Incorporating Climate Change Impacts/adaptation Considerations Into Remediation and NRDA Restoration at Superfund Sites

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August 19, 2019

Abt ASSOCIATES

WYANDOTTE NATION

PUEBLO DE SAN ILDEFONSO TEWA

Spokane Tribe of Indians

Workshop Agenda

1 – 1:45 pm

Brief background on Superfund Cleanup and Natural Resource Damage Assessment (NRDA)

Climate 101

Break

2:00 – 2:45 pm

Case Study #1: Pueblo de San Ildefonso, Los Alamos National Lab, NM

Break

3:00 – 3:45 pm

Case Study #2: Tar Creek Superfund Site, OK

Break

4:00 – 4:45 pm

Group Exercise: Midnite Uranium Mine Superfund Site, WA

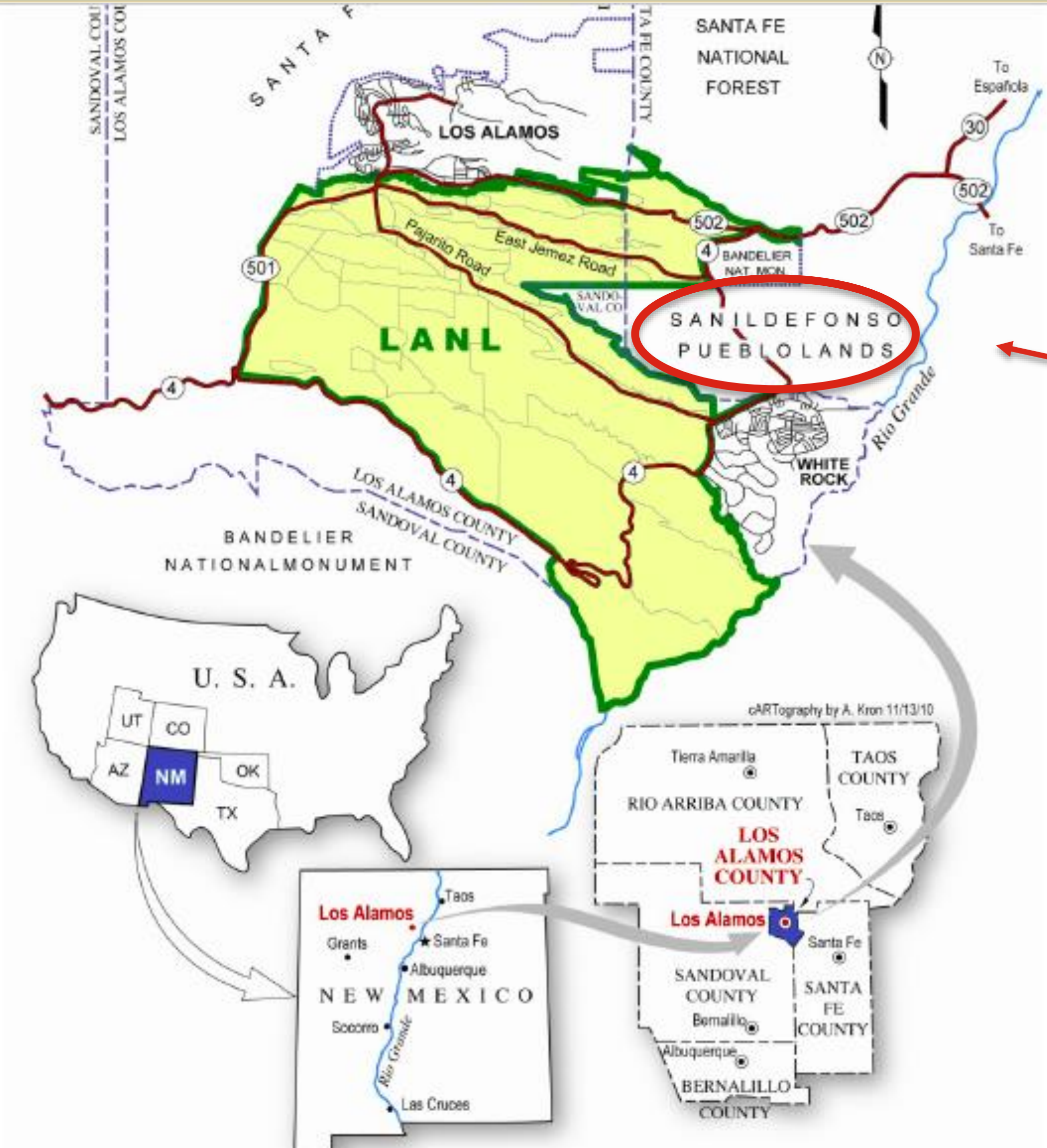
Wrap-up

Case Study #1: Pueblo de San Ildefonso

- Climate Change in the Southwest & Implications for the Pueblo
- Plutonium Transport Case Study

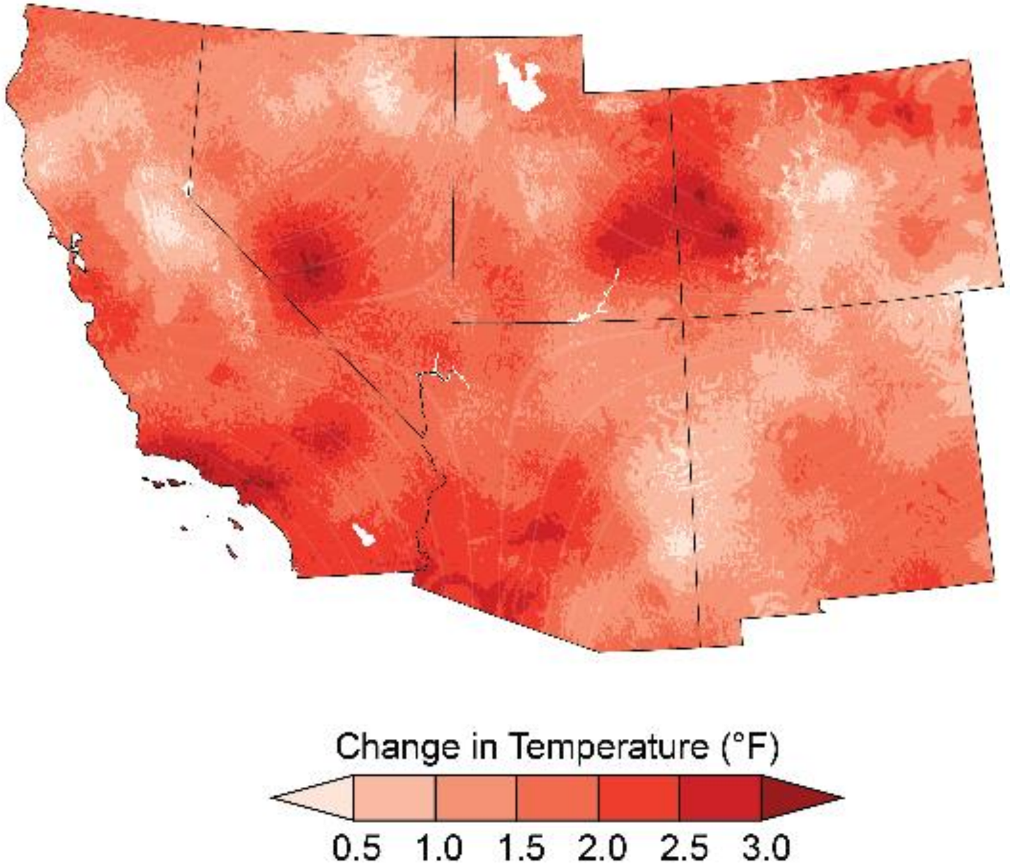
Climate Change in the Southwest & Implications for the Pueblo

Pueblo de San Ildefonso



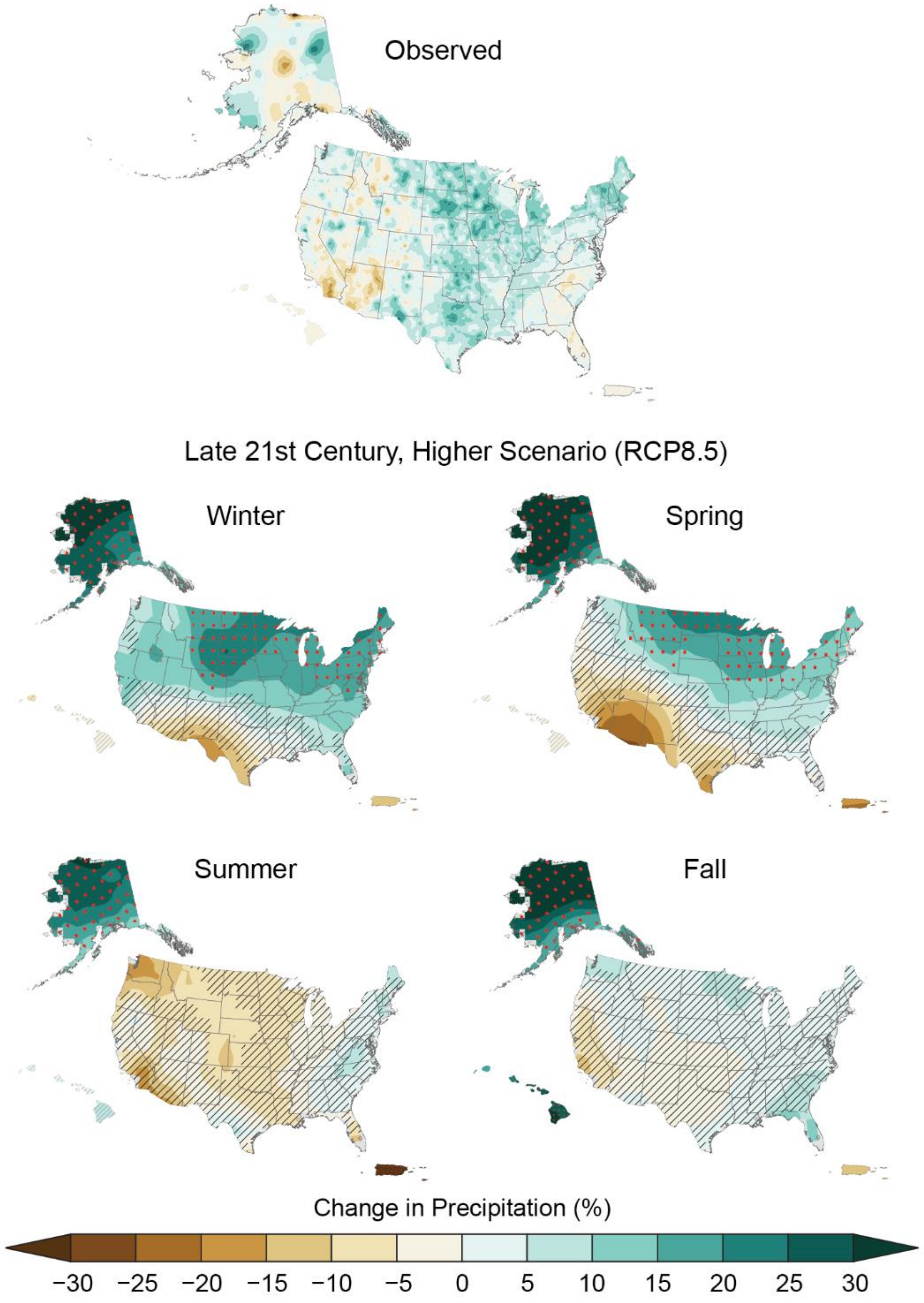
The Pueblo de San Ildefonso is located adjacent to and downstream of the Los Alamos National Lab (LANL), New Mexico

Temperature Changes



Observed change in temperature in the Southwest from 1901 to 2016

Source: Fourth National Climate Assessment, Vol II – Impacts, Risk and Adaptation in the United States. https://nca2018.globalchange.gov



Precipitation Changes

Observed and projected precipitation changes vary by region and season.

Historically, the Southwest has experienced a decrease for the period 1986–2015 relative to 1901–1960 (top figure).

Parts of the southwestern United States are projected to receive less precipitation in the winter and spring.

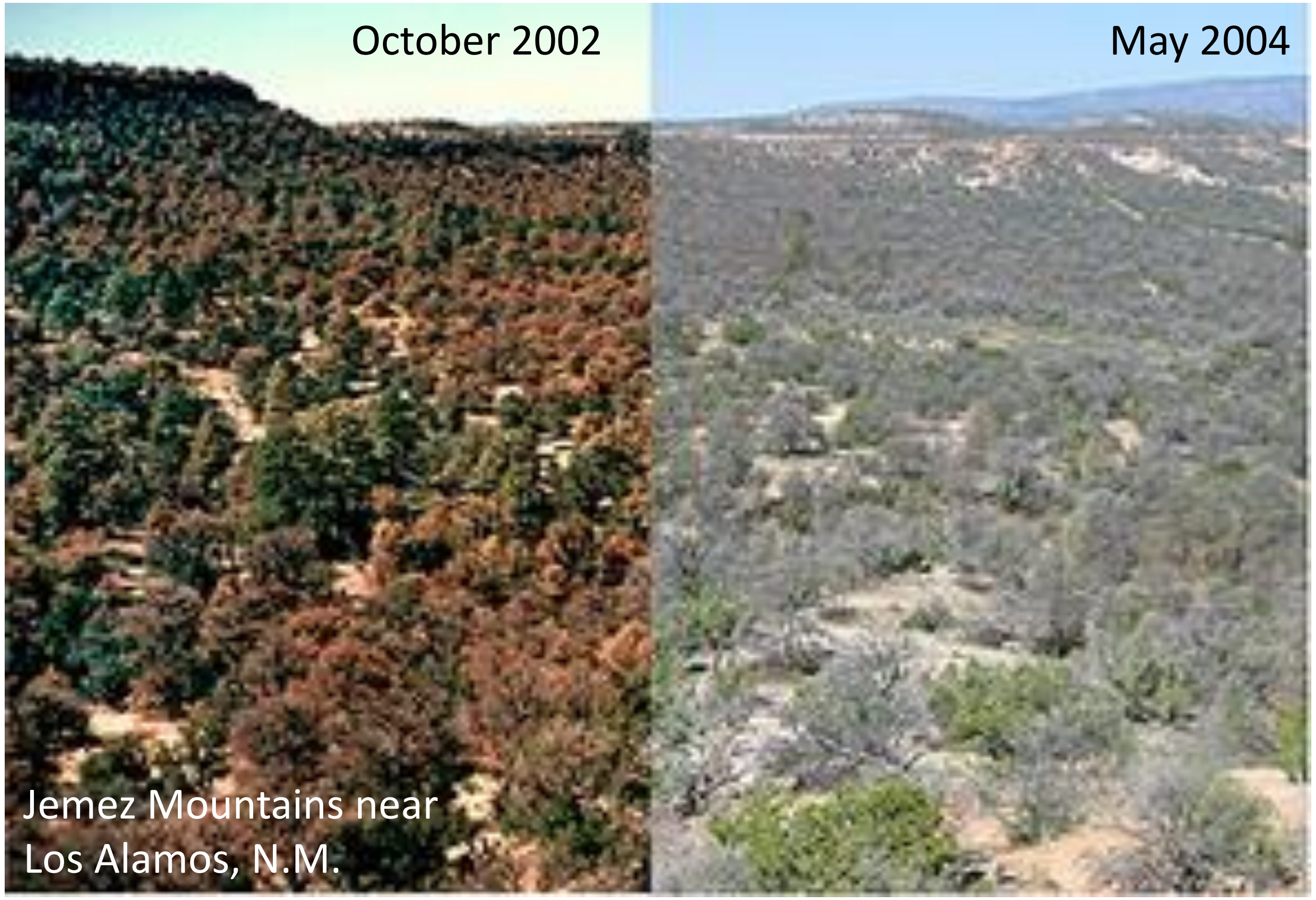
Source: Fourth National Climate Assessment, Vol II – Impacts, Risk and Adaptation in the United States. https://nca2018.globalchange.gov

Increased Drought

Fourth National Climate Assessment (NCA, 2018):
"Rising air and water temperatures and changes in precipitation are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in surface water quality"

Source: Fourth National Climate Assessment, Vol II – Impacts, Risk and Adaptation in the United States. https://nca2018.globalchange.gov

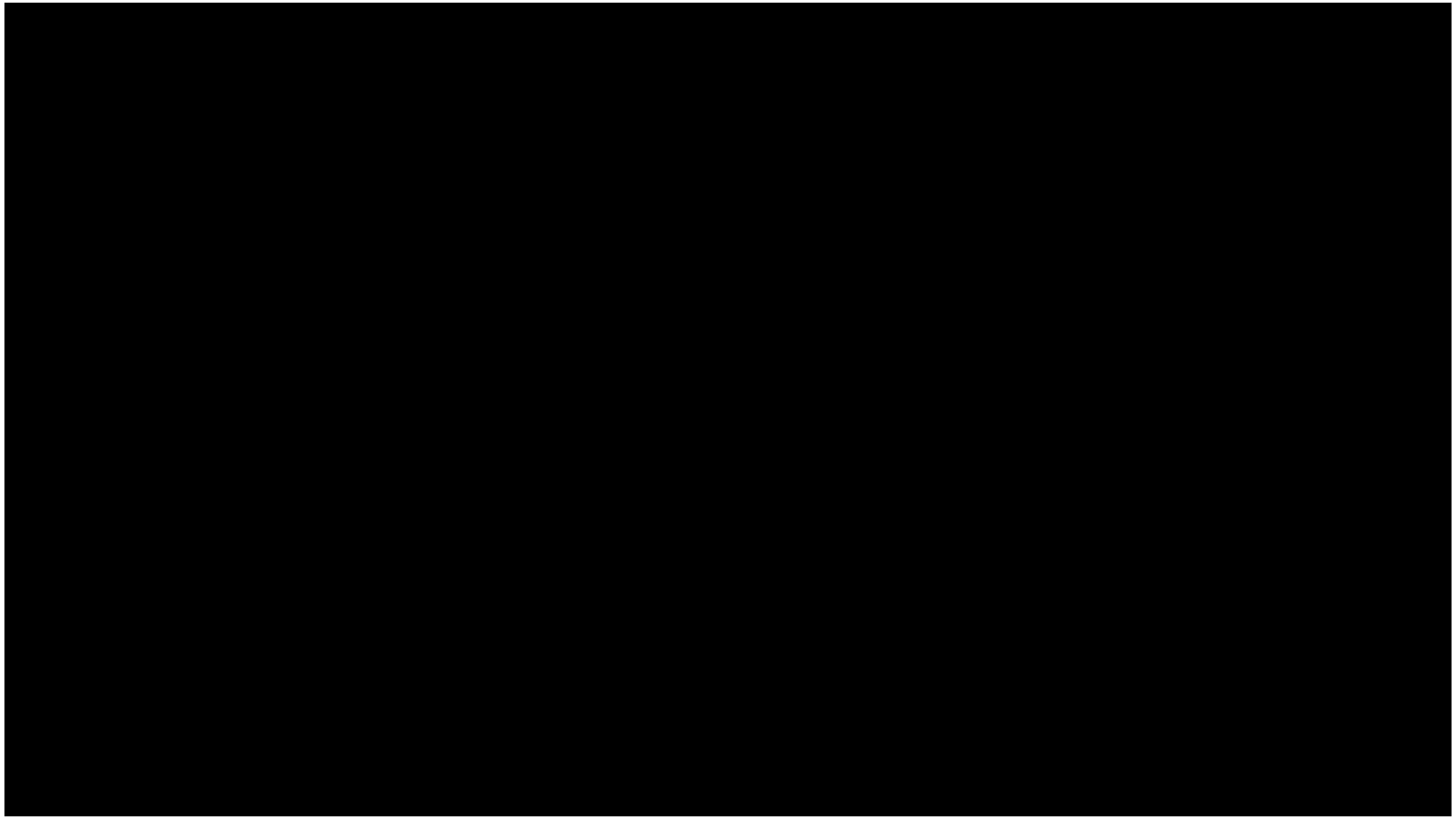
Observed Piñon on Tree Die-Off



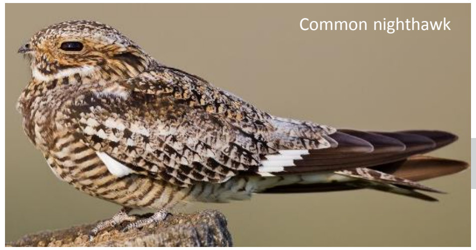
At study sites in Arizona, Colorado, New Mexico and Utah, 40% to 80% of the piñon trees died between 2002 and 2003.

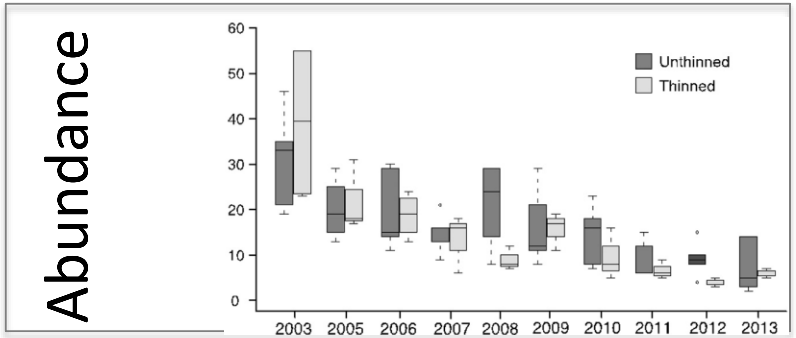
Breshears, B.B., et al. 2009. Tree die-off in response to global change-type drought: mortality insights from a decade of plant water potential measurements. Research Communications. *Front Ecol Environ* 7(4): 185-189.

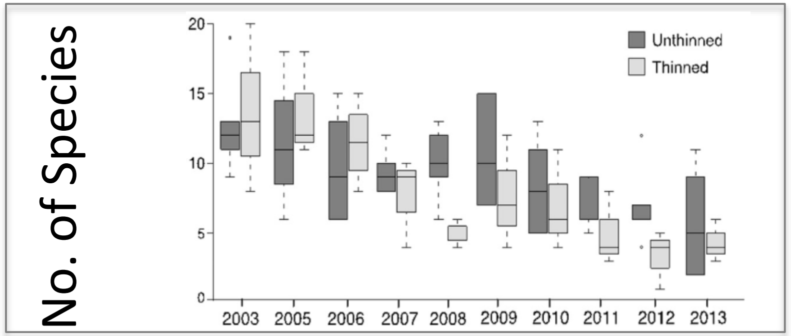
Projected Conifer Tree Mortality

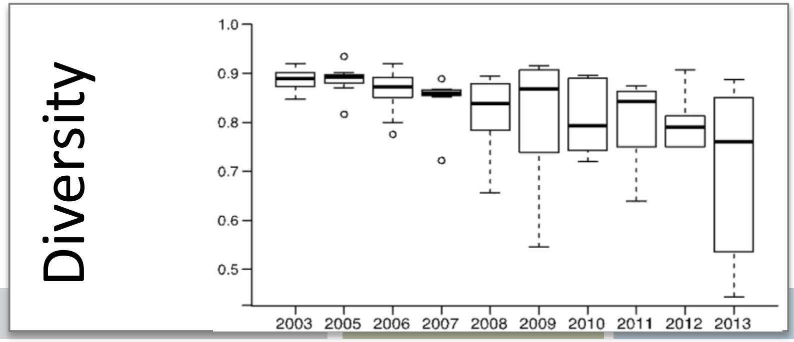


Observed Avian Declines

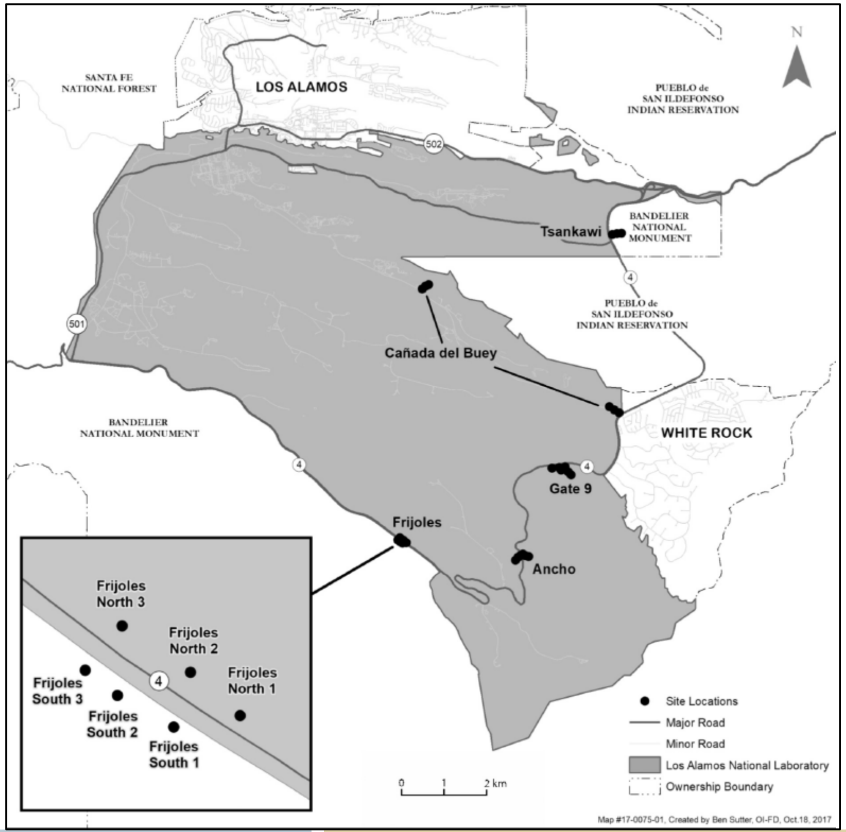








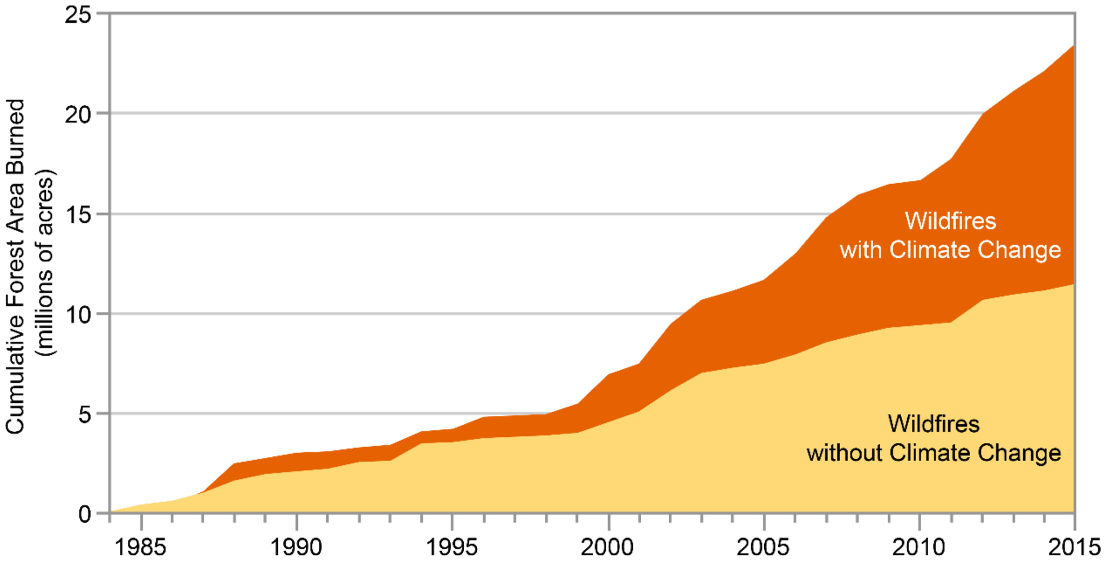
Fair et al (2018) report a 73% reduction in bird abundance & 45% reduction in richness at LANL study sites, 2003-2013



Fair, J.M., et al. 2018. Avian Communities are decreasing with pinon pine mortality in the southwest. *Biological Conservation* 226: 186-195.

Observed Increased Wildfires

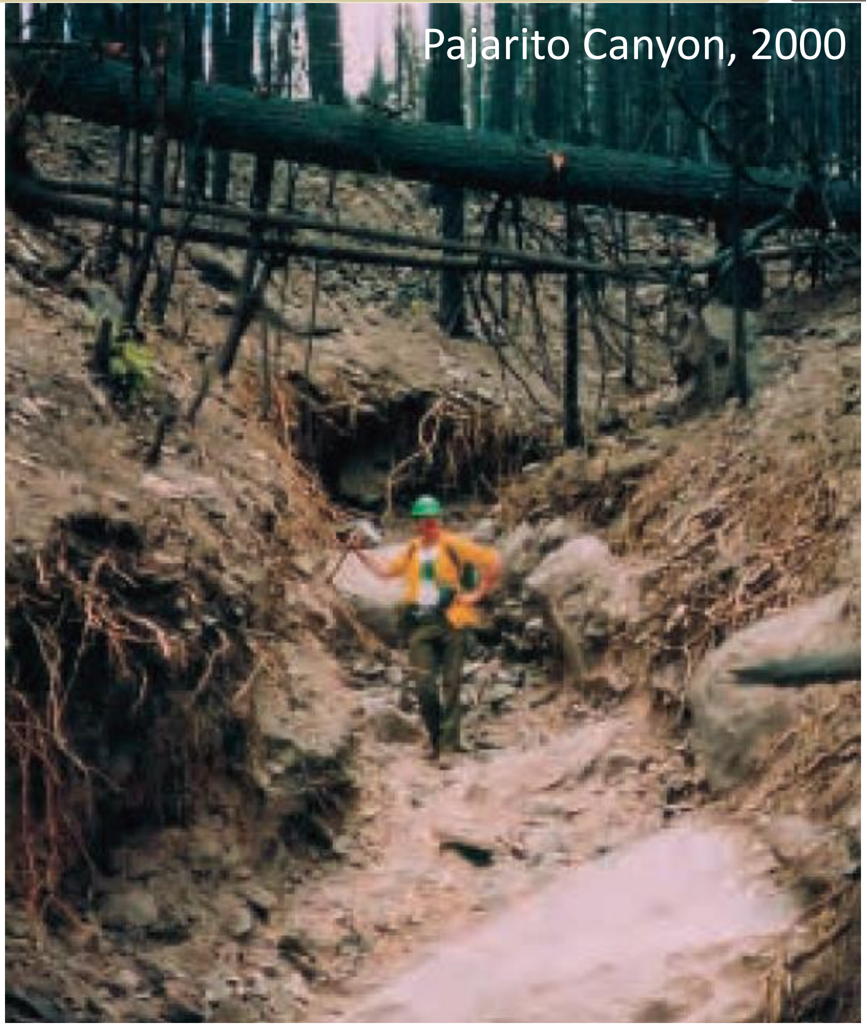
"…the area burned by wildfire across the western United States (1984-2015) is estimated to be twice what would have burned had climate change not occurred"
- NCA (2018), Chapter 25 - Southwest



Source: Fourth National Climate Assessment, Vol II – Impacts, Risk and Adaptation in the United States. https://nca2018.globalchange.gov

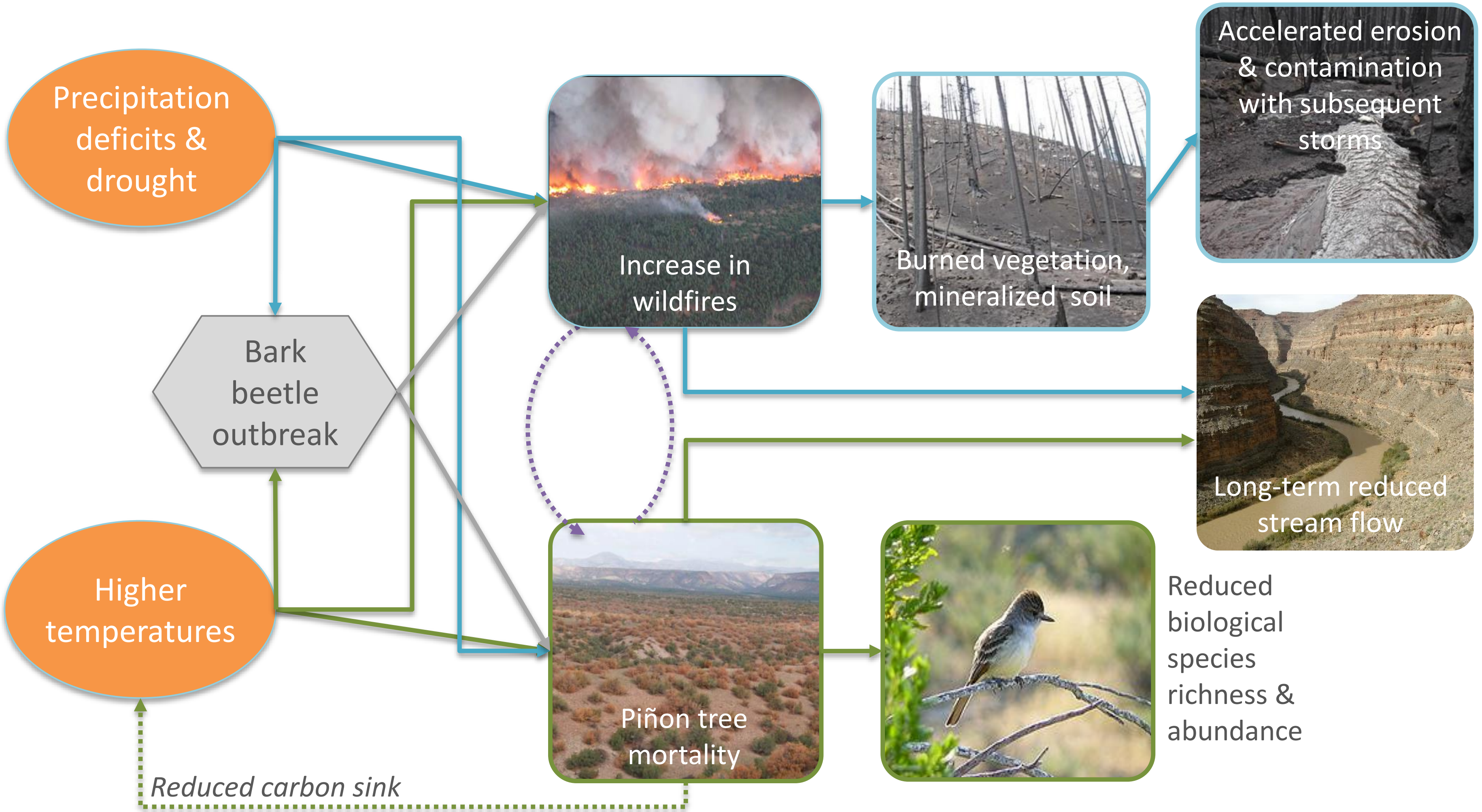
Observed Increased Storm Intensity

Fourth National Climate Assessment (NCA): *"Rising air and water temperatures and changes in precipitation are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in surface water quality"*



Source: Fourth National Climate Assessment, Vol II – Impacts, Risk and Adaptation in the United States. https://nca2018.globalchange.gov

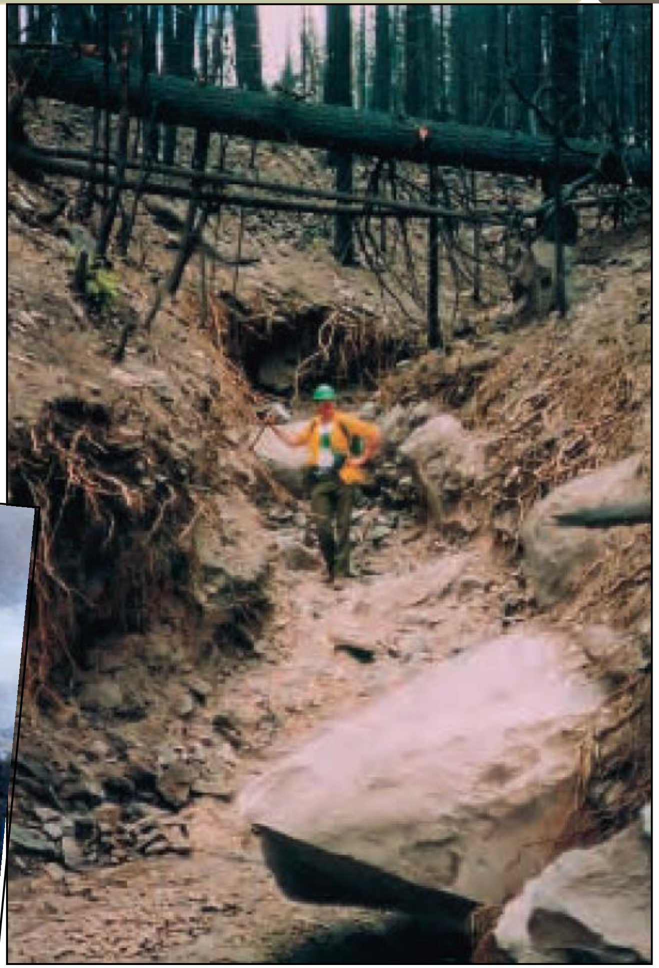
Implications for the Pueblo



Plutonium Transport Case Study

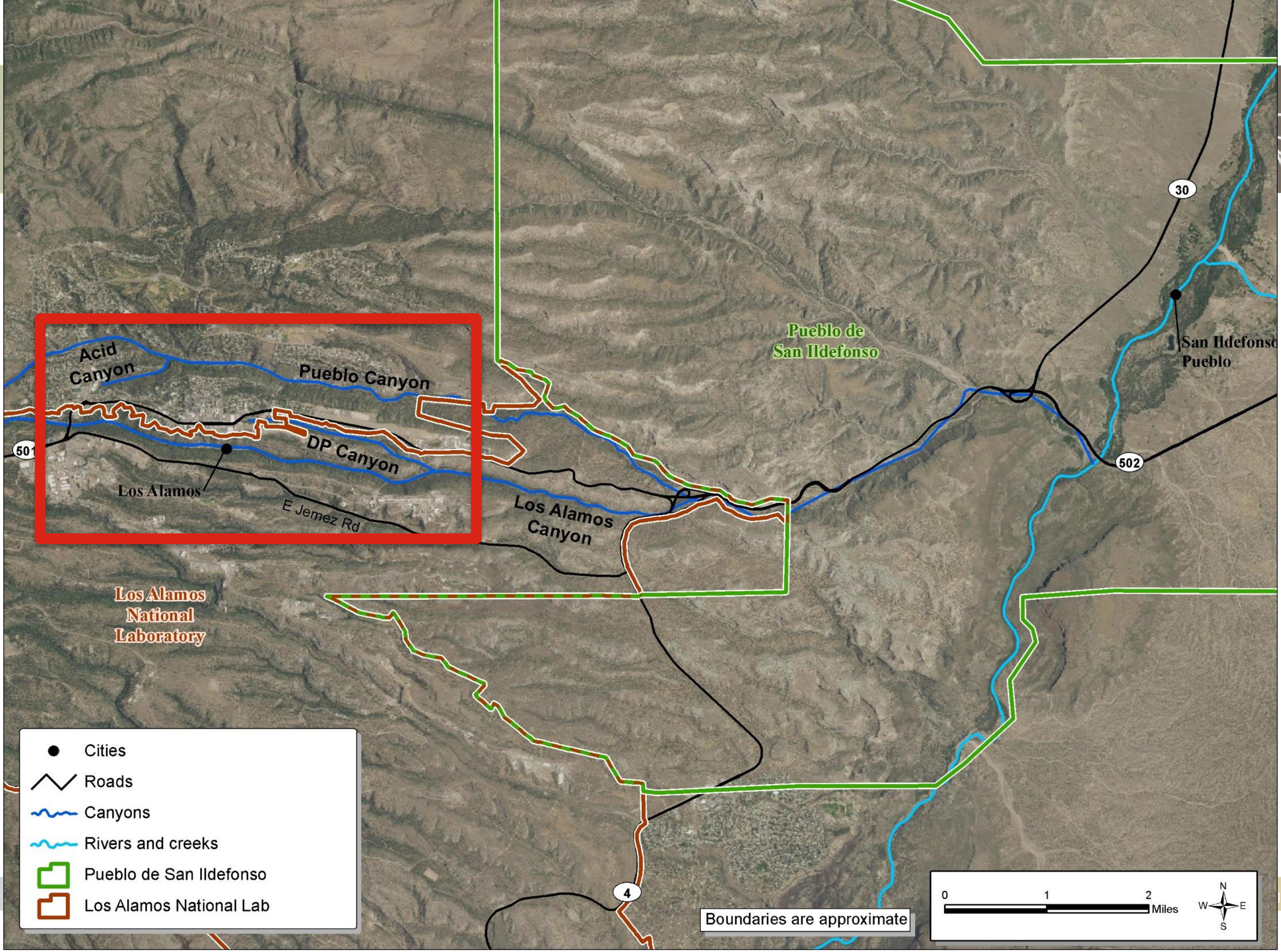
Observed Contaminant Movement

Legacy of contamination + wild fires + storm events & erosion = increased contaminant transport towards the Pueblo



LAHDRA report (CDC, 2010); LA &Pueblo Canyons Investigation Report (LANL, 2004)
https://www.energy.gov/sites/prod/files/2016/04/f30/CC_at%20LANLCase%20Study2-23-15final.pdf

Katzman, et al. 2001. Cerro Grande Ash as a Source of Elevated Rads and metals


Acid Canyon
Pueblo Canyon
DP Canyon
Los Alamos
E Jemez Rd
Los Alamos Canyon
Los Alamos National Laboratory
Pueblo de San Ildefonso
San Ildefonso Pueblo
501
502
30
4
Cities
Roads
Canyons
Rivers and creeks
Pueblo de San Ildefonso
Los Alamos National Lab
Boundaries are approximate
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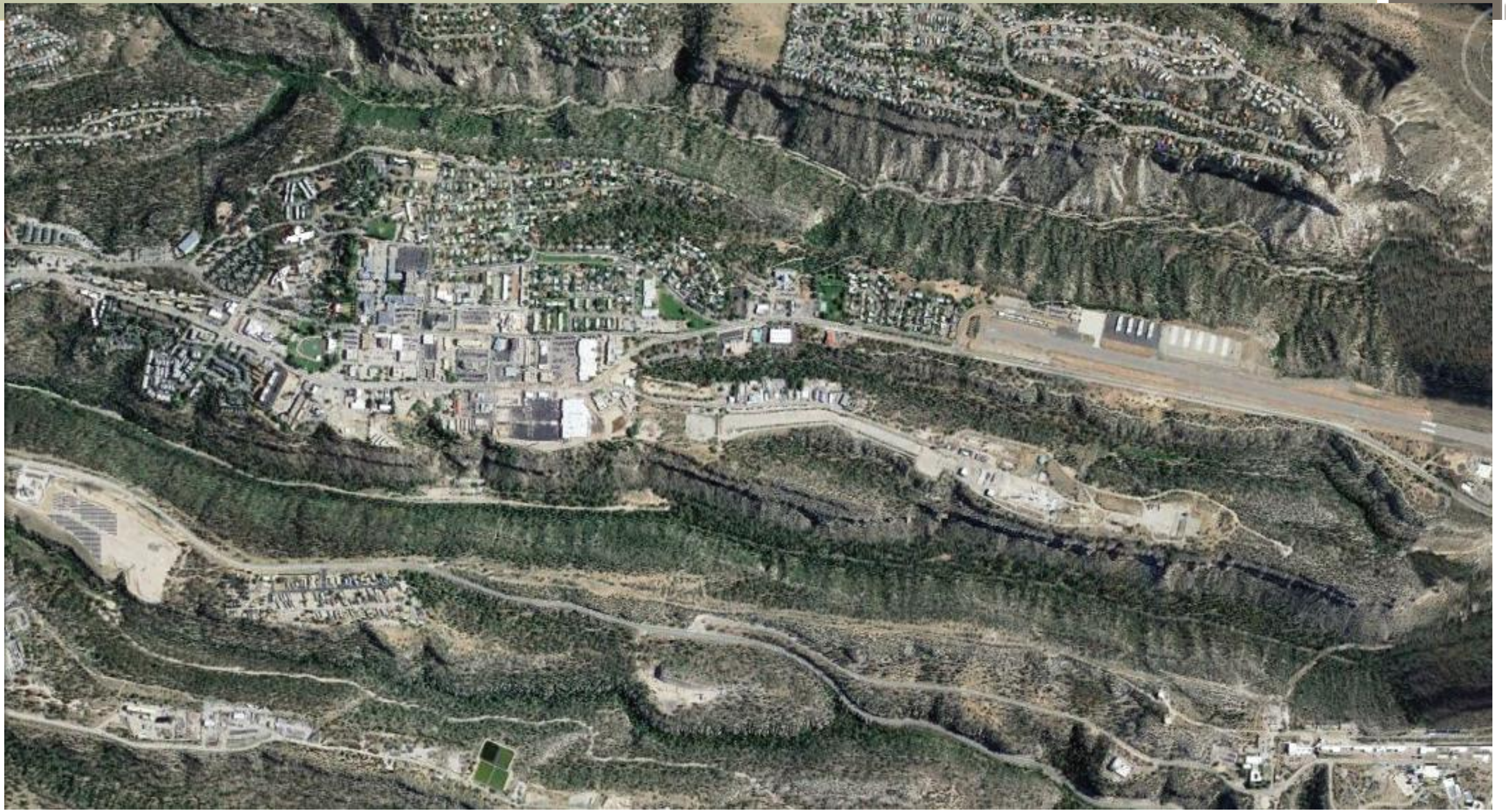
LANL – Legacy of Contamination



LAHDRA report (CDC, 2010); LA &Pueblo Canyons Investigation Report (LANL, 2004)

LANL – The Manhattan Project

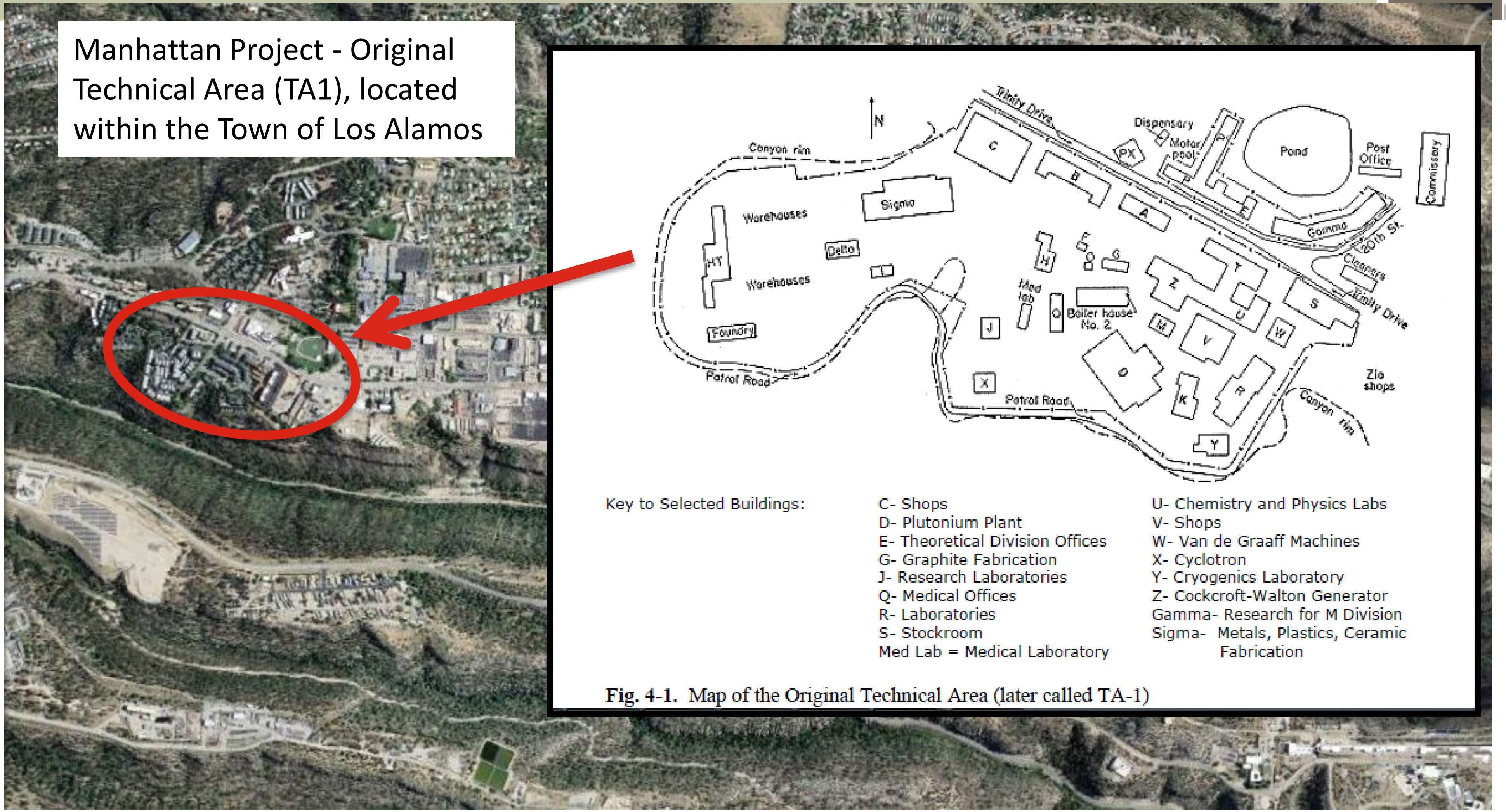
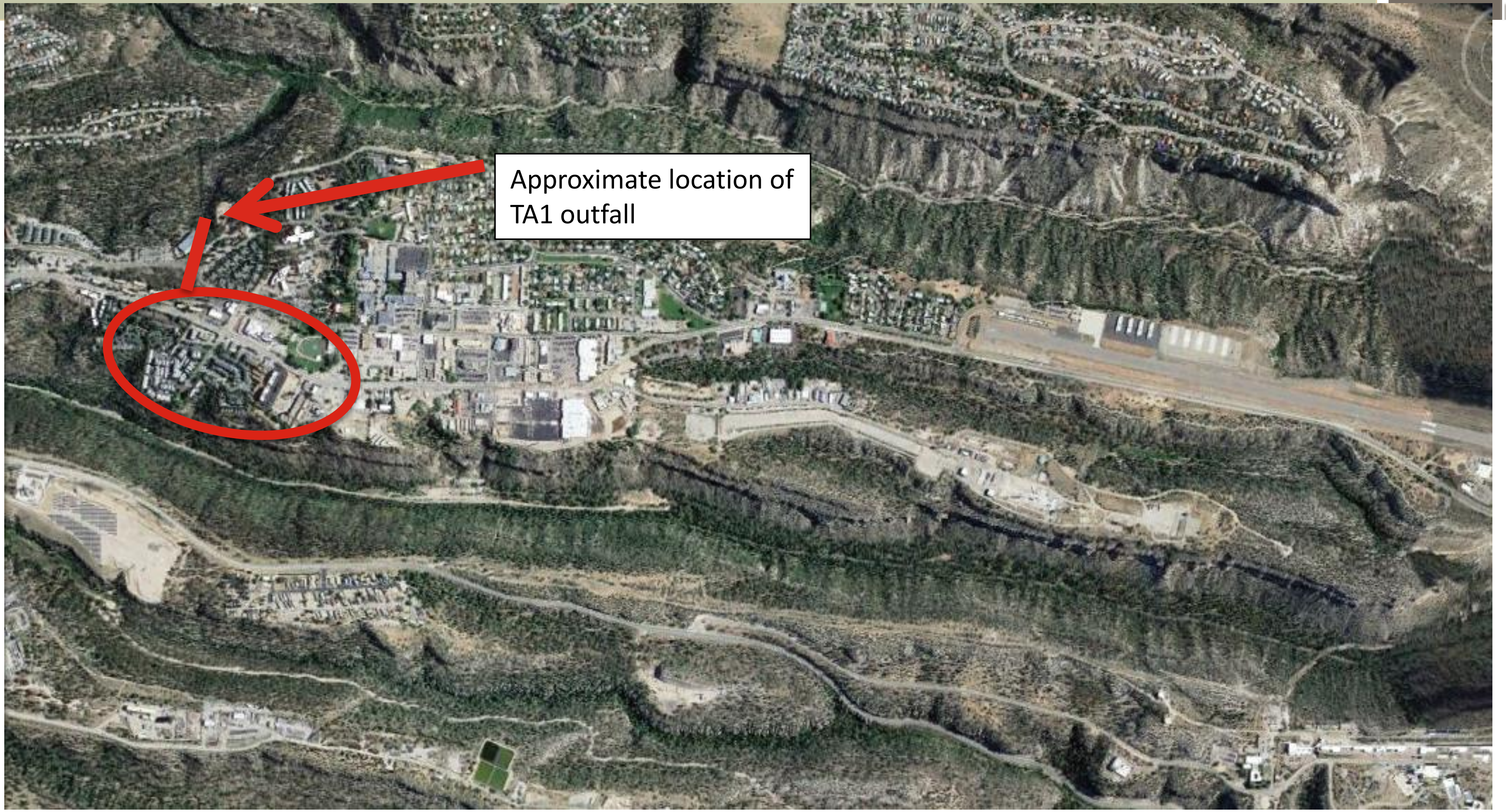


Fig. 4-1. Map of the Original Technical Area (later called TA-1)

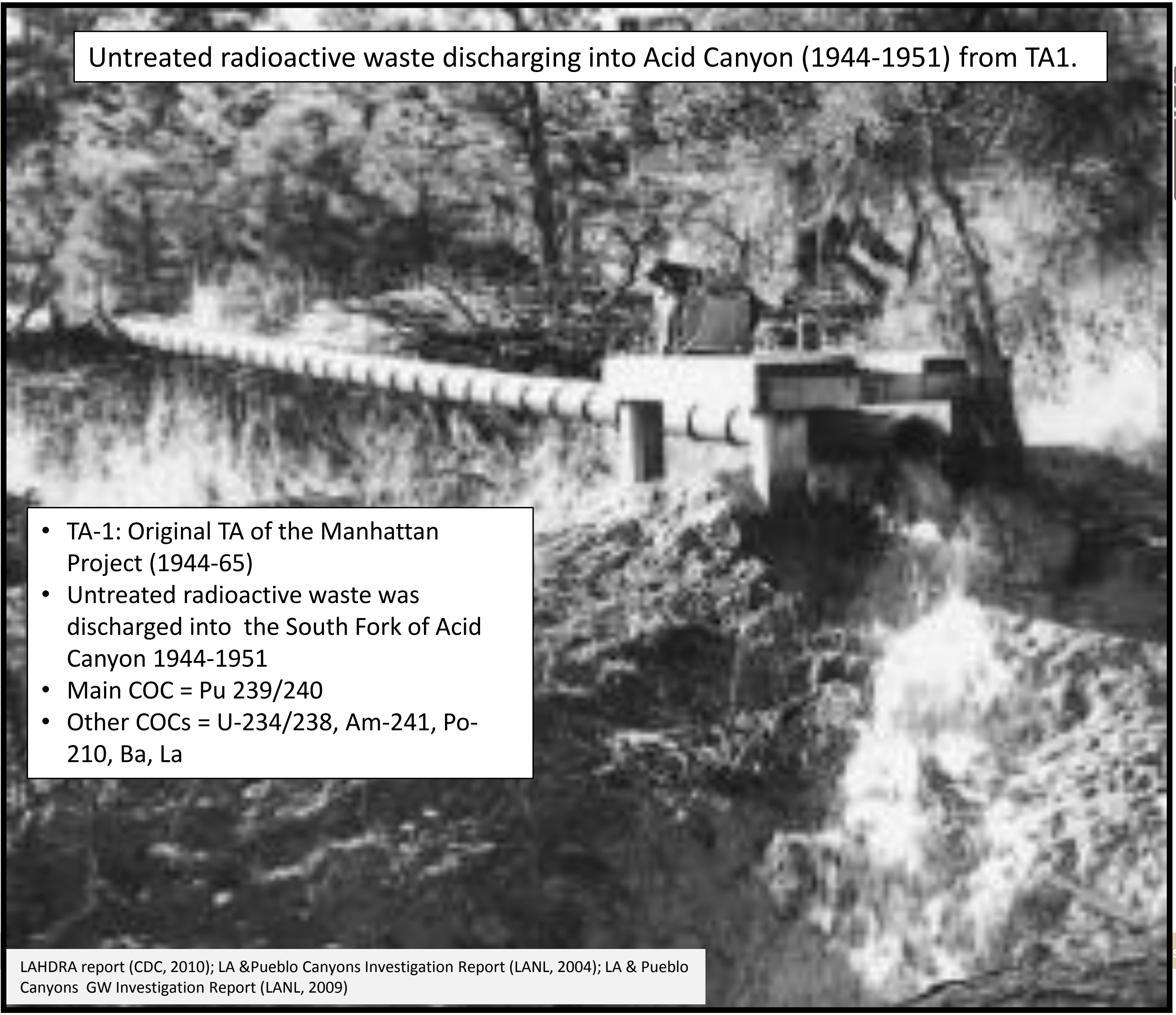
LAHDRA report (CDC, 2010); LA &Pueblo Canyons Investigation Report (LANL, 2004)

LANL – The Manhattan Project



LAHDRA report (CDC, 2010); LA &Pueblo Canyons Investigation Report (LANL, 2004); LA & Pueblo Canyons GW Investigation Report (LANL, 2009)

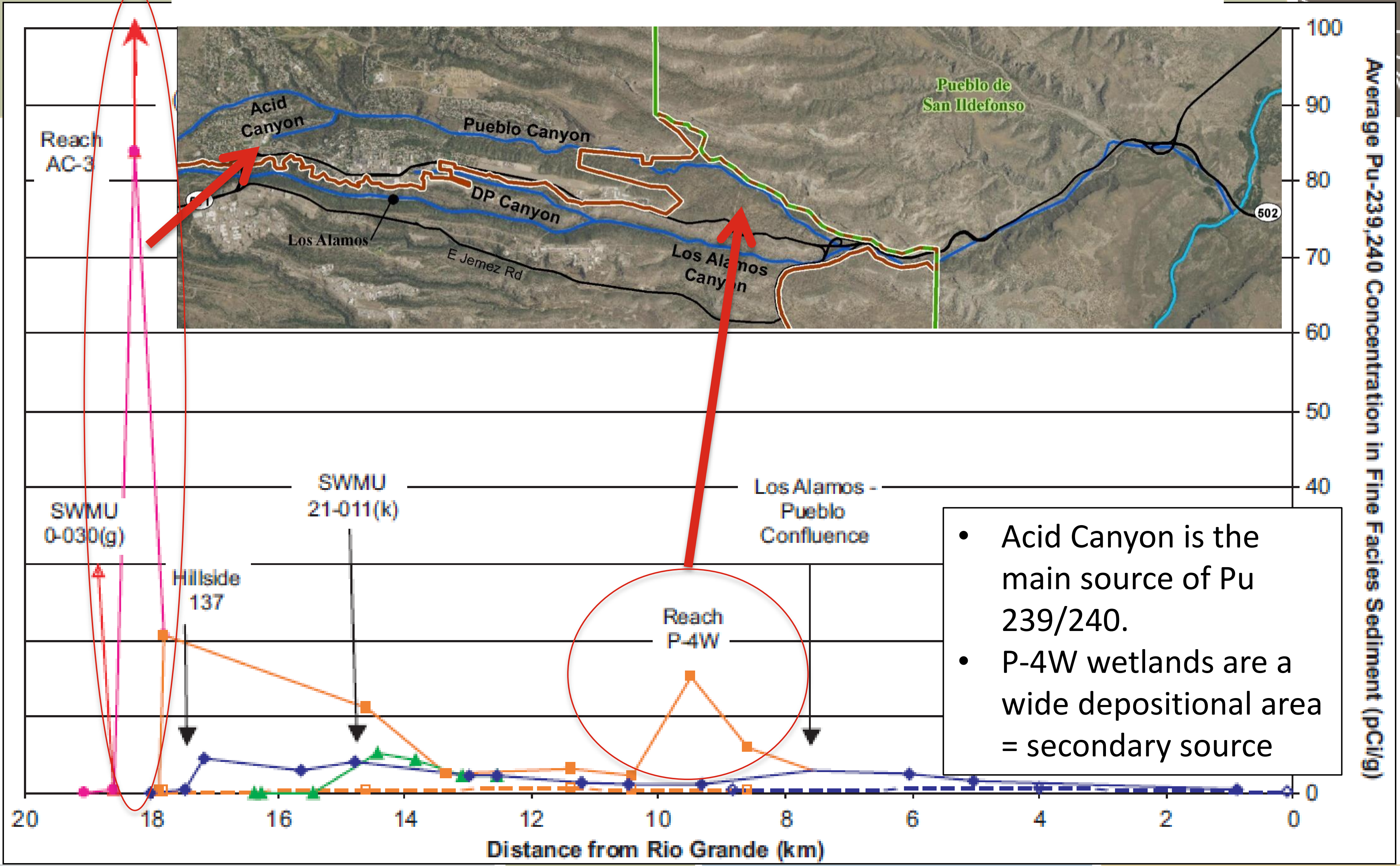
Untreated radioactive waste discharging into Acid Canyon (1944-1951) from TA1.



- TA-1: Original TA of the Manhattan Project (1944-65)
- Untreated radioactive waste was discharged into the South Fork of Acid Canyon 1944-1951
- Main COC = Pu 239/240
- Other COCs = U-234/238, Am-241, Po-210, Ba, La

LAHDRA report (CDC, 2010); LA &Pueblo Canyons Investigation Report (LANL, 2004); LA & Pueblo Canyons GW Investigation Report (LANL, 2009)

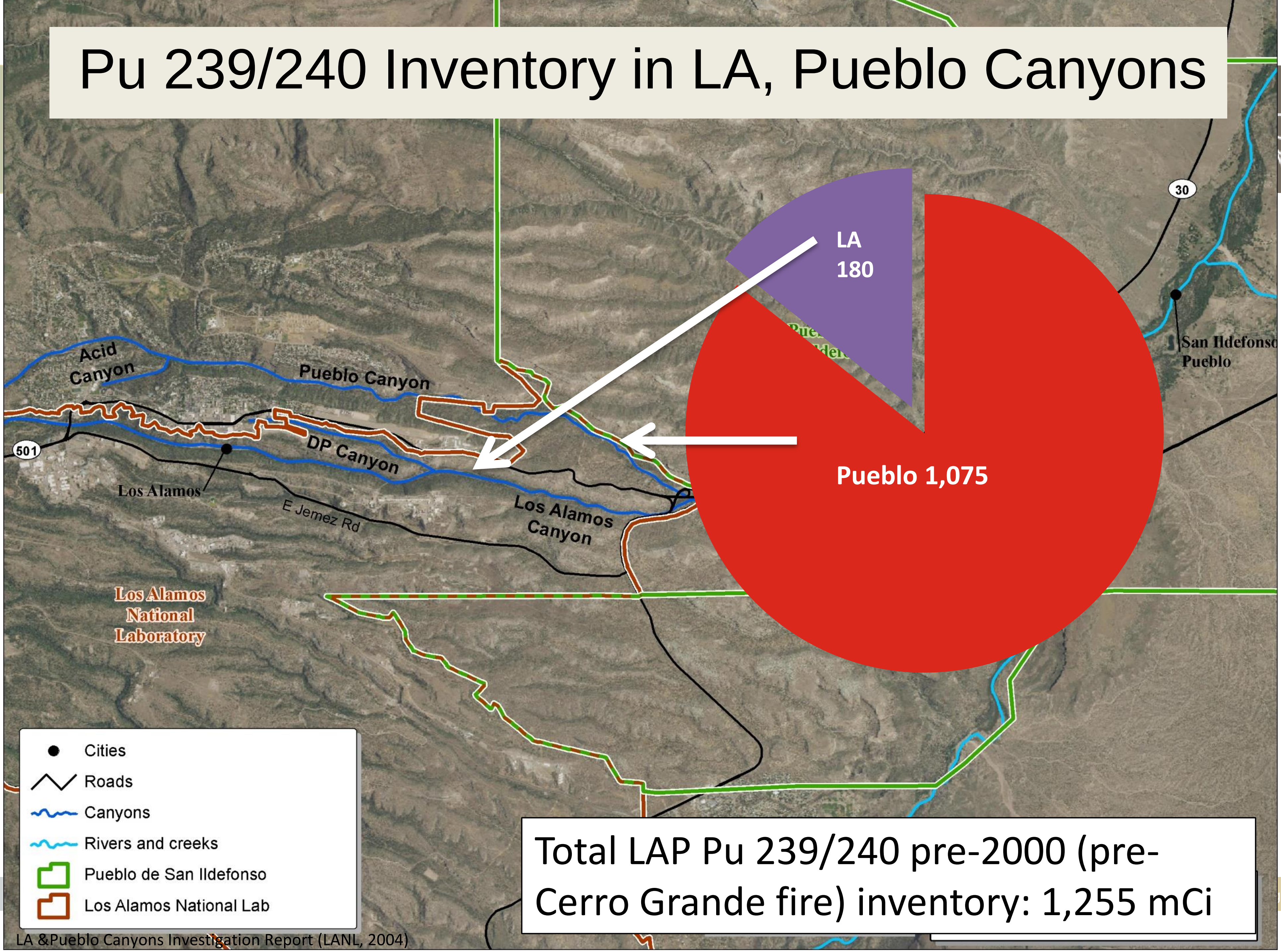
Pu239/240 in Fine Sediment – Pueblo Canyon



- Acid Canyon is the main source of Pu 239/240.
- P-4W wetlands are a wide depositional area = secondary source

LA &Pueblo Canyons Investigation Report (LANL, 2004)

Pu 239/240 Inventory in LA, Pueblo Canyons



Total LAP Pu 239/240 pre-2000 (pre-Cerro Grande fire) inventory: 1,255 mCi

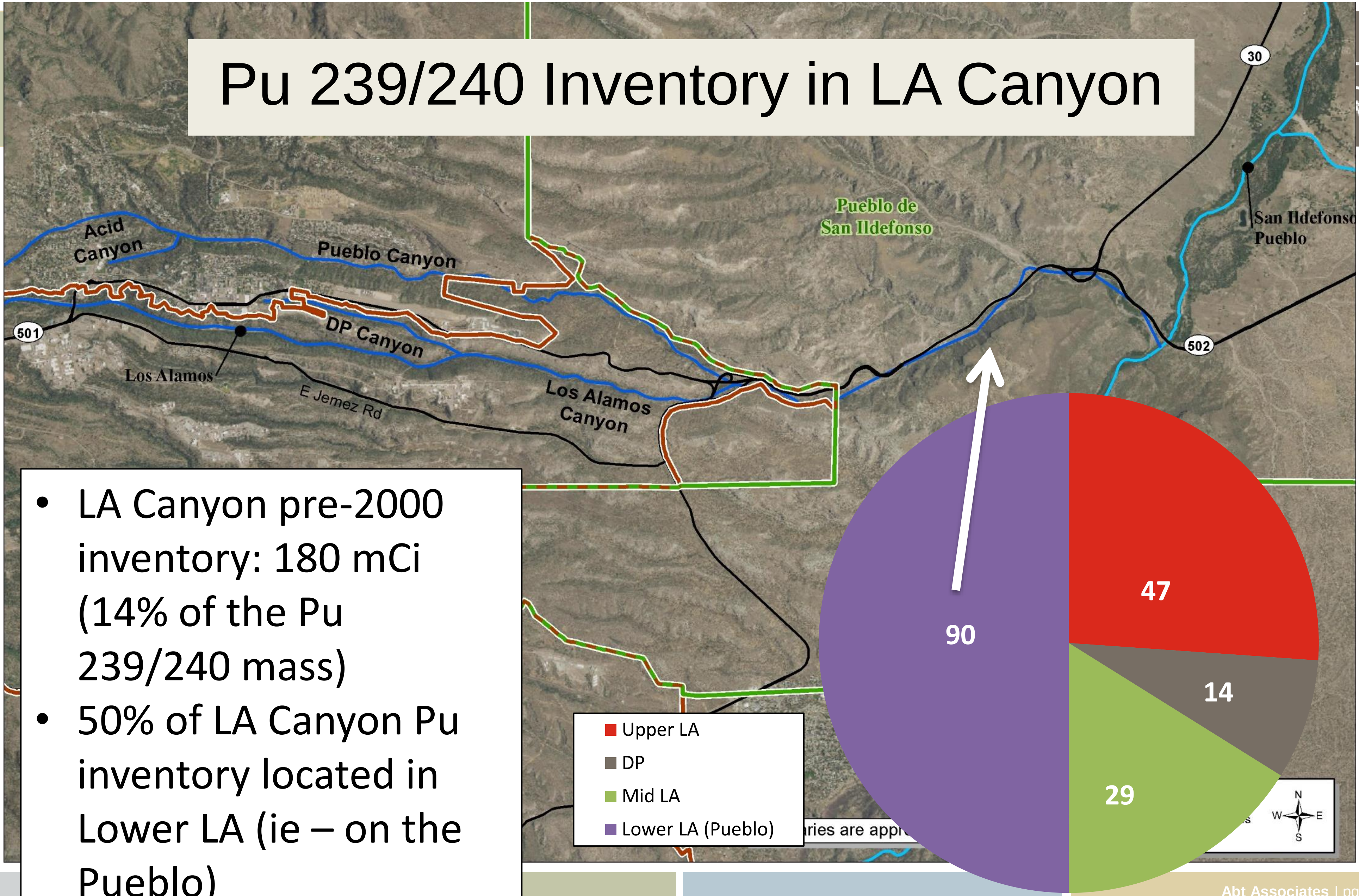
Approximately how much of the LAP Pu mass is on the Pueblo?

5%

10%

50%

Pu 239/240 Inventory in LA Canyon



- LA Canyon pre-2000 inventory: 180 mCi (14% of the Pu 239/240 mass)
- 50% of LA Canyon Pu inventory located in Lower LA (ie – on the Pueblo)

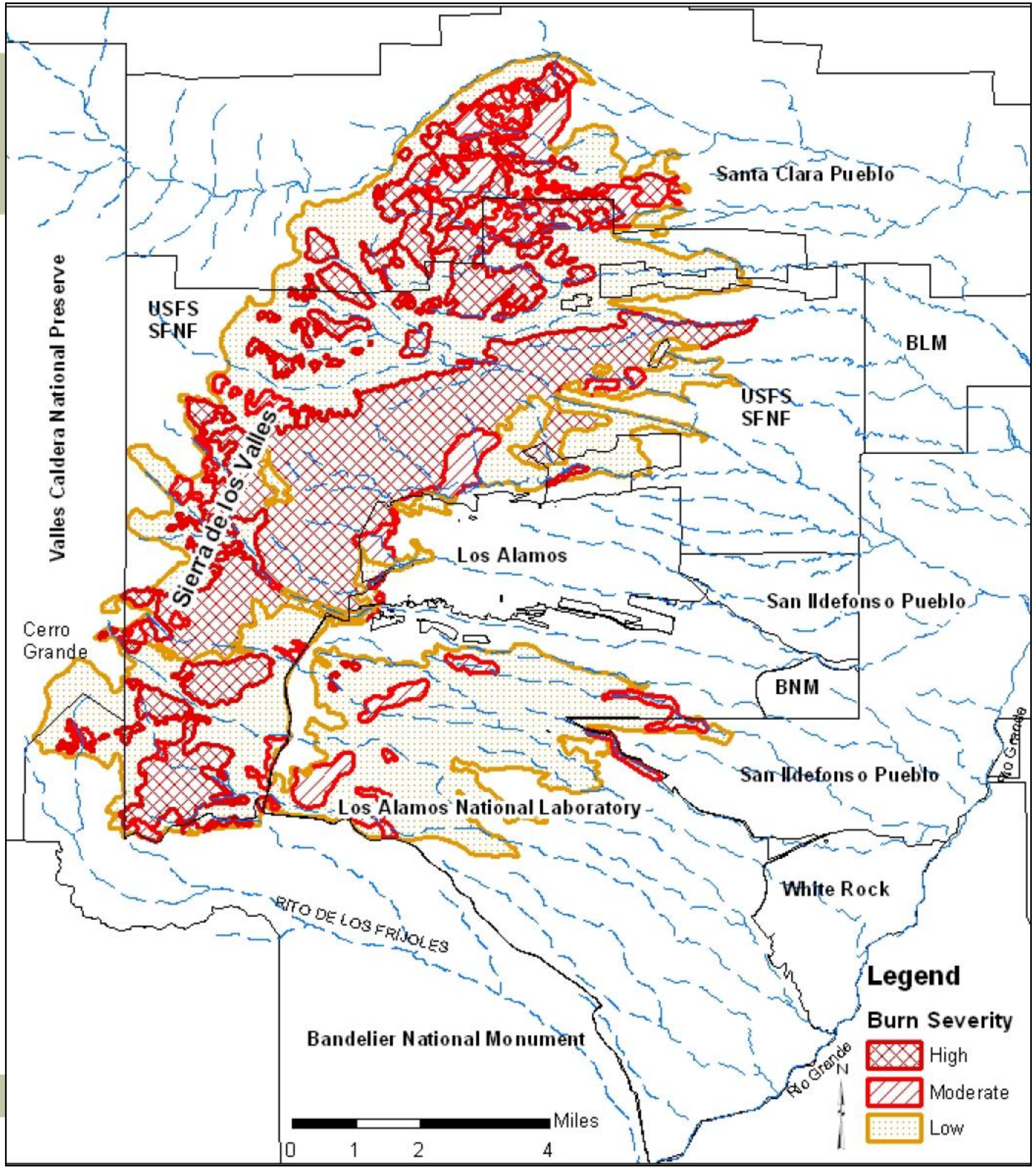
LA &Pueblo Canyons Investigation Report (LANL, 2004)

Cerro Grande Fire – May 2000

https://www.researchgate.net/figure/Cerro-Grande-wildfire-as-it-approached-Los-Alamos-NM-in-2000-This-fire-started-as-a_fig1_265454444

Cerro Grande - Burned Area

- May 4, 2000
- Burned a total of 43,000 acres
- Largest Fire in NM up to that time
- 43% of LAP watershed burned



Gallaher and Koch (2004) Cerro Grande Fire Impacts to Water Quality and Stream Flow near Los Alamos National Laboratory: Results of Four Years of Monitoring

The fire had an impact on runoff, approximately how much higher were peak discharges after the fire?

- 2 times
- 10 times
- 200 times

Impact of Fire on Runoff

2000 runoff after the fire:

- x200 greater peak discharges than previous years
- 50% increase in runoff, despite 13% precipitation decline

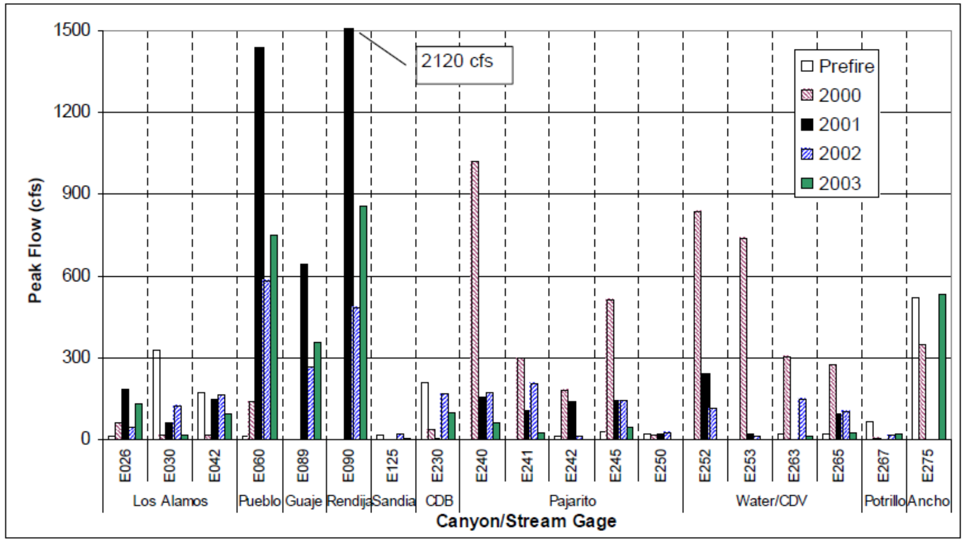


FIGURE 1—Photo showing the vertical incision and channel widening in upper South Fork of Pajarito Canyon following several recent, moderate-intensity storms.

Katzman, et al. 2001. Cerro Grande Ash as a Source of Elevated Rads and metals

Gallaher and Koch (2004) Cerro Grande Fire Impacts to Water Quality and Stream Flow near Los Alamos National Laboratory: Results of Four Years of Monitoring

What are some potential sources of Pu to the Pueblo?

Pu 239/240 Transport

Two sources of Pu 239/240:

- 2000 – Fire-related ash + LANL-contaminated soils
  - Ash was contaminated with both global fallout and legacy aerial deposition
- Post-2000 – LANL-contaminated soils
  - Soils and sediments contaminated by LANL releases

Gallaher and Koch (2004) Cerro Grande Fire Impacts to Water Quality and Stream Flow near Los Alamos National Laboratory: Results of Four Years of Monitoring

After the fire Pu concentrations were approximately how much higher than before the fire?

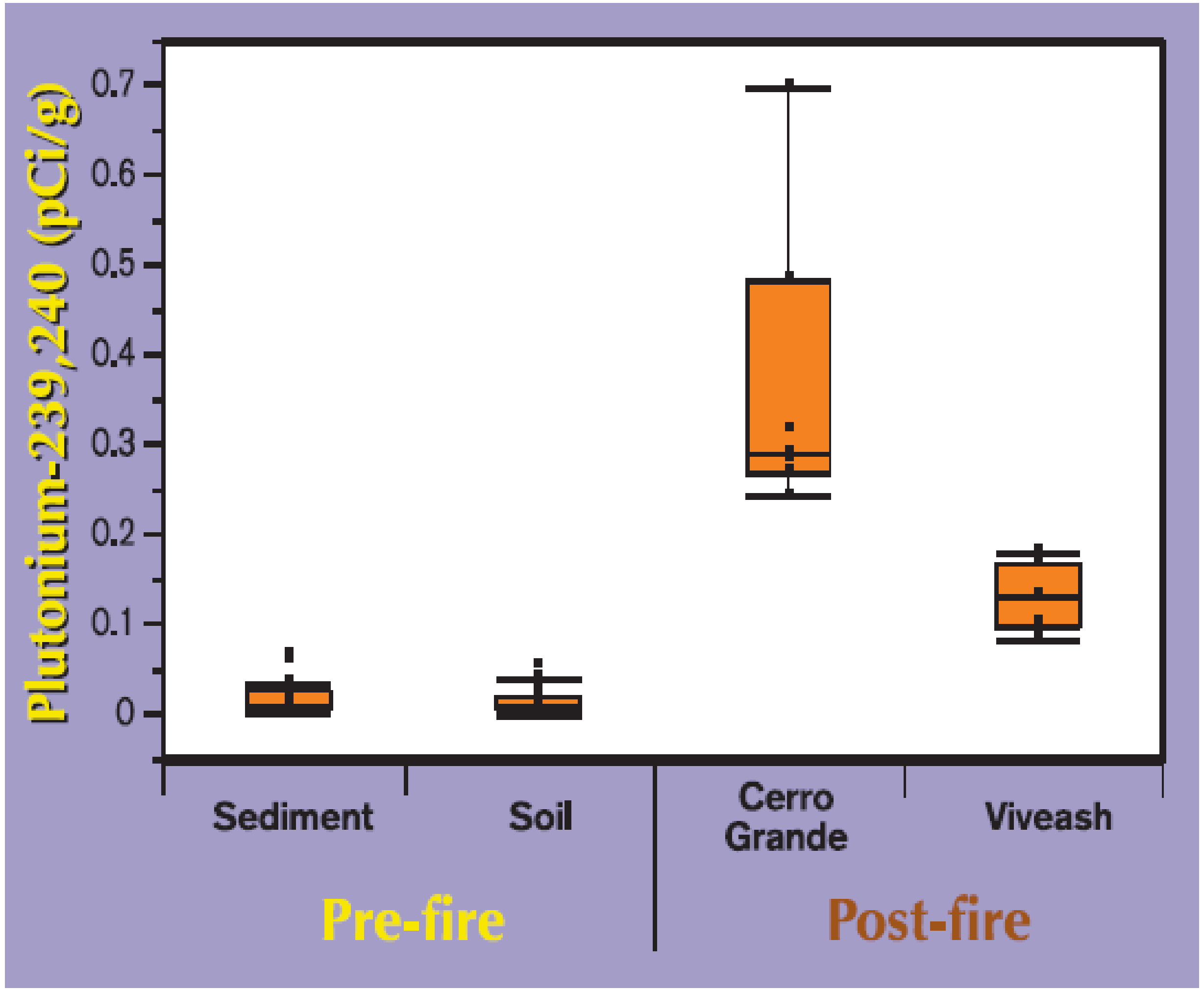
50%

2 times

10 times

Pu 239/240 in Ash (in 2000)

- Pu 239/240 Concentrations in ash is higher than other fires
- Surrounding burned forest had elevated Pu 239/240 levels due to LANL aerial deposition
- Pu239/240 in ash is a combination of global fallout and LANL aerial deposition



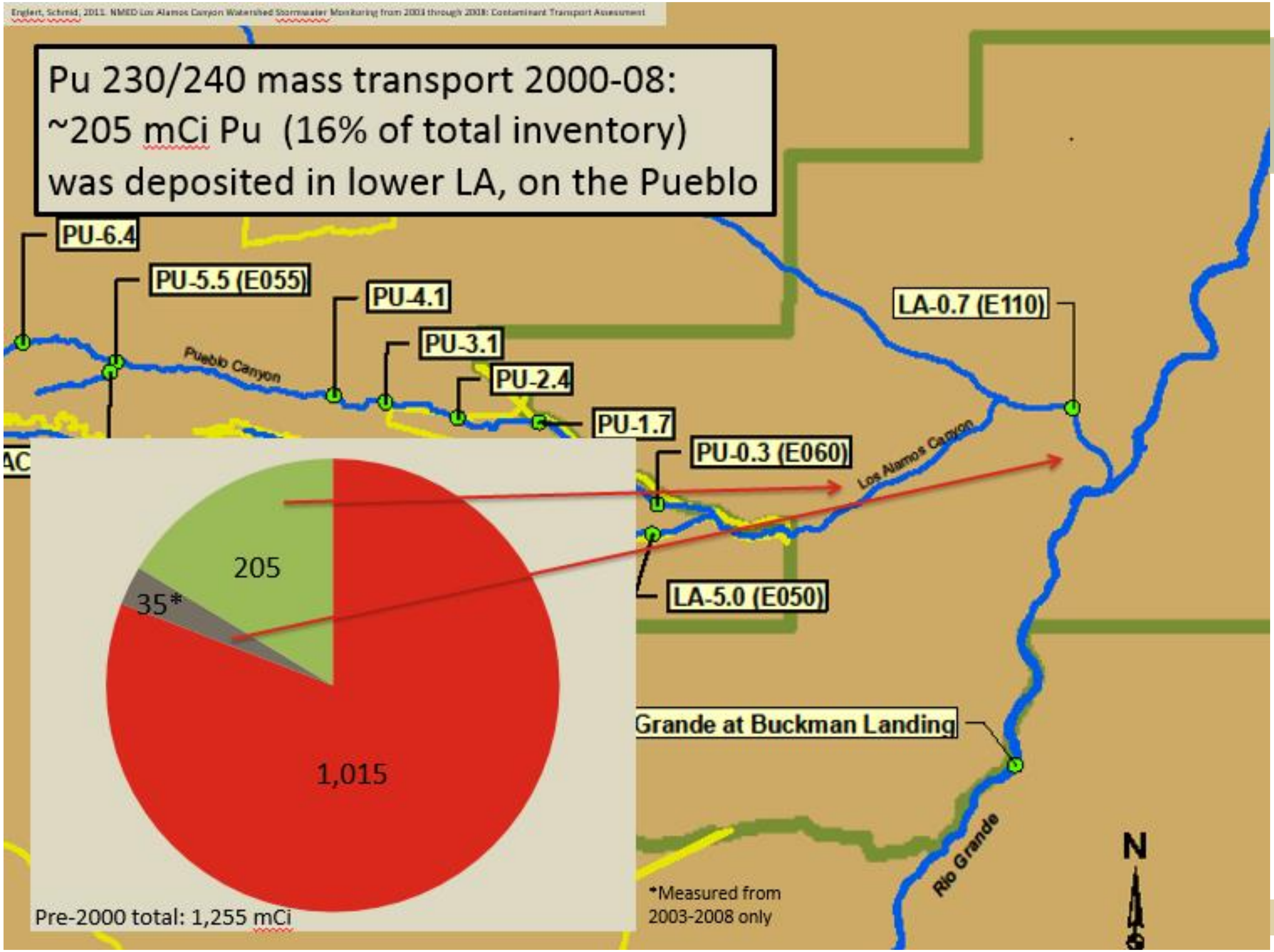
Katzman, et al. 2001. Cerro Grande Ash as a Source of Elevated Rads and metals

Approximately how much Pu was transported 2000-2008?

4%

16%

50%

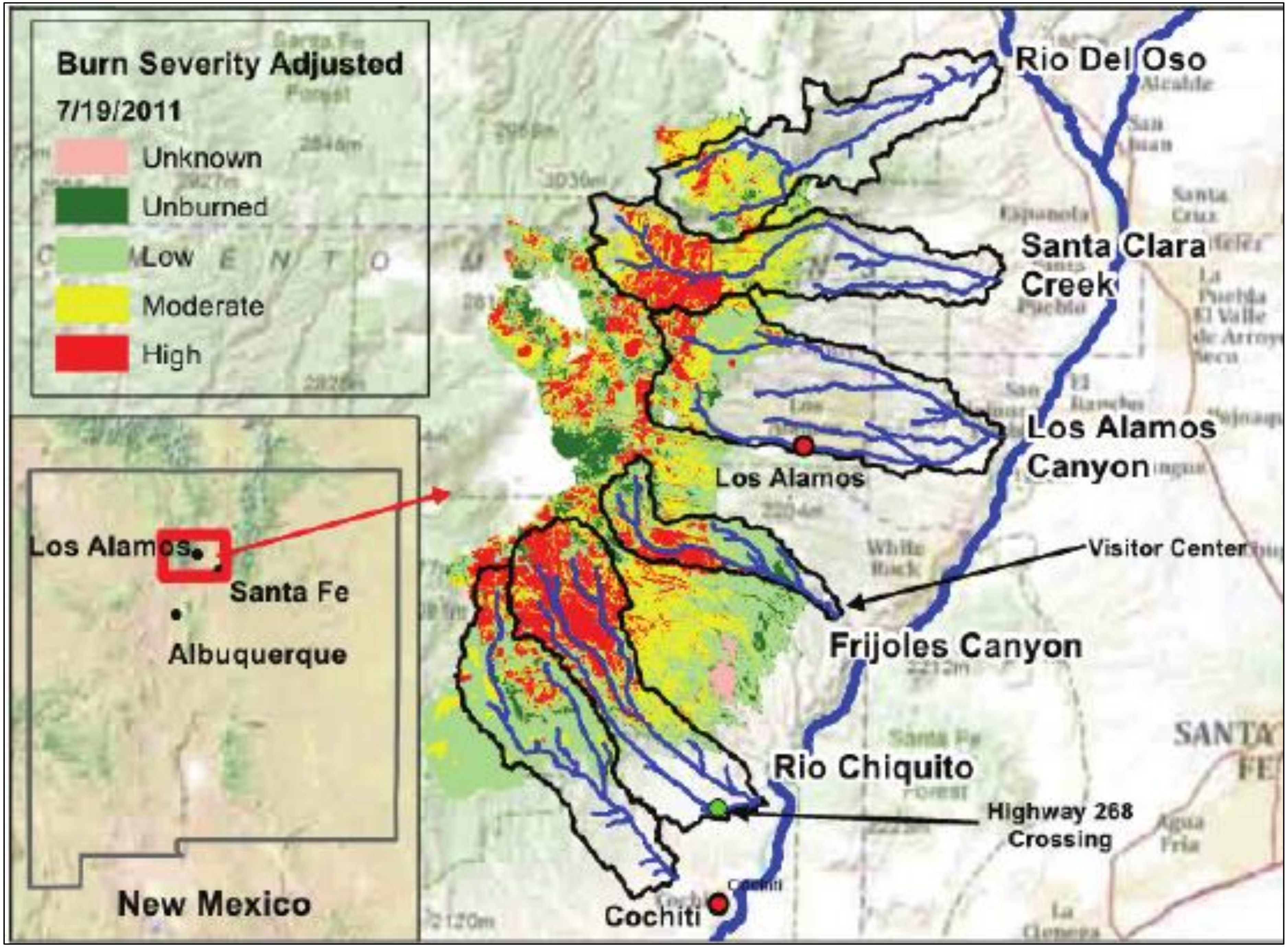


- >95% of radionuclides were bound to suspended sediment (SS) in the runoff
- Rads and metals correlated with clay and organic matter in SS
- Potentially significant for clay gathering

2011 Las Conchas Fire

- June 26, 2011 - Aug 1, 2011
- Jemez Mountains 10 mi west of LANL
- Burned 156,600 acres (largest fire in NM history at the time)
  - No burn within LANL

http://wildfiretoday.com/wp-content/uploads/2013/07/Las-Conchas-Fire-July-14-2011-Photo-by-Andrew-Ashcraft_145-sm.jpg



https://www.researchgate.net/publication/274344517_KINEROS2AGWA_model_use_calibration_and_validation/figures?lo=1

2013 Flood

- 1,000 yr event
- Occurred September 12-13, 2013
- 8.72 inches precipitation
- 350% of the average precipitation for September
- Wettest September on record
- Antecedent storm on Sept 10 saturated soils

https://www.weather.gov/abq/2013SeptemberFlooding-LosAlamosCounty

LANL, 2013 Environmental Surveillance Report

2013 Flood – LAP Damage

- Significant damage as a result of the flood:

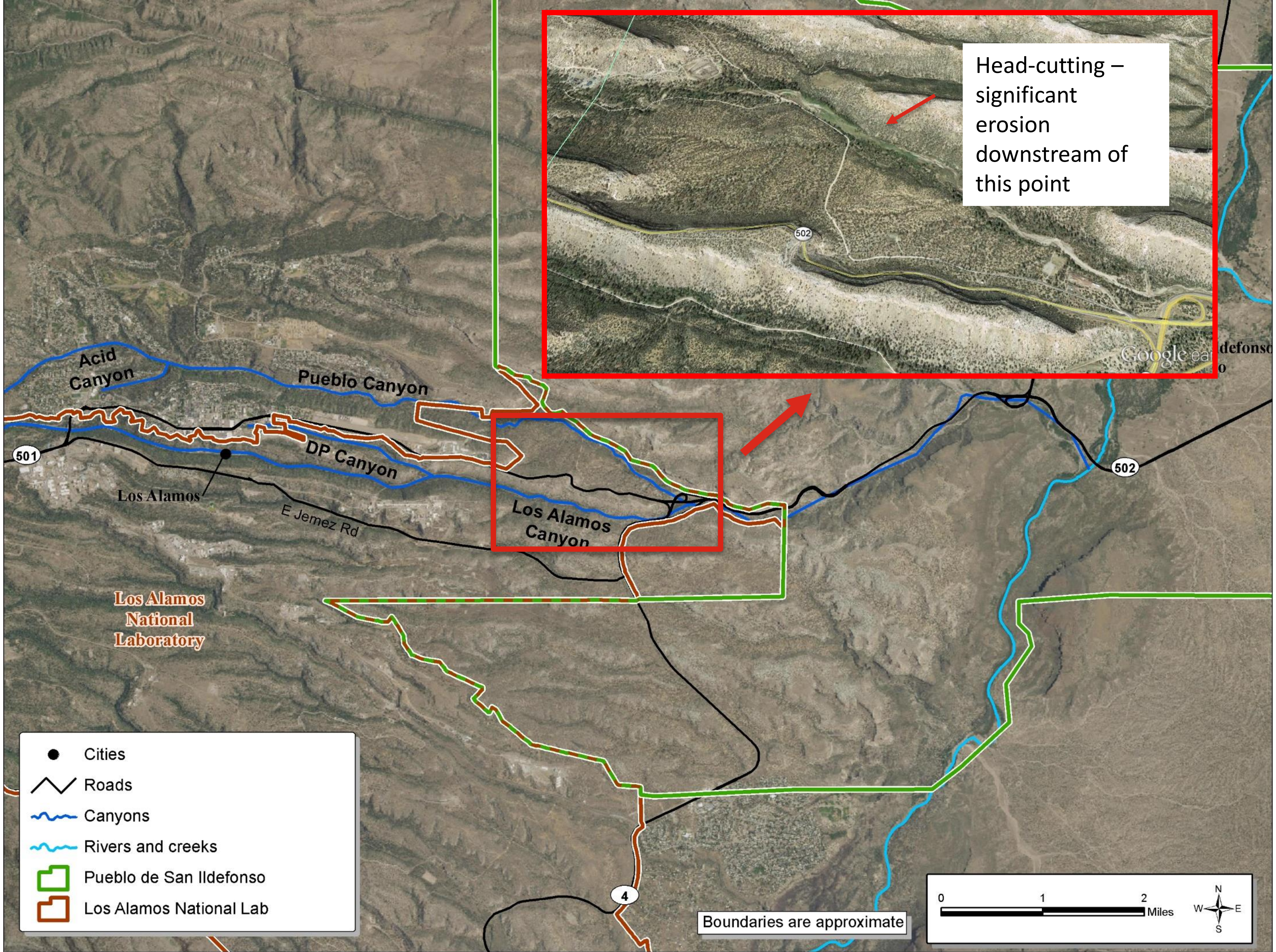
Pueblo Canyon, E060.1

LA Canyon Weir

Lower Pueblo Canyon

Walterscheid, 2015 September 2013 Storm and Flood Assessment Report

LANL, 2013 Environmental Surveillance Report


Head-cutting – significant erosion downstream of this point
502
Acid Canyon
Pueblo Canyon
DP Canyon
Los Alamos
E Jemez Rd
Los Alamos Canyon
501
502
4
Los Alamos National Laboratory
Cities
Roads
Canyons
Rivers and creeks
Pueblo de San Ildefonso
Los Alamos National Lab
Boundaries are approximate
0
1
2
Miles
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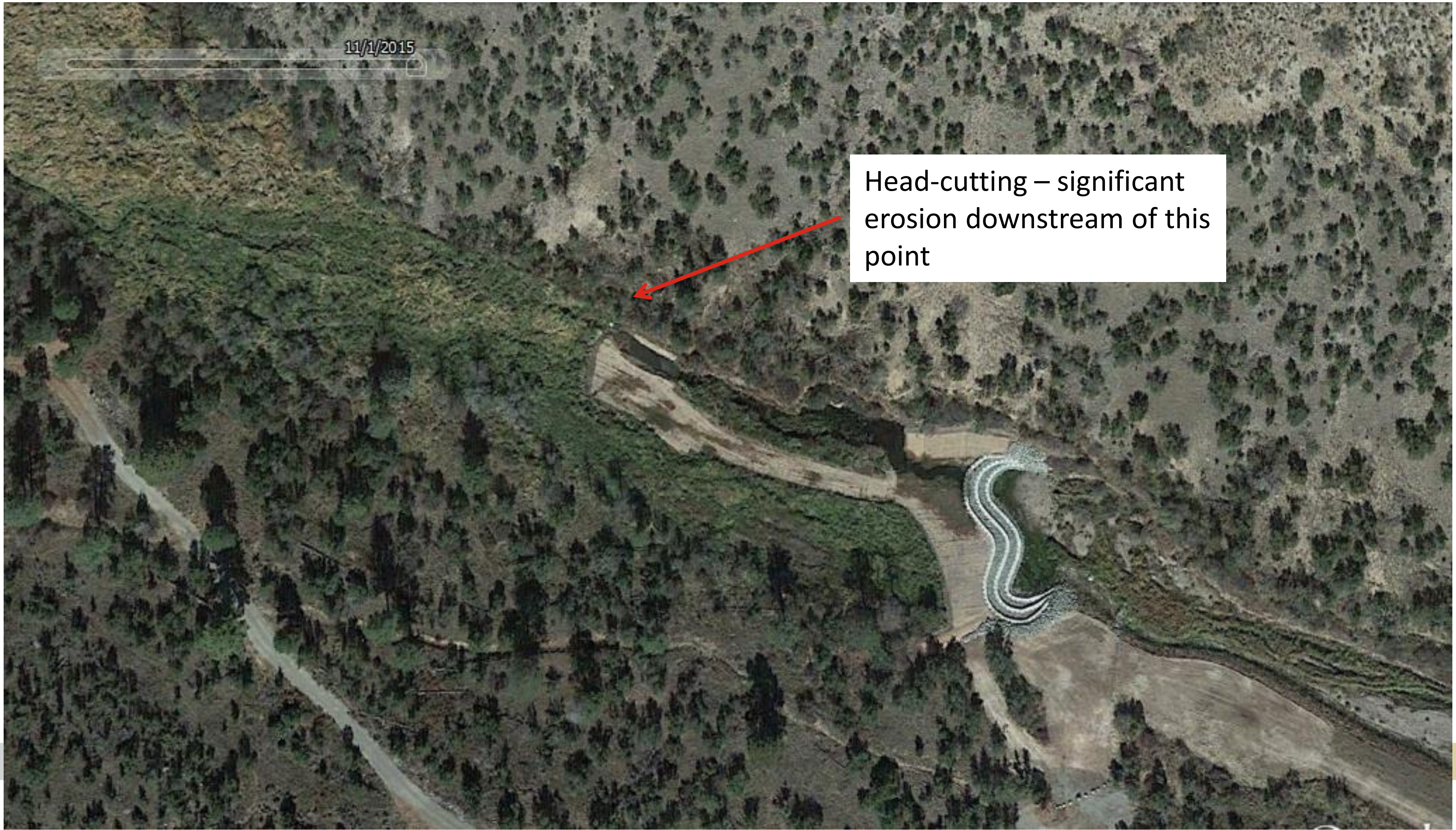
W

2013 Flood – Erosion in LAP
Pre-Flood (5/4/2012)

2013 Flood – Erosion in LAP
Post-Flood (11/1/2015)



2013 Flood – Erosion in LAP
Pre-Flood (5/4/2012)

2013 Flood – Erosion in LAP
Post-Flood (10/3/2013)

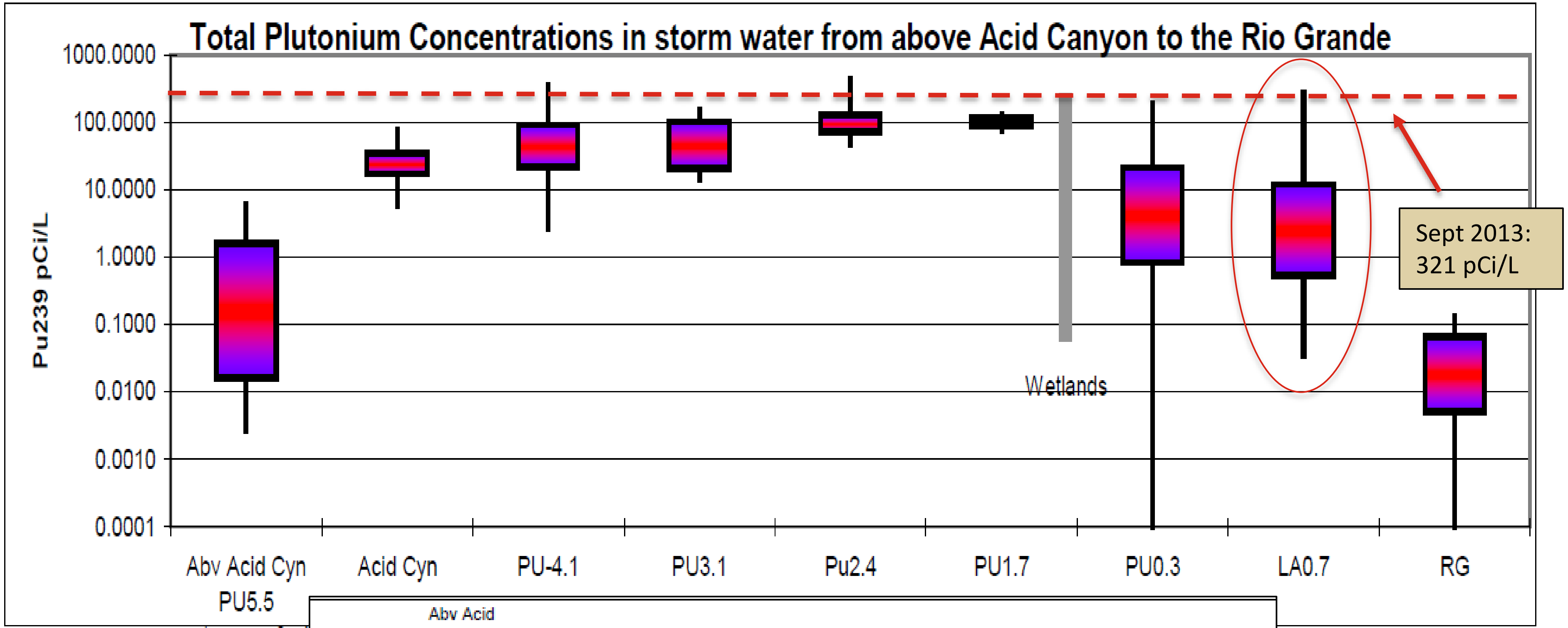
2013 Flood – Pu 239/240

Impacts of the flood on:

- Stormwater concentrations
- Estimated mass transport
- Sediment concentrations

2013 Flood – Pu 239/240 Stormwater Concentrations

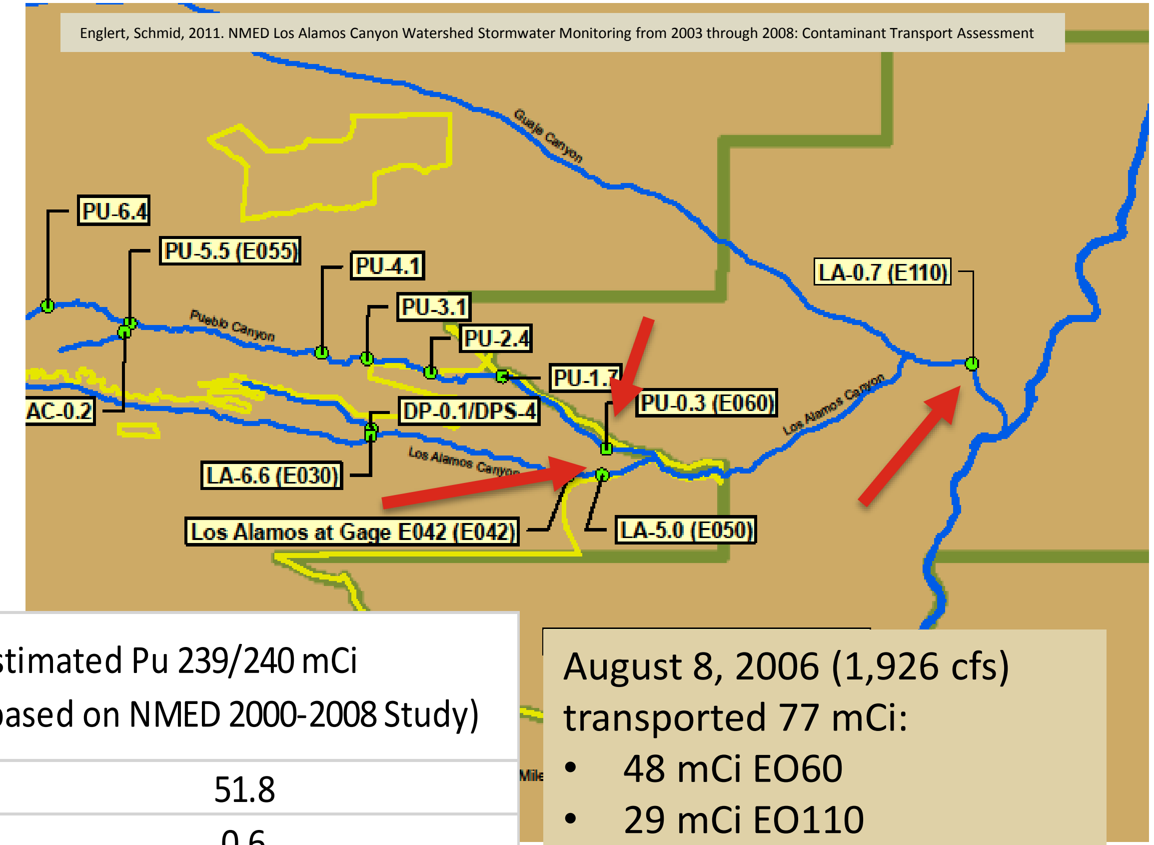
Pu in stormwater is higher than measured after the Cerro Grande Fire (2000-2008)



	Abv Acid Cyn PU5.5	Acid Cyn	PU-4.1	PU3.1	Pu2.4	PU1.7	PU0.3	LA0.7	RG
25th	0.0160	17	21.50	20.25	71.17	89.20	0.83	0.527	0.005
Max	5.8300	78	359.06	155.79	423.96	131.78	187.00	273.000	0.130
Min	0.0027	6	2.62	14.00	48.04	75.00	0.00	0.035	0.000
75th	1.6000	35	90.55	102.50	128.00	117.59	21.00	11.960	0.066
count	21	14	23	8	17	2	77	57	9
ave	1.02	28.96	73.71	63.60	118.84	103.39	15.38	18.90	0.041

2013 Flood – Pu 239/240 ***Estimated*** Mass Transport

- Used Pu 239/240 flow correlation from NMED Cerro Grande study (2000-2008) for gage stations EO60, EO50 and EO110
- Peak discharge data from LANL (2015), *"Surface Water Data, Water Year 2013"*



Gage	Flow Rate (CFS)	Estimated Pu 239/240 mCi (based on NMED 2000-2008 Study)
E060	1400	51.8
E050	740	0.6
E0110	5000	87.5

August 8, 2006 (1,926 cfs) transported 77 mCi:
- 48 mCi EO60
- 29 mCi EO110

Significant mass may have been transported onto the Pueblo. This storm may have also transported significant Pu into the Rio Grande

Post Sept 2013 Flood Pu 239/240 Sediment Concentration with Depth

Pu 239/240 (pCi/g)	Top Depth (cm)	Bottom Depth (cm)
0.264	0	15
0.0781	15	35

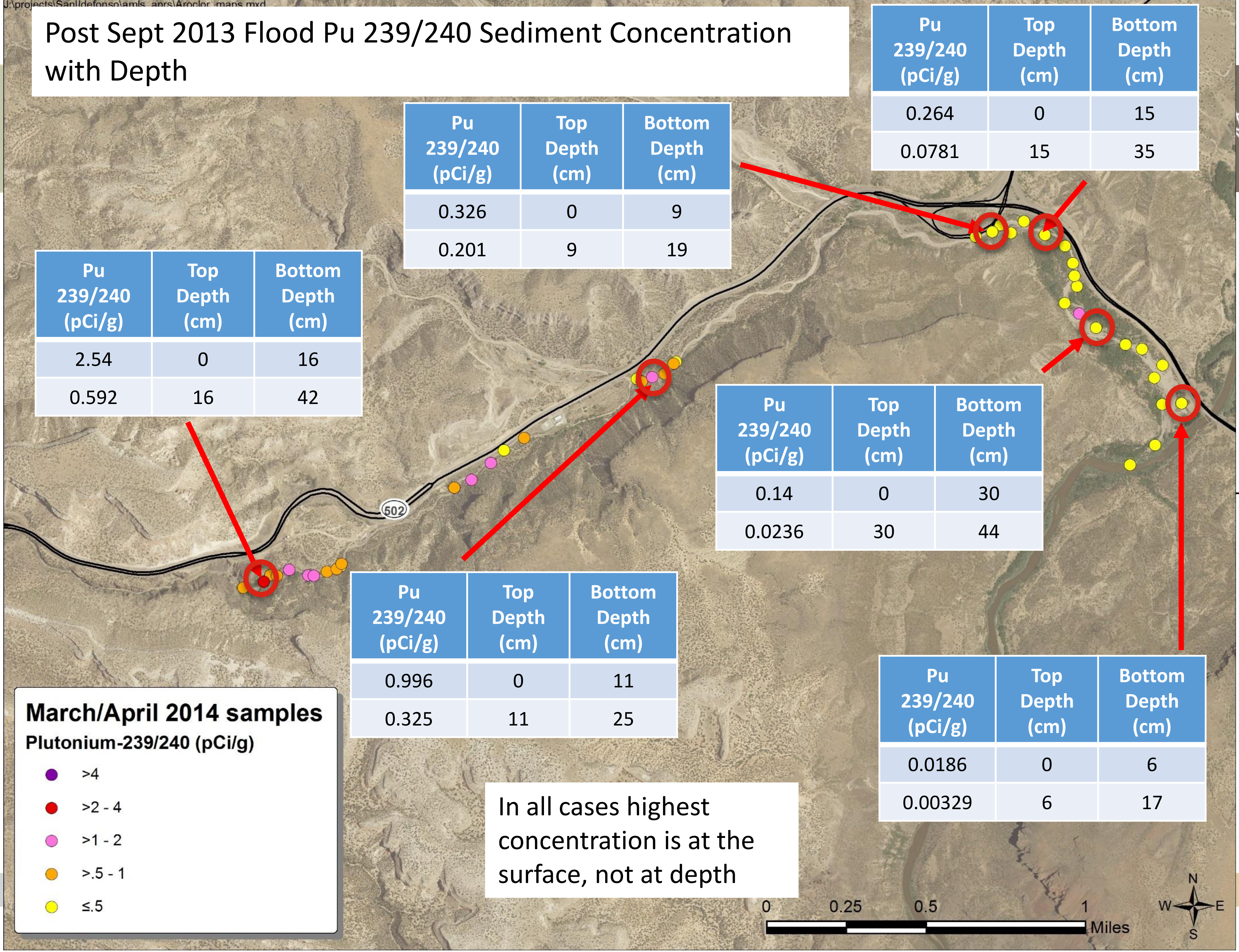
Pu 239/240 (pCi/g)	Top Depth (cm)	Bottom Depth (cm)
0.326	0	9
0.201	9	19

Pu 239/240 (pCi/g)	Top Depth (cm)	Bottom Depth (cm)
2.54	0	16
0.592	16	42

Pu 239/240 (pCi/g)	Top Depth (cm)	Bottom Depth (cm)
0.14	0	30
0.0236	30	44

Pu 239/240 (pCi/g)	Top Depth (cm)	Bottom Depth (cm)
0.996	0	11
0.325	11	25

Pu 239/240 (pCi/g)	Top Depth (cm)	Bottom Depth (cm)
0.0186	0	6
0.00329	6	17



In all cases highest concentration is at the surface, not at depth

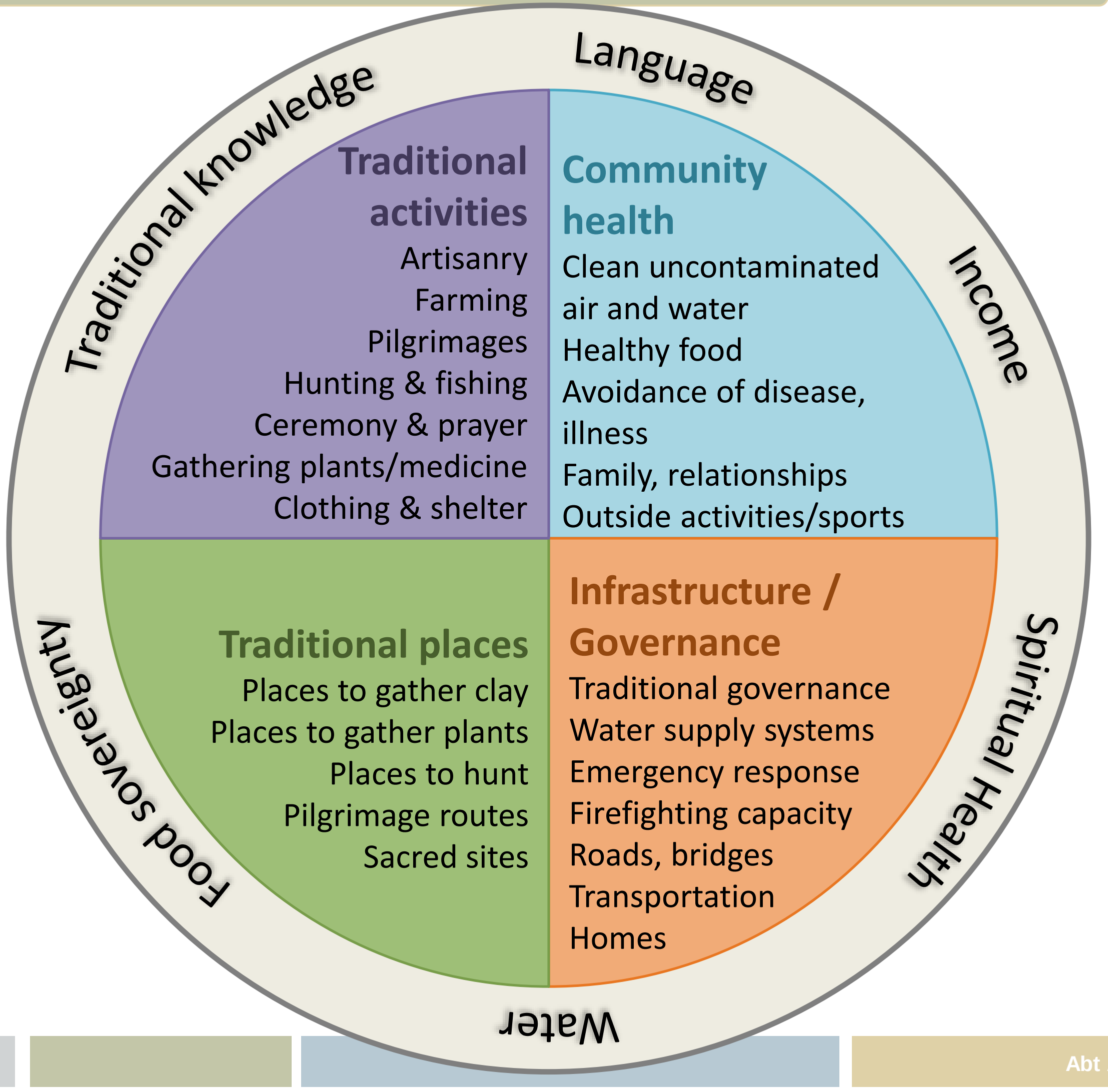
Summary

Cycles of wildfire and storm/flooding events have influenced Pu 239/240 transport in Pueblo and Los Alamos canyons, affecting the Pueblo de San Ildefonso lands

Adaptation Strategy

Community Vision

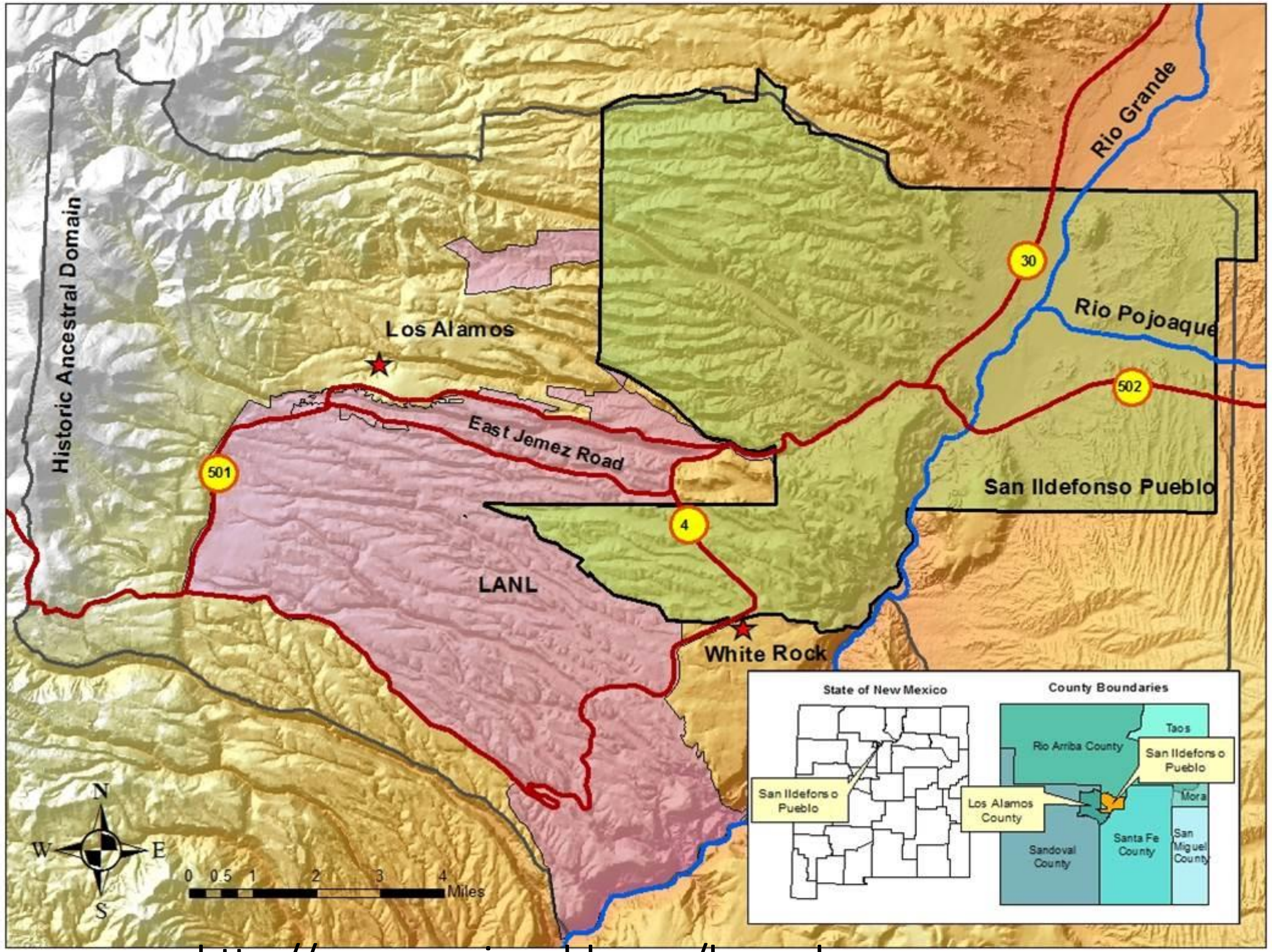
The Pueblo is developing an Adaptation Strategy that tiers from the Community's Vision



Preliminary Adaptation Strategies

Adaptation measures to address LANL contamination:

- Coordinate with LANL on contaminant transport mitigation actions (e.g. stabilization of contaminated wetlands, flood control structures)



http://www.sanipueblo.org/boundary-map.aspx

Preliminary Adaptation Strategies

Adaptation measures in coordination with LANL:

- Targeted actions (veg removal, erosion control, etc.) to protect cultural resources within LANL boundaries and downstream of LANL
- Ensure that Pueblo tribal cultural resource staff are on emergency response teams (to avoid destruction of cultural sites by fire line roads, etc.)

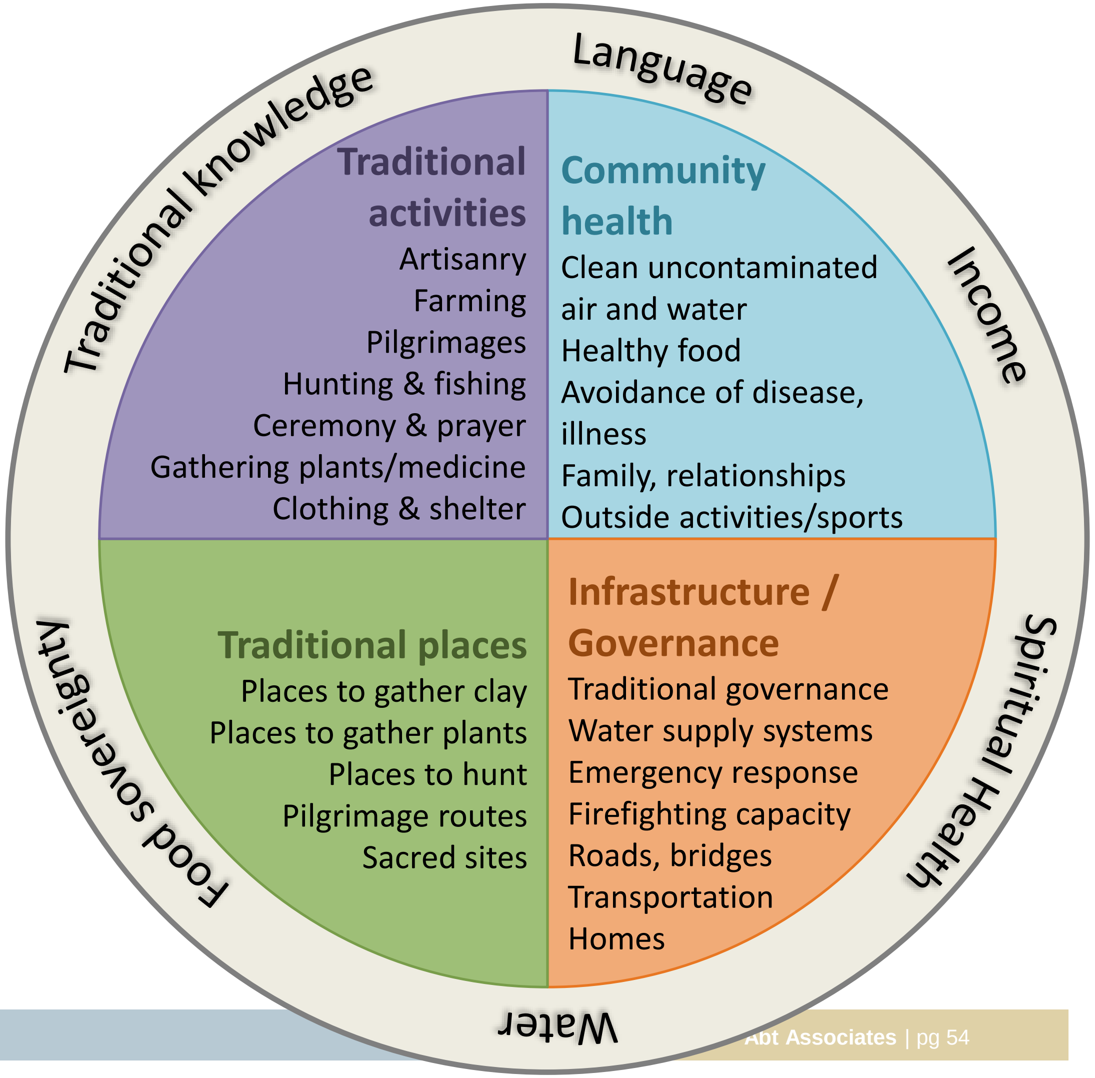
Willow planting to stabilize contaminated wetlands

https://www.energy.gov/sites/prod/files/2016/04/f30/CC_at%20LANLCase%20Study2-23-15final.pdf

Preliminary Adaptation Strategies

Additional adaptation measures to address LANL contamination on Pueblo Lands:

- Environmental monitoring on Pueblo lands
- Identify alternative resource-gathering areas
- Outreach within the community regarding contaminant levels



Preliminary Adaptation Strategies

- Over-arching approach: Integrate adaptation measures into all aspects of governance, infrastructure & resource management
    - Master land use plan – housing, farming, etc.
    - Water/waste water management planning; closed systems
    - Communications, energy, transportation
    - Community health planning – physical, spiritual
- Incorporate adaptation considerations into all funding requests/Pueblo financial planning
- Work with the global community – tribal, county, state, federal partners