotient: ratio of detected concentration to reference dose.
  - Reference dose is set to level believed to have no effect
  - Hazard quotients of less than one indicate that no noncancer effects are likely

Results and Conclusions

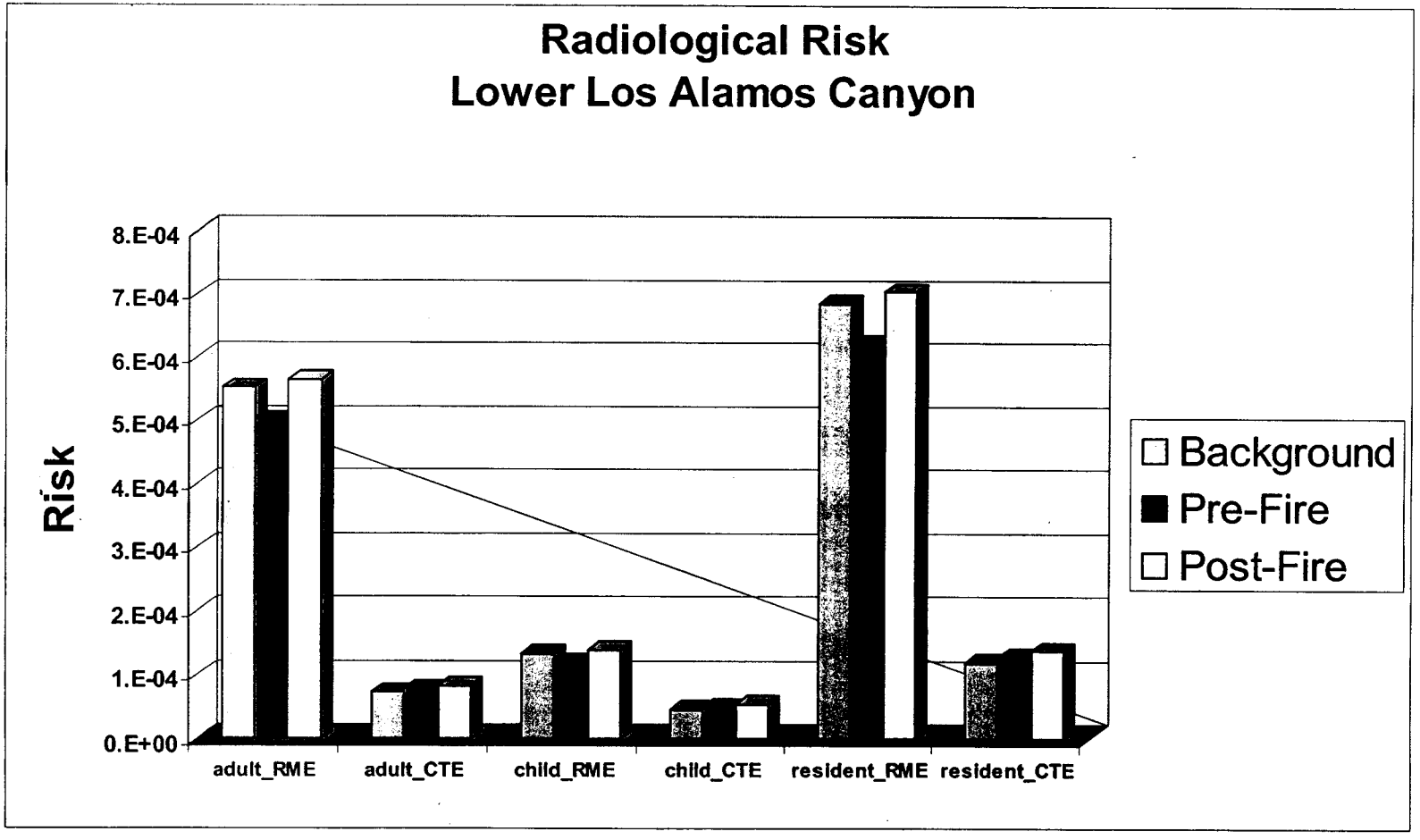
Changes in risk/hazard?

Changes in Pathways?

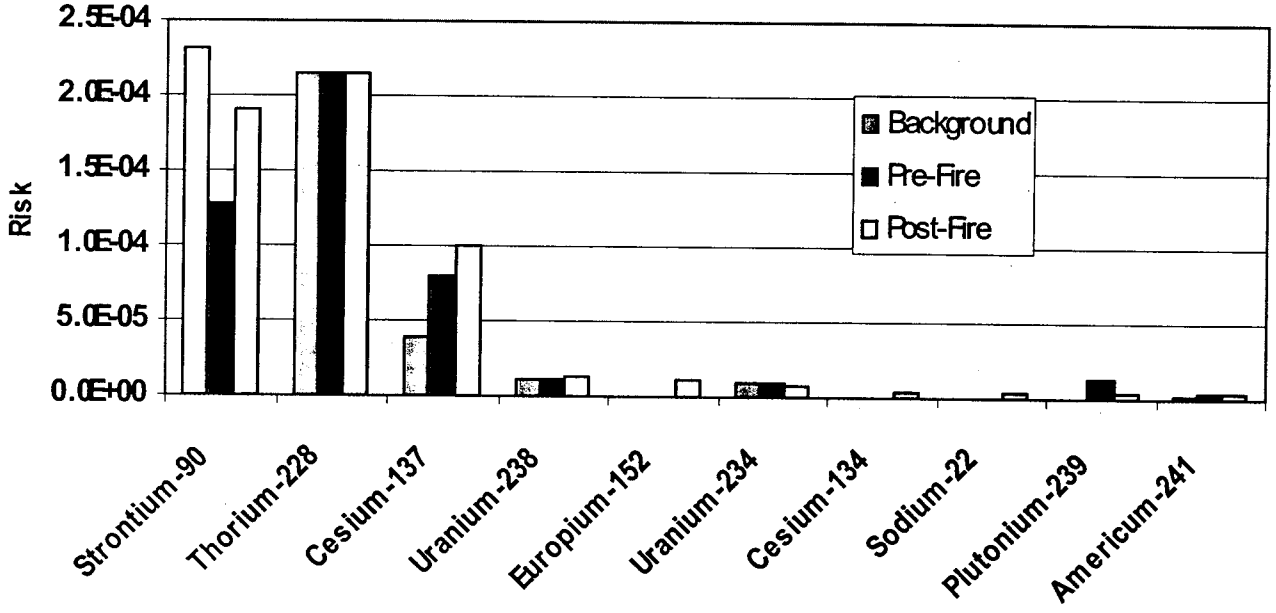
Changes in risk driver chemicals?

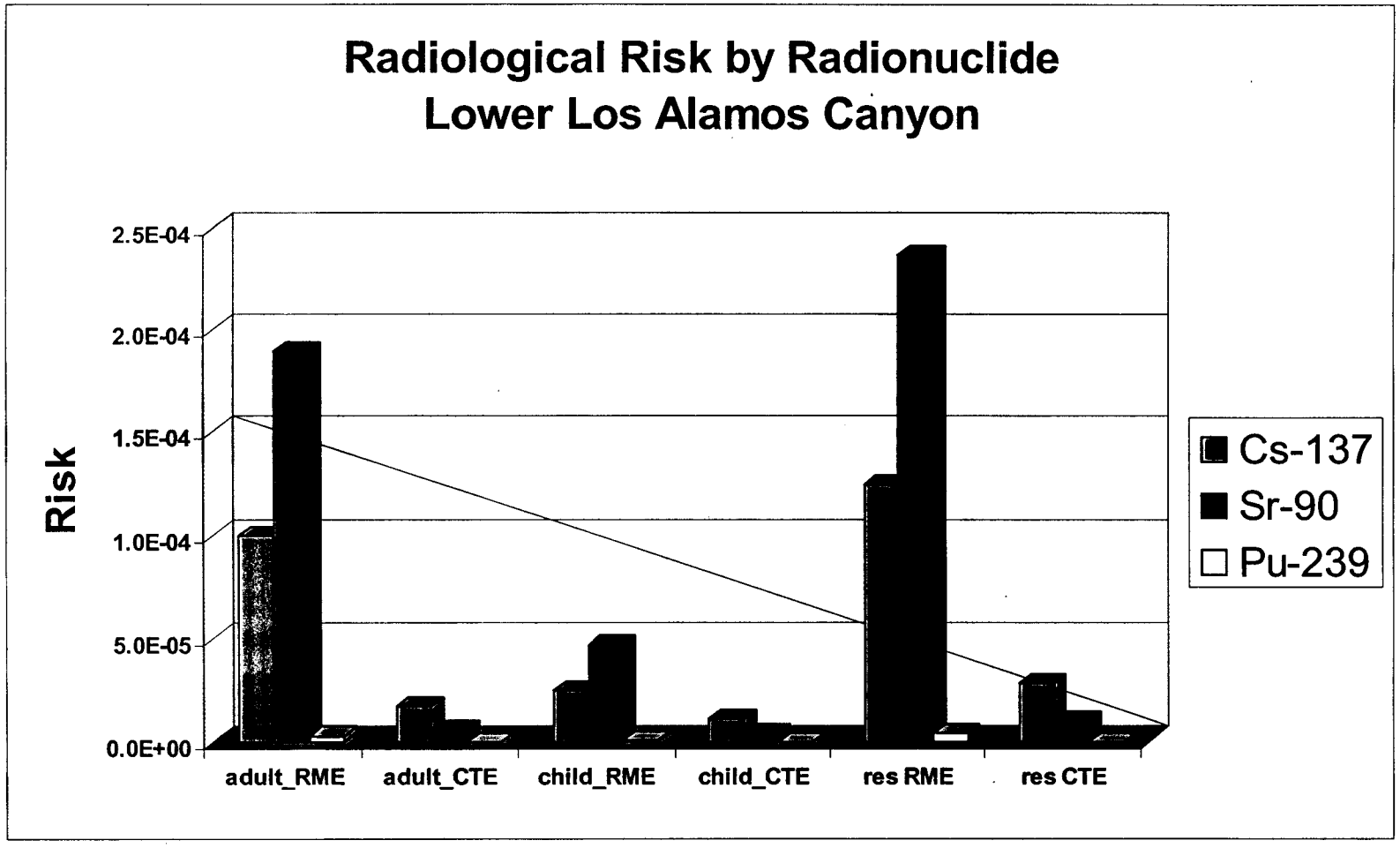
Definitions

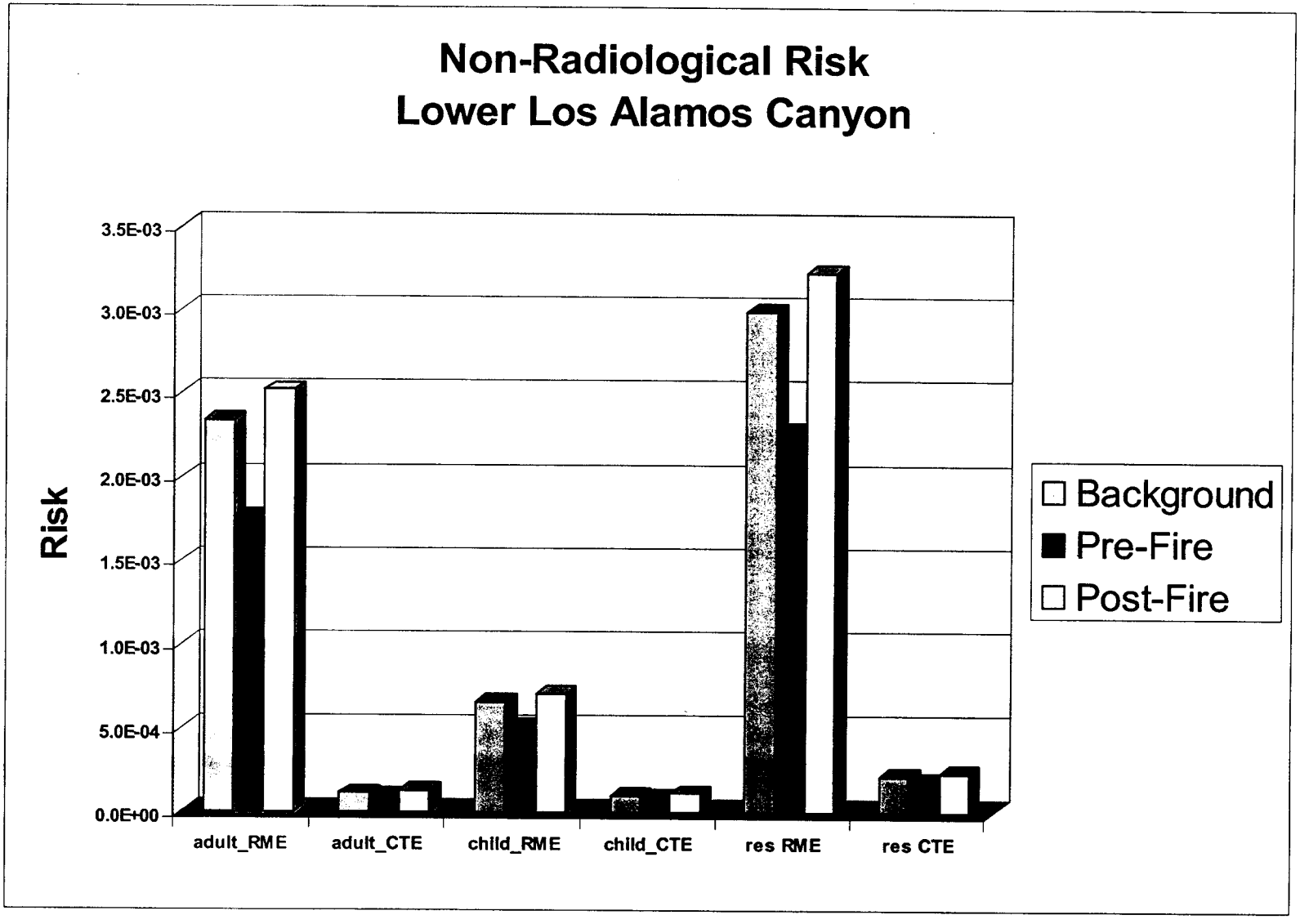
- Background: large data set representative of naturally occurring concentrations of inorganic chemicals and naturally occurring radionuclides in the Los Alamos area canyons
- Pre-Fire: smaller data set taken before the fire in an area near where the sampling was done for the Lower LA Canyon resident scenario (may include some contribution from LANL and townsite activities)
- Post-fire: sampling done in areas after the fire and after flood waters deposited some material in these areas.

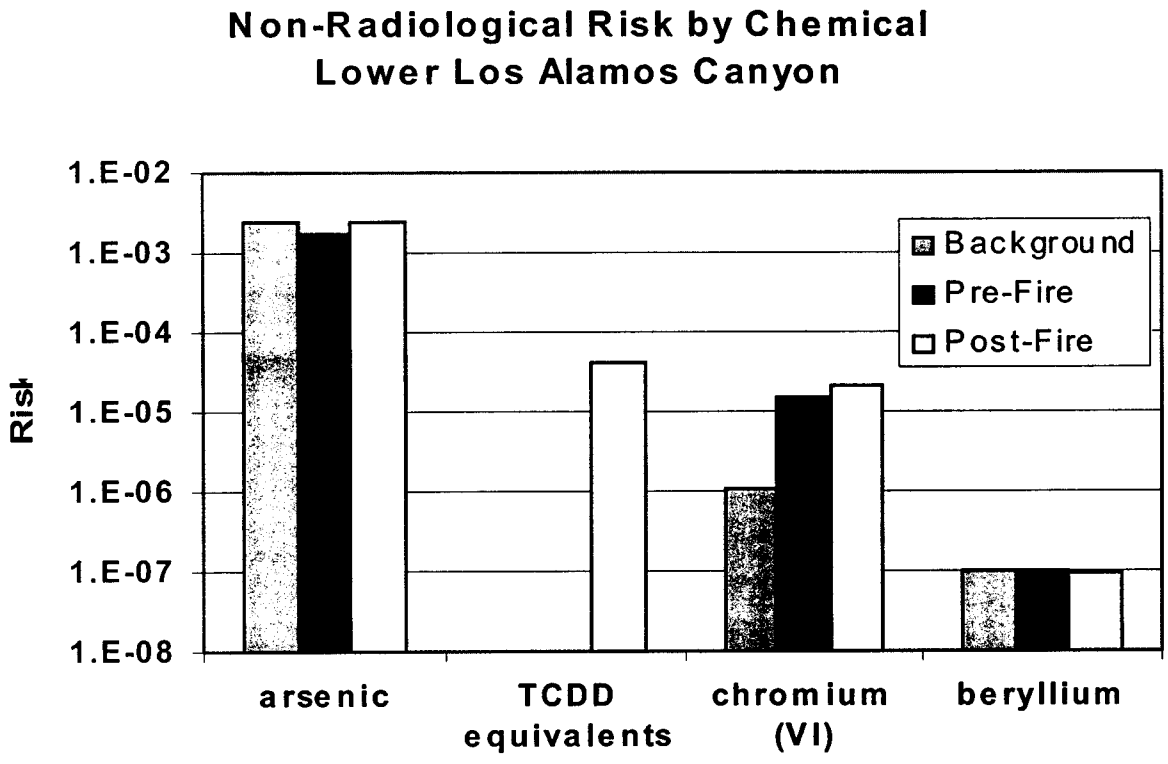

Radiological Risk
Lower Los Alamos Canyon
Risk
8.E-04
7.E-04
6.E-04
5.E-04
4.E-04
3.E-04
2.E-04
1.E-04
0.E+00
adult_RME
adult_CTE
child_RME
child_CTE
resident_RME
resident_CTE
Background
Pre-Fire
Post-Fire

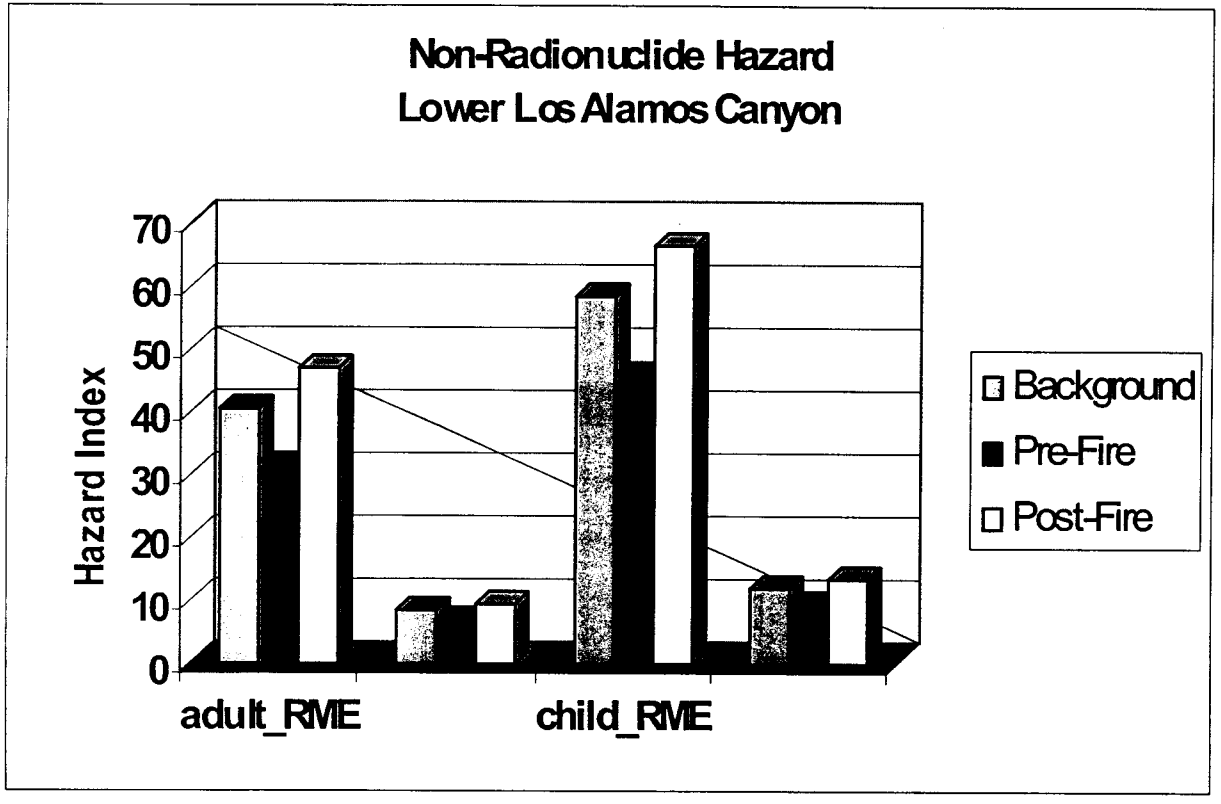
Radionuclide Risk by Radionuclide – Lower Los Alamos Canyon



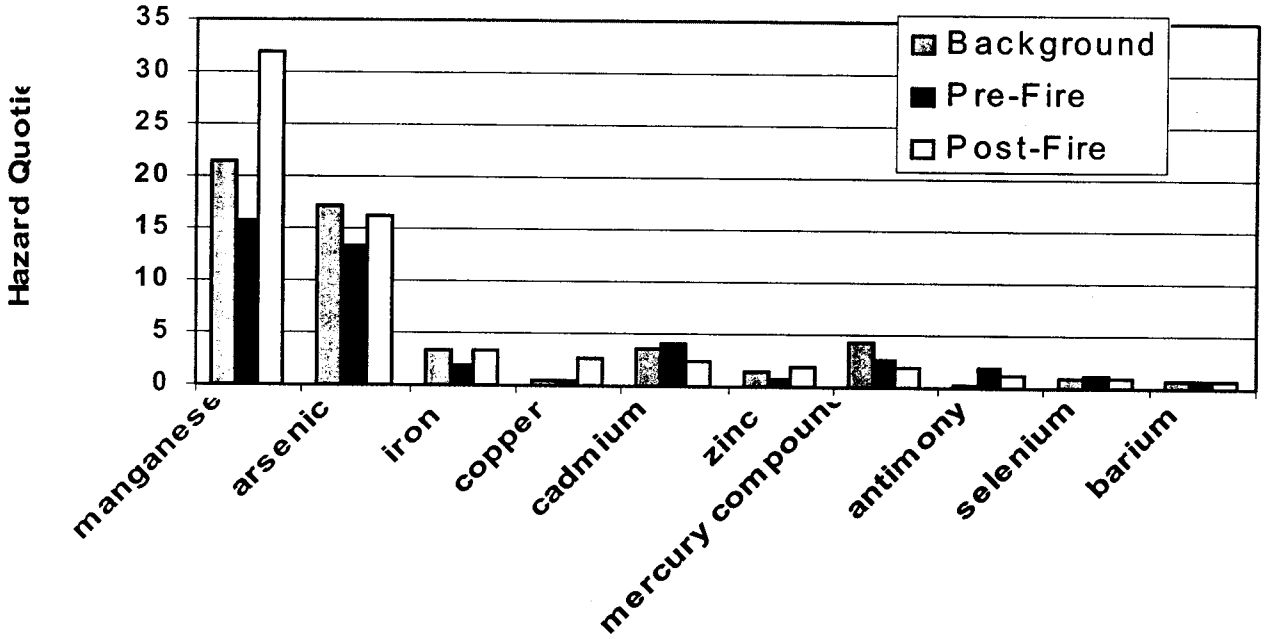

Radiological Risk by Radionuclide
Lower Los Alamos Canyon
Risk
2.5E-04
2.0E-04
1.5E-04
1.0E-04
5.0E-05
0.0E+00
adult_RME
adult_CTE
child_RME
child_CTE
res RME
res CTE
Cs-137
Sr-90
Pu-239


Non-Radiological Risk
Lower Los Alamos Canyon
Risk
3.5E-03
3.0E-03
2.5E-03
2.0E-03
1.5E-03
1.0E-03
5.0E-04
0.0E+00
adult_RME
adult_CTE
child_RME
child_CTE
res RME
res CTE
Background
Pre-Fire
Post-Fire


Non-Radiological Risk by Chemical
Lower Los Alamos Canyon
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
Risk
Background
Pre-Fire
Post-Fire
arsenic
TCDD equivalents
chromium (VI)
beryllium

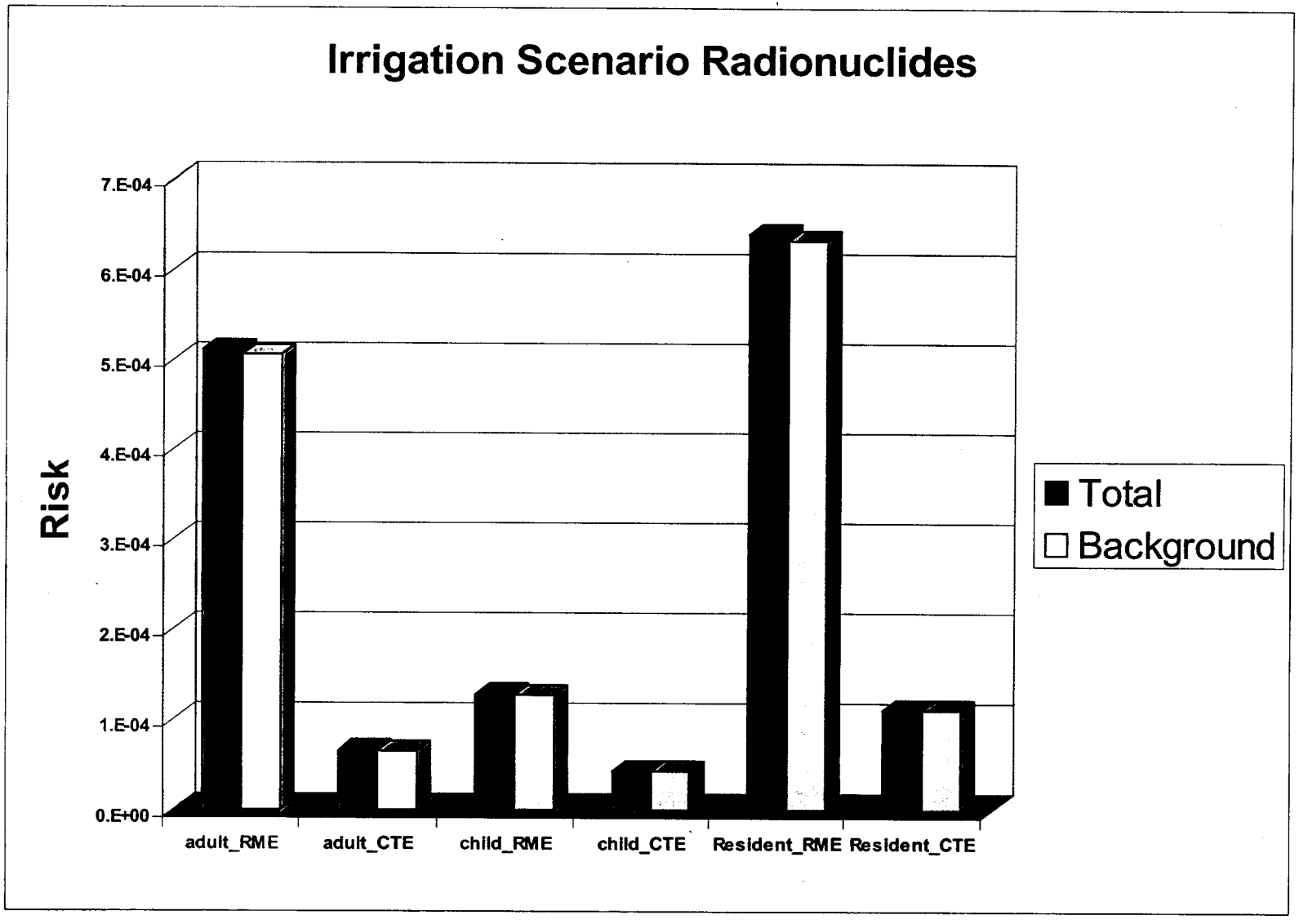

Non-Radionuclide Hazard
Lower Los Alamos Canyon
Hazard Index
70
60
50
40
30
20
10
0
adult_RME
child_RME
Background
Pre-Fire
Post-Fire

Non-Radiological Hazard by Chemical
Lower Los Alamos Canyon

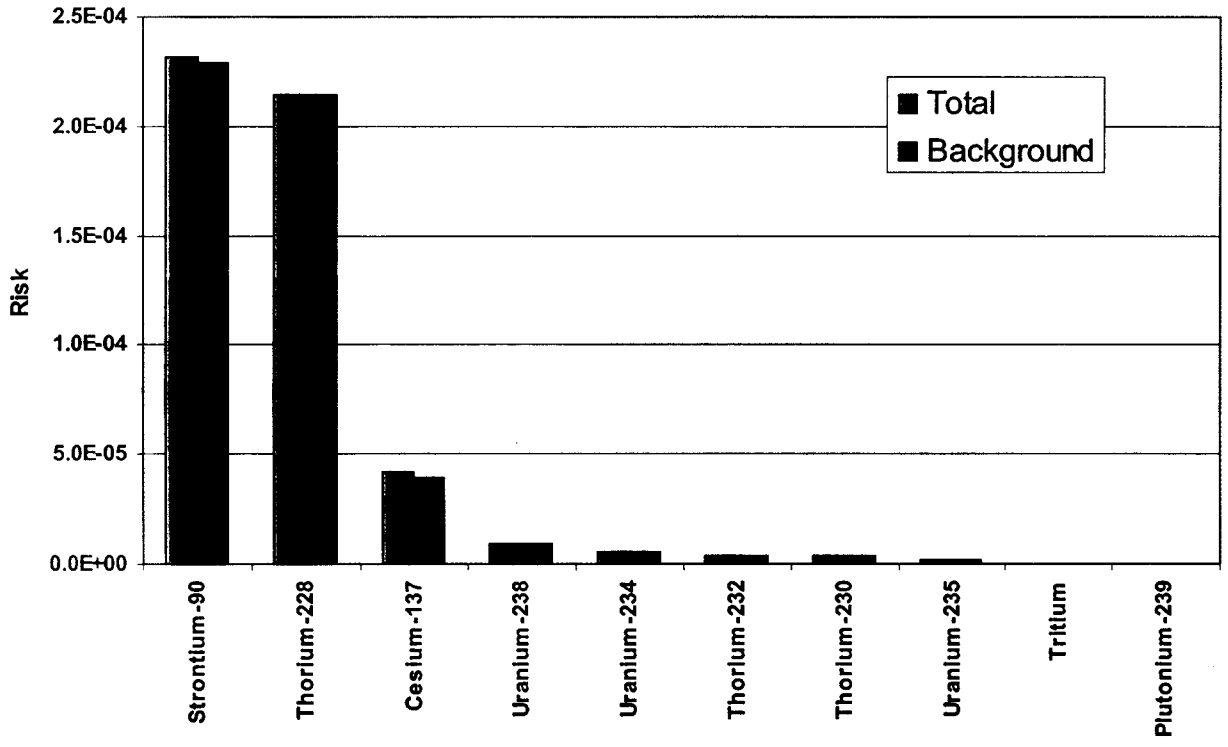


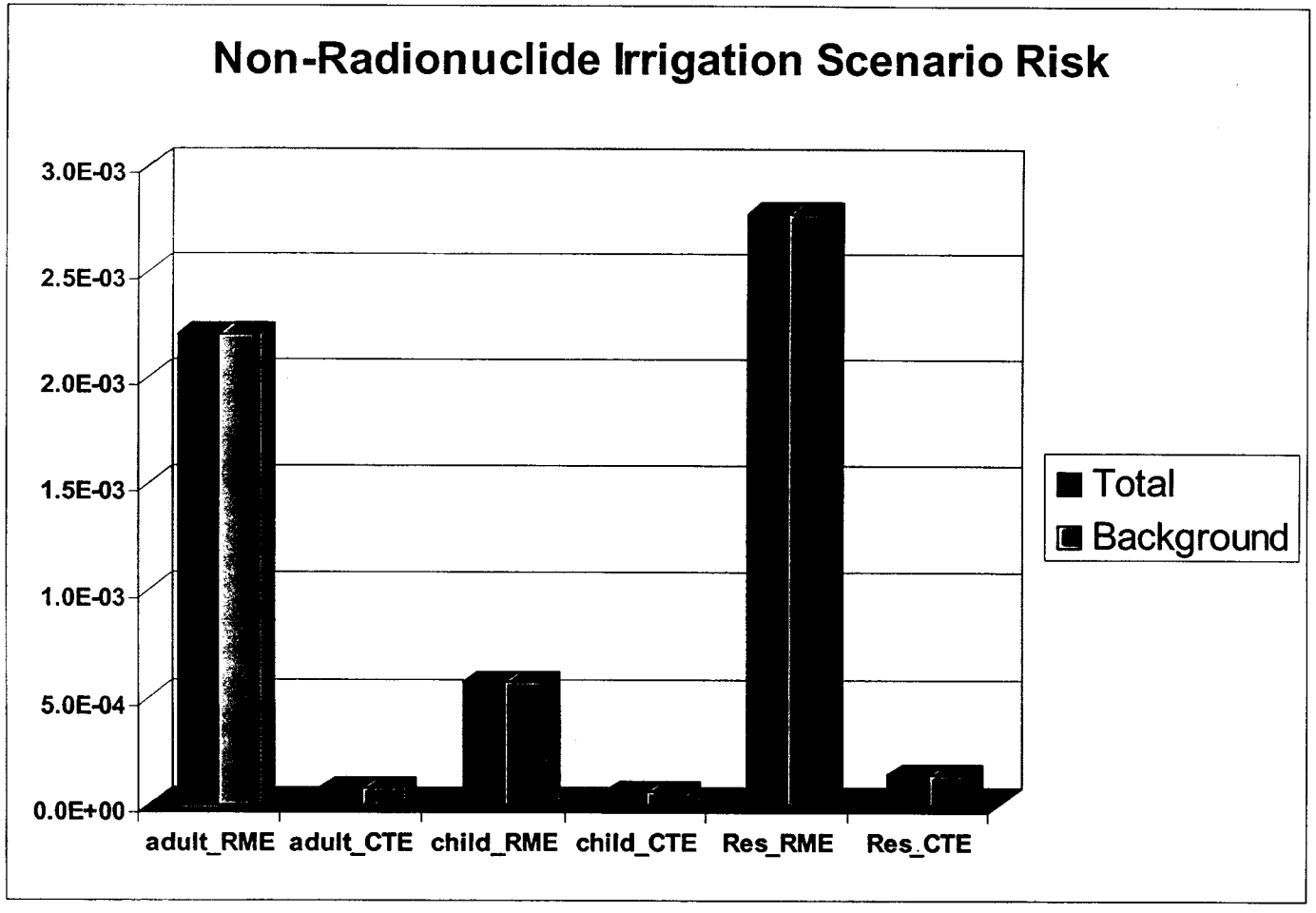
Irrigation Scenario

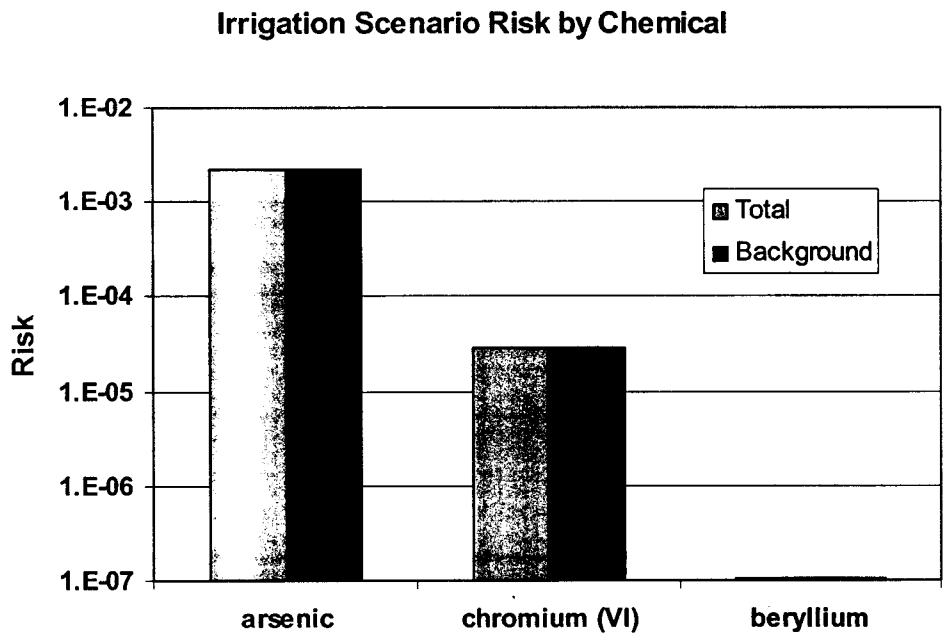
- Uses same exposure parameters and transfer factors as resident scenario
- Based on modeled concentrations in farm soil
  - Stormwater concentrations in canyons diluted by estimated factor to get irrigation water concentration
  - Assumed all estimated concentrations from one summer of irrigation transferred to farm soil
- Background risk calculated using Pajarito Plateau levels as farm soil concentrations.


Irrigation Scenario Radionuclides
Risk
7.E-04
6.E-04
5.E-04
4.E-04
3.E-04
2.E-04
1.E-04
0.E+00
adult_RME
adult_CTE
child_RME
child_CTE
Resident_RME
Resident_CTE
Total
Background

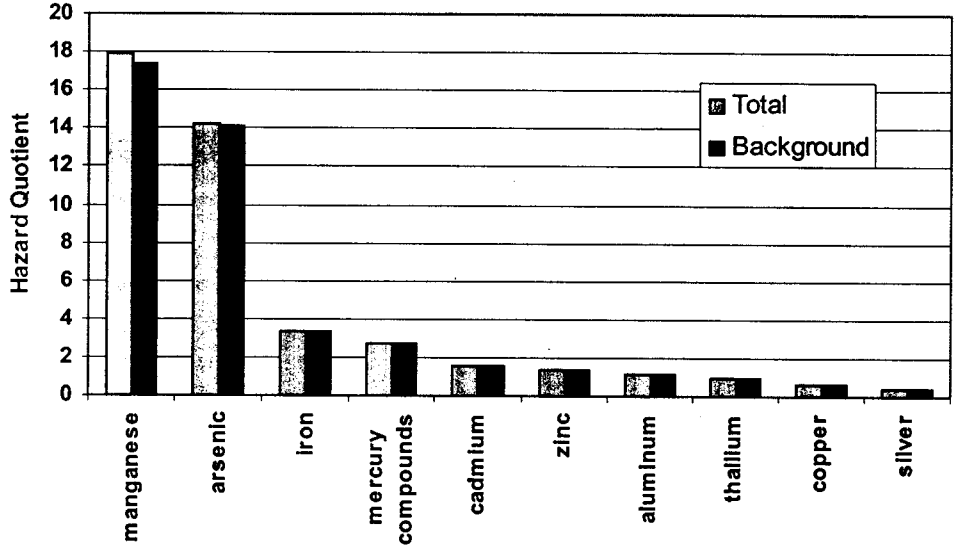
Irrigation Scenario Risk by Radionuclide




Non-Radionuclide Irrigation Scenario Risk
3.0E-03
2.5E-03
2.0E-03
1.5E-03
1.0E-03
5.0E-04
0.0E+00
adult_RME
adult_CTE
child_RME
child_CTE
Res_RME
Res_CTE
Total
Background


Irrigation Scenario Risk by Chemical
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
Risk
Total
Background
arsenic
chromium (VI)
beryllium

Irrigation Scenario Hazard by Chemical



Fish Consumption Risk

- Estimated dose based on actual measured fish tissue concentrations from Cochiti Lake in June of 2000 (immediately post-fire)
- Not a driving pathway for total risk
  - Max risk of 2.5 $x10^{-6}$ due to Americum-241
- Potential noncancer effects from mercury and cadmium (already a mercury advisory for lake)
- Fish may accumulate higher levels over time; fish resampled each year

Swimming Risk

- Based on swimming 3 hours at a time, 64 times a year for 24 years
- Calculated with surface concentrations in Cochiti Lake
- Not a significant pathway
  - Risk (rad) 2.4×10^{-7}
  - Hazard index 0.0001

What exposure pathways are of potential concern, i.e., risk drivers?

- Plant ingestion
  - metals (manganese, arsenic)
  - strontium-90
- External radiation for cesium-137
- Drinking water (metals)

What chemicals and radionuclides are or are not of potential concern?

- Arsenic
- Manganese
- Strontium-90
- Cesium-137
- Plutonium-239
- Dioxins
- Other metals

What pathways do not appear to be important? Why?

- Swimming
- Incidental soil ingestion
- Dust inhalation

Results Summary

- Potential risk from radionuclides not substantially elevated postfire compared to background
  - Strontium-90 (plants) and cesium-137 (external) are risk drivers
- Potential risk from nonradionuclides also not substantially elevated postfire compard to background
  - Difference seen in chromium (VI) and dioxins (small difference, in the 1 in 100,000 range of risk)
  - Arsenic and chromium risk drivers pre- and post-fire
- Potential increase in noncancer effects postfire
  - Manganese accounts for most of potential hazard
  - Model predicts elevated hazard due to background
- Irrigation scenario (1 year) shows no change in risk or hazard

Reducing Potential Risk

- Greatest change in potential risk associated with long-term consumption of plants grown directly in sediments containing ash
- Avoid planting crops directly in material deposited by floods
- Avoid using the dark ash-laden sediment as a garden amendment

Need for further sampling and analyses

- Continue to improve our understanding of the nature of constituents in ash and the fate of those constituents in the environment. This includes understanding the spatial distribution and persistence of "fire-effects" in various environmental media.

- - Characterize the effects of floods on transporting ash (and associated constituents) to downstream areas.

- - Continue to monitor for potential erosion and transport of LANL contaminants during floods.

Questions from the Cerro Grande Fire

- Is there an increased risk from flooding after the CGF? If so, what kind of risk?
- What can I do to reduce the risk?
- Is there an increased risk from contaminant runoff from LANL?