

Beyond the Obvious: National Economic Impact of the Most Likely New Madrid Earthquake

for the
Regional Interagency Steering Committee Meeting
FEMA Region V
Chicago, Illinois
December 11-12, 2007

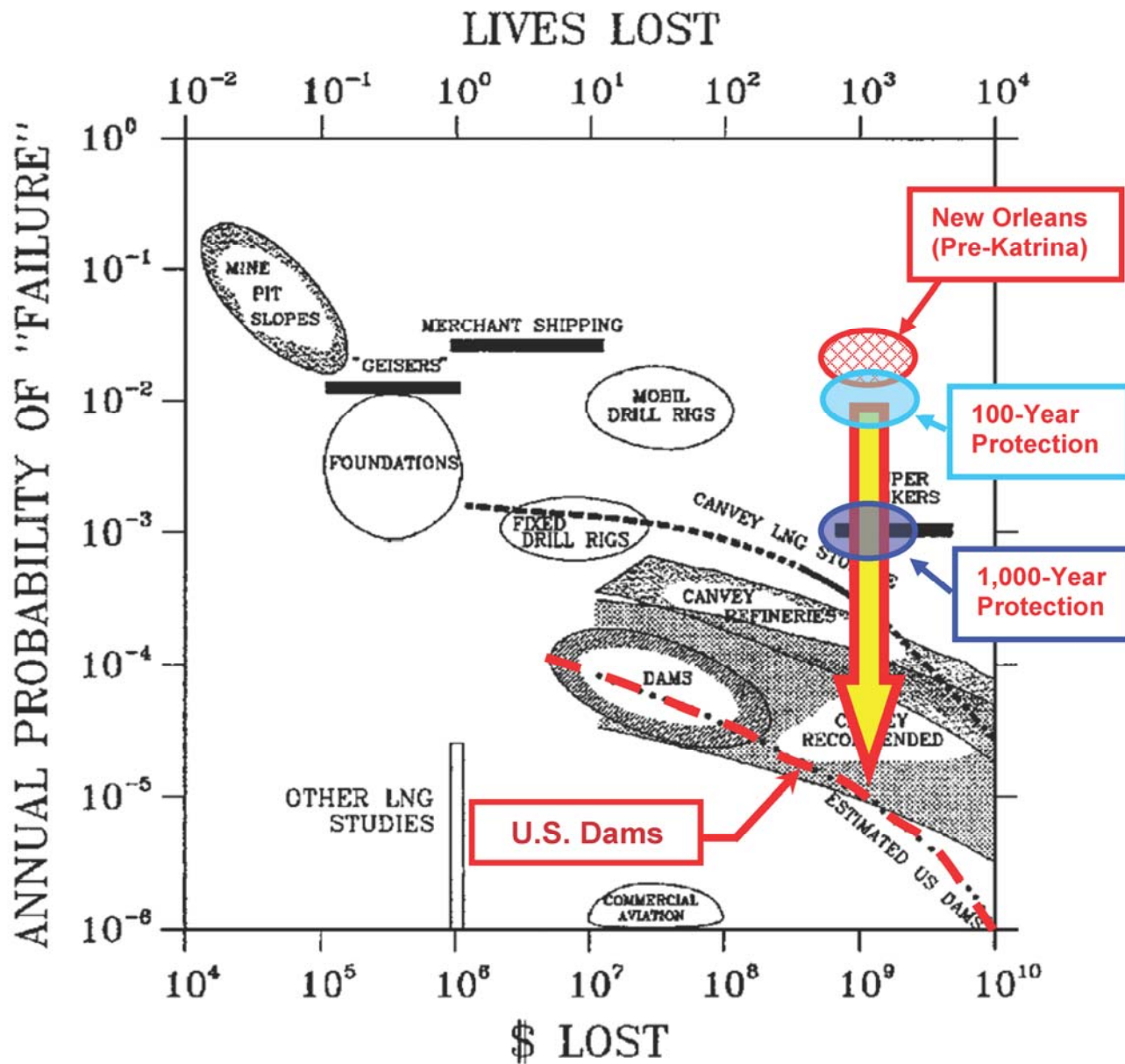
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Karl F. Hasselmann Chair in Geological Engineering
Natural Hazards Mitigation Institute
Missouri University of Science & Technology



Question #1

Why should Americans be concerned about the impacts of a New Madrid Earthquake?

Risk Diagram, Hurricane Katrina, and Economic Impacts

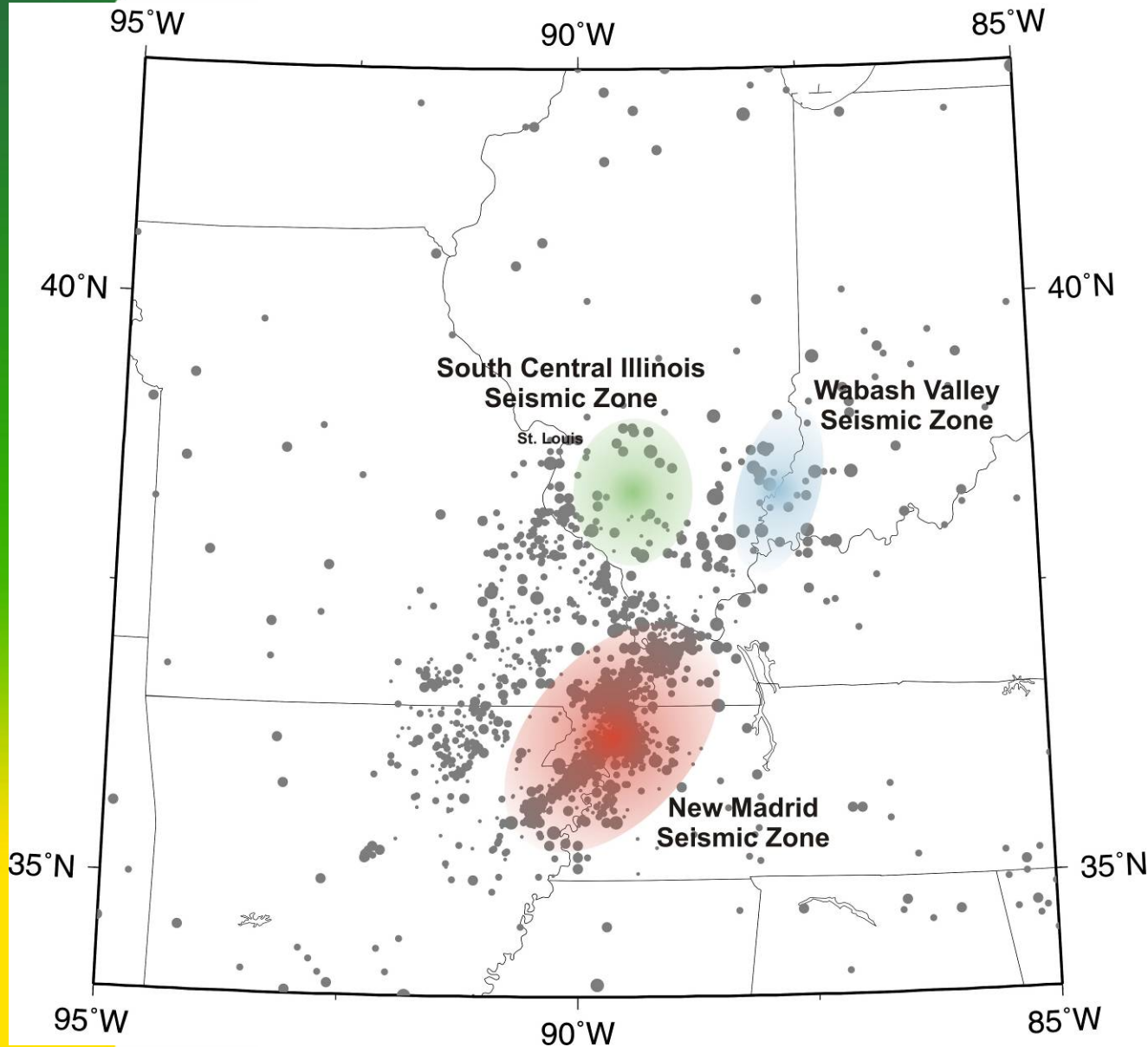


- Ask 11,000 former Ford Motor Co. employees about the impacts of Hurricane Katrina on SUV sales

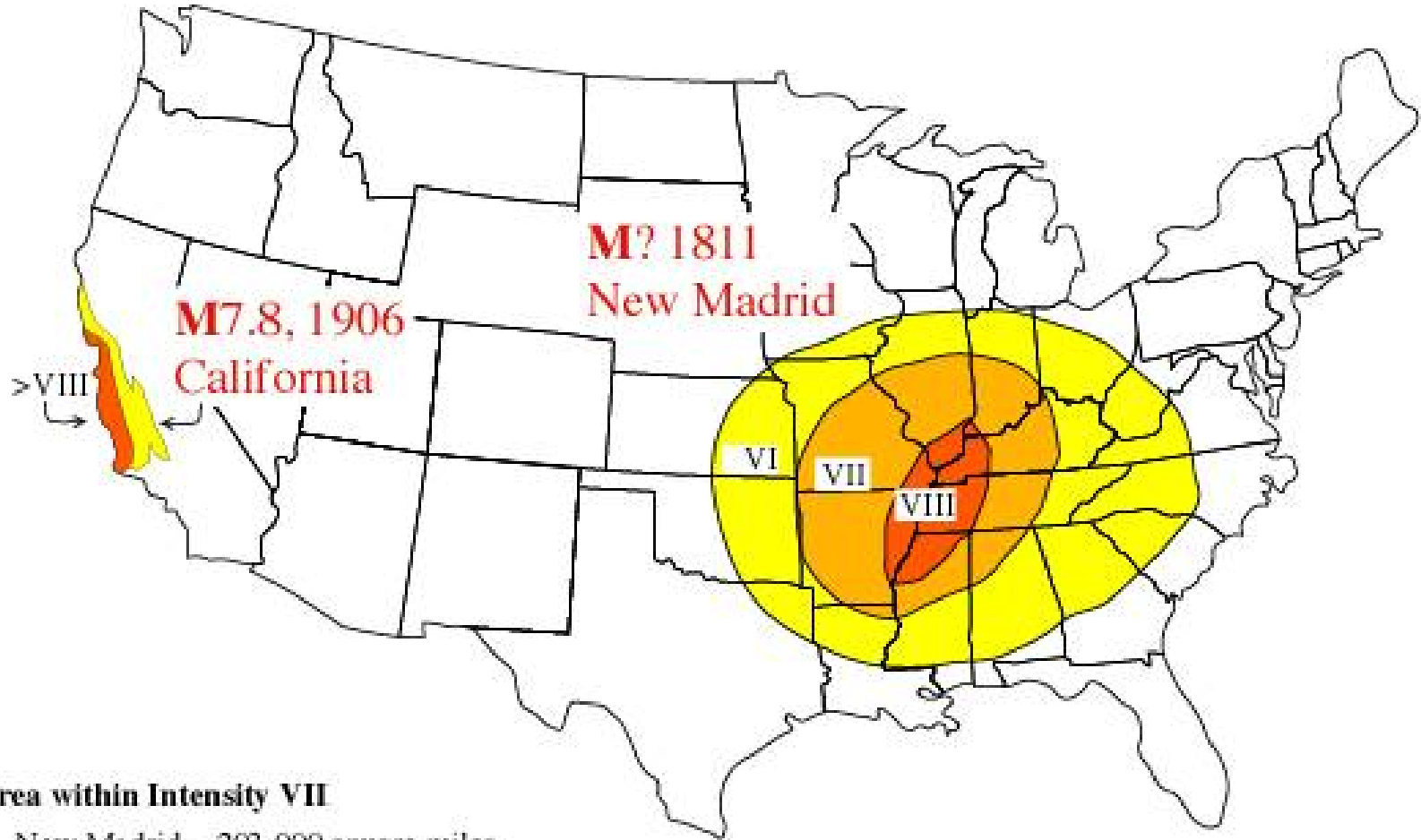
Question #2

How could cities like St. Louis, be damaged by an earthquake 200 kilometers away?

Active Midwest Seismic Zones



- ⌚ **New Madrid Seismic Zone rediscovered in 1973 NRC study of West Memphis power plant**
- ⌚ **Wabash Valley Seismic Zone generated M 5+ quakes in 1968 and 1987; initially suspected in 1993 and accepted in 2004**
- ⌚ **South Central Illinois spawned a M 5+ quakes in 1838, 1857, and 1891. Initially recognized in 1999**



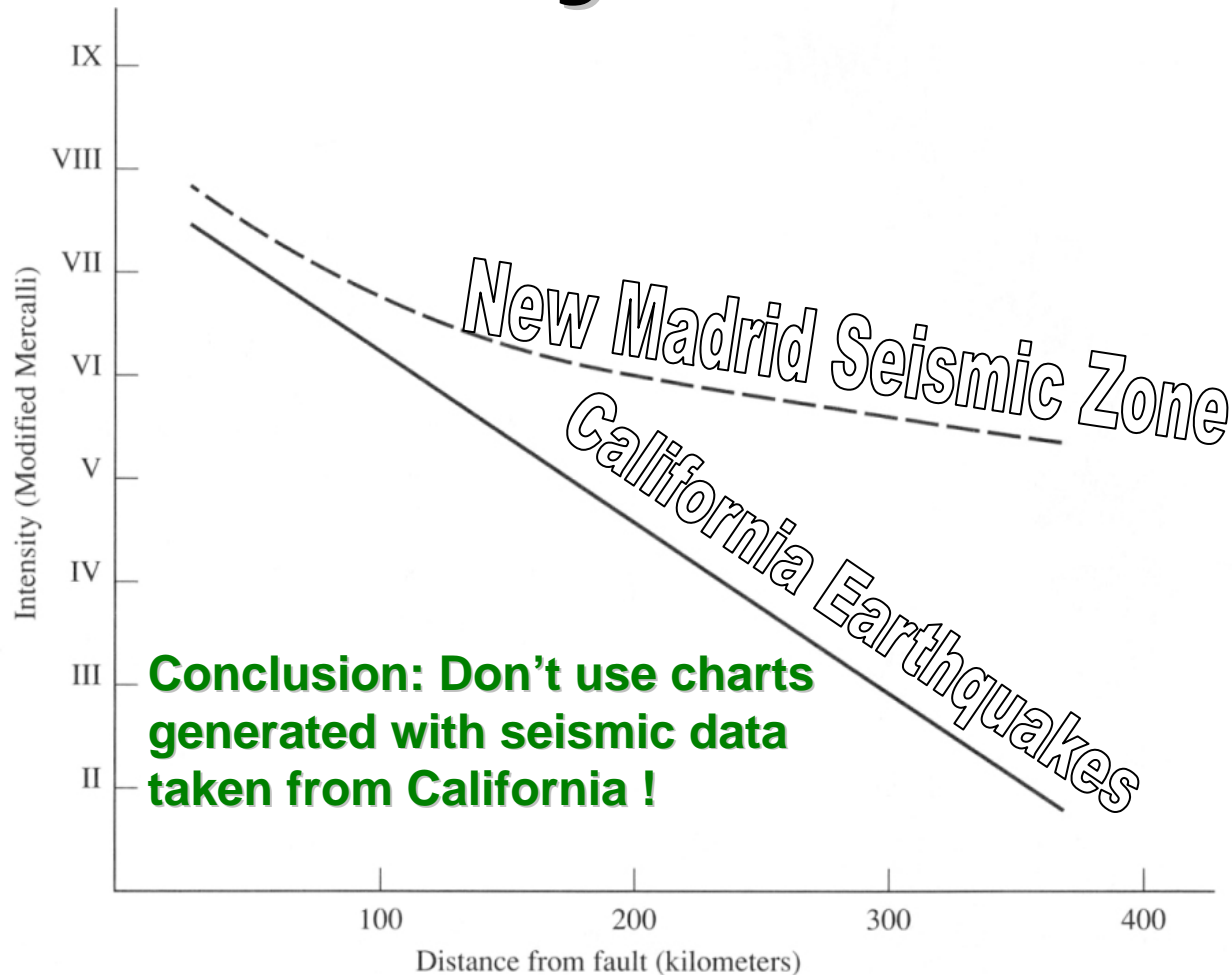
Area within Intensity VII

New Madrid = 203,000 square miles

San Francisco = only 12,000 square miles!

The 1895 M 6.2 Charleston, MO earthquake affected an area 20X greater than an equivalent magnitude quake in California. It also occurred during a severe drought, so little liquefaction damage.

The Big Problem is Shaking Intensity vs Distance

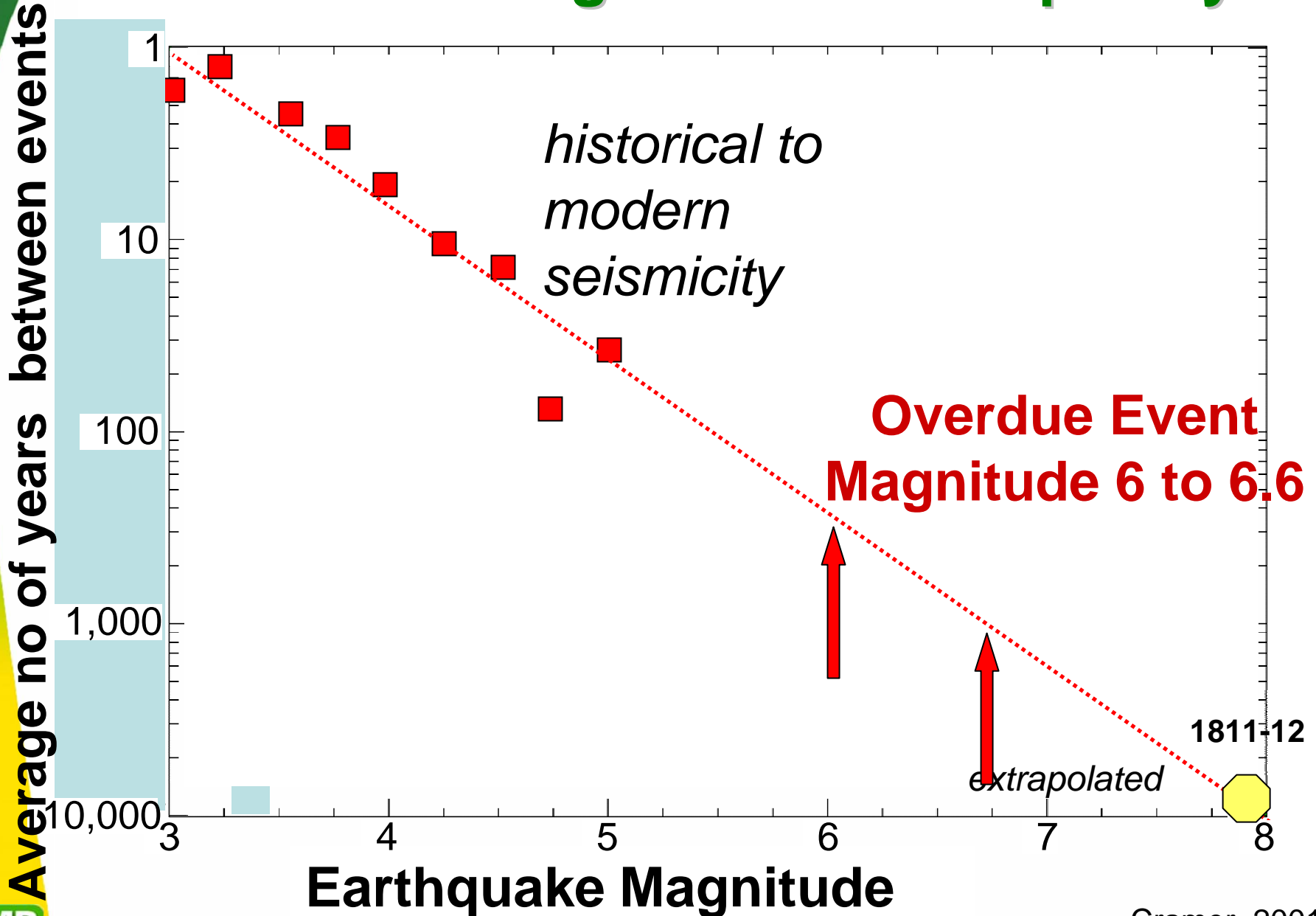


Midwest quakes are less frequent, but much more lethal than California quakes because there is less damping of seismic energy.

Question #3

What is the Most Likely Earthquake we can expect in the Here and Now; not 300 years from now?

New Madrid Magnitude vs. Frequency



Recurrence Intervals for New Madrid Earthquake Events*

Magnitude	Recurrence Interval
4.0	14 Months
5.0	10 – 12 Years
6.0	70 – 90 Years
7.0	254 – 500 Years
8.0	550 – 1200 Years

* based on existing data; always subject to update and revision

MOST LIKELY QUAKE

- In our lifetimes, the most likely earthquake to impact St. Louis would be something similar to the **Magnitude 6.2 Charleston, MO quake of 1895**, which has a recurrence frequency of 70+/- 15 years (overdue since 1980).
- It could emanate from either the **New Madrid Zone** or the **Wabash Valley Fault Zone**, or from **South Central Illinois**.

Question #4

**What is the
economic impact of
Soil Liquefaction?**



- Recent sand blows dot the landscape surrounding New Madrid, MO, testifying to **massive liquefaction**

LIQUEFACTION or “QUICK SAND” CONDITION

Liquefaction is a failure mechanism by which cohesionless materials such as sand and silt lose shear strength when the pore water pressure equals the effective confining stress. It is usually limited to the upper 50 feet and typically occurs in silt, sand and confined gravel.

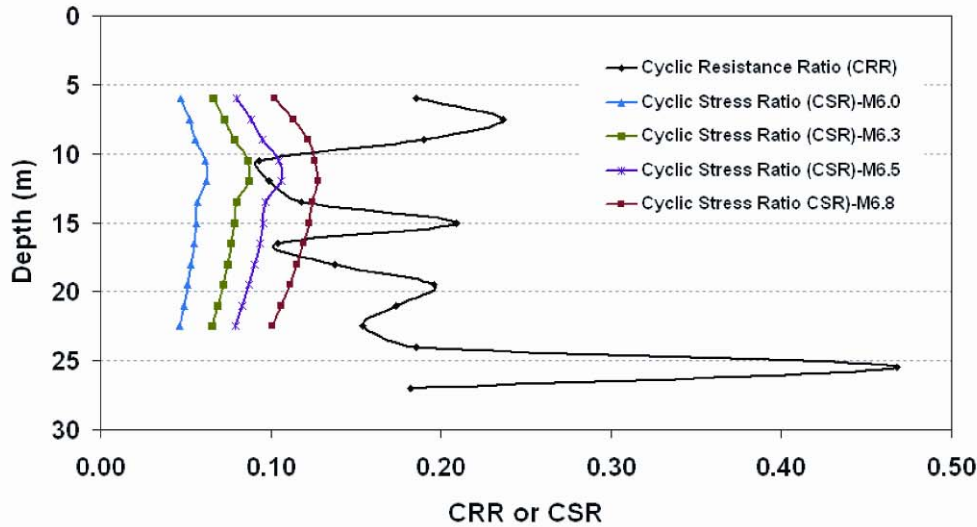


Liquefaction Potential

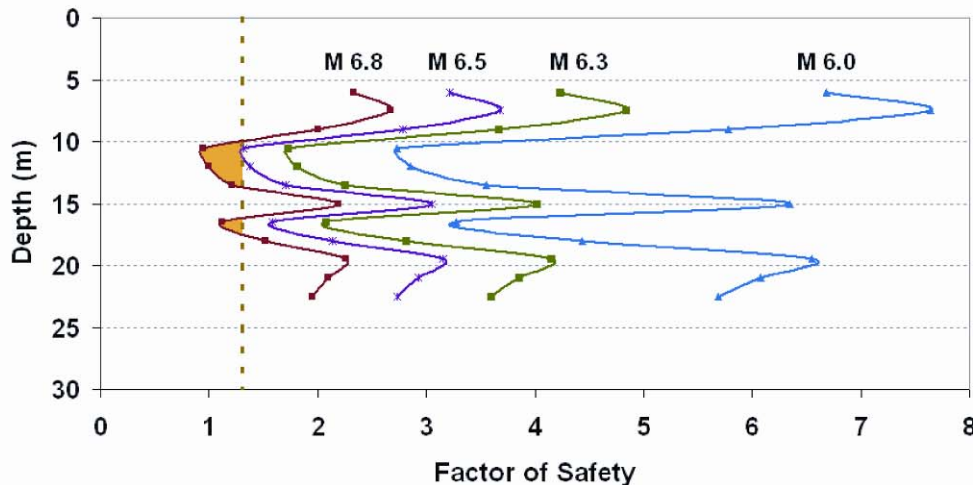
Liquefaction is predicted in the lower Missouri River Flood Plain for a **Magnitude 6.8** quake from **South Central Illinois** or **Wabash Valley Seismic Zones**.

Liquefaction to depths of **18 m** predicted for **Magnitudes > 6.5**

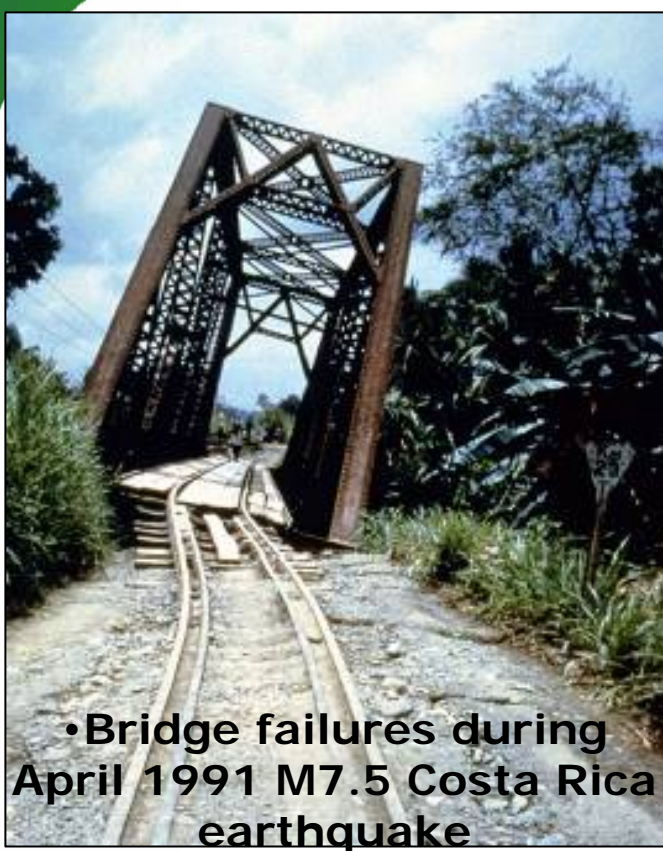
Creve Coeur Bridge Boring B2-61
Earthquake Source: South Central Illinois -110 km



Creve Coeur Bridge Boring B2-61
Earthquake Source: South Central Illinois -110 km
Factor of Safety for different earthquake magnitudes



Liquefaction Often Impacts Bridges



- Though supported on steel and concrete piles respectively, these bridges both failed due to liquefaction of foundation materials, which tilted the piles
- **Fiber optic cables strung across bridges would also be severed**



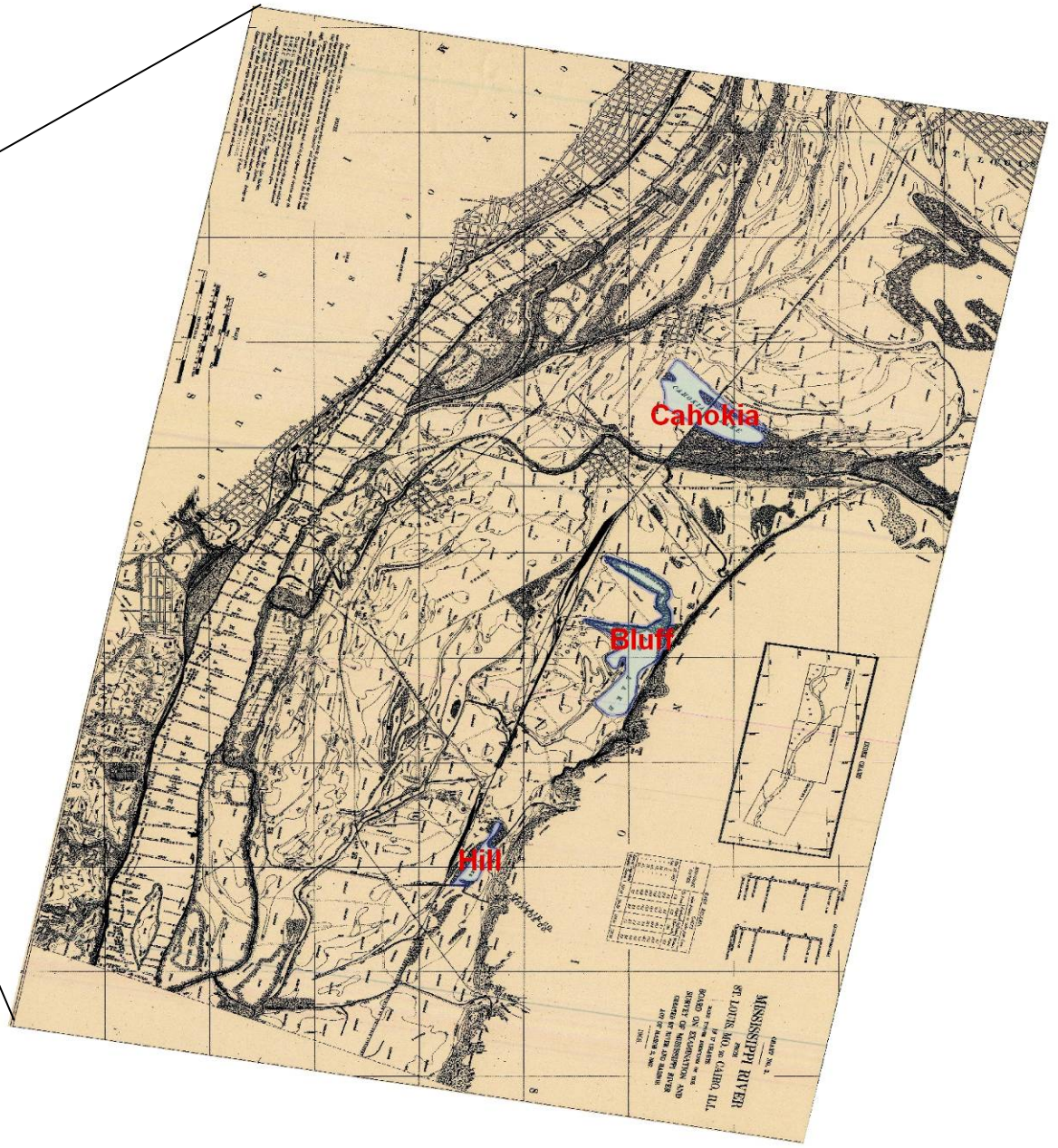
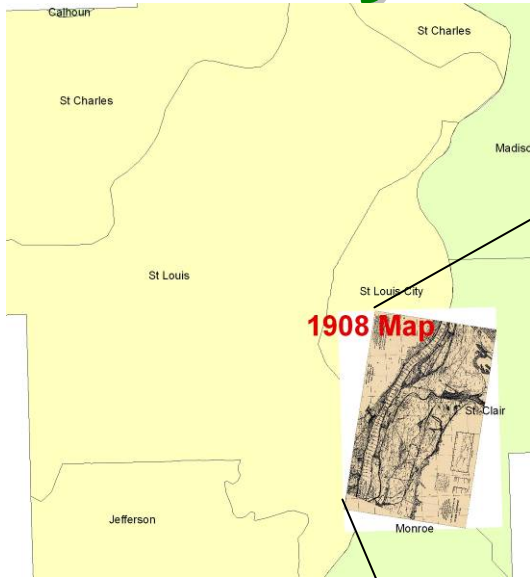
Question #5

**Why Are Old Lakes and
'Filled Ground'
Important Factors
in Predicting Ground
Shaking Intensity?**



- This 1796 map shows the spatial distributions of oxbows, cutoffs, and islands in the river floodplains around St. Louis.

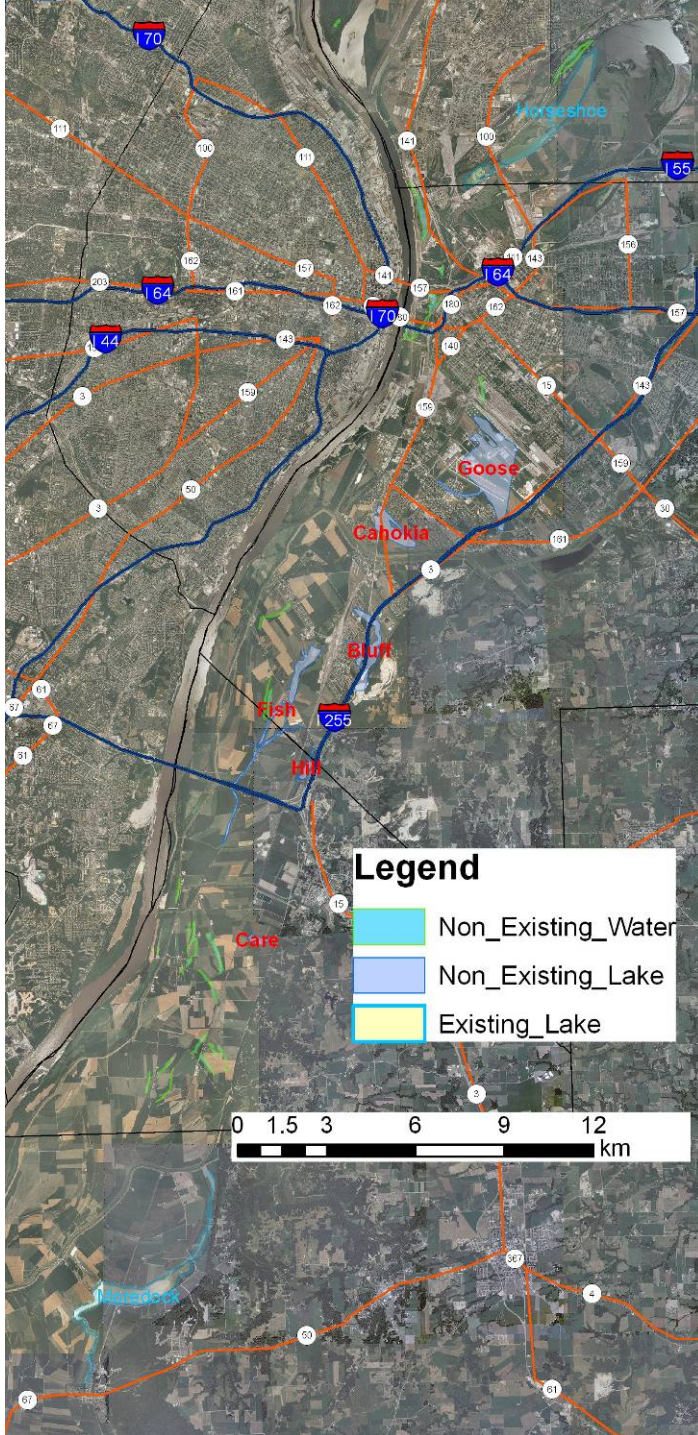
Overlay of 1908 Mississippi River Map



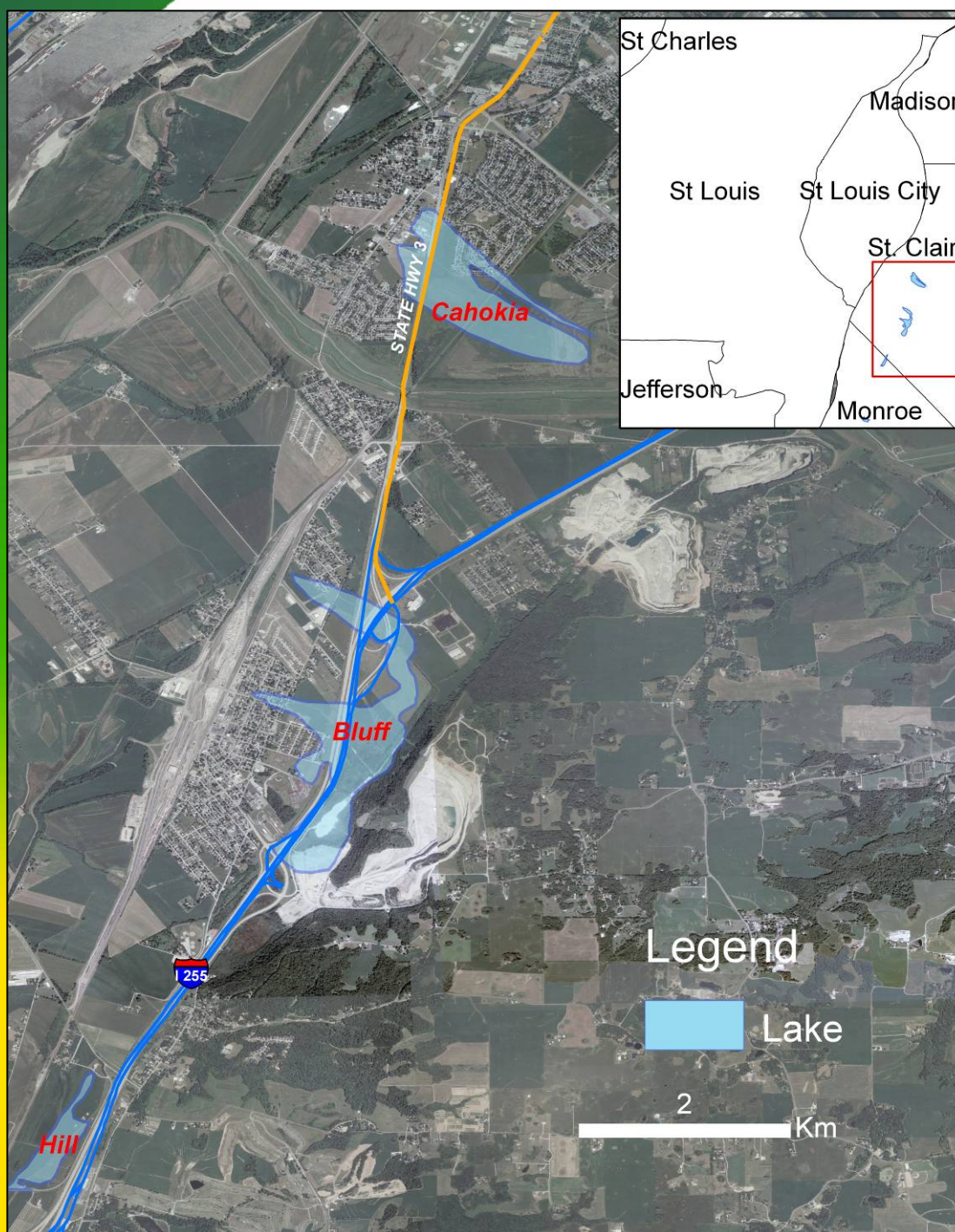
Overlay information on historic maps - in this case, old oxbow lakes and cutoffs that have since been infilled

Map Overlays Using Geographical Information Systems

- The spatial positions of the 1908 lakes in the Mississippi River floodplain are overlain on modern maps of the area, to gain a better perspective on which areas are on filled ground; which might be subject to asymmetric site response



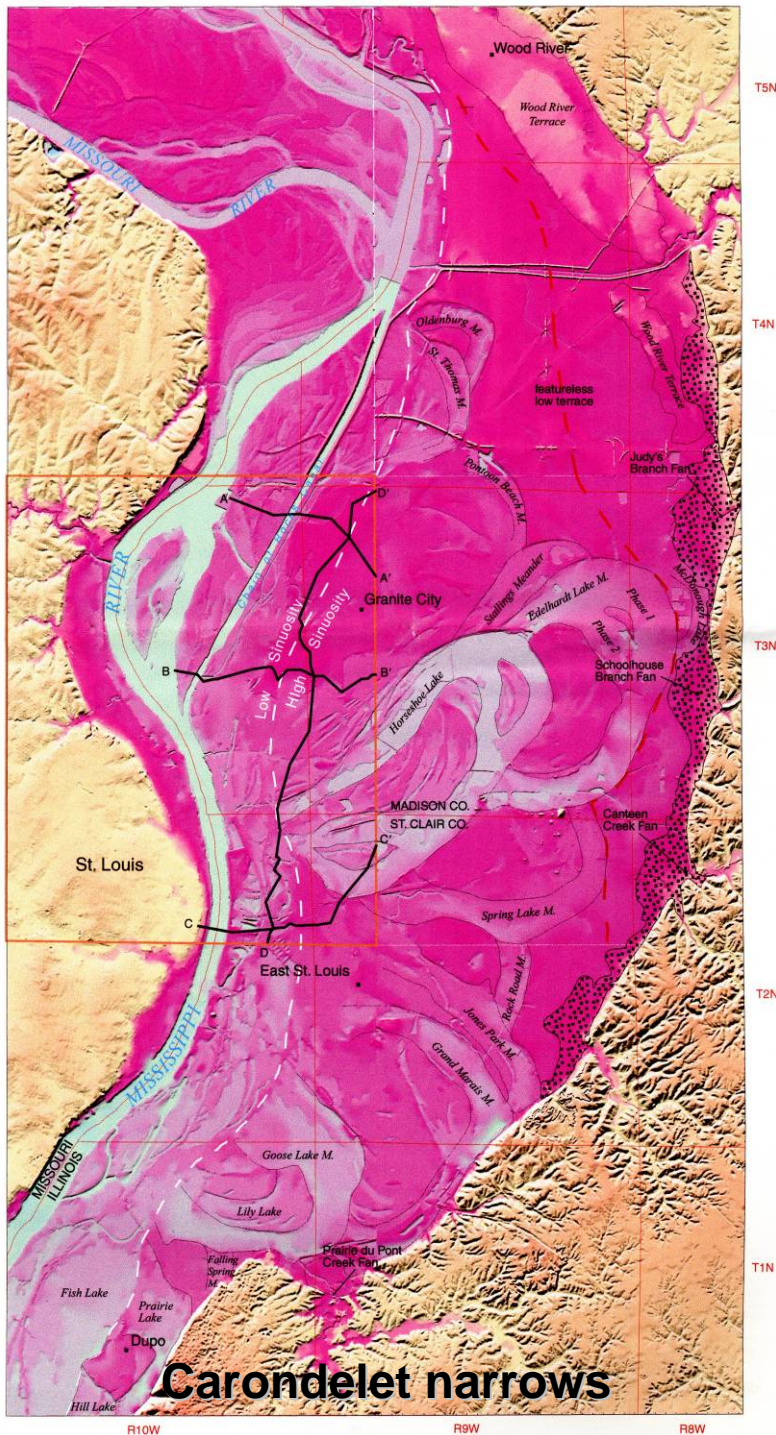
Detail of Overlay



- About half of the freeway interchange between Interstate 255 and Illinois Route 3 plots over one of the old cutoff lakes shown on the 1908 map.
- The different geologic conditions beneath either side of the interchange could be expected to foster asymmetric site response problems

Mississippi River Flood Plain

- One of the most important GIS map products in flood plains along major channels is a rendering of prehistoric channels
- These channels tend to develop one upon another, in spatially complex patterns
- Note bedrock narrows at Carondelet and position of the main channel, hugging the western bank



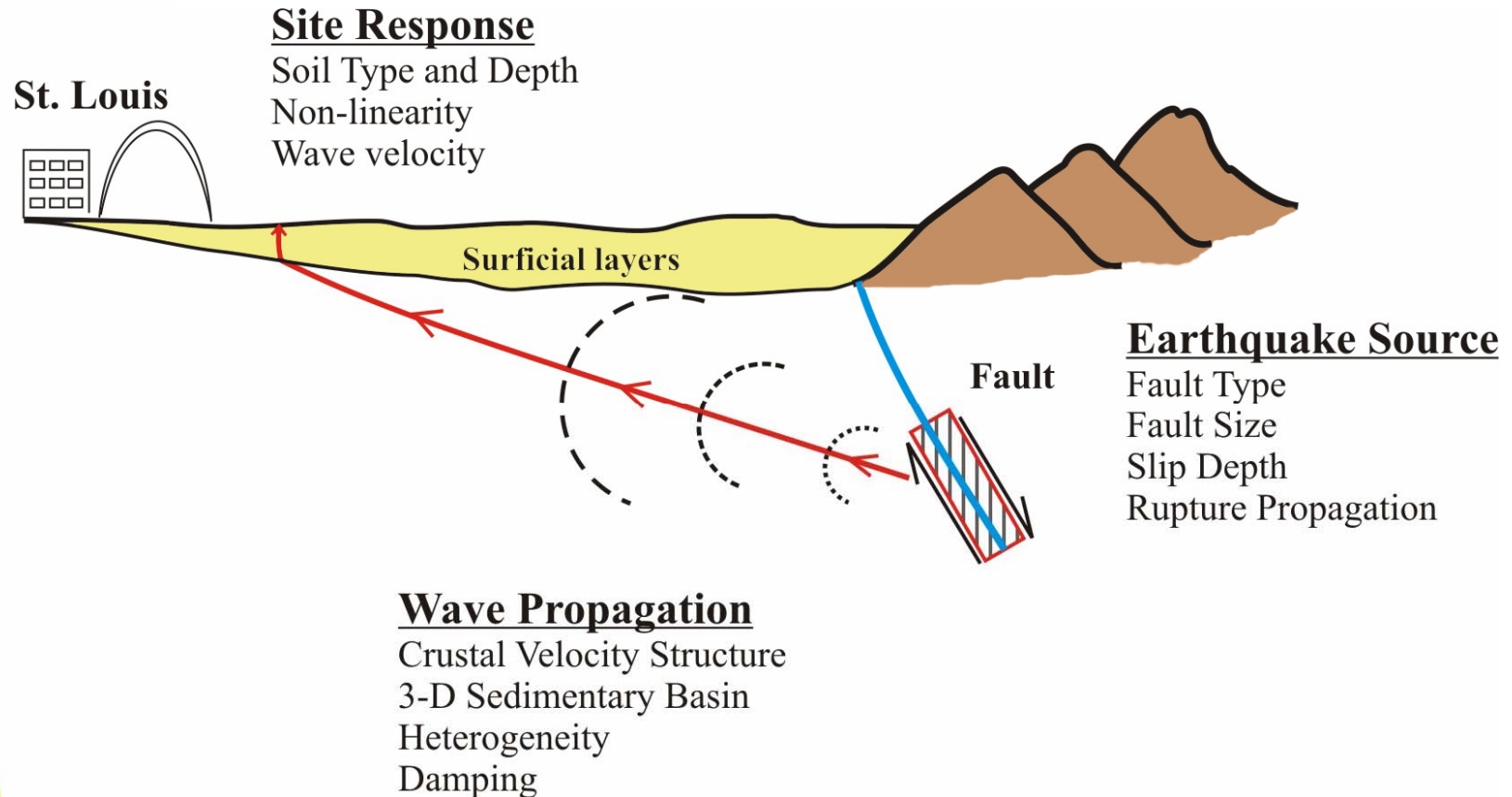
Carondelet narrows

Question #6

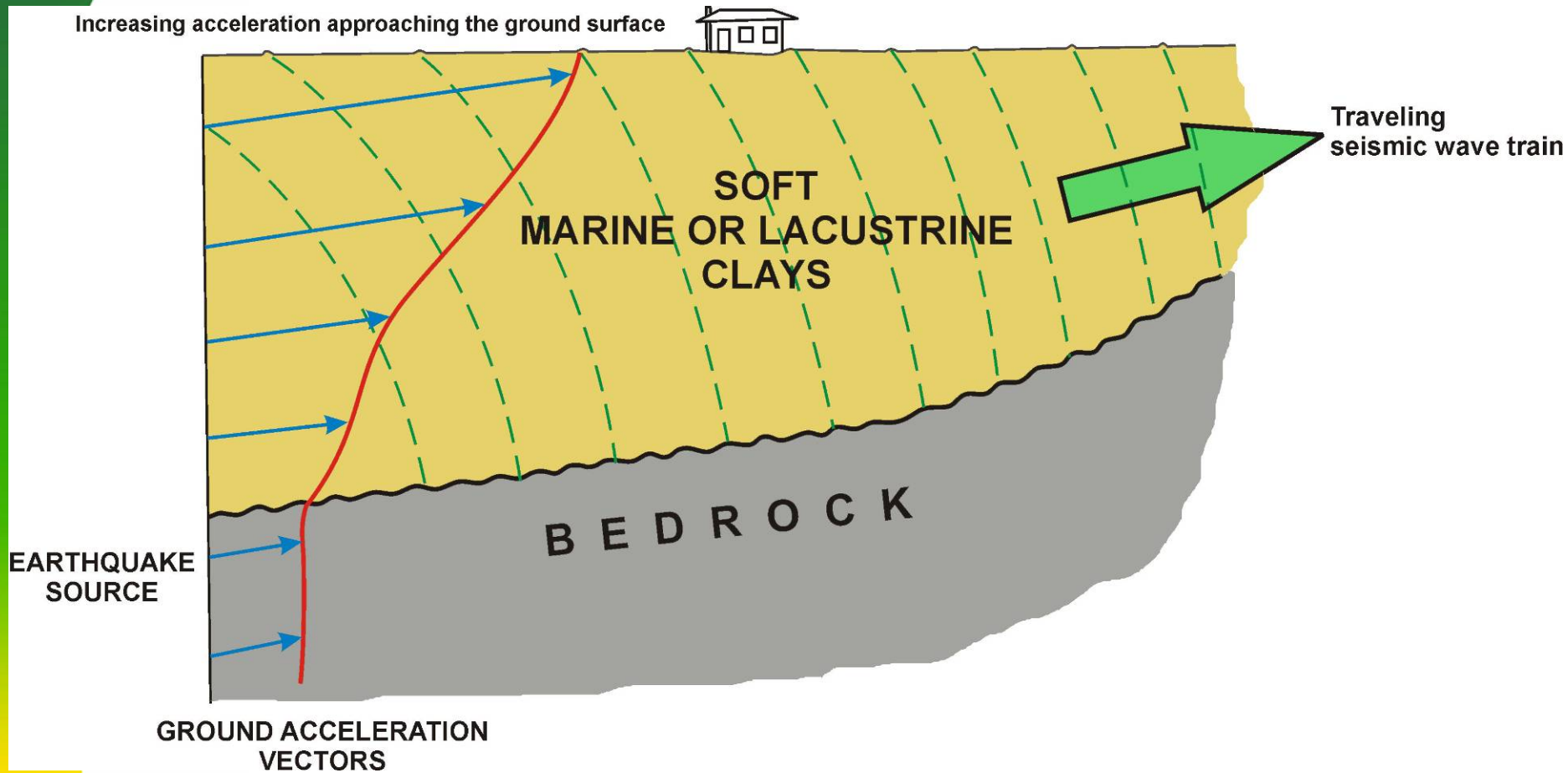
**How will the
Intensity of Shaking
vary from one area to
another ?**

**Some examples from the
St. Louis Metro area**

Shaking Intensity is Controlled by a factor called 'Seismic Site Response'



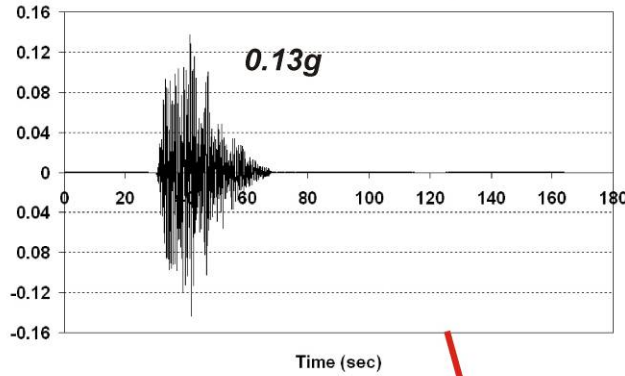
- The type, depth and size of fault, combined with physical properties of crust and geophysical properties of overlying surficial soils, all combine to affect **site response**.



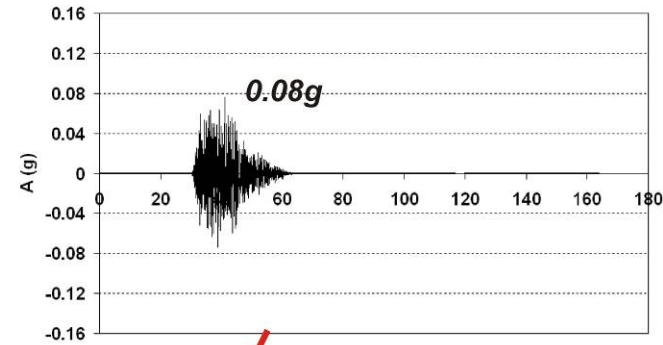
- **Site response** is used to describe the fundamental period of vibration and the lateral forces generated by a typical earthquake at any particular site.

Effect of Soil Thickness on Peak Ground Acceleration (PGA)

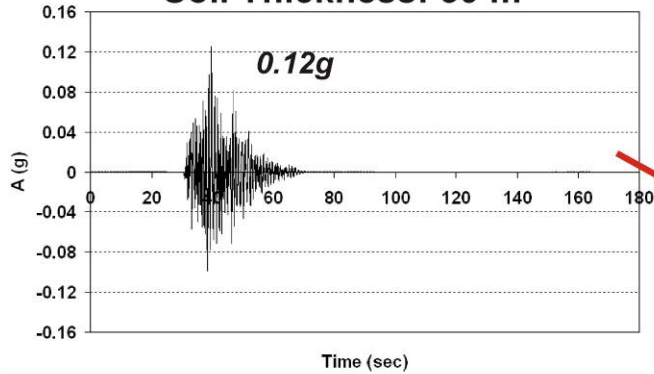
Soil Thickness: 28 m



Soil Thickness: 22 m



Soil Thickness: 39 m



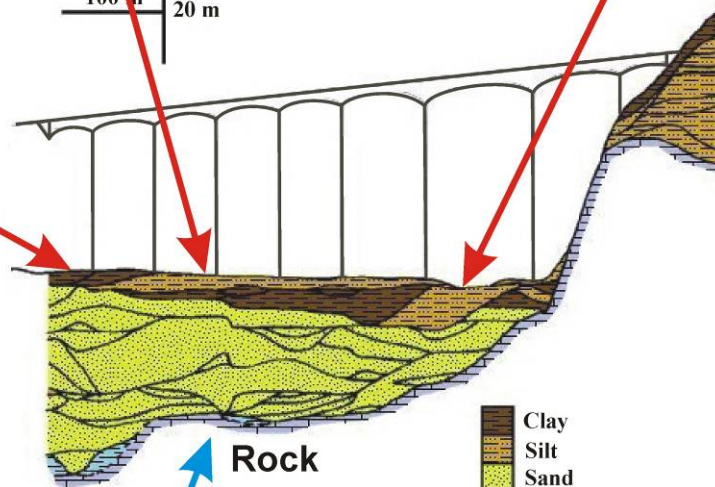
Time (sec)

W



Time (sec)

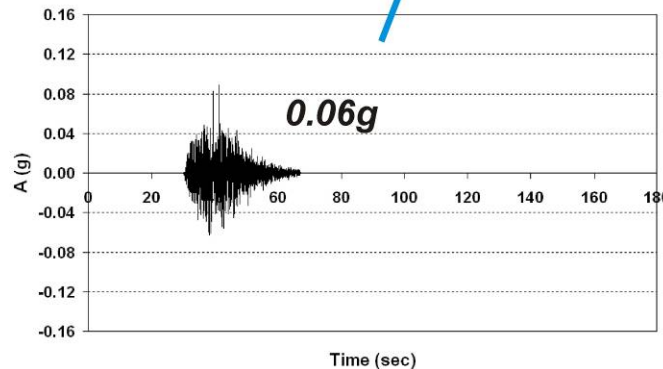
E



Rock

- Clay
- Silt
- Sand
- Shale
- Limestone

180
160
140
120
100
80

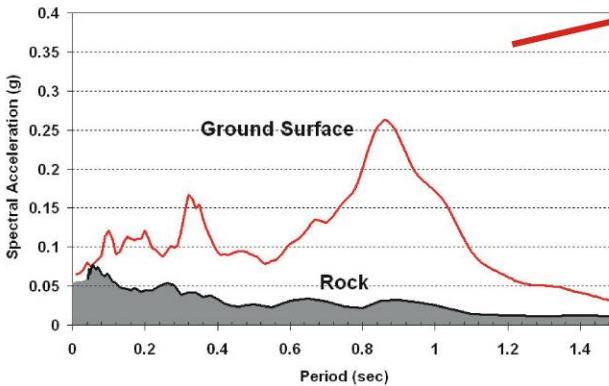
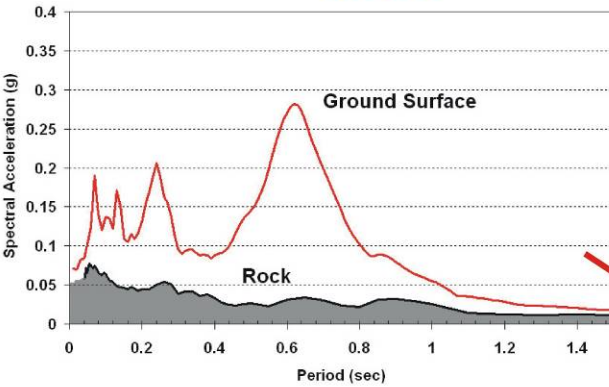


Magnitude 6.8 quake
emanating from
South Central Illinois
at 110 km

Effect of Soil Thickness on RESPONSE SPECTRA

Soil Thickness: 28 m

Peak SA = 0.28 g
Peak Period = 0.62 sec

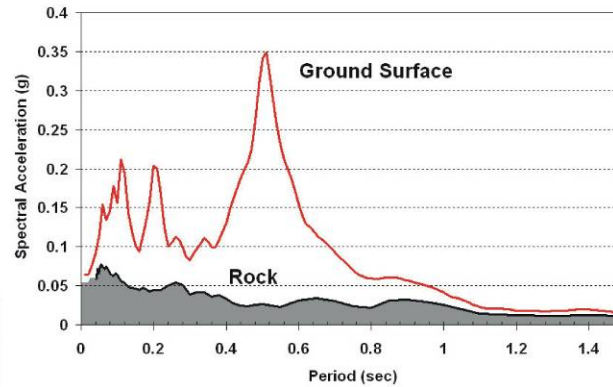


Soil Thickness: 39 m

Peak SA = 0.26 g
Peak Period = 0.87 sec

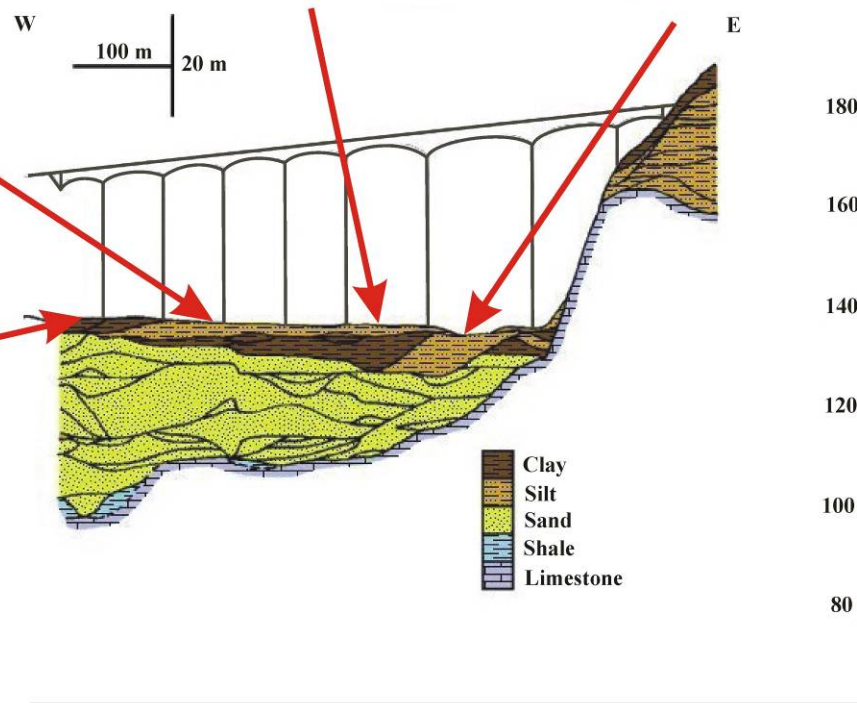
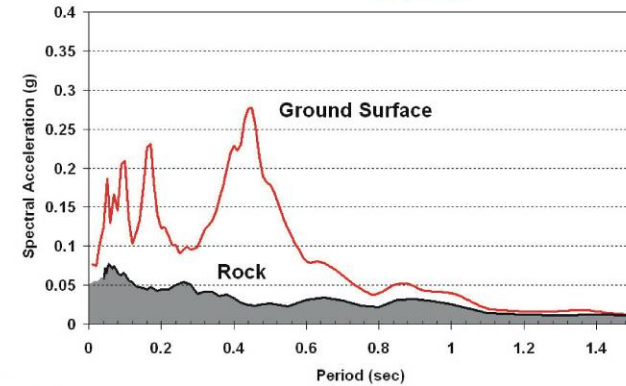
Soil Thickness: 25 m

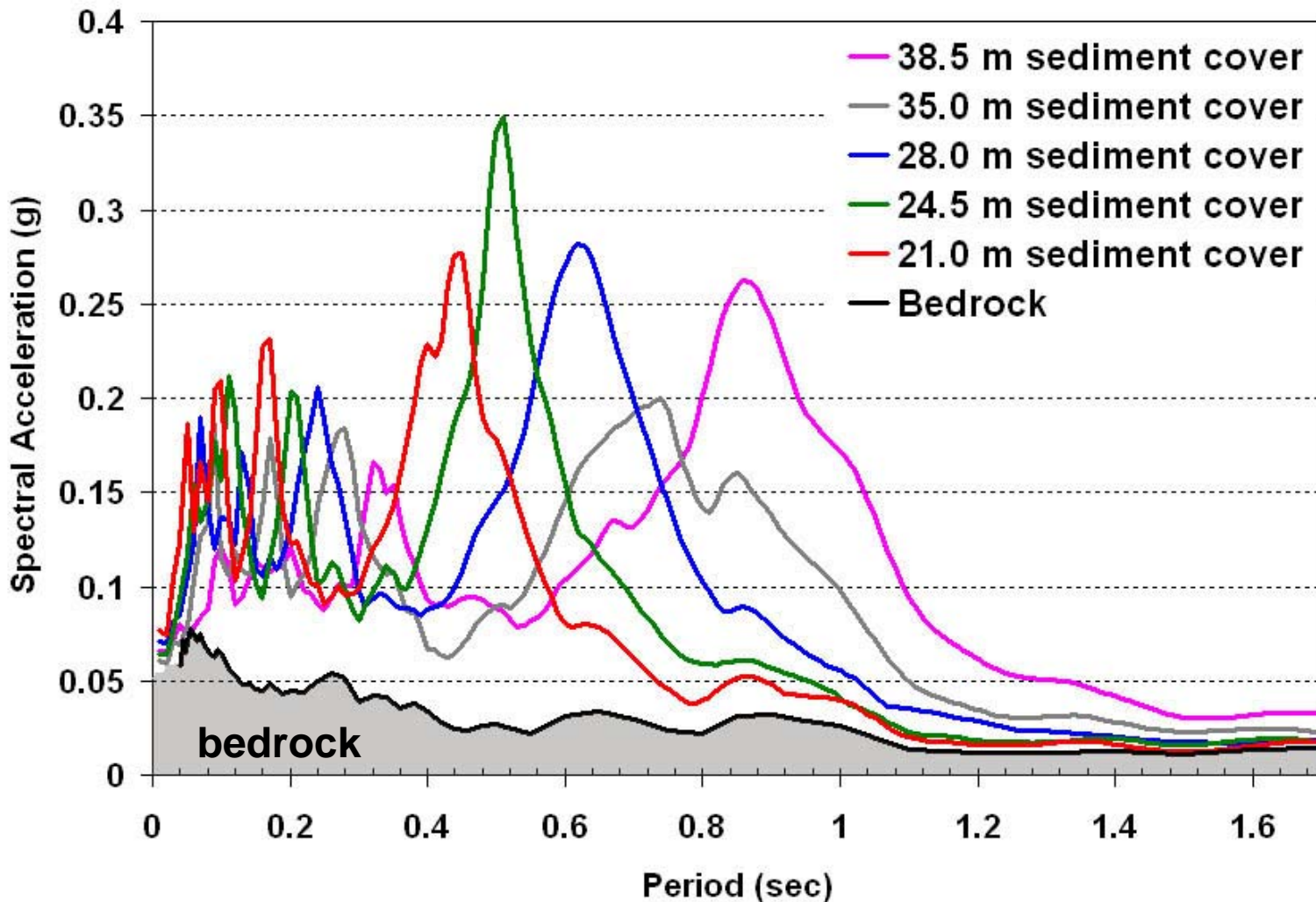
Peak SA = 0.35 g
Peak Period = 0.51 sec



Soil Thickness: 22 m

Peak SA = 0.28 g
Peak Period = 0.45 sec

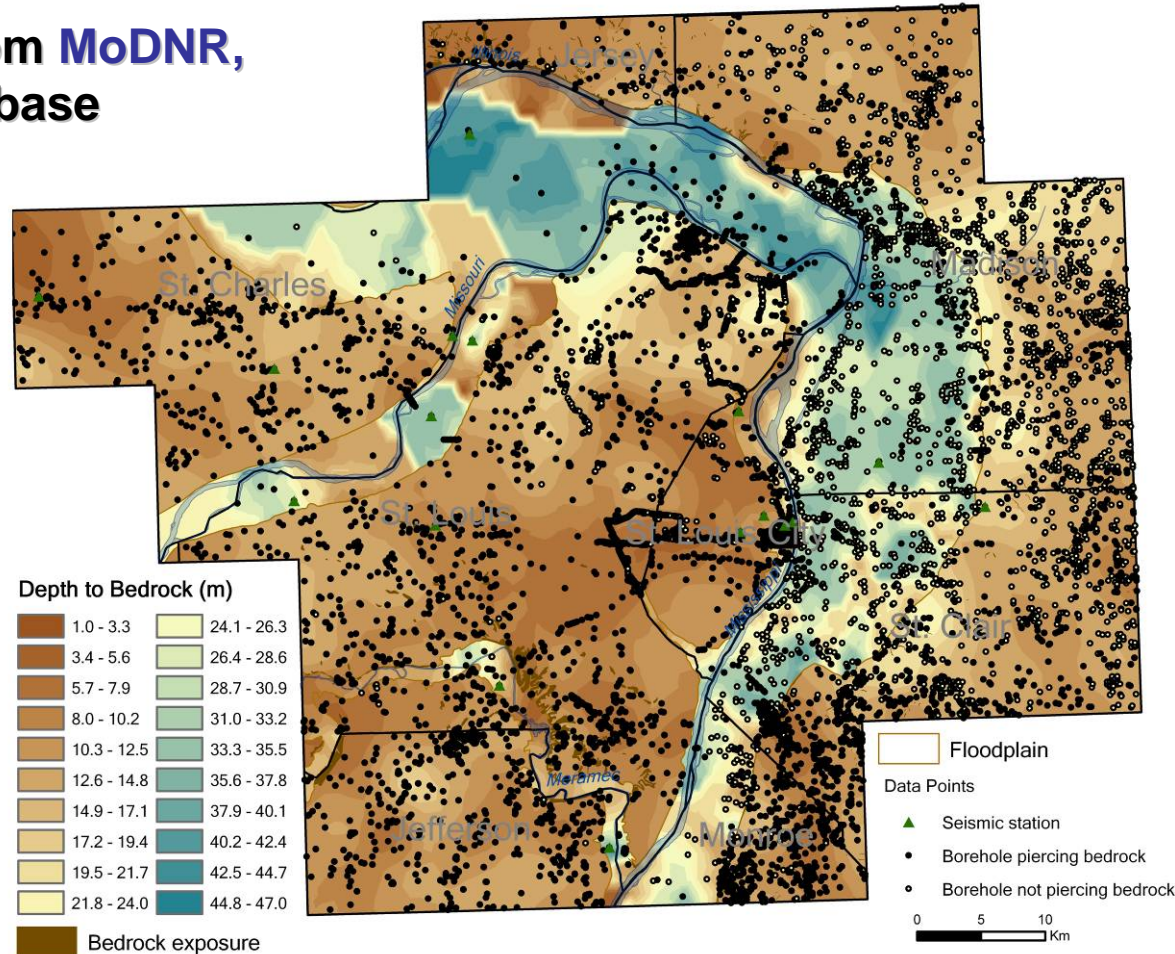




- **Variation in expected spectral acceleration with alluvial thickness for a M 6.8 quake in the St Louis, MO area**

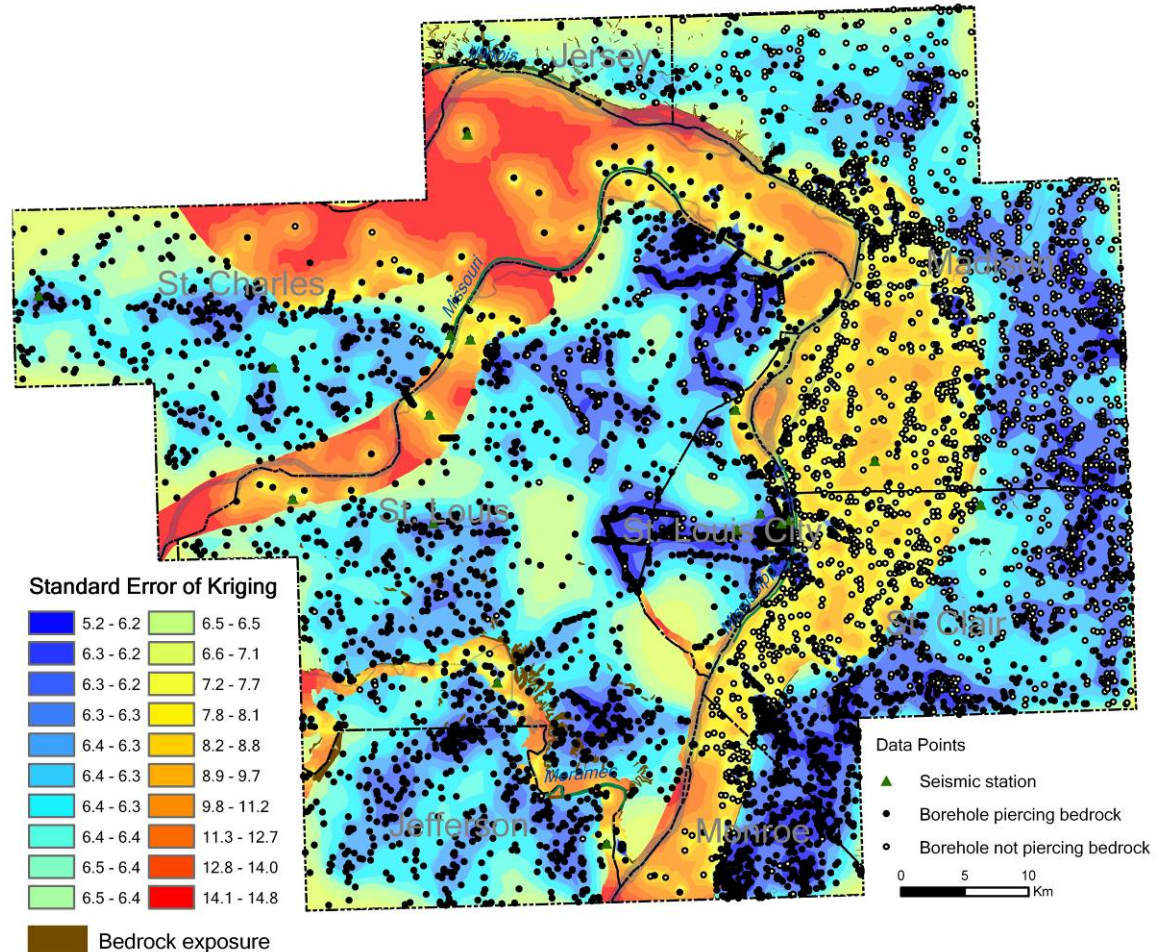
Thickness of Surficial Materials (m) from Kriging of subsurface data

- Subsurface data (8260) from **MoDNR**, **ISGS**, and **USGS** database



Standard Error Map of Kriging to estimate thickness of surficial materials

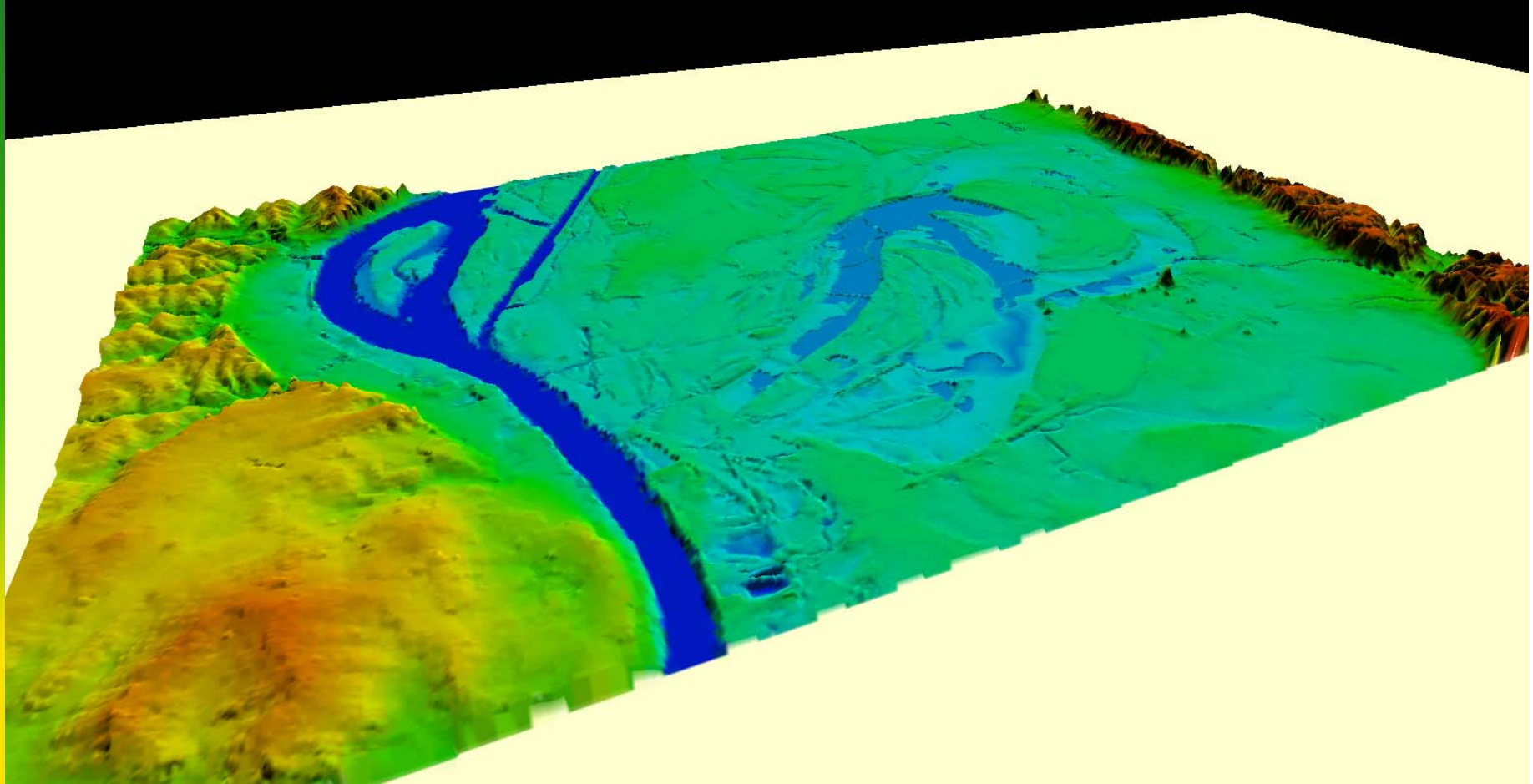
- Higher values indicate greater possible error (less accurate);
- More well logs are needed in the red areas (floodplains) to provide more consistent estimates.



Question # 7

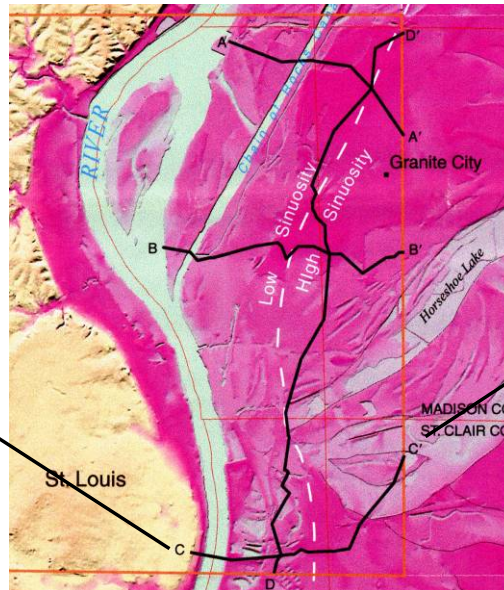
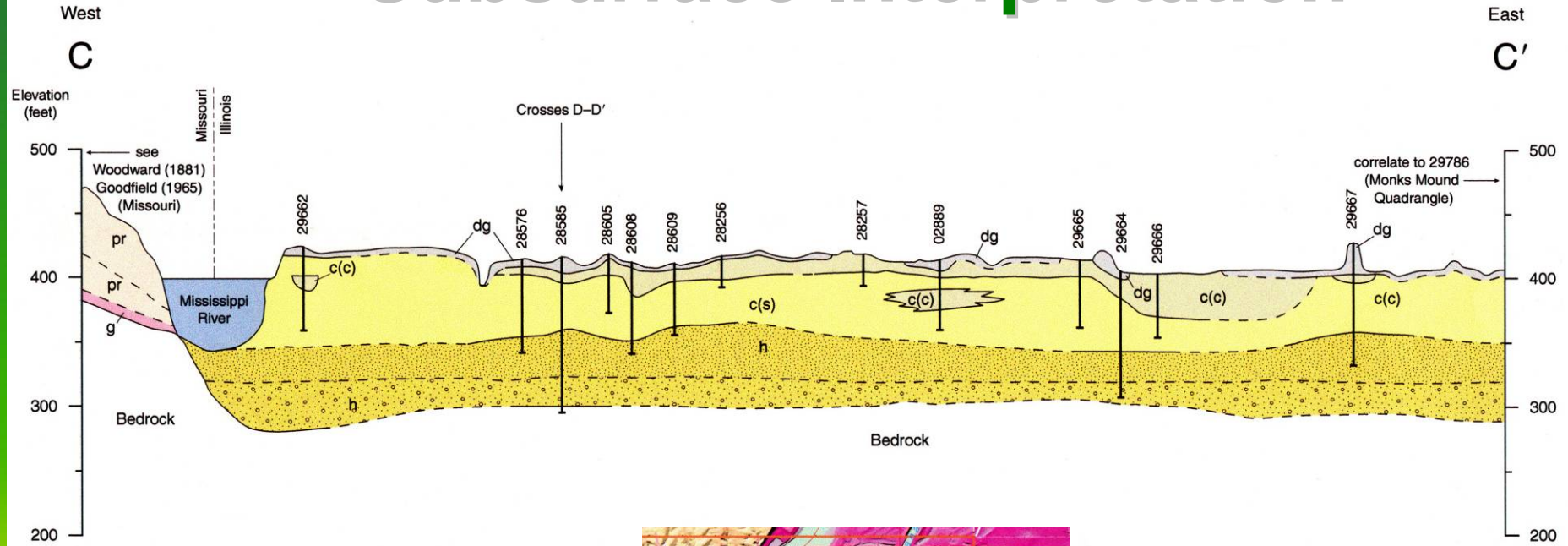
- How will we be constructing **Seismic Hazard Maps** that address the **Spatial Distribution of Risk ?**

Digital Elevation Model of Granite City and Monks Mound Quadrangles



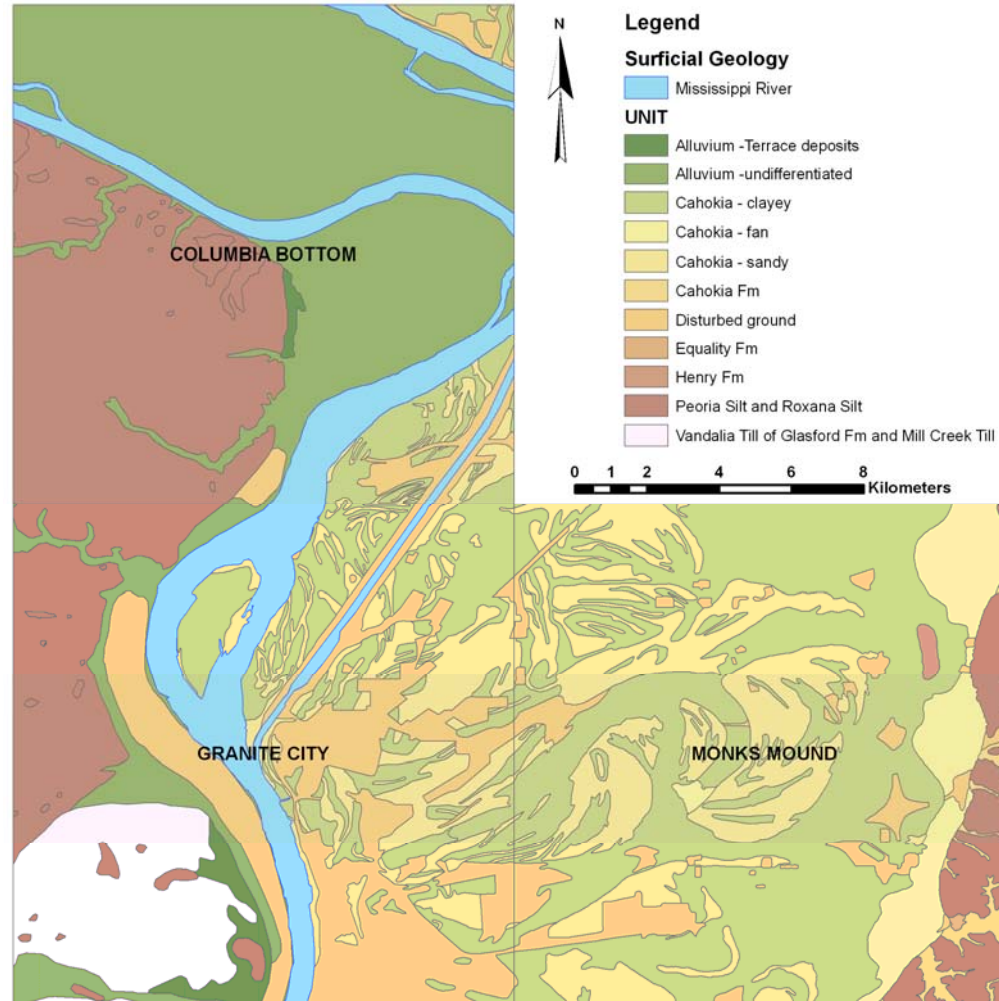
The underlying geology usually controls the topography

Geological Cross-sections and Subsurface Interpretation



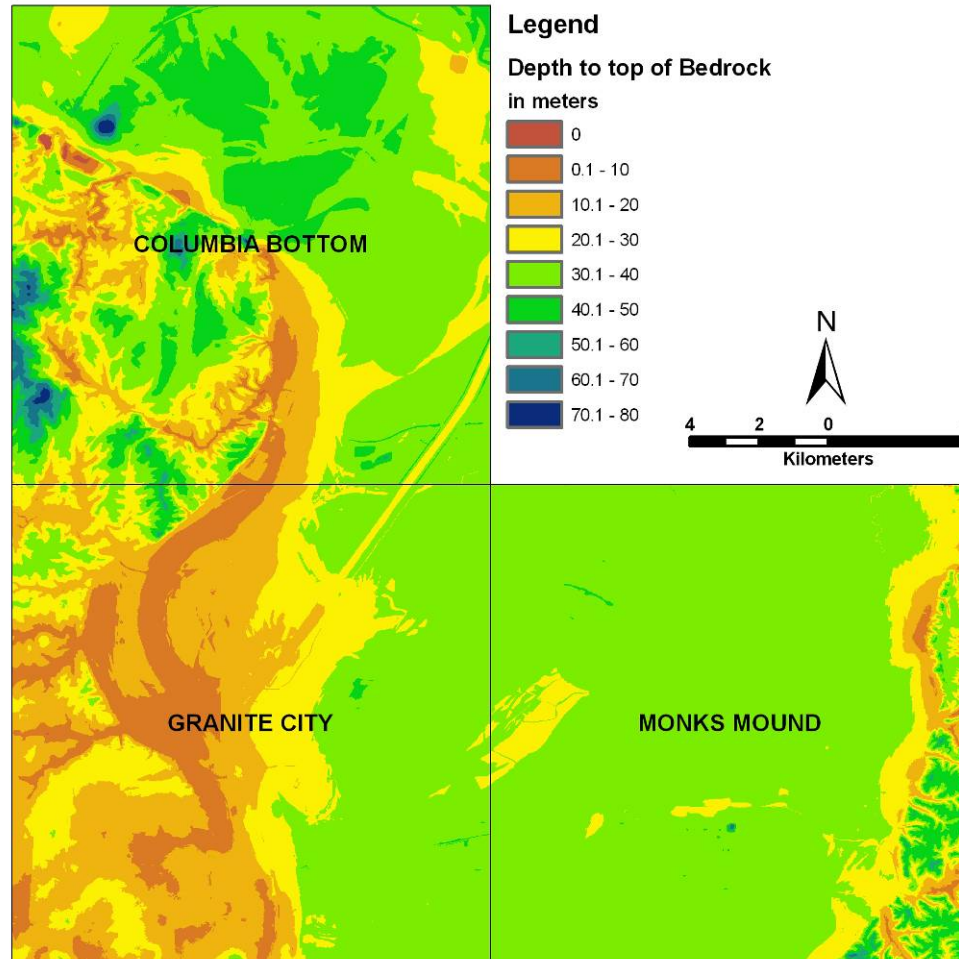
Cross section
interpretation by
Illinois State
Geological Survey

Surficial Geology of Granite City, Monks Mound and Columbia Bottom Quadrangles



12 kinds of unconsolidated sediment have been mapped on and adjacent to the Mississippi River flood plain.

Depth to Bedrock (Surficial Geology Thickness Map)



- The depth of alluvium beneath the Mississippi River flood plain opposite the downtown area varies between 6 and 40 meters.

Site Amplification Maps

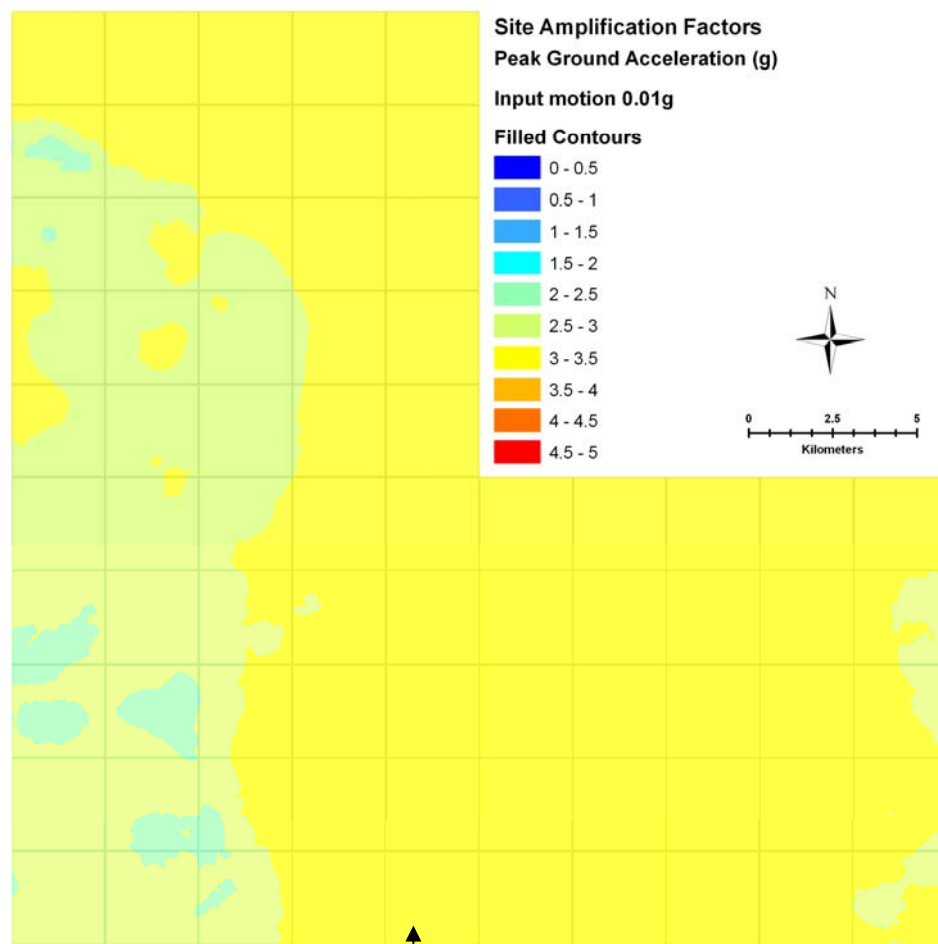
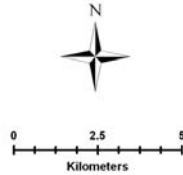
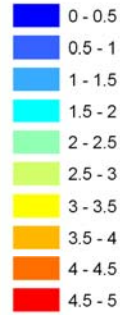
- **Site amplification maps are generated for every ground motion level of earthquake input and for ground motion parameter :**
 - **Peak Ground Acceleration (PGA)**
 - **0.2 sec Spectral Acceleration**
 - **1.0 sec Spectral Acceleration**

Site Amplification PGA (g)

Site Amplification Factors
Peak Ground Acceleration (g)

Input motion 0.01g

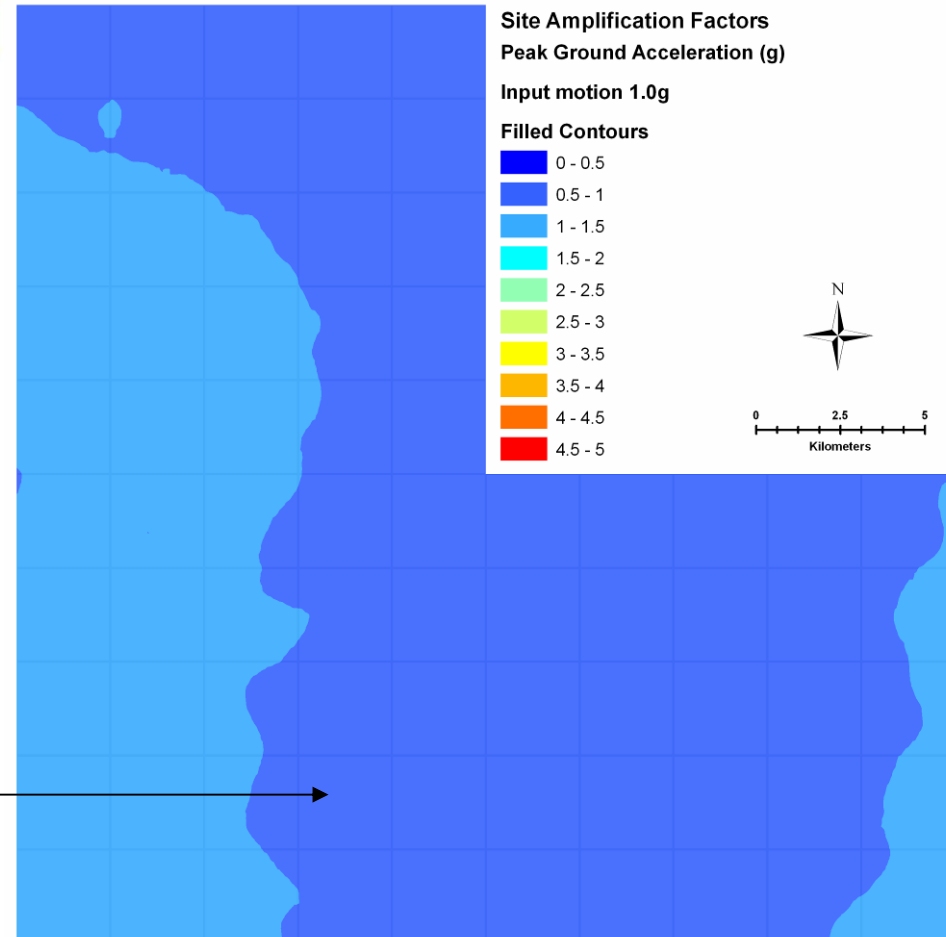
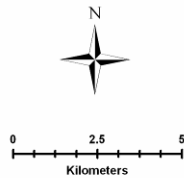
Filled Contours



Site Amplification Factors
Peak Ground Acceleration (g)

Input motion 1.0g

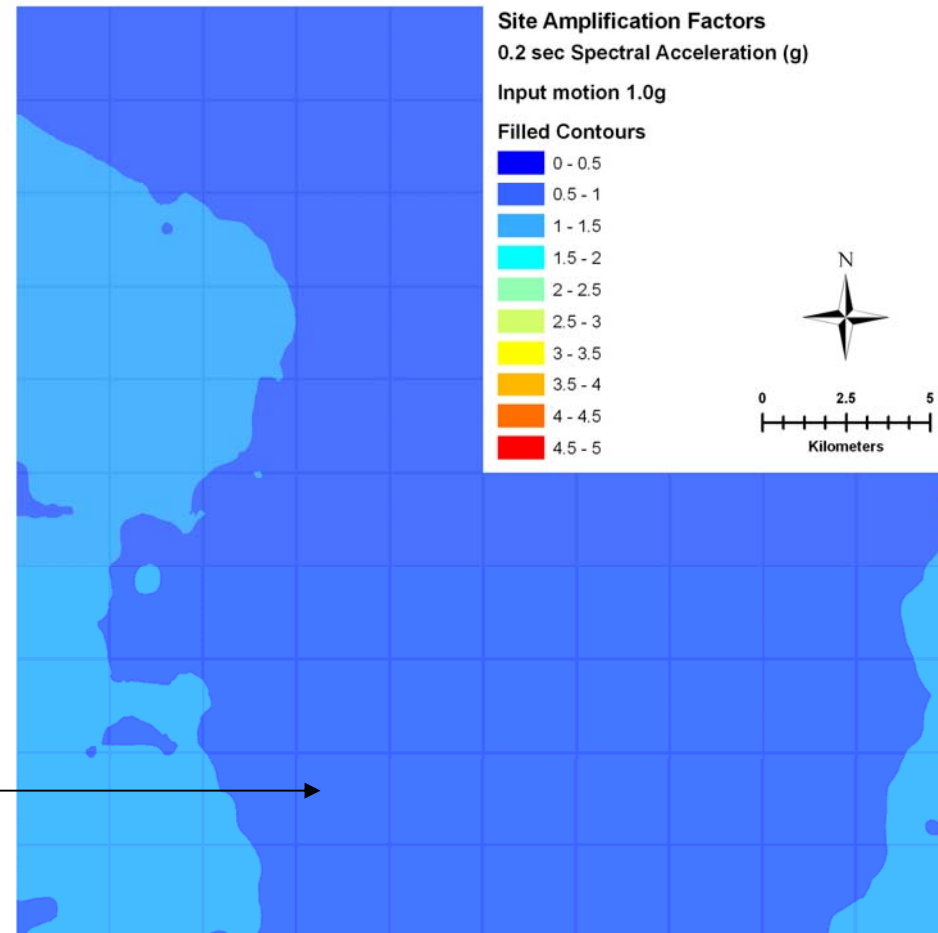
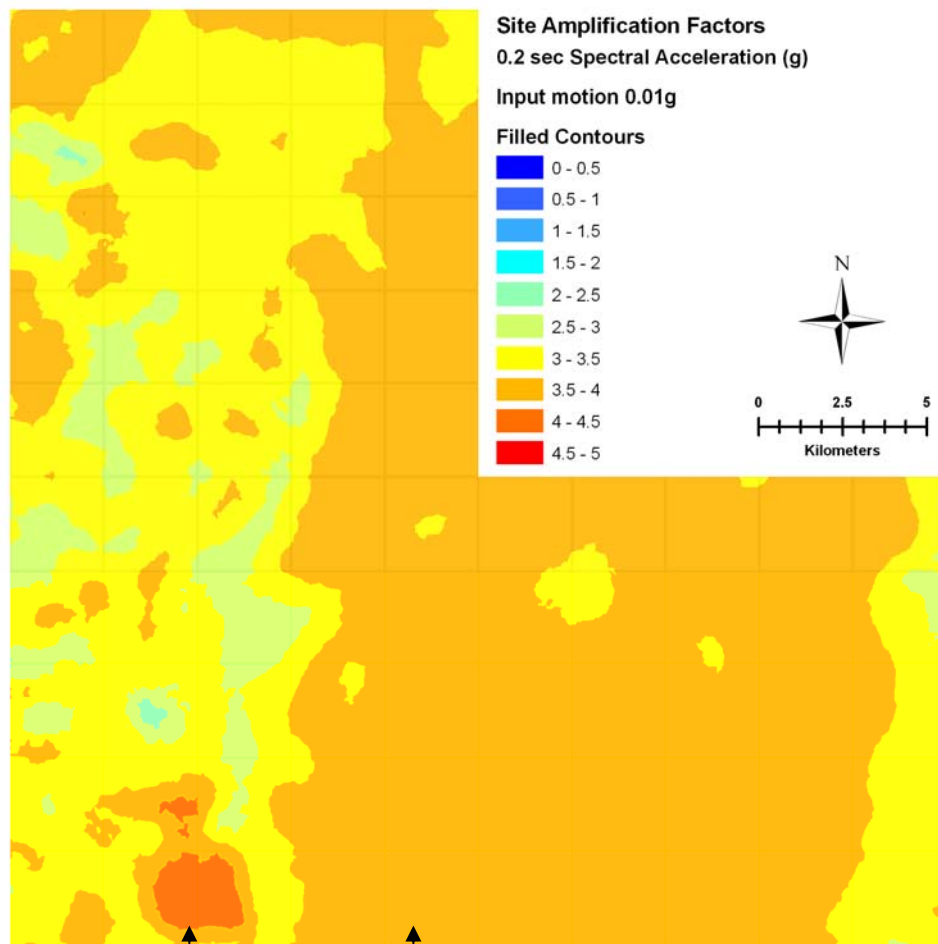
Filled Contours



3-3.5 site amplifications in alluvium

“deamplification” in alluvium

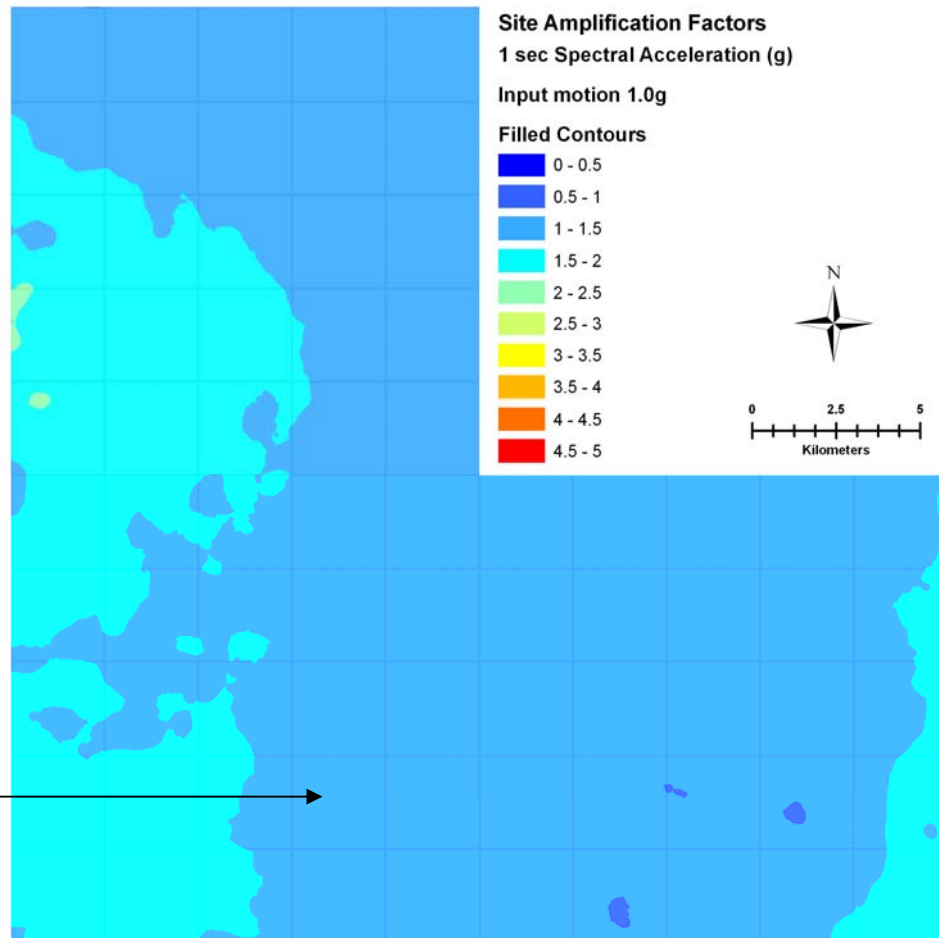
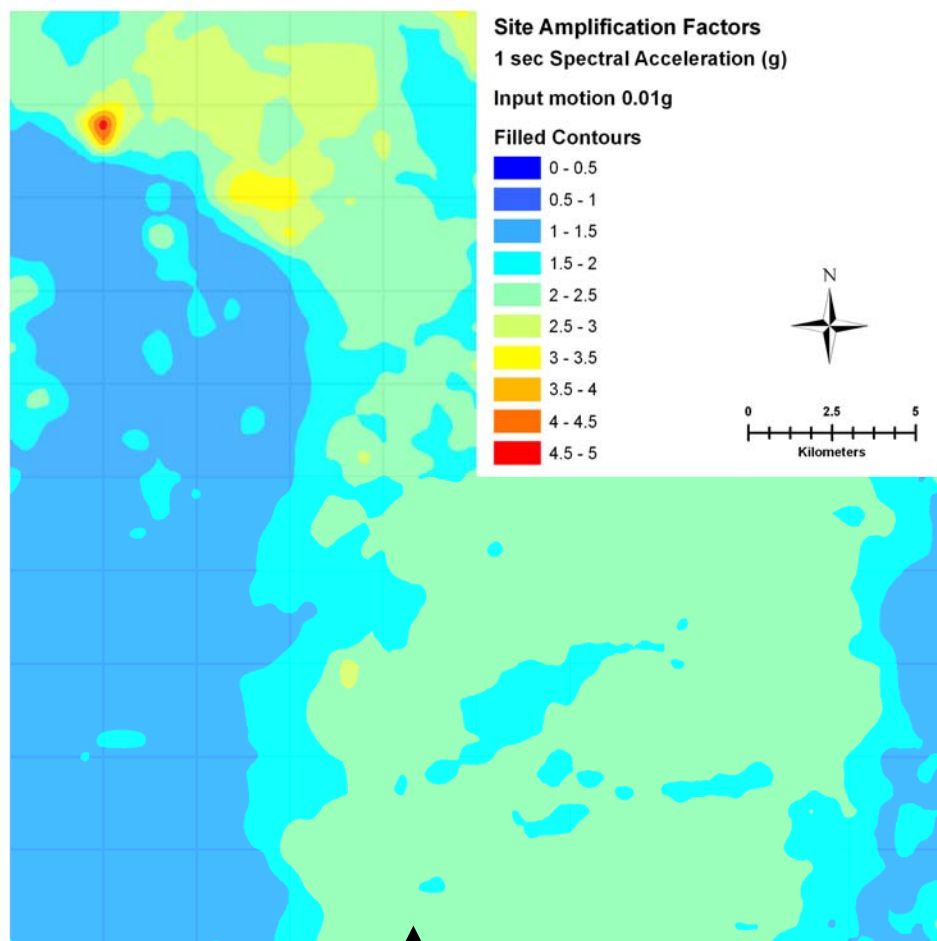
Site Amplification 0.2 sec SA



3-4 X site amplifications in alluvium
4-4.5 X site amplifications in loess

“deamplification” in alluvium

Site Amplification 1.0 sec SA



2-5 x site amplifications in alluvium

No “deamplification” in alluvium,
But very small amplifications

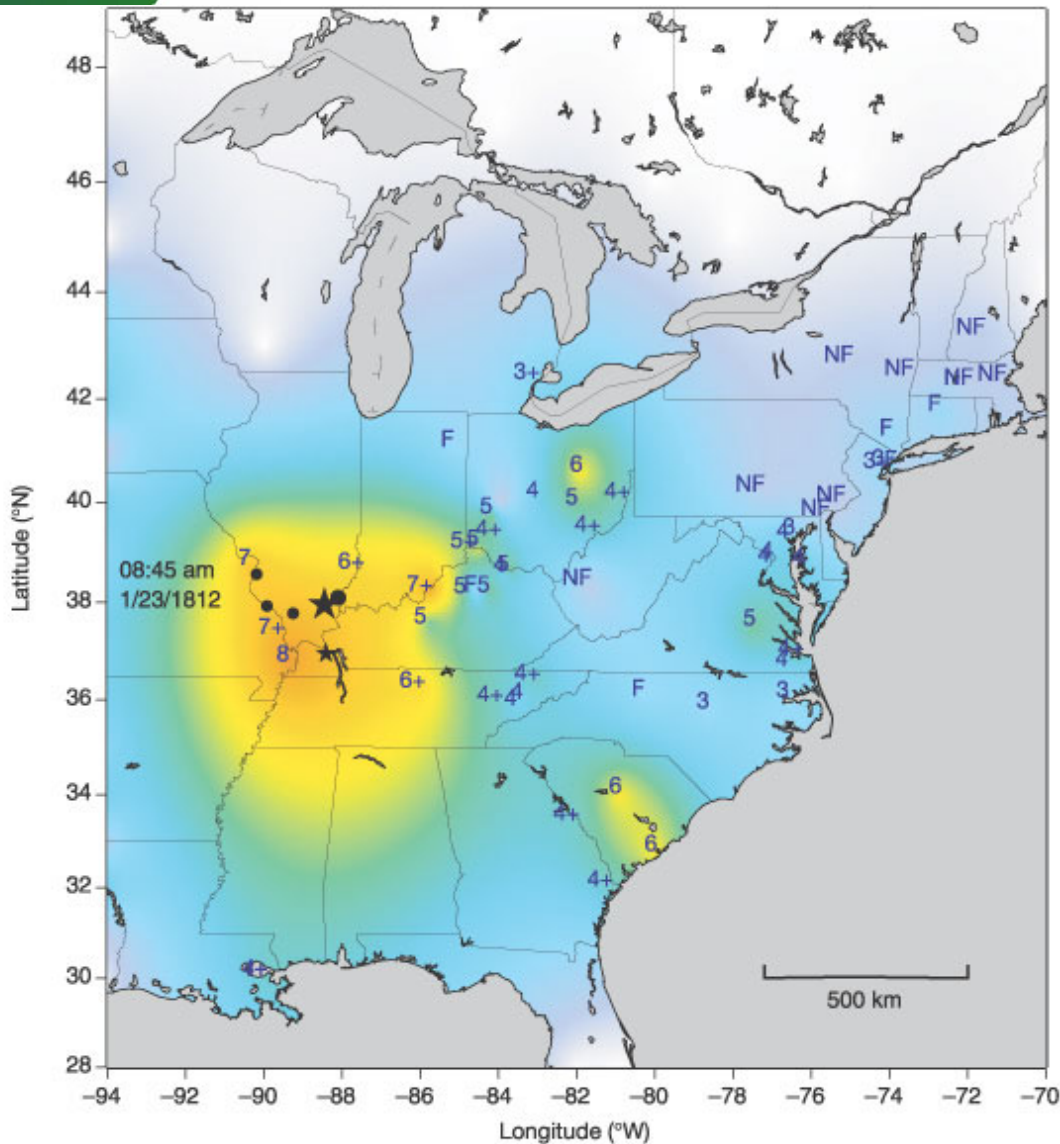
Summary of Results

- **Site amplification depends on the source earthquake magnitude.**
- **Site amplification depends on the physical characteristics of the geologic units underling any given site.**
- **Site Amplification is more severe on upland sites underlain by loess for structures less than 3 stories high.**
- **Site Amplification is most severe for structures > 8 stories high, situated on alluvium >30 m deep in the natural flood plains.**

Question #8

**So, what will Tomorrow's
Earthquake Hazard Map
for the Midwest
Look Like?**

Radiating Patterns

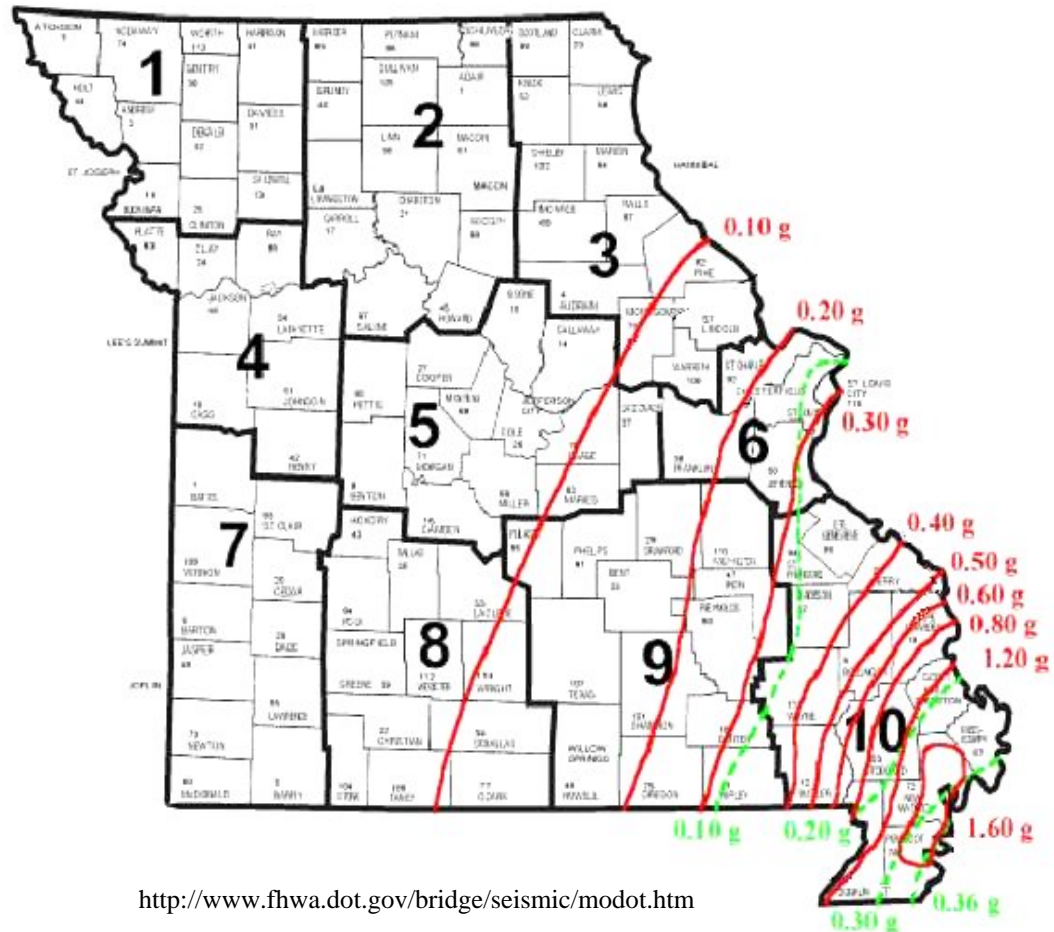


- Up till now, seismic hazard maps have been based upon conventional assumptions regarding shaking intensity.
- These assume radiating patterns of shaking intensity, emanating from the New Madrid area

Perceived shaking	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
Potential damage	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
Peak acceleration (% of g)	<0.17	0.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
Peak velocity (cm s^{-1})	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
Instrumental intensity	I	II-III	IV	V	VI	VII	VIII	IX	X+

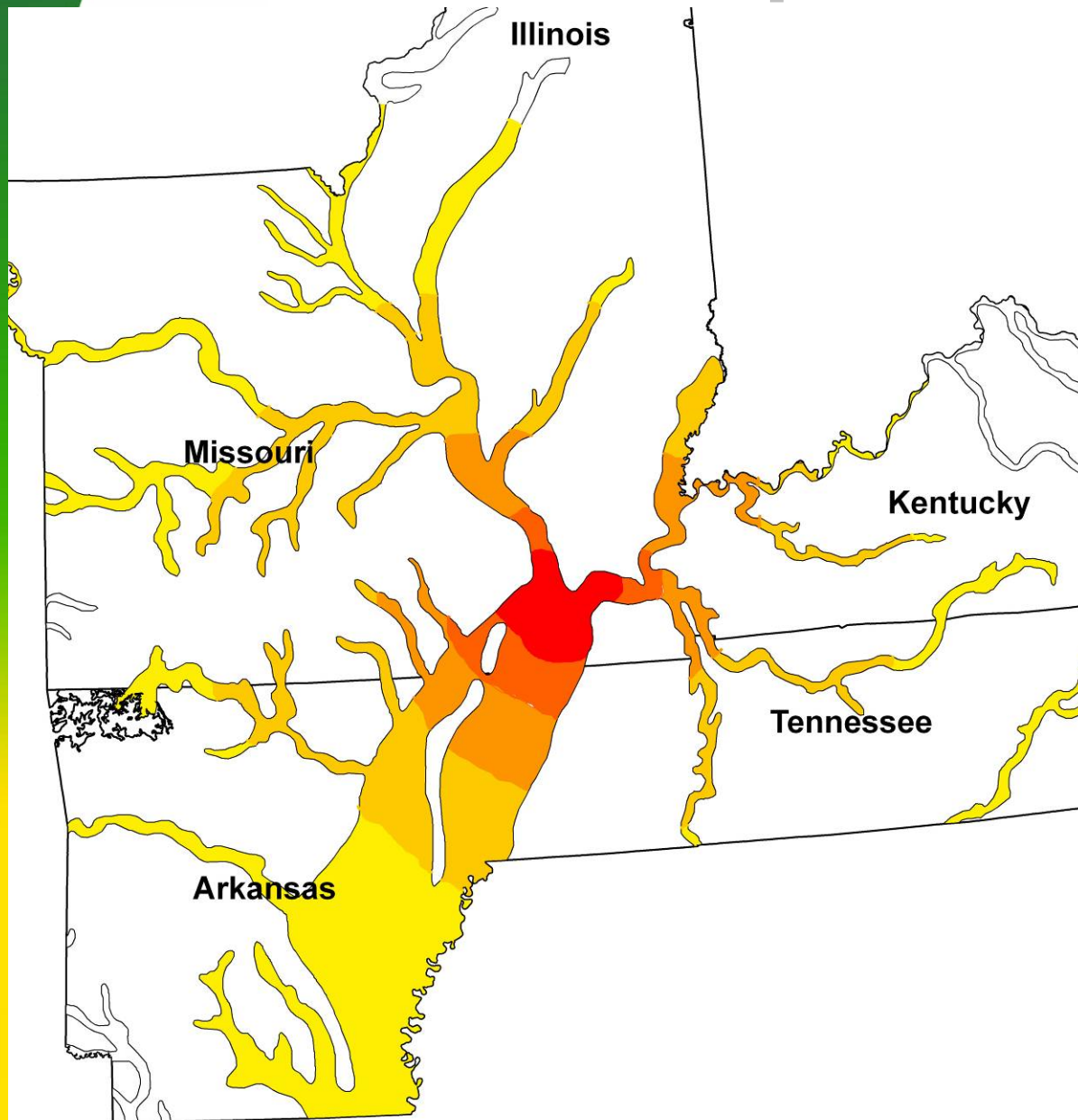
The Federal Highway Administration has been increasing required seismic loads for the NMSZ

- **Green lines** are AASHTO design parameters using USGS 10% Probability of Exceedance, adopted in 1988
- **Red lines** are new design parameters using 1996 USGS 2% Probability of Exceedance values adopted under federal mandate in 2005



<http://www.fhwa.dot.gov/bridge/seismic/modot.htm>

Future Earthquake Hazard Maps



- The earthquake hazard map of tomorrow will likely look something like this; highlighting those areas underlain by unconsolidated alluvium, along major river channels

Question #9

**What Would Be the
Economic Impacts of a
Magnitude 6.0 to 6.8
Earthquake....
if it happened tomorrow?**

What would get whacked in a Magnitude 6.5 earthquake in the St. Louis Area ?

- Structures sitting on alluvium and other unconsolidated materials deeper than about 15 meters (50 feet)
- Structures or improvements situated on filled ground, where fill + alluvium thickness > 15 m
- Taller structures, with fundamentals periods of vibration > 0.70 seconds
- Embankments placed on unconsolidated alluvial materials, where fill + alluvium > 15 m thick
- Tall structures (>8 stories) situated on old soil-filled basins greater than 25 to 35 m thick

Critical Infrastructure that would likely be impacted by a M 6.5 earthquake

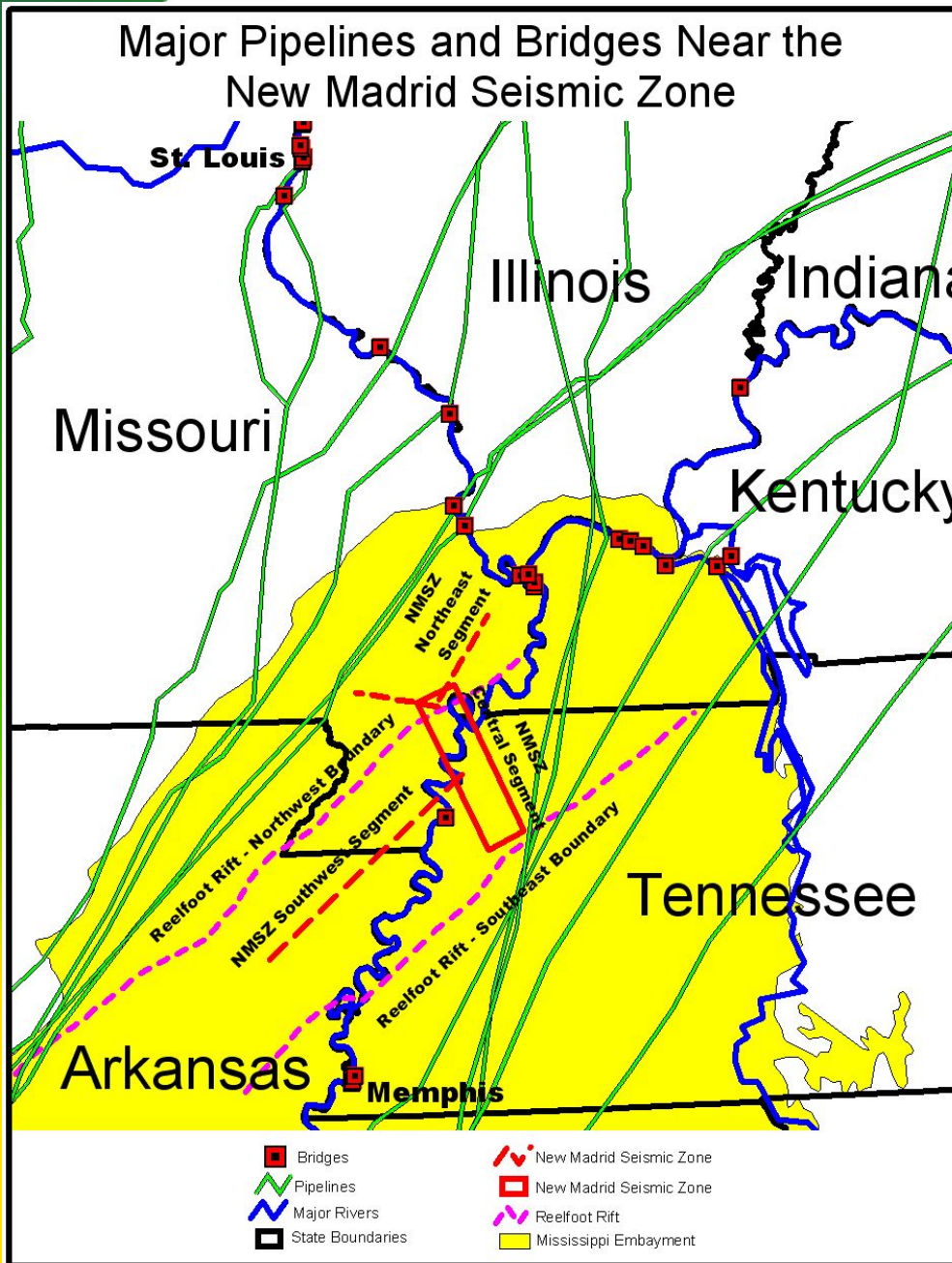
- **Multiple span bridges; in particular, tail spans**
- **Buried oil, gas, coal slurry, water, and sewer pipelines crossing flood plains**
- **High voltage (tall tower) transmission lines crossing flood plains**
- **Power plants situated along major river channels**
- **Water treatment and sewage treatment plants along channels**
- **Underground storage tanks**

Non-critical transportation infrastructure elements that would likely be affected

- **Barge traffic on navigable channels (many unknowns, but lateral spreads likely)**
- **Fuel pumps made inoperative by loss of electricity**
- **Drainage ditch network in reclaimed flood plains**
- **Railroad corridors**
- **Interstate and secondary highway network**
- **Airport runways, and fuel handling facilities**
- **Municipal off-stream water storage tanks and water distribution systems**

Crude Oil and Natural Gas Pipelines

- Upper map shows the largest crude oil transmission lines in the United States.
- 5 of the 6 main lines crossing the Mississippi River could be compromised in a M. 6.5 earthquake emanating from the NMSZ
- Lower map shows the largest natural gas trunk lines in the United States
- 4 of 9 lines crossing the Mississippi River could be compromised in a M. 6.5 quake

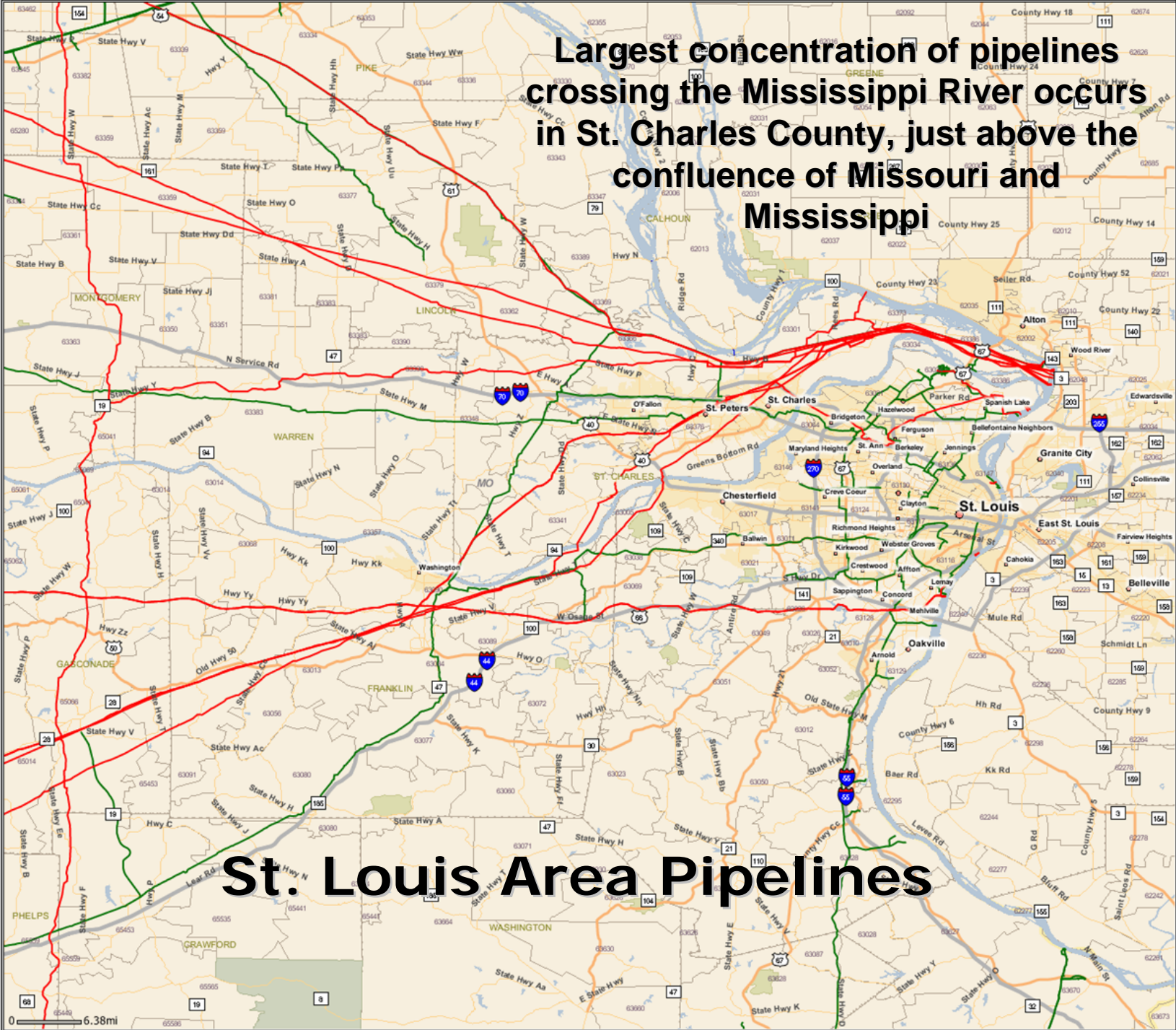


Major Refined Oil Products Pipelines



- Refined product service lines convey petroleum products between refineries and major metropolitan markets, from which these products are distributed.
- Significant disruption of the domestic refined product distribution lines has never occurred
- The ‘shock factor’ of fuel unavailability would be unprecedented, likely necessitating rationing

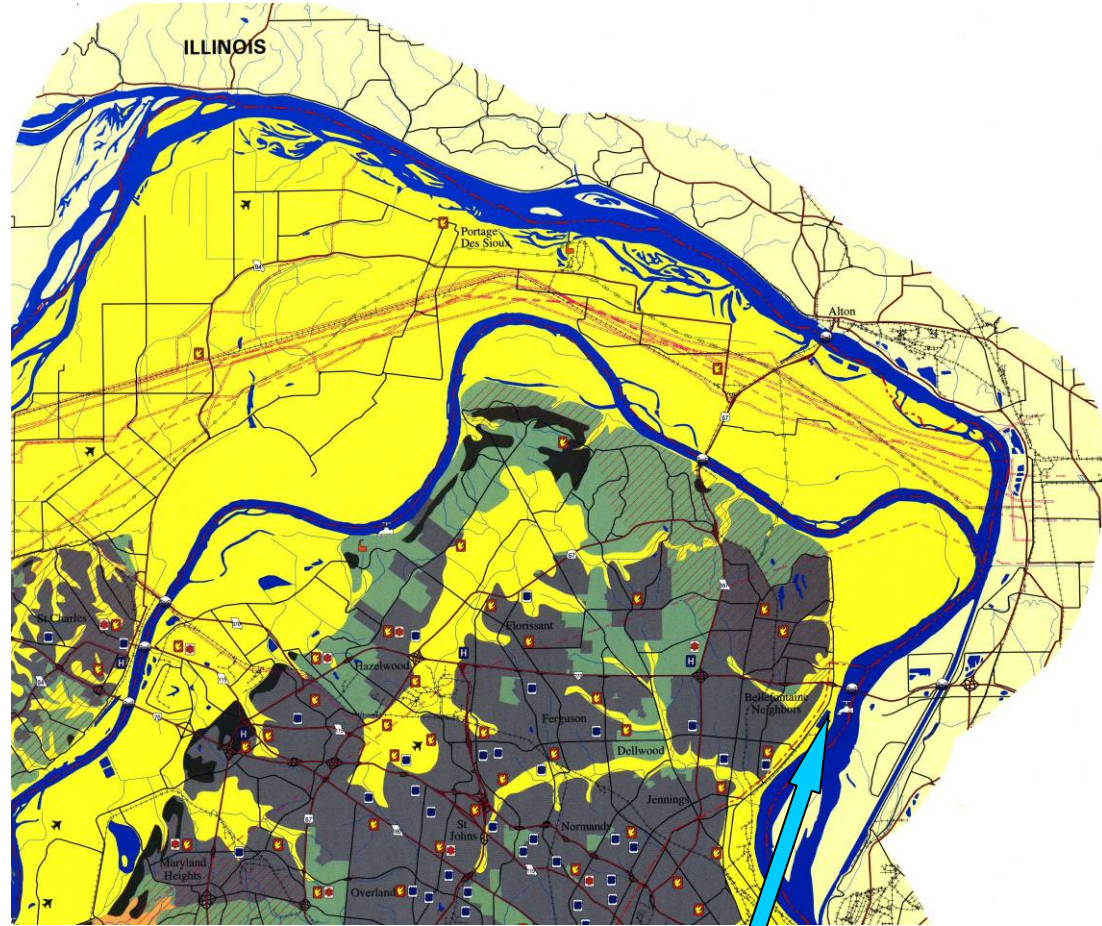
Largest concentration of pipelines crossing the Mississippi River occurs in St. Charles County, just above the confluence of Missouri and Mississippi



St. Louis Area Pipelines

Corridors of Vulnerability: Pipelines in St. Charles County

- There are 7 major pipelines crossing the Mississippi River in eastern St. Charles County
- All of these lines are buried in the loose unconsolidated sediments of the Missouri-Mississippi River flood plain most susceptible to liquefaction
- Spillage would contaminate the municipal water supply for St. Louis



Chain of Rocks Water Treatment Plant

Fiber Optic Cables...

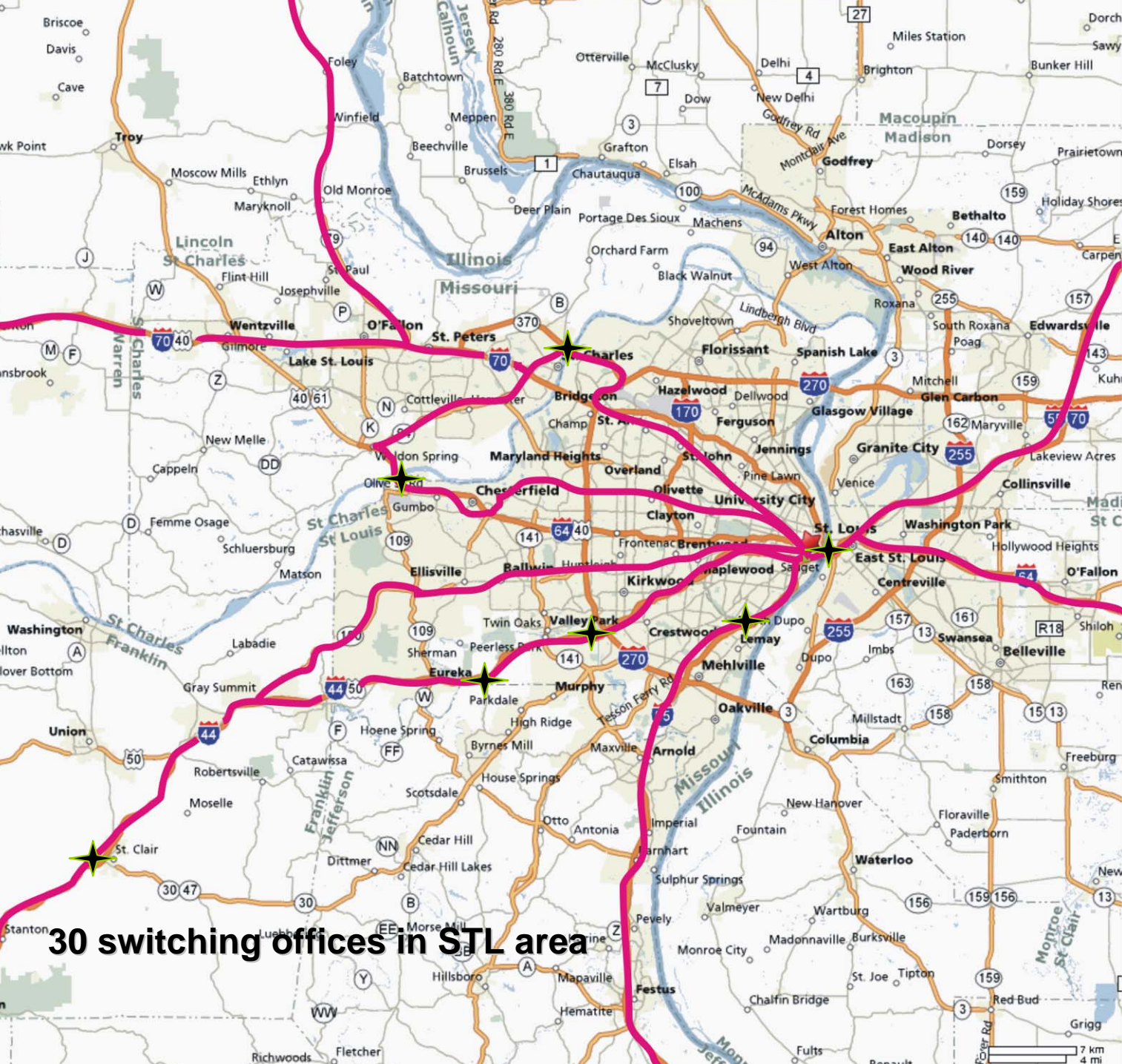


- Are composed of thin strands of glass or plastic bundled together.
 - Transfer laser light through these fibers using the principle of total internal reflection.
- They can transmit tremendous amounts of data when compared to electrical conductors, such as copper wire.
 - Third Generation Fiber Optical Cables can transmit **10 trillion bits per second down a single strand**, using the same cables buried 25 years ago!
 - This is the same amount of data stored on 1,900 full-length audio CDs or 150 million simultaneous phone conversations.

More on fiber optic cables...



- **Widespread adoption of this technology for communications began in the 1970's.**
- **They now form the backbone of most large communications networks.**
- **Fiber optics have reduced costs while increasing the quality of communications networks, all while keeping pace with the exponentially increasing demands of the digital age.**



Major Fiber Optic Cable Routes in the St. Louis Metro Area

Major river crossings are marked with black 4 point stars

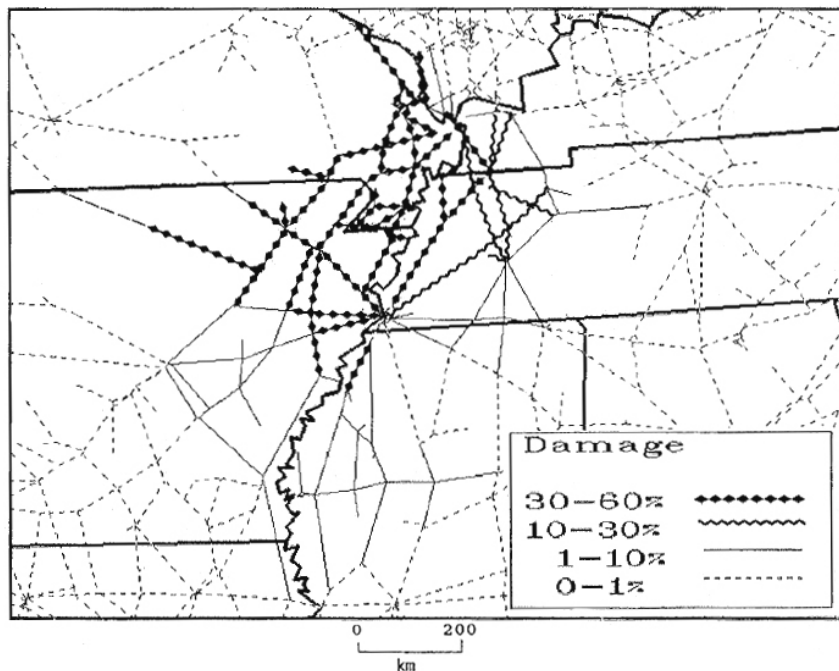
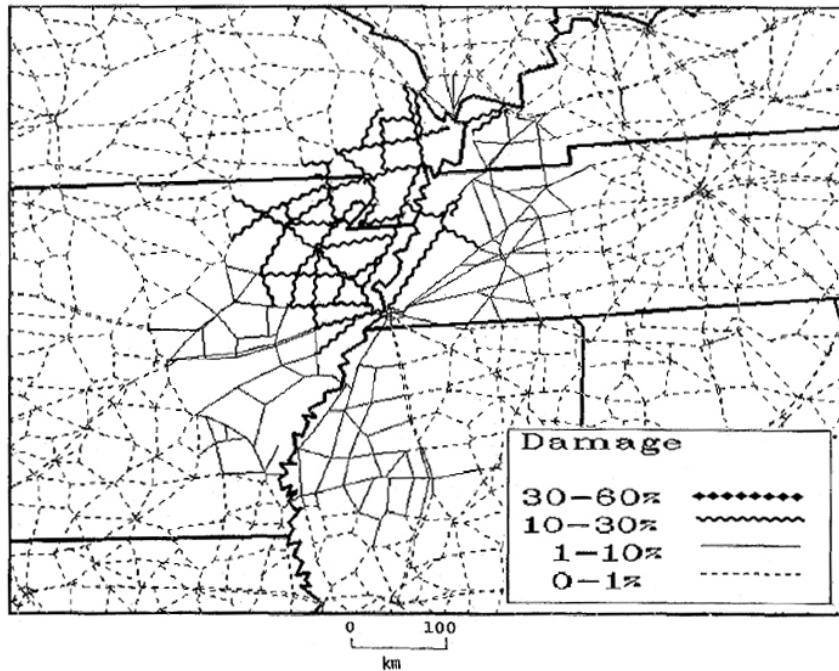
30 switching offices in STL area

Highway and Railway Bridges



- Only one major highway bridge south of St. Louis has been designed to resist earthquake ground motions
- The newer highway bridges in St. Louis, constructed since 1995, have been designed for seismic loads
- The I-64/US 40 double deck viaduct in St Louis is being retrofitted for seismic loading
- None of the railroad bridges have been designed for seismic loads

Expected Damage to Highways and Railroads



- Upper plot shows levels of expected damage to highways in the NMSZ area
- The lower plot shows expected damage to the railroad network criss-crossing the NMSZ
- Rail and truck traffic would have to be re-routed to the north and south while restorative work is completed
- Data from FEMA (1994)

Question # 10

**How Vulnerable is our
Electric Power Grid in
the Midwest?**

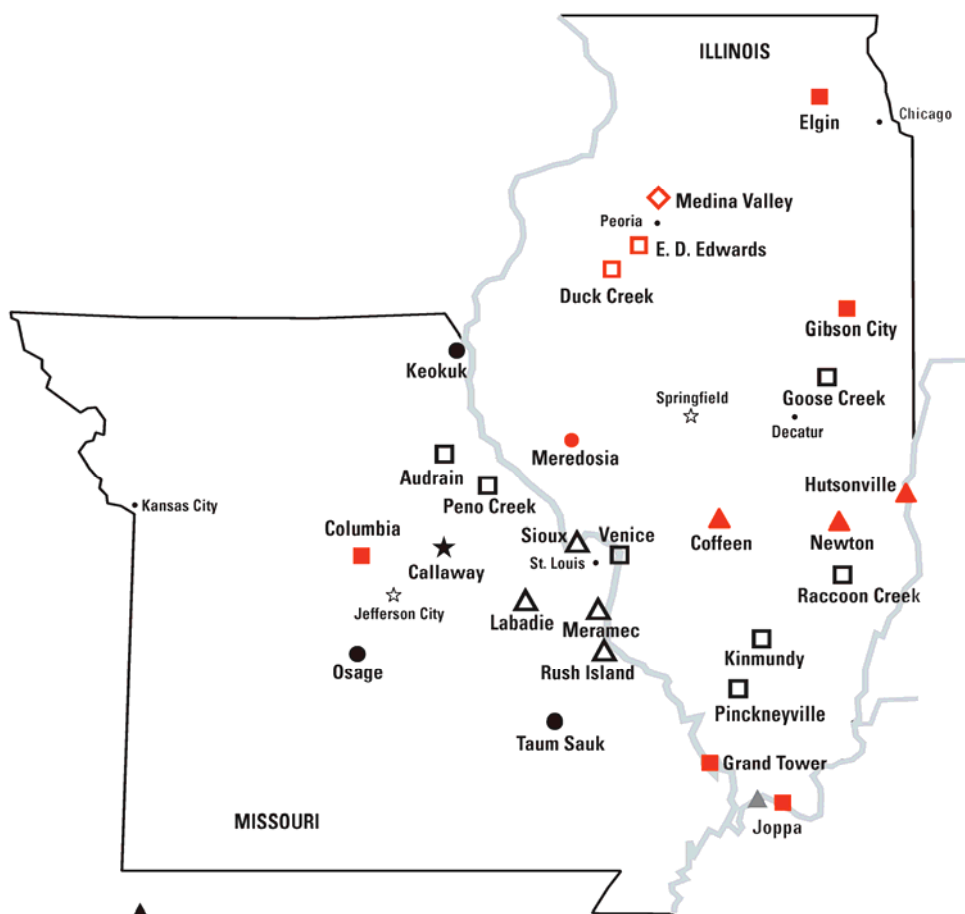
**Is this our
“Achilles Heel”?**

A lot of people have expressed concern about the vitality of the nation's Electric Power Grid

Is there enough energy to meet the needs ?

Answer: There IS sufficient power (e.g. enough generators) available to meet the US national load.....

AmerenUE Power Plants



- Impact of power generation loss depends on a number of factors, including the time of year or decade that an earthquake strikes.
- Biggest impacts would be on stalling disaster recovery, and some short term overloading of the surrounding transmission grid
- Recovery time is greatest single impact on economic loss

- ▲ AmerenUE Coal-Fired Plants
- AmerenUE Hydro Plants
- ★ AmerenUE Nuclear Plant
- AmerenUE CTGs
- ◻ AmerenEnergy Resources Generating Coal-Fired Plants
- ◊ Ameren Cogeneration Plant
- ▲ AmerenEnergy Generating Coal-Fired Plants
- AmerenEnergy Generating CTGs
- AmerenEnergy Generating Coal-, Oil- & Gas-Fired Plant
- ▲ Electric Energy Inc. (80 percent owned by Ameren)

Coal-Fired Plant



Many Power Plants located along rivers

- Most fossil fuel and nuclear power plants are located on unconsolidated alluvium
- *The greatest number of plants are located along the Mississippi and Missouri Rivers*
- The New Madrid power plant is shown at upper left



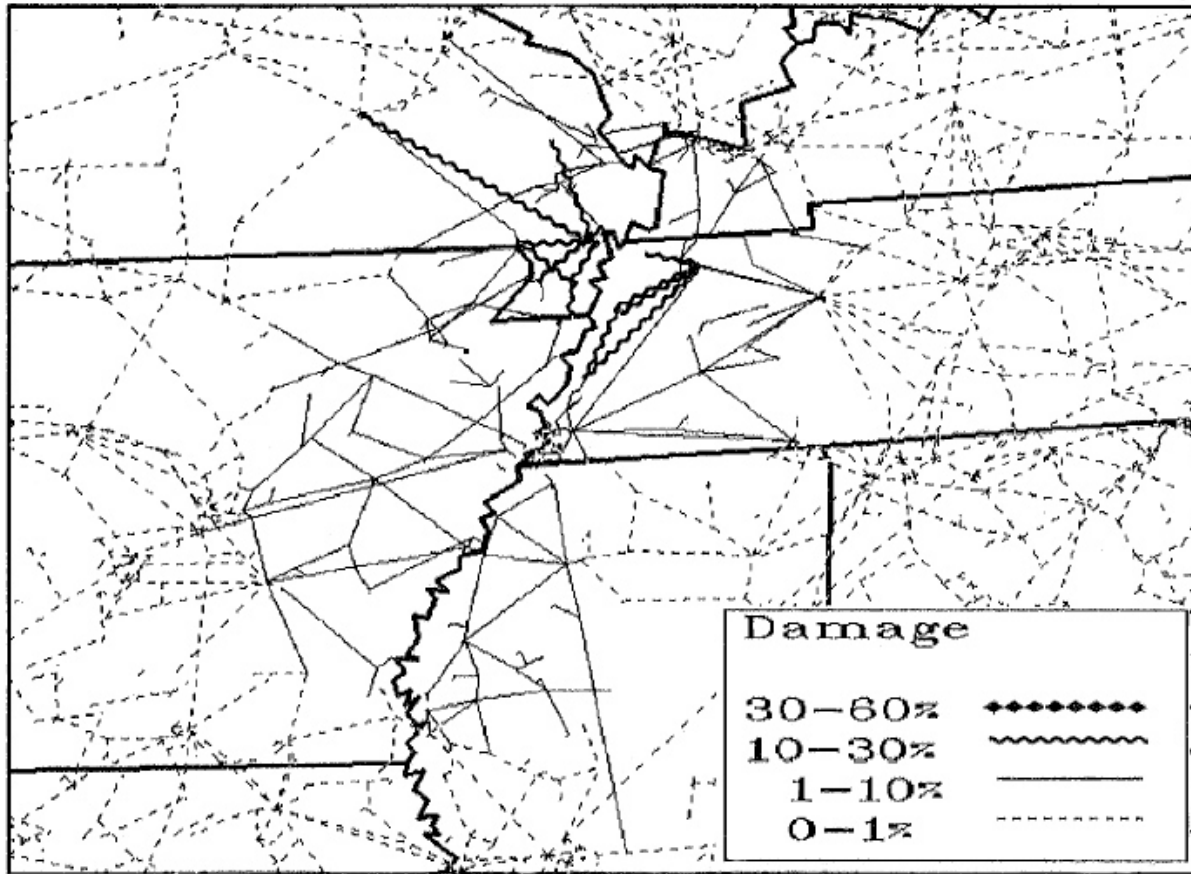
Transmission Network

- **The most vulnerable aspect of our power grid is problem we have is transmission - getting the power from where it is generated to where the demand centers are.**
- **Many large plants (coal, nuclear, hydro) are geographically remote from our urban centers –**
- **If one of the major transportation corridors goes down, then transmission congestion occurs and power lines overload – causing cascading failures.**

Not in My Backyard

- **Transmission “gridlock” is only going to get worse in the next decade, because while there is sufficient generation, there are not sufficient high voltage transmission lines – nobody wants a large transmission line going near their property.**
- **There was the electromagnetic field scare a few years ago when people thought that the EMF was causing cancer (this was ultimately disproved, but people are still very wary) and besides, transmission lines are unsightly.**

High Voltage Electrical Transmission Lines Criss-Crossing the New Madrid Seismic Zone



- *Transmission towers founded on >15 m of unconsolidated sediment* in major flood plains can be expected to experience foundation failure, dropping the lines
- Reconstruction of downed towers will be expensive and time-consuming

Why does it take so long for power to be restored when outages occur?

- This is a failure of the distribution system (as opposed to the transmission system). When many, many low voltage lines are damaged (such as ice, wind, etc.) they have to be manually repaired.
- The recovery time depends on *manpower availability*. Many major metropolitan areas have similar problems. The only way to protect against this is to put lines underground – but this is more expensive and underground lines are subject to interruptions caused by flooding.

Question # 11

Nagging Uncertainties.

How does the...

- 1) Speed of Recovery;
- 2) Ease of Recovery;
- 3) Duration of Recovery; &
- 4) Public Perception of Recovery Success

...influence the **Economic Impact**
of the Disaster ?

Post 9/11 FEMA SitReps

- After 9/11 FEMA re-vamped its entire disaster response organization to better equip themselves for over-arching management of all kinds of disasters; producing comprehensive *Situation Reports* every 12 hours.
- These were impressive documents, listing the status of various lifeline and response logistic issues, with continuous updates on when certain milestones would be achieved.
- Nothing like this existed in the aftermath of the 1989 and 1994 California earthquakes
- These were completely panned by the mainstream media in the reporting of Hurricane Katrina. Most of reports were of a negative nature, focusing on those who complained and were easily interviewed.



Hurricane Katrina - Impact to Petroleum Industry Infrastructure

Louisiana

UNCLASSIFIED

09 Sep 05
2200Z/1700L

Capline Pipeline
over 80% normal capacity

Plantation Pipeline
now at 100% normal capacity

Colonial Pipeline
now flowing at 100% capacity

TEXAS

MISSISSIPPI

LOUISIANA

(Total) Atofina
Petrochemicals, Inc.

Placid Refining Co.

ExxonMobil
Refining and Supply Co.

Valero Energy Corporation

Motiva (Shell) Enterprises LLC

Valero Energy Corporation

Beaumont

Lake Charles

Lafayette

Baton Rouge

New Orleans

Slidell

Biloxi-Gulfport

Motiva (Shell) Enterprises LLC

Murphy Oil USA, Inc.

Marathon Ashland
Petroleum LLC

Houma

(ExxonMobil)
Chalmette Refining LLC

Shell Chemical LP

ConocoPhillips Company

Clovelly Terminal
has no power

Fourchon Terminal is shutdown

LOOP Platform is operating
at 75 percent

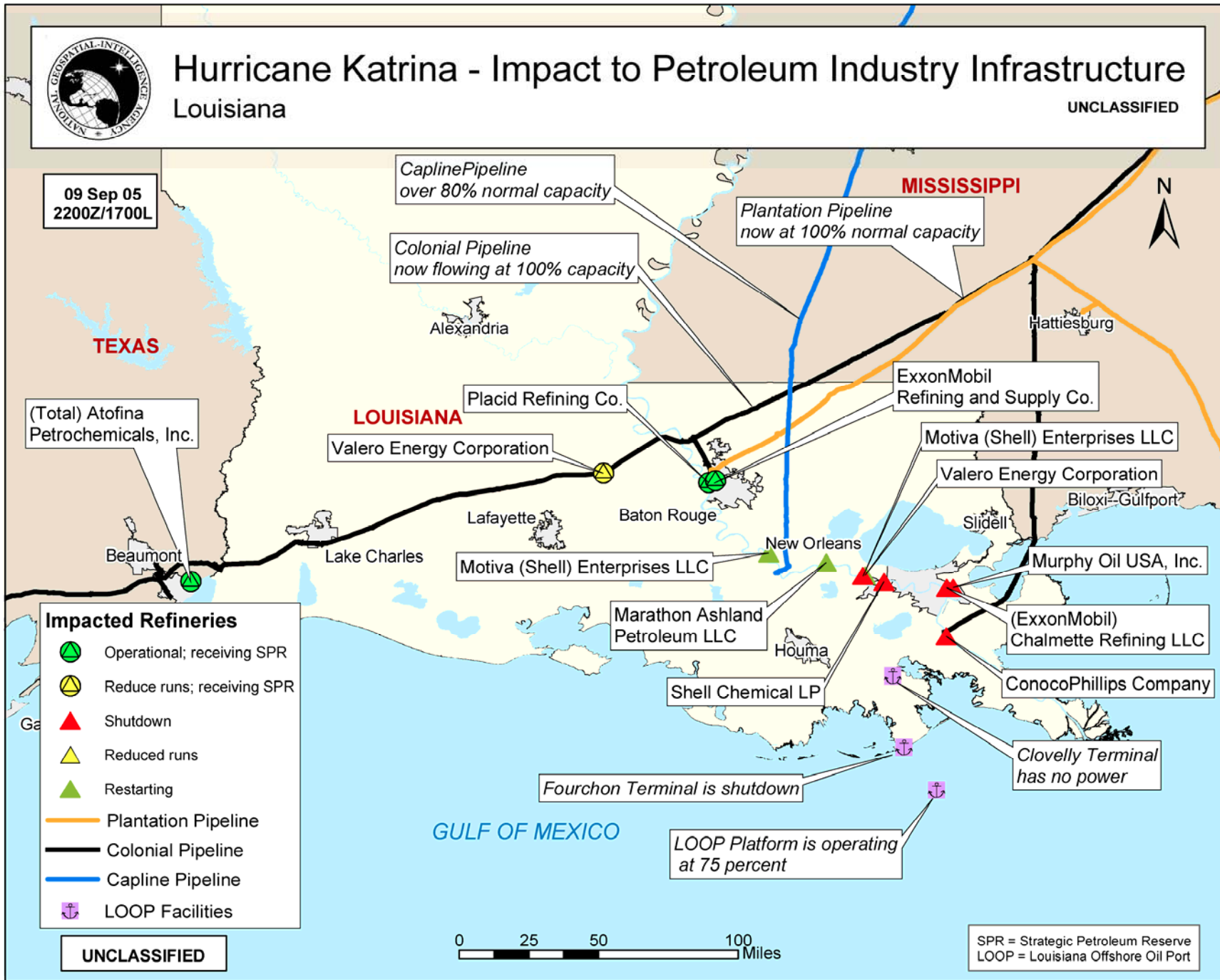
Impacted Refineries

- Operational; receiving SPR
- Reduce runs; receiving SPR
- Shutdown
- Reduced runs
- Restarting
- Plantation Pipeline
- Colonial Pipeline
- Capline Pipeline
- LOOP Facilities

UNCLASSIFIED

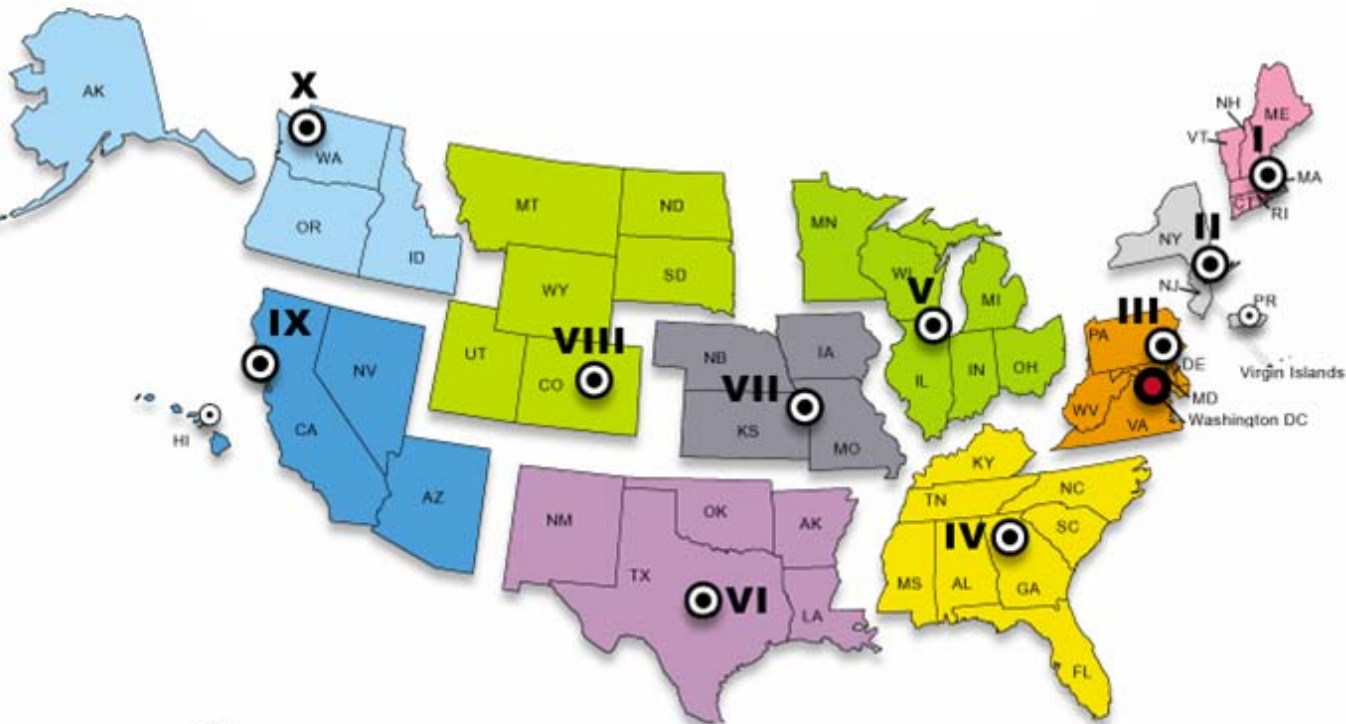
0 25 50 100 Miles

SPR = Strategic Petroleum Reserve
LOOP = Louisiana Offshore Oil Port



Public Confidence: Who will be in charge of the recovery, and manage it wisely ?

- **Answer:**
four
separate
DHS/FEMA
Regions
share
jurisdiction
in the New
Madrid
Seismic
Zone
- **Tough
issue to sell
to the
public**



● **Headquarters - Washington, DC**

● **Region I - Boston, MA**

● **Region II - New York, NY**
Caribbean Area Office San Juan, PR

● **Region III - Philadelphia, PA**

● **Region IV - Atlanta, GA**

● **Region V - Chicago, IL**

● **Region VI - Denton, TX**

● **Region VII - Kansas City, MO**

● **Region VIII - Denver, CO**

● **Region IX - San Francisco, CA**
Pacific Area Office Honolulu, HI

● **Region X - Bothwell, WA**

Disaster Planning that trickles down to the local bus drivers essential for recovery

- Local government agencies have to develop **coherent disaster plans**, **posted on the Internet** for everyone to see and understand, especially teachers (e.g. 1962 Cuban Missile Crisis)
- Those same agencies need to conduct **periodic disaster response exercises**
- **Every person** who will be tapped in an emergency **needs to know what will be expected of them**; such as: *bus drivers, medical personnel, law enforcement, etc.*
- **Disaster plans** need to include contingencies for extended loss of: power, vehicle access, fuel availability, sanitation, communications, and lifeline support
- **Mobilizing FEMA** doesn't solve any of these problems immediately, it only sets the rescue wheels into motion; e.g. *"calling the cavalry"*

Area Outages
 Shaded areas represent ZIP Codes with outages. See legend below for scale.

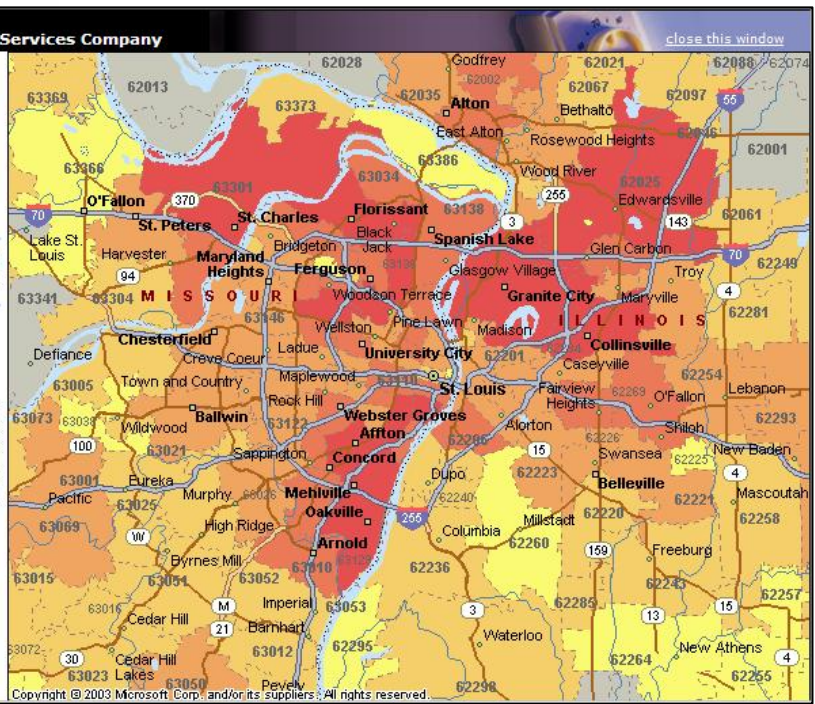
[Return to System map.](#)

Updated: Jul 21 3:26 PM
Area Outages: 529,063

ZIP	# of Customers	
	Out	Served
63113	5331	7805
63114	10638	18534
63115	5919	11717
63116	10612	23473

of Customers Out:

1-50
51-1,000
1,001-5,000
5,001-10,000
Over 10,000



Restoration of the Power Grid

- In today's culture, the economic impact of being without electrical power is *stupendous*
- Our information technology based culture can't survive for more than a few days without electricity
- Businesses forced to relocate rarely return to their original pre-disaster locations, because of the **cost**

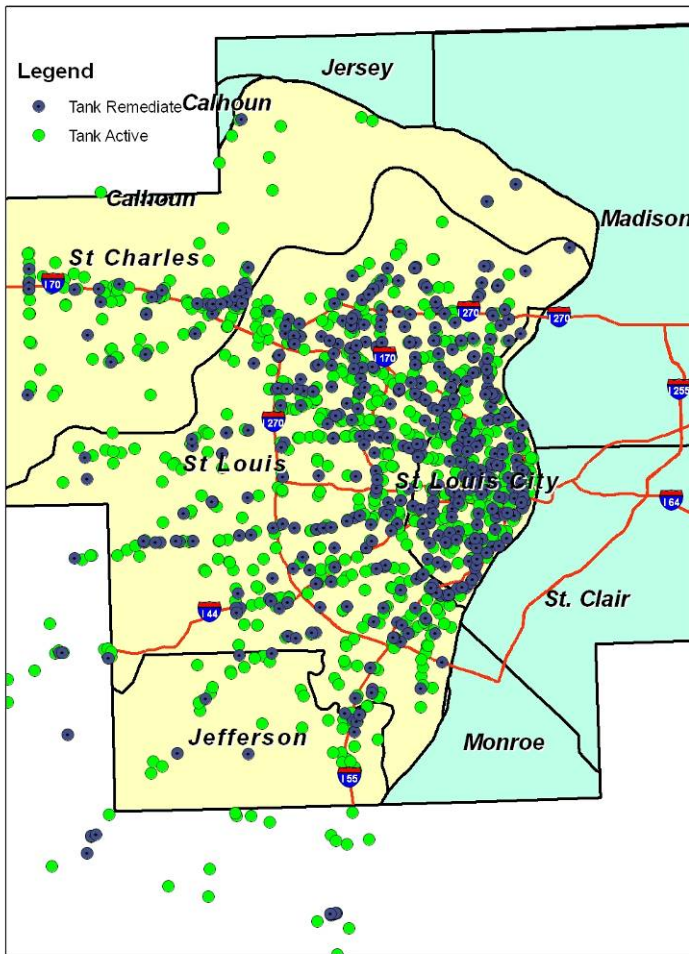


Portage des Sioux power plant near confluence of Missouri and Mississippi Rivers

Hidden Costs Lurk Everywhere

- **One of the hidden costs of earthquakes is their impact on retail business**
- **The 1989 Loma Prieta and 1994 Northridge earthquakes saw a record number of business failures occur in the wake of these events. Impact lasted for 10 years.**
- **Retail businesses cannot survive more than about 6 weeks without meaningful cash flow**
- **70% of the downtown businesses in New Orleans has been lost since Hurricane Katrina**
- **The economic impact will likely extend over several decades.**

Underground Storage Tanks



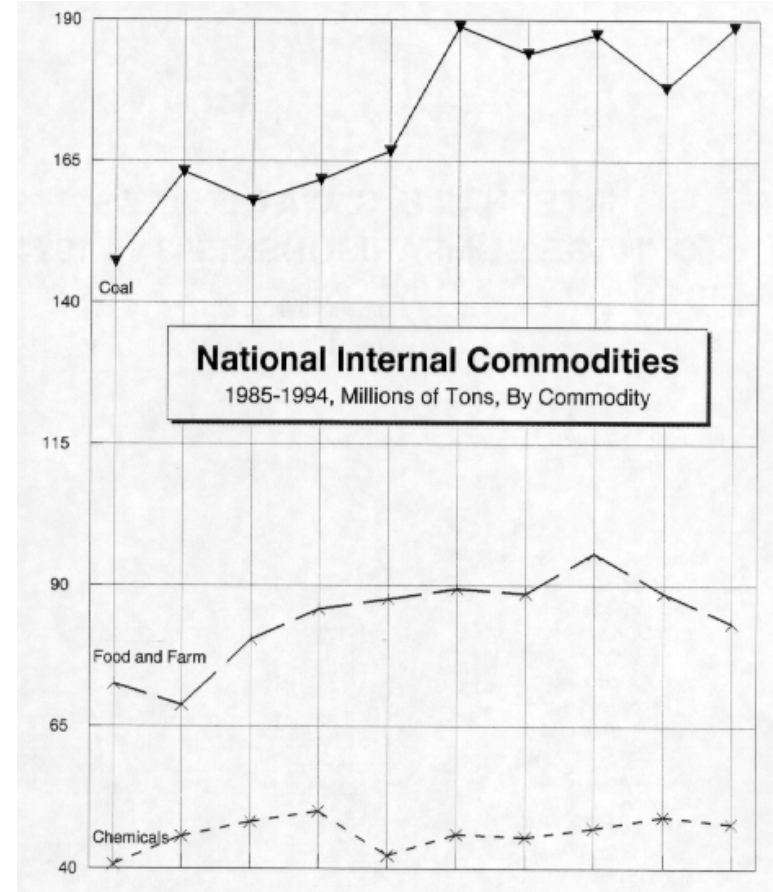
- **Underground fuel storage tanks tend to be lifted out of the ground during earthquakes, if situated close to the permanent groundwater table**
- **This upward movement usually compromises the feeder connections, negating serviceability**
- **These leaks can also promote costly clean-ups**

Above-Ground Storage Tanks



- Above-ground storage tanks are also susceptible to earthquake-induced distress, especially partial liquefaction of their foundation soils, shown here.

Barge Traffic



- Waterborne commerce along the Mississippi River fluctuates with the cost of diesel fuel; but continues to rise through each decade.
- Barges provide an environmentally clean alternative (much lower CO₂ emissions per ton-mile) and redundancy from rail and truck transport

Question # 12

**Is There Anything in Our
High Tech Arsenal that
Can Mitigate Some of the
Doom and Gloom?**

Identifying Critical Facilities and Components for Disaster Response

- Cellular phone transmission towers
- Fiber Optic data transmission cables
- Redundancy in electrical power grid
- Alternate routes and fuel sources for emergency responders
- Alternate route packaging for commerce
- Realize limitations of shelters, e.g. sports arenas like the *Louisiana Superdome*
- Sensor systems using GPS location fixed motes will provide monitoring feedback in future

Lack of Advance Warning Limits

Evacuation Mobility



- Unlike atmospheric events, such as hurricanes, **earthquakes strike without warning**. There will not be any evacuation ahead of the actual event
- Gasoline will be unavailable in areas without electrical power



How Can Stranded People Communicate their Peril ?

- We can't send in Army helicopters to rescue stranded victims unless we know **WHERE** they are
- We can expect that an earthquake will take down a fair number of the cellular repeater towers
- We can also expect that telephone transmission systems will be **overtaxed**
- **Text messaging** and **GPS receivers** will soon emerge as the preferred method of hailing assistance in the wake of disasters, natural or man-caused.



HLZ Suitability Analysis - Coastal Mississippi

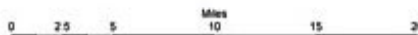
Derived from Satellite Imagery Acquired Sept. 02, 2005 (post-Hurricane Katrina)



Green = open grassy areas suitable for helicopter landing zones

- Open Grassy Area
- Dirt / Mixed Dirt and Grass
- Wetland or Saturated Area
- Standing or Open Water
- Vertical Obstruction
- Interstate
- Highway
- Major Road
- Minor Road
- Limited Access Road
- State Boundary
- City

This map is based on analysis of slope, landcover, and vertical obstruction information. All grassy and dirt areas indicated have a slope less than 15 percent, as determined by topographic modeling of a digital elevation model. The potential HLZ areas were delineated by spectral analysis and classification of 4 wave resolution multispectral imagery acquired September 2, 2005, in the aftermath of Hurricane Katrina. Vector overlays courtesy of ESRI.



SPHEROID: WORLD GEODETIC SYSTEM 1984 (WGS84)
 GRID: 1000 METER UTM 18N
 PROJECTION: TRANSVERSE MERCATOR
 HORIZONTAL DATUM: WORLD GEODETIC SYSTEM 1984 (WGS 84)
 VERTICAL DATUM: MEAN SEA LEVEL (MSL)
 PRINTED BY: USARSTRAT 09-05

Map created by U. S. Army Future Strategic Command
Special Operations Resource Center
Peterson AFB, Colorado Springs, CO



Elevation Guide

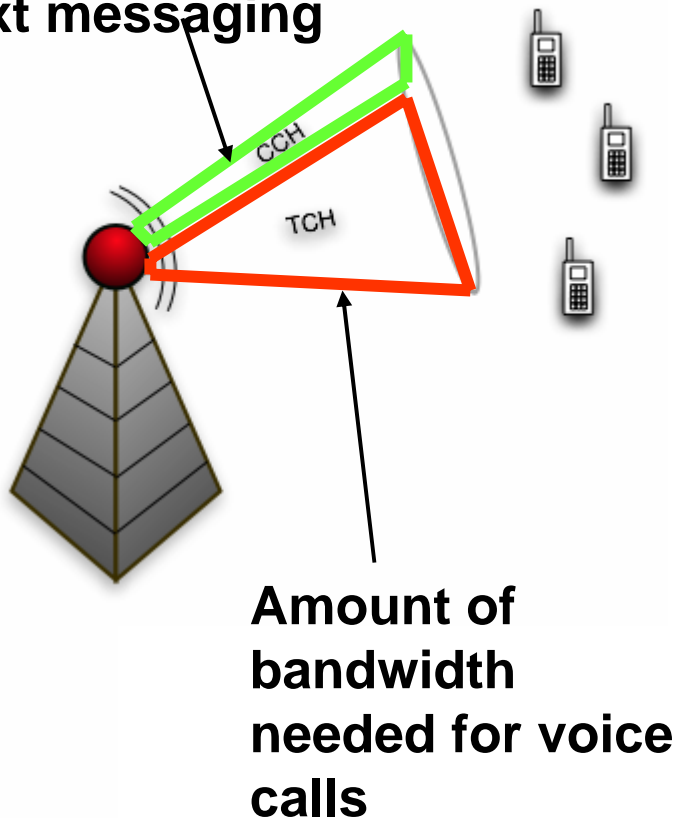


Image Locator



Text Messaging will play an increasing role in disaster response

Amount of bandwidth needed for text messaging



Amount of bandwidth needed for voice calls

- Text messaging does not require as much bandwidth as voice calls.
- If low reception, users are more likely to have a text message go through than a voice call.

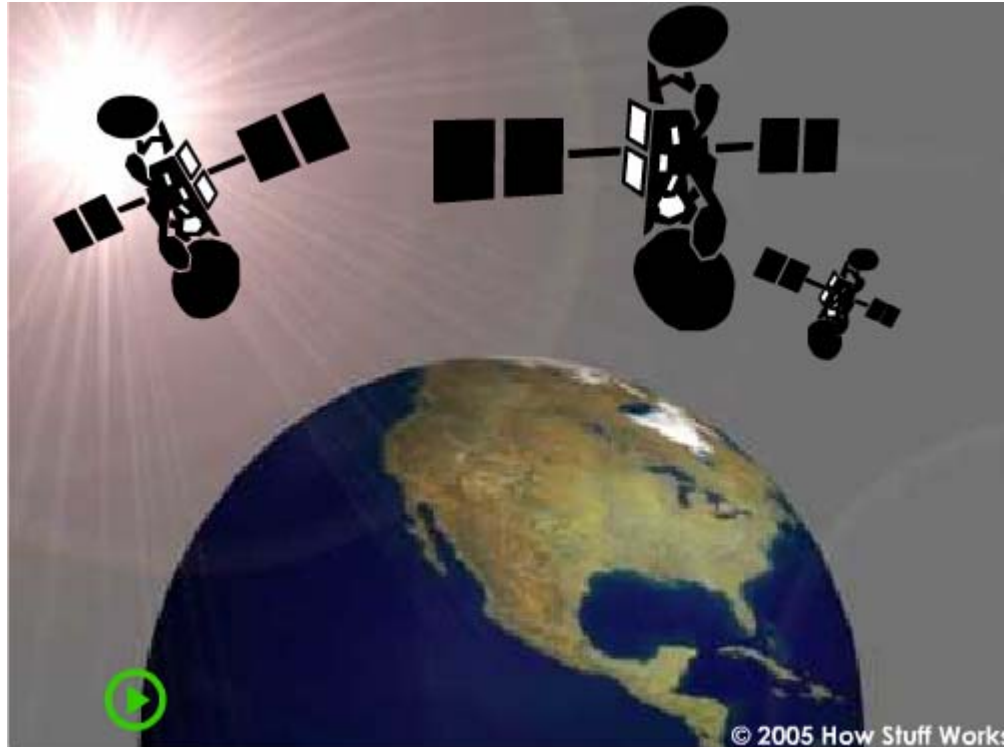
Communicating with the Outside World After a Disaster

- GPS-equipped phones can transmit user's location when calling 911.
- But what if they can't get through? Cell towers may be down.



- They may still be able to text message coordinates or an interstate mile marker taken from phone or external GPS device, if not all towers are completely down.

GPS Overview



To locate itself, a GPS receiver must find the distance to three satellites of known positions.

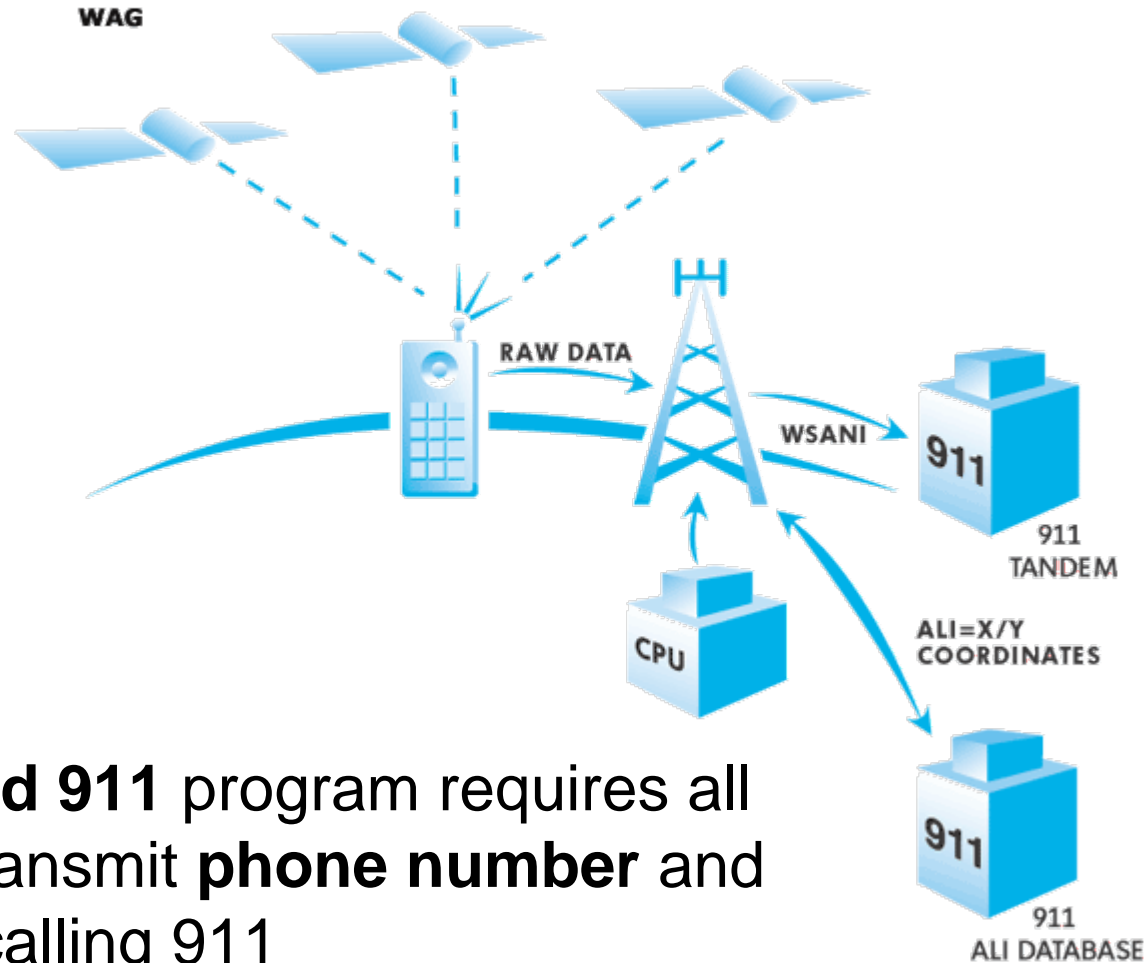
GPS Phones

- Many GPS-enabled phones available with each carrier
 - The user must have:
 - Calling plan that supports GPS data
 - Software that provides the maps
- iPhone – no GPS, but has Google Maps
 - Database of area businesses



Non-GPS Phones

- What about those who don't have GPS?
 - Analyze cell phone signals



FCC's **Enhanced 911** program requires all cell phones to transmit **phone number** and **location** when calling 911

But many **Public Safety Answering Points** don't yet have capability to receive info

People have to be educated about what to do in specific scenarios

- **Extreme events**, like combat, are always treacherous because most responders don't have first-hand experience with such catastrophes
- Mass evacuations are difficult to plan for without **recurring exercises and a through program of public education** (contrast 1960 Chile quake with 2004 Sumatra quake)
- You're lucky to get 2/3 of any populace to **evacuate** an area **ahead of a natural disaster**, if it is the first exposure to the natural peril (1963 Taal Volcano eruption).
- People with children more prone to leave than those without children.

Importance of Exercises and Familiarity with the Real Thing

- Emergency responders should be provided with **appropriate training to develop realistic expectations:** “*expect the unexpected*”, learn how to innovate (e.g. San Francisco’s loss of fire mains in 1989)
- **Teaching** most effective when done by other responders who have personal experiences to share, lessons learned (just like combat training)
- **Realistic training** is most crucial aspect of preparedness (e.g. military use of live ammunition; fire fighters practicing on real fires).
- **Sending responders to other agency’s disasters is probably our single best training option; there is no education like experience**

Question # 13

Does anyone really have a realistic idea of what the cost of a Midwest earthquake will be?

@ to RECENT FEMA studies.....

- A 1994 study estimated that a repeat of a M 7.5 to 7.7 event on the New Madrid Seismic Zone would cause upwards of **\$30 billion** in damage
- A 2006 study estimated that a M 7.7 event on the southwest arm of the NMSZ would cause \$200 million in hard damage to Memphis alone, and **\$50 to \$70 billion** in overall damage to the affected region
- Comparisons between projected damages and actual damages are extremely complex, for many reasons, not the least of which is that fickle factor so aptly dubbed **“public confidence,”** or **“market confidence”** by the *Wall Street Journal*

Economic Impacts

- **Local, Regional, and National Impacts**
- **Historically, FEMA HAZUS models have not accurately gauged factors such as:**
 - **the infrastructure disruption impacts (as opposed to structural damage)**
 - **trickle-down economic impacts, such as loss of confidence by consumers**
 - **People tend to hold onto their money after any sort of disaster (e.g. 9/11)**
 - **e.g. record number of retail business failures following 1989 and 1994 earthquakes in California**

Other “Spin Off” and “Spin Down” factors

- In the aftermath of Hurricane Katrina, FEMA is implementing a plan to remunerate those people who lost their homes and personal property...
- This process, along with re-building, will likely take 3 to 10 years to complete
- Adjacent residents may not have lost their homes, but have lost:
 - 1) Their jobs/livelihood in impacted area
 - 2) Ability to sell their homes and relocate
 - 3) Ability to purchase insurance

Regional and National Economic Impacts

- When raw materials or product stockpiles are suddenly or unexpectedly reduced/or their flow is constricted; the news media reports the *POTENTIAL* shortages and, unfortunately, all sorts of speculation ensues.....
- This speculation can easily lead to inflated prices, which triggers consumer reaction; and
- We may witness unforeseeable consequences, such as a drop in sales of SUVs, while everyone waits to see what will happen to the price of gasoline.

Last Question # 14

If spin-off and spin-down losses are tied to ‘*public confidence*’.... What influences this confidence in the wake of a disaster ?

Television and Print Media

- **Media coverage** is **ESSENTIAL** to the success or failure of any emergency response scenario
- The media tends to search out stories that elicit **emotional responses** or **show graphic images**, to spike their viewing audience
- Media market consultants recognize that **viewers tend to select one channel over all others during a newsworthy event**, and often remain loyal to that station thereafter (e.g. CNN in 1990-91 Gulf War; Fox News in 2003 Operation Iraqi Freedom)

The Public Is Informed Through the Media

- The media swiftly deployed their **best correspondents** into harm's way to report on conditions. **Live streaming via satellite** and video phone has changed viewer's expectations of being able to witness historic events when they occur
- The media depends on **cuing** from: 1) government agencies; 2) the public (via cell phones and e-mail); or, 3) from other media outlets, such as local affiliates, wire services, newspapers
- **They only report what fails**; not what remains standing

9/11: An example of good media management



- New York Mayor Rudy Giuliani inspired confidence with his skillful leadership and sensitivity to the emotions evoked by the **9/11 attacks**
- Scattered **anthrax incidents** almost turned the 9/11 aftermath into a national disaster of unprecedented proportions



Media stories tend to include lots of “maybe” statements



- Discovery of one incidence of **mad cow disease** in Yakima, WA in Dec 2003 triggered a sudden decline in beef prices and sales nationwide, and bans on many beef exports.
- CNN soon reported that: *“A British Health Department bulletin revealed that fourteen Britons have died of mad cow disease so far this year; **scientists say that 500,000 people could die of the disease by 2030**”*

Headlines on hold



- The potential **Avian Flue pandemic** remains on the media's radar screen right now
- Every incident is widely reported
- Western governments are developing contingency plans, similar to those developed for chemical and biological warfare scenarios.
- Public anxiety in America remains low...for the time being. One incident could change all that.

Like it or not, emergency responders are obliged to court the media



- The television media covers the “breaking news” as never before
- Those stories can install public confidence or hinder it
- We shouldn’t forget that news networks are profit-making corporations operating in a highly competitive marketplace
- **Courting positive media coverage is not only an essential aspect of disaster response, it will be good for the nation’s economy and benefit the recovery, more than most scientists or engineers realize.**



About the presenter



- **Dr. J. David Rogers began studying earthquakes when the February 1971 San Fernando Earthquake knocked him out of his bed. That event piqued his interest to major in geology at nearby Cal Poly Pomona (1972-76). He went on to earn MS (1979) and Ph.D. (1982) degrees in geological and geotechnical engineering at the University of California, Berkeley.**
- **Rogers has been in the near-field zone during eight of California's significant quakes between 1971-1994. He has also participated in post earthquake reconnaissances of some of the world's most damaging quakes, including: *Mexico City* in 1985, *Luzon, Philippines* in July 1990, *Hanshin (Kobe) Japan* in 1995 and the *Taiwan quake* in 1999.**
- **Dr. Rogers served on the faculty of the University of California, Berkeley between 1994-2001. In 2001 he accepted the Karl F. Hasselmann Chair in Geological Engineering at the University of Missouri-Rolla, the only endowed chair in engineering geology in the USA. His research has focused on assessment and mitigation of natural hazards, such as earthquakes, floods, and landslides. He has also worked on an IPA agreement with the U.S. Geological Survey.**
- **He holds professional registrations in civil engineering, geology, engineering geology, hydrology, and hydrogeology. He was appointed to the Missouri Seismic Safety Commission by Governor Matt Blunt in 2005.**

Thank You !

**This presentation will be posted
on my website at:**

www.umar.mst/~rogersda

under folder titled

**“Seismic Hazards in the
Midwest”**