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FEMA Mitigation
ESRI Map Gallery Entries

2011

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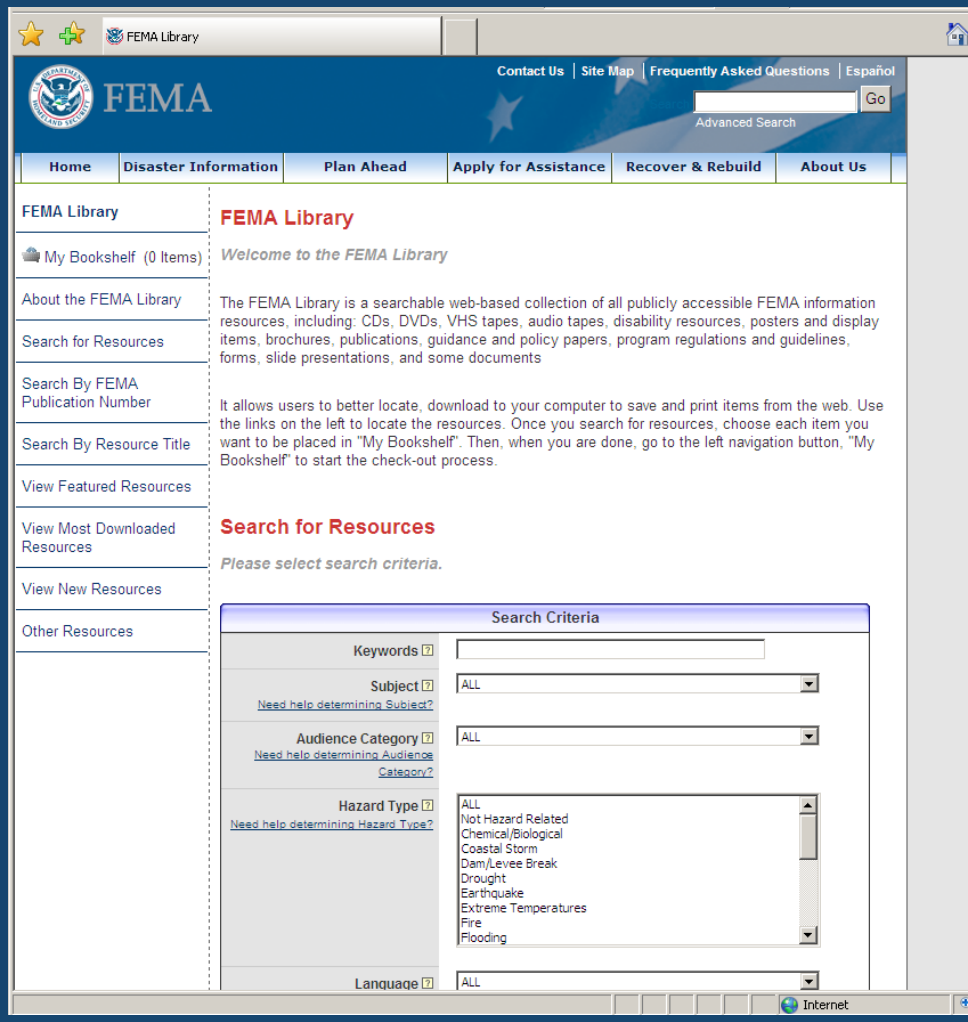

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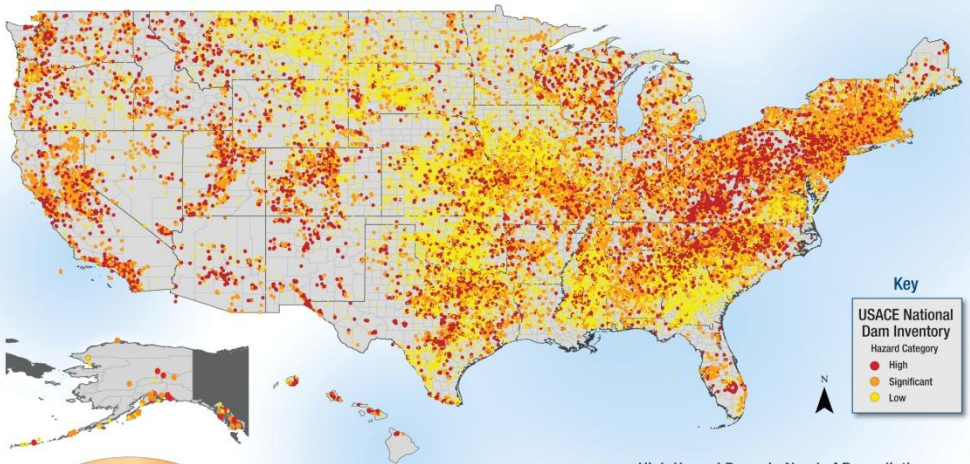
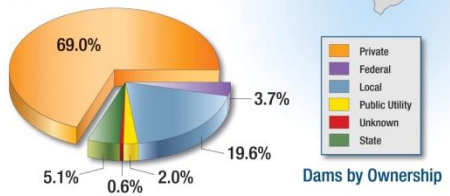
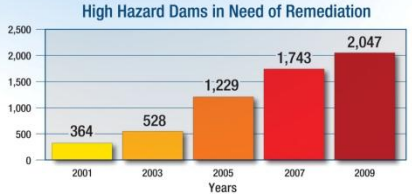




Dams by Ownership



Identifying High Hazard Dam Risk in the United States

The National Dam Safety Program (NDSP), led by the Federal Emergency Management Agency (FEMA), is a partnership of states, Federal agencies, and other stakeholders to encourage individual and community responsibility for dam safety.

The NDSP covers over 83,000 dams that provide:

- Renewable, clean electrical generation
- Inland river navigation and flood control
- Municipal water storage and irrigation
- Retention of hazardous waste

Balancing these benefits, the NDSP's mission is to reduce the risk to life and property should a dam fail — especially where large populations are living downstream. The NDSP's activities include providing grants for the improvement of state dam safety programs, funding dam risk reduction research initiatives, delivering training to state dam safety staff and inspectors, and providing for the education of the public, including State and local officials, in the hazards of dam failures.

John Day Dam, Rufus, Oregon

Image Source: www.bpa.gov/

There are approximately 14,000 dams in the United States classified as "high hazard potential." The failure or mis-operation of these dams will likely result in loss of life. According to the American Society of Civil Engineers and the Association of State Dam Safety Officials, the cost to repair deficient dams is $50 billion for all dams, or $16 billion to repair only high hazard dams. Geographic Information Systems are being used to analyze risk, raise awareness, and help the NDSP prioritize its limited resources — especially among stakeholders who have responsibility for dam inspections, repairs/maintenance, and emergency action plans.

Additional Information:

National Dam Safety Program: www.fema.gov/plan/prevent/damfailure/ndsp.shtm
Association of State Dam Safety Officials: www.damsafety.org
2009 ASCE Report Card: www.infrastructurereportcard.org/fact-sheet/dams
Dam Safety Coalition: www.damsafetycoalition.org
National Inventory of Dams: http://nid.usace.army.mil

Data Sources: U.S. Army Corps of Engineers National Inventory of Dams, 2009. http://nid.usace.army.mil

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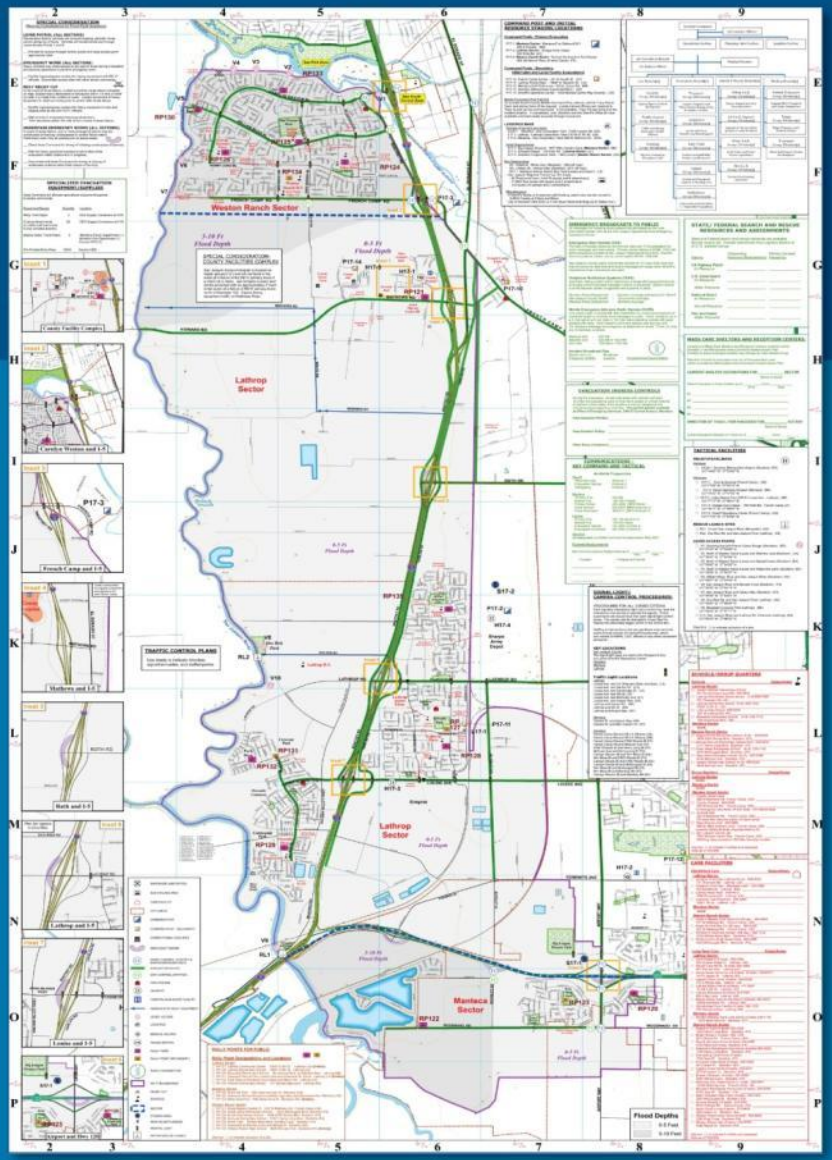

San Joaquin County, California:

Levee-Related Flood Contingency and Evacuation Maps

In 1968, Congress created the National Flood Insurance Program (NFIP) to help provide a means for property owners to financially protect themselves. Since standard homeowners insurance doesn't cover flooding, it's important to have protection from the floods associated with hurricanes, tropical storms, heavy rains, and other conditions that impact the United States.

Levee systems have been identified in over one-fourth of the counties receiving modernized flood maps, or Digital Flood Insurance Rate Maps (DFIRMs). No levee system provides full protection from all flooding events to the people and structures located behind it. Therefore, the Federal Emergency Management Agency (FEMA) works with Federal, state, and local professionals and technical partners to accurately reflect the flood hazard and risk in levee-impacted areas on the DFIRMs, which are used to establish flood insurance rates.

San Joaquin County, California has been proactive in developing flood contingency and evacuation maps for levee-impacted areas in the event that the levee is, or may potentially be, compromised and flooding threatens life and property. Partners in this effort include Reclamation Districts, local engineers, cities in San Joaquin County, and San Joaquin County.

Risk Mapping, Assessment, and Planning (Risk MAP) builds on flood hazard data and maps to provide communities, and ultimately individuals, with the information and tools they need to identify, assess, and take action to reduce flood risks. Advancements in Geographic Information Systems provide the tools needed to achieve the goals of Risk MAP and address gaps in flood hazard data to form a solid foundation for risk assessment and floodplain management.

Additional Information:

Levee System Information for Stakeholders: www.fema.gov/plan/prevent/fhm/lv_intro.shtm

Risk Mapping, Assessment, and Planning (Risk MAP): www.fema.gov/plan/prevent/fhm/rm_main.shtm

Data Source: San Joaquin County, California

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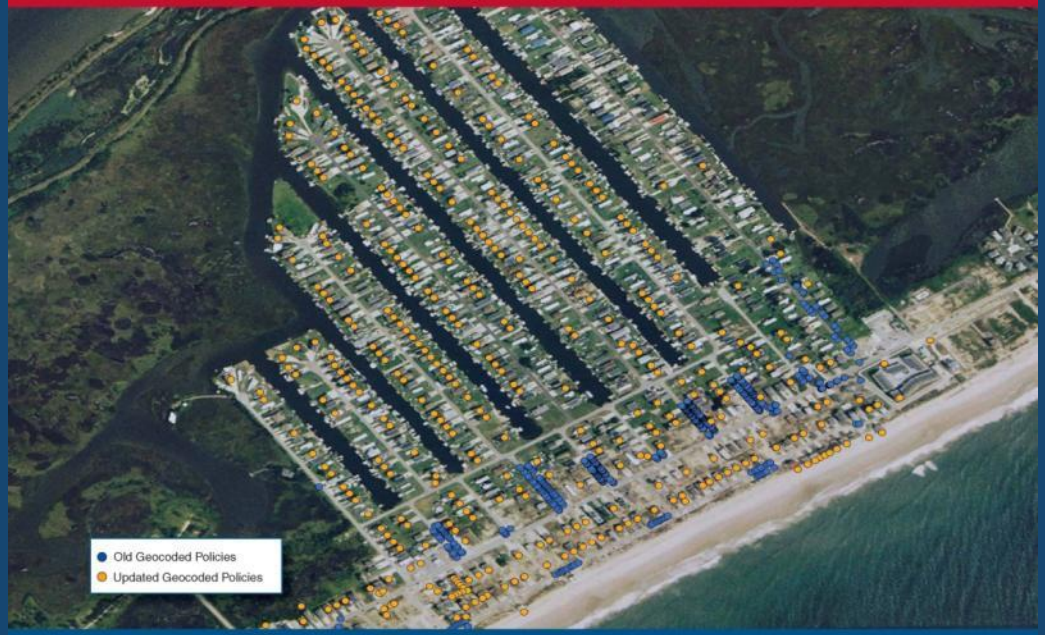

Geocoding Flood Insurance Policies and Claims to Better Analyze Flood Risk Areas

Nearly 20,000 communities across the United States and its territories participate in the National Flood Insurance Program (NFIP) by adopting and enforcing floodplain management ordinances to reduce future flood damage. Managed by the Federal Emergency Management Agency (FEMA), the NFIP makes Federally backed flood insurance available to homeowners, renters, and business owners in these participating communities.

Risk Mapping, Assessment, and Planning (Risk MAP) builds on flood hazard data and maps to provide communities, and ultimately individuals, with the information and tools they need to identify, assess, and take action to reduce flood risks. Risk MAP addresses gaps in flood hazard data to form a solid foundation for risk assessment, floodplain management, and actuarial soundness of the NFIP.

Recent advancements in Geographic Information Systems provide the tools needed to help FEMA achieve the goals of Risk MAP. Using geospatial tax parcel data, flood insurance policies and claims can be more accurately geocoded to individual properties (addresses) to determine the proximity to current and future flood hazards. Enhanced attribute matching on these maps— including address, year built, number of stories, square footage, assessed value of property and land, etc.— will greatly increase the accuracy of risk and loss reports and be used to mitigate risk through floodplain management and building codes.

Using this information, insurance agents can more accurately rate Preferred Risk Policies (PRPs) by determining distances from high flood risk areas known as Special Flood Hazard Areas (SFHAs). Property owners in SFHAs who have home mortgage loans granted by Federally regulated or insured lenders are required by law to purchase flood insurance.

Additional Information:

National Flood Insurance Program (NFIP): www.fema.gov/business/nfip/index.shtm
Risk Mapping, Assessment, and Planning (Risk MAP): www.fema.gov/plan/prevent/fhm/rm_main.shtm

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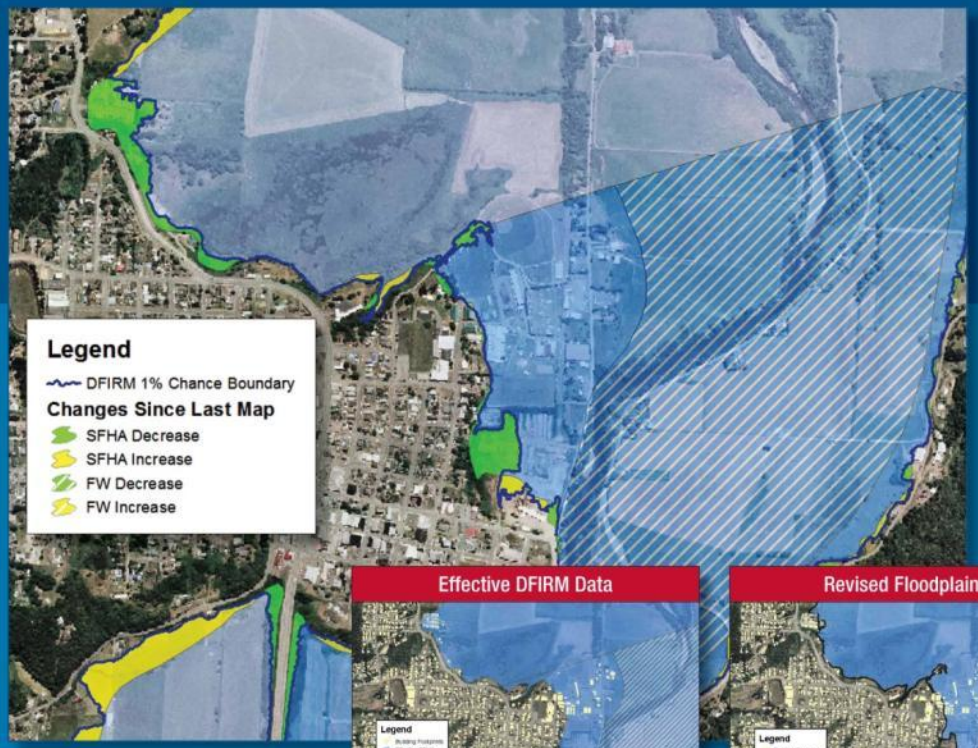
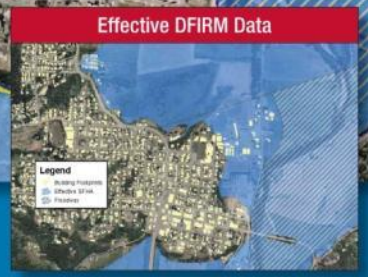
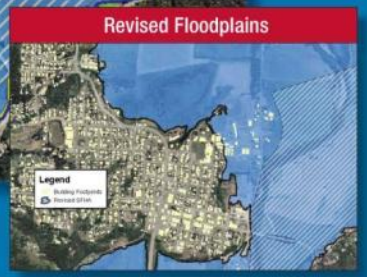
Risk Assessment Product:

Changes Since Last Map



The four insets at right depict additional layers based on software parameters that can be applied to the effective DFIRM data layer (top left image).





The Federal Emergency Management Agency's (FEMA's) Risk Mapping, Assessment, and Planning (Risk MAP) builds on flood hazard data and maps to provide communities, and ultimately individuals, with the information and tools they need to identify, assess, and take action to reduce flood risks.

The *Changes Since Last Map* is part of *The Risk Assessment Products Suite* to help communities understand changes to their flood maps and prepare for the upcoming flood map adoption process. This product is a spatial dataset that identifies areas of floodplain and flood zone changes since a previous flood map study. The dataset captures areas where the floodplain and floodway have increased or decreased, as well as areas where the flood zone designation has changed (e.g., Zone A to Zone AE). The built environment affected by the change is quantified and summarized to help locate previously unidentified areas at risk.

Under Risk MAP, Geographic Information Systems (GIS) are used to provide information about where the regulatory floodplain has changed and the impact this might have on a community's overall risk.

Additional Information:

Risk Mapping, Assessment, and Planning (Risk MAP):
www.fema.gov/plan/prevent/fhm/rm_main.shtm

Data Source: Don Lewis, Oregon Department of Geology and Mineral Industries (DOGAMI); www.oregongeology.org

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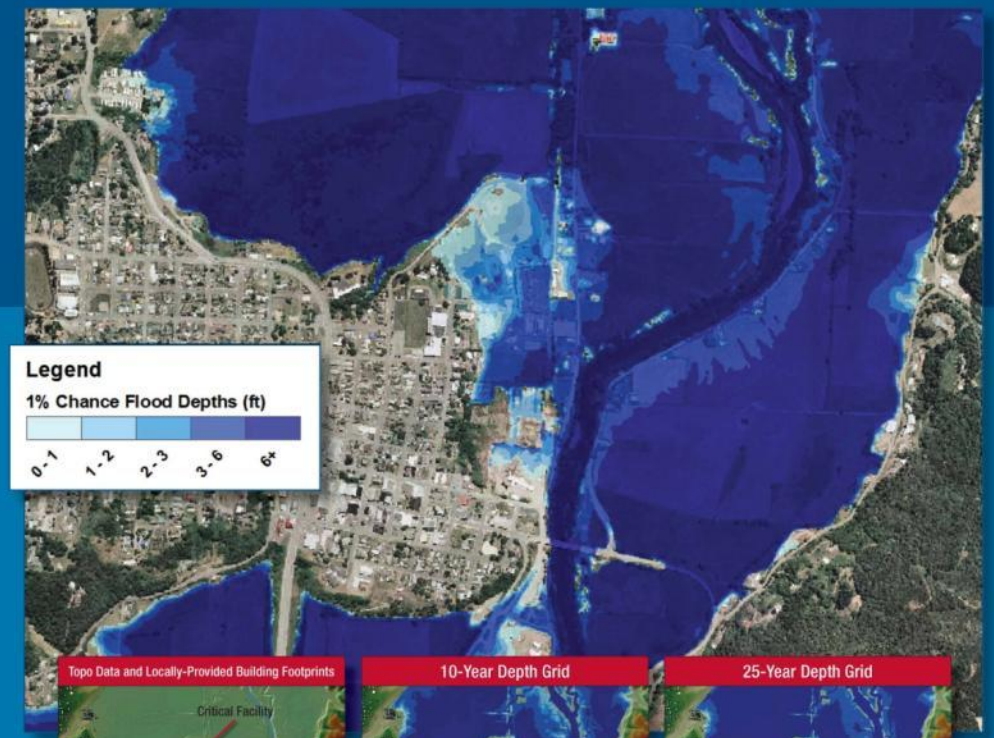

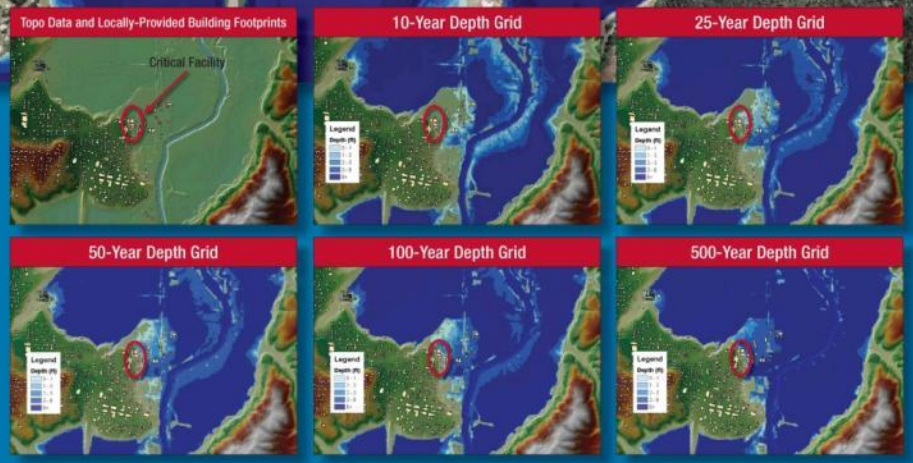

Risk Assessment Product:

Multi-Frequency Depth Grids

The Federal Emergency Management Agency's (FEMA's) Risk Mapping, Assessment, and Planning (Risk MAP) builds on flood hazard data and maps to provide communities, and ultimately individuals, with the information and tools they need to identify, assess, and take action to reduce flood risks.

The *Multi-Frequency Depth Grids* is part of *The Risk Assessment Products Suite* to help communities understand changes to their flood maps and prepare for the upcoming flood map adoption process. This product helps communities better understand their flood hazard risk beyond the 1% annual chance floodplain and provides information in developing a Benefit Cost Analysis.

The main image shows the flood hazard at the 1% annual chance floodplain. Using the Multi-Frequency Depth Grids product, grids will be produced for the 10% (10-year depth), 4% (25-year depth), 2% (50-year depth), 1% (100-year depth), and 0.2% (500-year depth) annual chance flood events. These grids will be used to create additional analyses that depict the percent annual chance of flooding and the percent chance of flooding over a 30-year time period in the floodplain.

Under Risk MAP, FEMA will use Geographic Information Systems (GIS) to provide end users with powerful flood risk information for events beyond the 100-year regulatory flood.

Additional Information:

Risk Mapping, Assessment, and Planning (Risk MAP):
www.fema.gov/plan/prevent/fhm/rm_main.shtm

Floodplain Management:
www.fema.gov/plan/prevent/floodplain/index.shtm

Data Source: Don Lewis, Oregon Department of Geology and Mineral Industries (DOGAMI). www.oregongeology.org

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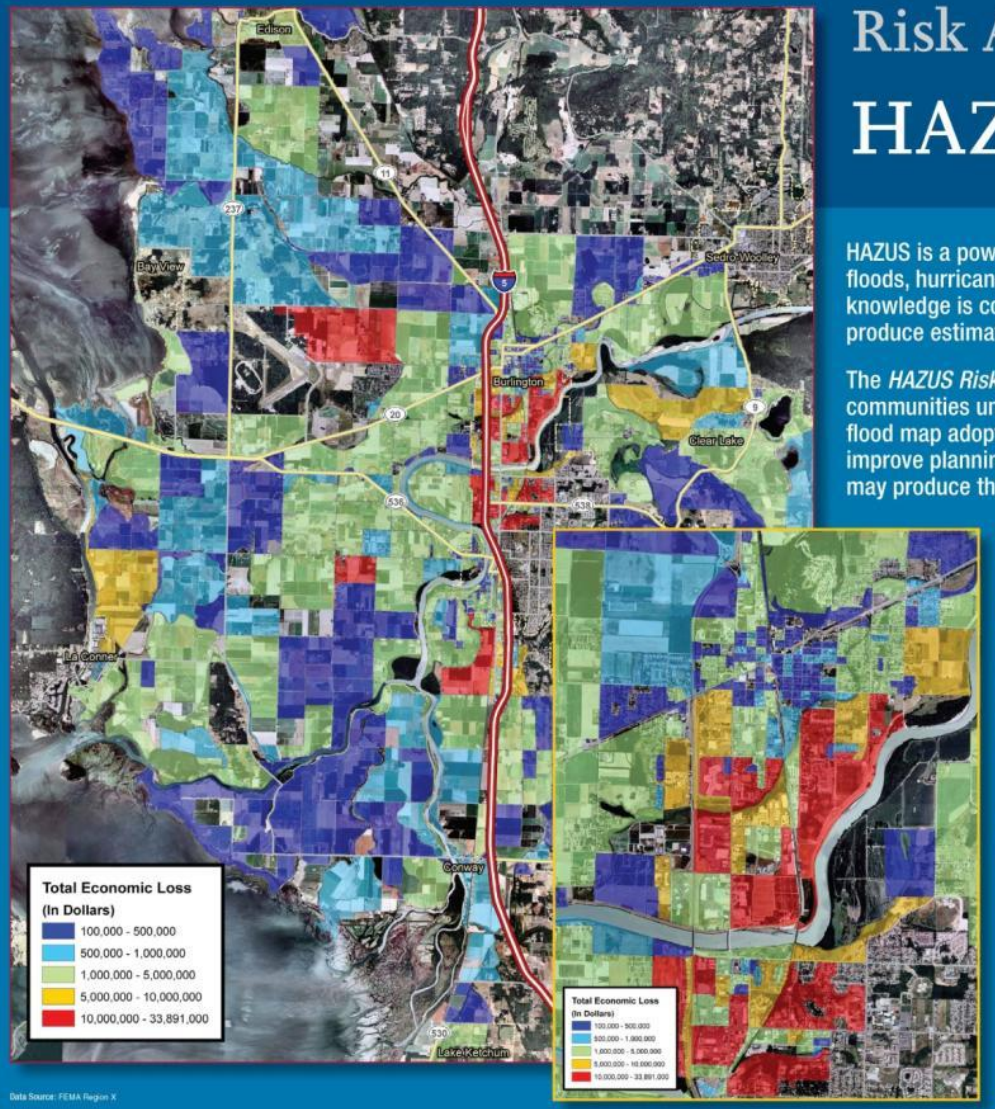
HAZUS MH

Risk Assessment Product:

HAZUS Risk Assessment



Data Source: FEMA Region X

HAZUS is a powerful risk assessment methodology for analyzing potential losses from floods, hurricanes, and earthquakes. In HAZUS, current scientific and engineering knowledge is coupled with the latest geographic information systems technology to produce estimates of hazard-related damage before, or after, a disaster occurs.

The *HAZUS Risk Assessment* is part of *The Risk Assessment Products Suite* to help communities understand changes to their flood maps and prepare for the upcoming flood map adoption process. This product enables communities to visualize their risk and improve planning and mitigation efforts by highlighting areas where risk reduction actions may produce the highest return on investment.

Building on the foundation of the 2010 HAZUS National Average Annualized Loss (AAL) Study, basic refined HAZUS loss estimation analyses will be performed for flooding sources with new or updated flood modeling using default HAZUS building stock information. Where local built environment data is available, enhanced HAZUS analyses are possible. These results can then be incorporated into hazard mitigation plans. Communities are required to have a Federal Emergency Management Agency (FEMA) approved Multi-Hazard Mitigation Plan in order to apply for and/or receive non-emergency assistance under the Stafford Act.

FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) builds on flood hazard data and maps to provide communities, and ultimately individuals, with the information and tools they need to identify, assess, and take action to reduce flood risks.

Additional Information:

HAZUS: www.fema.gov/plan/prevent/hazus/index.shtm

Risk Mapping, Assessment, and Planning (Risk MAP): www.fema.gov/plan/prevent/fhm/rm_main.shtm

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Loss Avoidance: Northern California Flood Control Mitigation

The Federal Emergency Management Agency (FEMA) developed a loss avoidance methodology to evaluate the effectiveness of the mitigation projects. The methodology is based on the analysis of actual events that have occurred in the project study area since project completion. It determines losses avoided by comparing damage that would likely have been caused by the same storms without the project (Mitigation Project Absent, or MP_A) with damages that actually occurred with the project in place (Mitigation Project Complete, or MP_C).

The methodology was piloted by FEMA Region IX and the California Governor's Office of Emergency Services who noticed a dramatic decrease in damages from severe storms and flooding in 2005 and 2006 when compared with similar flood events from the late 1990s. The study analyzed six projects in the Northern California area that were impacted by the winter and spring storms of 2005 and 2006.

One of these projects was the Petaluma River Payran Reach Flood Control and Floodways project, completed in late 2004. It included floodwall construction, channel excavation and widening, mitigation planting, bridge replacements and relocations, storm drainage facilities, and a channel constriction weir at the upstream extent of the Payran Reach to relieve the flood levels associated with a 5-year storm event.

To determine the level of construction needed, officials used both hydrologic and hydraulic analyses and modeling that included Geographic Information Systems (GIS)-based data such as topography, aerial photography, and stream gage data for information such as water flow and channel stage (depth).

The total cost was $44,907,802 (adjusted for 2008 dollars), using funds from FEMA's Hazard Mitigation Grant Program, the U.S. Army Corps of Engineers, and local funds. It was evaluated for one post-construction storm event in a 10-year period on December 31, 2005. Losses avoided due to the completion of the mitigation project totaled $44,170,317. When compared to the project investment, it yields a return on investment (ROI) of 98%, indicating that with one event the project costs were almost fully recovered. If a similar event occurs within the expected life of the project (30 years), the ROI will likely exceed 100%. As a result, investment could be fully recovered within the project's intended lifespan.

Petaluma River Payran Reach Flood Control and Floodways Project Area

FEMA's Hazard Mitigation Grant Program:
www.fema.gov/government/grant/hmgp/index.shtm

FEMA's Loss Avoidance Program contact:
Gina White, Program Manager
gina.white@dhs.gov

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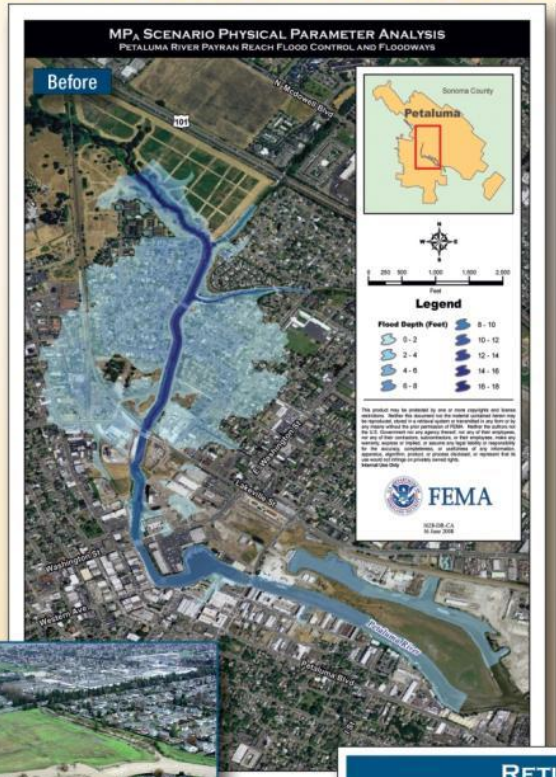

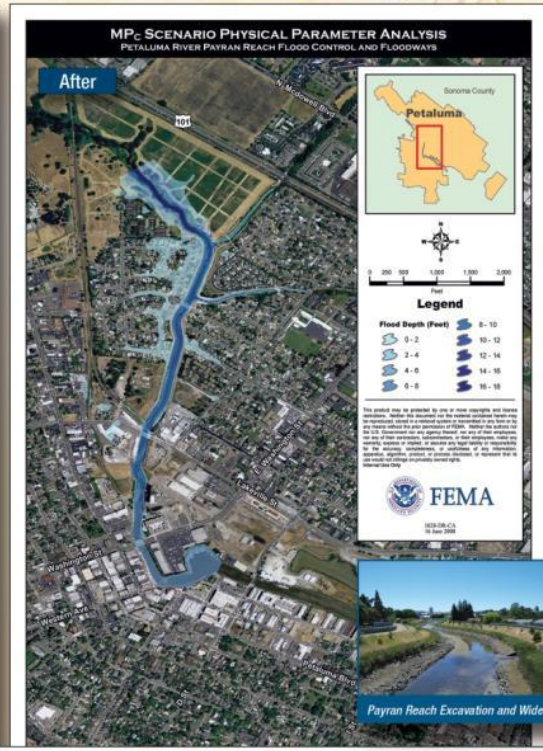

Payran Reach Excavation and Widening

Return on Mitigation Investment

General Project Information			Results by Loss Category			Losses Avoided Total	Project Investment Adjusted for 2008 Dollars	Current ROI
Project Name	County	Date of Project Completion	Physical Damage Subtotal	Loss of Function Subtotal	Emergency Management Subtotal			
Petaluma River Payran Reach Flood Control and Floodways	Sonoma	**2004**	$36,704,454	$7,319,808	$146,055	**$44,170,317**	**$44,907,802**	**98.36%**
Soscol Avenue Area Drainage Interceptor	Napa	**10/28/1998**	$294,057	$94,091	$12,213	**$400,361**	**$766,914**	**52.20%**
Humboldt Road Box Culvert at Malloy Creek	Butte	**10/14/1998**	$9,428	$50,762	$7,734	**$67,924**	**$257,106**	**26.42%**
Alhambra Creek Channel Improvements	Contra Costa	**07/06/2001**	$280,104	$19,354	$170,586	**$470,044**	**$1,709,693**	**27.49%**
Hilltop Green Flood Mitigation Project	Contra Costa	**07/03/1999**	$132,891	$1,452	$58,366	**$192,709**	**$248,520**	**77.54%**
Broadway Culvert Replacement	Yuba	**09/29/1998**	$1,328,497	$233,289	$42,063	**$1,603,849**	**$138,961**	**1,154.17%**
		Total	**$38,749,431**	**$7,718,756**	**$437,017**	**$46,905,204**	**$48,028,996**	**97.66%**

All amounts rounded to the nearest dollar.

DATA SOURCES: **Gage Data for Maps–** California Department of Water Resources, California Data Exchange Center: http://cdec.water.ca.gov/

Hydraulic Modeling for Maps– U.S. Army Corps of Engineers. 1994. *Petaluma River Basis of Design to the Section 205: Detailed Report for Flood Control*

Topographic Data for Maps– James Lopez, City of Petaluma

Building Data for Analysis of Return on Investment– FEMA project files for Project 1046-1007; R.S. Means, *2006 Building Construction Cost Data*; R.S. Means, *2008 Residential Cost Data*; Dean Eckerson, P.E., Engineering Manager, Department of Water Resources and Conservation, City of Petaluma, CA; FEMA. 2001. *What is a Benefit? Guidance on Benefit-Cost Analysis of Hazard Mitigation Projects*.

Photo Credits– Dean Eckerson, City of Petaluma (left); Robert Patton, FEMA (right)

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Severe Repetitive Loss Property Locations in FEMA Regions IV and VI

The National Flood Insurance Program (NFIP), a Federal program overseen by the Federal Emergency Management Agency (FEMA), enables property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, FEMA will make flood insurance available as a financial protection against flood losses.

Repetitive loss properties comprise approximately one percent of currently insured properties but account for 25 to 30 percent of flood claims. They constitute a significant expense of the NFIP, costing about $200 million annually. The Severe Repetitive Loss (SRL) Grant Program's purpose is to provide funding to reduce or eliminate claims under the NFIP through project activities that will result in the greatest savings to the National Flood Insurance Fund (NFIF).

On the maps of FEMA Region IV and FEMA Region VI, the shaded counties represent the count range of SRL properties. Each red dot is a SRL property that has also been obligated funding to be mitigated (as of February 28, 2009).

Mitigating severe repetitive loss properties through buyouts, elevations, relocations, or floodproofing will save money for NFIP policyholders and for Federal taxpayers by reducing the number of properties affected by floods and reduced Federal disaster assistance. These kinds of mitigation solutions shift the burden of recovery costs to property owners who choose to remain vulnerable to repetitive flood damage and encourages property owners to take appropriate actions that reduce loss of life and property damage and also benefits the financial soundness of the NFIP.

Information on SRL Grant Program:
www.fema.gov/government/grant/srl/index.shtm

The two photographs above are before and after photos for a home that was purchased and demolished under the 2008 SRL grant program. A vast savings to the National Flood Insurance Fund will result from the acquisition of this structure.

The definition of Severe Repetitive Loss (SRL) as applied to this program was established in section 1361A of the National Flood Insurance Act (NFIA), as amended 42 U.S.C. 4102a. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

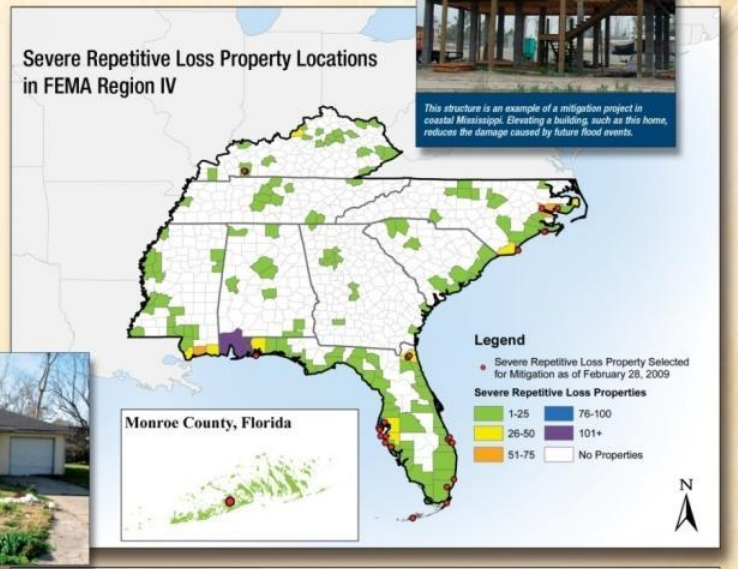
(a) That has at least four NFIP claim payments (including building and contents) over $5,000 each and the cumulative amount of such claims payments exceeds $20,000; or

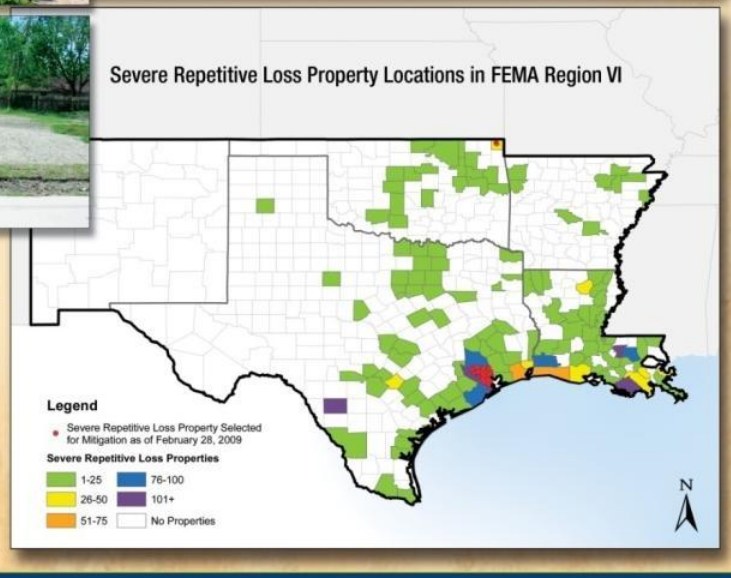
(b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any 10-year period, and must be greater than 10 days apart.

DATA SOURCE: NFIP Bureau and Statistical Agent Repetitive Loss master file as of February 28, 2009.

This structure is an example of a mitigation project in coastal Mississippi. Elevating a building, such as this home, reduces the damage caused by future flood events.





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Using HAZUS-MH and GIS to Measure Mitigation Successes

Red River Flood

April 2007 marks the ten-year anniversary of the Grand Forks Red River Flood Disaster that caused $3.7 billion in total losses in North Dakota. In 2006, a severe flood of the same river matched the 1997 flood heights but resulted in only $6.5 million in total losses. The reduction in total losses resulted from a partnership between FEMA, North Dakota, and localities that was created following the 1997 disaster to reduce future flood losses through mitigation projects and studies.

After the 2006 flood, FEMA's Mitigation Directorate conducted a study that included field data collection and analysis of the performance of acquisition projects in five counties—Richland, Grand Forks, Cass (City of Fargo), Traill and Pembina—along the Red River. The depth of flooding was determined using high resolution DEM data, the 100-year base flood elevation, and high water marks on FEMA mitigation projects affected by the 2006 event. The potential losses avoided were measured using HAZUS-MH flood model depth-loss relationships. The data allowed for an estimate of losses avoided for the 2006 event, as well as potential assessments based on a repeat of the 1997 Red River Flood Disaster and/or probabilistic flood events.

Demonstrating the cost-effectiveness of mitigation in reducing flood losses is critical to the continued success of FEMA mitigation programs.

To view flood maps at the FEMA Flood Map Store:
www.store.msc.fema.gov

To learn about HAZUS-MH, a loss estimation software:
www.fema.gov/plan/prevent/hazus/index.shtm

DATA SOURCES: Vicinity Map: Hillshade created by URS from USGS 1:250,000-scale DEM data. Acquisitions from FEMA. Other basemap features from ESRI, 2007.

Grand Forks Map: Acquisitions and flood depths from FEMA. Aerial photography from USDA NAIP, 2004.

The 1997 disaster caused $3.7 billion in economic losses.

When the Red River of the North flooded again in 2006, losses to North Dakota communities were about $7 million. The investment in acquisition projects in Grand Forks paid for itself in just one flood event – the 2006 flood.

FEMA

06/02/07

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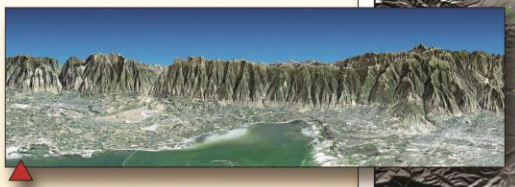
Using HAZUS-MH to Promote Seismic Safety

HAZUS-MH is a valuable tool for risk and emergency managers at all levels of government and the private sector. The earthquake model has been used to carry out National studies of annualized earthquake loss, to develop scenarios for catastrophic planning, to support evaluations of seismic safety of hospitals and other essential facilities, and to support risk assessments and mitigation planning in seismically vulnerable regions of the United States.

HAZUS-MH Used in Support of Utah Seismic Safety Legislation

The State of Utah took important steps in reducing the vulnerability of schools to damaging earthquakes, as well as addressing its Unreinforced Masonry (URM) building stock. HAZUS-MH played an important role in these initiatives. Specifically, HAZUS-MH was used to focus on the vulnerability of Utah schools and to estimate losses and potential casualties from scenario earthquakes in a region that is among the most susceptible in the U.S. to seismic activity.



Most of the population of Utah lives just west of the Wasatch Mountains in the north central part of the state. This view shows the region with the cities of Ogden and Salt Lake City in the foreground.

The Wasatch Front region of Utah is an extremely active seismic zone that experiences approximately 700 earthquakes per year. Though many of these temblors are less than 3.0 on the Richter magnitude scale, a 7.0 quake will occur roughly once every 350 years along the central portion of the Wasatch Fault. The last large quake along the fault occurred between 400 and 600 years ago.

HAZUS-MH Used to Generate Scenarios for Catastrophic Planning

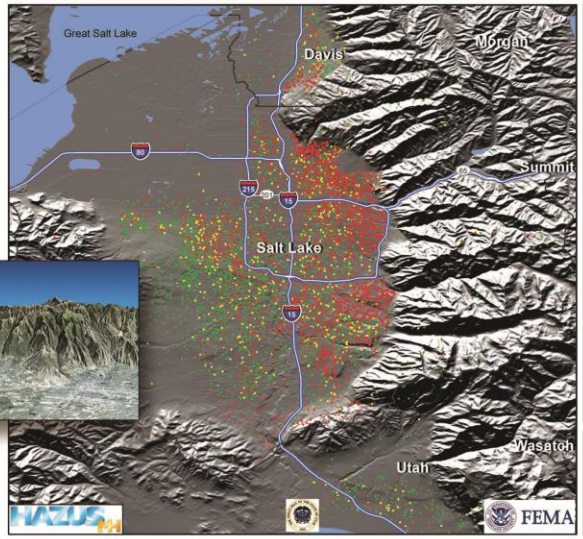
HAZUS-MH has been used extensively for scenario development in support of the Federal Emergency Management Agency's (FEMA's) catastrophic earthquake planning initiatives in the New Madrid Seismic Zone and Northern California. The earthquake scenarios detailed loss estimates that were used in a series of State workshops in the Central United States. Map-based templates capture essential information that are critical to response planning, including geographic areas that have sustained the greatest damage, shelter requirements, displaced households, and exposure of lifelines to ground shaking and soil failure.

HAZUS-MH information: www.fema.gov/plan/prevent/hazus

DATA SOURCES: Top: HAZUS-MH (Loss Estimation Software developed by FEMA); State of Utah.
Bottom: HAZUS-MH (Loss Estimation Software developed by FEMA)
Image: National Aeronautics and Space Administration (NASA) – The 3-D perspective view was generated using topographic data from the Shuttle Radar Topography Mission (SRTM), a Landsat 5 satellite image mosaic, and a false sky. Topographic expression is exaggerated four times.

FEMA

Estimated Building Inspection Needs - Earthquake Scenario: Wasatch Front



Mw 7.0 Salt Lake City Segment

	Estimated # of Structures	Estimated # of Inspectors Needed*
Red (Complete)	119,219	795
Yellow (Extensive)	41,219	550
Green (Slight/ Moderate)	159,701	1,065
Total	320,139	2,409

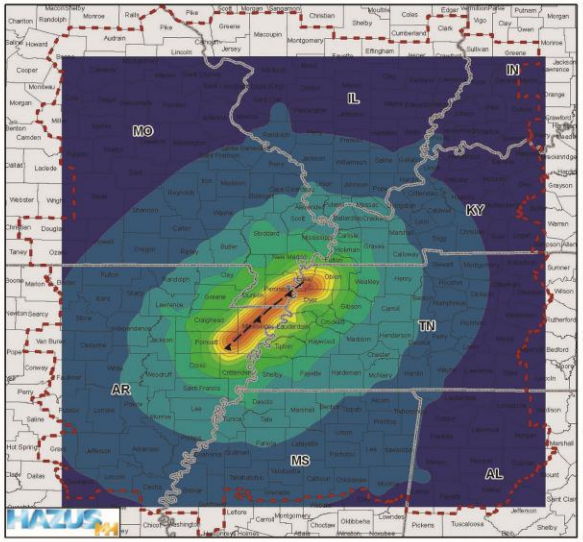
*Estimated number of inspectors needed to complete inspections in 30 days.

1 Dot = 50 Red Tag (Complete Damage)
1 Dot = 50 Yellow Tag (Extensive Damage)
1 Dot = 50 Green Tag (Slight/Moderate Damage)
County Boundaries

N
0 2 4 8 Miles
08/08/07 J. Rozelle
FEMA Region VIII Mitigation GIS

Location Map

Peak Ground Acceleration & Source - Earthquake Scenario: New Madrid Region



Southwest Scenario Magnitude 7.7

PGA
< 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1.0
1.0 - 1.1
1.1 - 1.2
> 1.2

Thrust Fault - SW Segment
Study Region Boundary
County Boundaries
State Boundaries

N
0 25 50 100 Miles

Location Map

06/24/08