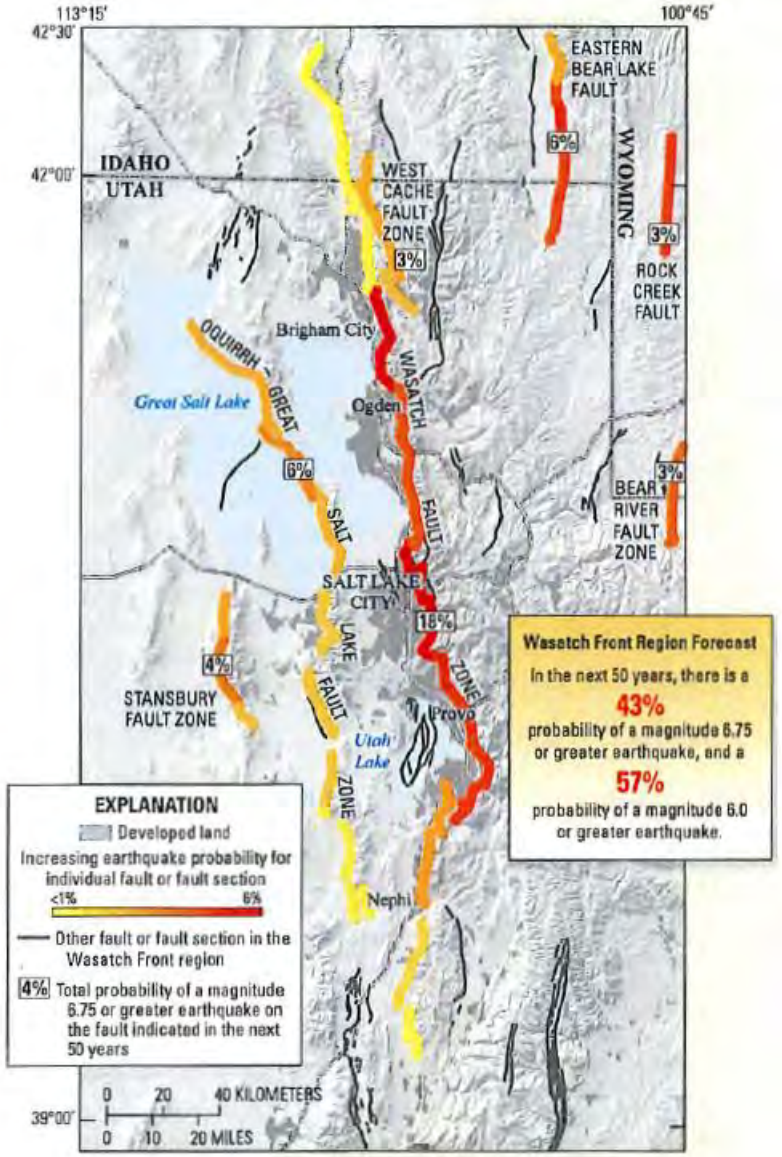
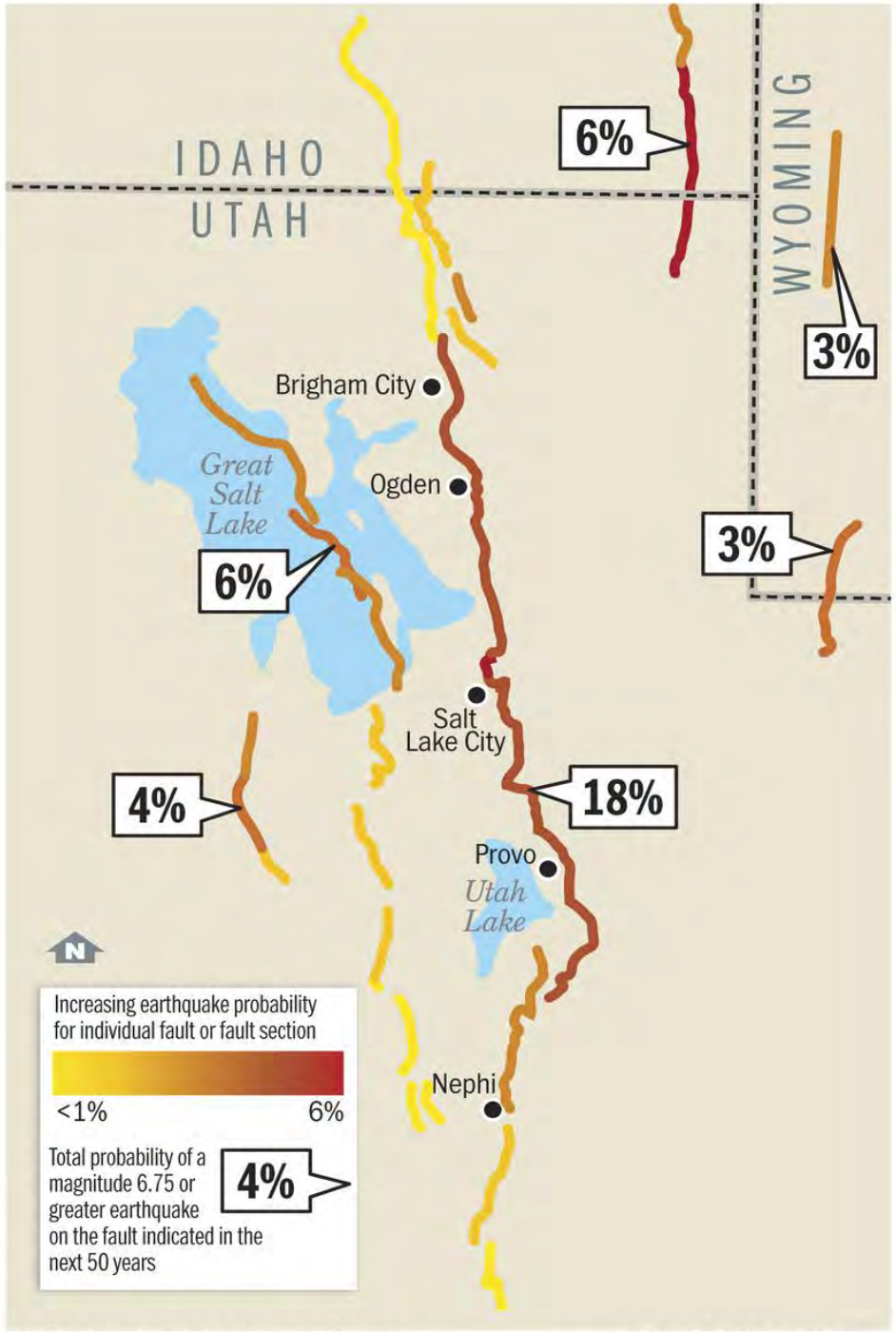


Figure 1. Magnitude 6.75 or greater earthquake probabilities may vary along faults (yellow to red fault colors), but entire fault probabilities are labeled. For example, the total probability for the entire Wasatch fault is 18 percent. Only faults with a probability of 2 percent or greater are shown. Modified from Working Group on Utah Earthquake Probabilities (in press). (%, percent)[14]

Utah Disaster Resilience

Envision Utah How we grow matters.



SOURCE: Working Group on Utah Earthquake Probabilities

DESERET NEWS GRAPHIC

EARTHQUAKE PROBABILITIES

WASATCH FRONT REGION – NEXT 50 YEARS

- **57% chance of a 6.0** or greater quake
- **43% chance of a 6.75** or greater quake

THE "BIG ONE"

- 22 around 7.0 over the past ~6,000 years, once every 300 years
- Last "big one" along the fault was more than 300 years ago

SALT LAKE SEGMENT

- "Big one" every 1300-1500 years; last one was 1400 years ago
- Characteristic magnitude: 7.1 ± 0.2

HAZUS ESTIMATES

7.0 Earthquake along the Wasatch Front

FATALITIES: **2,000-2,500**

CRITICALLY INJURED: **7,400-9,300**

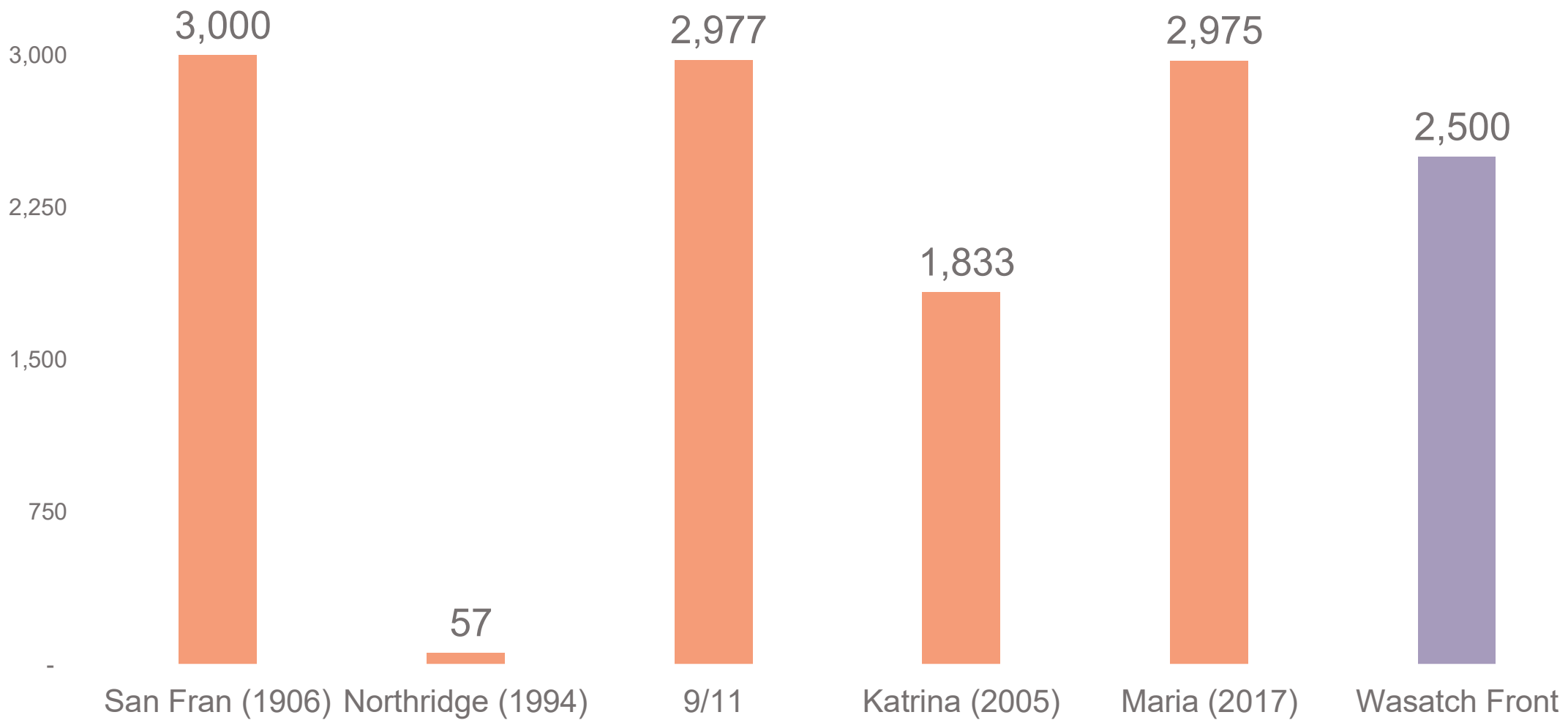
DISPLACED HOUSEHOLDS: **84,400**

HOMES WITHOUT WATER: **480,000 (64 PERCENT)**

HOMES WITHOUT POWER: **444,000 (59 PERCENT)**

FATALITIES IN MAJOR U.S. DISASTERS

Since 1900



LIFELINES — CRITICAL UTILITY SYSTEMS

	DAY 1	DAY 3	DAY 7	DAY 30	DAY 90
Households without **potable water**	483,600	466,100	442,800	362,900	332,800
Households without **electricity**	444,600	251,200	105,900	27,300	80

Natural Gas Restoration to the majority of structures within two weeks

Sewer Restoration time likely 2-3 times that of water restoration

SHORT TERM ECONOMIC LOSS ESTIMATES

Building-Related	$24.9 billion
Income	$6.9 billion
Lifeline-Related	$1.4 billion
TOTAL	**$33.2 billion**

WHY IS UTAH'S RISK SO HIGH?

LOCALIZED POPULATION

- Population and infrastructure concentrated along the Wasatch Front

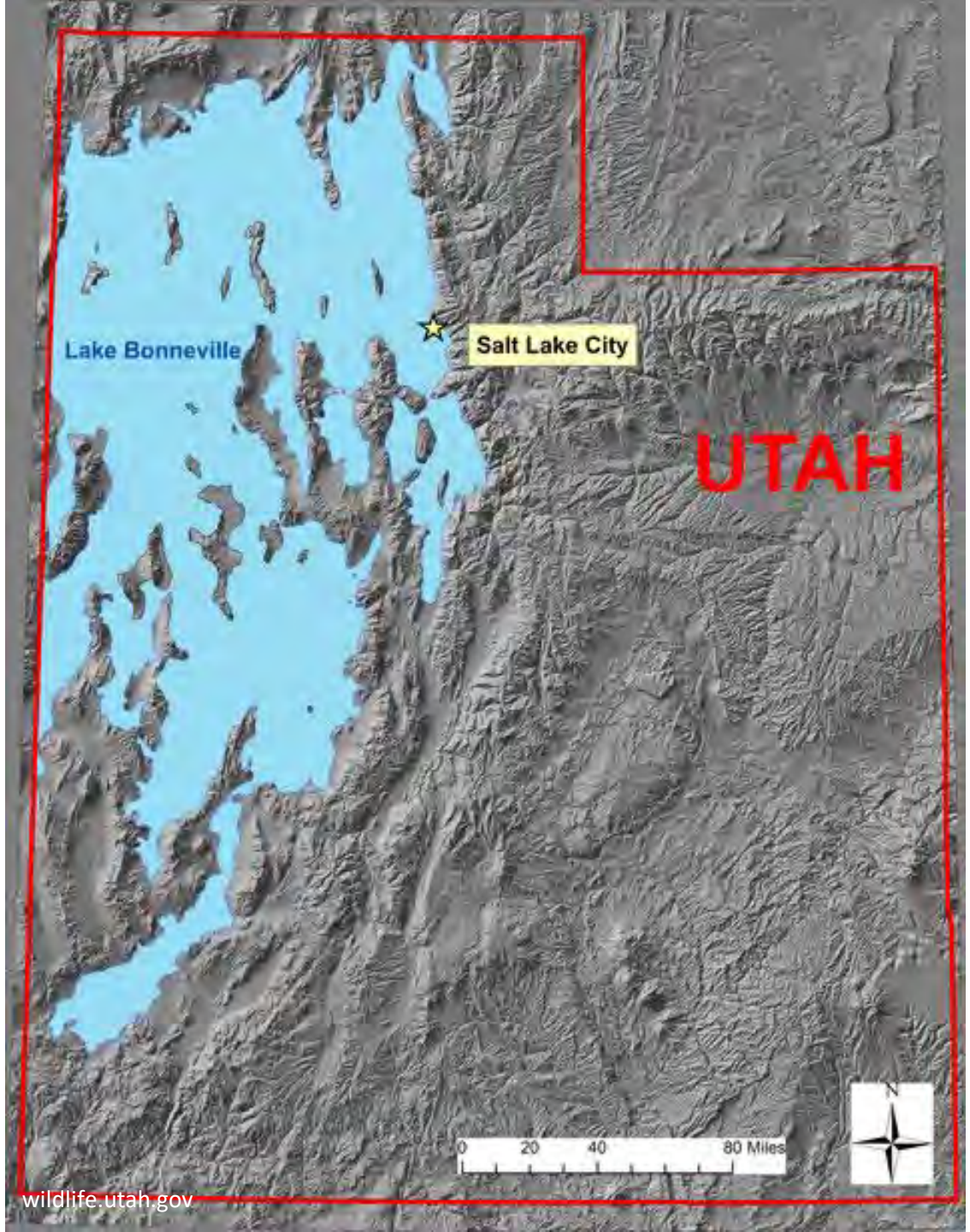
CHRISTCHURCH 6.2 EARTHQUAKE, FEB. 22, 2011

WHY IS UTAH'S RISK SO HIGH?

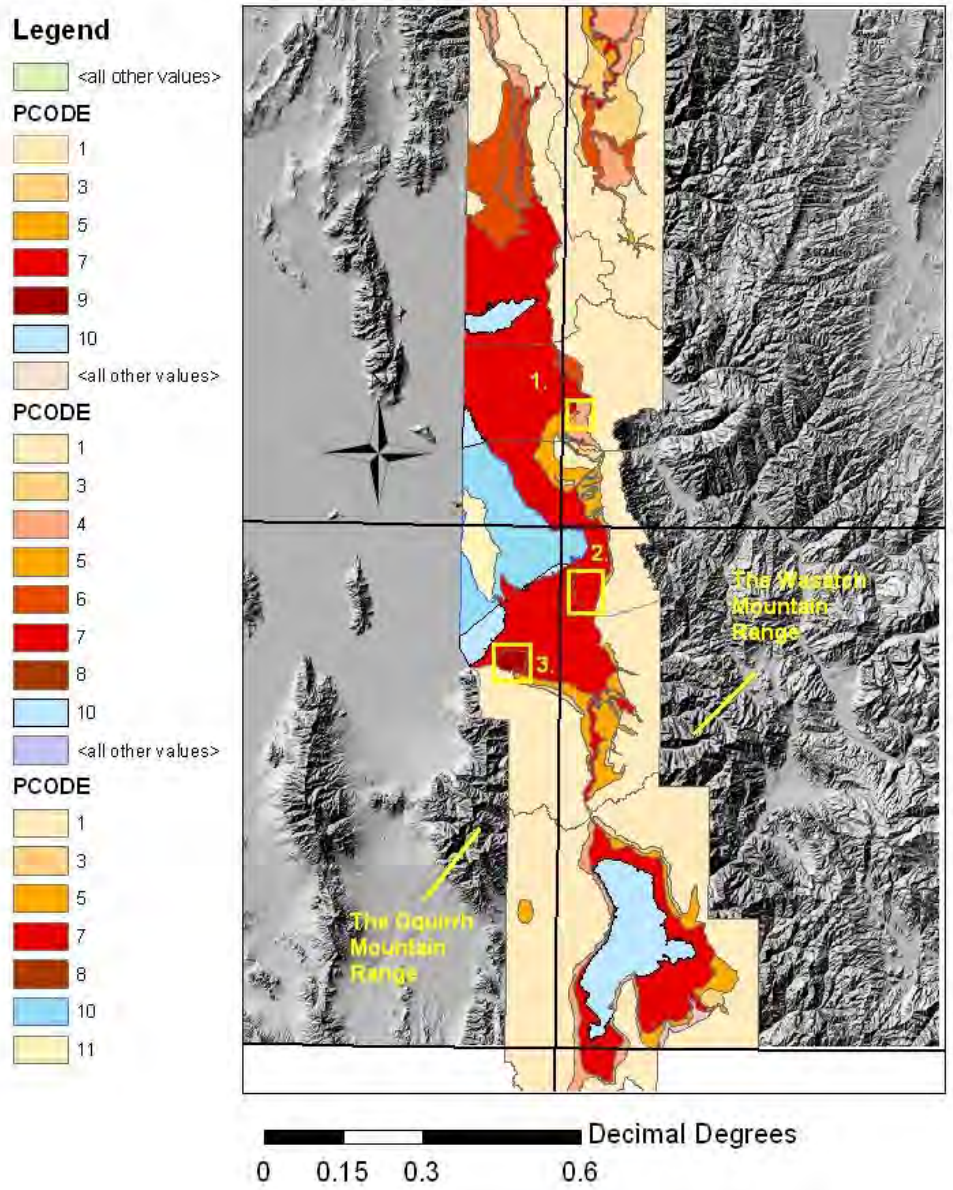
LOCALIZED POPULATION

- Population and infrastructure concentrated along the Wasatch Front

LIQUEFACTION POTENTIAL


Lake Bonneville
Salt Lake City
UTAH
0 20 40 80 Miles
N
wildlife.utah.gov

Liquefaction Hazard for the Wasatch Front



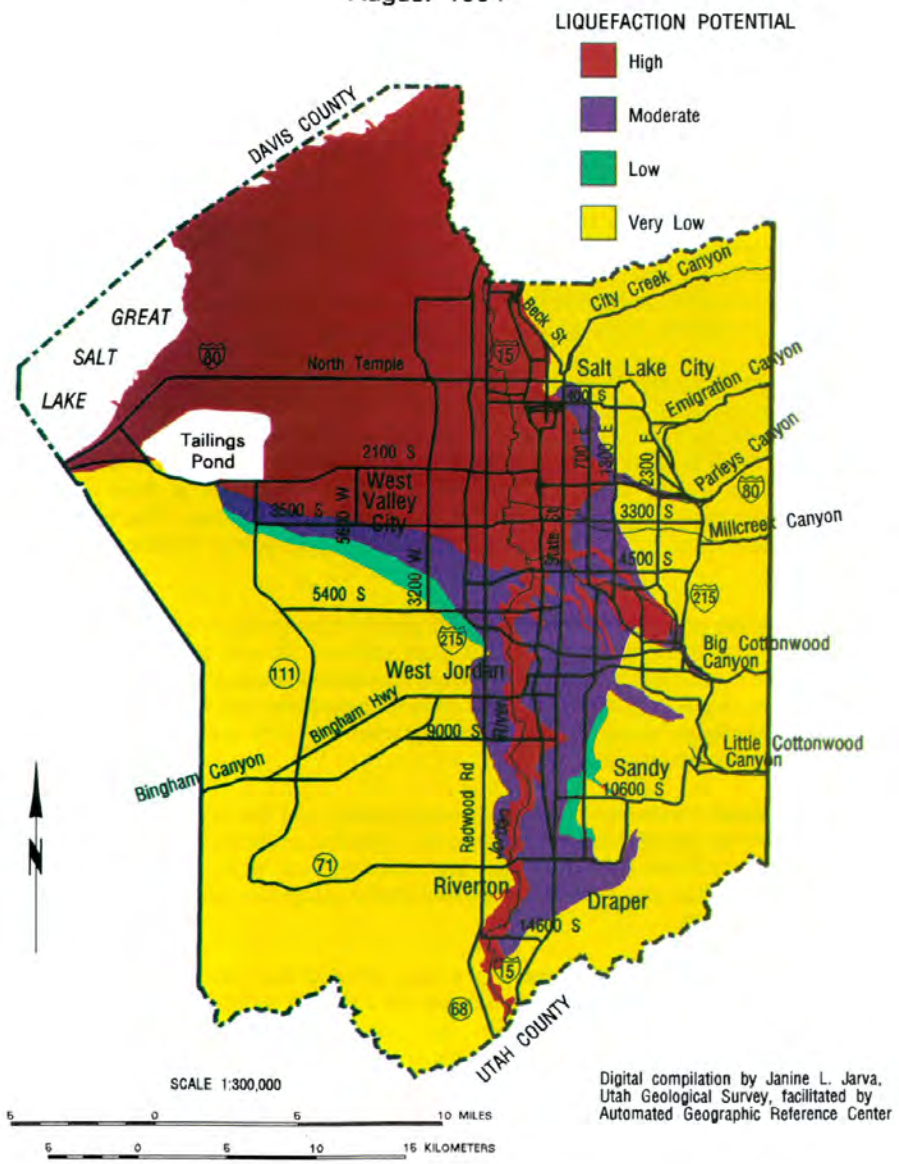
Kevin Franke, hydrology.usu.edu

LIQUEFACTION-POTENTIAL MAP FOR A PART OF SALT LAKE COUNTY, UTAH

UTAH GEOLOGICAL SURVEY

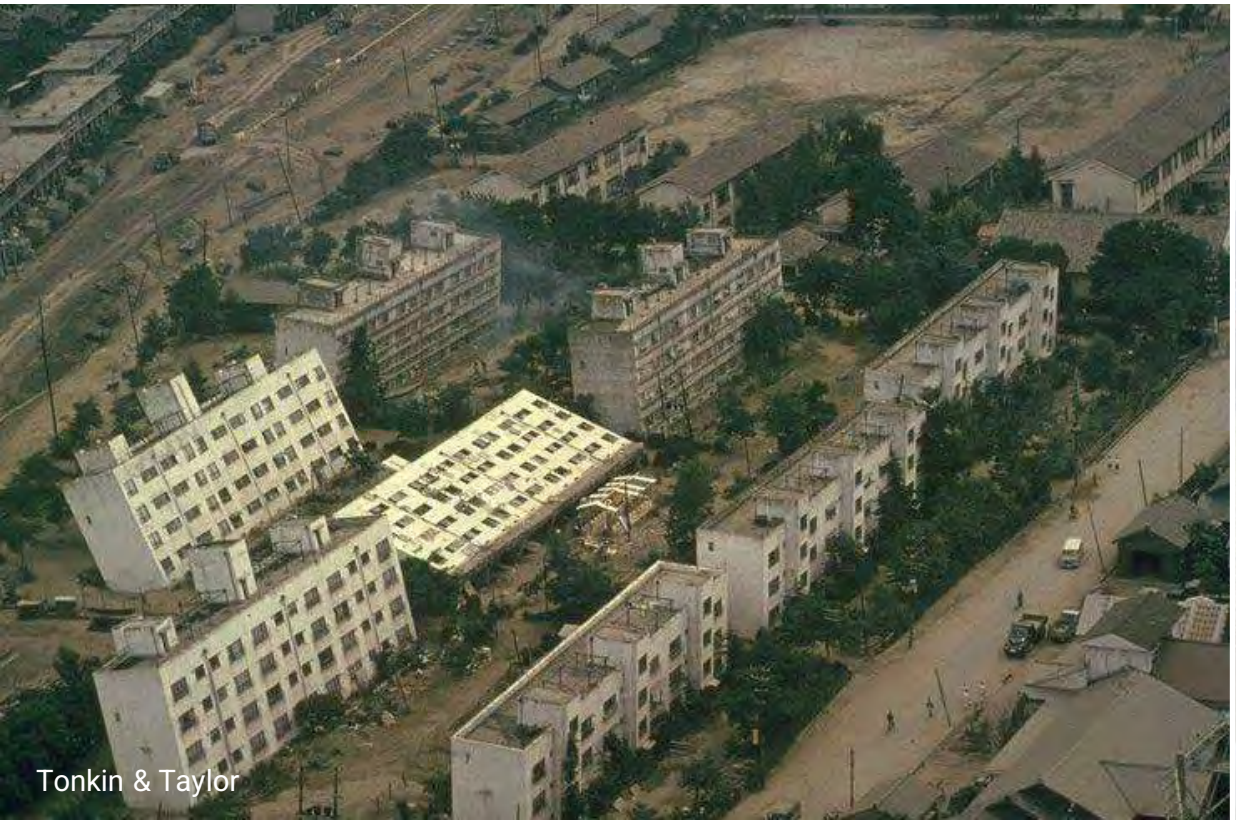
Public Information Series 25

August 1994



Digital compilation by Janine L. Jarva, Utah Geological Survey, facilitated by Automated Geographic Reference Center

This map is for general reference only and was modified from Anderson, L.R., Keaton, J.R., Spitzley, J.E., and Allen, A.C., 1994, Liquefaction potential map for Salt Lake County, Utah: Utah Geological Survey Contract Report 94-4, 48 p., scale 1:48,000. Copies of this report are available at the Utah Geological Survey.


Tonkin & Taylor


Oregon State University

WHY IS UTAH'S RISK SO HIGH?

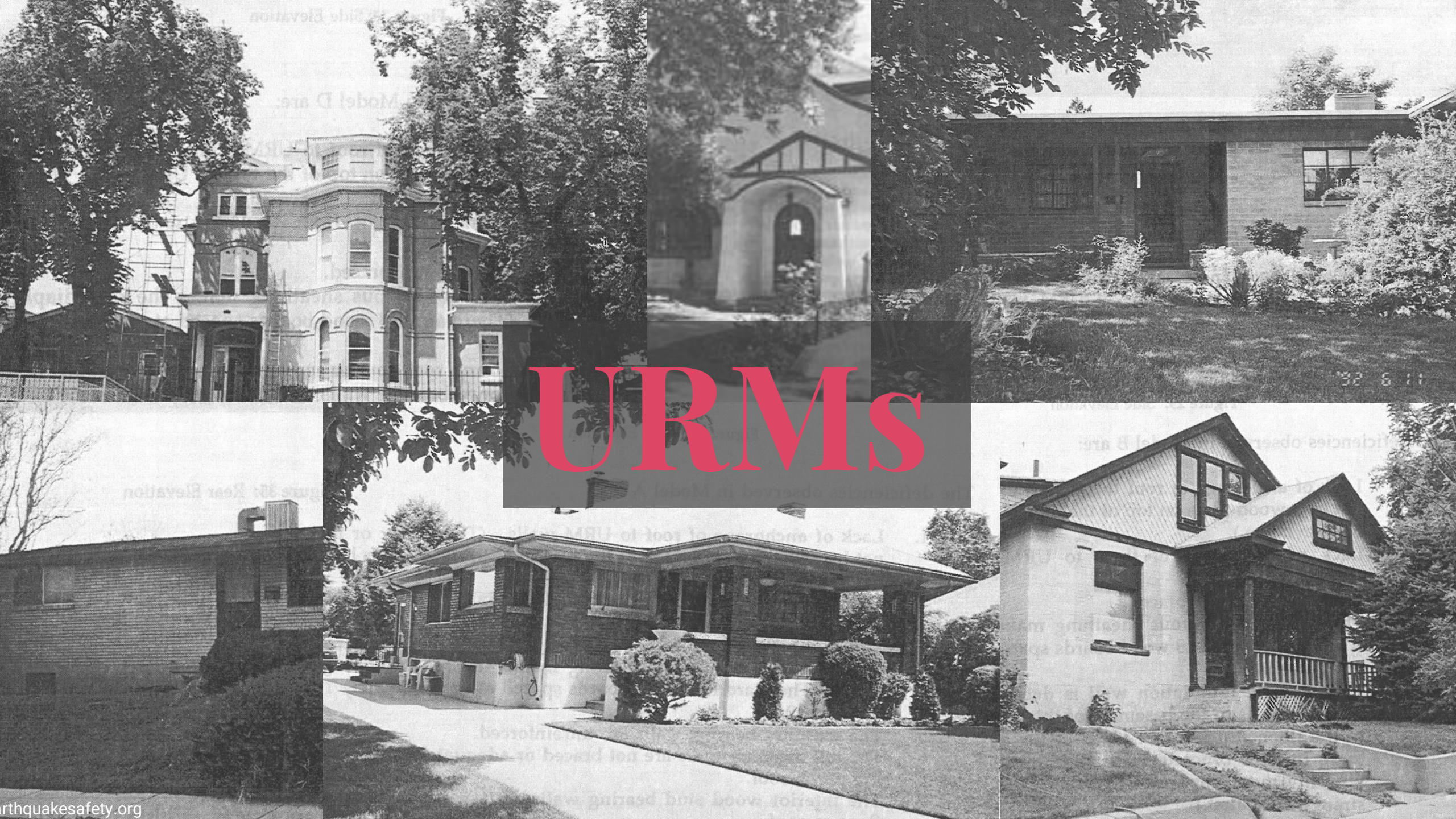
LOCALIZED POPULATION

- Population and infrastructure concentrated along the Wasatch Front

LIQUEFACTION POTENTIAL

LIMITED AWARENESS OF RISK (UNTIL MID-1970s)

- Luck and long return times
- Late building codes
- Life-threatening buildings (more than 140,000 URMs remain)

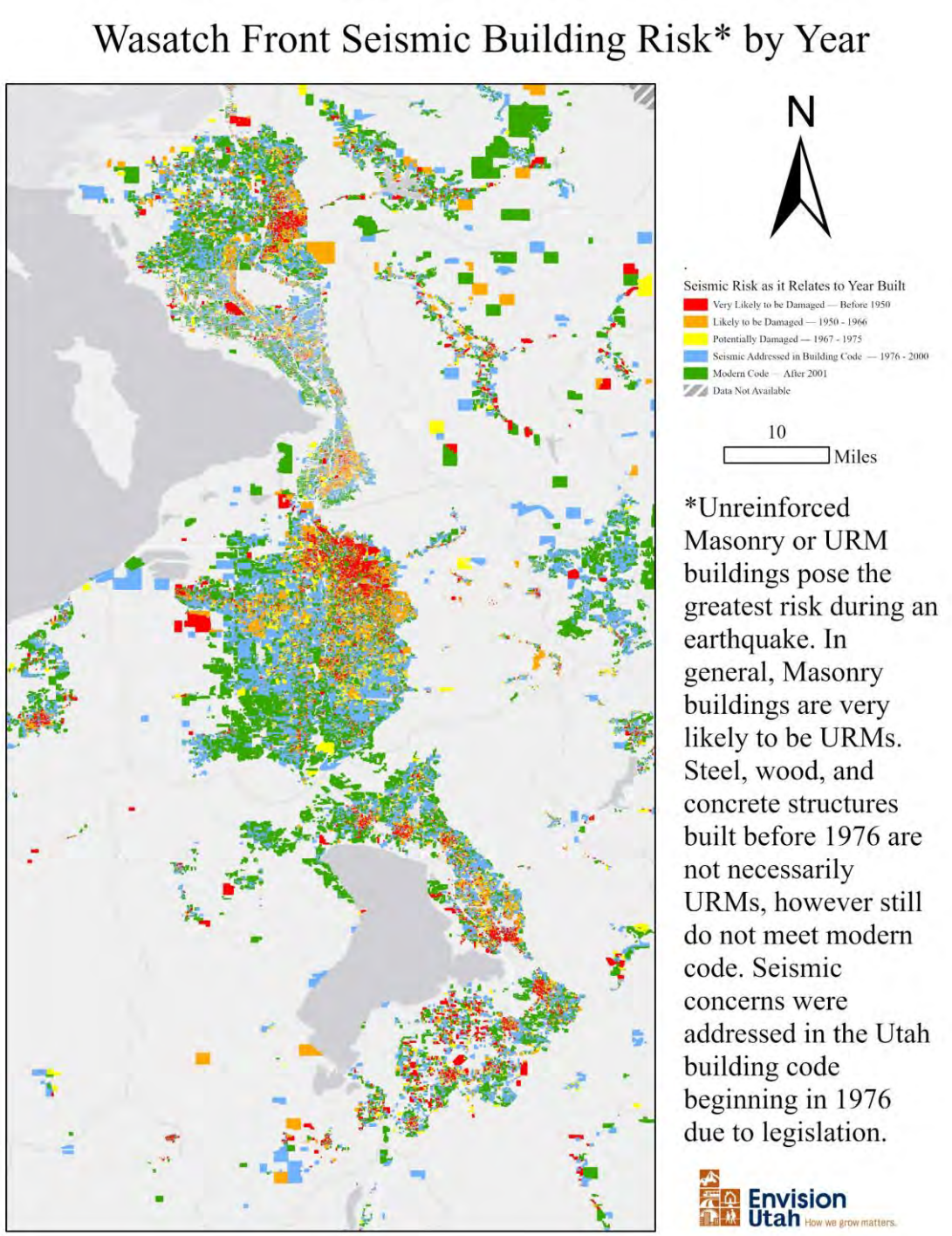


URMs

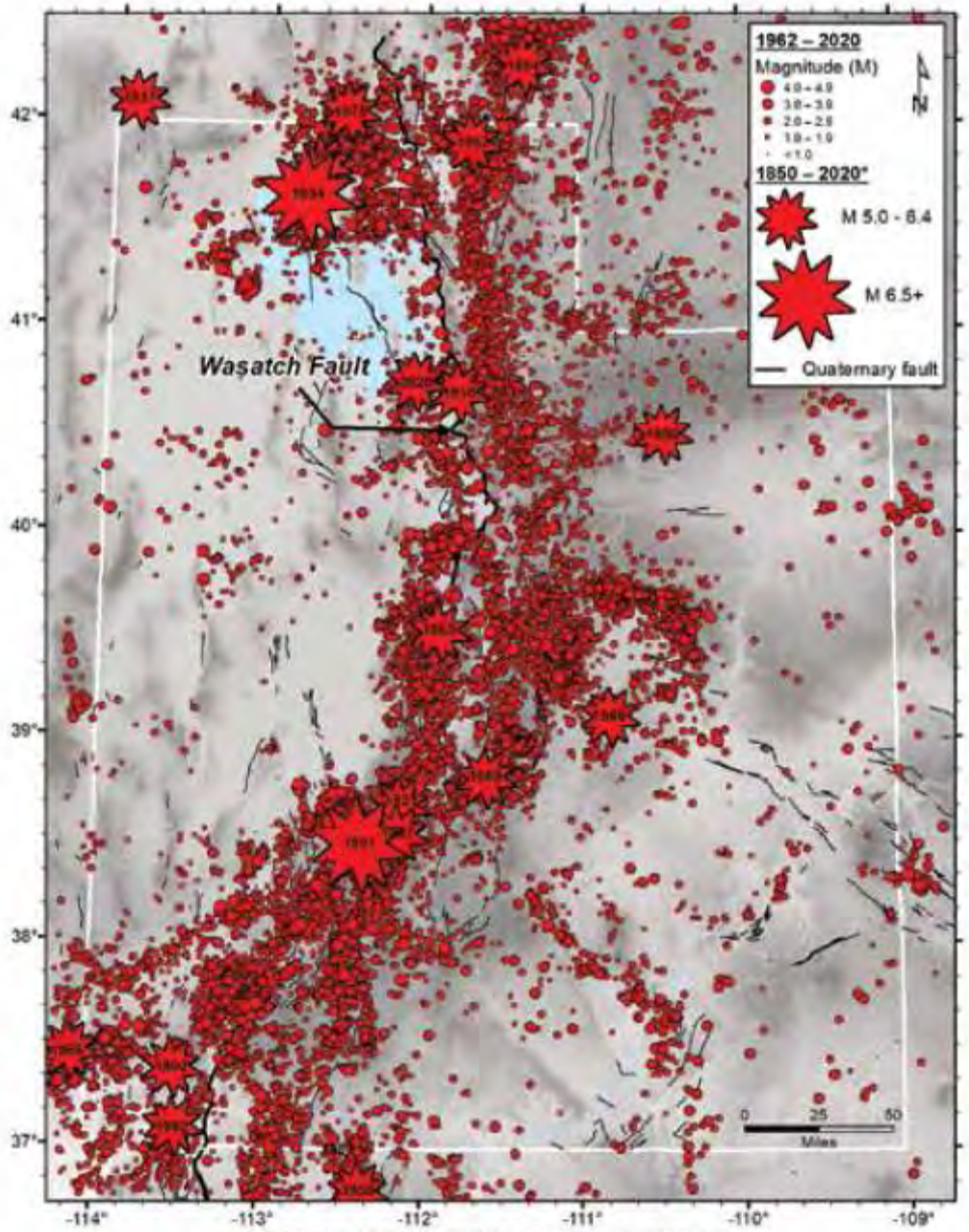
WESTLAKE JUNIOR HIGH AFTER THE MAGNA 2020 EARTHQUAKE (PHOTO CREDIT SL TRIBUNE)

140,000 URMS

- URM buildings were constructed up until 1976 and are scattered across the state
- They are single family homes, multifamily structures, and offices
- **Most of our projected injuries and deaths occur in these buildings**



Earthquakes in the Utah region



*Starbursts (moment magnitudes) show mainshocks only.
Source: University of Utah Seismograph Stations earthquake catalogs

EARTHQUAKES.

A Prophetic Discourse by G. K. Gilbert, United States Geologist.

The Matter Brought Home to the People of Salt Lake.

There are many geologists who are very wise, but even they do not understand the forces which produced mountains. And yet it must be admitted, not only that mountains have been made, but that some mountains are still rising. The mysterious forces appear to act in different ways in different places, and it is possible that their nature is not universally the same. Suffice it to say that in the Great Basin the movements they cause are vertical. It is as though something beneath each mountain was slowly, steadily, and irresistibly lifting, carrying the mountain with it.

In yielding to this all-compelling upward thrust, the earth's crust sometimes bends and stretches, but more often it breaks, and when it breaks, the fracture occurs in a peculiar place. It does not run along the medial axis of the mountain, but along one margin. On one side of the fracture the crust is lifted and tilted, on the other side it either sinks or remains undisturbed. The uplifted part of the crust is the mountain, and the storms carve out its canyons; the unlifted part remains a lowland or valley, and receives the debris washed out from the canyons.

A mountain is not thrown up all at once by a great convulsive effort, but rises little by little. The subterranean pothrust is continuous and slow, and would produce a continuous upward movement of the mountain if the mountain's weight were the only resisting factor. But there is also a great friction to overcome, the friction along the surface of fracture, between the rising and stationary parts of the crust, and friction gives to slow motion an intermittent or rhythmic character.

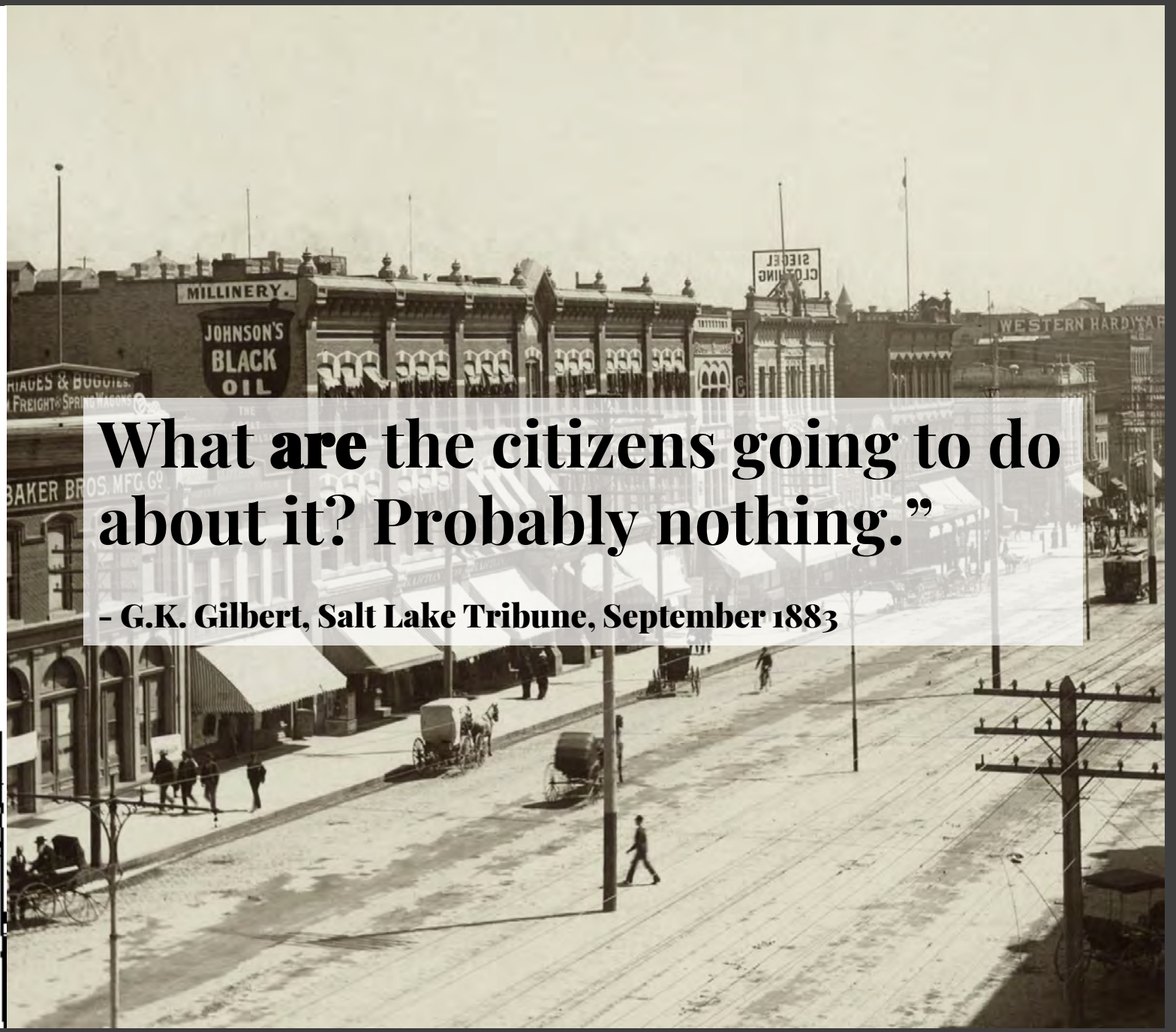
The disagreeable jarring of a railway car started while the brake is set is due to the interruption of motion by friction, the wheels alternately sliding and stopping. The musical vibration of a violin strings is due to the alternate coherence and sliding of the bow upon it, and fails when the friction of the bow is insufficient. Attach a rope to a heavy box and drag it slowly, by means of a windlass, across a floor. As the crank is turned the tension of the rope gradually increases until it suffices to overcome the starting friction, as it is called. Once started, the box moves easily, because sliding friction is less than starting friction. The rope shortens or stays until its tension is only sufficient for the sliding friction, and it would continue in that state but that the box, having acquired momentum, is carried a little too far. Theoretically, the main strain of the earth's crust was relieved at once, but a complete equilibrium was brought about more slowly.

The surviving inhabitants of Lone Pine observed that the only houses which remained standing were of wood, and in rebuilding they employed that material exclusively. Such a course was natural, but I conceive that their precaution was unnecessary. They may indeed feel feeble shocks propagated from earthquakes centering elsewhere, but in their own locality the accumulated earthquake force is for the present spent, and many generations will probably pass before it again manifests itself. The old maxim "lightning never strikes the same spot twice," is unsound in theory and false in fact, but something similar might truly be said about earthquakes. The spot which is the focus of an earthquake (of the type here discussed) is thereby exempted for a long time. And conversely, any locality on the fault line of a large mountain range, which has been exempt from earthquake for a long time is by so much nearer to the date of recurrence—and just here is the application of what I have written. Continuous as are the fault scarps at the base of the Wasatch, there is one place where they are conspicuously absent, and that place is close to this city. From the Warm Springs to Emigration Canyon fault scarps have not been found, and the rational explanation of their absence is that a very long time has elapsed since their last renewal. In this period the earth strain has been slowly increasing, and some day it will overcome the friction, lift the mountains a few feet and re-enact on a more fearful scale the catastrophe of Owens Valley.

It is useless to ask when this disaster will occur. Our occupation of the country has been too brief for us to learn how fast the Wasatch grows; and, indeed, it is only by such disasters that we can learn. By the time experience has taught us this, Salt Lake City will have been shaken down and its existing citizens will have sorrowfully rebuilt it of wood to use a homely figure, the horse will have escaped, and the barn-door, all too late, will have been closed behind him.

When the earthquake comes, the severest shock is likely to occur along the line of the great fault at the foot of the mountain. This line follows the upper edge of the upper bench from Big Cottonwood canyon to the rifle targets back of Fort Douglas, cutting across each creek just where it issues from between walls of bed rock, and passing only a short distance back of the Fort. At a point not far north of the targets the fault divides, one branch continuing northward, across the spur, toward Farmington; the other turning westward, running just back of that hopeless artesian boring, and following the upper edge of the gravel bench to the vicinity of the Warm Springs. Should the earthquake follow the former of these branches, the city will not fare so badly as the Fort, should it follow the latter, or follow both, city and fort will alike suffer severely.

What are the citizens going to do about it?



What are the citizens going to do about it? Probably nothing."

- G.K. Gilbert, Salt Lake Tribune, September 1883

WHY DON'T WE DO MORE TO ADDRESS THE RISK?

COST

DISTRIBUTED RISK

DISTORTED RISK PERCEPTION

THE IRRATIONAL WEIGHER: "BOUNDED RATIONALITY"

COLLECTIVE JUDGMENT

- If all my neighbors have houses like mine, my house must be "safe enough"

HEURISTICS

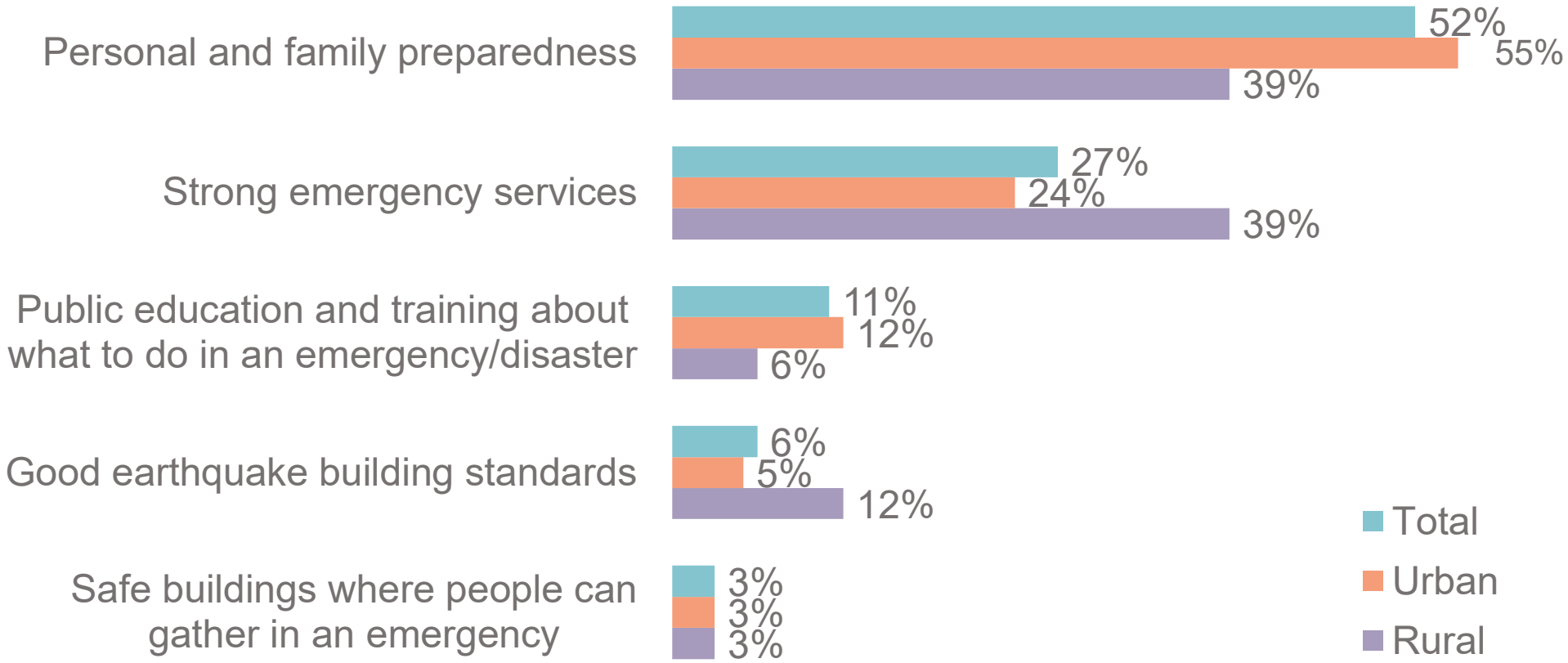
- Cognitive biases and mental shortcuts
- Manmade risks are more serious than natural risks
- "Affect"
- "Availability"
- "Optimism Bias"

CULTURAL COGNITION OF RISK

Worrying about the wrong things . . .

FOCUSING ON EMERGENCY RESPONSE AND INDIVIDUAL PREPAREDNESS INSTEAD OF COMMUNITY RESILIENCE:

Utahns tend to think about disaster resilience in short-term, personal/family terms



BASE: ALL QUALIFIED RESPONDENTS (N=166)

Q530. When it comes to emergency preparedness and the ability to recover from a disaster, which of the following do you feel has the biggest impact on you and your family personally?

THE OPPORTUNITY FOR LONG-TERM RESILIENCE

- The “Big One” has the potential to halt Utah’s strong economy and high quality of life, as residents are forced to close their businesses and move elsewhere.
- However, investments into seismic resilience provide the opportunity to reduce damage, and help Utahns return to their normal lives quickly
- Recent research by FEMA shows that on average **every dollar spent on disaster mitigation now avoids $6 in future disaster costs**

DISASTER RESILIENCE VISIONING PROJECT

ENVISION UTAH

PROJECT GOAL

Heighten awareness, momentum, prioritization, and coordination so that Utah takes the needed steps to improve resilience.

STEERING COMMITTEE

Names	Organization	Names	Organization
Lisa Sun	**BYU Law Professor**	Darren Hess	Weber Basin Water Conservancy District
Gary Porter	**Deseret Management Corporation**	Sam Jarman	Alpine School District
Ty McCutcheon	**Daybreak Communities**	Cameron Diehl	Utah League of Cities and Towns
Gary Hoogeveen	Rocky Mountain Power	Jerry Stevenson	Utah State Senate
Chris Gamvroulas	Ivory	Beth Holbrook	Utah Transit Authority
Maria Garciaz	Neighborworks	Bart Forsyth	Jordan Valley Water Conservancy District
Martin Bates	Granite School District	Lonnie Bullard	Jacobsen Construction
Jona Whitesides	Utah Division of Emergency Management	Ryan Longman	Zions Bank
Jenny Wilson	Salt Lake County Mayor	Annalee Munsey	Metro Water
Robert Grow	Envision Utah Board Member and Former CEO	Mike DeVries	Metro Water
Andrew Gruber	Wasatch Front Regional Council	Isaac Paxman	Provo City
Barry Welliver	BHW Engineers/Earthquake Engineering Research Institute	Mike Caldwell	Ogden City
Jessica Chappell	Reavely Engineering	Tara Thue	AT&T
Carlos Braceras	Utah Department of Transportation	Kyle Weaver	Comcast
Divya Chandrasekhar	University of Utah	Nathan Anderson	Union Pacific Railroad
Theresa Foxley	Economic Development Corporation of Utah	Pamela Lofgreen	SLC Emergency Management
Sean McGowan	FEMA	Rich Brown	Dean of Engineering
Brett Crable	Dominion Energy	Roger Jackson	FFKR
Tage Flint	Weber Basin Water Conservancy District	Scott Baird	Utah Department of Environmental Quality

WORKING GROUPS & TOPICS

Homes & Buildings	Lifeline Infrastructure	Development Planning	Messaging & Education
• Retrofits • New Construction • Schools • Hospitals	• Water & Sewer • Transportation • Energy • Communications	• Wildfire • Flood	• Project Outcomes • Resilience Messaging • Public Outreach Campaign

MEDIA COVERAGE

Water, schools, among major concerns for Utah earthquake commission

Jan 27, 2022, 6:50 PM

FILE: Caution
centered near

Aging aqueducts and earthquakes: Why millions in Utah could lack water

Report says major delivery systems couldn't survive 'Big One'

By Amy Joi O'Donoghue | Jan 12, 2022 10:04 a.m. MST

SHARE

Could 'Big One' in Utah be costliest natural disaster in U.S. history?

Major quake on Wasatch Fault could be 'most costly natural disaster in U.S. history,' official says

By Amy Joi O'Donoghue | March 24, 2020 10 p.m. MDT

SHARE

Caution tape surrounds a damaged building on Magna's Main Street on Tuesday, March 24, 2020, following a
earthquake that was centered near the city on March 18. The street is now open to traffic. | Steve Griffin, Des

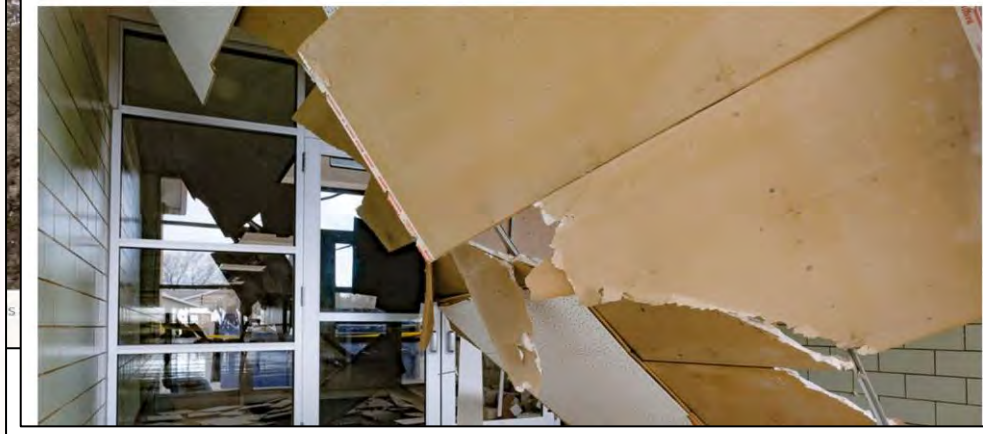
Remember that earthquake? Is Utah doing anything to prepare for the big one?

By Jay Evensen | Dec 9, 2020 10 p.m. MST

SHARE

These are the 119 Utah schools that experts worry put kids most at-risk in an earthquake

The report marks the first time all schools in the state have been studied and inventoried. And it follows the 2020 quake in Magna.



STAKEHOLDER ENGAGEMENT

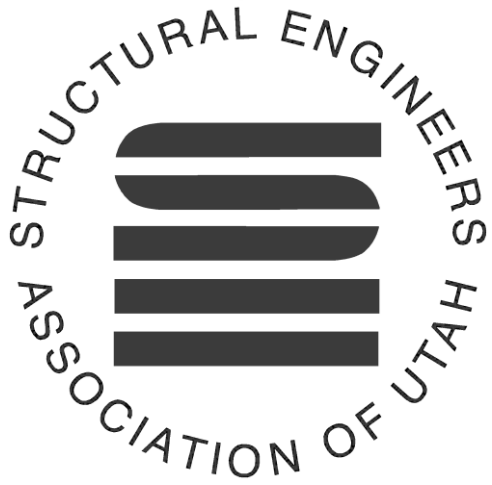
- The USSC recommendations are a result of a collaborative process. Stakeholders represented organizations including:
  - Utah Division of Emergency Management
  - Envision Utah
  - Weber Basin Water Conservancy District
  - Central Utah Water Conservancy District
  - Jordan Valley Water Conservancy District
  - Metropolitan Water District of Salt Lake and Sandy
  - FEMA Region VIII
  - Utah Realtors Association
  - Utah Geological Survey
  - University of Utah
  - Utah State University
  - Brigham Young University
  - Utah Department of Natural Resources
  - Utah League of Cities and Towns
  - Utah State Board of Education
  - Fannie Mae
  - Salt Lake City
  - Deseret Management
  - Utah Homebuilders Association
  - Ivory Homes
  - Salt Lake County
  - Legislative leadership
  - Associated General Contractors of Utah
  - ACEC Utah
  - EERI Utah
  - Salt Lake Chamber
  - Structural Engineers Association of Utah

Utah Seismic Safety Commission Recommendations

USSC

ENDORSEMENT

The following organizations endorse this report:



5 KEY RECOMMENDATIONS

1. Invest in seismic improvements for the four major water aqueducts that bring water to the Wasatch Front
2. Significantly limit the danger to tens of thousands of Utah children who attend school in seismically unsound buildings
3. Increase the public awareness of the high risk from Utah's 140,000 URM buildings
4. Ensure adequate building code enforcement for large/important buildings
5. Invest in a feasibility study for an Earthquake Early Warning System

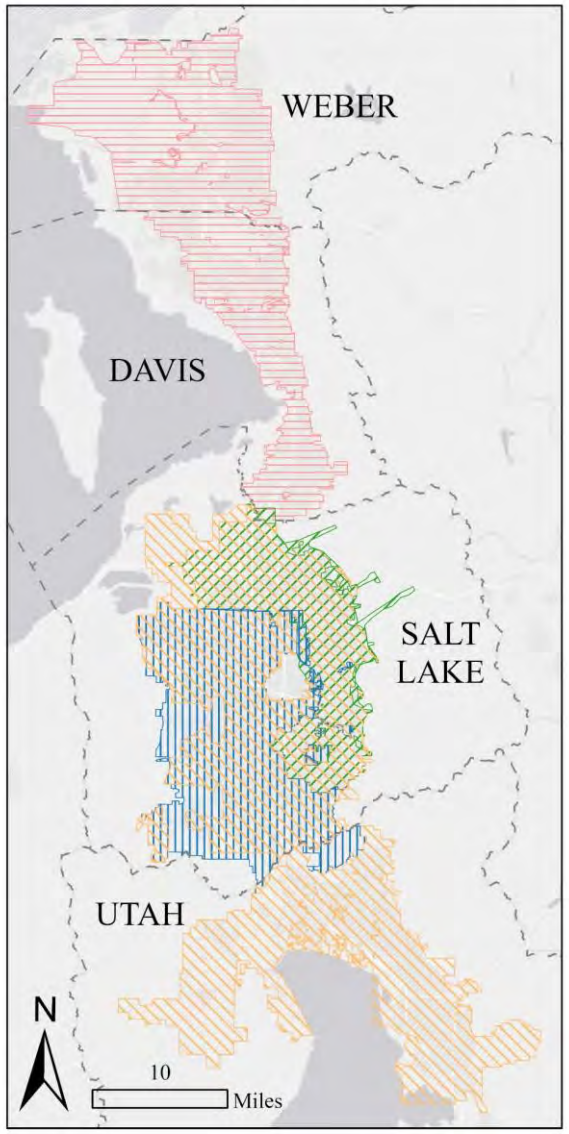
KEEP WATER FLOWING

- 1 aqueduct project from each major Wasatch Front water district
- Aqueducts **serve over 2 million residents**, and are susceptible to major damage as they cross the fault, landslide areas, liquefaction zone, and/or high ground shaking areas

PHOTO CREDIT: WEBER BASIN WATER CONSERVANCY DISTRICT

KEEP WATER FLOWING

- Should any one of these pipelines rupture, over a million Utahns **could be left without water for 6 months or even longer**
- **Total cost for all 4 aqueducts is $192 million**, which is less than the cost of expanding 3 miles of U.S. 89 in Layton into freeway or of building 3 freeway interchanges on Bangerter Highway



SCHOOL BUILDING RETROFITS

KEEP OUR KIDS SAFE

- Early results suggest about **130 school campuses in the state include URMs**. These schools serve at least **70,000 Utah children.**

Utah K-12 Public Schools Unreinforced Masonry Inventory

Methods, Findings, and Recommendations

KEEP OUR KIDS SAFE

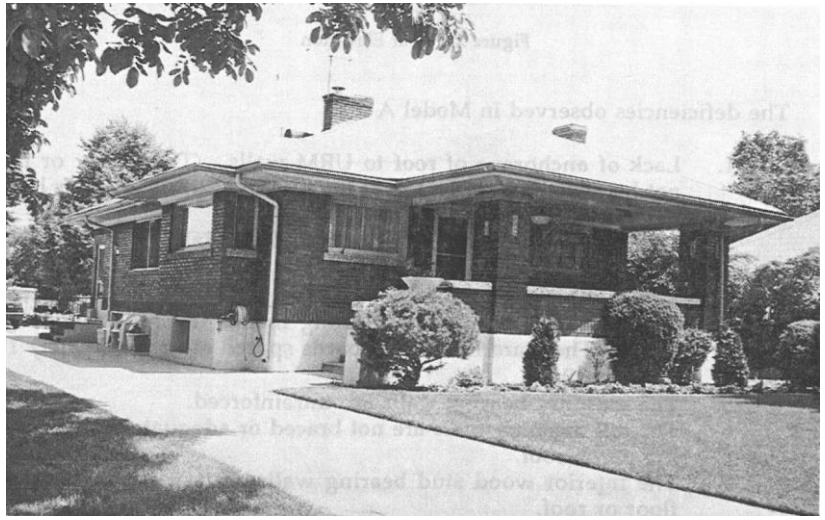
- **$3.75 million** would fund a multidisciplinary feasibility study for each school and develop cost estimates for replacing or retrofitting these structures

WEST HIGH SCHOOL IS A URM SCHOOL THAT WAS RETROFITTED IN 1996.

INCREASE PUBLIC AWARENESS OF URMS

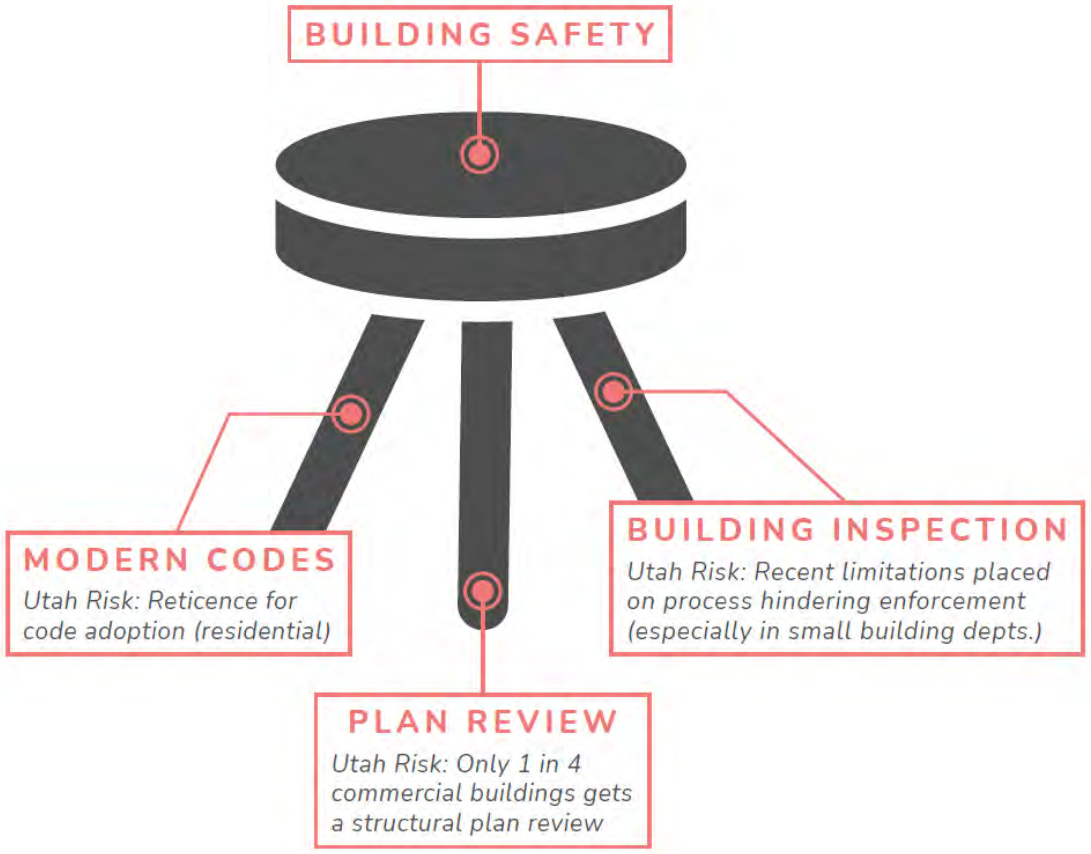
- Improved public awareness will increase market function and apply market pressure to upgrade more of these buildings

- A public awareness campaign would cost **$200,000** over 2 years



STATEWIDE RETROFIT ASSISTANCE PROGRAM?

KEEP OUR BUILDINGS STANDING



- **This recommendation is not advocating for any changes to the Utah Building Code**
- Instead, every building classified as International Building Code Risk Category III or IV (e.g. hospitals, schools, police stations) or over 200,000 sq. ft. should be required to undergo a plan review conducted by a Utah-licensed Professional Structural Engineer
- This ensures our most critical facilities are functioning following a large seismic event

KEEP UTAH READY TO RESPOND

- **$150,000** to conduct a feasibility study for installation of an Earthquake Early Warning System
- An EEWS could provide 10s of seconds of warning time before ground shaking starts
- This provides enough warning to shut off utilities like gas and transit like TRAX which can help save lives

5 KEY RECOMMENDATIONS

1. Invest in seismic improvements for the four major water aqueducts that bring water to the Wasatch Front
2. Significantly limit the danger to tens of thousands of Utah children who attend school in seismically unsound buildings
3. Increase the public awareness of the high risk from Utah's 140,000 URM buildings
4. Ensure adequate building code enforcement for large/important buildings
5. Invest in a feasibility study for an Earthquake Early Warning System

OTHER HAZARDS

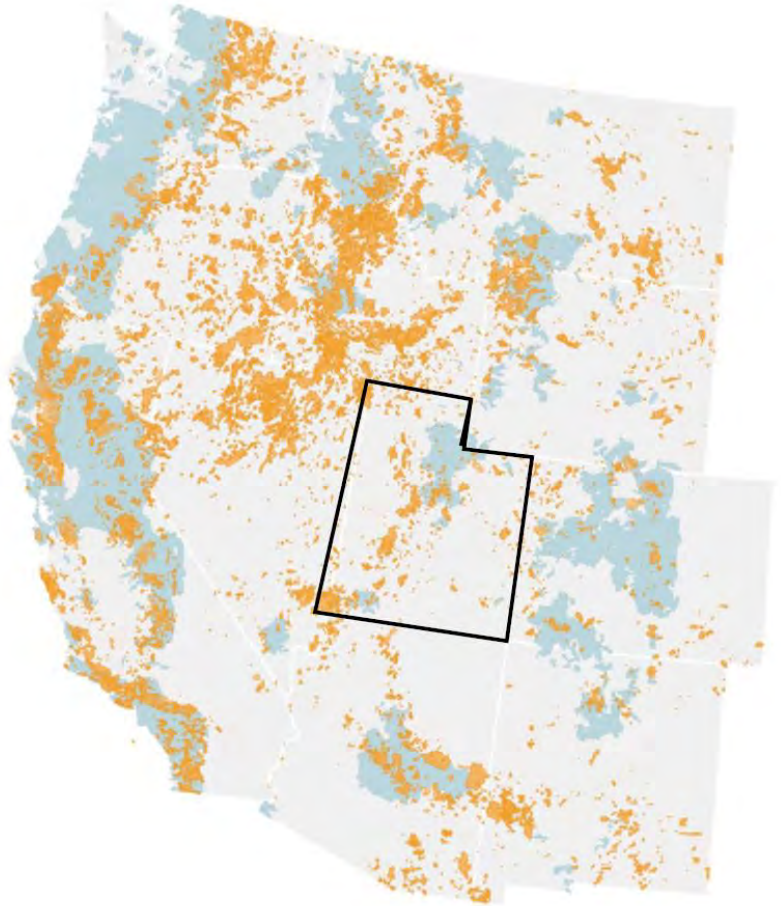
WILDFIRE

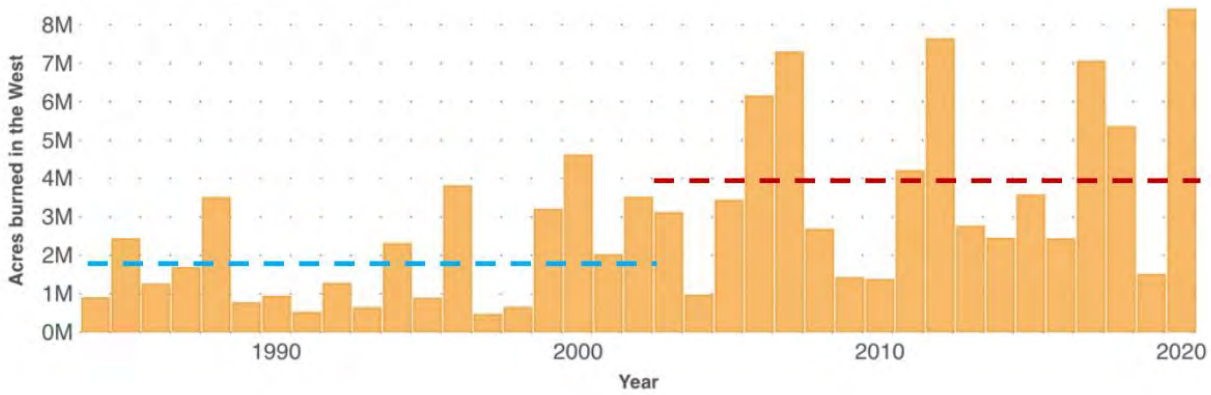
FLOODING

WATER SHORTAGES

Wildfire in the West 1984-2020

- 106 million acres since 1984
  - 1984-2002: 1.8 million acres
  - 2003-2020: 4 million acres
- Wildfire size increasing
- CA and ID have most acres burned
- Utah relatively less fire
  - 5.4 million acres since 1984

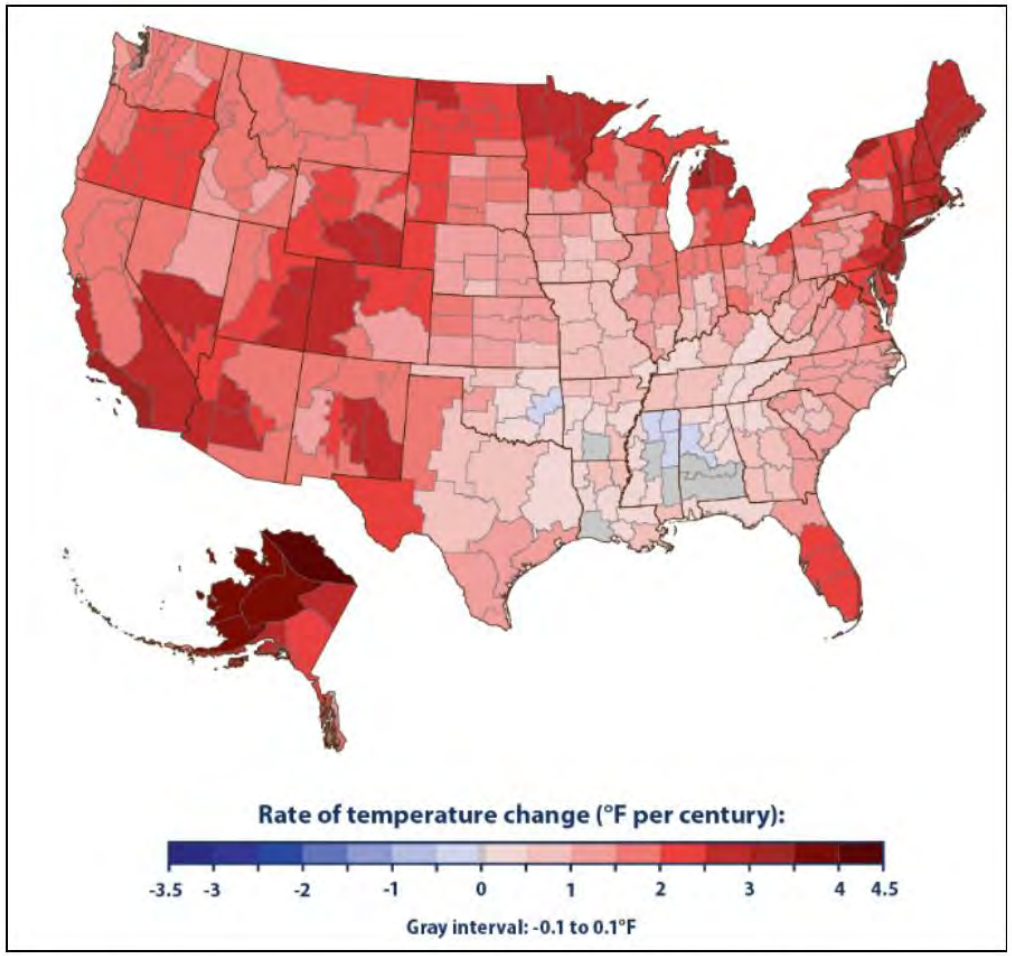




Source: [How wildfire threatens water supply](), USGS

Why is western wildfire increasing?

- Temperatures increasing in West
  - 2.5°F since 1895
  - Most warming since 1970
- Slighter more warming in Utah
  - 2.7°F since 1895
  - 3.9°F warming in Grand County
  - 3.7°F warming in Uintah County
  - SLC warmed 3.2°F since 1948



Rate of temperature change, 1901-2020

https://www.epa.gov/climate-indicators/climate-change-indicators-us-and-global-temperature

WHAT CAN YOU DO?

- Incorporate disaster resilience into planning process
- Harden infrastructure & improve redundancy
- Adopt a geohazards ordinance
- Ensure adequate building code enforcement
- Be aware of publicly-owned URMs, like city halls
- Enforce statewide WUI code
- Plan for larger storms
- Others?