Multi-hazard Loss Estimation Methodology

Earthquake Model

Hazus®–MH 2.1

User Manual

Developed by:
Department of Homeland Security
Federal Emergency Management Agency
Mitigation Division
Washington, D.C.

This manual is available on the FEMA website at www.fema.gov/plan/prevent/hazus.

To order the Hazus software visit www.msc.fema.gov and go to the Product Catalog to place your order

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MESSAGE TO USERS

The Hazus Earthquake Model is designed to produce loss estimates for use by federal, state, regional and local governments in planning for earthquake risk mitigation, emergency preparedness, response and recovery. The methodology deals with nearly all aspects of the built environment, and a wide range of different types of losses. Extensive national databases are embedded within Hazus, containing information such as demographic aspects of the population in a study region, square footage for different occupancies of buildings, and numbers and locations of bridges. Embedded parameters have been included as needed. Using this information, users can carry out general loss estimates for a region. The Hazus methodology and software are flexible enough so that locally developed inventories and other data that more accurately reflect the local environment can be substituted, resulting in increased accuracy.

Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics and economic parameters add to the uncertainty. These factors can result in a range of uncertainty in loss estimates produced by the Hazus Earthquake Model, possibly *at best* a factor of two or more.

The methodology has been tested against the judgment of experts and, to the extent possible, against records from several past earthquakes. However, limited and incomplete data about actual earthquake damage precludes complete calibration of the methodology. Nevertheless, when used with embedded inventories and parameters, the Hazus Earthquake Model has provided a credible estimate of such aggregated losses as the total cost of damage and numbers of casualties. The Earthquake Model has done less well in estimating more detailed results - such as the number of buildings or bridges experiencing different degrees of damage. Such results depend heavily upon accurate inventories. The Earthquake Model assumes the same soil condition for all locations, and this has proved satisfactory for estimating regional losses. Of course, the geographic distribution of damage may be influenced markedly by local soil conditions. In the few instances where the Earthquake Model has been partially tested using actual inventories of structures plus correct soils maps, it has performed reasonably well.

Users should be aware of the following specific limitations:

- While the Hazus Earthquake Model can be used to estimate losses for an individual building, the results must be considered as average for a group of similar buildings. It is frequently noted that nominally similar buildings have experienced vastly different damage and losses during an earthquake.

- When using embedded inventories, accuracy of losses associated with lifelines may be less than for losses from the general building stock. The embedded databases and assumptions used to characterize the lifeline systems in a study region are necessarily incomplete and oversimplified.

- Based on several initial studies, the losses from small magnitude earthquakes (less than M6.0) centered within an extensive urban region appear to be overestimated.

- Because of approximations in modeling of faults in California, there may be discrepancies in motions predicted within small areas immediately adjacent to faults.

- There is considerable uncertainty related to the characteristics of ground motion in the Eastern U.S. The embedded attenuation relations in the Earthquake Model, which are those commonly recommended for design, tend to be conservative. Hence use of these relations may lead to overestimation of losses in this region, both for scenario events and when using probabilistic ground motion.

Hazus should still be regarded as a work in progress. Additional damage and loss data from actual earthquakes and further experience in using the software will contribute to improvements in future releases. To assist us in further improving Hazus, users are invited to submit comments on methodological and software issues by letter, fax or e-mail to:

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What's New In Hazus-Mh 2.1

Please refer to **Getting Started.pdf** document for a list of the new features in Hazus-MH 2.1.

The document has also details about the installation of the software, its limitations and capabilities.

Technical Support

Technical assistance is available via the Hazus Help Desk at for https://support.hazus.us. If you do not yet have login credentials for https://support.hazus.us please send an e-mail to helpdesk@support.hazus.us to gain access. The Help Desk is available 24/7. Users can also call the technical hotline at 1-877-336-2627 (1-877-FEMA-MAP) as an alternative means of support.

Chapter 1. Introduction to the Earthquake Loss Estimation Methodology

The earthquake loss estimation provides local, state and regional officials with a state-of-the-art decision support tool for estimating potential losses from scenario earthquakes. This forecasting capability will enable users to anticipate the consequences of future earthquakes and to develop plans and strategies for reducing risk. The GIS-based software can be applied to study small or large geographic areas with a wide range of population. **Hazus** will accommodate budget constraints, and can be implemented by users with varying technical and subject expertise. The modular approach of the methodology (with different modules addressing various user needs) provides additional flexibility in a variety of applications.

The various users of a loss estimation study will have different needs. A local or state government official may be interested in the costs and benefits of specific mitigation strategies, and thus may want to know the expected losses if mitigation strategies have been applied. Health officials will want information about the demands on medical care facilities and will be interested in the number and severity of casualties for different scenario earthquakes. Fire fighters may be interested in areas where large fires can be expected or where hazardous materials might be released. Emergency response teams may use the results of a loss study in planning and performing emergency response exercises. In particular, they might be interested in the operating capacity of emergency facilities such as fire stations, emergency operations centers, and police stations. Emergency planners may want to know how much temporary shelter will be needed and for how long. Utility company representatives, as well as planners want to know about the locations and lengths of potential utility outages. Federal and state government officials may require an estimate of economic losses (both short term and long term) in order to direct resources toward affected communities. In addition, government agencies may use loss studies to obtain quick estimates of impacts in the hours immediately following an earthquake so as to best direct resources to the disaster area. Insurance companies may be interested in monetary losses so they can assess their exposure. This list of uses of earthquake loss estimation studies is not comprehensive. As users become familiar with the loss estimation methodology, they will determine which **Hazus** modules are most appropriate for their needs, and how to interpret the study results.

Some of the first earthquake loss estimation studies were performed in the early 1970's following the 1971 San Fernando earthquake. These earlier studies were funded by Federal agencies and were intended to provide a basis for disaster relief and recovery. These studies put a heavy emphasis on loss of life, injuries and the ability to provide emergency health care. More recent studies have focused on disruption to roads, telecommunications and other lifeline systems. An understanding of disruptions to these systems is essential in planning for post earthquake emergency response. More recently, municipalities have invested in earthquake loss estimation methodologies based on geographic information systems (GIS). These municipalities have found that as inventories are collected, they may be useful for purposes beyond the scope of earthquake loss estimation. For example, data collected for an earthquake loss estimation model in San Bernardino County, California (FEMA, 1985) are now being used for city planning purposes.

Two useful resources on loss estimation studies are “Estimating Losses from Future Earthquakes” (FEMA, 1989) and “Assessment of the State-of-the-Art of Earthquake Loss Estimation Methodologies” (FEMA, 1994). Other useful applications of earthquake loss estimation methodologies are contained in “Comprehensive Earthquake Preparedness Planning Guidelines” (FEMA, 1985) and “A Cost Benefit Model for the Seismic Rehabilitation of Buildings” (FEMA, 1992).

1.1 Overview of the Methodology

This brief overview of the earthquake loss estimation methodology is intended for local, regional, or state officials contemplating an earthquake loss study. The methodology has been developed for the Federal Emergency Management Agency (FEMA) by the National Institute of Building Sciences (NIBS) to provide a tool for developing earthquake loss estimates for use in:

- Anticipating the possible nature and scope of the emergency response needed to cope with an earthquake-related disaster,
- Developing plans for recovery and reconstruction following a disaster, and
- Mitigating the possible consequences of earthquakes.

If developed for areas of seismic risk across the nation, estimates also will help guide the allocation of federal resources to stimulate risk mitigation efforts and to plan for federal earthquake response.

Use of the methodology will generate an estimate of the consequences to a city or region of a "scenario earthquake", i.e., an earthquake with a specified magnitude and location. The resulting "loss estimate" generally will describe the scale and extent of damage and disruption that may result from a potential earthquake. The following information can be obtained:

- *Quantitative estimates of losses* in terms of direct costs for repair and replacement of damaged buildings and lifeline system components; direct costs associated with loss of function (e.g., loss of business revenue, relocation costs); casualties; people displaced from residences; quantity of debris; and regional economic impacts.

- *Functionality losses* in terms of loss-of-function and restoration times for critical facilities such as hospitals, and components of transportation and utility lifeline systems and simplified analyses of loss-of-system-function for electrical distribution and potable water systems.
- *Extent of induced hazards* in terms of fire ignitions and fire spread, exposed population and building value due to potential flooding and locations of hazardous materials.

To generate this information, the methodology includes:

- Classification systems used in assembling inventory and compiling information on the building stock, the components of highway and utility lifelines, and demographic and economic data.
- Standard calculations for estimating type and extent of damage, and for summarizing losses.
- National and regional databases containing information for use as default (built-in) data, in the absence of user-supplied data., and useable in calculation of losses.

These systems, methods, and data have been combined in the development of user-friendly GIS software for this loss estimation application. GIS technology facilitates the manipulation of data on building stock, population, and the regional economy. The current version of the software (**Hazus-2.1)** has been certified only for ArcView 10 SP1.

The software makes use of GIS technologies for displaying and manipulating inventory, and permitting losses and consequences to be portrayed on both spreadsheets and maps. Collecting and entering the necessary information for analysis are the major tasks involved in generating a loss estimate. The methodology permits estimates to be made at several levels of sophistication, based on the level of inventory entered for the analysis (i.e., default data versus locally enhanced data). The better and more complete the inventory information, the more meaningful the results.

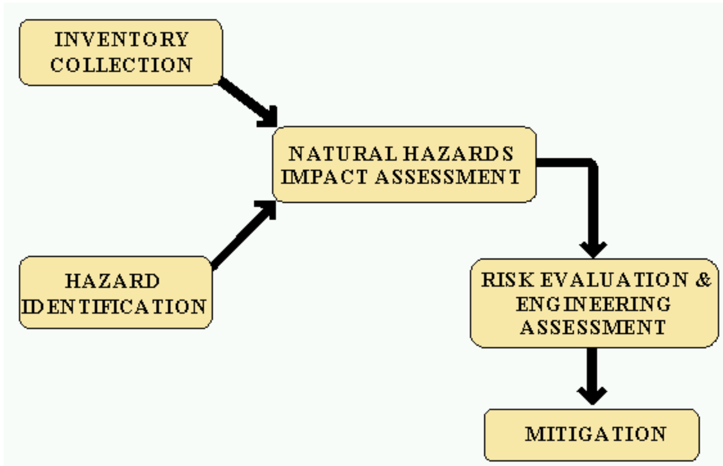


Figure 2.1 Steps in assessing and mitigating losses due to natural hazards

Figure 2.1 Steps in assessing and mitigating losses due to natural hazards shows the steps that are typically performed in assessing and mitigating the impacts of a natural hazard such as an earthquake. The methodology incorporates inventory collection, hazard identification, and the natural hazards impact assessment. In a simplified form, the steps include:

- Select the area to be studied. The region of interest is created based on Census Tract, Census Block, county, or state. The area generally includes a city, county, or group of municipalities. It is generally desirable to select an area that is under the jurisdiction of an existing regional planning group.
- Specify the magnitude and location of the scenario earthquake. In developing the scenario earthquake, consideration should be given to the potential fault locations.
- Provide additional information describing local soil and geological conditions, if available. Soil characteristics include site classification according to the National Earthquake Hazard Reduction Program (NEHRP) and susceptibility to landslides.
- Using formulas embedded in Hazus, probability distributions are computed for damage to different classes of buildings, facilities, and lifeline system components. Loss-of-function is also estimated.
- The damage and functionality information is used to compute estimates of direct economic loss, casualties and shelter needs. In addition, the indirect economic impacts on the regional economy are estimated for the years following the earthquake.
- An estimate of the number of ignitions and the extent of fire spread is computed. The amount and type of debris are estimated. If an inundation map is provided, exposure to flooding can also be estimated.

The user plays a major role in selecting the scope and nature of the output of a loss estimation study. A variety of maps can be generated for visualizing the extent of the losses. Numerical results may be examined at the level of the census tract, or may be aggregated by county or region.

1.2 Earthquake Hazards Considered in the Methodology

The earthquake-related hazards considered by the methodology in evaluating casualties, damage, and resultant losses are collectively referred to as *potential earth science hazards* (PESH). Most damage and loss caused by an earthquake is directly or indirectly the result of *ground shaking*. Thus, it evaluates the geographic distribution of ground shaking resulting from the specified scenario earthquake and expresses ground shaking using several quantitative parameters, ex. peak ground acceleration and spectral acceleration.

Three other features of earthquakes that can cause permanent ground displacements and have an adverse effect upon structures, roadways, pipelines, and other lifeline structures also are considered:

- *Fault rupture*: Ground shaking is caused by fault rupture, usually at some depth below the ground surface. However, fault rupture can reach the surface of the earth as a narrow zone of ground offsets and tear apart structures, pipelines, etc. within this zone.
- *Liquefaction*: This sudden loss of strength and stiffness in soils can occur when loose, water-saturated soils are shaken strongly and can cause settlement and horizontal movement of the ground.
- *Landsliding*: This refers to large downhill movements of soil or rock that are shaken free from hillsides or mountainsides which can destroy anything in their path.

Soil type can have a significant effect on the intensity of ground motion at a particular site. Soil, as defined in this methodology is classified in terms of geology. The software contains several options for determining the effect of soil type on ground motions for a given magnitude and location. The user may select the default classifications, or choose an alternative.

Tsunamis (waves moving across oceans) and seiches (oscillatory waves generated in lakes or reservoirs) are also earthquake-caused phenomena that can result in inundation or waterfront damage. In the methodology, potential sites of these hazards may be identified, but they are evaluated only if special supplemental data are provided.

The definition of the scenario earthquake is not just a matter of earth science. Hazard management and political factors must be considered as well. Planning for mitigation and disaster response generally is based on large, damaging events, but the probability that such events will occur also should be considered. In a region of high seismicity, the *maximum credible earthquake* is generally a suitable choice. In areas of lower seismicity, it is prudent to assume a very large earthquake event is possible, although unlikely. In such regions, it is often most appropriate to choose an earthquake with a specified mean recurrence interval, such as the "500-year earthquake." Consideration should be given to calculating losses using several scenario earthquakes. Each scenario would be defined by different magnitudes, locations, and probabilities of occurrence, since these factors are a major source of uncertainty.

Data concerning past earthquakes are provided within Hazus. Chapter 9 provides guidance concerning the selection of scenario earthquakes. It is always desirable to consult local earth science experts during the process of choosing scenario events.

1.3 Types of Buildings and Facilities Considered

The buildings, facilities, and lifeline systems considered by the methodology are as follows:

- *General building stock*: The majority of commercial, industrial and residential buildings in your region are not considered individually when calculating losses. Buildings within each census tract are aggregated and categorized. Building information derived from Dunn & Bradstreet data are used to form groups of 36 model building types and 33 occupancy classes. Degree of damage is computed for each group combination of model building type and occupancy class.
- Examples of model building types are light wood frame, mobile home, steel braced frame, concrete frame with unreinforced masonry infill walls, and unreinforced masonry. Each model building type is further subdivided according to typical number of stories and apparent earthquake resistance (based primarily upon the earthquake zone where they are constructed). Examples of occupancy types are single family dwelling, retail trade, heavy industry, and churches. All structures are categorized in this manner and referred to as General Building Stock or GBS in short.
- *Essential facilities*: Essential facilities, including medical care facilities, emergency response facilities and schools, are those vital to emergency response and recovery following a disaster. School buildings are included in this category because of the key role they often play in housing people displaced from damaged homes. Generally there are very few of each type of essential facility in a census tract, making it easier to obtain site-specific information for each facility. Thus, damage and loss-of-function are evaluated on a building-by-building basis for this class of structures, even though the uncertainty in each such estimate is large.
- *Transportation lifeline systems*: Transportation lifelines, including highways, railways, light rail, bus systems, ports, ferry systems and airports, are broken into components such as bridges, stretches of roadway or track, terminals, and port warehouses. Probabilities of damage and losses are computed for each component of each lifeline; however, total *system* performance cannot be evaluated (for example, how well various sections, nodes and connections of the total system perform to enable to move from point A to point B after an earthquake).
- *Utility lifeline systems*: Utility lifelines, including potable water, electric power, waste water, communications, and liquid fuels (oil and gas), are treated in a manner similar to transportation lifelines. Examples of components are electrical substations, water treatment plants, tank farms and pumping stations.
- *High potential loss facilities:* In any region or community there will be certain types of structures or facilities for which damage and losses will not be (reliably) evaluated without facility-specific supplemental studies. Such facilities include dams, nuclear power plants, liquefied natural gas facilities, military installations, and large one-of-a-kind residential or commercial structures.
- It would be potentially misleading to estimate damage and losses of these structures without a detailed engineering analysis performed with the agreement of the facility owner. The general approach is to call attention to these facilities, include their locations in the inventory, and indicate a potential for loss in the final report. Although the loss cannot be

quantified without further investigation, the location of the structures with respect to ground failure or intense ground motions may provide a starting point for more in-depth studies. To include these structures in the loss estimation study outputs, results from supplemental studies, such as damage-motion curves, can be entered.

1.4 Levels of Analysis

To provide flexibility, the losses are estimated at three levels. The first level only uses default inventory and parameter data. The second level of estimation is achieved by improving inventories and/or parameters with user-supplied data. The third level of loss estimation incorporates data from third-party studies. The appropriate level of analysis must be determined to meet the needs of the user.

1.4.1 Analysis Based on Default Information

The basic level of analysis uses only the default databases built into the methodology for information on building square footage and value, population characteristics, costs of building repair, and certain basic economic data. One average soil condition is assumed for the entire study region. The effects of possible liquefaction and landsliding are ignored. Direct economic and social losses associated with the general building stock and essential facilities are computed. Default data for transportation and utility lifelines are included, thus these lifelines are considered in the basic level of analysis. Uncertainty, however, is large. Fire ignitions and fire spread are considered using a simplified model. Indirect economic impacts for the region are calculated but are based on a synthetic economy that may or may not accurately reflect the characteristics of the region. Table 2.1 summarizes the output that can be obtained from an analysis. Outputs that cannot be obtained using only default data are marked with a footnote.

Table 2.1. Earthquake Loss Estimation Methodology Output

Maps of seismic hazards • Intensities of ground shaking for each census tract • Contour maps of intensities of ground shaking • Permanent ground displacements for each census tract* • Contour map of permanent ground displacements* • Liquefaction probability* • Landsliding probability* **Characterization of damage to general building stock** • Structural and nonstructural damage probabilities by census tract, building type and occupancy class. **Transportation and utility lifelines** • For components of the 13 lifeline systems: damage probabilities, cost of repair or replacement and expected functionality for various times following earthquake • For all pipeline systems: the estimated number of leaks and breaks • For potable water and electric power systems: estimate of service outages **Essential facilities** • Damage probabilities • Probability of functionality • Loss of beds in hospitals **High potential loss facilities (HPLF)** • Locations of dams • Locations of nuclear plants • Damage probabilities and cost of repair for of military facilities* • Locations of other identified HPLs	**Fire following earthquake** • Number of ignitions by census tract • Percentage of burned area by census tract **Inundated areas** • Exposed population and exposed dollar value of general building stock* **Hazardous material sites** • Location of facilities which contain hazardous materials **Debris** • Total debris generated by weight and type of material **Social losses** • Number of displaced households • Number of people requiring temporary shelter • Casualties in four categories of severity based on three different times of day **Dollar losses associated with general building stock** • Structural and nonstructural cost of repair or replacement • Loss of contents • Business inventory loss • Relocation costs • Business income loss • Employee wage loss • Loss of rental income **Indirect economic impact** • Long-term economic effects on the region based on a synthetic economy • Long-term economic effects on the region based on an IMPLAN model*

- * Outputs cannot be obtained using only default data.

Other than defining the study region, selecting the scenario earthquake(s) and making decisions concerning the extent and format of the output, an analysis based on default data requires minimal effort from the user. As indicated, estimated losses are incomplete and the estimates involve large uncertainties when inventories are limited to the default data. This level of analysis is suitable primarily for preliminary evaluations and crude comparisons among different study regions with a Census Block as the smallest regional unit.

1.4.2 Analysis with User-Supplied Inventory

Results from an analysis using only default inventory can be improved greatly with at least a minimum amount of locally developed input. This is generally the intended level of implementation (Level II). Table 2.1 summarizes the output that can be obtained from this level of analysis. Improved results are highly dependent on the quality and quantity of improved inventories. Significance of the improved results also relies on the user's analysis priorities. The following inventory improvements impact the accuracy of analysis results.

- Development of maps of soil conditions affecting ground shaking, liquefaction and landsliding potential. These maps would be used for evaluation of the effects of these local conditions upon damage and losses.
- Use of locally available data or estimates concerning the square footage of buildings in different occupancy classes.
- Use of local expertise to modify, primarily by judgment, the databases concerning percentages of model building types associated with different occupancy classes.
- Preparation of a detailed inventory for all essential facilities.
- Collection of detailed inventory and cost data to improve evaluation of losses and lack of function in various transportation and utility lifelines.
- Use of locally available data concerning construction costs or other economic parameters.
- Collections of data, such as number of fire trucks, for evaluation of the probable extent of areas affected by fires.
- Development of inundation maps.
- Gathering of information concerning high potential loss facilities and facilities housing hazardous materials.
- Synthesis of data for modeling the economy of the study region used in calculation of indirect economic impacts.

User-supplied inventory can require months of dedicated work to prepare. The extent of preparation and data compilation work involved depends on the condition and completeness of existing information, required data conversions, and the contributions of expertise. The greatest impact from enhanced inputs are produced by editing both the basic inventory and updating the model parameters. These input improvements are best accomplished by a cooperative team effort. Strategic planning is required to estimate and execute the level of effort required to produce the useful analysis outputs.

The most detailed type of analysis incorporates the results from completed loss studies. For example, it is possible to include the output of loss estimates performed using locally developed traffic models that have identified the bridges most susceptible to damage. Similar analyses can provide information on water distribution or other pipeline systems. Review and updates to the vulnerability ratings for each model building type will also produce more accurate analysis results.

It is advisable to run a baseline analysis for comparison with results after introduction of user-supplied data. Sensitivity of the loss estimation methodology under local conditions is measured best by review of outputs after inclusion of each enhanced inventory. Good record-keeping and inventory documentation are essential.

1.5 Assumed Level of Expertise of Users

Users can be broken into two groups: those who perform the study, and those who use the study results. For some studies these two groups will consist of the same people, but generally this will not be the case. However, the more interaction that occurs between these two groups, the better the study will be. End users of the loss estimation study need to be involved from the beginning to make results more usable.

Those who are performing the study must, at minimum, have a basic understanding of earthquakes, their causes and their consequences. In many cases, the results will be presented to audiences (i.e. city councils and other governing bodies) that have little technical knowledge of the earthquake loss problem.

It is assumed that a loss study will be performed by a representative team consisting of geologists, geotechnical engineers, structural engineers, architects, economists, sociologists, hydrologists, emergency planners, public works personnel, and loss estimate users. These individuals are needed to develop earthquake scenarios, identify problematic soils, develop and classify building inventories, provide and interpret economic data, provide information about the local population, and to provide input on what loss estimates are needed to fulfill the study goals. At least one GIS specialist must participate on the team, and others with some level of familiarity or expertise in data management and GIS are beneficial.

If a local or state agency is performing the study, some of the expertise can be found in-house. Experts are generally found in several departments: building permits, public works, planning, public health, engineering, information technologies, finance, historical preservation, natural resources, and land records. Although internal expertise may be most readily available, participation of individuals from academic institutions, citizen organizations, and private industry cannot be underestimated.

1.5.1 When to Seek Help

The results of a loss estimation study should be interpreted with caution. Application of default input values have a great deal of uncertainty associated with them. If the loss estimation team does not include individuals with expertise in the areas described above, then it is likely that one or more outside consultants may be required to assist with interpreting the results. It is also advisable to retain objective reviewers with subject expertise to evaluate and comment on map and tabular data outputs.

A seismologist will be needed to provide, or review each scenario earthquake, and to describe it in terms of moment magnitude (M), spectral velocity and spectral acceleration. Attention should be given to any differences in the methodology used to define documented scenarios. A scenario event that is defined without an in-depth understanding of earthquake sources, recurrence and the geology of the region, may not be appropriate for the loss study.

If the user intends to modify the default inventory data or parameters, assistance will be required from an individual with expertise in the subject. For example, if the user wishes to change default percentages of model building types for the region, a structural engineer with knowledge of regional design and construction practices will be helpful. Similarly, if damage-motion relationships (fragility curves) need editing, input from a structural engineer will be required. Modifications to defaults in the direct and indirect economic modules will require input from an economist.

Technical help for the users of Hazus has been established by NIBS. Users should contact FEMA or NIBS at the email, phone, fax, or addresses provided in this manual for information on technical support. Agency and organizational websites are also listed in this report to access Frequently Asked Questions (FAQs), software updates, training opportunities, and User Group activities.

1.6 Displaying Analysis Results

There is a great deal of flexibility in displaying output. Tables of social and economic losses can be displayed on the screen, printed, or pasted into electronic documents. Most outputs can also be mapped. Colors, legends and titles can be easily altered. Results can be compiled to create electronic presentations, or as inserts to a community project report.

Examples of graphical and numerical outputs that can be produced by the program are found in Figures 1.2 and 1.3.

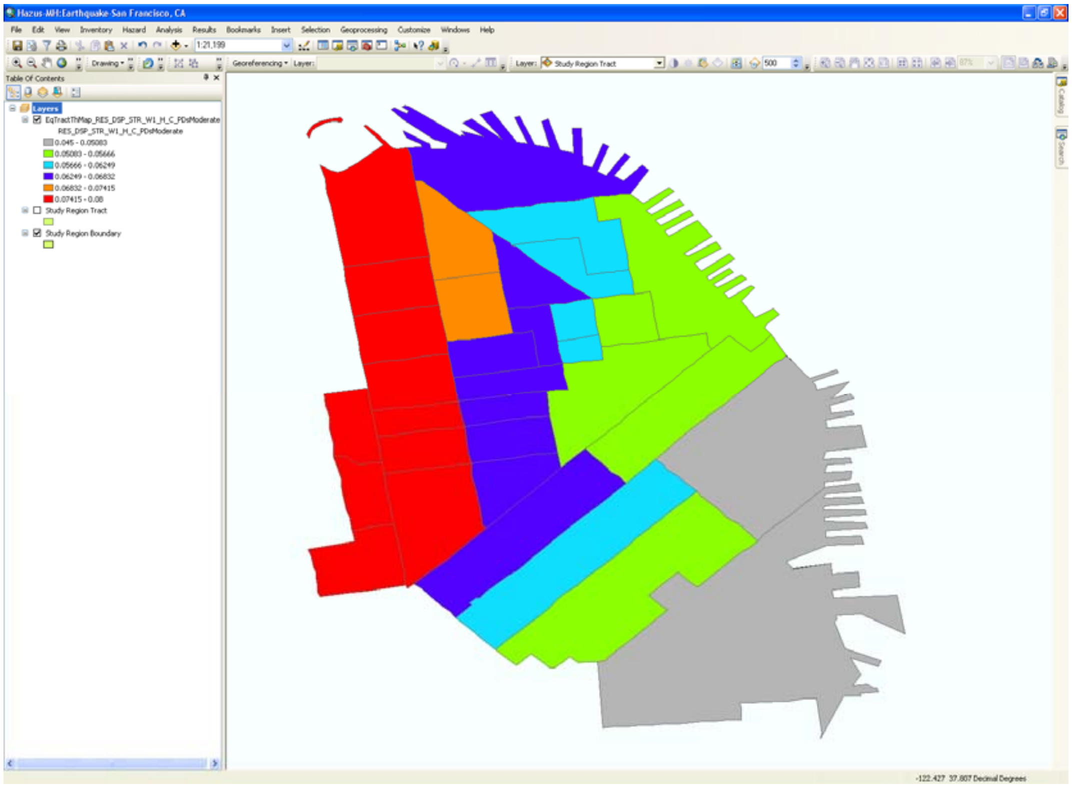
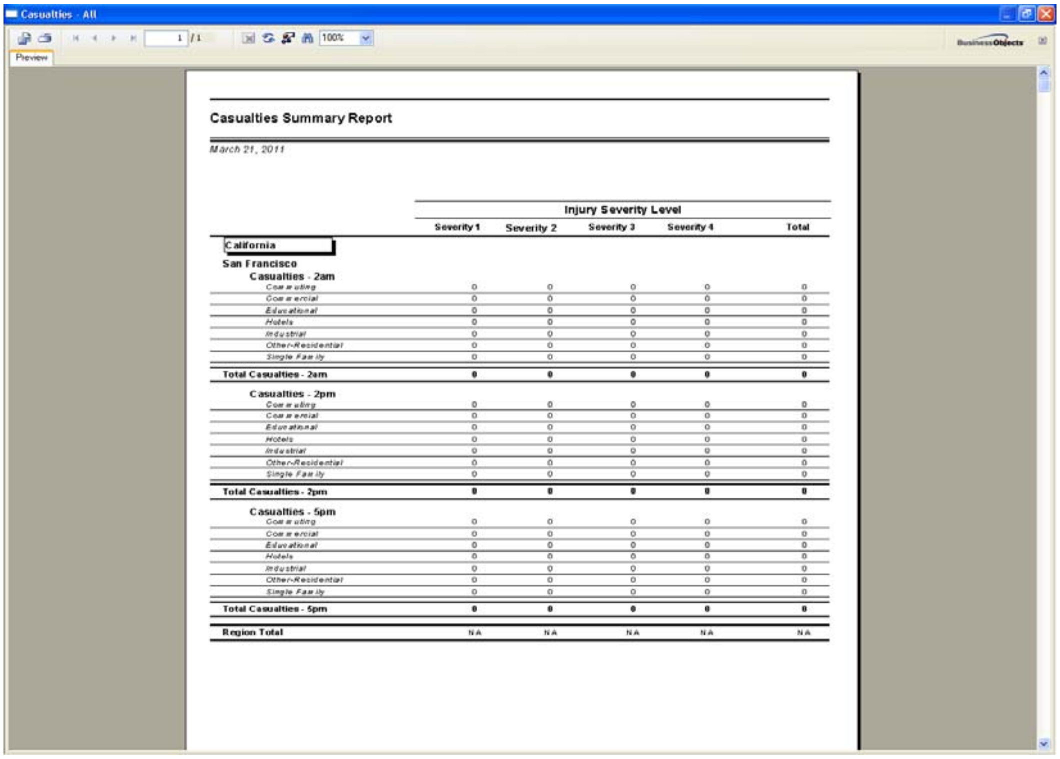


Figure 2.2 Sample output: damage to wooden residential structures.



Casualties - All

Casualties Summary Report

March 21, 2011

	Injury Severity Level				
	Severity 1	Severity 2	Severity 3	Severity 4	Total
California					
San Francisco					
Casualties - 2am					
Commuting	0	0	0	0	0
Commercial	0	0	0	0	0
Educational	0	0	0	0	0
Hotels	0	0	0	0	0
Industrial	0	0	0	0	0
Other-Residential	0	0	0	0	0
Single Family	0	0	0	0	0
Total Casualties - 2am	0	0	0	0	0
Casualties - 2pm					
Commuting	0	0	0	0	0
Commercial	0	0	0	0	0
Educational	0	0	0	0	0
Hotels	0	0	0	0	0
Industrial	0	0	0	0	0
Other-Residential	0	0	0	0	0
Single Family	0	0	0	0	0
Total Casualties - 2pm	0	0	0	0	0
Casualties - 5pm					
Commuting	0	0	0	0	0
Commercial	0	0	0	0	0
Educational	0	0	0	0	0
Hotels	0	0	0	0	0
Industrial	0	0	0	0	0
Other-Residential	0	0	0	0	0
Single Family	0	0	0	0	0
Total Casualties - 5pm	0	0	0	0	0
Region Total	NA	NA	NA	NA	NA

Figure 2.3 Sample output: Casualties' summary report.

1.7 Uncertainties in Loss Estimates

Although the software offers users the opportunity to prepare comprehensive loss estimates, it should be recognized that, even with state-of-the-art techniques, uncertainties are inherent in any such estimation methodology.

History has taught that the next major earthquake to affect a U.S. city or region will likely be quite different from the "scenario earthquake" anticipated as part of an earthquake loss estimation study. The magnitude and location of the earthquake and the associated faulting, ground motions and landsliding will not be precisely what was anticipated. Hence, the results of an earthquake loss study should not be looked upon as a *prediction*. Instead, it is only an indication of what the future may hold. This is particularly true in areas where seismicity is poorly understood.

Any region or city studied will have an enormous variety of buildings and facilities of different sizes, shapes, and structural systems constructed over years under diverse seismic design codes. Similarly, many types of components with differing seismic resistance will make up transportation and utility lifeline systems. Due to this complexity, relatively little is certain concerning the structural resistance of most buildings and other facilities. Further, there simply are not sufficient data from past earthquakes or laboratory experiments to permit precise predictions of damage based on known ground motions even for specific buildings and other structures. To deal with this complexity and lack of data, buildings and components of lifelines are lumped into categories, based upon key characteristics. Relationships between key features of ground shaking and average degree of damage with associated losses for each building category are based on current data and available theories. While state-of-the-art in terms of loss estimation, these relationships do contain a certain level of uncertainty.

Ranges of potential losses are best evaluated by conducting multiple analyses and varying certain input parameters to which the losses are most sensitive. Guidance for planning *sensitivity studies* is found in Section 9.7.

1.8 Applying Methodology Products

The products of the FEMA methodology for estimating earthquake losses have several pre-earthquake and/or post-earthquake applications in addition to estimating the scale and extent of damage and disruption.

Examples of pre-earthquake applications of the outputs are as follows:

- *Development of earthquake hazard mitigation strategies* that outline policies and programs for reducing earthquake losses and disruptions indicated in the initial loss estimation study. Strategies can involve rehabilitation of hazardous existing buildings (e.g., unreinforced masonry structures), building code enforcement, development of appropriate zoning ordinances for land use planning in areas of liquefiable soils, and the adoption of advanced seismic building codes.
- *Development of preparedness (contingency) planning measures* that identify alternate transportation routes and planning earthquake preparedness and survival education seminars.
- *Anticipation of the nature and scope of response and recovery efforts* including: identifying alternative housing and the location, availability and scope of required medical services; and establishing a priority ranking for restoration of water and power resources.

Post-earthquake applications of the outputs would include:

- *Projection of immediate economic impact assessments for state and federal resource allocation and support* including supporting the declaration of a state and/or federal disaster by calculating direct and indirect economic impact on public and private resources, local governments, and the functionality of the area.
- *Activation of immediate emergency recovery efforts* including search and rescue operations, rapid identification and treatment of casualties, provision of emergency housing shelters, control of fire following earthquake, and rapid repair and availability of essential utility systems.
- *Application of long-term reconstruction plans* including the identification of long-term reconstruction goals, implementation of appropriate wide-range economic development plans for the impacted area, allocation of permanent housing needs, and the application of land use planning principles and practices.

Once inventory has been collected, making modifications and running new analyses are simple tasks. The ease with which reports and maps can be generated makes the software a useful tool for a variety of applications.

1.9 Organization of the Manual

The *User's Manual* provides the background and instructions for developing an inventory to complete an earthquake loss estimation study using Hazus. It also provides information on how to install and run the software, and how to interpret and report model output. The contents and organization of the User's Manual are outlined below.

The Technical Manual accompanies this publication. It documents the default data and explains the methods of calculating losses. Together, the two manuals provide a comprehensive overview of the nationally applicable loss estimation methodology.

Chapter 1 provides the user with a general understanding of the purpose, uses and components of a regional earthquake loss estimation study.

Chapter 2 gives instructions for installing and starting Hazus-2.1.

Chapter 3 runs through an analysis using only default data.

Chapter 4 provides an overview of the types of data required to run the loss study, as well as a description of the default databases.

Chapter 5 contains detailed information about what data are needed to complete a loss study, sources of inventory, how to collect inventory, and related expenses to anticipate. This chapter also describes how to convert data to the correct format for the methodology, and how to enter data into Hazus.

Chapter 6 includes instructions for entering data, editing records and geocoding addresses.

Chapter 7 provides the user with a discussion of how to display, modify and print databases.

Chapter 8 provides a description of the comprehensive data management system (CDMS)

Chapter 9 provides a detailed step-by-step description of how to run an analysis using Hazus, including analysis with user-supplied data.

Chapter 10 discusses how to view results and provides suggestions about putting together a report.

Chapter 11 contains a general discussion of vulnerability to natural hazards and key factors that should be considered in estimating losses as well as brief discussions of supplemental data that are available with Hazus.

The *User's Manual* is written in language that should be easily understood by a user of the methodology. Highly technical terms are avoided where possible, but a glossary of terms is provided in Appendix H to supplement any definitions that are needed. A compilation of relevant references is found in References Section.

The appendices contain detailed information about the structure of the methodology.

Appendix A is the installation verification document.

Appendix B lists all of the classification systems that are used.

Appendices C and D provide descriptions of the model building types and lifeline components that are used in the methodology.

Appendix E describes the content and origin of the default databases.

Appendix F is a database dictionary containing details about the format of all of the databases used by Hazus.

Appendix G includes a sample questionnaire that was used for assessing characteristics of regional building stock.

Appendix H describes the hazardous materials that are covered under SARA Title III, including their Chemical Abstracts Service (CAS) registry numbers, and the threshold quantities for reporting purposes.

Appendix I is a glossary of technical terms.

Appendix J has the steps for converting SHP Shake maps to Geodatabase with proper Projection and Schema.

Appendix K has the steps for converting SHP Hazard Data Maps to Geodatabase with proper Projection and Schema.

Appendix L shows how Hazus can be configured to run with a full version of SQL Server 2005.

Appendix M gives instructions on how to use the enhanced Hawaii earthquake data.

Appendix N shows how to change the inventory data path in Hazus-MH.

Appendix O shows how to enable the Large Region analysis option in Hazus-MH.

Chapter 2. Installing and Starting Hazus-MH

Please refer to the *Getting Started.pdf* document that comes with the Hazus 2.1 software for installation assistance. It is very important to read these instructions before attempting to install Hazus 2.1. Contact Hazus technical support if you cannot locate the instructions document (https://support.hazus.us or 1-877-336-2627).

Chapter 3. Running Hazus with Default Data

Hazus contains a variety of default parameters and databases. You can run a loss estimation analysis using only default data, but your results will be subject to a great deal of uncertainty. Default data supplied with **Hazus** are described in Section 3.9. If you wish to reduce the uncertainty associated with your results, you can augment or replace the default information with improved data collected for your region of study. This chapter will guide you through a very simple analysis using only default data. For more detailed information about collecting and entering additional data, or modifying default parameters and data, see Chapters 4 through 8.

Before running a loss estimation analysis you must define a study region. *The Study Region*, in **Hazus** terminology, is the geographic unit for which data are aggregated, the earthquake hazard defined, and the analysis carried out. **Hazus** will prompt the user to create a new region or import a previously created region. You can also open, delete, duplicate, backup, or export an existing region.

3.1 Creating the Study Region

The study region can be any combination of states, counties, cities, census tracts, or census blocks. The study region you define will depend upon the purpose of the loss study. In many cases the region will follow political boundaries such as city or county limits. If you are performing a study for a particular city, then the region may include only the area within the city limits. On the other hand, if you are looking at an entire metropolitan area the region may consist of several counties. Defining the study region requires only that you be able to identify the census tracts that comprise the region.

However, it is important to note that **Hazus** will not include any site-specific inventory data that you have defined outside the region. In fact, if you include facilities that are located outside the defined study region, **Hazus** will automatically eliminate these facilities from the inventory databases. The region will always be defined by a census tract boundary, within which population, demographics, and general building stock values are aggregated. The user can only define a study area that intersects U.S. census tract boundaries by gridding the census tracts involved into smaller units.

The earthquake methodology is based upon using census tracts as the smallest geographic unit. Census tracts are divisions of land that are designed to contain 2,500 to 8,000 inhabitants with relatively homogeneous population characteristics, economic status and living conditions. For this reason the physical area within census tracts will vary depending on the density of the population. In densely populated regions census tracts can be a few city blocks, whereas in rural areas a census tract may be many square miles.

Census tract divisions and boundaries change only once every ten years. Census tract boundaries never cross county boundaries; hence census tracts can completely and uniquely define all the area within a county. This characteristic allows for a unique division of land from country to state to county to census tract. Note, however, that a census tract can cross city boundaries. A unique 11-digit number identifies census tracts. The first two digits represent the tract's state; the next three digits represent the tract's county, while the last six digits represent a number that identifies the tract within the county. For example, a census tract numbered 10050505800 would be located in Delaware (10) in Sussex County (050).

You have the flexibility to define any arbitrary study region by selecting a set of census tracts. The study region may overlap multiple states and counties and may contain only portions of counties or cities. You can define any number of study regions (limited only by disk space), and can switch between them at any time. The steps to defining the study region are to 1) name the study region, 2) select the state or states, 3) select counties, and 4) select census tracts. Users can also choose to define the aggregation area by developing a customized gridding method for use with the loss estimation model until a standardized method becomes available.

Figure 3.1 displays the first dialogue box that appears when **Hazus** is launched. Non-valid selections will appear disabled. In order to create a new study region the state inventory data must be available see the inventory data section of the installation instructions document for details. Select to **Create a new region** and click on the **OK** button.

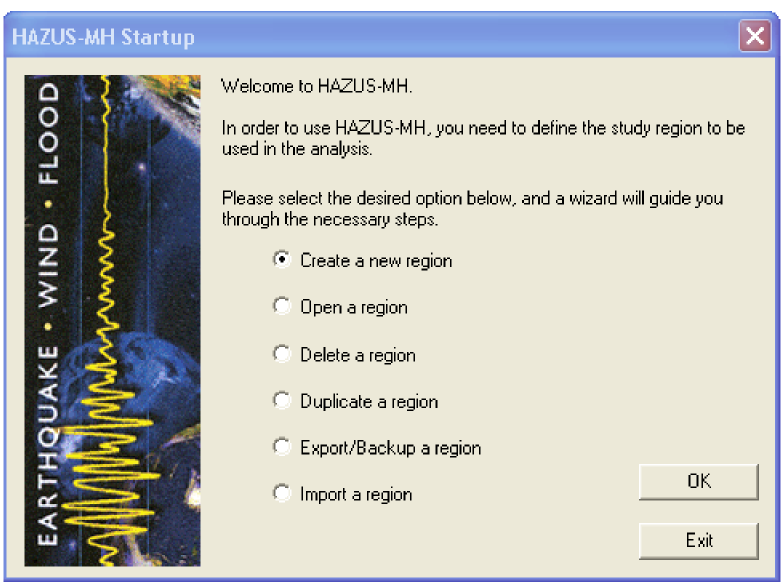


Figure 3.1 Hazus startup dialogue.

The wizard will present the following dialogue windows to guide you through the steps for creating a region. Figure 3.2 prompts the user for a region name and description.

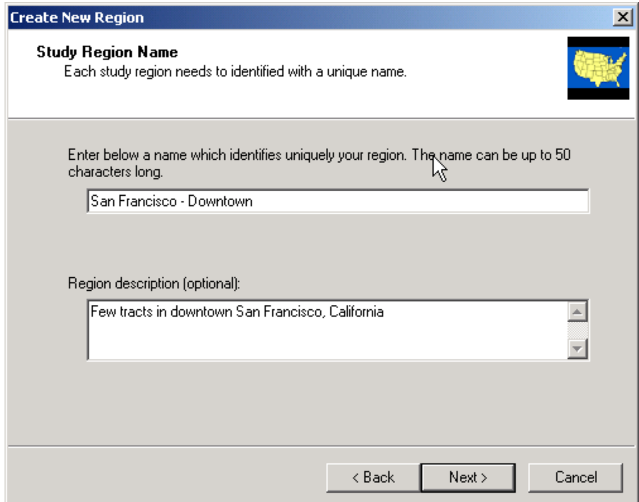


Figure 3.2 Name the new study region and enter a description.

Next, you will be asked to select one or more hazard types to analyze (see Figure 3.3). Only hazard modules that have been installed will be available for selection. The hazards selected here will be the ones that may be used for analysis of this particular study region. The user cannot add another hazard to this region after it has been created, but can create a similar study region with different hazards.

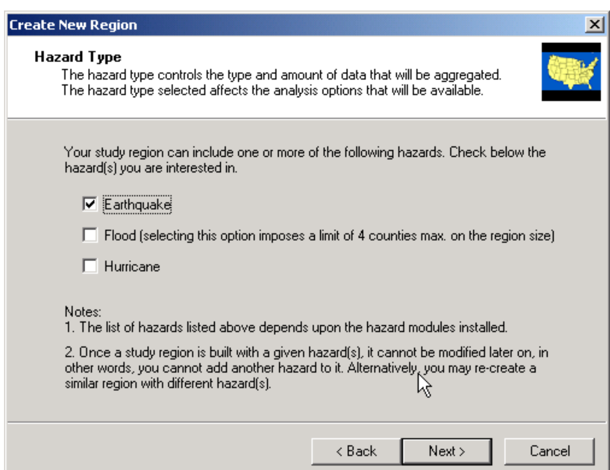


Figure 3.3 Hazard type for new study region analysis.

Select an aggregation level: state, county, or census tract. Census tract is the smallest allowable unit for analysis, and the level at which population and general building stock values will be aggregated for estimating losses (see Figure 3.4).

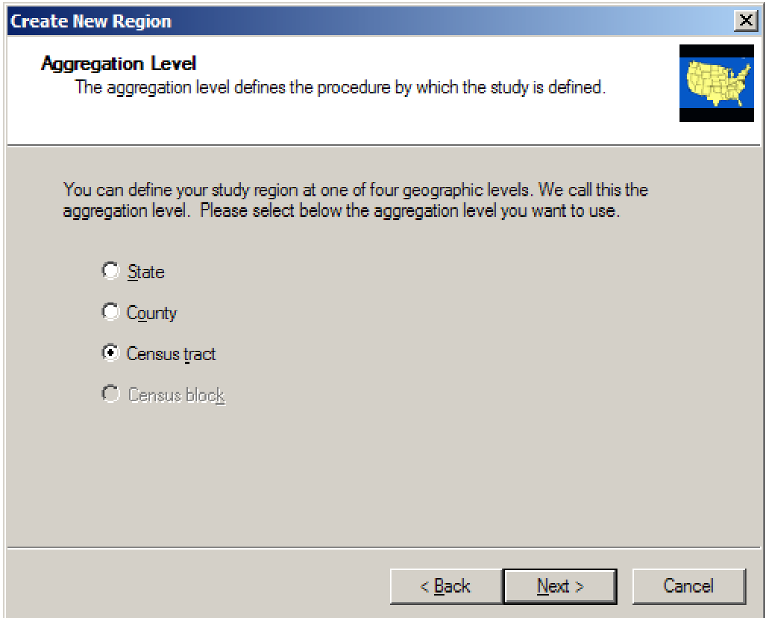


Figure 3.4 Aggregation level for analysis.

Select which states are included in the study region[1]. To select a state, click on the name of that state. To select multiple states, hold down the <**Ctrl**> key while you click on all of the states you wish to include. The user has selected California in the example shown in Figure 3.5 below. Alternatively you can click the **Map** button and choose the states from a map, as shown in Figure 3.6 below. To select multiple states, hold down the **Shift** key while clicking on the desired states. When finished, press **Selection Done** button.

[1] When clicking ‘Next’ from the ‘Aggregation Level’, HAZUS-MH will look for the boundary file to start the aggregation selection process. Insert the one of the six State Data DVDs’ to continue.

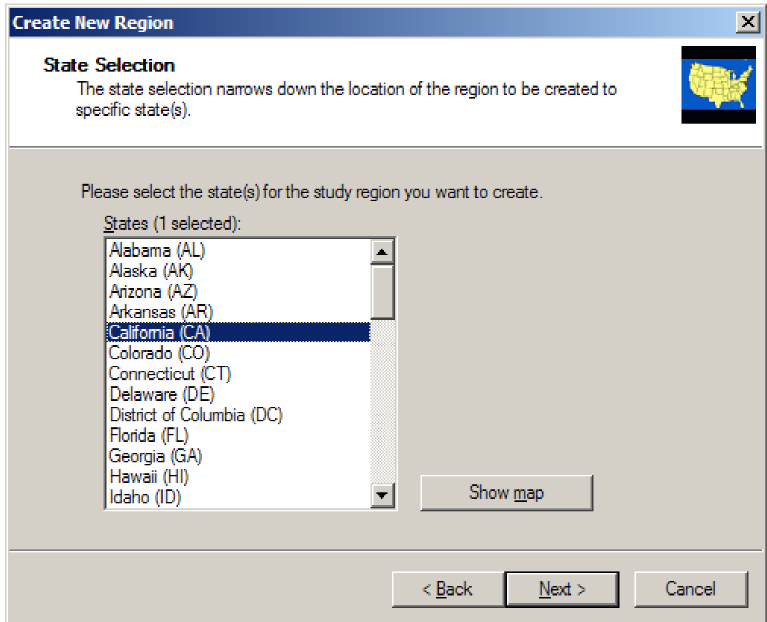


Figure 3.5 State selection from list.

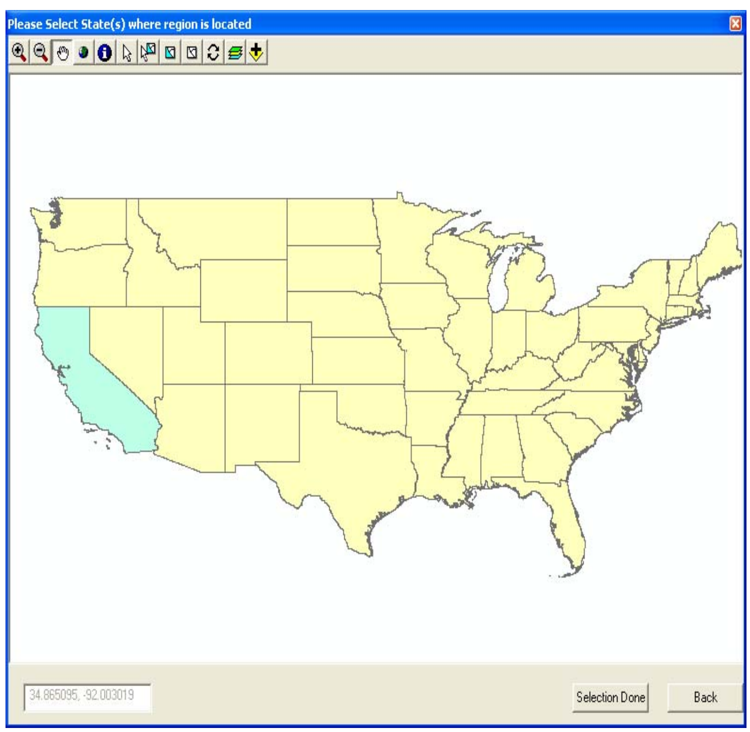


Figure 3.6 State Selection from map.

It is important to make sure that you have enough disk space before you start the aggregation as per the requirements given in **Error! Reference source not found.** in the previous chapter. When you have finished selecting the state(s), click on the **Next >** button.

Select the counties you wish to include in the study region by clicking on the names of those counties. Multiple counties can be selected by holding down the <**Ctrl**> key and clicking on the desired counties as shown in Figure 3.5. Alternatively you can click the **Map** button and choose the counties from a map of the state as shown in Figure 3.6. When finished, press **Selection Done** button.

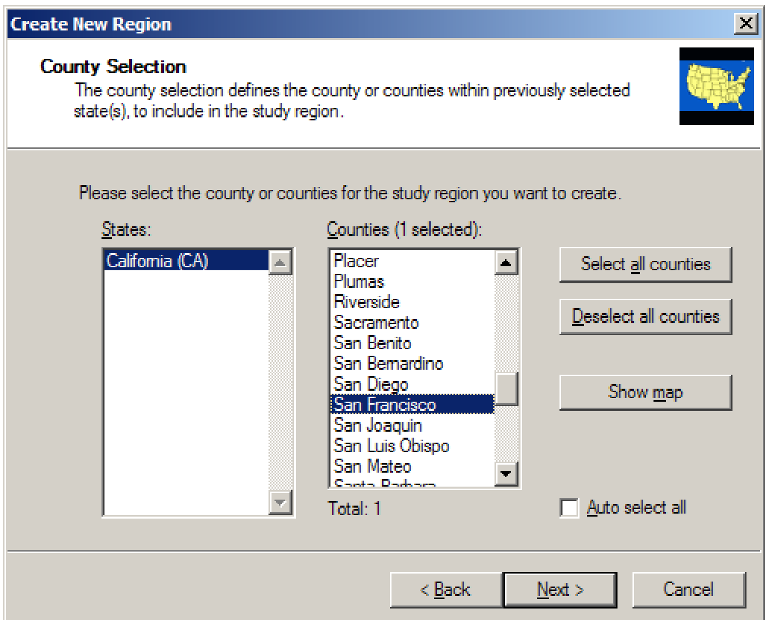


Figure 3.5 County selection from list.

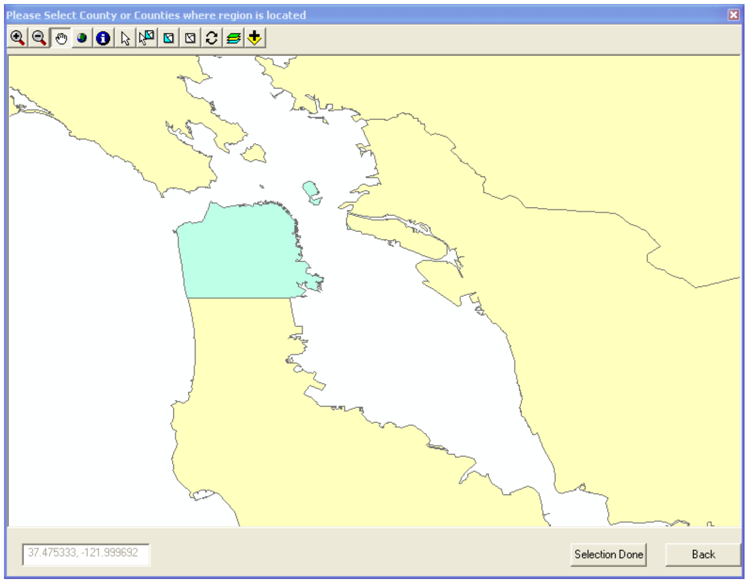


Figure 3.6 County selection from map.

Once you have selected the counties and clicked on the **Next>** button, you will be presented with a list all of the census tracts in the selected counties as shown in Figure 3.7. You can then select the census tracts that define the study region from the list, or from the map (see Figure 3.8). At any point in this process you can undo your selections by using the **<Back** button.

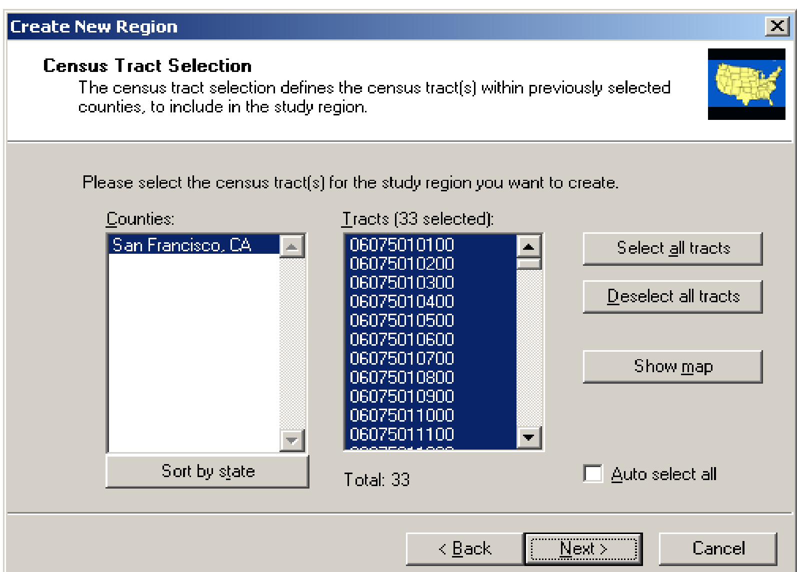


Figure 3.7 Census tracts selection from list

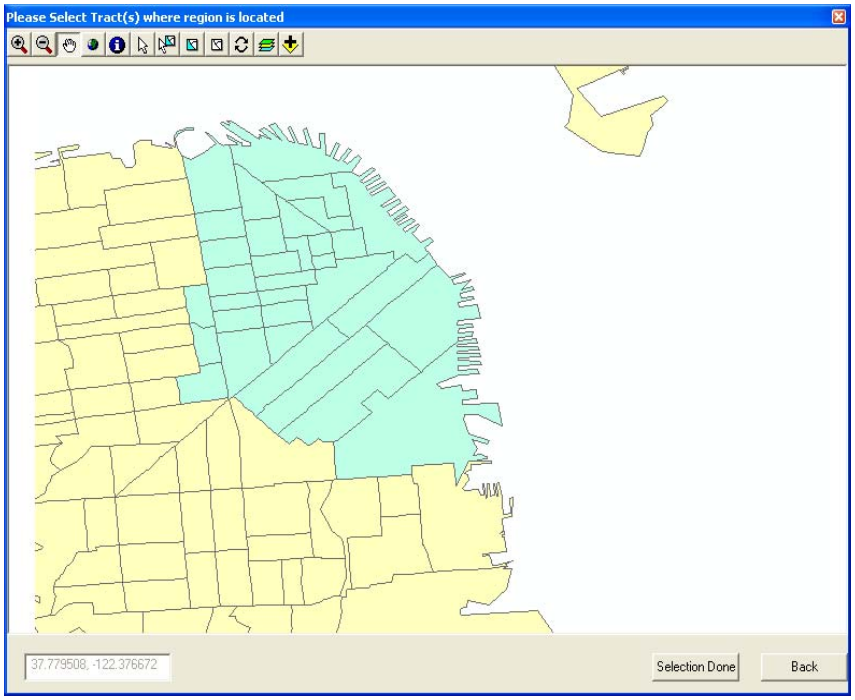


Figure 3.8 Census tracts selection from map.

The census tracts do not have to have continuous numbering, nor do they need to be contiguous. As with the other windows you may graphically select census tracts by using the **Map** button. The selection of census tracts directly from the map is helpful when choosing census tracts that are in the vicinity of a city yet not in a numerical sequence; or for the case when the location of a city is known while the census tract numbers around that city are not known.

When you have selected the census tracts, click on the **Finish** button. A processing status window will indicate the progress of aggregation. You will be prompted to copy the default inventory data for your state of interest per the installation instructions. The default inventories have greater uncertainties associated with them, but can be used for a baseline analysis. Replacement of the default data with improved inventories is discussed in Chapter 6. Move directly to Section 3.5 if you have successfully created your new study region.

3.2 Importing a Study Region

Study regions that have been previously created and exported may be imported. At the startup dialogue window, click in the radio button to select **Import a region** and press the **OK** button (see Figure 3.9).

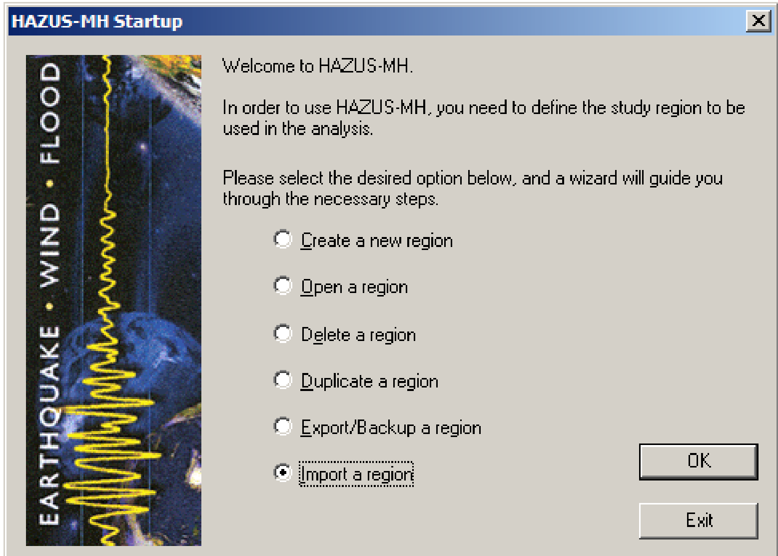


Figure 3.9 Import a study region.

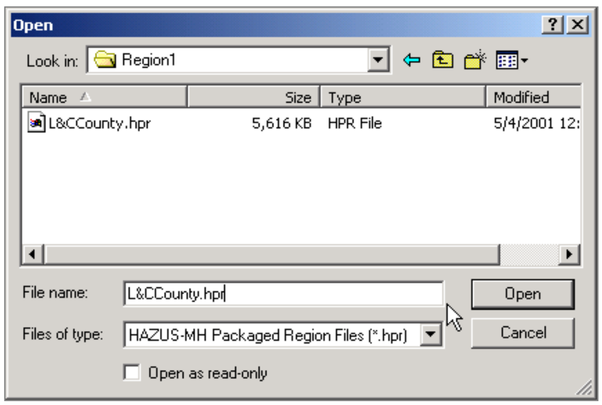


Figure 3.10 Select a previously created study region.

The default directory for region files will appear with any available files to import. The file suffix, ***.hpr** indicates the file has been packaged and exported. Make sure you are where the established region file exists, highlight the file, and select it to open the region from the list of available files (see Figure 3.10). Remember: **Hazus** uses a new data structure. Region files are no longer fully-independent folders with data and analysis results. You can only import those regions created with **Hazus**.

Region files may be chosen from the list in the dialogue window whenever opening, deleting, duplicating, exporting, or importing. In each case, file information will be shown for the unique regions: name, description, date created, date last accessed, applied hazard(s), region identifier, and validity status[2]. The particular function can only be applied to the regions listed.

3.3 Opening a Study Region

The startup **Hazus** dialogue window also includes the option to open an existing region. If a valid study region is available as in Figure 3.11, you can select it by the name and description it was given when the region was created.

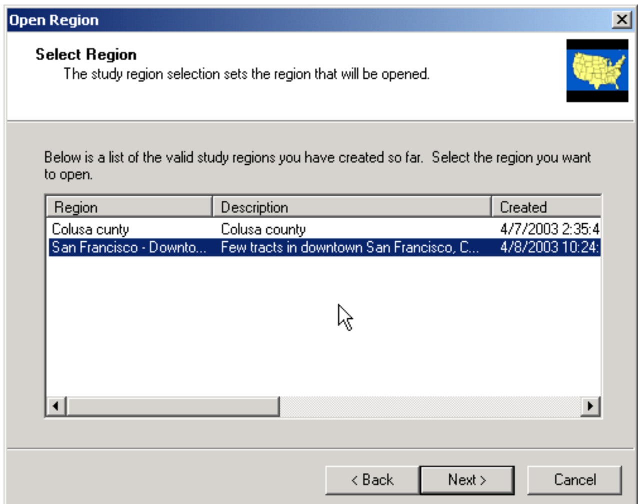


Figure 3.11 Open a study region.

Click 'Finish' at the 'Completing the Open Region Wizard' to open the selected region as shown in Figure 3.12.

[2] A valid region has a valid value of 1 (true). An invalid region has valid value of 0 (false). An invalid region is the result of an aggregation process that did not complete successfully.

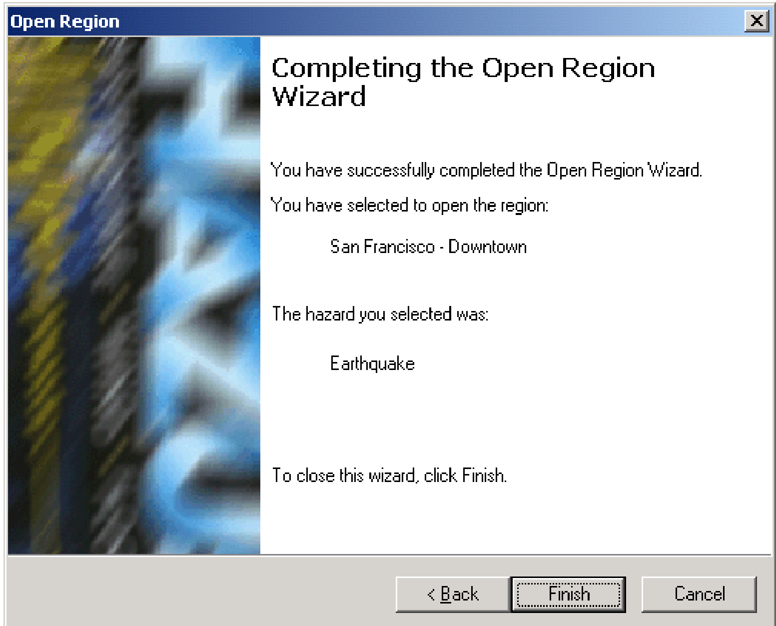


Figure 3.12 Completing the Open Region Wizard Dialog.

3.4 Deleting and Duplicating a Study Region

Regions can be deleted, duplicated, and backed up from the same Hazus startup menu. The user is given the choice to select among the valid regions. If no valid regions exist to be acted upon, the selection on the startup window will not be available. The user will be warned before a serious data loss might occur, as in Figure 3.13 .

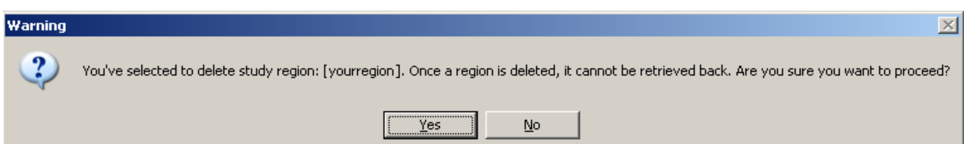


Figure 3.13 Deletion of a study region is permanent.

3.5 Interacting with the Study Region

When the study region is selected (either via Open a Region or Import a Region), an ArcMap interface will appear displaying the study region (see Figure 3.14).

The map displayed will have one or more layers, depending on the aggregation level chosen. For example, if an entire state equals the study region and the aggregation level is equal to census tract, two boundary layers will be listed for display in the Table of Contents (TOCs): one polygon representing the entire region, and one layer of all the census tracts within the study region. County boundaries (and other boundary layers) can be added by highlighting Layers in the TOC and right-clicking the mouse. Select the "+" sign to add more data layers.

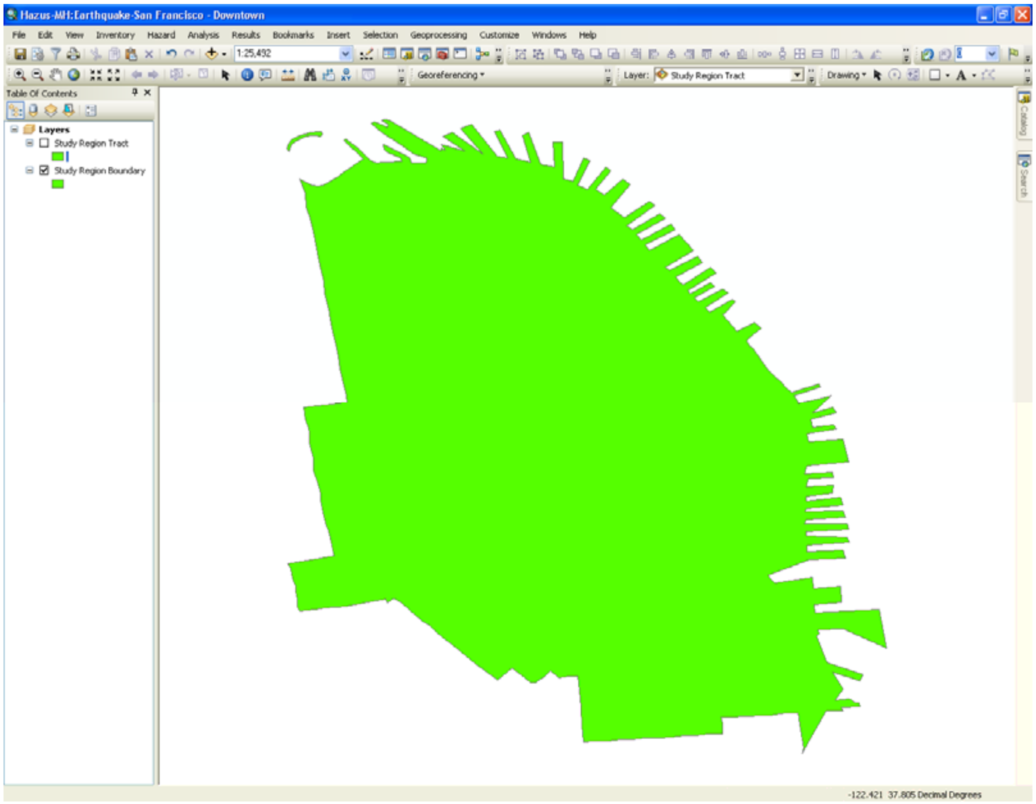


Figure 3.14 Map of a study region.

The software operator will see the four Hazus menus and two buttons added to the graphic interface. All ArcMap and ArcView functions are available, i.e. view properties of each data layer. The operator can edit the feature symbols to distinguish the data layers, as in Figure 3.14.

The remaining default inventory extracted from the DVD for the study region can be displayed. Select the Inventory menu to display the study region data including building stock, hospitals, transportation, utilities, and hazardous materials (see Figure 3.15).

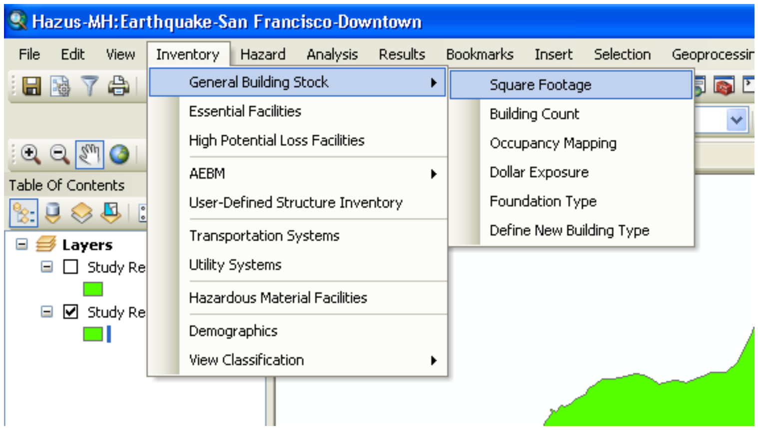
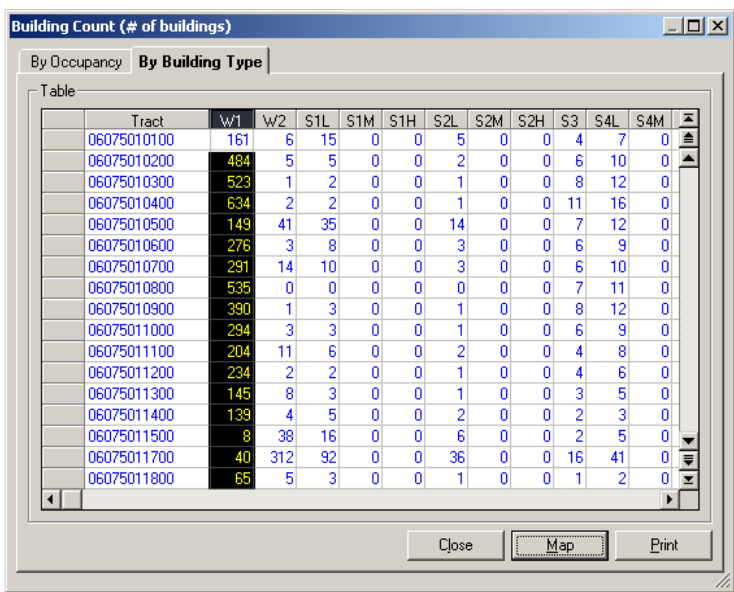


Figure 3.15 Hazus Inventory menu.

Inventories are viewable in tabular format, and in many cases can also be mapped. Figure 3.16 and Figure 3.17 show default data available for our sample study region (downtown San Francisco). The number of wood buildings are shown as aggregated by census tract (i.e. general building stock class), and highways and hospitals are overlaid.



Tract	W1	W2	S1L	S1M	S1H	S2L	S2M	S2H	S3	S4L	S4M
06075010100	161	6	15	0	0	5	0	0	4	7	0
06075010200	484	5	5	0	0	2	0	0	6	10	0
06075010300	523	1	2	0	0	1	0	0	8	12	0
06075010400	634	2	2	0	0	1	0	0	11	16	0
06075010500	149	41	35	0	0	14	0	0	7	12	0
06075010600	276	3	8	0	0	3	0	0	6	9	0
06075010700	291	14	10	0	0	3	0	0	6	10	0
06075010800	535	0	0	0	0	0	0	0	7	11	0
06075010900	390	1	3	0	0	1	0	0	8	12	0
06075011000	294	3	3	0	0	1	0	0	6	9	0
06075011100	204	11	6	0	0	2	0	0	4	8	0
06075011200	234	2	2	0	0	1	0	0	4	6	0
06075011300	145	8	3	0	0	1	0	0	3	5	0
06075011400	139	4	5	0	0	2	0	0	2	3	0
06075011500	8	38	16	0	0	6	0	0	2	5	0
06075011700	40	312	92	0	0	36	0	0	16	41	0
06075011800	65	5	3	0	0	1	0	0	1	2	0

Figure 3.16 Default building stock data inventory.

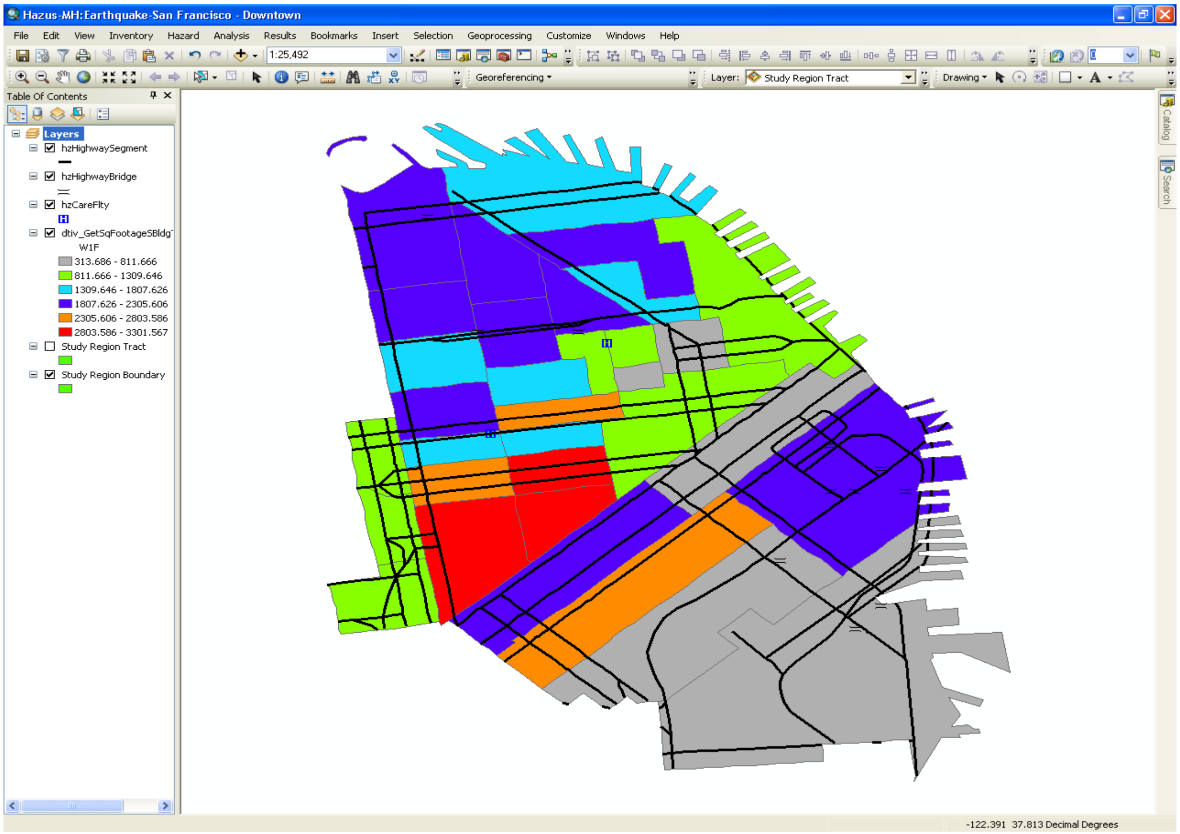


Figure 3.17 Default inventory data for study region.

3.6 Defining a Scenario Earthquake

Before an analysis can be run, you must quantify the potential earth science hazards (PESH) that will serve as a basis for evaluating damage and losses. For an earthquake loss analysis, this involves identifying the size and location of the earthquake and estimating its associated ground motions and ground deformations due to ground failure. For this methodology, ground deformations due to liquefaction, landslides, and surface fault rupture can be included.

While there are a number of options available for defining PESH (see Section 9.1), the only method described in this section is defining a scenario earthquake using the arbitrary event option.

Click on the **Hazard** menu as shown in Figure 3.18. Clicking on the **Scenario** option allows you to define the earthquake hazard using the window shown in Figure 3.19.

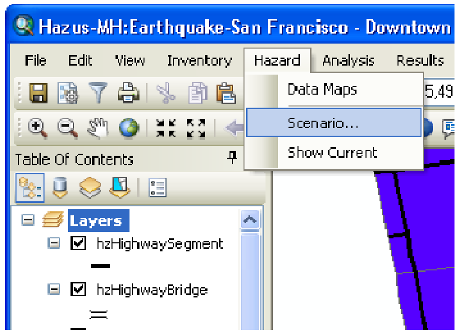


Figure 3.18 Hazard definition menu in Hazus.

The scenario definition wizard will appear for entering a new event. Select to define a new scenario, and press **Next** >.

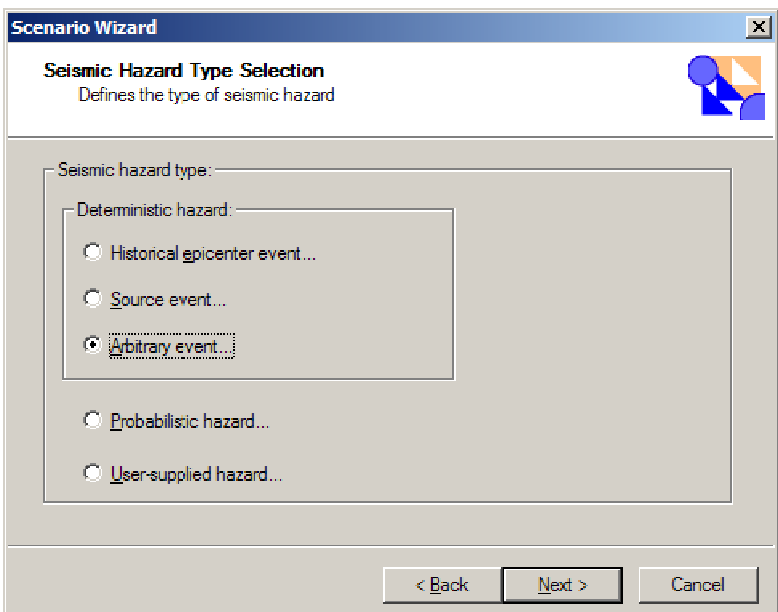


Figure 3.19 Earthquake Hazard Scenario window in Hazus.

For ground motion, click on **Arbitrary event…** and select to use the "Extensional West-US-N" attenuation function. Supply the parameters shown in the window in Figure 3.12. At a minimum, you need to supply the latitude and longitude of the event. Without any additional input from you, **Hazus** will default to a minimum of 5.0 moment magnitude (depending on the attenuation function chosen) with a corresponding surface and subsurface rupture length, a depth of 0 kilometers, a fault rupture orientation of 0 degrees and a strike-slip/normal fault type. Entering data in the appropriate places will change the default values. Accept the defaults on next dialog.

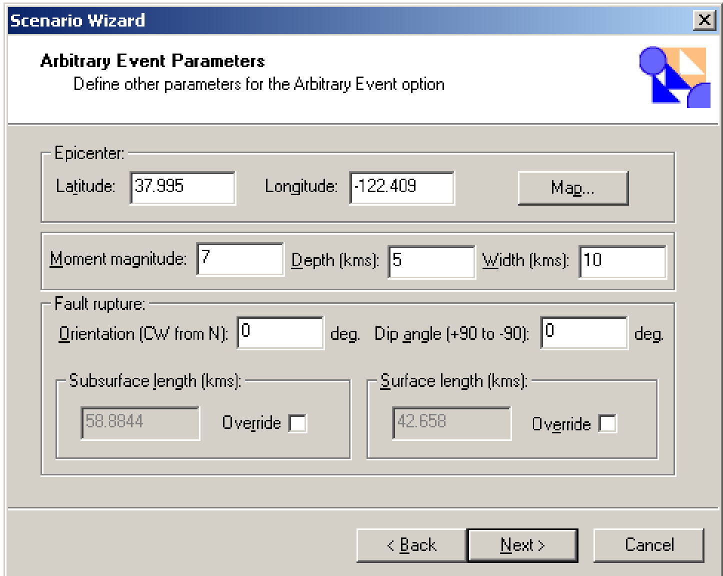


Figure 3.20 Defining an arbitrary earthquake event.

You can also select the latitude and longitude from a map of the region by clicking on the **Map** option. You will be prompted to select a point in the study region by clicking on the screen. Note: The point approximating the epicenter of an arbitrary event must be selected on the study region map without the advantage of additional reference features. Press **Selection Done** when finished; then **Next** > when you are returned to the Arbitrary Event Parameters window.

Name the earthquake event you have just defined with a descriptive title, i.e. "Aribitray M7.0". Press **Next** >, and you will see a summary of the scenario that you just defined (see example Figure 3.21). If the parameters listed are satisfactory, press the **Finish** button to close the scenario definition wizard.

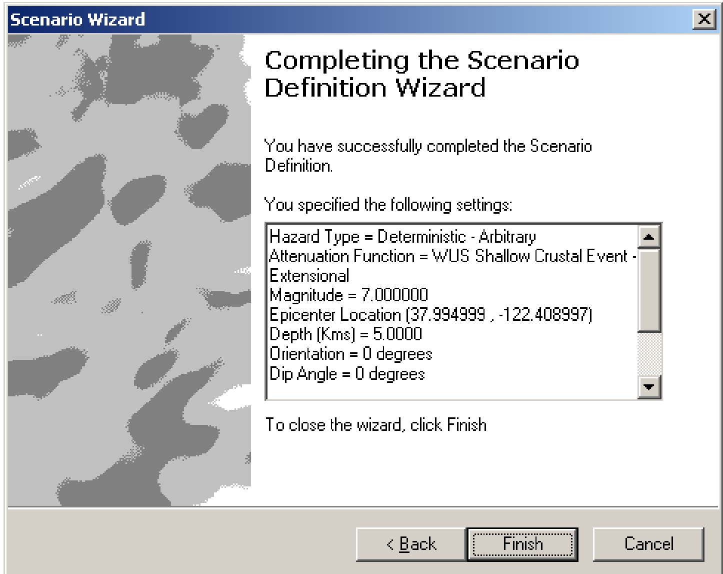


Figure 3.21 Scenario definition wizard and earthquake event parameters.

3.7 Running an Analysis Using Default Data

If you opt to run your analysis with default data and parameters, the only information you will need to supply **Hazus** is the definition of the study region and the size and location of the scenario earthquake. Defining the study region was discussed in Section 3.1, and definition of the scenario earthquake was outlined in Section 3.6. Once this information has been supplied the analysis can be run.

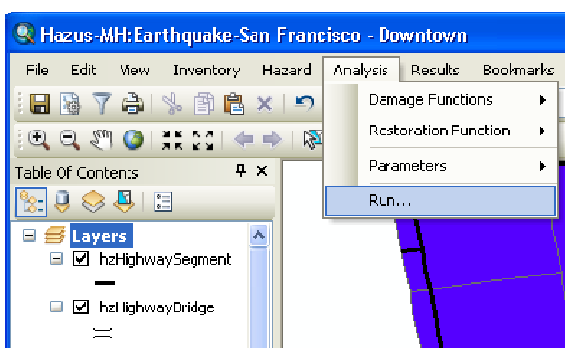


Figure 3.22 Hazus Analysis menu.

Select the **Analysis** menu on the main **Hazus** window to view the options. Damage functions, restoration functions, and parameters may be modified from this menu if the user has local information to improve the analysis. Otherwise, you can run an analysis using only default data and inventory, without modifying any parameters whatsoever.

Choose **Run...** and the window in Figure 3.23 will appear. This window provides a number of analysis options that can be selected by clicking in the associated box. Each option is composed of at least one analysis module; the number is posted near the bottom of the window when the option is selected.

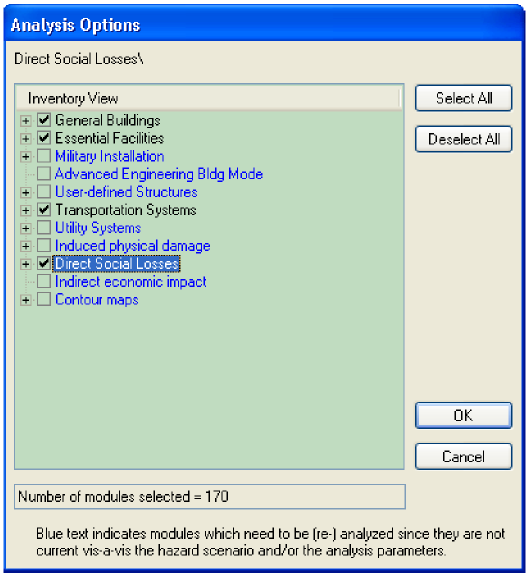


Figure 3.23 Analysis options.

All analysis options can be run at the same time, or each can be run separately. If a study region is large (a few hundred to more than a thousand census tracts), a complete analysis can take several hours. It is suggested that you run the analysis options one at a time while you are developing and modifying scenarios, inventories, and model parameters. This allows you to review intermediate results and check to determine if the results look reasonable, or serve your needs without waiting several hours to run a complete analysis. Once you are satisfied with inventories and model parameters, you may wish to perform additional analyses with all options running simultaneously.

If you wish to ask "what if" questions, individual options can be run repeatedly without performing a complete analysis. Once an option is run, all of the results from that option are saved until it is run again. For example, if a you want to know what would happen if costs of repairs were increased (keeping everything else the same), you would only have to run the **Direct social and economic loss** option again. **Hazus** will use damage results from the previous analysis to estimate economic losses.

All loss estimation analyses start with the calculation of potential earth science hazards. Results include outputs by census tract, and are viewable in tables and maps. You can view and use contours representing ground motion for display. If specified, you can include liquefaction, landslide and/or surface faulting in the analysis.

When ground motion is mapped by census tract, a constant level of ground motion is displayed for each census tract. Contour maps provide a more detailed mapping of the ground motion and thus take a longer time to generate. Contour maps are for display purposes only and are not used in calculating damage and losses. Users may opt to not generate contour maps if they wish to shorten analysis time.

The Analysis options window from the **Analysis|Run** menu (see Figure 3.24) allows you to specify exactly which damage and losses you want to estimate. For example, you can select to estimate direct physical damage to essential facilities by clicking on and highlighting those items as shown in Figure 3.24. You may specify **Debris** only from the **Induced Physical Damage** window, shown in Figure 3.25 and **Casualties** from the direct social and economic loss window shown in Figure 3.26. Once all of the desired options have been specified, click on the **OK** button to run the analysis.

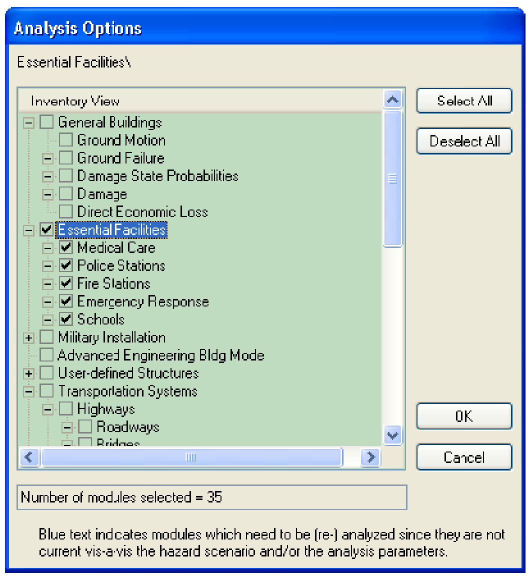


Figure 3.24 Direct physical damage analysis of essential facilities.

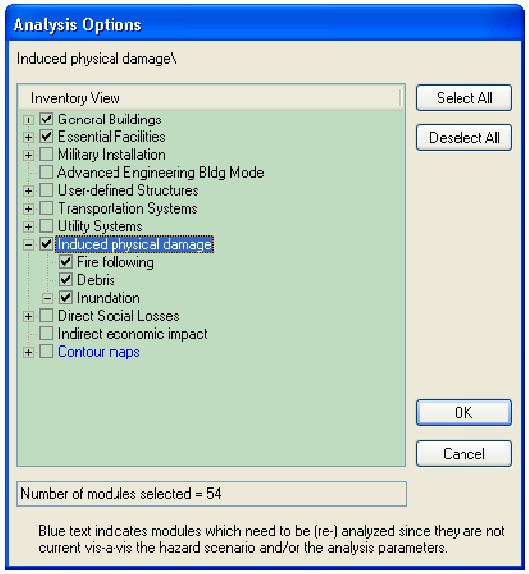


Figure 3.25 Induced physical damage analysis.

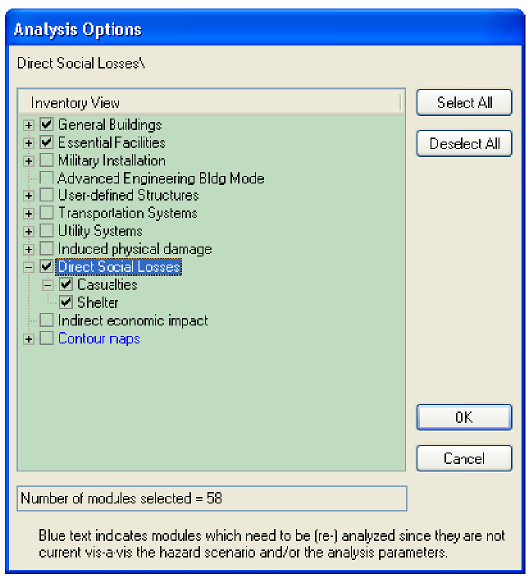


Figure 3.26 Direct social damage analysis.

3.8 Viewing Analysis Results

Each of the modules of **Hazus** provides the user with a series of outputs. The outputs can be in a tabular or graphical form. Some of the analysis modules yield intermediate results that are used as inputs to other modules. For example, the first calculations estimate the potential earth science hazards to determine ground motion at different locations for a specified earthquake scenario. This information by itself may not be very useful for hazard mitigation and emergency planning. However, these results are used as an input to determine the damage to structures in the Buildings analysis module.

Analysis results are accessed from the **Results** menu as shown in Figure 3.27.

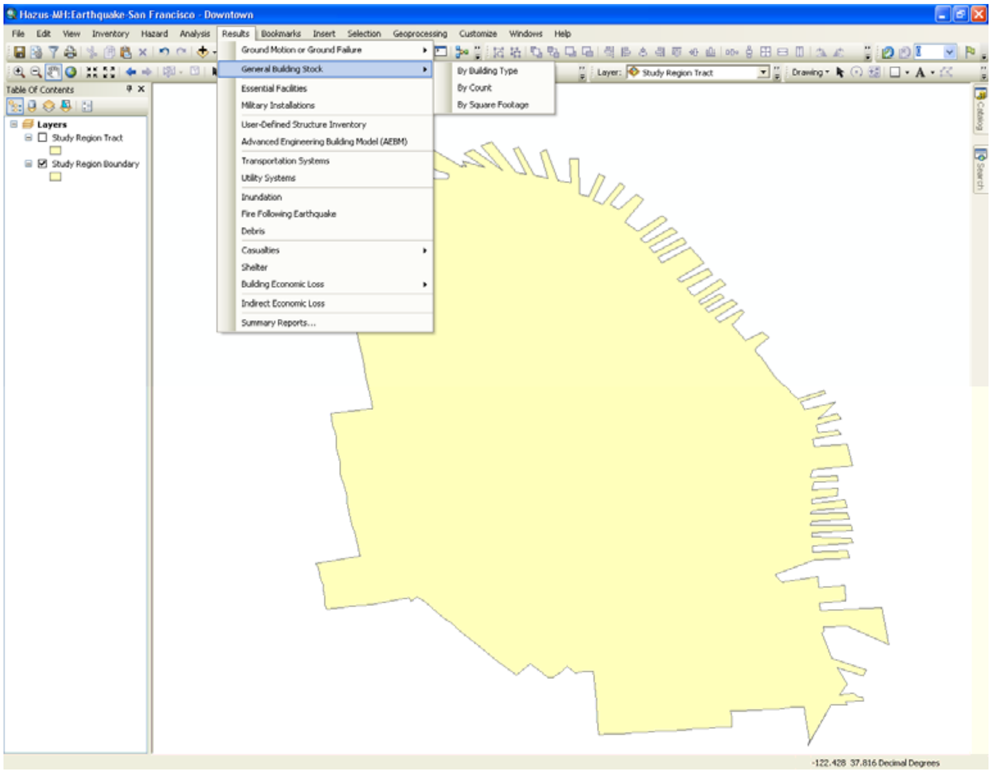


Figure 3.27 Hazus Results menu.

Three types of output are available:

- Thematic map of results (Figure 3.28 and Figure 3.29)
- Table of results by census tract (Figure 3.30)
- Results summarized by county and for the whole region (Figure 3.31)

Thematic maps use colors and symbols to display results. Results can be thematically mapped by using the **Map** button at the bottom of a table of results (see Figure 3.30). A variety of summary reports are also available using the **Results|Summary Reports** menu from the main menu bar. Displaying results is discussed in more detail in Chapter 10.

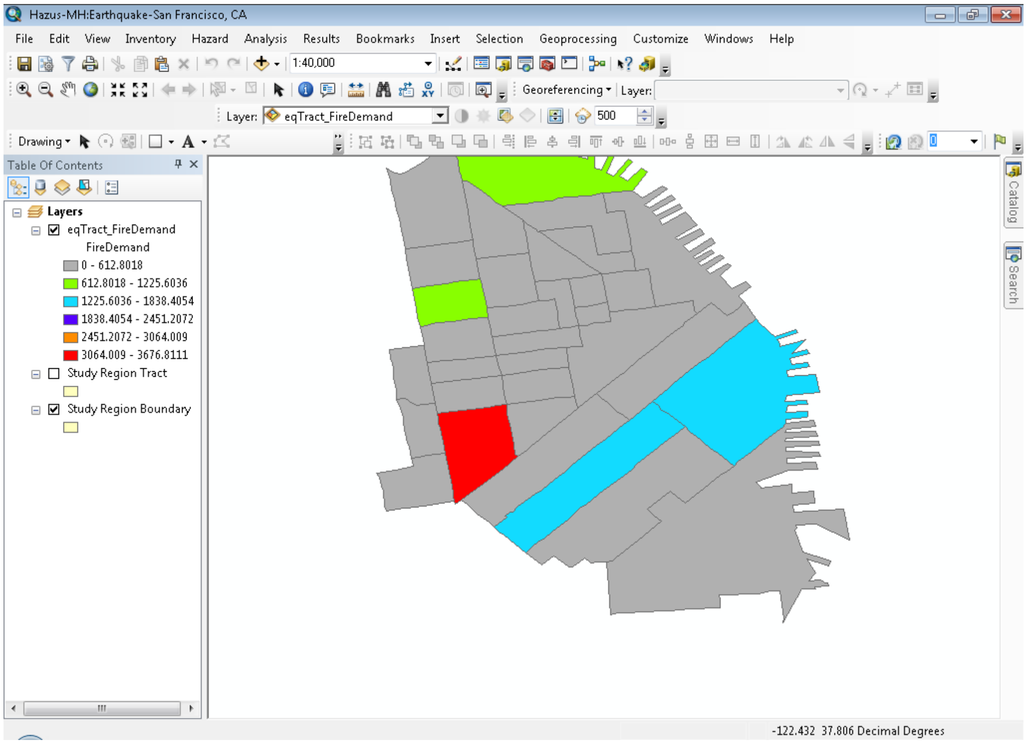


Figure 3.28 Sample thematic map: fire demand for each census tract burned.

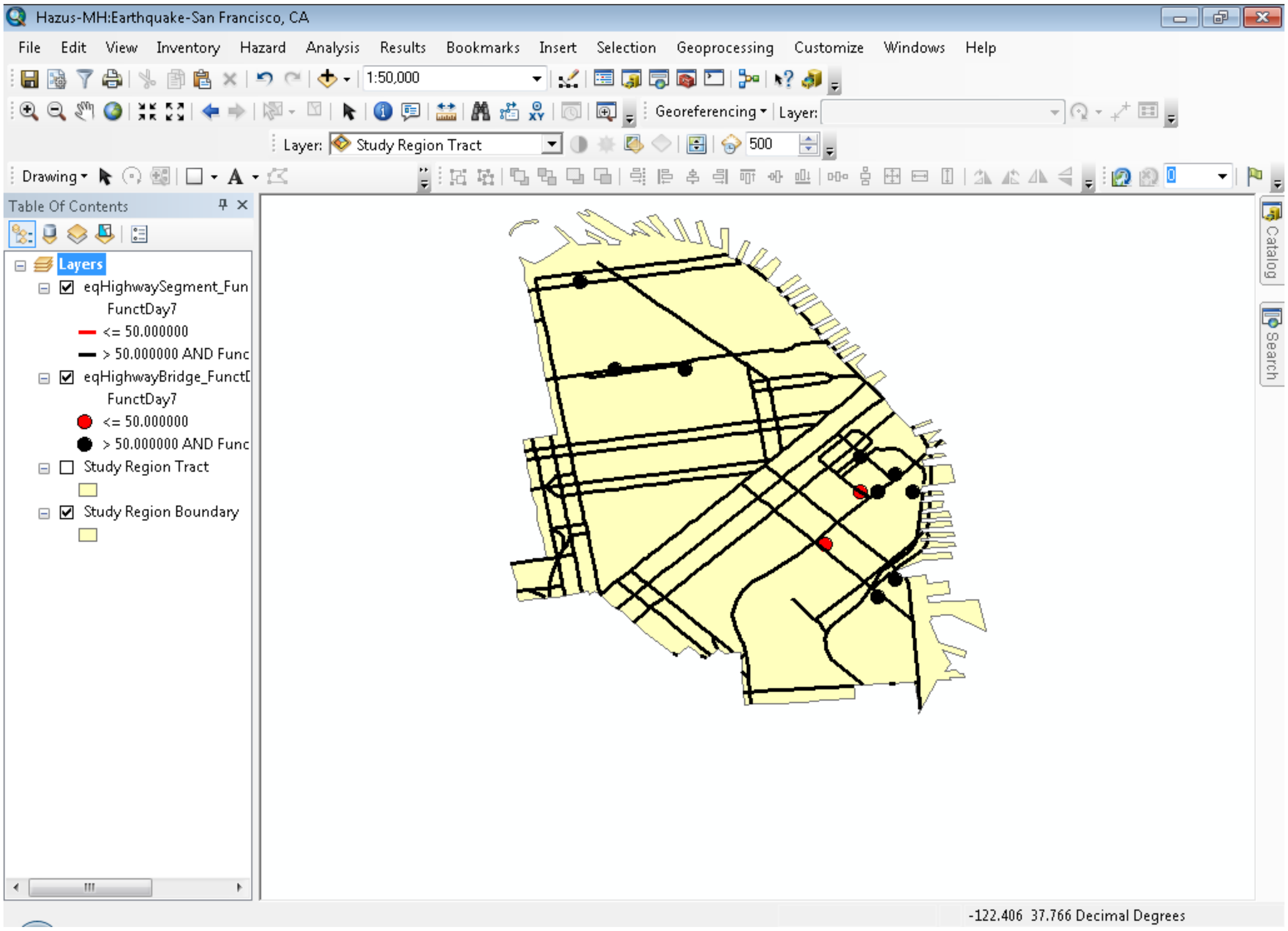
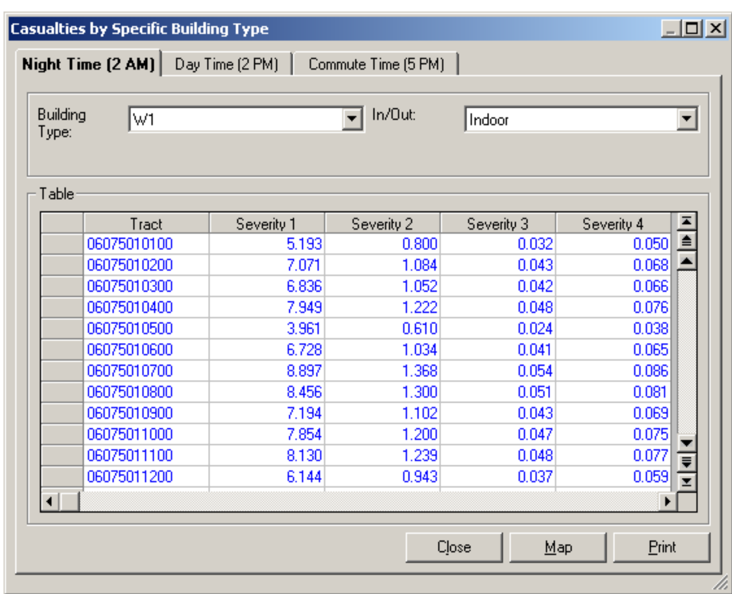


Figure 3.29 Sample thematic map: functionality of highway bridges at 7 days after the earthquake.



Tract	Severity 1	Severity 2	Severity 3	Severity 4
06075010100	5.193	0.800	0.032	0.050
06075010200	7.071	1.084	0.043	0.068
06075010300	6.836	1.052	0.042	0.066
06075010400	7.949	1.222	0.048	0.076
06075010500	3.961	0.610	0.024	0.038
06075010600	6.728	1.034	0.041	0.065
06075010700	8.897	1.368	0.054	0.086
06075010800	8.456	1.300	0.051	0.081
06075010900	7.194	1.102	0.043	0.069
06075011000	7.854	1.200	0.047	0.075
06075011100	8.130	1.239	0.048	0.077
06075011200	6.144	0.943	0.037	0.059

Figure 3.30 Sample table of results: residential casualties at 2 AM.

Building Damage % Distribution by Building Type for Low Design Level

March 16, 2011

	% Distribution by Damage State				
	None	Slight	Moderate	Extensive	Complete
California					
San Francisco					
Wood	100.00	0.00	0.00	0.00	0.00
Steel	100.00	0.00	0.00	0.00	0.00
Concrete	100.00	0.00	0.00	0.00	0.00
Precast	100.00	0.00	0.00	0.00	0.00
Reinforced Masonry	100.00	0.00	0.00	0.00	0.00
Unreinforced Masonry	100.00	0.00	0.00	0.00	0.00
Manufactured Home	100.00	0.00	0.00	0.00	0.00
County	**100.00**	**0.00**	**0.00**	**0.00**	**0.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region : San Francisco - Downtown
Scenario : Aribitray M7.0

Page : 1 of 1

Earthquake Hazard Report

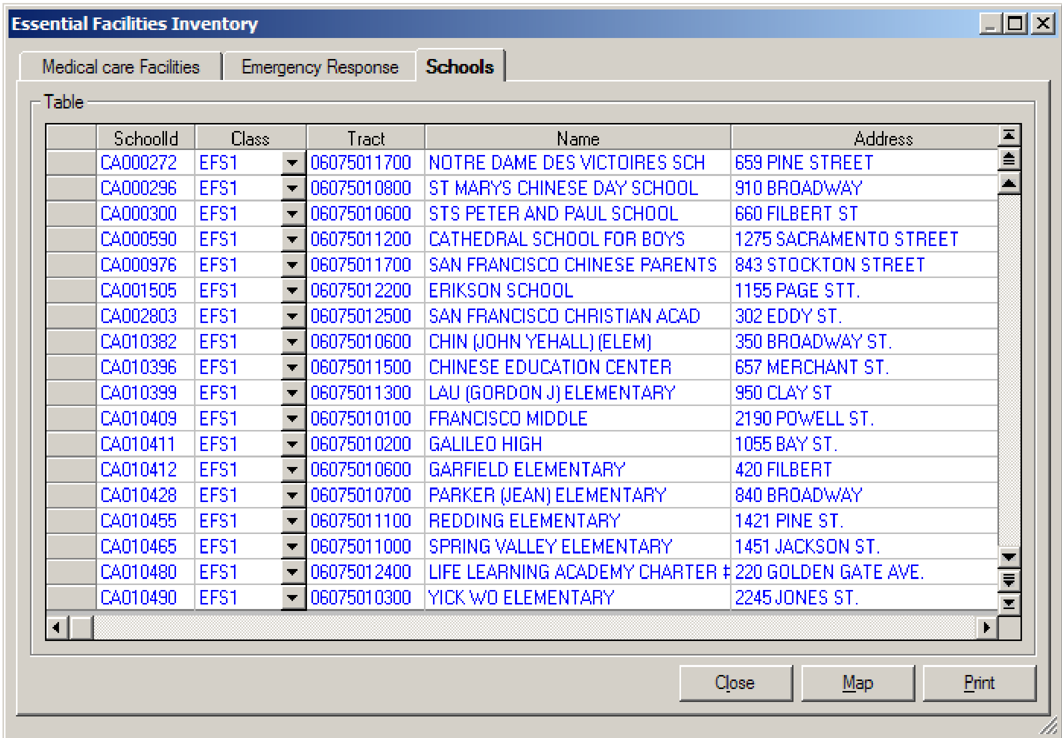
Figure 3.31 Sample summary report: building damage by building type.

3.9 Default Databases and Default Parameters

While most users will develop a local inventory that best reflects the characteristics of their region, such as building types and demographics, **Hazus** is capable of producing crude estimates of losses based on a minimum of local input. Of course, the quality and uncertainty of the results will be affected by the detail and accuracy of the inventory and the economic and demographic data provided. The crude estimates would most likely be used only as initial estimates to determine where more detailed analyses would be warranted. This section describes the types of data that are supplied as defaults with **Hazus**.

3.9.1 Default Databases

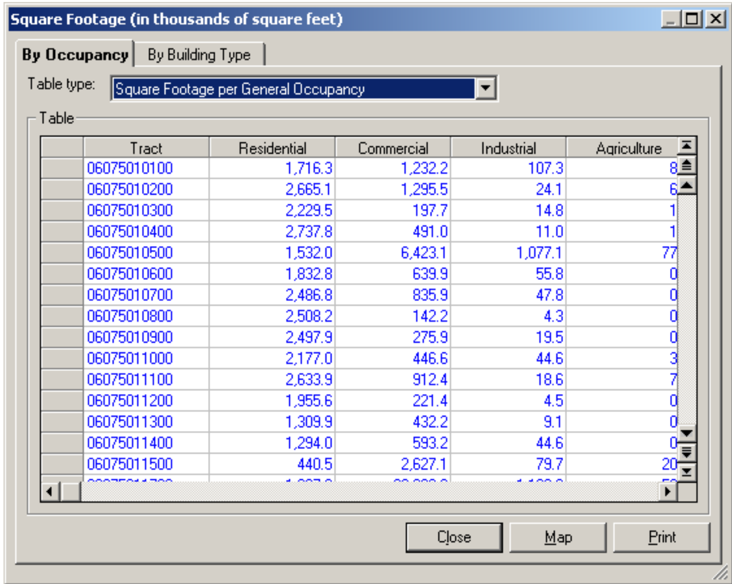
Default inventory databases provided with **Hazus** are of two types. The first type is a national listing of individual facilities, such as dams, bridges, or locations where toxic materials are stored (see Figure 3.32). These databases are modified versions of publicly available databases. The modifications that have been made have been to eliminate data elements that are not needed for the earthquake loss estimation methodology.



SchoolId	Class	Tract	Name	Address
CA000272	EFS1	06075011700	NOTRE DAME DES VICTOIRES SCH	659 PINE STREET
CA000296	EFS1	06075010800	ST MARYS CHINESE DAY SCHOOL	910 BROADWAY
CA000300	EFS1	06075010600	STS PETER AND PAUL SCHOOL	660 FILBERT ST
CA000590	EFS1	06075011200	CATHEDRAL SCHOOL FOR BOYS	1275 SACRAMENTO STREET
CA000976	EFS1	06075011700	SAN FRANCISCO CHINESE PARENTS	843 STOCKTON STREET
CA001505	EFS1	06075012200	ERIKSON SCHOOL	1155 PAGE STT.
CA002803	EFS1	06075012500	SAN FRANCISCO CHRISTIAN ACAD	302 EDDY ST.
CA010382	EFS1	06075010600	CHIN (JOHN YEHALL) (ELEM)	350 BROADWAY ST.
CA010396	EFS1	06075011500	CHINESE EDUCATION CENTER	657 MERCHANT ST.
CA010399	EFS1	06075011300	LAU (GORDON J) ELEMENTARY	950 CLAY ST
CA010409	EFS1	06075010100	FRANCISCO MIDDLE	2190 POWELL ST.
CA010411	EFS1	06075010200	GALILEO HIGH	1055 BAY ST.
CA010412	EFS1	06075010600	GARFIELD ELEMENTARY	420 FILBERT
CA010428	EFS1	06075010700	PARKER (JEAN) ELEMENTARY	840 BROADWAY
CA010455	EFS1	06075011100	REDDING ELEMENTARY	1421 PINE ST.
CA010465	EFS1	06075011000	SPRING VALLEY ELEMENTARY	1451 JACKSON ST.
CA010480	EFS1	06075012400	LIFE LEARNING ACADEMY CHARTER	220 GOLDEN GATE AVE.
CA010490	EFS1	06075010300	YICK WO ELEMENTARY	2245 JONES ST.

Figure 3.32 Default inventories: Modified public databases (schools)

The second type of default database consists of data aggregated on a county or census tract scale. Examples are building stock square footage for each census tract and census demographic data (see Figure 3.33). These default databases are also derived from publicly available data, eliminating fields of data that are not needed for the methodology.



	Tract	Residential	Commercial	Industrial	Agriculture
	06075010100	1,716.3	1,232.2	107.3	8
	06075010200	2,665.1	1,295.5	24.1	6
	06075010300	2,229.5	197.7	14.8	1
	06075010400	2,737.8	491.0	11.0	1
	06075010500	1,532.0	6,423.1	1,077.1	77
	06075010600	1,832.8	639.9	55.8	0
	06075010700	2,486.8	835.9	47.8	0
	06075010800	2,508.2	142.2	4.3	0
	06075010900	2,497.9	275.9	19.5	0
	06075011000	2,177.0	446.6	44.6	3
	06075011100	2,633.9	912.4	18.6	7
	06075011200	1,955.6	221.4	4.5	0
	06075011300	1,309.9	432.2	9.1	0
	06075011400	1,294.0	593.2	44.6	0
	06075011500	440.5	2,627.1	79.7	20

Figure 3.33 Default inventories: Aggregated building data.

The databases are stored on the **Hazus** State Data DVDs. When you aggregate a region, **Hazus** extracts only those portions of the databases that are relevant to your study region. You can then access these region-specific default databases and update them with improved information that you have obtained. Displaying and modifying inventories is discussed in Chapter 7.

Appendix D enumerates all the default databases included with the earthquake module of **Hazus**. Following is a list of default inventory information currently supplied with **Hazus**:

- Demographic Data
- Population Distribution
- Age, Ethnic, and Income Distribution
- General Building Stock
- Square Footage of Occupancy Classes for Each Census Tract
- Essential Facilities
- Medical Care Facilities
- Emergency Response Facilities (fire stations, police stations, EOCs)
- Schools
- High Potential Loss Facilities
- Dams
- Nuclear Power Plants
- Military Installations
- Facilities Containing Hazardous Materials
- Transportation Lifelines
- Highway Segments, Bridges and Tunnels
- Railroad Tracks, Bridges, Tunnels and Facilities
- Light Rail Tracks, Bridges, Tunnels and Facilities
- Bus Facilities
- Port Facilities
- Ferry Facilities
- Airports Facilities and Runways
- Utility Lifelines
- Potable Water Facilities, Pipelines and Distribution Lines
- Waste Water Facilities, Pipelines and Distribution Lines
- Oil Facilities and Pipelines
- Natural Gas Facilities, Pipelines and Distribution Lines
- Electric Power Facilities and Distribution Lines
- Communication Facilities and Distribution Lines

3.9.2 Default Parameters

In addition to default databases, the user is supplied with default parameters documented throughout the Technical Manual. Access the **Hazus** parameters from the **Analysis|Parameters** menu, shown in Figure 3.34. In many cases these parameters are defined on a national basis without adjustments for regional variations. In other cases such as with repair costs, regional variations are included.

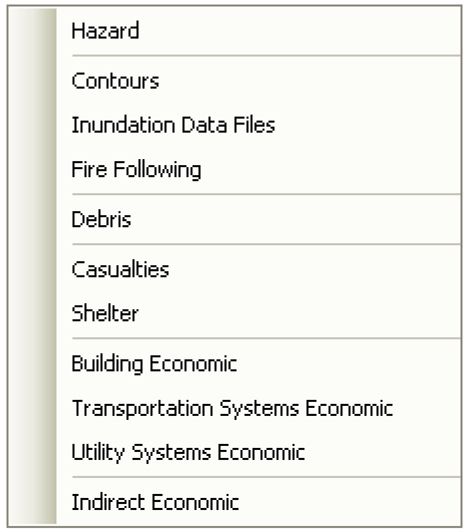


Figure 3.34 Analysis Parameters menu.

Examples of default parameters are costs per square foot to repair a structure, percent of residences that are owner occupied, and casualty rates for specific building types experiencing different damage states. Default relationships between occupancy classes and building types are provided to infer building inventory characteristics. Fragility curves (used for estimating damage) with default means and variances are supplied for each model building type. The user can modify all of these parameters if better information is available (inferred in Figure 3.35). Modifying default parameters is discussed in Chapters 4 through 8.

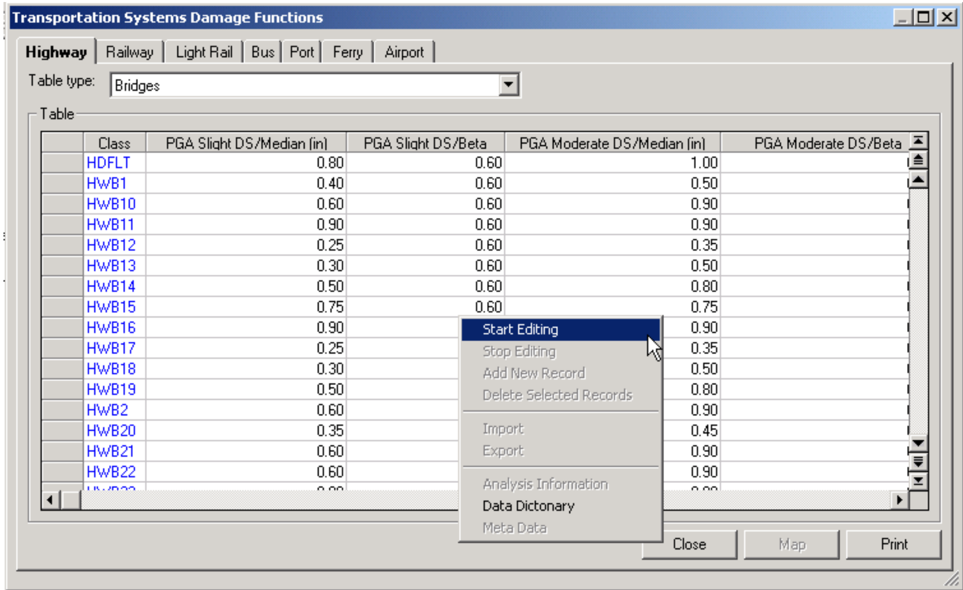


Figure 3.35. Damage function parameter values can be edited.

Chapter 4. Data Needed for More Complete Loss Estimation Study

Figure 4.1 shows the steps that are typically performed in assessing and mitigating the impacts of a natural hazard such as an earthquake, hurricane or flood. In order to estimate regional losses resulting from a natural disaster, you need to have an understanding of both the size of the potential event (hazard identification) and the characteristics of the population and the environment that will be impacted (inventory collection). For example, a flood that occurs near a densely populated region will cause different types of losses than one that occurs in a mostly agricultural region. Similarly, the economic impacts of an earthquake in a highly industrialized region will be different from those in a region that predominantly supports a service economy. Thus, to reliably model the losses in your region, you will need to collect a wide variety of data so as to be able to characterize the buildings and lifelines, the population, and the structure of the local economy.

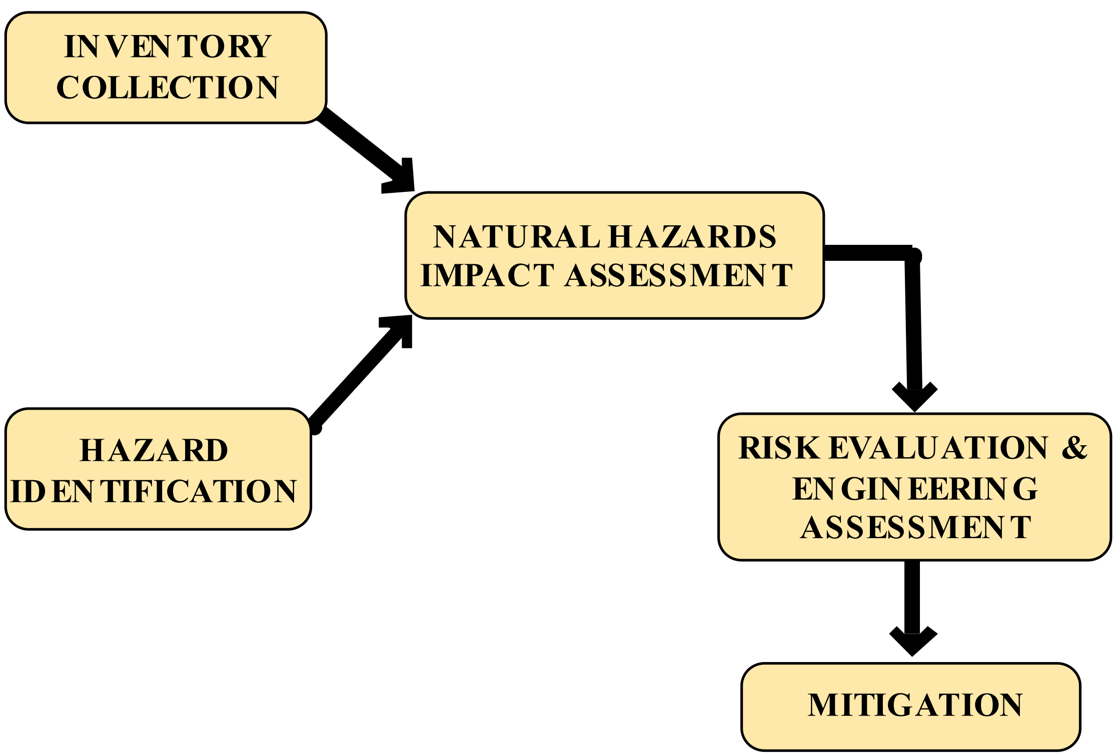


Figure 4.1 Steps in assessing and mitigating losses dues to natural hazards.

4.1 Developing a Regional Inventory

In developing a regional inventory, it is almost impossible from a cost point of view to identify and inventory each man-made structure individually. Some important structures such as hospitals, schools, emergency operation centers, fire stations, important bridges, and electrical power substations may be identified individually, but the majority of buildings in a region are grouped together collectively and identified by their total value or square footage.

To permit modeling of spatial variation in types and occupancies of buildings, a region is built up from sub-regions, and the inventory is collected for each sub-region. In the earthquake loss estimation methodology, **census tracts** are used as the basic sub-region unit, and all regions are built up by aggregating census tracts. Thus for each census tract, your inventory might consist of the number of square feet of wood frame buildings, the number of square feet of unreinforced masonry buildings and so on for each building type.

Figure 4.2 shows the inventory of single-family residential construction in a region, expressed as building count by occupancy type. Note that the number of single-family residential buildings is stored and displayed for each census tract in the region. Likewise, the total value of residential units in each census tract can be estimated, as in Figure 4.3, and used as a general guide to residential risk exposure (in dollars) in each area.

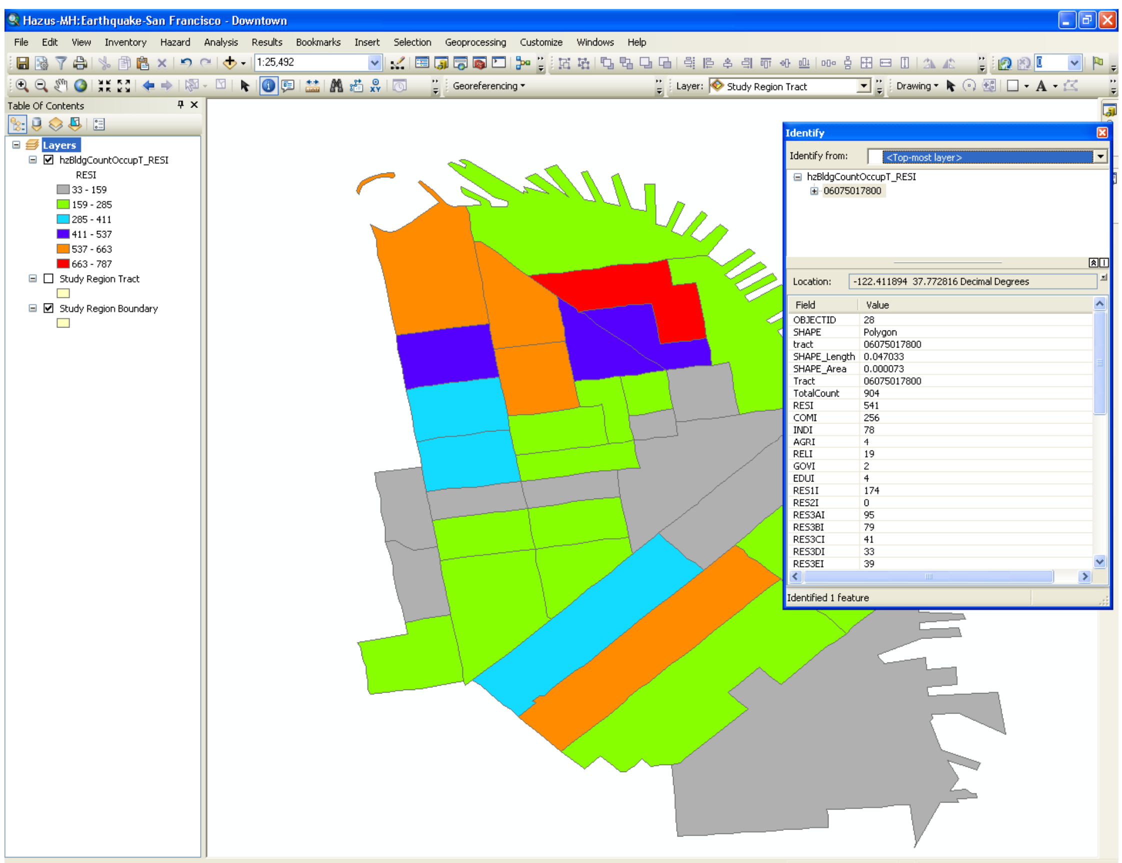


Figure 4.2 Residential occupancy by census tract.

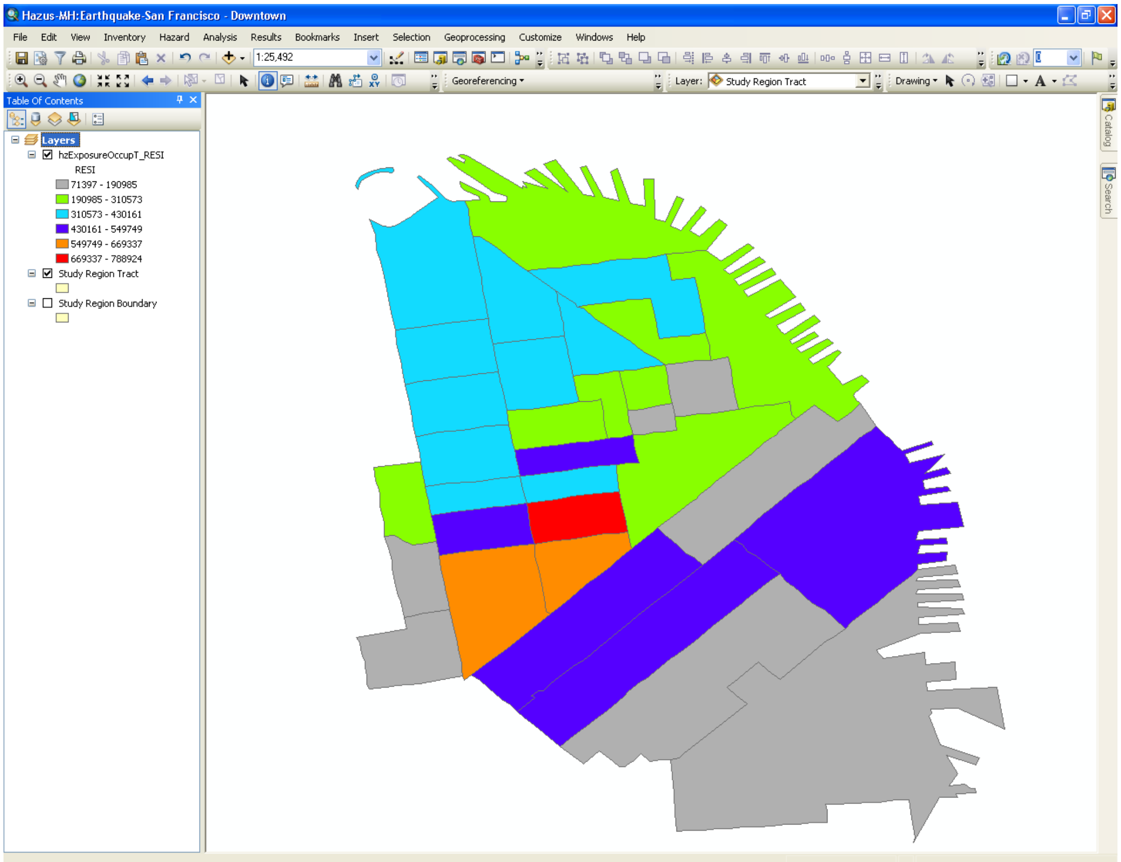


Figure 4.3 Value of single-family residential homes (RES1) by census tract.

In the methodology, the residential, commercial and industrial buildings that are not identified individually (user-defined structures, i.e. historic buildings) are called **general building stock**. General building stock is inventoried by calculating, for each census tract, the total square footage of groups of buildings with specific characteristics (i.e., calculating the total square footage of low-rise unreinforced masonry structures).

Collecting even this “simplified” inventory can be problematic. There are rarely reliable and complete databases that provide the necessary information such as building size, building occupancy, building height and structural system that could be used to obtain total values for each census tract. Therefore, inferences are made about large groups of buildings based on land use patterns, census information, business patterns, assessors’ files, insurance files, etc. Inferences can take the form, “if this is a residential area, 50% of the buildings are single family wood structures and 50% are multi-family wood structures”.

While there are inaccuracies in the inventory of general building stock due to inferences that are made, the error tends to be random and can be accounted for in the probabilistic aspects of the methodology. Similar types of inferences are made with respect to lifeline systems (e.g., the number of miles of water supply pipe in a census tract may be inferred from the number of miles of streets).

In contrast to the inventory of general building stock which is maintained in terms of total value per census tract, facilities that have some special significance such as essential facilities or components of lifeline systems (ex. Communication centers) can be maintained in the database by individual location. Correspondingly, losses for essential facilities and some lifeline components are computed for individual facilities, while losses for general building stock are calculated by census tract.

While some inferences can be used for site-specific facilities when data are unavailable, often you will have better access to databases about these facilities than you will for general building stock. Sometimes there will be few enough of these facilities that you can actually go to the site and collect the required inventory information. Sources of inventory information and how to go about collecting it are discussed in Chapter 5.

4.2 Standardizing and Classifying Data

There are two issues that must be considered in the development of an inventory: classification of data, and collection and handling of data. Classification systems are essential to ensuring a uniform interpretation of data and results. As discussed earlier, it is almost impossible, from a cost point of view, to identify and individually inventory each building or component of each lifeline. Thus losses in a regional study are estimated based on general characteristics of buildings or lifeline components, and classification systems are a tool to group together structures or lifeline components that would be expected to behave similarly in a seismic event. For each of the types of data that must be collected to perform a loss study, a classification system has been defined in this methodology.

4.2.1 Building Classification – Model Building Types

The building classification system used in this methodology has been developed to provide an ability to differentiate between buildings with substantially different damage and loss characteristics. In general, buildings behave differently due to the types of structural systems they have (i.e. wood versus steel), the codes to which they were designed, their heights, their shapes or footprints, and local construction practices.

As a consequence of the variations in design, shape, height etc., no two buildings will behave exactly the same when subjected to an earthquake. Therefore, **model building types** are defined to represent the average characteristics of buildings in a class. Within any given building class there will be a great deal of variation. The damage and loss prediction models in this methodology are developed for model building types and the estimated performance is based upon the “average characteristics” of the total population of buildings within each class.

Table 4.1 provides a summary of the 36 model building types that have been defined in the methodology. Each model building type is defined by a short description of the related structural system. These short descriptions can be found in Appendix B. It can be seen in the table in Appendix B that there are 16 general model building types (shown in bold) with some building types being subdivided by height. In addition, the seismic design level, which reflects the relationship between design quality and extent of damage, can be used to further classify each model building type. Four design levels are defined in the methodology: High-Code, Moderate-Code, Low-Code and Pre-Code. For a detailed discussion of how the classification system was developed and the characteristics that were used to differentiate classes, see Chapters 3 and 5 of the Technical Manual.

Table 4.1 Structural building classifications (Model Building Types)

No.	Label	Description	Height			
			Range		Typical	
			Name	Stories	Stories	Feet
1	W1	Wood, Light Frame (≤ 5,000 sq. ft.)		1 - 2	1	14
2	W2	Wood, Commercial and Industrial (> 5,000 sq. ft.)		All	2	24
3	S1L	Steel Moment Frame	Low-Rise	1 - 3	2	24
4	S1M		Mid-Rise	4 - 7	5	60
5	S1H		High-Rise	8+	13	156
6	S2L	Steel Braced Frame	Low-Rise	1 - 3	2	24
7	S2M		Mid-Rise	4 - 7	5	60
8	S2H		High-Rise	8+	13	156
9	S3	Steel Light Frame		All	1	15
10	S4L	Steel Frame with Cast-in-Place Concrete Shear Walls	Low-Rise	1 - 3	2	24
11	S4M		Mid-Rise	4 - 7	5	60
12	S4H		High-Rise	8+	13	156
13	S5L	Steel Frame with Unreinforced Masonry Infill Walls	Low-Rise	1 - 3	2	24
14	S5M		Mid-Rise	4 - 7	5	60
15	S5H		High-Rise	8+	13	156
16	C1L	Concrete Moment Frame	Low-Rise	1 - 3	2	20
17	C1M		Mid-Rise	4 - 7	5	50
18	C1H		High-Rise	8+	12	120
19	C2L	Concrete Shear Walls	Low-Rise	1 - 3	2	20
20	C2M		Mid-Rise	4 - 7	5	50
21	C2H		High-Rise	8+	12	120
22	C3L	Concrete Frame with Unreinforced Masonry Infill Walls	Low-Rise	1 - 3	2	20
23	C3M		Mid-Rise	4 - 7	5	50

24	C3H		High-Rise	8+	12	120
25	PC1	Precast Concrete Tilt-Up Walls		All	1	15
26 27 28	PC2L PC2M PC2H	Precast Concrete Frames with Concrete Shear Walls	Low-Rise Mid-Rise High-Rise	1 - 3 4 - 7 8+	2 5 12	20 50 120
29 30	RM1L RM2M	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms	Low-Rise Mid-Rise	1-3 4+	2 5	20 50
31 32 33	RM2L RM2M RM2H	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms	Low-Rise Mid-Rise High-Rise	1 - 3 4 - 7 8+	2 5 12	20 50 120
34 35	URML URMM	Unreinforced Masonry Bearing Walls	Low-Rise Mid-Rise	1 - 2 3+	1 3	15 35
36	MH	Mobile Homes		All	1	10

4.2.2 Building Classification – Building Occupancy

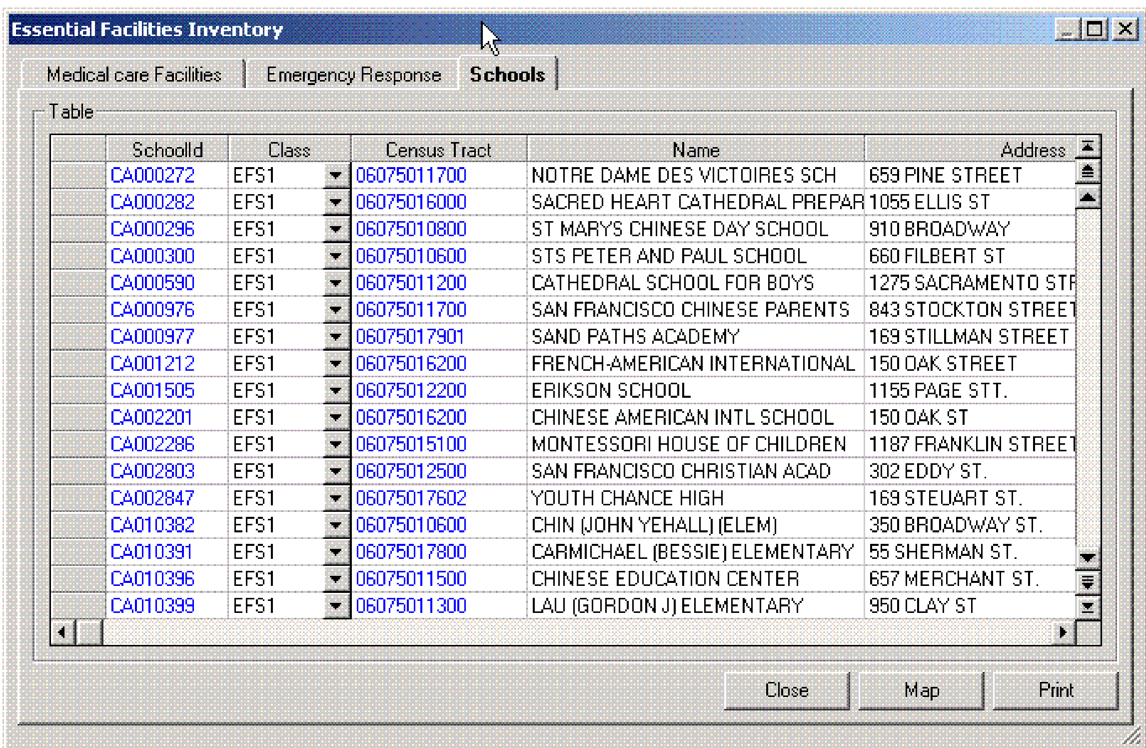
General building stock is also classified based on occupancy. The occupancy classification is broken into **general occupancy** and **specific occupancy** classes. For the methodology, the general occupancy classification system consists of six groups: residential, commercial, industrial, religion/non-profit, government, and education. Specific occupancy consists of 33 classes. Occupancy classes are used to account for the fact that contributions to losses are from damage to both the structural system and non-structural elements. The types and costs of non-structural elements are often governed by the occupancy of the building, e.g. in a warehouse there may be few expensive wall coverings; whereas, a bank may have expensive lighting and wall finishes.

If the structural systems of these two buildings experience the same amount of damage, the costs to repair the bank will be greater than the warehouse due to the more expensive finishes. Other issues related to occupancy may also be important, such as rental costs, number of employees, type of building contents and importance of function. Finally, a great deal of inventory information, such as county business patterns or census data, is only available by occupancy.

Classification systems developed for soils, model building types, building occupancies, essential facilities, high potential loss facilities, and lifelines are listed in Appendix A. Descriptions of the characteristics of lifeline components are found in Appendix C.

4.3 Inventory Databases

Once data have been collected, they can be accessed more easily and updated in the future if they are maintained in an orderly manner. Database formats have been developed for all of the data that you will collect to perform the loss study. Figure 4.4 is an example of a database of school facilities as you would see it when using **Hazus**.



SchoolId	Class	Census Tract	Name	Address
CA000272	EFS1	06075011700	NOTRE DAME DES VICTOIRES SCH	659 PINE STREET
CA000282	EFS1	06075016000	SACRED HEART CATHEDRAL PREPAR	1055 ELLIS ST
CA000296	EFS1	06075010800	ST MARYS CHINESE DAY SCHOOL	910 BROADWAY
CA000300	EFS1	06075010600	STS PETER AND PAUL SCHOOL	660 FILBERT ST
CA000590	EFS1	06075011200	CATHEDRAL SCHOOL FOR BOYS	1275 SACRAMENTO STR
CA000976	EFS1	06075011700	SAN FRANCISCO CHINESE PARENTS	843 STOCKTON STREET
CA000977	EFS1	06075017901	SAND PATHS ACADEMY	169 STILLMAN STREET
CA001212	EFS1	06075016200	FRENCH-AMERICAN INTERNATIONAL	150 OAK STREET
CA001505	EFS1	06075012200	ERIKSON SCHOOL	1155 PAGE STT.
CA002201	EFS1	06075016200	CHINESE AMERICAN INTL SCHOOL	150 OAK ST
CA002286	EFS1	06075015100	MONTESSORI HOUSE OF CHILDREN	1187 FRANKLIN STREET
CA002803	EFS1	06075012500	SAN FRANCISCO CHRISTIAN ACAD	302 EDDY ST.
CA002847	EFS1	06075017602	YOUTH CHANCE HIGH	169 STEUART ST.
CA010382	EFS1	06075010600	CHIN (JOHN YEHALL) (ELEM)	350 BROADWAY ST.
CA010391	EFS1	06075017800	CARMICHAEL (BESSIE) ELEMENTARY	55 SHERMAN ST.
CA010396	EFS1	06075011500	CHINESE EDUCATION CENTER	657 MERCHANT ST.
CA010399	EFS1	06075011300	LAU (GORDON J) ELEMENTARY	950 CLAY ST

Figure 4.4 Database of school facilities.

The database contains fields that allow you to store a variety of attributes about each facility. For example, in addition to the name, address, and city of the school facility (as shown in Figure 4.4), there are data fields to enter zip code, contact name and phone number at the facility, class of facility (e.g. elementary, secondary), number of students, and the structural type. There is also a "comments" field that allows you to include any information that does not fit into other fields.

Some of these fields are not shown in the above figure, but can be accessed if you scroll to the right. Some of the essential facilities may be missing information such as address. A missing address does not prevent a facility from being included in the database or in the analysis. In order to be included, only the latitude, longitude and county need be specified while other attributes can be inferred (with corresponding uncertainty).

Figure 4.5 shows an inventory database for general building stock. For general building stock, data are stored by census tract and for each census tract you will find the total monetary value for each of the seven general occupancy types: residential, commercial, industrial, agricultural, religious/non-profit, governmental and educational. For example, in census tract 37019020501, the value of residential construction is $23.2 million and for commercial construction is $79.5 million. The inventory can also be viewed in terms of each specific occupancy types (RES1, RES2, RES3A, etc.) by clicking on **Exposure By Specific Occupancy** tab to the left of the general classifications at the top of Figure 4.5. At the lower right of the window, the **Map** button allows the user to graphically display the information by census tract.

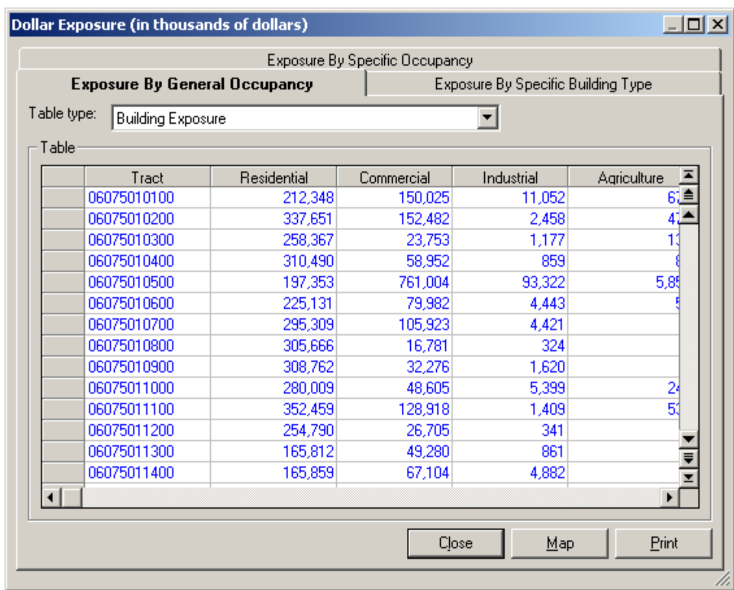


Figure 4.5 Value of general building stock inventory.

You will find that data entry is in a familiar spreadsheet format to allow for easy entry and modification. Moving around in the database involves using the arrow keys at the bottom and to the right of the window. Discussion of how to display, print, modify and map your inventories is found in Chapter 7. All data are stored in a SQL Server database[3]. The structures of all the parameter and inventory databases that are maintained by **Hazus** are found in Appendix E: Data Dictionary. A discussion of default databases is found in Section 3.9.

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[3] To be accurate, only the attributes tables are stored in SQL Server. Mappable tables have the attributes stored in SQL Server and the map objects stored in an ArcMap geodatabase (*.mdb).

4.4 Inventory Requirements

Each module in the earthquake loss estimation methodology requires a specific set of input data. The required data can take two forms. The first is inventory data such as the square footage of buildings of a specified type, the length of roadways or the population in the study region. These are used to estimate the amount of exposure or potential damage in the region. The second data type includes characteristics of the local economy that are important in estimating losses (e.g., rental rates, construction costs or regional unemployment rates). This section summarizes the inventory information that is needed to perform a loss study.

Table 4.2 lists the inventory required for each type of output that is provided in the methodology. You will find that there are varying degrees of difficulty in developing this inventory. For example, in your region excellent records may be available concerning the police and fire stations and schools. On the other hand you may find that it is difficult to obtain detailed information about some of the lifeline facilities.

An issue that you will likely run into is that data you collect will have to be adjusted so that the inventory is classified according to the systems defined in the methodology. For example, a school may have two building wing additions that were constructed over the forty-year lifetime of the structure. Each era of construction used improved materials, but the best materials were used to construct the smallest addition. The individual responsible for assigning the building type of the school according to the **Hazus** methodology will need to define and document the criteria applied to classify the structure. Easiest approach is to break the facility into different entries, i.e. records.

In some cases, you may find that you require a consultant to assist with the classification of data. Default values are provided for most of the input information (see Section 3.9). In Table 4.2, a star is placed next to those input requirements that do not have default values.

Table 4.2 Minimum inventory for the Earthquake Loss Estimation Methodology

Desired Output	Required Input
POTENTIAL EARTH SCIENCE HAZARDS (PESH)	
Intensities of ground shaking for scenario earthquake	Definition of scenario earthquake and attenuation functions, soil map
Permanent ground displacements	Liquefaction and landslide susceptibility maps
Liquefaction probability	Liquefaction susceptibility map
Landsliding probability	Landslide susceptibility map
GENERAL BUILDING STOCK	
Damage to general building stock by occupancy or building type	Total square footage of each occupancy by census tract, occupancy to building type relationships

ESSENTIAL FACILITIES	
Damage and functionality of essential facilities	Location and building type of each facility
Loss of beds and estimated recovery time for hospitals	Number of beds at each facility
HIGH POTENTIAL LOSS FACILITIES	
Map of high potential loss facilities	Locations and types of facilities
Damage and loss for military installations	Location, building type, and value of military installations
TRANSPORTATION LIFELINES	
Damage to transportation components	Locations and classes of components
Restoration times of transportation components	Estimates of repair times for each level of damage
UTILITY LIFELINES	
Damage to utility components	Locations and classes of components
Restoration times of utility components	Estimates of repair times for each level of damage
INDUCED PHYSICAL DAMAGE	
Inundation exposure	Inundation map
Number of ignitions and percentage of burned area by census tract	General building stock inventory, average speed of fire engines, and speed and direction of wind
Map of facilities containing hazardous materials	Inventory of facilities containing hazardous materials
Type and weight of debris	General building stock inventory and estimates of type and unit weight of debris

DIRECT SOCIAL LOSSES	
Number of displaced households	Number of households per census tract
Number of people requiring temporary shelter	Population including ethnicity, age, income
Casualties in four categories of severity based on event at three different times of day	Population distribution at three times of day
ECONOMIC LOSSES	
Structural and nonstructural cost of repair or replacement	Cost per square foot to repair damage by structural type and occupancy for each level of damage
Loss of contents	Contents value as percentage of replacement value by occupancy
Business inventory damage or loss	Annual gross sales in $ per square foot
Relocation costs	Rental costs per month per square foot by occupancy
Business income loss	Income in $ per square foot per month by occupancy
Employee wage Loss	Wages in $ per square foot per month by occupancy
Loss of rental income	Rental costs per month per square foot by occupancy
Cost of damage to transportation components	Costs of repair/replacement of components
Cost of damage to utility components	Costs of repair/replacement of components
INDIRECT ECONOMIC LOSSES	
Long-term economic effects on the region	Unemployment rates, input/output model parameters

4.5 Relationship between Building Types and Occupancy Classes

As discussed earlier, contributions to the loss estimates come from damage to both the structural system and the non-structural elements. In order to estimate losses, the structural system must be known, or inferred for all of the buildings in the inventory. Since much of the inventory information that is available is based on occupancy classes, inferences must be made to convert occupancy class inventory to model building types. These inferences affecting inventory can introduce uncertainty in the loss estimates.

The relationship between structural type and occupancy class will vary on a regional basis. For example, in California, the occupancy RES1 (single family dwelling) can be 95% W1 (wood, light frame) and 5% URML (unreinforced masonry bearing wall, low rise). In a city on the east coast, the relationship can be 40% W1, 50% URML and 10% RM1L (reinforced masonry bearing wall with wood or metal deck diaphragm, low rise).

In most cases, structures in a study region or census tract have been built at different times. As a result, some structures might have been built before 1950, some between 1950 and 1970 and others after 1970. An exception can be a large development that occurred over a short period in which most structures would have about the same age. Since construction practices change over time, so does the mix of structural types. For example, Table 4.3 shows a typical mix of low-rise model building types for west coast construction for occupancy class COM1 (retail trade). Looking at the building type S5L (low rise steel frame with unreinforced masonry infill walls) it can be seen that before 1950, 20% of stores were built using this structural system, whereas after 1970 none were.

Table 4.3 Distribution of floor area for occupancy COM1,

Age	Model Building Type													
	2	**3**	**6**	**9**	**10**	**13**	**16**	**19**	**22**	**25**	**26**	**29**	**31**	**34**
	W2	S1L	S2L	S3	S4L	S5L	C1L	C2L	C3L	PC1	PC2L	RM1L	RM2L	URML
Pre-1950	22%	2%		6%	3%	20%		17%	1%			6%		23%
1950 to 1970	34%	3%	1%	3%	2%	4%		13%	5%	10%	1%	18%	2%	4%
Post-1970	26%	9%	1%	2%	1%		6%	10%	1%	15%	5%	21%	3%	

While the relationship shown in Table 4.3 can be developed from data collected locally, **Hazus** provides default mappings of specific occupancy classes to model building types. Three general mapping schemes have been defined and assigned depending upon whether a state is in the Western U. S., the Mid-West or the Eastern U. S. Table 3C.1 of the *Technical Manual* provides the regional classification for each state. Default mappings will be the same for regions that are created anywhere within a particular state. It will be up to you to modify these defaults to reflect characteristics that are specific to your local region.

In addition to geographical location, the distributions can also depend on when the buildings were constructed and whether they are low, medium or high-rise structures.

Age is important because it affects the types of structures that exist in a region. For example, if most of the buildings in a region were built after 1970, there will be very few unreinforced masonry structures. An example of how age and height information affects the mix of building types is shown as follows:

Suppose you determined the following information:

All of the buildings in a census tract are low-rise

50% of the buildings were built before 1950

30% of the buildings were built between 1950 and 1970

20% of the buildings were built after 1970.

A new occupancy mapping can be calculated by combining the different mapping schemes presented in Table 4.3. The new occupancy mapping for COM1 would be determined by multiplying the first row of Table 4.3 by 0.5, the second row by 0.3, the third row by 0.2 and then summing. To calculate the modified occupancy mapping for the building type W2, the calculation would be:

$$0.5 \text{ x } 22\% + 0.3 \text{ x } 34\% + 0.2 \text{ x } 26\% = 26\%$$

The resulting occupancy mapping is shown in Table 4.4. Similar calculations would occur if you were also to include a mix of building heights.

Table 4.4 Modified occupancy mapping for COM1 to include age mix

Specific Occupancy Class	Model Building Type													
	2	**3**	**6**	**9**	**10**	**13**	**16**	**19**	**22**	**25**	**26**	**29**	**31**	**34**
	W2	S1L	S2L	S3	S4L	S5L	C1L	C2L	C3L	PC1	PC2L	RM1L	RM2L	URML
COM1	26%	4%	1%	4%	2%	11%	1%	15%	2%	6%	1%	13%	1%	13%

Modifying occupancy to model building type relationships in **Hazus** is discussed in Chapter 7. Developing custom mapping schemes using local data and experts is discussed in Chapter 5. Developing mapping schemes using tax assessor or property records is discussed in Chapter 8.

Chapter 5. Collecting Inventory Data

A limiting factor in performing a loss estimation study is the cost and quality of the inventory. Collection of inventory is without question the most costly part of performing the study. Crude estimates of damage do not require extensive inventory data and can be performed on a modest budget. As the damage estimates become more precise, the need for inventory information increases, as does the cost to obtain this information.

Since many municipalities have limited budgets for performing an earthquake loss estimation study, **Hazus** accommodates different users with different levels of resources. It should be understood, however, that the uncertainty of the loss estimates increases with less detailed inventory, and that there are uncertainties associated with modules other than inventory. For example, even with a perfectly accurate inventory of soils and buildings in the study area, **Hazus**, or any other loss estimation methodology, cannot infallibly predict damage and associated losses.

Inventory information will come from and/or be collected in databases compatible with the GIS technology. Once collected and entered into the database, the data can also be made available to users for other applications. For example, data collected for an earthquake loss estimation model in San Bernardino County, California is now being used for city planning purposes.

5.1 Sources of Information

As discussed in Chapter 3, the use of default parameters and default inventory in performing a loss study introduces a great deal of uncertainty. Loss studies performed with only default data may be best for preliminary assessments to determine where more information is needed. For example, an analysis using only default information suggests that the scenario earthquake will cause a great deal of damage in a particular part of your community. You may want to collect more detailed inventory for that area to have a better understanding of the types of structures, the essential facilities and businesses that might be affected. Similarly, your default analysis may indicate that components of your electrical system are vulnerable. Based on this outcome, you may wish to perform walk-downs of the substations to see how they are really configured. In short, it is likely that you will want to augment and update the default data that are supplied with **Hazus**.

Regional building inventories can be built up from a variety of sources including federal government, state government, local government and private sector databases. These databases may be useful for obtaining facility-specific information. In many cases, information may be plentiful, yet the quality and assembly requirements difficult to assess. Inventory improvements must be balanced with time and budgetary constraints. Request metadata (detailed description and history of the dataset) from information sources, or you may be unable to substantiate the quality of inventories –and loss estimates.

Following are examples of sources of inventory data that can be accessed to enhance the **Hazus** building data:

- Locations of government facilities, ex. military installations and government offices.
- Databases of hazardous buildings, ex. California Safety Commission database of unreinforced masonry buildings.
- Tax assessor's files
- School district or university system facilities
- Databases of fire stations or police stations
- Databases of historical buildings
- Databases of churches and other religious facilities
- Postal facilities (ATC-26, 1992)
- Hospitals (The AHA Guide of the American Hospital Association; ATC-23A, 1991A)
- Public and private utility facility databases
- Department of transportation bridge inventory
- Dun and Bradstreet database of business establishments
- Insurance Services Office databases used for fire assessment of large buildings.

It should be kept in mind that each of these databases includes only a portion of the building stock, and none is complete. For example, the tax assessor's files do not include untaxed properties such as government buildings, public works and tax-exempt private properties. School district databases probably will not include private schools. A good discussion of available databases is found in Applied Technology Council -13 (1985) and Vasudevan et al. (1992), although some of the databases discussed in these two references are specific to California.

Other possible sources of inventory information are previous loss or hazard studies. An example is "Earthquake Hazard Mitigation of Transportation Facilities" (Allen et al., 1988), which contains a listing of all "seismically significant" points along priority routes surrounding the New Madrid Seismic Zone. This listing includes dams, pipelines, high fills, cut slopes, signs, tanks, mines, faults, bridges, and buildings subject to collapse. This type of list could certainly be used as a starting point for developing a complete lifeline inventory. Unfortunately, many regional loss studies do not contain a listing (either hard copy or electronic) of the inventory that was used.

Mitigation plans can be excellent sources of historical information and references on losses from earthquakes. Each state and local government is encouraged to draft hazard mitigation plans under the Disaster Mitigation Act (DMA 2000, amended), and may be available from state, county, and local government Disaster and Emergency Services. The following sections contain more detailed information about sources of information for specific modules of the earthquake loss estimation methodology.

5.1.1 Potential Earth Science Hazards (PESH)

5.1.1.1 Soil Maps

Soils are defined in geologic terms for the purpose of estimating earthquake losses, as compared to surficial soil definitions. In order to account for the effects of local soil conditions for estimating ground motion and landslide and liquefaction potential, you need to enter a soil map into **Hazus**. High-resolution (1:24,000 or greater) or lower resolution (1:250,000) geologic maps are generally available from geologists, regional U. S. Geological Survey offices, state geological agencies, regional planning agencies, or local government agencies.

There are a variety of schemes available for classifying soils. **Hazus** uses the seismic soil type classes recommended by the National Earthquake Hazard Reduction Program (NEHRP). The geologic maps typically identify the age, depositional environment, and material type for a particular mapped geologic unit. You will require the services of a geologist or geotechnical engineer to convert the classification system on your map to the one used in this methodology (see Table A.1 in Appendix A).

If a previous regional loss study has been conducted, you may find that the study contains soil maps. Once again, for use with **Hazus** you may need to convert the classification to the one described in Table A.1.

5.1.1.2 Liquefaction Susceptibility

Liquefaction susceptibility maps, usable in the hazard analysis, have been produced for a few selected areas, i.e., greater San Francisco region (ABAG, 1980); San Diego (Power, et. al., 1982); Los Angeles (Tinsley, et. al., 1985); San Jose (Power, et. al., 1991); Seattle (Grant, et. al., 1991). Applied Technology Council published a summary of regional liquefaction hazard maps (Power and Holtzer, 1996). Seek out the most current data from state and local government, academic institutions, and online resources.

If no liquefaction susceptibility maps are available, and liquefaction is a potential hazard, a geologist or geotechnical engineer will be required to develop one. The level of effort required depends on the size of the region and the desired resolution of the contours. Soil maps at large scales (1:24,000 to 1: 50,000) provide important source data for developing your liquefaction map, if they are available.

A crude map with a great deal of uncertainty can be developed in a few weeks using the procedure outlined in Chapter 4 of the *Technical Manual*. An experienced geotechnical engineer or hydro-geologist with knowledge of the region can develop a simple map in about one month. A detailed map can require a separate study that could take several months to years. Digitizing a map can take a day to a week depending on the size and complexity of the region. Look for geologic and groundwater maps published in digital format to assist your effort.

5.1.1.3 Landslide Susceptibility

Landslide hazard and susceptibility maps are available from federal land agencies and land planning offices at the state, county and municipal government levels. Increasingly, you will find them available electronically.

If no landslide susceptibility maps are available, and landslides are potential hazards, a geologist or geotechnical engineer will be required to develop one. Transportation departments are excellent sources for landslide hazard information. The level of effort required depends on the size of the region, and the desired resolution of the contours.

5.1.2 General Building Stock

Developing the inventory for general building stock most likely will require combining information from several sources. As mentioned earlier, there is no complete single source of general building stock information. In addition, you will find that the quality and format of the information varies dramatically from county to county. Furthermore, since general building stock inventory is not normally compiled by counting individual buildings, but instead is developed using various assumptions and inferences, you may find that you need input from local engineers and building officials to ensure that you have captured unique aspects of the region.

High quality information may be available, yet difficult to cost-effectively compile. Users will need to balance access to the most accurate and site-specific data with available time and funding resources to develop an acceptable inventory compilation strategy.

As the data sources are diverse and compilation of this inventory is complex, documentation of references used is essential. Also document your assumptions, guidelines, and criteria for making inferences when mapping to the model building types. The building stock inventory improvements may be an on-going task, and inconsistencies in the edit criteria can produce confusing results. The inventory represents trends in construction over time, as well as geographic distribution. Therefore, metadata describing the information sources and lineage of improvements will reap long-term benefits in evaluating the loss estimates as reasonable, or not.

5.1.2.1 County Tax Assessor Files

County Tax Assessor files may or may not be a source of general building stock information. Since Tax Assessor files are kept for the purposes of collecting property taxes, they may contain little or no useful structural information. A comprehensive online directory of Tax Assessors is currently hosted by Northwestern University, Illinois (See http://pubweb.acns.nwu.edu/~cap440/assess.html).

The quality of the data varies widely from county to county. Many counties use Computer-assisted Mass Appraisal (CAMA) systems, which can significantly reduce the data compilation time. Parcel data may already exist in GIS format, which can be useful in making inferences based on spatial patterns.

The most useful data will contain occupancy, structural type, square footage, height, and age. Generally, the files contain good information on the use (occupancy) of the building, since tax rates often depend on building use; therefore, either a land use code and/or a specific occupancy of the building is included.

Ideally, if good information is available, you can use the Comprehensive Data Management System (CDMS) described in Chapter 8 to develop region-specific occupancy to model building type relationships. However, several problems generally occur:

- Square footage: Many Tax Assessor files do not contain building square footage information. In some counties, square footage is not recorded at all. In other cases, it is only sometimes recorded. You should ask the Tax Assessor before you buy the records as to what percentage of the records contain square footage information. Calculation of square footage varies, and should accompany the data source.
- Multiple occupants and owners: Many Tax Assessor files contain square footage information that may be difficult to interpret. For example, a property that is owned by several owners (such as an office building) may appear several times in the files. Perhaps Owner #1 owns two floors of the building and Owner #2 owns eight floors. The Tax Assessor's records may not reflect the fact that Owner #1 owns 20% of the Building and Owner #2 owns 80%. In fact, sometimes both property entries will show the total building square footage instead of Owner #1 with 20% of the square footage and Owner #2 with 80%. Without going through the files record by record, this is difficult to fix.
- Non-taxable entities: Since some occupants that do not pay taxes (e.g., schools, churches, and government buildings) are not usually well represented in the Tax Assessor's files. Often these types of properties include an entry and an Assessor's Parcel Number, but omit assessed value, square footage, structural type, height or age.
- Structure information missing: Structural type may not be recorded at all in the files. You need to ask the Tax Assessor what percentage of the records has structural information before you buy or use the files.
- Year of construction: Similar comments about missing data can be made about age and height.
- Property identifiers: Some or all of the properties in the Tax Assessor's files may contain no address information. In some counties, the Assessor's Parcel Number is the only identifier in the database. While this can be mapped to location, it is not an easy task. The file may contain a mailing address of the owner, but this is not a reliable address to locate

properties. Owners do not always occupy their properties and mailing addresses may not correspond at all to the study region of interest. In other cases, selected properties are missing addresses. Property address information is important because you can use addresses to see how the types and occupancies of buildings vary geographically.

- Replacement costs: Construction materials and costs associated with replacement of buildings vary regionally. Value adjustments might require assistance of state or local labor and industry officials, and use of regional economic indices.
- Structure classification schemes: Perhaps one of the most difficult problems is that, in many cases, the Tax Assessors use a system of classifying structures that is difficult to map to the model building types defined in Table A.2.
- For example, there may only be five building types, such as steel frame, wood frame, fire resistant, masonry and other. It is difficult from this very simple classification system to determine whether masonry structures are reinforced or unreinforced. Similarly, it is impossible to distinguish braced steel frames from moment resisting steel frames. Fire resistant construction could include a variety of structural types consisting of concrete or masonry. In these cases you will need to use local experts to help define the mix of construction keeping in mind the purpose of the loss estimates.

5.1.2.2 Commercial Sources of Property Data

There are a variety of online services that maintain databases of real property that are designed to assist realtors and other commercial enterprises in gathering property sales data and owner information, and to assist in generating mailing lists and labels. The databases are developed from County Tax Assessor's files and updated as properties are sold, or as other information becomes available.

You can subscribe to one of these services and download records over a telephone line, or you can order CDs of selected counties and use software supplied by the service to extract the records on your own computer. It seems that different services tend to focus their efforts in different parts of the United States. Therefore, one service may not maintain a database on the county you wish to study while another service may. Typical costs for a county are $300 to $1000, depending on its size. Addresses and phone numbers of several on-line services are listed below. (Note: While these are California addresses, they carry data from around the country. There may be local offices for these companies.)

If one of these services does not have the counties in your study region you may find that there is a service in your own community that maintains these types of records. Local real estate agencies or the local Board of Realtors would probably know about this. Alternatively, you can try calling local Tax Assessors and see if they have sold their data to this type of service.

Some of the Commercial Sources of Property Data are:

Experian Property Data (formally known as TRW)
3610 Central Avenue
Riverside, CA 92506
(800) 345-7334

Website: http://www.experian.com/

First American Corporation
1 First American Way
Santa Ana, California 92707
(800) 854-3643

Website: http://www.firstam.com/faf/services/propinfo-services.html

Transamerica Information Management (offer a program called MetroScan)
1860 Howe Avenue, Suite 455
Sacramento, CA 98525
(800) 866-2783

Website: http://users1.ee.net/megnkate/met-is2.htm

DataQuick Information Services
9171 Towne Centre Drive, #404
San Diego, CA 92122
(800) 950-9171

Website: http://www.dataquick.com/

The commercially available databases contain the same type of problems found in the County Assessor's data since they were obtained from them. One advantage of the commercially available information is that it can be distributed to you in a usable electronic database format. Although the software interfaces vary, each company provides one that enables you to view data on individual properties or to sort properties in a variety of ways (i.e. by zip code, census tract, age, occupancy). On the other hand, assessor's data may be stored on 9-track tape and provide little or no instruction to extract the data.

One note of caution: Property record selection and downloads are limited to a certain number of records (ex. 9000) at a time. A large county such as Los Angeles contains over two million records. Thus, extracting all of the records for the county can be a tedious task, sometimes taking several days. Requests for data on compact diskette may be most cost-effective.

5.1.3 Occupancy to Model Building Type Relationships

Developing occupancy to model building type mapping schemes that accurately reflect your study region will require combining available data with input from local experts. The Comprehensive Data Management System (CDMS) discussed in Chapter 8 has a utility that develops occupancy to model building type mapping schemes from the assessor's files or other commercially available property data. Collecting supplemental information about local building practices through the use of a questionnaire and/or a workshop is recommended.

A questionnaire that was used to collect region specific information for developing some of the default mapping schemes in **Hazus** is found in Appendix F. This questionnaire was used in a one-day workshop that was attended by about ten individuals with significant experience with local construction that included design engineers, building officials and a university professor. Workshop participants were presented with preliminary occupancy to model building type relationships that were developed from County Assessor's files. Using the questionnaire to focus on the workshop, participants modified preliminary schemes based on their own experience. The advantage of using a workshop instead of sending the questionnaires out was that participants were able to discuss their different opinions and come to a consensus on a reasonable representation of local practices.

5.1.4 Essential Facilities

Essential facilities include hospitals, schools, and emergency services. Many of these are owned or licensed by government agencies. Consequently, lists of these facilities are often available for a region. Facility inventories are typically incomplete and sometimes incorrect; verification of the data with most current information is required. Assignment of the building model type and square footage will depend on the best information available.

The time associated with collecting inventory on essential facilities may be relatively small; perhaps a few days, if no building type information is collected and default occupancy to building type mappings are used. However, more detailed building type information may require a site visit for each facility.

Some essential facilities are subject to special design and construction considerations that may help these structures perform better than the typical building when subjected to an earthquake. Data you collect with respect to special seismic design and construction considerations may be useful later on in identifying whether structures are high-code, moderate-code or low-code design.

The criteria for determining seismic design level categories are summarized in Table 5.1. An additional bias can also be defined for essential facilities to reflect the potential for different damage and losses based on the vintage of the design code. This is described in Section 6.7.1 of the *Technical Manual*.

Table 5.1 Suggested seismic design levels for essential facilities

Seismic Design Level (I = 1.5)	Seismic Zone (1994 Uniform Building Code)	Map Area (1994 NEHRP Provisions)
High-Code	4	7
Moderate-Code	2B	5
Low-Code	1	3

5.1.4.1 Medical Care Facilities

Sources of inventory information for medical care facilities include the yellow pages of the telephone book, city and county emergency response offices, the American Hospital Association and previous loss studies. The default medical facilities database included with **Hazus** was developed from a FEMA database and contains the number of beds for many of the facilities. Determining the number of beds for other facilities may require the user to contact facilities on an individual basis. Medical care directories of licensed and non-licensed facilities are readily available online and from the county Public Health departments in each state.

5.1.4.2 Fire Stations, Police Stations and Emergency Operations Centers

Locations of fire stations, police stations and emergency operations centers can be obtained from local and statewide disaster and emergency service offices. In addition, many city maps show locations of police and fire stations. Determining the number of fire trucks typically requires the user to contact an administrator in the fire department.

5.1.4.3 Schools

Locations of public schools and their enrollments can be obtained from district offices. The Board of Education in some states compiles a directory of all schools (public and private) in the state with names, addresses, phone numbers and enrollments. The yellow pages and government office pages of your local phone book are general sources.

Regional governments often compile directories of local educational institutions (including colleges and universities). The National Center for Educational Statistics[4] is also a resource for information. Verification of data from this, and other secondary sources is recommended.

5.1.5 High Potential Loss Facilities

While High Potential Loss Facilities include nuclear power plants, dams and military installations, default data are currently provided only for nuclear power plants and dams. Military installations will have a program for assessing potential and local hazards. Facility descriptions for estimating study region losses will be subject to allowable release of national security information for that purpose. Requests for information should be directed to the local installation Information Officer.

5.1.5.1 Nuclear Power Plants

Hazus does not include damage and loss estimates for nuclear power plants. These structures are so complex that estimating losses would require a dedicated study. Instead, only the location of these facilities is mapped in the study region. You will only need to add those nuclear power plants that are not listed in the default database provided with the program. Utilities that operate these facilities will have information on their locations, though they may not be willing to share it. Local, state and Federal regulatory agencies should also have inventories of power plants (e.g. nuclear and fossil fuel plants).

5.1.5.2 Dams

The methodology does not include damage and loss estimates for dams. The default dam database provided with **Hazus** is a modified version of the NATDAM database supplied by the National Inventory of Dams. It contains over 80,000 entries and includes most of the dams of any significance in a study region, along with descriptive information about each dam. The criteria for inclusion in the database are found in Table 5.2 and the list of fields is found in Appendix E. The default classes that are included in this database were assigned by converting the rather complex classification system used by NATDAM to the twelve classes used in this methodology.

Cities, counties, states, the Army Corps of Engineers, the U.S. Soil Conservation Service, other federal agencies, water districts, flood control districts, or private parties may own dams or levees. Thus, obtaining more detailed information on dams may require contacting a number of different sources. In addition to the above-mentioned agencies,

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[4] Page: 10Reference: (http://nces.ed.gov/ccd/schoolsearch/)

you may wish to contact the State Office of Emergency Services, local emergency services, fire protection services, or regulatory agencies.

Table 5.2 Criteria for inclusion in the NATDAM database

Characteristic	Criterion	Excluded
Dam Height	Dam height greater than 25 feet	Dam height < 6 feet, regardless of reservoir capacity
Reservoir Size	Reservoir impoundment capacity greater than 50 acre-feet	Reservoir impoundment capacity less than 15 acre-feet maximum capacity regardless of dam height
Hazard	Any dam that poses a significant threat to human life or property in the event of its failure	N/A

5.1.5.3 Levees

Users are responsible for developing their own inventory of levees since **Hazus** doesn't supply default levee inventory. Levees are defined in terms of endpoints of levee segments (latitude and longitude coordinates). There are a number of fields defined in the levee database structure (see Appendix E) including:

- Levee design basis (for example 100 year flood)
- Levee crest elevation
- Water elevation during most of the year
- Levee owner/operator

Since some levees are designed only to provide protection during flooding, they may be dry during most of the year. These levees may not pose a significant inundation hazard.

5.1.5.4 Military Installations

The methodology includes the capability to estimate damage and loss for facilities on military bases that can be modeled as one of the 36 model building types. Locations of military installations can be obtained from maps or Topologically Integrated Geographic Encoding and Referencing (TIGER) files. These sources give locations of installations but no breakdown as to the number or type of structures. FEMA maintains databases of major Army, Navy and Air Force installations, although they are not included in **Hazus**.

5.1.6 User-Defined Structures

User-defined structures are those structures, other than essential facilities or high potential loss facilities, which the user may wish to analyze on a site-specific basis. For example, you may wish to identify all of the unreinforced masonry buildings in the community or all of the pharmacies. You can collect data about these types of structures using the same sources you would use for general building stock or essential facilities. Specific databases may be available to you through agency property management offices, state insurance funds, commercial sources of property data, the phone book, interviews with owners, and site visits.

5.1.7 Lifelines

Hazus includes default datasets from federal agencies for transportation (highway, railway, light rail, bus, port, airport, and ferry) and utilities (electric, gas, potable water, wastewater, gas, oil, and communication). Most of these inventories are minimal. Developing a lifeline inventory or improving the inventories supplied with **Hazus** most likely will require the cooperation of local utilities or government agencies that operate and maintain the systems. It is difficult to estimate how much time will be required to collect and organize lifeline information because it depends on the size of the region, the level of detail required, the quality of existing data, and the degree of cooperation from utility corporations and agencies within the region.

Previous loss estimation or hazard studies may be sources of information on all types of lifelines. For example, the planning scenarios developed by the California Division of Mines and Geology (CDMG) provide detailed inventories of lifelines and essential facilities (See Davis et al., 1982). In the Davis study, addresses and the number of beds for all hospital facilities are provided. A limitation of the CDMG planning scenarios is that the inventory is only for the area around the epicenter of the scenario earthquake.

Another example of a previous loss study is the study performed for the Portland, Oregon water and sewer systems (Kennedy/ Jenks/Chilton et al., 1989). It should be noted that a detailed lifeline study such as the one performed for Portland might provide information in addition to component inventory. This study contains values of facilities and loss curves (based on MMI[5]) for some components.

In more recent years, New York City Area Consortium for Earthquake Loss Mitigation (NYCEM) has published detailed studies. In the same state, the Multidisciplinary Center for Earthquake Engineering Research, Buffalo, has become a comprehensive source for tracking loss studies. FEMA's Report 249 (FEMA, 1994) also provides information on loss studies that have been performed. The Association of Bay Area Governments in the San Francisco area and Metro in Portland, have been studying hazard mitigation policies and procedures for quite some time. In some cases their studies have involved developing inventories of local lifeline and essential facilities.

[5] Modified Mercalli Intensity.

5.1.7.1 Transportation Lifelines

The default databases of highways and bridges included with **Hazus** were created from data obtained from Federal Highway Administration (FHWA) and the Census Bureau's TIGER files. You may find that the locations of these lifeline components contain omissions and inaccuracies; however, the locations can easily be modified based on more accurate information obtained by the user.

Many states, cities, and counties have invested in GIS systems and may already have computerized databases that you can use. Road centerline files are more often available as maintenance and construction funding is closely tied to transportation inventories. They generally provide the route number, name, road class, and may include street width and average daily traffic. Where road centerline files in GIS do not exist, Computer Assisted Drawing (CAD) files and street maps are two more excellent sources for locating streets and highways. CAD files require spatial transformation of the data; while paper maps will offer a simple scheme for identifying freeways, expressways, main highways, and surface streets. A potential drawback, however, is that to use street maps, you will probably have to digitize them.

To obtain cost and structural information about roads, bridges and tunnels that is not included in the default inventory, local and state transportation agencies maintain lists of bridges and tunnels, and may also have detailed information about their design, construction and configuration. Road engineers are the best source for cost per mile information, if a local agency uses values other than recommended federal guidelines. You may find that you need to perform a survey to collect cost per mile data for roads (surveys are discussed in Section 5.2.)

To obtain information about traffic on road segments you may wish to consult the default bridge database included with **Hazus**. This database, obtained from the FHWA includes average daily traffic counts. Verify the default data with your regional transportation agency, as the database maintained locally is sometimes more complete and current. As a first step you can assume that the average daily traffic on a bridge is the same as that on a highway leading to that bridge. Alternatively, the public works departments or the city, county, state or the federal agencies that own and operate the roads likely have performed studies with respect to the daily traffic and capacities of the roads.

The Federal Railway Administration maintains databases of railways and associated facilities. In order to improve the default **Hazus** inventories, you will need to contact the rail companies operating in the study region. These sources should be able to provide structural information as well as cost data.

Light rail, ferry and bus inventories are also part of the default data supplied with **Hazus**. They are derived from databases managed by programs under the U.S. Department of Transportation and can be improved by contacting the related local operations. In many cases, the data compiled at the federal level came from the local operations, but may be outdated. Verification of the current conditions and cost-replacement values can significantly affect transportation losses.

While the locations of ports and airports are provided in the default inventories, no information is provided about the types of buildings, cranes, tanks, etc. that are at these facilities. The Federal Aviation Administration (FAA) maintains a database of airports along with information about the number of runways and the average daily traffic. It is unclear if you will be able to access this information. Access to this information may require submitting request forms to the FAA and waiting long periods while information security issues are addressed. Facility maps may be obtained from the agencies that operate these ports and harbors. However, it is likely that a phone call and formal written requests to the owner, and possibly a meeting with authorities will be required to get structural and cost information.

5.1.7.2 Utilities Lifelines

Developing a lifeline inventory or improving the default inventories supplied with **Hazus** generally requires the cooperation of local utilities or government agencies that operate and maintain the systems. In some cases utilities and government agencies are already maintaining databases on GIS systems or in CAD systems. However, the data may have to be converted to a format that is compatible with the ArcGIS software.

More than one supplier may supply water to a region. Suppliers may be either government owned or they may be private companies. Systems may already be mapped in a GIS or CAD system. In this case, the data files may need to be converted to a GIS format. If the water system is not maintained in a GIS, a map of the pipe network can be digitized or scanned for input into **Hazus**. Similar comments apply to wastewater systems.

A rather crude analysis of water and wastewater systems can be performed by knowing the number of kilometers of different types of pipes for each census tract. Owners of these systems can typically provide this information. If pipeline information is not available from maps or drawings, a surrogate system can be constructed using common alignments with roads and other utilities.

Oil and gas systems consist of not only the pipelines but also refineries, tank farms, pumping plants and compressor stations. In addition to inventories available from suppliers, databases of hazardous waste sites can serve as a locator of fuel storage facilities. Refer to state and local regulatory and monitoring agencies (i.e. water quality, energy) for these data.

5.1.8 Inundation

Sources of existing inundation studies due to dam failure, levee failure or tsunami include state and federal agencies that regulate dams, dam or lake owners, the State Office of Emergency Services (OES), the U.S. Geological Survey (USGS), etc. The availability of such studies may be limited.

If inundation maps are available, they may be digitized and entered into **Hazus** (see Section 9.2). Digitizing a map for display may take a day to a week. If an inundation map is not available, development of an inundation map for a particular earthquake scenario requires an analysis of the response of the dam to the earthquake and the involvement of a hydrologist to define the extent of flooding. This is a detailed study requiring up to several months.

A crude inundation map can be created from floodplain levels (ex. 100-year flood). Flood Insurance Rate Maps (FIRM), Digital FIRMs, and Q3 Flood Data published by FEMA, or more accurate ones available from local resource agencies will serve this purpose. FIRMs were prepared in the 1970s – early 1980s, and many provide outdated information. Although some flood maps have been improved (DFIRMs, Q3) and meet 1:24,000 mapping standards, they are very general representations of potential inundation areas. You may need to digitize floodplain elevations from the older paper maps, or use several digital flood data files for your study area.

5.1.9 Fire Following Earthquake

Aside from the locations of fire stations, and the number of trucks that should be available from fire departments or regional emergency response organizations, there is little inventory information available to investigate fire following earthquake. Typical wind speeds and wind directions can be obtained from the weather service, and average fire engine speeds should be available from the fire department.

5.1.10 Hazardous Materials

Due to the considerations of limiting the methodology to those hazardous materials whose release could have regional consequences, the default database contains only those chemicals that are considered highly toxic, flammable or highly explosive. In addition, it is limited to those facilities where large quantities of these materials are stored. The Environmental Protection Agency (EPA) compiles an annual inventory of manufacturing facilities that release toxic chemicals into the air, water, and ground. This inventory focuses on 305 chemicals that may cause chronic health problems and serious environmental effects.

The default database was built from the 1993 EPA Toxic Release Inventory (TRI) database of hazardous materials sites. The latest version of the TRI database may be obtained from the EPA. You may opt to use only the information contained in the default database provided with **Hazus**. This database, however, is limited and you are urged to collect additional inventory for a better representation of the types of chemicals stored in your study region.

The ease with which information regarding hazardous materials storage and usage is available varies from jurisdiction to jurisdiction. Some jurisdictions have this information available in the form of a computer database/printout managed by the municipal fire stations, whereas other jurisdictions do not. Most likely the format of the database will vary from place to place, and even if hazardous materials inventories are easy to get, there will be some effort required to combine databases from several cities in a region.

At the present time, users and handlers of hazardous materials have to meet two primary reporting requirements. One is the requirement mandated by the Uniform Fire Code, and the other is required by the Superfund Amendments and Reauthorization Act of 1986, Title III (SARA Title III). The reporting requirements for each of these are rather different. The Uniform Fire Code is very comprehensive in its coverage. It covers materials that pose any physical or health hazard. The SARA Title III reporting requirements are restricted to 360 hazardous materials that are known to be particularly toxic. These chemicals have been termed Acutely Hazardous Materials (AHM). For either of these reporting specifications, based upon the hazard posed by each material, there are minimum (i.e. threshold) hazardous material quantities, below which the user/handler may store without a permit.

The information contained in the application for a permit is a matter of public record, and the agency granting the permit is able to provide that information to the community, if deemed necessary. The hazardous materials that are covered under SARA Title III, including their Chemical Abstracts Service (CAS) registry numbers, and the threshold quantities for reporting purposes, are listed in Appendix G.

The user should contact the local Fire Department in the case of cities, or the County Health Department in the case of unincorporated areas, to obtain a list of facilities that have obtained permits to store, handle or use hazardous materials. It appears that most jurisdictions within the United States require all users and handlers of hazardous materials to obtain permits from the proper local authority.

The user should also be cognizant of the dynamic nature of hazardous materials data. This will be particularly true of areas that are undergoing economic and industrial growth. For best results, it is strongly recommended that the data be periodically updated, with the update interval being dependent on the rate of growth of the region.

5.1.11 Demographics

Population statistics are used in estimating several different losses such as casualties, displaced households and shelter needs. Population location, as well as ethnicity, income level, age and home ownership is needed to make these estimates. The 2000 Census data are included with **Hazus**. Population migration patterns, based on place of employment, were developed from Dun and Bradstreet data as described in Section 3.6 of the Technical Manual. The user may be able to obtain updated information from the Census Bureau or from a regional planning agency.

5.1.12 Direct Economic Loss Parameters

Direct economic losses begin with the cost of repair and replacement of damaged or destroyed buildings. However, building damage results in a number of consequential losses that are defined as direct economic losses. Thus, building-related direct economic losses (which are all expressed in thousands of dollars) comprise two groups. The first group consists of losses that are directly derived from building damage:

- Cost of repair and replacement of damaged and destroyed buildings
- Cost of damage to building contents
- Losses of building inventory (contents related to business activities)

The second group consists of losses that are related to the length of time the facility is non-operational (or the immediate economic consequences of damage):

- Relocation expense (for businesses and institutions)
- Capital-related income loss (a measure of the loss of services or sales)
- Wage loss (consistent with income loss)
- Rental income loss (to building owners)

Damage to lifeline and transportation systems causes direct economic losses analogous to those caused by building damage. In this methodology, direct economic loss for lifelines and transportation systems are limited to the cost of repairing damage to the systems and business losses due to cessation of electrical power supply. A large part of the data required to estimate direct economic losses is concerned with the cost of repair and replacement, the value of lost inventory, wages and rent. Many of these types of economic parameters are documented by government agencies.

5.1.12.1 County Business Patterns

County Business Patterns is an annual series published by the United States Census Bureau that presents state and county-level employment, annual payrolls, total number of establishments, and establishments by employee size. The data are tabulated by industry as defined by the Standard Industrial Classification (SIC) Code. Most economic divisions are covered, which include agricultural services, mining, construction, manufacturing, transportation, public utilities, wholesale trade, retail trade, finance, insurance, real estate and services.

The data generally represents the types of employment covered by the Federal Insurance Contributions Act (FICA). Data for employees of establishments totally exempt from FICA are excluded, such as self-employed persons, domestic service employees, railroad employees, agricultural production employees and most government employees.

County Business Patterns is the only complete source of sub-national data based on the four-digit SIC system. The series, therefore, is useful in making basic economic studies of small areas (counties), for analyzing the industrial structure of regions, and as a benchmark for statistical series, surveys and other economic databases. The data can serve a variety of business uses as well as being used by government agencies for administration and planning.

County Business Patterns data are extracted from the Standard Statistical Establishment List, a file of known single- and multi-establishment companies maintained and updated by the Bureau of the Census every year. The Annual Company Organization provides individual establishment data for multi-location firms. Data for single-location firms are obtained from various programs conducted by the Census Bureau as well as from administrative records of the Internal Revenue Service (Census Bureau, 2000).

5.1.12.2 Means Square Foot Costs

The default replacement costs supplied with the methodology (where damage state = complete) were derived from Means Square Foot Costs 2002 for Residential, Commercial, Industrial, and Institutional buildings. The Means publication is a nationally accepted reference on building construction costs, which is published annually. This publication provides cost information for a number of low-rise residential model buildings, and for 70 other residential, commercial, institutional and industrial buildings. These are presented in a format that shows typical costs for each model building, showing variations by size of building, type of building structure, and building enclosure. One of these variations is chosen as "typical" for this model, and a breakdown is provided that shows the cost and percentages of each building system or component.

The methodology also allows the user to adjust costs for location of the structure (i.e., San Francisco versus Dallas). A description of how to estimate costs from the Means publication is found in Sections 15.2.1.1 and 15.2.1.2 of the *Technical Manual*. Since Means is published annually, fluctuations in typical building cost can be tracked and the user can insert the most up-to-date Means typical building cost into the default database. This procedure is outlined in Section 15.2.1.3 of the *Technical Manual*.

For **Hazus**, selected Means models have been chosen from the more than 70 models that represent the 33 occupancy types. The wide range of costs shown, even for a single model, emphasize the importance of understanding that the dollar values shown should only be used to represent costs of large aggregations of building types. If costs for single buildings or small groups (such as a college campus) are desired for more detailed loss analysis, then local building specific cost estimates should be used.

5.1.12.3 Dun and Bradstreet

Dun and Bradstreet is an organization that tracks all businesses that are incorporated. Dun and Bradstreet maintain data on the type of business, the number of employees, the square footage of the business, the annual sales and a variety of other information. The default square footage for the occupancy classes and for all the census tracts was created from the 2 and 4 digit Standard Industrial Classification (SIC) 1995-1996 Dun and Bradstreet data. This mapping scheme is listed in Table 3.20 of the *Technical Manual*. Dun and Bradstreet will provide aggregated information for a specific region on total number of employees, total annual sales and total square footage by census tract. They can also provide information on specific businesses. Dun and Bradstreet has a helpful online site (http://www.dnb.com/us/), multiple offices in the United States, and can be located using the local telephone directory assistance.

5.1.12.4 Capital-Related Income

The U.S. Department of Commerce's Bureau of Economic Analysis reports regional estimates of capital-related income by economic sector. Capital-related income per square foot of floor space can then be derived by dividing income by the floor space occupied by a specific sector. Income will vary considerably depending on regional economic conditions. Therefore, default values need to be adjusted for local conditions.

5.1.13 Indirect Economic Loss Parameters

To estimate long-term economic losses (indirect economic losses), you need to supply the variables summarized in Table 5.3. Other inputs will need to be estimated as described below.

Estimates of Supplemental Imports, Inventories (Supplies), Inventories (Demand), and New Export Markets are perhaps the most difficult parameters to estimate. If you have had an earthquake in your region, you will need both pre-quake and post-quake estimates in order to calculate percents as defined in Table 5.3. There are County and Area Development Corporations (CDCs and ADCs) that can provide estimates of local economic activities. However, it is likely you will have to develop estimates of these parameters through discussions with individuals in the local community. One option is to perform a telephone survey. Another option is to create a panel of individuals from all of the sectors in the local community, ask them these same questions and reach some sort of consensus. There are also many universities that have programs, personnel, and resources dedicated to economic research and business development.

Table 5.3 User supplied inputs for indirect economic loss analysis module

Variable	Definition	Units	Default Value
Current Level of Employment	The number of people gainfully employed, by place of work (not residence).	Employed persons	Region-specific
Current Level of Income	Total personal income for the study region.	Million dollars	Region-specific
Composition of the Economy (Level I only)	1. Primarily manufacturing 2. Primarily service, secondarily manufacturing. 3. Primarily service secondarily trade.	1, 2, or 3	1
Supplemental Imports	In the event of a shortage, the amount of a good/service that was supplied from within the region that can be imported from elsewhere.	Percent of current annual imports (by industry)	Defaults for "distinct region"
Inventories (Supplies)	In the event of a shortage, the amount of a good that was supplied from within a region that can be drawn from inventories within the region.	Percent of current annual sales (by industry)	0 (for all industries)
Inventories (Demand)	In the event of a surplus, the amount of a good placed in inventory for future sale.	Percent of current annual sales (by industry)	0 (for all industries)
New Export Markets	In the event of a surplus, the amount of a good which was once sold within the region that is now exported elsewhere.	Percent of current annual exports (by industry)	Defaults for "distinct region"
Percent Rebuilding	The percent of damaged structures that are repaired or replaced	Percent	95%
Unemployment Rate	The pre-event unemployment rate as reported by the U.S. Bureau of Labor Statistics	Percent	6%
Outside Aid/Insurance	The percentage of reconstruction expenditures that will be financed by Federal/State aid (grants) and insurance payouts.	Percent	50%
Interest Rate	Current market interest rate for commercial loans.	Percent	5%
Restoration of function	The percent of total annual production capacity that is lost due to direct physical damage, taking into account reconstruction progress.	Percent (by industry, by year for 5 years)	Defaults for "moderate-major" event

Rebuilding (buildings)	The percent of total building repair and reconstruction that takes place in a specific year.	Percent (by year for 5 years)	70% (yr. 1), 30% (yr. 2)
Rebuilding (lifelines)	The percent of total transportation and utility lifeline repair and reconstruction that takes place in a specific year.	Percent (by year for 5 years)	90% (yr. 1), 10% (yr. 2)
Stimulus	The amount of reconstruction stimulus anticipated in addition to buildings and lifelines repair and reconstruction.	Percent (by industry, by year for 5 years)	0% (for all)

5.1.13.1 Current Level of Employment

You can usually obtain data about current levels of employment from the CDC, state departments of Labor & Industries, local employment offices, and the U.S. Bureau of Labor Statistics. The U.S. Bureau of Labor Statistics can be contacted at:

Bureau of Labor Statistics
2 Massachusetts Ave., N.E.
Washington, D.C. 20212
Phone: 202-606-7800
Fax: 202-606-7797
Website: http://stats.bls.gov/

5.1.13.2 Current Level of Income

You can usually obtain data about current levels of income from the following sources:

U.S. Department of Census - Bureau of Economic Analysis

U.S. Bureau of Labor Statistics.

Area or County Development Corporation

County and City Employment Offices

University economic research programs

5.1.13.3 Composition of the Economy

Information about the composition of the economy may be obtained through the County Development Corporation, Governor's Office, Chamber of Commerce, County Commissioner's Office, or the Mayor's office of the largest city in the county.

5.1.13.4 Percent Rebuilding

The percent of destroyed property that is reconstructed will depend on the health of the economy of the region when the earthquake occurs. If there are many vacant properties, there are places for displaced companies and households to move. Thus it is likely that not all of the damaged and destroyed properties will be rebuilt. On the other hand, if the economy is booming and the vacancy rate was very low, then there will be a great deal of competition for space. In this case you can expect that most of the damage will be repaired.

There is no source of data that will directly tell you the percent of destroyed property that will be reconstructed. Centers for economic development are housed at numerous universities, and can often refer you to appropriate data sources. As suggested above, you might use vacancy rates to get a feel for the extra building capacity in your region. However, you will probably want to run the analysis using several values to see how the analysis changes. Reasonable values rebuilding estimates would be in the range of 95% to 100%.

5.1.13.5 Unemployment Rates

You can obtain pre-event unemployment rates from the U.S. Bureau of Labor Statistics and government research and analysis bureaus within the state departments of labor and industry.

5.1.13.6 Outside Aid and Insurance Payouts

Many state governments have an Insurance Commissioner who will most likely have compiled insurance payout statistics for previous disasters in the region. If you have not had a disaster in your region, you may have to contact someone from some other location in the country to ask about payouts resulting from a natural disaster in that region.

In the absence of data, you can run the model twice, once with outside aid set to 100% and once with outside aid set to 0%. This will provide you with lower and upper bounds on the indirect economic impacts.

For state aid statistics, contact the state governor's chief economist at the Office of the Governor. For federal aid statistics contact FEMA either at the main office (in address below) or at a regional office (see Table 5.4):

Federal Emergency Management Agency
500 C. Street S.W., Federal Center Plaza
Washington, D.C. 20472
Phone: 202-646-4600
Fax: 202-646-2531

Website: http://www.fema.gov

Table 5.4 Addresses of regional offices of FEMA

FEMA Region	Address		Phone
Region 1	442 J.W. McCormack POCH	Boston, MA 02109	617-223-9540
Region 2	26 Federal Plaza Room 1307	New York, NY 10278-0001	212-680-3600
Region 3	615 Chestnut Street	Philadelphia, PA 19106	215-931-5608
Region 4	3003 Chamblee-Tucker Road	Atlanta, GA 30341	770-220-5200
Region 5	536 South Clark Street, 6th Floor	Chicago, IL 60605	312-408-5500
Region 6	800 N Loop 288	Denton, TX 76209	817-898-5399
Region 7	2323 Grand Blvd. Suite 900	Kansas City, MO 64106	816-283-7061
Region 8	Denver Federal Center, Building 710, P. O. Box 25267	Denver, CO 80225-0267	303-235-4800
Region 9	1111 Broadway, Suite 1200	Oakland, CA 94607	415-627-7100
Region 10	130 228th St. SW Federal Regional Center	Bothell, WA 98021	206-487-4600

5.1.13.7 Interest Rate

The current market interest rate for commercial loans should be available from a bank, a local newspaper or the Board of Realtors.

5.2 Collecting Inventory Data

It should be understood that many available databases do not contain all of the information that is needed to perform a loss study. For example, they may contain street addresses, the size of the facility, or the value of the facility, but may not contain information about structural type or age. A discussion of inferring missing attributes in inventory databases is found in King and Kiremidjian (1994). Databases may be out of date and may not contain all of the facilities in the region. Databases may be on paper, rather than in electronic format, making them difficult or impossible to use. Combining multiple databases can also be problematic. Issues such as double counting facilities and eliminating unnecessary information need to be addressed (King and Kiremidjian, 1994).

In general, the majority of the building inventory used in the regional loss estimation will not be collected or kept on a facility-by-facility basis. Resource limitations make it difficult to collect such detailed information. Management and storage of such a large amount of information, while possible, is beyond the state-of-practice for many municipalities and government agencies.

Maintaining facility-specific databases will be most useful for important or hazardous facilities such as hospitals, fire stations, emergency operation centers, facilities storing hazardous materials, and high occupancy facilities, to name a few. Procedures exist for supplementing facility-specific databases with area-specific inventory information. An example of an area specific inventory is the number of square feet of commercial space in a census tract or zip code.

These area-specific inventories are often based on economic or land use information that is augmented using inference techniques. For example, the user may have available the number of commercial establishments in a region. Assuming an average size (in square feet) per establishment, the user can infer the total square footage of that occupancy. Similarly, a land use map may be converted to building square footage by multiplying land use area by percent of area covered by buildings (see Section 5.2.2 on Land Use Data).

Techniques for developing inventories by using sidewalk surveys, land use data and aerial photography are briefly discussed below.

5.2.1 Sidewalk/Windshield Survey

5.2.1.1 What Is Needed:

- Data Collection Sheet
- Map
- Clip Board
- Camera (optional)
- Pre-field Planning
- Your Feet or an Automobile

A sidewalk survey is a technique that can be used to rapidly inventory and identify characteristics of buildings without entering or performing any engineering analyses of the structure. Essentially, most of the inventory collection is done from the sidewalk or the street. An individual uses a pre-defined data collection sheet, a map and possibly a camera and walks or drives through an area to identify buildings and specified characteristics.

A critical aspect of the sidewalk survey is the data collection sheet. An example of a data collection sheet is found in Figure 5.1. This particular data sheet was used for ranking buildings for potential seismic hazards and a scoring system is also included. However, the data sheet could be modified for the needs of the particular region being evaluated.

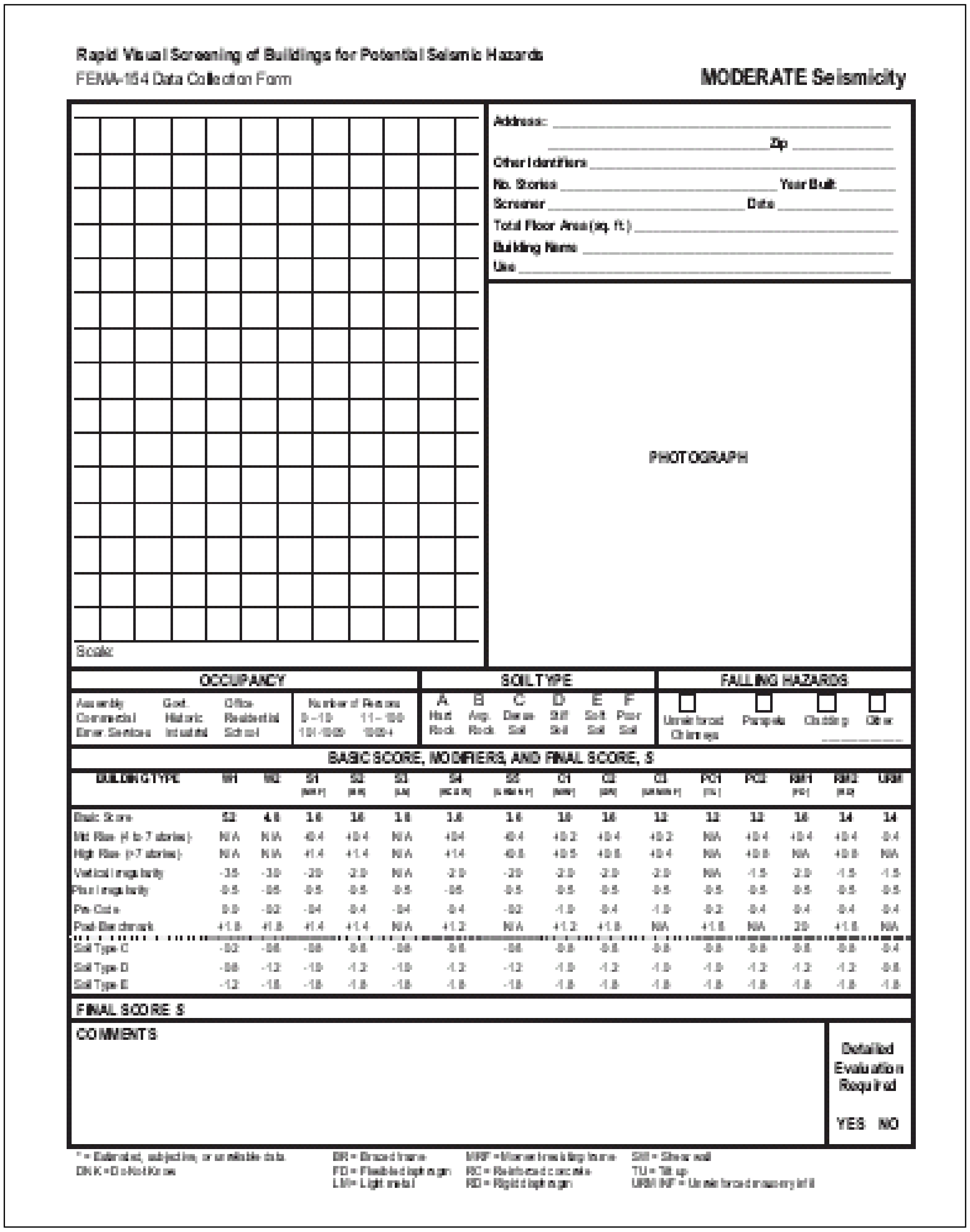


Figure 5.1 Example of a data collection sheet for sidewalk survey (Rapid Visual Screening) from FEMA 154.

How the Information is used:

- Develop Inventories of Specific Building Types or Occupancy Classes
- Develop or Check Inferencing Rules
- Check Accuracy of Available Inventories

Sidewalk surveys have been performed in a number of cities. In Oakland (Arnold and Eisner, 1984) and Redlands California (County of San Bernardino, 1987), studies were performed to identify unreinforced masonry or other "seismically suspicious" buildings. In Portland Oregon, a sidewalk survey was used to collect building inventory (about 9000 buildings) for all commercial occupancies in the downtown and surrounding areas. An excellent overview of studies that have been performed using sidewalk surveys or rapid visual screening techniques is found in FEMA 155 (1988).

A sidewalk survey can be used to develop or check inference rules that are used to characterize that region. An example of such rules might be that 90% of all low-rise residential buildings are wood frame and 10% are unreinforced masonry. Data collected in a residential portion of the study region can be compared with the rule to check validity. Similarly, different areas within a region will have different building and occupancy patterns depending on when structures were built, zoning laws and land use. Sampling of different areas within the study region can be used to identify these variations.

Finally, the user may have access to previously collected inventories such as tax assessors files. A sidewalk survey can be used to determine if structural information in the assessors file is accurate.

5.2.1.2 Steps Followed to Perform a Sidewalk Survey

- Define survey objectives
- Develop survey data sheet
- Identify area where survey is to be performed
- Examine map of survey area looking at density of building construction, and other characteristics that would affect how the area is surveyed
- Perform pre-field data collection (e.g. building age)
- Train individuals who will perform survey

As discussed earlier, a sidewalk survey can be performed for a variety of purposes. Examples of survey objectives are:

- Inventory building stock according to occupancy
- Inventory building stock according to model building type
- Identify specific occupancies (e.g. # of buildings on a school campus)
- Identify specific model building types (e.g. unreinforced masonry)
- Identify characteristics of the building stock (e.g. age, height)
- Identify potential seismic hazards (e.g. unbraced parapets, overhangs, unusual geometry)

The design of the survey data sheet will depend on the objectives that are defined. As discussed in FEMA 154, the survey data sheet should include a minimum amount of information as listed below:

- Complete address or other identifier of building (i.e. tax assessor's parcel number)
- Name of surveyor
- Number of stories
- Estimate of building plan dimensions

The above minimum information is needed so that the survey can be updated or used again at a later time. It is also useful for directing any survey related questions to the surveyor. It is also useful to have:

- Sketch of building plan
- Photo of building

A good data sheet will be in a check off format so that 1) all buildings will be in the same format, and 2) the inspector will not forget to mark certain information. One suggestion is to develop data labels from some pre-existing database such as Assessor's files or building department files with street addresses, building type and other information that may be determined before going into the field. Using an Assessor's map to mark down relevant information can also be useful.

Identifying structural types from the street can be extremely difficult. Structural frames and walls are often covered with finishes that mask their characteristics. However, building practices can be associated with certain eras, architectural styles or occupancies. This will likely vary by region. FEMA 154 devotes a whole chapter to inferring model building type from architectural styles. Training of surveyors should include instruction in building practices of the region and characteristics that might be used to identify certain building types. Surveyors should train together on the same group of buildings to improve consistency in survey results.

5.2.2 Land Use Data

Land use data can be combined with a series of inferences to develop a building inventory. This approach has been used in many previous loss studies and is described in some detail in Scawthorn and Gates (1983) and ABAG (1986). Land Use data provides information about the location and area of different land use categories in a region. Several steps are required to convert the land use areas to building inventory:

- Land use must be converted to building type
- Land use area must be converted to square feet of building

To convert land use to building type, inferencing rules about the proportion of model building types in each land use category must be developed. An example of these inferences taken from a loss study for Los Angeles County (Scawthorn and Gates, 1983) is shown in Table 5.5. It can be inferred from this table that if the land use is General Commercial (Code 129), then 23% of the land has 1 to 4 story concrete block construction, 9 % has 1 to 2 story tilt-up, 58% has 1 to 2 story wood, 2% has unreinforced masonry, and 8% has reinforced masonry.

Table 5.5 Land Use to Building Type Conversion - Proportion by Percent
(from Scawthorn and Gates, 1983)

CODE	LAND USE CATEGORY	BUILDING TYPE - STRUCTURAL MATERIAL AND NUMBER OF FLOORS												
		CONC. BLOCK 1-4	TILT-UP 1-2	WOOD 1-2	WOOD 3-4	CONCRETE 1-2	STEEL 1-2	CONCRETE 3-4	STEEL 3-4	CONCRETE 5-19	STEEL 5-19	URM**	REINFORCED MASONRY	STEEL ≥20
111	ESTATE	3		85								4	8	
112	SINGLE FAMILY			87								5	8	
113	DUPLEX / ROW HOUSING			84								11	5	
114	LOW RISE APARTMENTS / CONDOMINIUMS			84								11	5	
115	MEDIUM RISE APARTMENTS / CONDOMINIUMS			75								13	12	
116	RURAL CLUSTERED			89								6	8	
117	RURAL DISPERSED			96								7	4	
118	MOBILE HOMES / TRAILER PARKS	4		92									4	
119	HIGH RISE APARTMENTS / CONDOMINIUMS									69	21		10	
121	MAJOR OFFICE USE	12		10	3	38	7		5		10	3	12	
122*	MAJOR OFFICE USE -- 8 OR MORE FLOORS													
123	REGIONAL SHOPPING CENTER	13	27	4		44		3					9	
124	NEIGHBORHOOD SHOPPING CENTER	13	7	72								1	7	
125	STRIP/ ROADSIDE COMMERCIAL	6		82								6	6	
127	COMMERCIAL RECREATION	18	3	62		6	2						9	
128	HOTEL / MOTEL	16		61	8							3	12	
129	GENERAL COMMERCIAL	23	9	58								2	8	
132	OIL AND GAS EXTRACTIVE	6				3	91							
133	RESEARCH AND DEVELOPMENT	24	18	9		24	18							
134	MOTION PICTURE	27	15	49									7	
135	MANUFACTURING AND ASSEMBLY	15	34	35		7							9	
136	PETROLEUM REFINING / PROCESSING	10	9			4	46	12	13			1	5	
138	MAJOR METALS	5	5			25	65							
139	WHOLESALING AND WAREHOUSING	19	45	5		13	10			3		1	5	
141	AIRPORT	14	15	27		10	15	10				16	8	
142	RAILROAD	7		33		28	11					7	5	
144	HARBOR FACILITIES	4		32		24	28						5	
150	ELECTRIC POWER FACILITIES	10	5			50	25						10	
152	LIQUID WASTE DISPOSAL FACILITIES	25				50	25							
156	COMMUNICATION FACILITIES	32	5	10		40			4		3		6	
160	SPECIALIZED USE INSTITUTION	22		40		19	4	4	4				7	
161	GOVERNMENT OFFICES AND FACILITIES	21		50	3	12						4	10	
162	EMERGENCY RESPONSE FACILITIES	27		27		28							18	
163	MAJOR HEALTH CARE FACILITIES	6		17		47		10	5				15	
164	ELEMENTARY SCHOOL	7		49		16	15						13	
165	JUNIOR HIGH SCHOOL	13		29		37	3						18	
166	HIGH SCHOOL	13		19		38	6	7					17	
167	COLLEGE / UNIVERSITY / OTHER SCHOOL	16	3	5		48	7	4					17	
168	TRADE SCHOOL	16		27		32	3					1	21	
169	RELIGIOUS FACILITIES	16		42		21	3					2	16	

* Code 122 was distributed amongst building types concrete, 5-19; steel, 5-19; and steel ≥ 20 using a method described in Section 2.4.1.3.1. Land Use Code 122 was the only one with any of its total area assigned to the steel ≥ 20 building type.

** All of the area assigned to Unreinforced Masonry (URM) was distributed according to a method described in Section 2.4.1.3.2.

This table was developed based on interviews with experienced engineers and personnel from local building departments. Using the standardized model building types developed in this methodology, concrete block would be classified as reinforced or unreinforced masonry. You will need to discuss with a local building official or other expert whether or not the concrete block construction contains reinforcing.

To estimate square footage of each building type, one needs to make inferences about the ratio of building square footage to total land. An example of this type of inference is found in Table 5.6. This table, also taken from Scawthorn and Gates (1983), was developed with the help of real estate consulting services, the local school district, and experienced engineers.

Table 5.6 shows that for land containing high-rise apartments (Code 119), the square footage of the apartment is equal to 184% of the land area; whereas, for single family dwellings (Code 112), the square footage of these dwellings is only 18% of the land area. For example, if 4 acres of land contain high-rise apartments and 3 acres contained single-family dwellings, the following inventory results:

4 acres x 43,560 sq. ft/acre x 1.84 bldg. sq. ft/sq. ft = 320,600 sq. ft high rise apartments

3 acres x 43,560 sq. ft/acre x 0.18 bldg. sq. ft/sq. ft = 23,522 sq. ft single family residences

These numbers can then be proportioned among building types using the inferences in Table 5.5. The results are shown in Table 5.7.

Table 5.6 Site coverage for different land use categories

CODE	LAND USE CATEGORY	FLOOR AREA RATIO (%)
111	ESTATE	23
112	SINGLE FAMILY	18
113	DUPLEX / ROW HOUSING	25
114	LOW RISE APARTMENTS / CONDOMINIUMS	48
115	MEDIUM RISE APARTMENTS / CONDOMINIUMS	100
116	RURAL CLUSTERED	4
117	RURAL DISPERSED	5
118	MOBILE HOMES / TRAILER PARKS	25
119	HIGH RISE APARTMENTS / CONDOMINIUMS	184
121	MAJOR OFFICE USE	80
122*	MAJOR OFFICE USE -- 8 OR MORE FLOORS	200
123	REGIONAL SHOPPING CENTER	30
124	NEIGHBORHOOD SHOPPING CENTER	28
125	STRIP/ ROADSIDE COMMERCIAL	40
127	COMMERCIAL RECREATION	35
128	HOTEL / MOTEL	70
129	GENERAL COMMERCIAL	35
132	OIL AND GAS EXTRACTIVE	2
133	RESEARCH AND DEVELOPMENT	35
134	MOTION PICTURE	20
135	MANUFACTURING AND ASSEMBLY	65
136	PETROLEUM REFINING / PROCESSING	5
138	MAJOR METALS	50
139	WHOLESALING AND WAREHOUSING	60
141	AIRPORT	5
142	RAILROAD	5
144	HARBOR FACILITIES	30

CODE	LAND USE CATEGORY	FLOOR AREA RATIO (%)
150	ELECTRIC POWER FACILITIES	10
152	LIQUID WASTE FACILITIES	2
156	COMMUNICATION FACILITIES	5
160	SPECIALIZED USE INSTITUTION	15
161	GOVERNMENT OFFICES AND FACILITIES	60
162	EMERGENCY RESPONSE FACILITIES	50
163	MAJOR HEALTH CARE FACILITIES	80
164	ELEMENTARY SCHOOL	25
165	JUNIOR HIGH SCHOOL	23
166	HIGH SCHOOL	33
167	COLLEGE / UNIVERSITY / OTHER SCHOOL	25
168	TRADE SCHOOL	30
169	RELIGIOUS FACILITIES	30
*The amount of area in Land Use Code 122 was distributed according to a method described in Section 2.4.1.3.1 and this Floor Area Ratio was used only as a check against the estimate.		

Table 5.7 Square footage of each building type for study region

	Wood (1-2 stories)	Unreinforced Masonry	Reinforced Masonry	Concrete (5-19 stories)	Steel (5-19 stories)
High Rise Apartments	-	-	32,060	221,214	67,326
Single Family Residential	20,464	1,176	1,882	-	-

Land use information can be obtained from Land Use and Land Cover maps and digital data available from the USGS, or from maps developed by local counties and cites. It should be understood that the resolution of USGS maps (1/100,000 or 1/250,000 scale) might not be adequate. Some of these maps are based on aerial photography from the mid-1970s and have not been updated. As a result, they may not contain newer developments. Check the aerial photography source date before using these maps. An index of available maps and digital data can be obtained from the USGS.

A mix of higher resolution landuse data and mapping has been completed, or is in-progress by many counties and watersheds in the U.S. for planning purposes. Some municipalities maintain their own land use maps or computerized land use databases. Increasingly, landuse datasets are available online from local GIS programs around the country.

5.2.3 Aerial Photography

Aerial photography may be most useful for developing land use maps in areas where they do not already exist. A great deal of research has been done on how to convert aerial photographs to land use maps (Gauchet and Schodek, 1984; Johnson, 1986; Jones et al., 1987). The effort involved is significant; therefore, other methods of collecting inventory may be more appropriate.

5.2.4 Discussions with Local Engineers and Building Officials

Valuable information, particularly on age and type of construction, can be collected from discussions with engineers, building officials and inspectors. Past experience has shown that the best data collection occurs if interviews are conducted in an organized and consistent manner. In a loss study by the Association of Bay Area Governments (ABAG, 1986) typical interviews lasted 1 to 3 hours and involved filling out a form such as the one shown in Figure 5.2. It was discovered in the interview process that building officials who had been working and living in the region for a number of years could provide much more information than those who were new to the region. In addition, building officials could provide little information about facilities for which they have no jurisdiction - these included public schools, hospitals, state colleges and universities, state penitentiaries and federal military installations.

To develop the occupancy to model building type relationships used in this methodology, several one-day workshops were performed around the country. These workshops were comprised of building officials, engineers and academics. Appendix F contains an example of a questionnaire that was used to better understand the characteristics of the regional building stock.

TABLE 8-1-
PERCENTAGE OF SELECTED BUILDING TYPES
WITHIN LAND USE CLASSIFICATIONS

CENSUS TRACT NO.________ JURISDICTION:________	IS TRACT SPLIT:________ OTHER JURISDICTIONS: ________ ________	TRACT POPULATION:________ TRACT POPULATION IN JURISDICTION:________ TRACT EMPLOYMENT:________

LAND USE	WOOD FRAME (%)	LIGHT METAL (%)	MASONRY (%)	CONCRETE AND STEEL (%)	PRE-CAST CONCRETE (%)	MOBILE HOME-TYPE (%)
11 RESIDENTIAL						
(111) 1 or less Du/acre						
(112) 2-8 Du/acre						
(113) 9 or more Du/acre						
(114) Mobile Home Parks						
12 COMMERCIAL & SERVICES						
(121) Retail & Wholesale						
(122) Commercial Outdoor Recreation						
(123) Education						
(1231) Elementary & Secondary						
(1232) Colleges & Universities						
(1233) Stadiums						
(124) Hospitals, Rehab Centers, Other Public Facilities						
(125) Military Installations						
(126) Other Public Institutions and Facilities						
(1261) Stadiums						
(1262) Church						
(127) Research Centers						
(128) Office						
(129) Hotels						
13 INDUSTRIAL						
(131) Heavy Industrial						
(132) Light Industrial						
14 TRANSPORTATION UTILITIES						
(141) Highways						
(142) Railways						
(143) Airports						
(144) Ports						
(145) Power Lines						
(146) Sewage treatment plants						
15 COMMERCIAL AND INDUSTRIAL						
16 MIXED URBAN OR BUILT-UP LAND						
(161) Transitional						
(162) Mixed use in buildings						
17 OTHER URBAN OR BUILT-UP						
(171) Extensive recreation						
(1711) Golf Courses						
(1712) Racetracks						
(172) Cemeteries						
(173) Parks						
(174) Open space-urban						
NON URBAN						
(233) Greenhouses						
(55) Sedimentation ponds						
(75) Mines, quarries and gravel pits						
(761) Sanitary land fills						
Comments:						

Figure 5.2 Association of Bay Area Governments (ABAG) survey

Chapter 6. Entering and Managing Data in Hazus

Hazus contains a variety of default parameters and databases. You can run a loss estimation analysis using only default data (Chapter 3), but your results will be subject to a great deal of uncertainty. If you wish to reduce the uncertainty associated with your results, you can augment or replace the default information with improved data collected for your region of study.

Hazus contains two import tools for entering data: the stand-alone CDMS (Comprehensive Data Management System) for improving general building stock and site-specific data (discussed in Chapter 8), and the Inventory import menu option for entering site-specific (ex. hospitals, schools) and hazard data (ex. liquefaction, landslides). Data which has not been imported can still be used as overlays and for general spatial queries, but will not be treated in the loss estimation model.

As has been discussed in earlier sections, it is very likely that data obtained from different sources will not be in the same format. Furthermore, the data may contain a different number of fields than the data defined in **Hazus**. This will require mapping the data fields to the correct format and inclusion in the centralized geodatabase. The following sections describe importing data, entering data through **Hazus** windows, and managing the data.

6.1 Importing Features and Files

Only some offices and potential **Hazus** users will have the most current version of GIS software; others will not currently use ESRI software. Those who have previously applied **Hazus** for Level II analysis will recognize the similarity of data field headers and inventory requirements. All operators of **Hazus** will be starting with the newest default datasets; first to be evaluated, and then improved by directly editing the default inventories, or by importing new data files. Data that are not already formatted in GIS will require conversion to the standardized ESRI ArcGIS geodatabase format before importing.

6.1.1 Importing Site-Specific Data Files

Arcview shapefiles, ArcInfo coverage files, CAD files, image files, and tabular database files (e.g. Paradox, dBase) must be converted to a geodatabase (*.mdb) for use with **Hazus**. Several file types (e.g. shapefile, drawing, tabular) may be converted to one or more geodatabases for import. MapInfo, Atlas, or other CAD file formats will generally require exporting files to a shapefile format in order to bring them into ArcGIS. Images or files designated for reference only can still be added as a simple layer for use in displays, and need not be imported. Data intended for consideration by the loss estimation model must be imported. ArcCatalog or ArcMap can be used for this purpose.

Select the inventory you wish to improve from the **Hazus** Inventory menu and begin editing (see Figure 6.1). Using the mouse, left-click on a record, then right-click and choose "Start Editing". Now that you are in the edit mode, "Import" will appear in bold when you right-click the mouse (Figure 6.2). Enter the directory and filename for the database you wish to import, as in Figure 6.3.

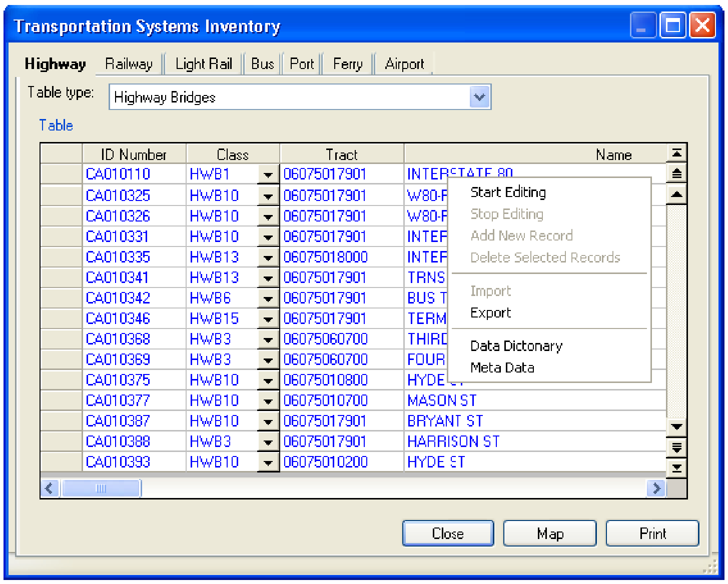


Figure 6.1 Start editing to import data.

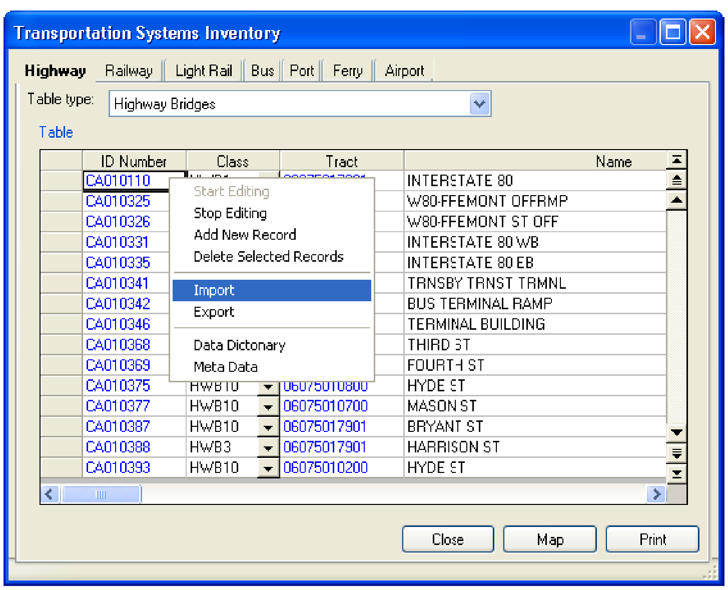


Figure 6.2 Import features with attributes.

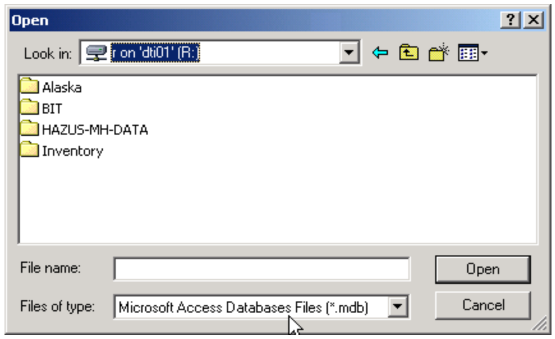


Figure 6.3 Identify the database to be imported.

6.1.2 The Import Database Utility

A database import utility has been developed to assist you in converting an electronic database to the appropriate format for **Hazus**. Clicking on the right mouse button accesses this import utility. Select the **Import database** and click on the name of the file you want to import; click the **OK** button.

The mapping window shown in Figure 6.4 is used to map the each field in your database (the source) to the corresponding field used in the **Hazus** database (the target database). The Database Dictionary in Appendix E contains the names and structures of all of the databases that are used by **Hazus**. From the Database Dictionary you can determine the names of the target fields. The Database Dictionary, in an abbreviated, form is available interactively in **Hazus**. To access it, click on the right mouse button; using the same menu shown in Figure 6.2, click on **Dictionary**. An example from the Database Dictionary is shown in Figure 6.5.

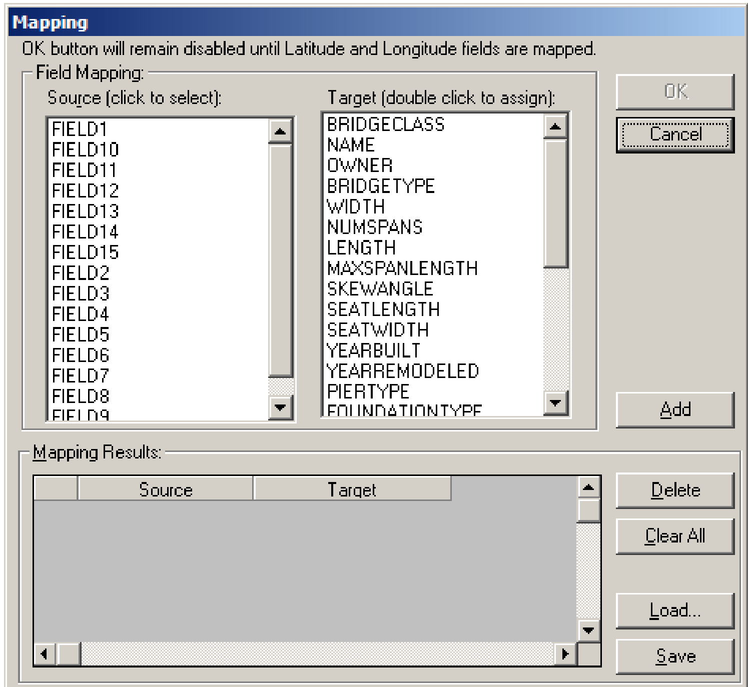


Figure 6.4 Mapping the fields of your data file to the Hazus data structure

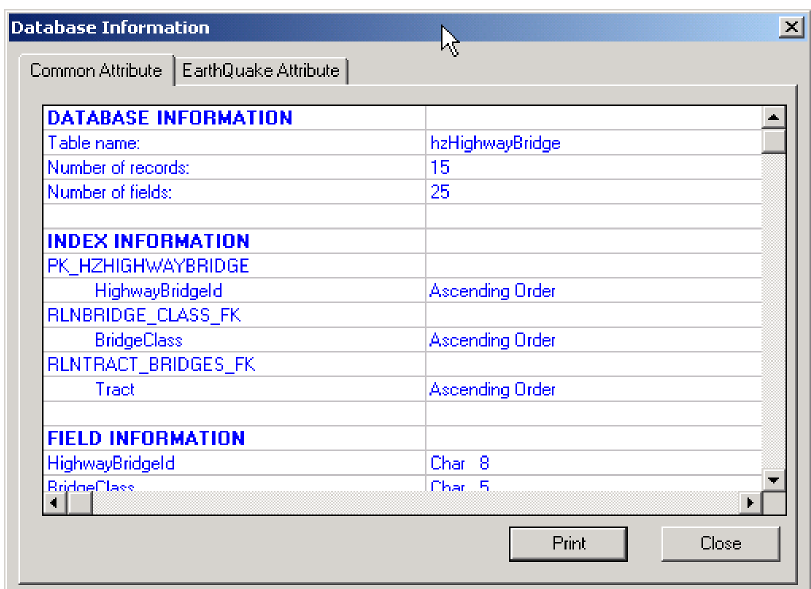


Figure 6.5 Interactive database dictionary.

The fields from the **Source** menu do not have to be in the same order nor do they have to have the same names as the fields in the **Target** menu. To define the desired mapping scheme, simply click on a field name from the **Source** menu (e.g. LON) and the corresponding field name from the **Target** menu (e.g. Longitude); then click on the **Add** button.

After performing these steps, the mapping you have defined will disappear from the **Source** and **Target** menus and will appear in the **Mapping Results** box at the bottom of the window. If you make a mistake, click the **Delete** button, and the last mapping pair you have defined will be undone. In this example, the user has already defined six relationships and is in the process of defining a seventh. When you have completed defining all of the information, click on the **OK** button, wait a few seconds, and your imported database will be displayed in **Hazus**. You do not have to map all of the fields from the **Source** menu. However, any fields you do not map will not be imported into the **Target** database.

It is possible to have several databases with the same format. To save the mapping that you have defined so that it can be reapplied to other files, click the **Save** button in Figure 6.4 and the dialog box shown in Figure 6.6 will appear. Enter a name for the mapping scheme and click the **OK** button. To retrieve the saved mapping, click on the **Load** button in Figure 6.4.

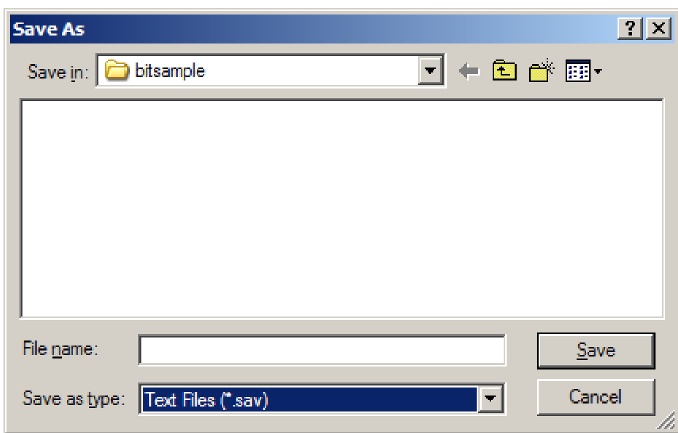


Figure 6.6 Saving a database mapping scheme.

6.2 Adding Records to Site Specific Databases

In addition to importing entire datasets, you can add one or more site-specific (point) feature records at a time to improve inventories of essential facilities, high potential loss facilities, lifeline components and facilities storing hazardous materials. When you identify a new site, you will need to add a new feature record with attributes.

6.2.1 Adding Features Using the Study Region Map

You will notice that feature locations are listed in the ArcMap attribute table without the entire set of feature attributes. **Hazus** stores attributes other than the each feature identifier and coordinates using SQL Server. This design for feature and attribute storage is for efficiency, and allows for anticipated expansion to interactive web-based delivery of the program. The database design requires you to add features in the following steps:

Map the table you want to edit.

Start Editing using the ArcMap Editor toolbar.

Select the appropriate and available database (e.g. util.mdb for editing utility facilities).

Add features[6].

Select **Stop Editing** features from the Editor toolbar when.

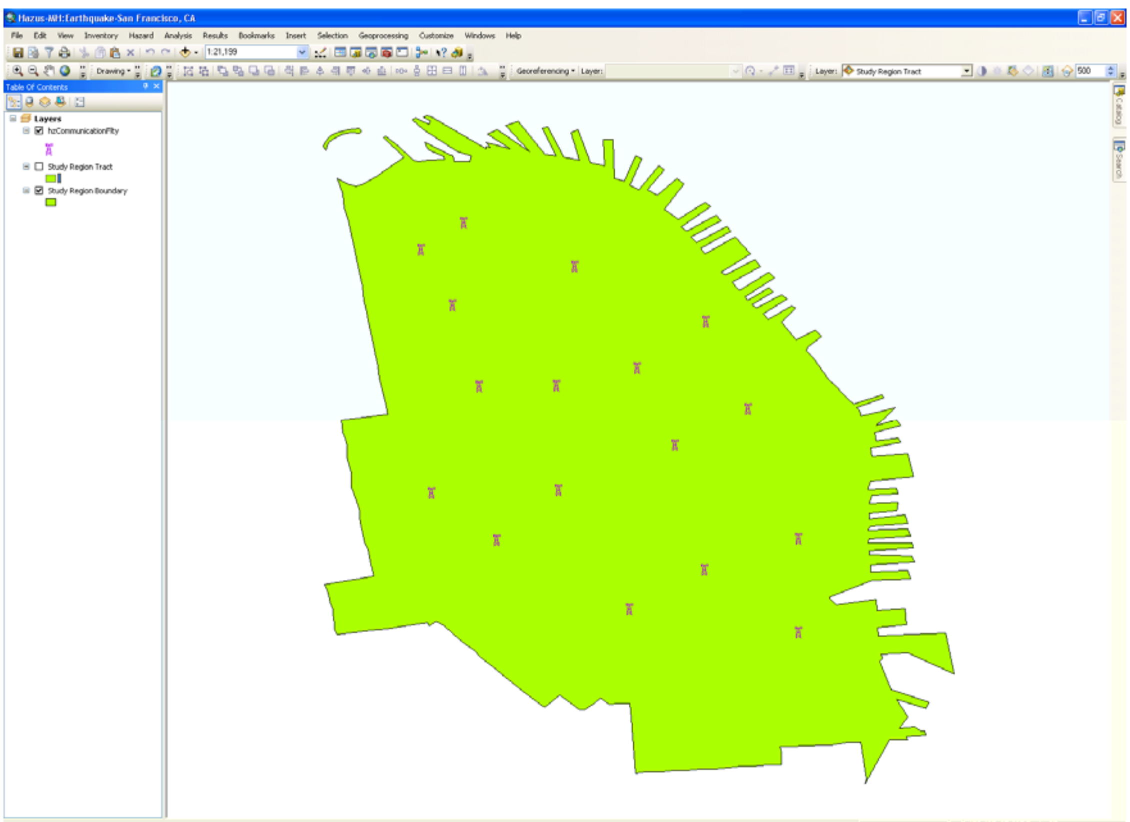
Open **Hazus** Inventory menu and select the appropriate inventory (e.g. utilities).

Add attributes to each new feature record by placing the cursor in the desired field.

Notes:

The feature ID field cannot be edited.

Several fields include a pick list for standardized data entry (see Figure 6.10)



[6] Editing using the **Editor** toolbar is a standard ArcMap. Refer to ArcMap's documentation and online help for details.

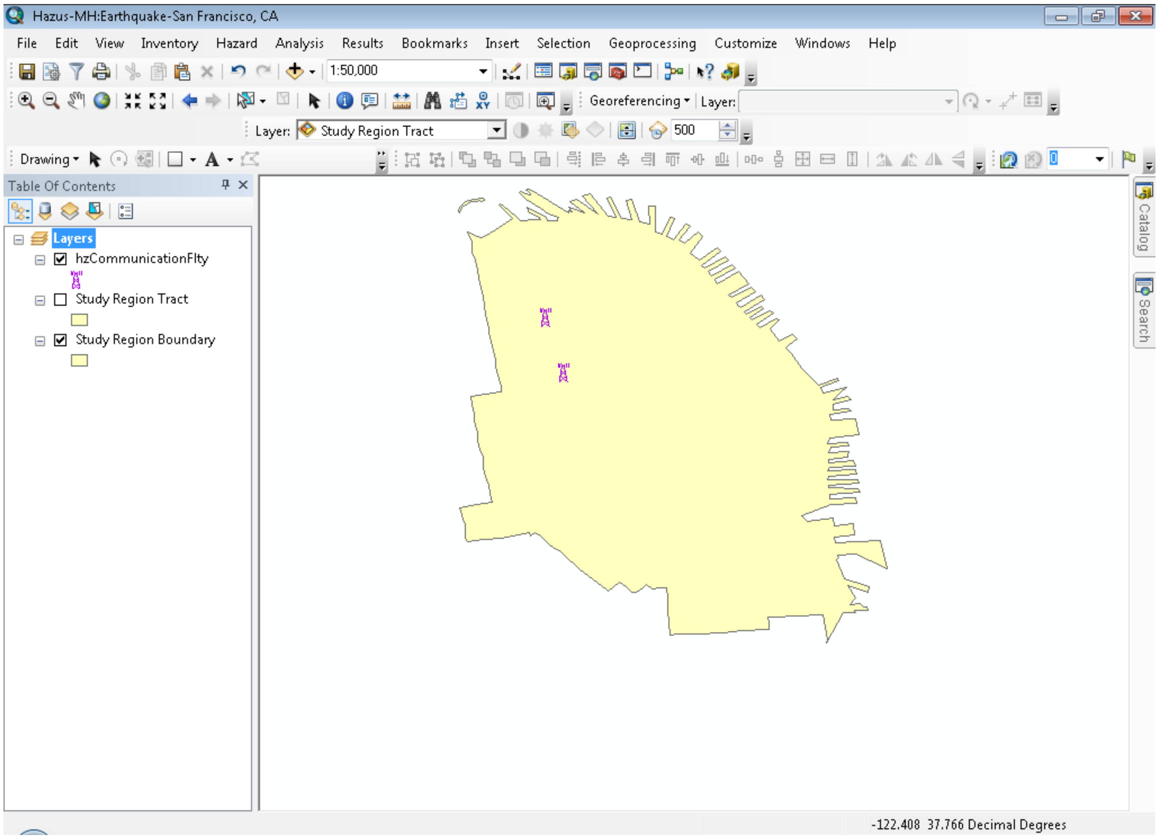


Figure 6.7 Add site-specific feature.

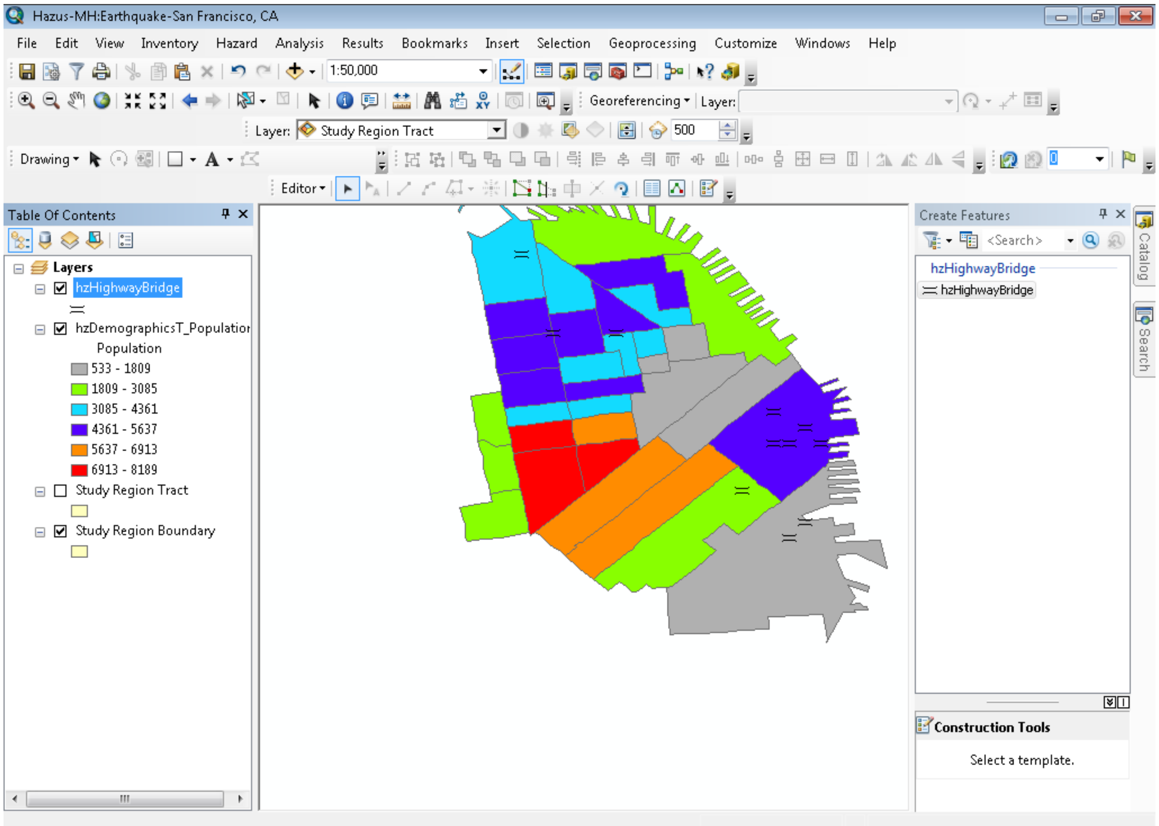


Figure 6.8 Add feature using ArcMap edit tool.

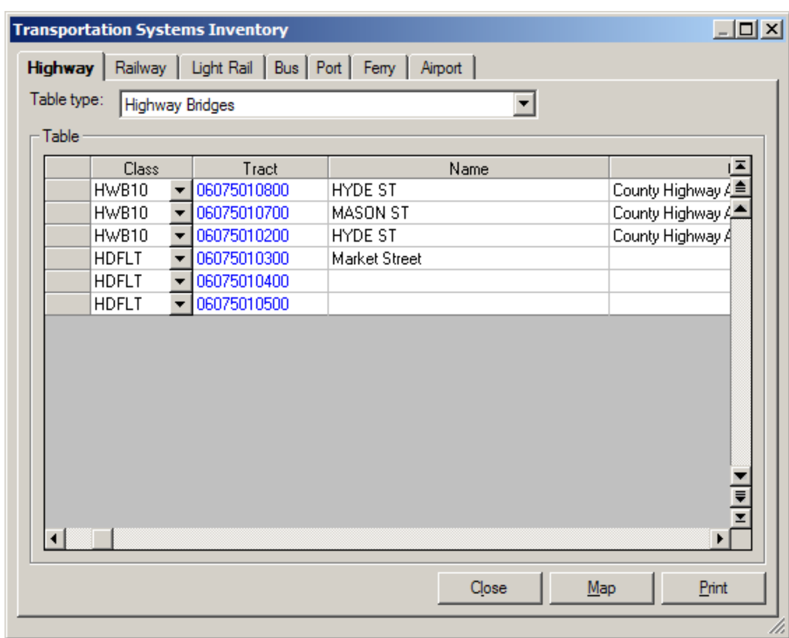


Figure 6.9 Add attributes under Hazus Inventory menu.

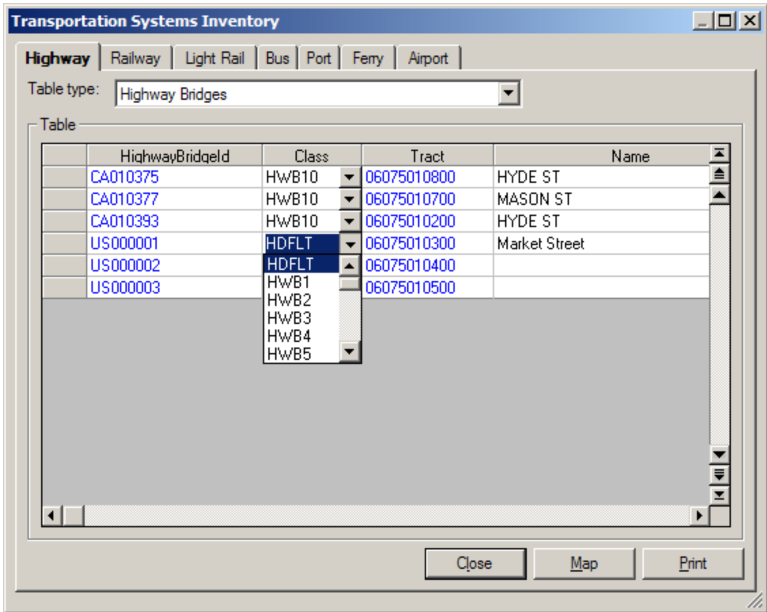


Figure 6.10 Use attribute pick lists where available.

The site-specific, or facility inventories have many more data fields than are required for estimating potential losses. The additional information is beneficial to the overall analysis, and cost-efficient to collect along with the minimum data required running **Hazus**. At minimum, the required fields for each database are specified in Appendix E[7]. **Hazus** will create automatically a unique ID to identify uniquely the record[8].

6.2.2 Adding Records to the Attribute Table

The one essential datum element ***required*** to define a facility is its location. If its location was not added graphically (see Figure 6.7), the only other way to define a facility location in **Hazus** is to type the longitude and latitude of the facility, as in Figure 6.11. If you don't know the longitude and latitude of the facility, you will need to use a geocoder[9] to get the longitude and latitude of the location and then add it to the database in **Hazus**. Once you have defined a location, click on the **OK** button and the new point feature will be saved.

---

[7] Required fields are labeled as *mandatory* fields in the data model. While required, in most cases the data model has *default* values assigned as shown also in the data model in Appendix E.

[8] For user-input data, the ID is in the format USnnnnnnnn, where n is sequential number. For the default data, the first two characters are the state code (CA, DC, GA, etc.)

[9] The geocoding process is performed outside Hazus® Any commercial geocoder application can be used.

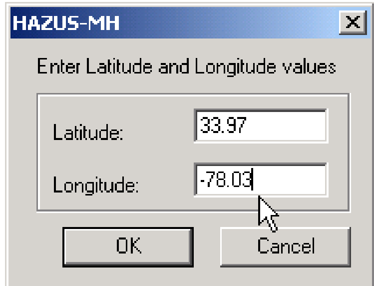


Figure 6.11 Add Record latitude/longitude coordinates.

When the location has been entered, a default set of attributes will be assigned to each new record, in the event no other detail is available. For example, **Hazus** assumes a generic default bridge class of HDFLT if no bridge class is supplied. To complete the new records using improved information, fill in the required fields using the pick lists provided for standardized data entry (see Figure 6.10). Complete the data fields that do not have a pick list with the best available information.

To save the new added records to the database, right-click and select **Stop Editing**. **Hazus** will prompt for confirmation and will save then the data to the hard-disk.

6.2.3 Errors When Adding Records

Hazus is very strict about enforcing the rule that *all inventory data points must fall within the study region boundary*. If you define facility locations that are outside the study region, **Hazus** deletes them and displays the dialog show in Figure 6.12.

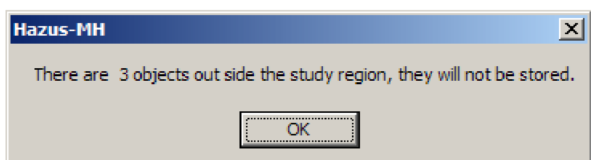


Figure 6.12 Sites added outside the study region will not be accepted.

6.3 Deleting Records from Site Specific Databases

Select the record to be deleted from a database by clicking on the record marker on the left side of the record ID. When the records have been selected, use the right mouse button to display the database management options shown in Figure 6.13, and choose **Delete Selected Records**.

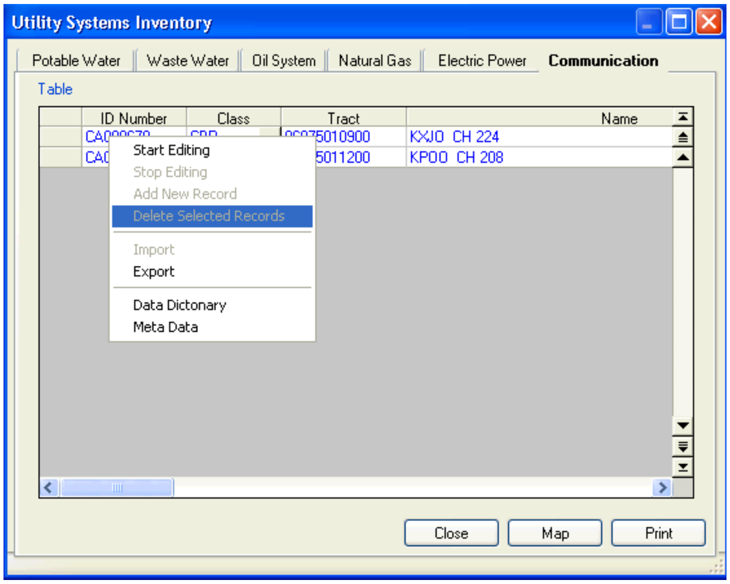


Figure 6.13 Select and delete records from a facility database.

6.4 Editing Records

Attributes associated with default, or improved point and line features can be edited directly in **Hazus**. Open the **Hazus** menu **Inventory** and choose the database to edit. Right-clicking the mouse on the spreadsheet, placing the cursor in the desired cell, and replacing the text to be modified can edit data within a record. In order to minimize errors, use the pick lists to fill in the value whenever a list is offered (see Figure 6.10)

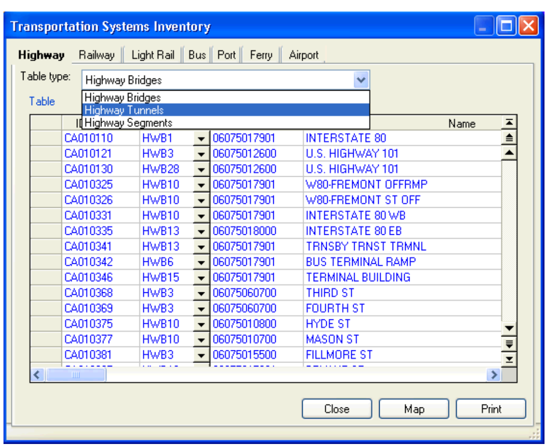


Figure 6.14 Edit default inventory.

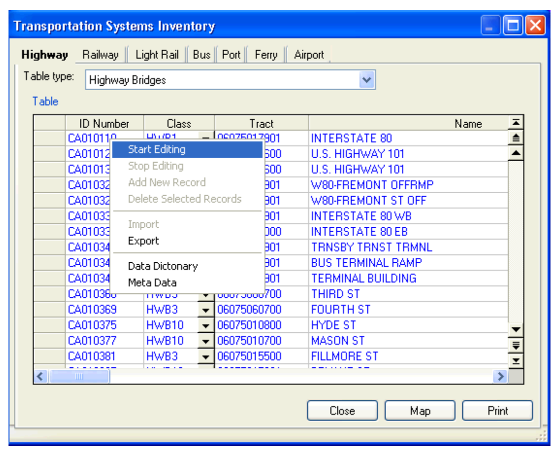


Figure 6.15 Menu option to start editing.

Alternatively, a facility's location can be moved by choosing **Start Editing** from the ArcMap **Editor** toolbar. In edit mode, use one of ArcMap's selection buttons to isolate the facility of interest. With your feature selected and mouse button held down, drag and drop the facility symbol from its old location to the desired new location. To delete a location, select the facility on the map and press the <**Delete**> key. The feature and all associated attributes in the inventory database will be deleted.

You can move or delete multiple records at one time. To do so, use the ArcMap selection tools to select by location. You can draw a box around several sites to select a group; or, select a single structure by clicking on each location, one at a time, while holding the <**Shift**> key down. When all the locations have been selected, release the <**Shift**> key and follow the above steps for deleting or moving a record. When finished, click on the **Editor** toolbar and select **Stop Editing**. You will be asked to confirm (or dismiss) your changes to the database.

6.5 Adding Lifeline Segments

Lifeline segments must be created using ArcMap **Editor** tools. To add lifeline segments (ex. highway, railway, light rail, etc.) you must be familiar with the functionality of the "Editor" in ArcMap. Refer to the ArcMap documentation for details.

6.6 Specifying Hazard Maps

Simplified hazard maps are generated during the creation of the study region. These crude hazard maps are based on default soil maps and the census tract boundaries and can be modified by a user that has a general understanding of spatial distribution of the hazards. If digital information is available from experts or other state agencies, the expert-generated maps should replace the simplified maps. Refer to **Appendix K** for instructions about how to convert shape file based hazard maps to corresponding geodatabases based hazard maps that could be used with **Hazus**.

Define hazard soils under the **Hazus** menu **Hazard / Scenario**. The wizard shown in Figure 6.16 will guide you through the choices to reset the default soil hazard value of the primary soil map (NEHRP). You will also have an opportunity to reset the default values assigned to liquefaction, landslide, and water depth; or, to enter an improved map for each.

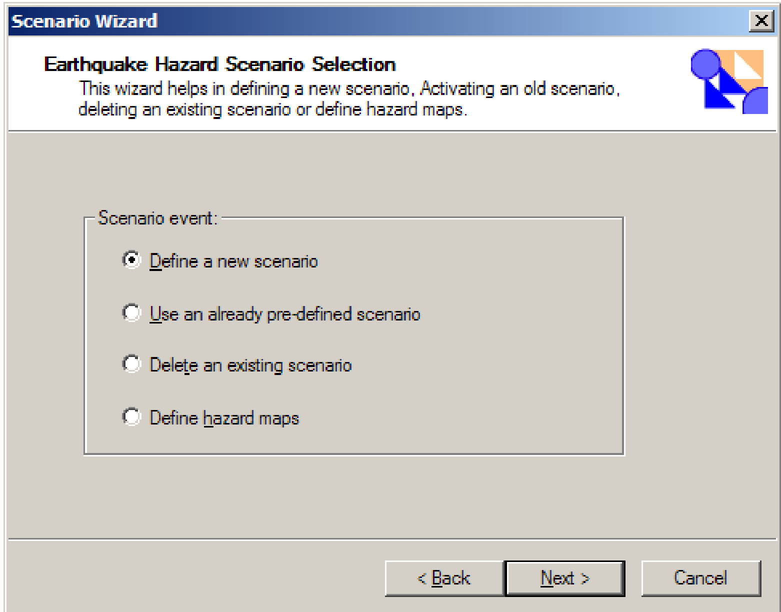


Figure 6.16 Define earthquake hazards maps.

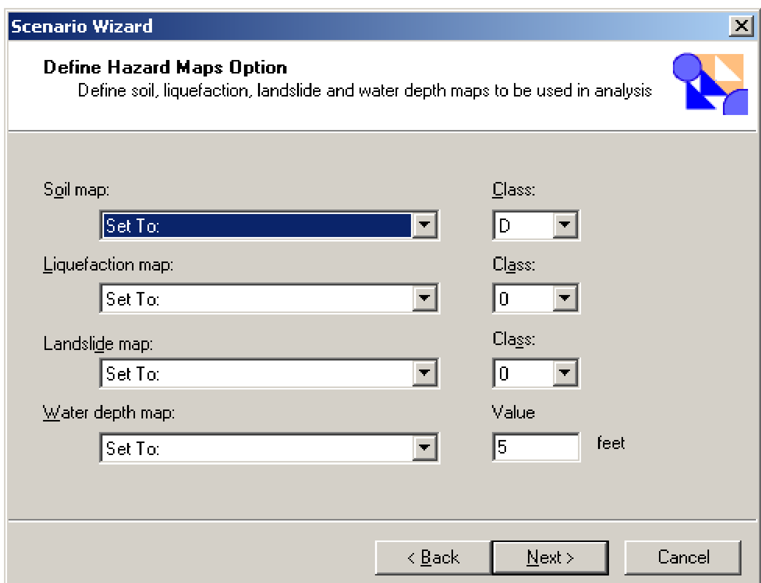


Figure 6.17 Select soil hazard values, or use improved hazard maps.

Soil, liquefaction susceptibility and landslide susceptibility maps listed in the 'Define Hazard Maps Option) shown in Figure 6.17 are input through the **Hazard|DataMaps** menu. To add a file, either type the path name in the provided box, or click on the button to the right of the box. This button will access a standard "Open" window. Move around the directories to find the needed file. Remember, hazard data, like all other data used in **Hazus** must be in geodatabase format (*.mdb).

When hazard data have been added, you will be able to choose among them for use in an analysis. The window in Figure 6.18 tracks the addition and use of each hazard map, and is available from the menu **Hazard|Data Maps**. Figure 6.19 confirms the replacement of the default liquefaction map with improved data.

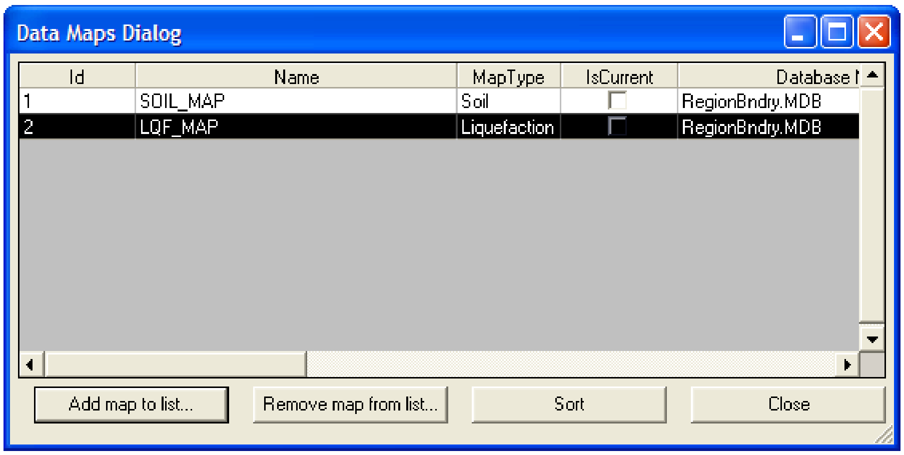


Figure 6.18 Hazus Data Maps Dialog.

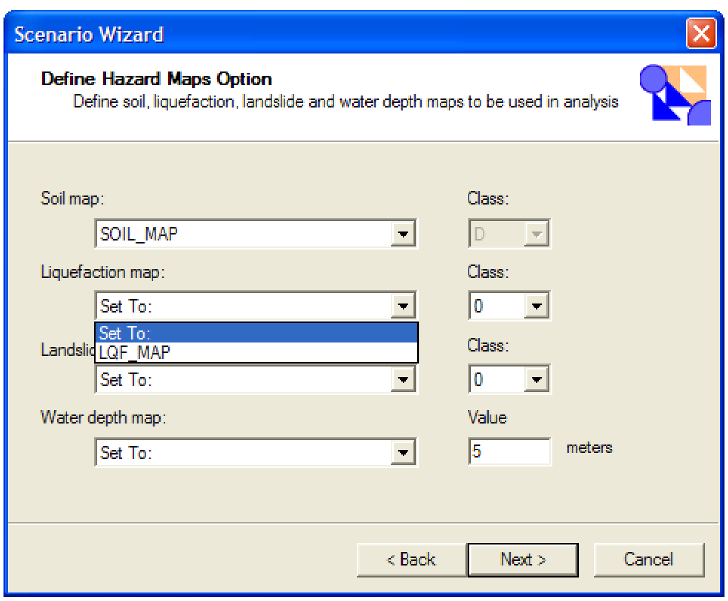


Figure 6.19 Improved hazard maps can replace default hazard maps.

6.6.1 Modifying Hazard Maps

The default earthquake hazard maps can be modified by directly entering the newly desired default value or class as in Figure 6.20. If information derived from local sources suggests the default data do not represent actual conditions, yet improved hazard maps are not available, the site class of each hazard for the study region can be changed. These modifications may also be considered as part of a model sensitivity analysis.

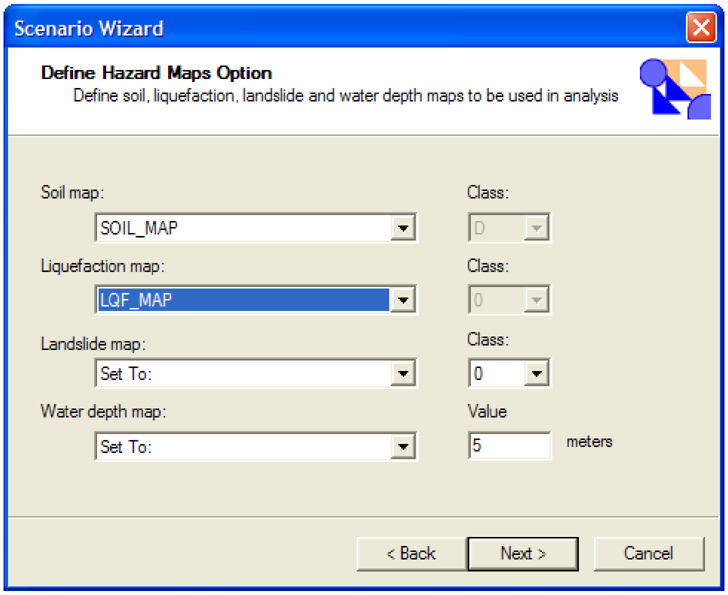


Figure 6.20 Default hazard maps can be modified.

Chapter 7. Displaying, Modifying and Mapping Inventories

Chapter 6 discussed how to enter data and import databases. Once your data is entered into **Hazus**, you have a number of options available for displaying and modifying the data.

7.1 Editing a Database

Data within a database can be edited by double clicking on the spreadsheet cell containing the data you want to change. Highlight the text you wish to modify and your typing will replace the highlighted text.

7.2 Printing a Database

All databases can be printed to hardcopy using the **Print** button at the bottom of the window (see Figure 7.1).

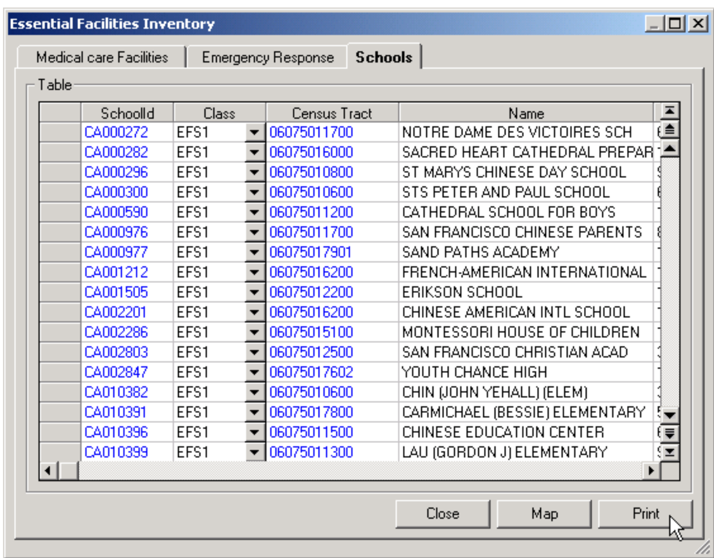


Figure 7.1 Print database.

7.3 Modifying Occupancy to Model Building Type Relationships

The method for creating and editing relationships between occupancy and building types is new with **Hazus**. Modifications to these relationships are easily traced for comparative analyses.

On the main menu select **Inventory|General Building Stock|Occupancy Mapping**. The initial window opens with a table including the default occupancy mapping scheme for your region, as in Figure 7.2 Occupancy mapping schemes list.. The default scheme text is in blue, indicating that it cannot be edited. You will also see the total number of census tracts that have the mapping scheme assigned (default = all tracts). You can view the default scheme, create or import a new scheme, and print the list of occupancy mapping schemes that you have to use for the study region. Each scheme on the list is available to assign individual census tracts an occupancy map that accurately represents the area (vs. the default assignment). A mapping scheme may be deleted, but only when it is not assigned to a census tract.

Clicking the right mouse button when an occupancy mapping scheme is highlighted on the list will allow you to create a new scheme from a duplicate of the one you have selected. Choose the option **New** from the options menu and type in a new scheme name and description. Describe the new occupancy mapping scheme to explain variations in building types, age and height of buildings, originator of scheme, etc.

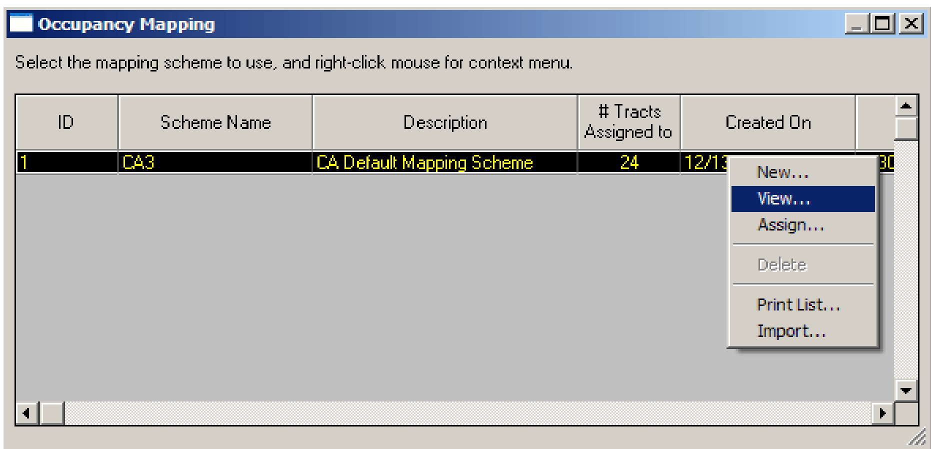


Figure 7.2 Occupancy mapping schemes list.

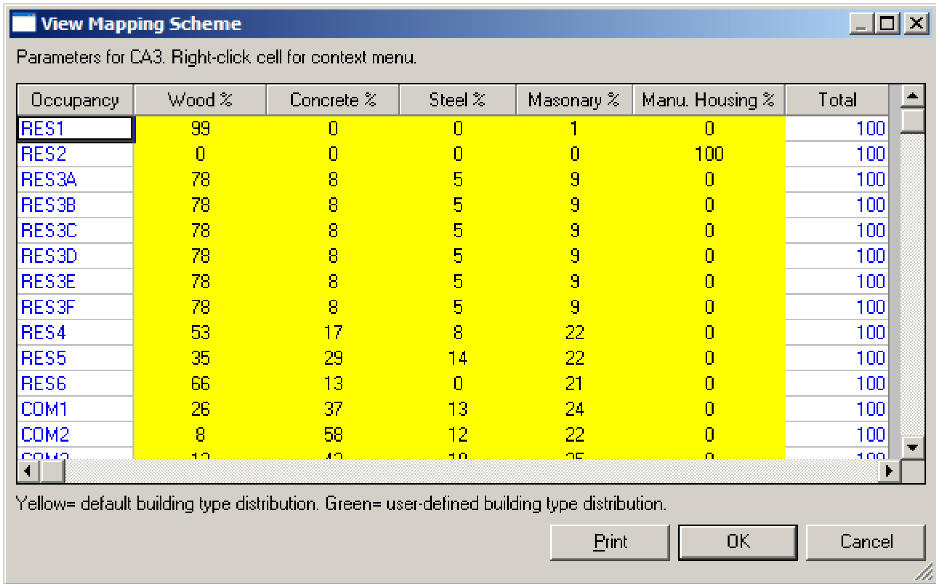


Figure 7.3 View of default Occupancy Mapping.

Figure 7.3 is the view of default values by general building type used to describe each occupancy type (ex. RES1, COM1). The makeup of each occupancy type can be changed to reflect the actual conditions for any single, or multiple census tracts. Each row of the spreadsheet represents an occupancy class and each column represents a model building type. For this example, retail trade stores (COM1) consists of 26% Wood, 37% Concrete, 13% Steel, 24% Masonry, 0% Manufactured Housing. The sum of the model building type percentages for each occupancy must equal 100, and the sum value is found in the last column of the spreadsheet, entitled "Total".

Occupancy mapping in **Hazus** does not isolate age of the building as a variable; instead, the overall design level (High, Moderate, Low, and Pre-code) is considered when assigning a mapping scheme. Building height is accommodated in the building type sub-category. For example, a low rise reinforced masonry building (RM1L) may be used to map buildings used for commercial retail (COM1) or residential multi-family dwelling (RES4).

The composition of building types associated with each occupancy can be further refined by editing the characteristics of each general building type. Right-click on the spreadsheet cell corresponding to the occupancy/building type you wish to refine. Behind each percent value of a general building type is a distribution matrix that describes the quantity and quality of the buildings in that general building type category. When you edit the composition of buildings that make up each type, the spreadsheet cell will turn from yellow (default) to green (see Figure 7.4), signifying that the general building type has been customized.

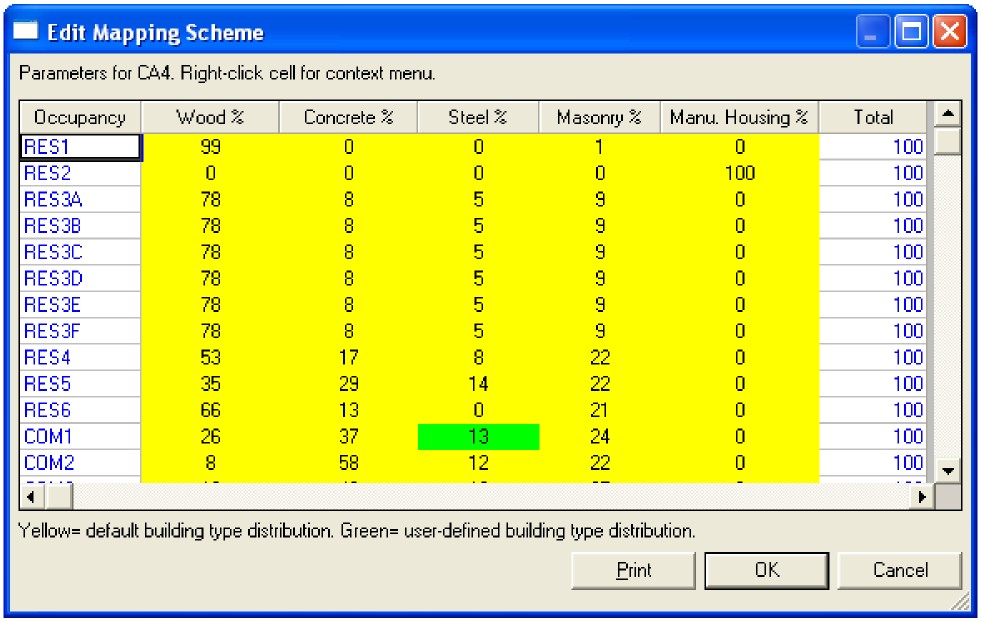


Figure 7.4 Composition of steel buildings occupied by retail commerce has changed.

For example, an old commercial center was torn down and half of it replaced by a new shopping mall in Census Tract 37019020501. Fifty percent of all the retail buildings in this one tract have changed the occupancy map for the census tract area. The new buildings were constructed to a high Seismic Design Level and superior to the existing Building Code, as shown in Figure 7.5. An occupancy map was created to reflect this change in steel buildings and the new scheme was assigned to the appropriate tract, as in Figure 7.6and Figure 7.7.

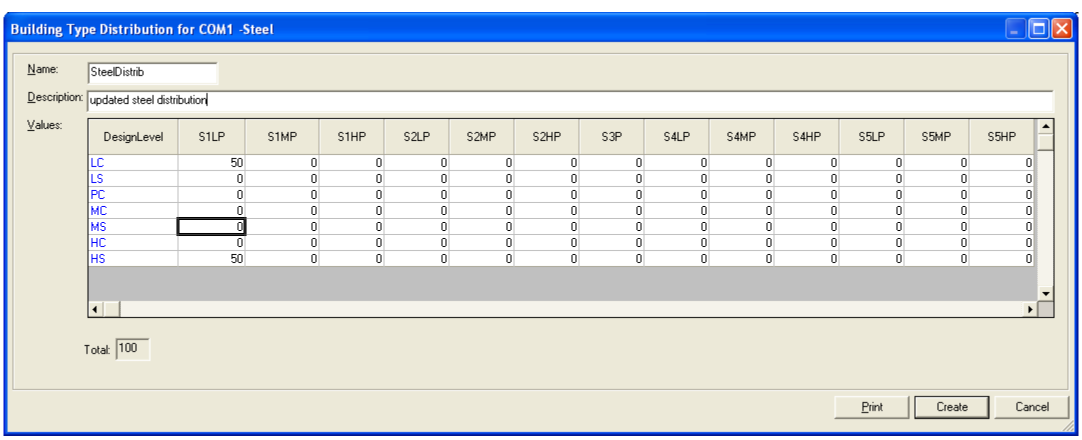


Figure 7.5 Fifty percent of the steel buildings are now superior (S) in building quality and high (H) in design level.

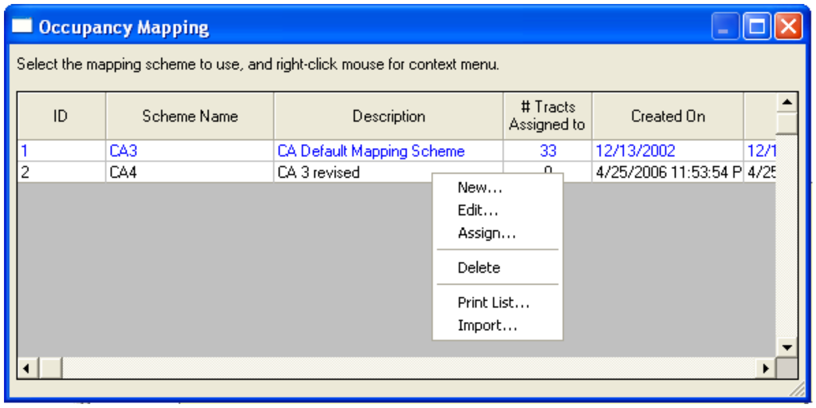


Figure 7.6 Select the new occupancy map to assign to a census tract.

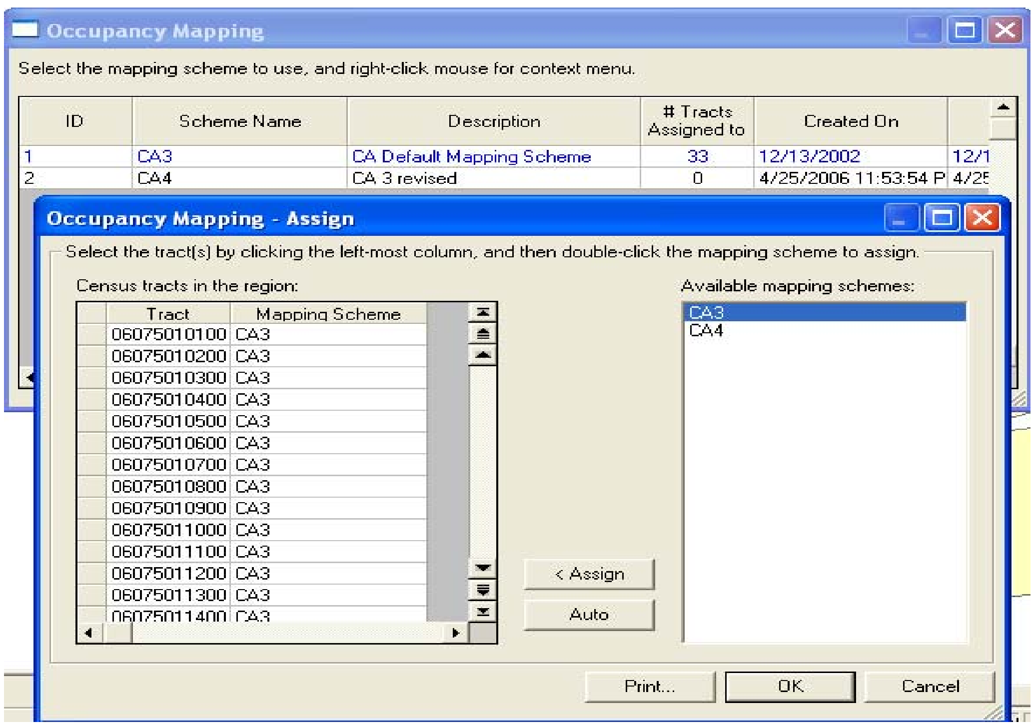


Figure 7.7 New occupancy mapping scheme assigned to a census tract.

7.3.1 Design Level

The design level designation is tied to the vulnerability to damage of a structure, and is reflected in the damage functions (fragility curves). Fragility curves are discussed in Chapter 9 of this manual and in the *Technical Manual*. **Hazus** gives you the option to define a mix of design levels for each model building type. A mix of design levels can occur when structures are built at different times and are designed under different codes. The damage functions are based on current NEHRP provisions (FEMA, 1991a) and are intended to represent current code provisions. Damage functions are developed for each of three seismic design regions, defined in terms of the 1994 NEHRP Provisions map areas: High Seismic Design (Map Area 7), Moderate Seismic Design (Map Areas 5 and 6), and Low Seismic Design (Map Areas 1 to 4).

In those regions that have not enforced seismic design codes or have a number of buildings that do not meet current standards, the damage functions may under-predict damage. In contrast, the damage functions may over-predict damage for buildings that are designed/constructed for performance beyond code requirements. The latter case is not expected to include a large population of buildings and is not expected to affect regional damage/loss estimation.

The year when seismic provisions were included in building codes varies by region. The user should consult a local structural engineer or the local building department to determine what year seismic design provisions was enforced. Section 5.7 of the *Technical Manual* and FEMA publication 154 both provide some general guidelines for different regions of the United States.

7.3.2 Modifying the Mapping Scheme to Reflect Different Design Levels

Users may tailor the damage functions to their study area of interest by determining the appropriate fraction of each building type that generally conforms to current code provisions (ex. High in California, Moderate and Low in Florida), and the fraction that is substandard by a significant degree. Buildings that are considered significantly substandard would be assigned a lower seismic design group.

For instance, certain types of older buildings in Map Area 7 should be evaluated using damage functions for Map Areas 5 & 6. Such buildings would include concrete moment frames (Building Type C1) on the west coast built prior to the mid-1970's. Buildings over 60 years old were likely designed only for wind. At least a portion of these older buildings may best be evaluated using the damage functions developed for Map Areas 1-4. To modify defaults, users must be knowledgeable about the type and history of construction in the study region of interest and apply engineering judgment in assigning the fraction of each building type to a seismic design group.

7.4 Assigning Different Mapping Schemes to Different Census Tracts

The user can create a series of occupancy mappings by modifying the default values and saving the different mapping schemes under different names. Different mapping schemes can then be assigned to different census tracts. The reason the user may wish to create different mapping schemes is that building practices may vary throughout the study region. For example, in an older area 30% of the retail buildings (COM1) may be low rise unreinforced masonry (URML), while in more recently developed areas, only 5% of COM1 may be of model building type URML.

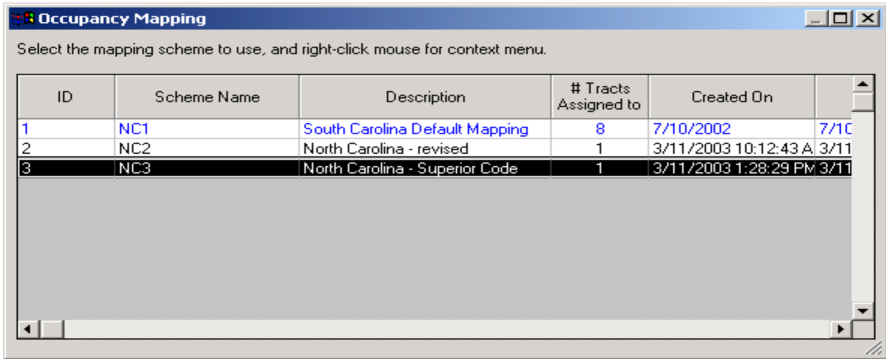


Figure 7.8 Tracking assignments of each occupancy mapping scheme.

7.5 User Specified Building Types

By default **Hazus** supports thirty six specific building types as shown in Table C1 of Appendix C that could be grouped into five general building types Wood, Steel, Concrete, Masonry and Manufactured Homes. All the default mapping schemes, damage functions, debris parameters, casualty parameters available in **Hazus** default data are based on these thirty six specific building types. What if a user has a building type not modeled by any of these thirty six building types? For example the user has an 8 storey Reinforced Masonry Bearing Wall with Metal Deck building. By default **Hazus** could model this building as a mid rise building only.

The User Specified Building Types is a new feature added to **Hazus-MH since MR1** to allow the user to add a new specific building type that is not currently modeled by **Hazus** methodology. Considering the above example, now you can model it as a high rise building by creating a new building type that represents a Reinforced Masonry Bearing Wall with Metal Deck High Rise.

On the main menu select **Inventory|General Building Stock|Define New Building Type**. The welcome screen of the Create New Building Type Wizard gets launched (Figure 7.9 Welcome Screen). Click on the Next button to proceed.

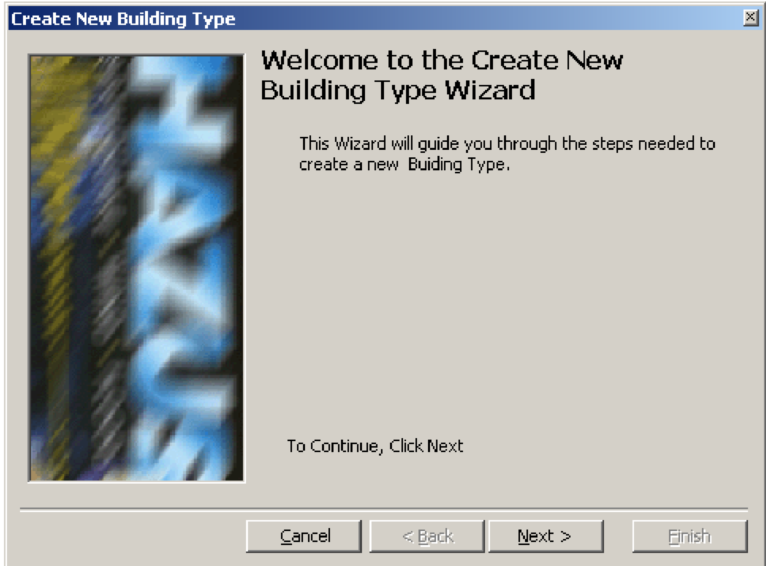


Figure 7.9 Welcome Screen

The Figure 7.10 Building Type Name/Description shows the first input screen of the Create New Building Type Wizard. Enter the name of the new building type, maximum 4 characters in length. Provide a detailed description of the building type in the Description edit box. This name must be unique across all the specific building types. In case the name you provide is not unique, the dialog will give you message. You must specify the general building type under which this new specific building type is to be modeled. This could be one of the five general building types namely Wood, Steel, Concrete, Masonry and Manufactured Homes. Next you should identify an existing Specific Building Type that most closely models the behavior of this new building type. This closest building type could be the one that you added earlier, i.e., it's not necessary that this closest building type should be one of the default building types. This information is used by **Hazus** to provide initial values for damage functions, debris parameters and casualty parameters.

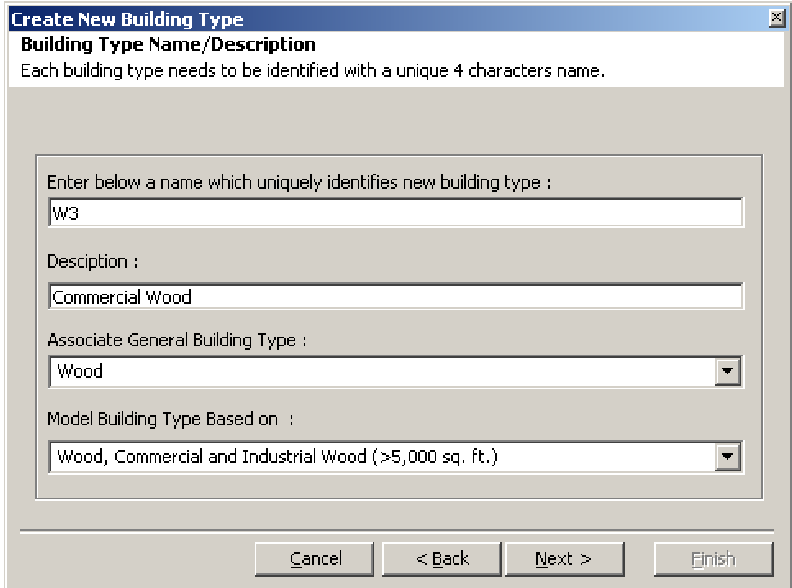


Figure 7.10 Building Type Name/Description

Click on the **Next** button to launch the **Building Damage Functions** dialog (Figure 7.11 Building Damage Functions). For every building type **Hazus** needs a set of damage functions in terms of capacity curves that model the building strength, structural fragility curves that model the structural behavior of the building when subject to ground shaking, non-structural fragility curves that model the behavior of the non-structural components of the building when subject to ground shaking. The four items in the combo box correspond to these damage functions. Select an item and review/modify the default values provided by **Hazus**. These default values a based on the closest building type selected in Figure 7.10 Building Type Name/Description. For details about Capacity and Fragility curves refer to section 9.3 of Chapter 9 in this manual.

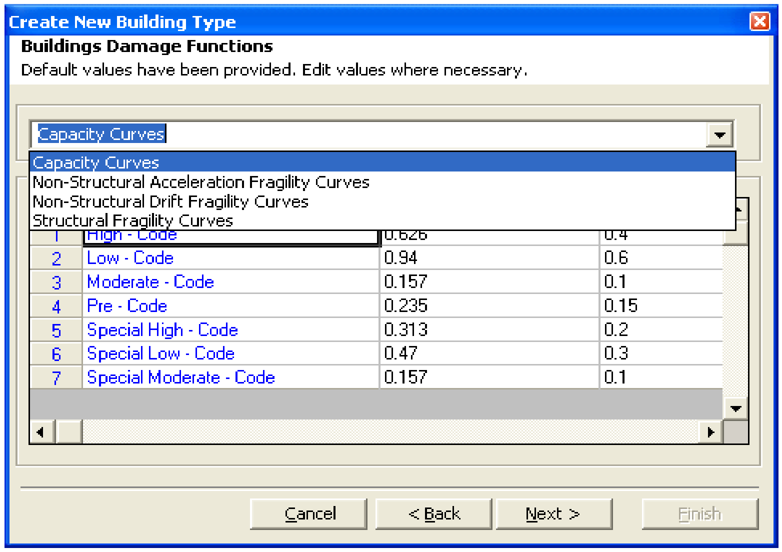


Figure 7.11 Building Damage Functions

Clicking the **Next** button will launch the **Debris** parameters dialog (Figure 7.12 Debris Parameters). You will see the default weight in tons of structural and non-structural elements per square foot of floor area and the amount of debris generated for each structural and non-structural damage state in terms of percent of weight of elements based on the existing building type selected for modeling this new building type in Figure 7.10 Building Type Name/Description. For details about these parameters refer to section 9.4.4 of Chapter 9. Review/Modify the necessary values and click on the **Next** button.

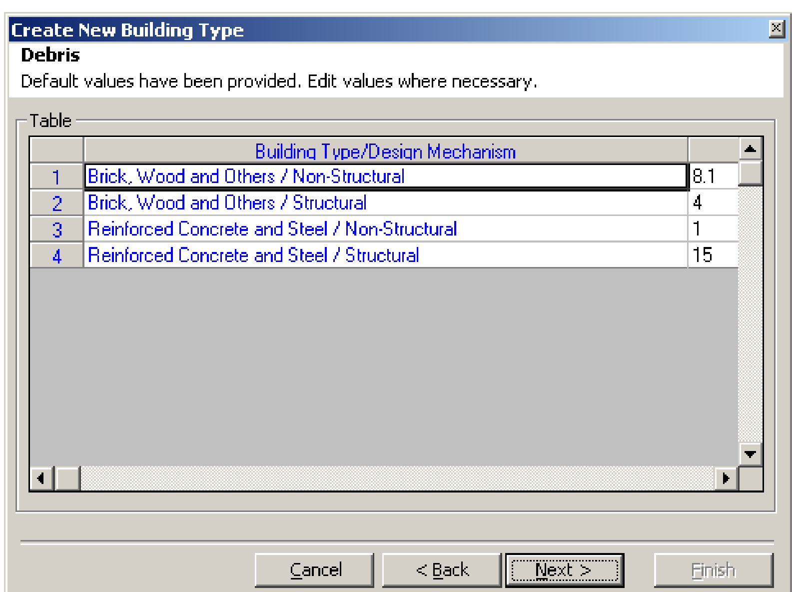


Figure 7.12 Debris Parameters

The **Casualty Parameters** dialog (Figure 7.13 Casualty Parameters) provides you the opportunity to tune the default Casualty Rates and Building Collapse rates provided by **Hazus**. The Casualty Rates have to be specified for various damage states (refer to section 9.3 in Chapter 9 for details about damage states) for Inside the structure (Indoor) and outside the structure (Outdoor). Review/modify the necessary values. For details about Casualty module refer to section 9.5.1 of Chapter 9.

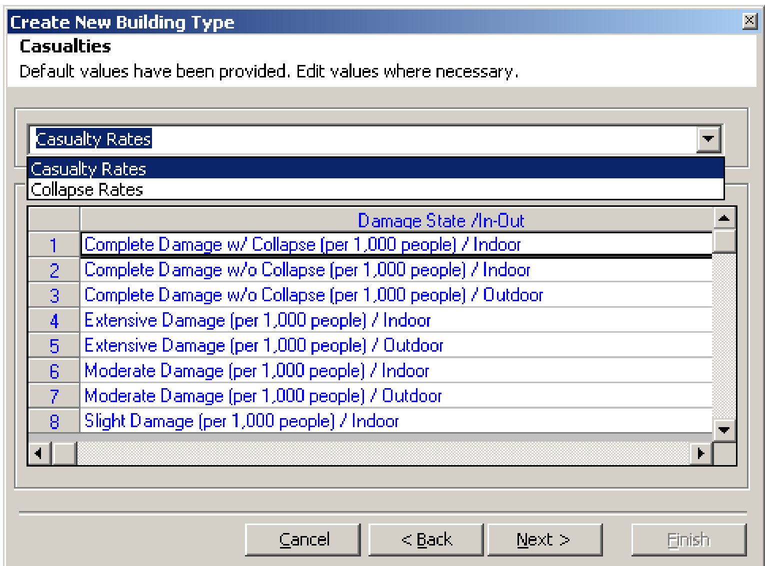


Figure 7.13 Casualty Parameters

Click next to view the Create New Building Type Wizard's completion page. This shows the name, description and General Building Type for the new building type being created. If you are satisfied with these then click finish.

Figure 7.14 Completion Dialog

This may take a couple of minutes before the **Hazus** menu will be available again. Now the new building type has been created and has been added to all the default and user create Occupancy Mapping schemes. Open the Occupancy Mapping dialog from **Inventory|General Building Stock|Occupancy Mapping** and modify the building type distribution to reflect the buildings in specific occupancies and this newly added building type. For details about how to modify a building type distribution refer to the section 7.3 above.

NOTE: It is very important to update the Occupancy Mapping Schemes' Building Type distribution before this new building type could be used by the model.

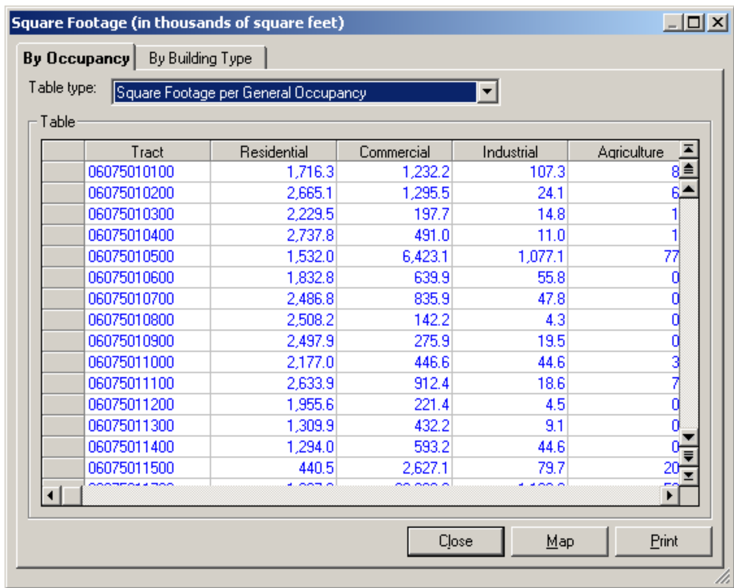
7.6 Display and Modification of General Building Stock

General Building Stock values are aggregated at the census tract level for estimating earthquake losses. The categorical set of values that comprise General Building Stock can each be displayed and modified: square footage, building count, dollar exposure, and foundation type. Occupancy mapping has been covered in the previous section. The following categories are found under the **Hazus** menu **Inventory|General Building Stock**.

7.6.1 Display and Modification of Square Footage

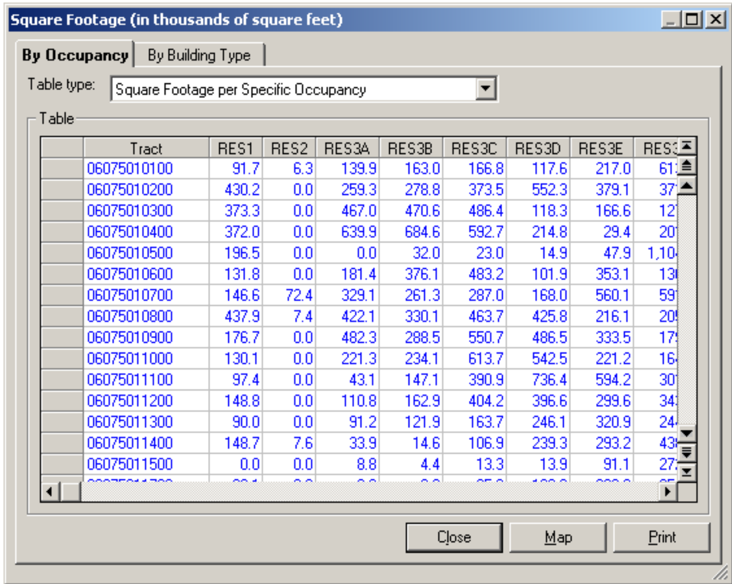
You have the option to modify the distribution and total square footage of building structures by specific occupancy class. The default values are based on the 2000 Census and 2006 Dun & Bradstreet data; therefore, may not represent the most recent construction in your study region. Figure 7.15 Square footage by general occupancy

class
(values in 1,000 sqft). displays total square footage in each census tract and by general occupancy. Figure 7.16 Square footage of buildings by specific occupancy class (values in 1,000 sqft). displays each census tract by specific occupancy. There are a total of 33 occupancy classes under the 7 general occupancy headings (ex. Residential, Commercial, Education, Industrial). This window is accessed from the **Inventory|General Building Stock| Square Footage** menu.



Tract	Residential	Commercial	Industrial	Agriculture
06075010100	1,716.3	1,232.2	107.3	8
06075010200	2,665.1	1,295.5	24.1	6
06075010300	2,229.5	197.7	14.8	1
06075010400	2,737.8	491.0	11.0	1
06075010500	1,532.0	6,423.1	1,077.1	77
06075010600	1,832.8	639.9	55.8	0
06075010700	2,486.8	835.9	47.8	0
06075010800	2,508.2	142.2	4.3	0
06075010900	2,497.9	275.9	19.5	0
06075011000	2,177.0	446.6	44.6	3
06075011100	2,633.9	912.4	18.6	7
06075011200	1,955.6	221.4	4.5	0
06075011300	1,309.9	432.2	9.1	0
06075011400	1,294.0	593.2	44.6	0
06075011500	440.5	2,627.1	79.7	20

Figure 7.15 Square footage by general occupancy class (values in 1,000 sqft).



Tract	RES1	RES2	RES3A	RES3B	RES3C	RES3D	RES3E	RES3
06075010100	91.7	6.3	139.9	163.0	166.8	117.6	217.0	61
06075010200	430.2	0.0	259.3	278.8	373.5	552.3	379.1	37
06075010300	373.3	0.0	467.0	470.6	486.4	118.3	166.6	12
06075010400	372.0	0.0	639.9	684.6	592.7	214.8	29.4	20
06075010500	196.5	0.0	0.0	32.0	23.0	14.9	47.9	1,10
06075010600	131.8	0.0	181.4	376.1	483.2	101.9	353.1	13
06075010700	146.6	72.4	329.1	261.3	287.0	168.0	560.1	59
06075010800	437.9	7.4	422.1	330.1	463.7	425.8	216.1	20
06075010900	176.7	0.0	482.3	288.5	550.7	486.5	333.5	17
06075011000	130.1	0.0	221.3	234.1	613.7	542.5	221.2	16
06075011100	97.4	0.0	43.1	147.1	390.9	736.4	594.2	30
06075011200	148.8	0.0	110.8	162.9	404.2	396.6	299.6	34
06075011300	90.0	0.0	91.2	121.9	163.7	246.1	320.9	24
06075011400	148.7	7.6	33.9	14.6	106.9	239.3	293.2	43
06075011500	0.0	0.0	8.8	4.4	13.3	13.9	91.1	27

Figure 7.16 Square footage of buildings by specific occupancy class (values in 1,000 sqft).

Using the mouse, right-click on the **By Occupancy** table you wish to change. Select **Start Editing** from the options menu. Click in the spreadsheet cell to change each value. When you are done modifying the square footage value(s), right-click and select **Stop Editing**. You will be asked if you want to save your edits. The total square footage of the specific and general occupancy of each affected census tract will be automatically updated. Likewise, the corresponding square footage values by building type will change according to the occupancy mapping scheme you assigned.

7.6.2 Display and Modification of Building Count

Display and modification of building counts is done the same way described in Section 7.6.1. Only the values on the **By Occupancy|Number of buildings by specific occupancy** table may be changed (see Figure 7.17). The **By Building Type** table will reflect your edits according to your occupancy mapping scheme design. Building count values are expressed in absolute numbers for each census tract. This window is accessed from the **Inventory|General Building Stock| Building Count** menu.

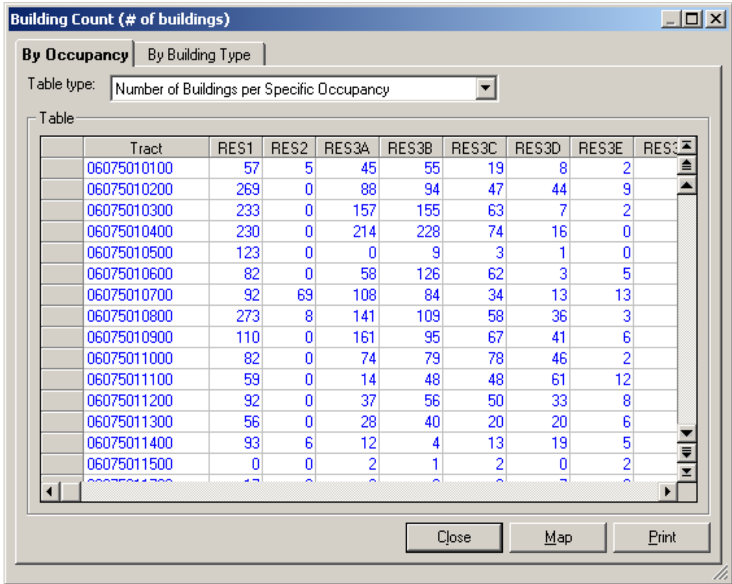


Figure 7.17 Display and editing of building counts.

7.6.3 Display and Modification of Dollar Exposure

Risk exposure in dollars is treated separately from building counts and square footage. Modification to dollar values does not affect other General Building Stock categories. The dollar amounts of any specific occupancy type can be adjusted to better represent actual costs in the study region, and the totals will be updated.

Access the risk exposure tables using the **Inventory|General Building Stock|Dollar Exposure** menu. Only the values on the **Building Exposure** and **Content Exposure** tables under the **Exposure By Specific Occupancy** tab may be changed (see Figure 7.18). All other exposure values for occupancy and building type will be updated automatically when you right-click the mouse on the table to **Stop Editing**. Dollar values are expressed in units of $1000 for each census tract.

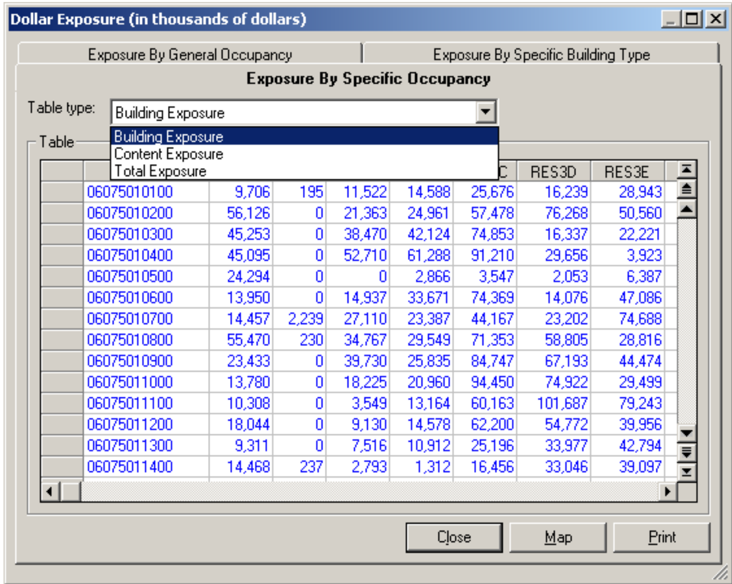


Figure 7.18 Building and content exposure values can be modified by specific occupancy class.

7.6.4 Mapping a Database

All databases can be mapped using the **Map** button at the bottom of the window. Each inventory has a default symbology, which can be modified using the ArcMap data layer **Properties** menu. The drawing order of each data layer is managed in the project file display list (Table of Contents). Site-specific databases, such as emergency facilities and lifeline components, will appear as point symbols on the map. Census data, soil types, and general building stock inventory are displayed as thematic maps. In thematic maps, shading or colors can be used to display attributes of a particular region. Variations in population density are displayed in Figure 7.19.

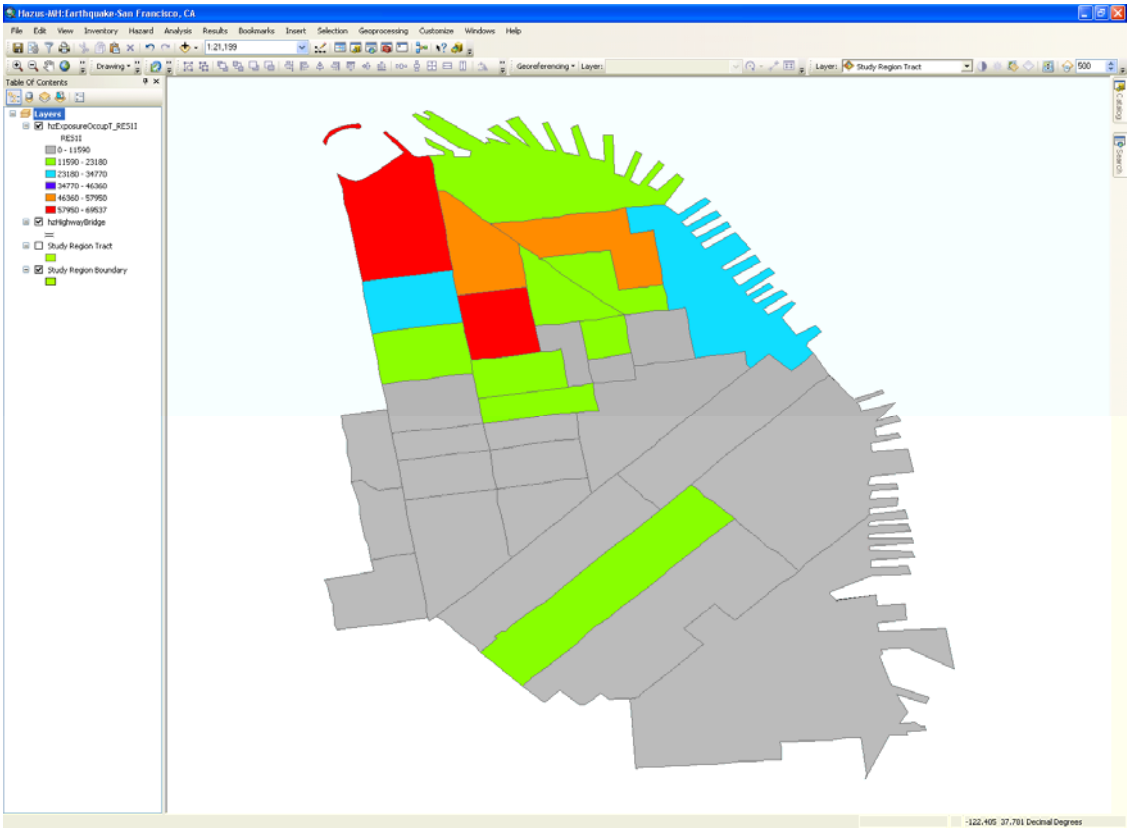


Figure 7.19 Default thematic map of population as displayed by Hazus

In order to map the population information shown in Figure 7.19, click on the column header *Population* to highlight the entire column of the database. When you click on the **Map** button at the bottom of a database window (see Figure 7.20), a thematic map will be displayed using a default legend for the ranges and colors of data. Customize the look of a map display to meet your own needs by clicking the right mouse button on the data layer of interest to access the ArcMap **Properties|Symbology** menu.

Apply ArcMap symbology options to re-classify the value ranges, or set new colors and patterns to each attribute class (i.e. population). Labels can be modified using the data layer **Properties|Labels** menu. Save your legend modifications by clicking the right mouse button over the data layer of interest and selecting **Save As Layer File**. The layer can be loaded from the ArcMap **Properties|Symbology** menu, which has an **Import** option.

For more details on modifying legends and general instructions in using ArcMap, see ESRI's software manual. The functions detailed in this manual are primarily for executing loss estimation analysis. The **Hazus** software operator is expected to have some familiarity with ArcGIS, and be able to access the program help options as needed.

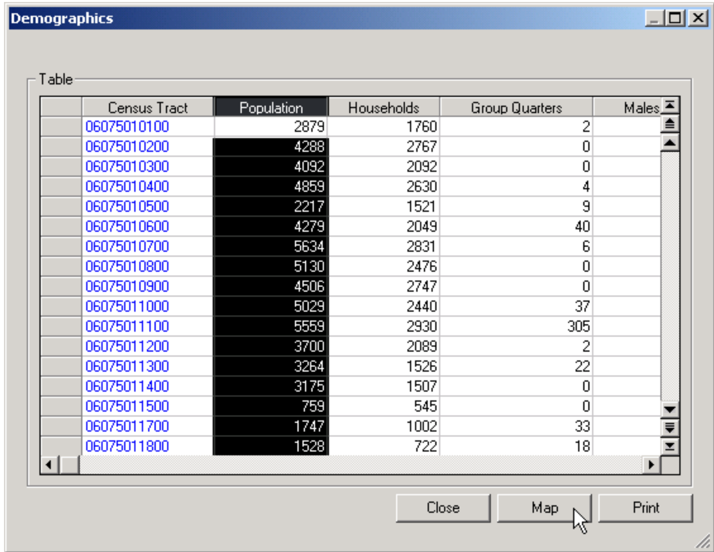


Figure 7.20 Highlighting the population column of the population inventory.

7.6.4.1 Creating a Layout Window and Printing Maps

Create a map layout to format your **Hazus** data for printing. Change the window view from **Data** to **Layout** by selecting the option button at the lower left corner of the map display area. The default **Hazus** map layout will appear with your data. Re-scale and arrange the pieces of the layout (i.e. legend, title, date, author of map) as you find most useful to the viewer. Save your work under the ArcMap **File|Save** menu, and print according to your printer specifications from the **File|Print** menu.

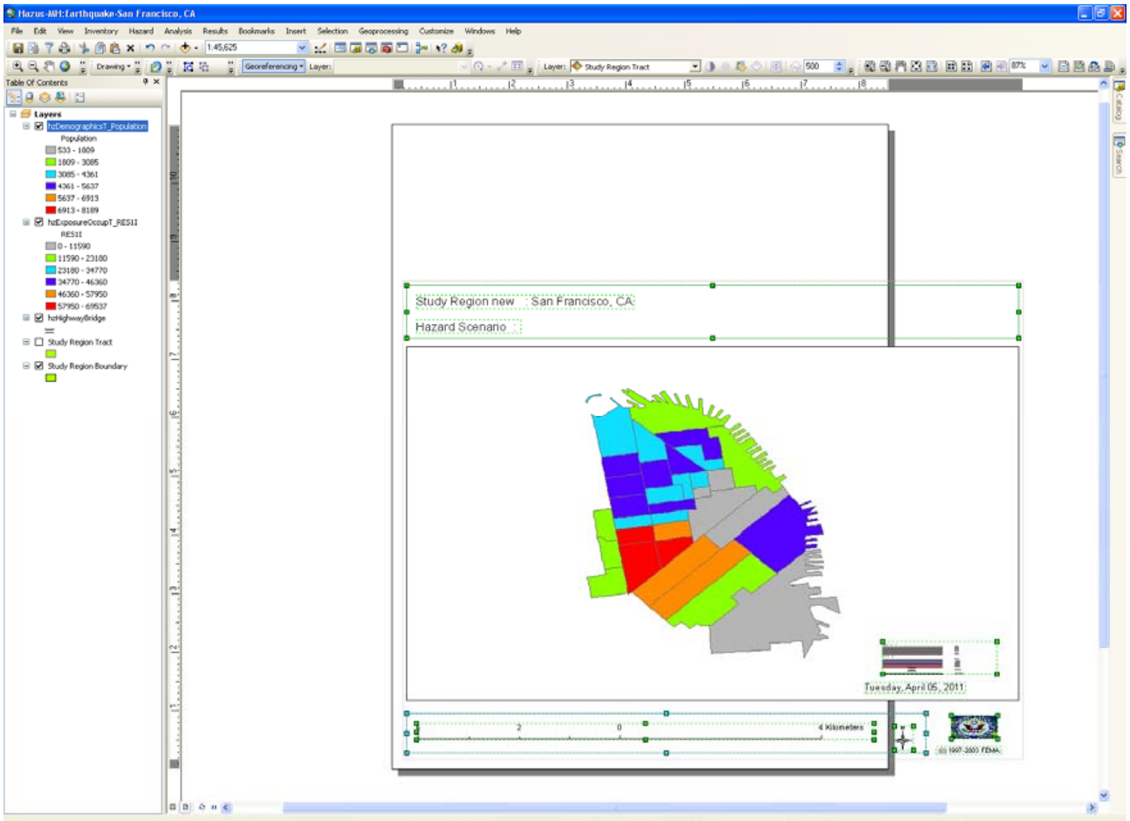


Figure 7.21 Layout window, used to modify a map for printing.

Chapter 8. Hazus-MH Comprehensive Data Management System (CDMS)

8.1 Introduction

The purpose of the CDMS is to provide a standardized approach that will allow users to import and manage Hazus-MH datasets. The system supports a variety of methods to assist users in managing information including:

- Site Specific Inventory Data (essential facilities, high potential loss facilities...)
- Aggregated General Building Stock Data (building counts, square footage, exposure,...)
- Building Specific Data

Updating Hazus-MH statewide level 1 data prior to the creation of study regions in Hazus-MH allows for increased accuracy within the Hazus-MH software outputs and CDMS provides a user friendly environment that evaluates and validates structural components of user defined data to verify information required by Hazus-MH. Within CDMS users may update information using a variety of methods including:

8.1.1 Site Specific Inventory Data

- Import / Update Inventory information from a user provided file: MS Excel Spreadsheet (.xls), MS Access Database (.mdb), ESRI Shape File (.shp) and ESRI Personal Geodatabase File (.mdb)
- Import / Update Inventory information from a Hazus-MH Study Region
- Query and Export Inventory information to a MS Excel spreadsheet or ESRI Personal geodatabase
- Delete Inventory information

8.1.2 Aggregated General Building Stock Data

- Update Aggregate data from a user provided file containing individual building or parcel information in MS Excel Spreadsheet (.xls), MS Access Database (.mdb), ESRI Shape File (.shp) and ESRI Personal Geodatabase File (.mdb) formats
- Updating Aggregate data from information which has already been summarized according to existing Hazus-MH data structures: i.e. Demographics, Square Footage by Census Block
- Update Aggregate data from a Hazus-MH Study Region

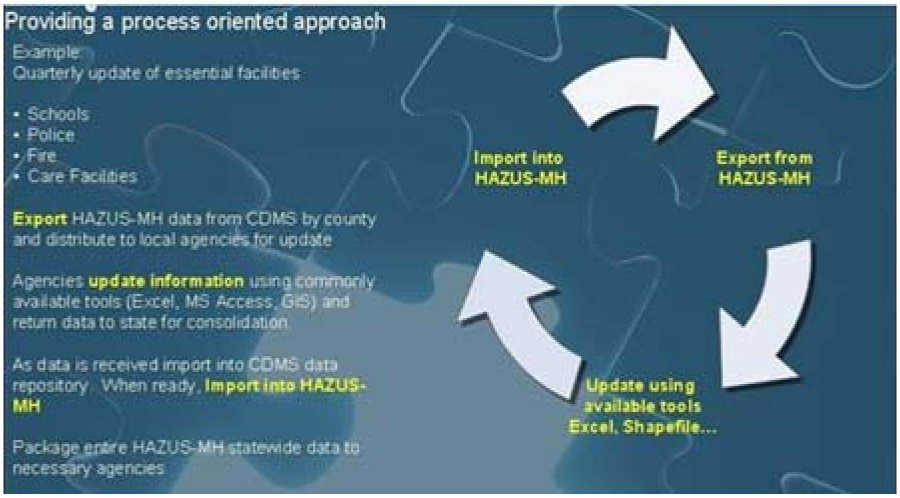
- Update Aggregate data from information existing in the Building Specific data module of CDMS

8.1.3 Building Specific Data

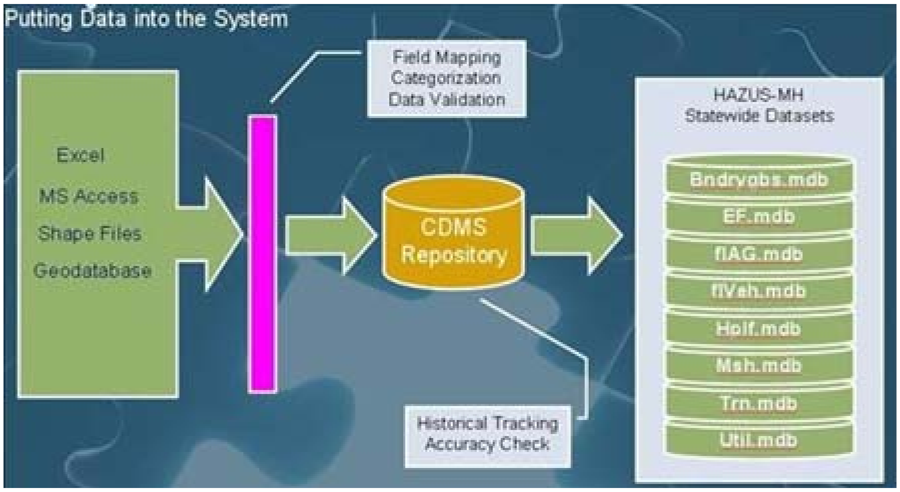
- Import Building Specific Information in to the Building Specific Data module for refinement and tracking
- Update and Aggregate General Building Stock from Building Specific Data
- Query and Export Statewide data by County, Census Tract, or Census Block in MS Excel (.xls) or ESRI Personal Geodatabase (.mdb) formats

The CDMS will support the transfer of data into and out of master statewide geodatabases, provide validation of new data into the system, and allow users to query and print

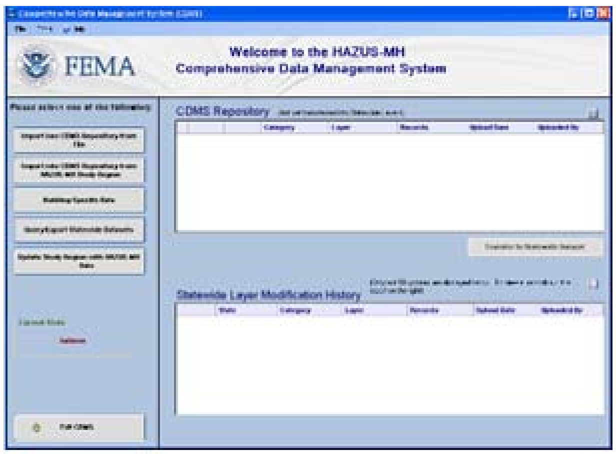
An example process of CDMS functionality is listed below:



CDMS is built around existing Hazus-MH data structures. As outlined in the diagram below, the system will accept information in a variety of user supplied formats. The system contains field mapping and validation routines to allow user to control data import. Once validation occurs, data is maintained within the CDMS repository until the user requests that the data be merged with the Hazus-MH geodatabases for their state.

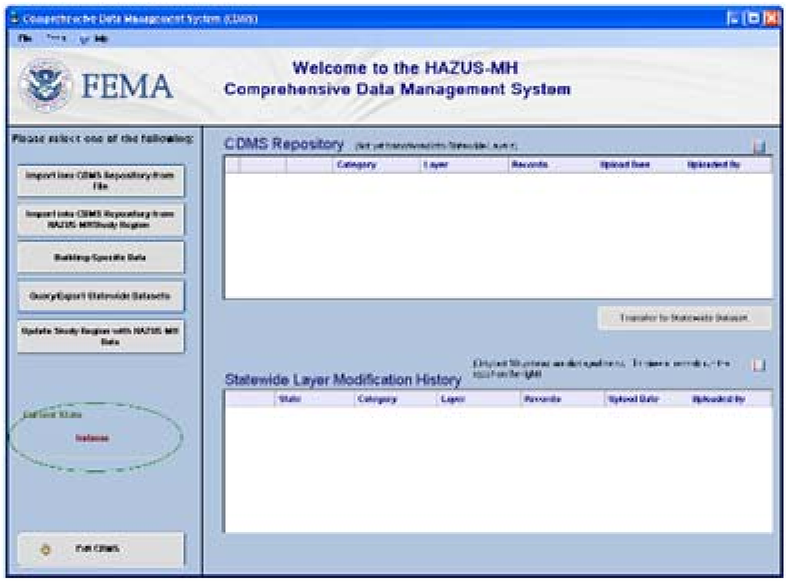


8.2 Getting Started



To learn about the different options available from the CDMS Home screen

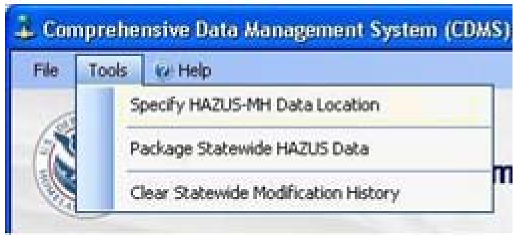
The first time that CDMS runs, the system will not have a default statewide database specified. You can verify if a state has been specified by examining the left side of the CDMS home screen in the **Current State** area. If no state has been specified a label stating **Please Select Hazus Statewide**



CDMS relies on this information to perform modifications to Hazus-MH Level 1 statewide datasets, the user must specify where their Hazus-MH Level 1 data resides.

NOTE: The user should have appropriate permissions to edit the Level 1 data and the files should be located on the user's computer with read/write permissions. Typically when copying this data from a DVD the data is read only by default. This can be changed by copying the files to the local hard drive from the State DVD right clicking the data directory and selecting properties. Next, uncheck the Read only checkbox and select OK.

- Select the **Tools** option from the menu and then **Specify Hazus-MH Data Location**.



- A new form will open and ask the user to specify their statewide database folder.

- Select a folder to connect to by manually entering the folder name or selecting the **Browse** button and choosing the folder.
- Select the **OK** button

The system will inspect the directory selected to verify that all required Hazus-MH datasets are present. When the system has completed the verifications the state name for the specified directory will appear on the screen beneath current state on the left side of the screen.

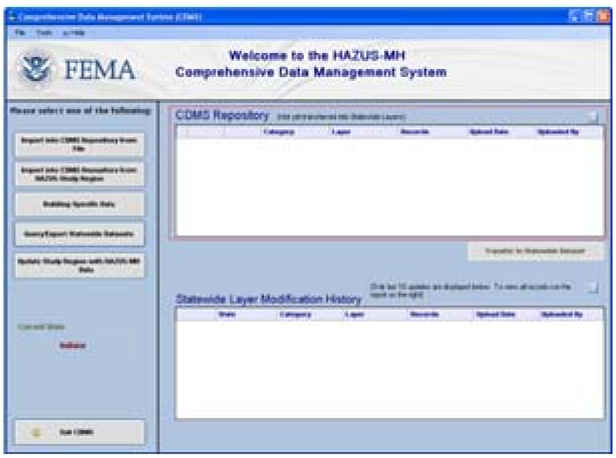
Now the user is ready to perform modifications on the Hazus-MH statewide data.

Note: Until users are comfortable in using CDMS, it is recommended that prior to making changes on statewide datasets, a backup be made to ensure that data is not lost.

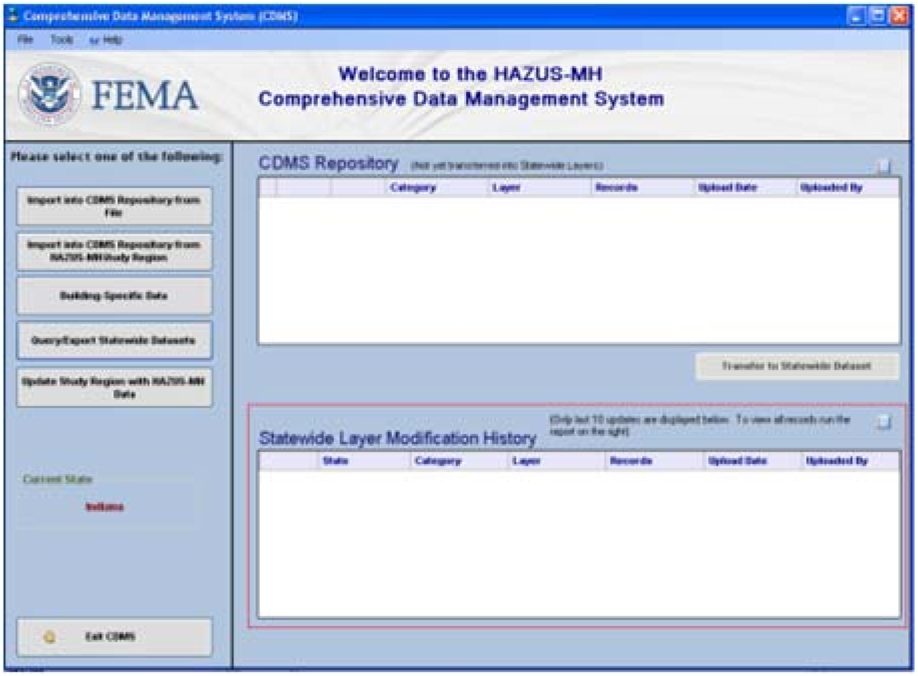
8.3 CDMS Home

Users can get back to CDMS Home from any screen in the system. This serves as the central location from which data modification actions start. The main items on the CDMS Home screen are the CDMS Repository, the Statewide Layer Modification History and the Main Menu on the left side of the screen.

The CDMS Repository holds any data that has been imported and converted to Hazus-MH data structures. Data shown in this window has not been merged with Hazus-MH statewide geodatabases.



The Statewide Layer Modification History is located at the bottom of the CDMS Home screen. This section is where the data is shown after it has been transferred to the statewide Hazus-MH datasets.



The Main Menu on the left side of the screen holds five buttons that navigate to the main screens in the system, the current state, and the Exit CDMS button.

8.4 General Functionality

The menu contains items relative to general system functionalities. Currently there are three primary menu categories **File**, **Tools**, and **Help**.

File Menu

Currently, the **File** menu allows the user to exit the system.

- Select **File > Exit** to exist CDMS
- Alternatively a user may select the **Exit CDMS** button or
- Select the **X** button in the upper right side of the form.

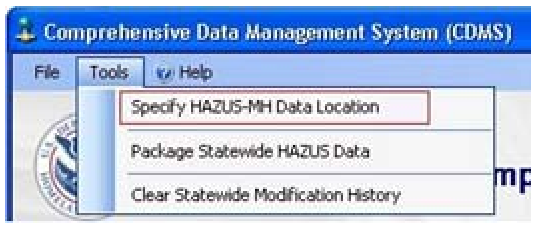
Tool Menu

The **Tool** menu contains system action and options not related to importing and exporting information. Currently the following items are available from the menu:

- Specify Hazus-MH Data Location
- Packaging Statewide Hazus-MH Geodatabases and Related Files for Distribution
- Clear Statewide Modification History

8.4.1.1 <u>Specify Hazus-MH Data Location</u>

This menu item allows user to tell the system where their statewide Hazus-MH Level 1 data resides.



CDMS relies on this information to perform modifications to Hazus-MH Level 1 statewide datasets. The user must specify where their Hazus-MH Level 1 data resides.

NOTE: The user should have appropriate permissions to edit the Level 1 data and the files should be located on the user's computer with read/write permissions. Typically, when copying this data from a DVD the data is read only by default. This can be changed by copying the files to the local hard drive from the State DVD, right clicking the data directory and selecting properties. Next, uncheck the "Read only" checkbox and select OK.

- Select the **Tools** option from the menu and then **Specify Hazus-MH Data Location**.

A new form will open and ask the user to specify their statewide database folder.

- Select a folder to connect to by manually entering the folder name or selecting the **Browse** button and choosing the folder.
- Select the **OK** button

The system will inspect the directory selected to verify that all Hazus-MH datasets are present. When the system has completed the verifications, the state name for the specified directory will appear on the screen beneath current state label on the left side of the screen.

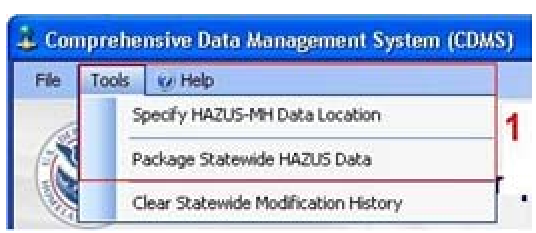
Now the user is ready to perform modifications on the Hazus-MH statewide data.

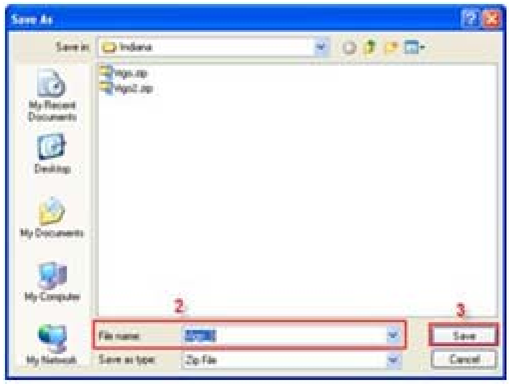
Note: Until users are comfortable using CDMS, it is recommended that prior to making changes on statewide datasets, a backup be made to ensure that data is not lost.

8.4.1.2 Packaging Statewide Hazus-MH Geodatabases and Related Files for Distribution

Within CDMS, users have the ability of packaging their statewide Hazus-MH data in a zip format for easy distribution to other agencies or for backup purposes. The information packaged is depended on the statewide data location specified earlier in this manual. To package statewide data files:

- Select Tools from the menu at the top of the screen and select Package Statewide Hazus Data.





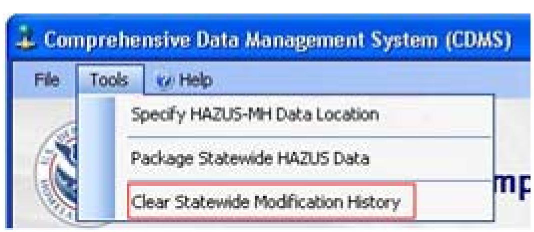
- A new window will appear and request the user to enter a zip file name.
- Enter the name of the zip file and specify where it will be saved.
- Select the Save button and the window will close.

The data will be saved to the specified folder.

8.4.1.3 <u>Clear Statewide Layer Modification History</u>

CDMS tracks the history of updates made to Hazus-MH statewide datasets. As data is updated in CDMS and transferred to Hazus-MH statewide datasets a log will be available from the CDMS Home screen under the title **Statewide Layer Modification History**. This history is kept until a user changes their statewide data location or they use the **Clear Statewide Layer Modification History** tool menu item to remove it. To clear the statewide modification history:

- Select Tools from the top of the screen and select Clear Statewide Layer Modification History

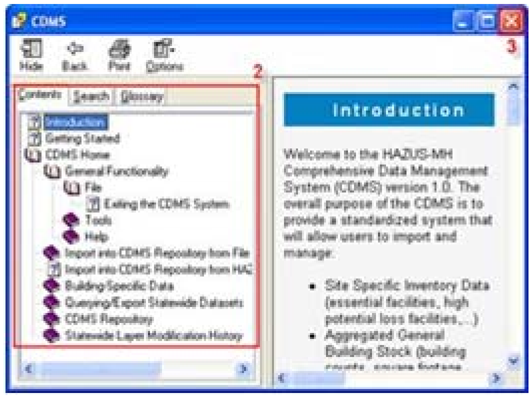


The home screen will refresh with all of the data removed from the page.

Help Menu

CDMS provides an online help menu with information contained in this document to assist the user in navigating though and performing data update operations. To access the Help system

- Select **Help** > **Contents**



8.5 Importing Site Specific Inventory Data

The import function of the CDMS application allows users to import, validate and convert inventory data into a format which can be merged into statewide Hazus-MH datasets.

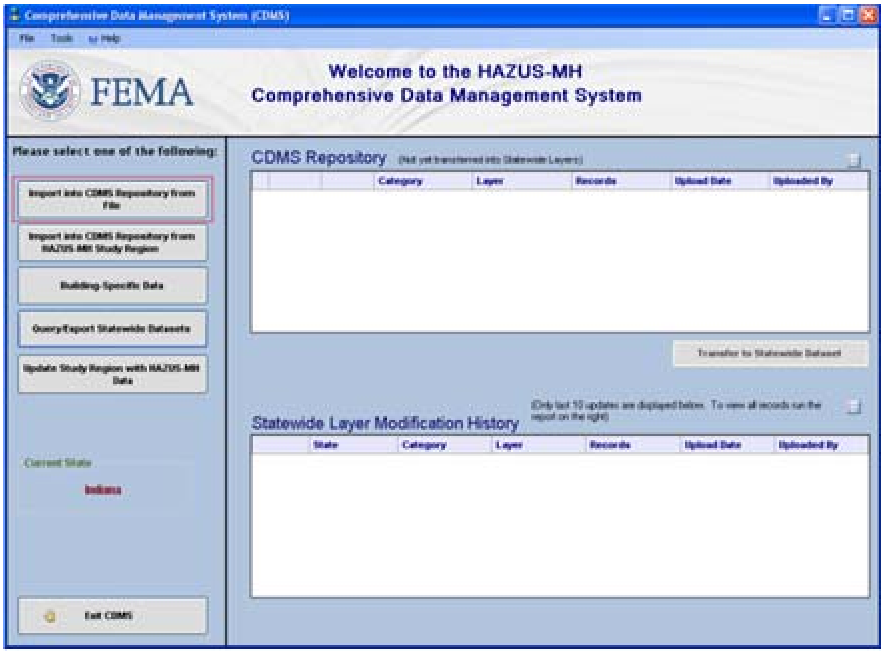
Users should import site specific inventory data when updating individual records such as essential facilities or high potential loss facilities.

- Selecting a Source Data File
- Specifying the Destination Category
- Defining Source Data Parameters
- Matching Fields
- Validation Issues
- Data Categorization
- Viewing the Results in the CDMS Repository

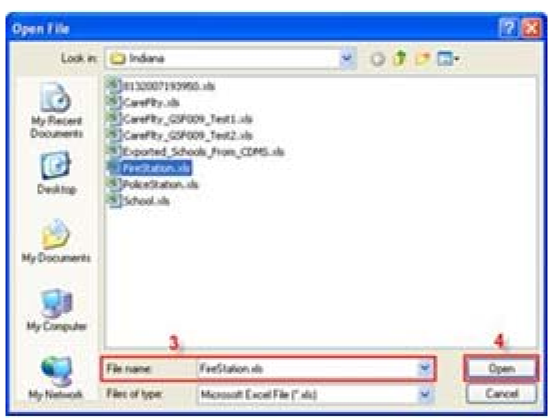
8.5.1 Selecting a Source Data File

To import a file into the CDMS system, the following steps should be followed. From the CDMS Home screen:

- Select the **Import into CDMS Repository from File** button

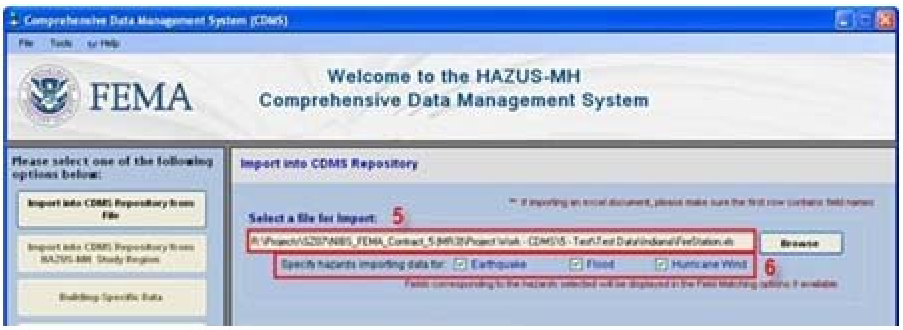


Specify a source file by selecting the **Browse** button and select a source file.



- Select the **Open** button and the folder path will appear in the indicated area on the screen.

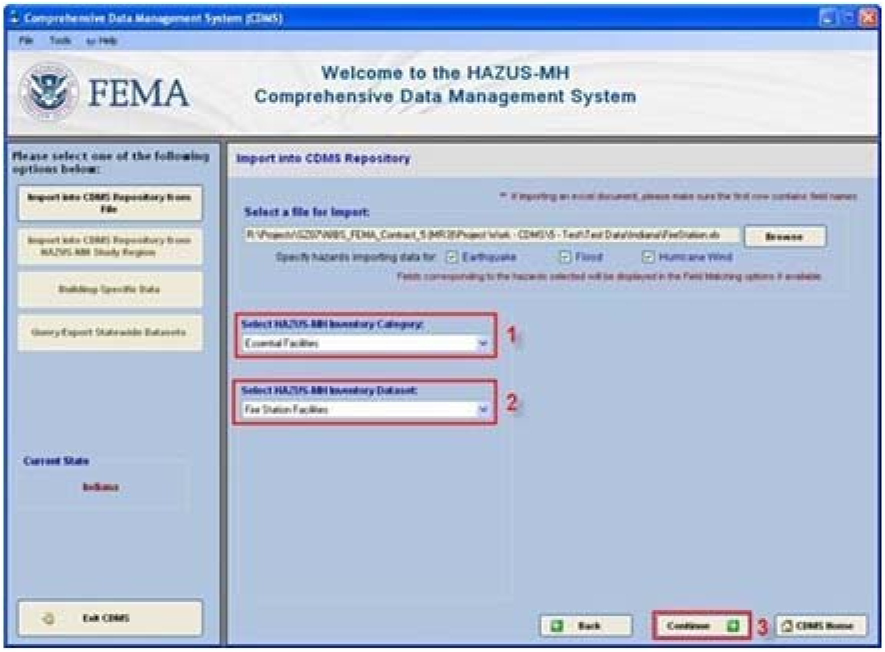
- The user will also need to choose one or more hazards by using the check boxes under the file path. This is necessary to allow user to update only partial information for a dataset. By default, all three hazards will automatically be selected, but the user can un-select any of the hazards before continuing. Default values will be provided if no hazards are selected.



8.5.2 Specifying the Destination Category

For each file imported, a destination must be specified. The destination is determined according to what category and dataset are selected. To import site specific inventory data, a site specific category will need to be selected (i.e. essential facilities, transportation systems).

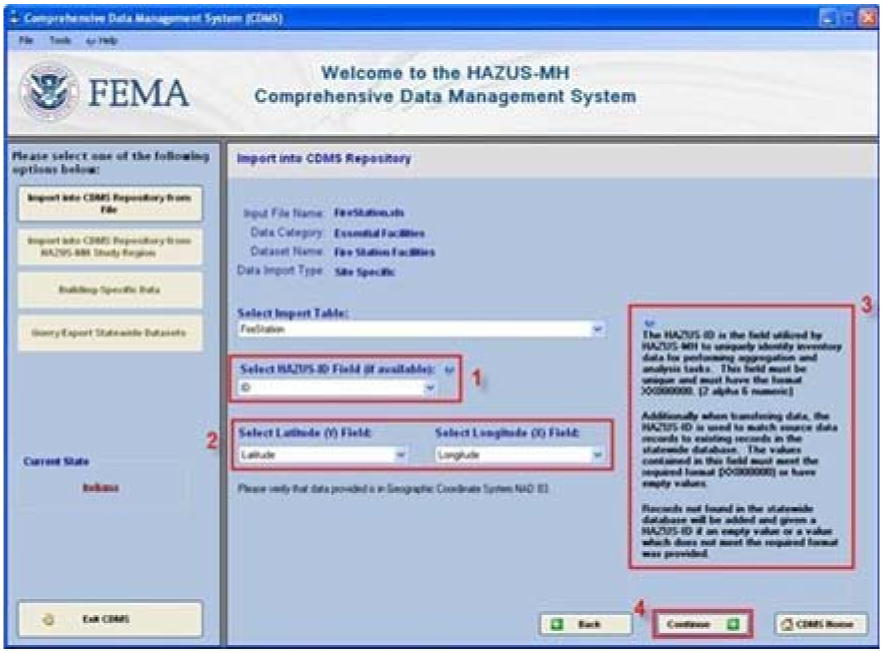
- Select a category from the **Select Hazus-MH Inventory Category Dropdown** list.
- Select a dataset from the **Select Hazus-MH Inventory Dataset** drop down list will populate and the user will need to select a dataset.
- Select the **Continue** button at the bottom of the screen to move to the next page.

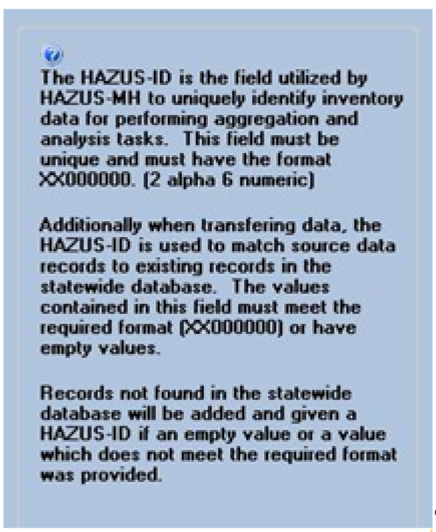


Note: Use the Back button to go back and update information as needed. Also use the CDMS Home button to navigate back to the primary navigation screen.

8.5.3 Defining Source Data Parameters

After specifying the file location, inventory category and inventory dataset, parameters for the source data must be defined before the system can import the source data file. Options for the source data parameters are dependant upon what type of file was chosen for importing. If an ESRI Personal Geodatabase or an ESRI Shape file were chosen, then the only parameter the user must choose is the Hazus ID. Otherwise the user must specify the Latitude and Longitude of their data.





The system will automatically select the import table for the data if the data provided is a ESRI Shape file. With other data types such as Excel or MS Access many worksheets or data tables may exist. The user should specify the correct source Import Table and continue to the Hazus-ID field selection.

The Hazus-ID field is very important to CDMS. This field is used by the system to match records being uploaded to existing records in the statewide Hazus-MH datasets. If the user does not have a Hazus-ID field they can select the **No Hazus-ID Field** menu option in the listing. By selecting this option all records will be treated as new information and will be added to the statewide Hazus datasets.

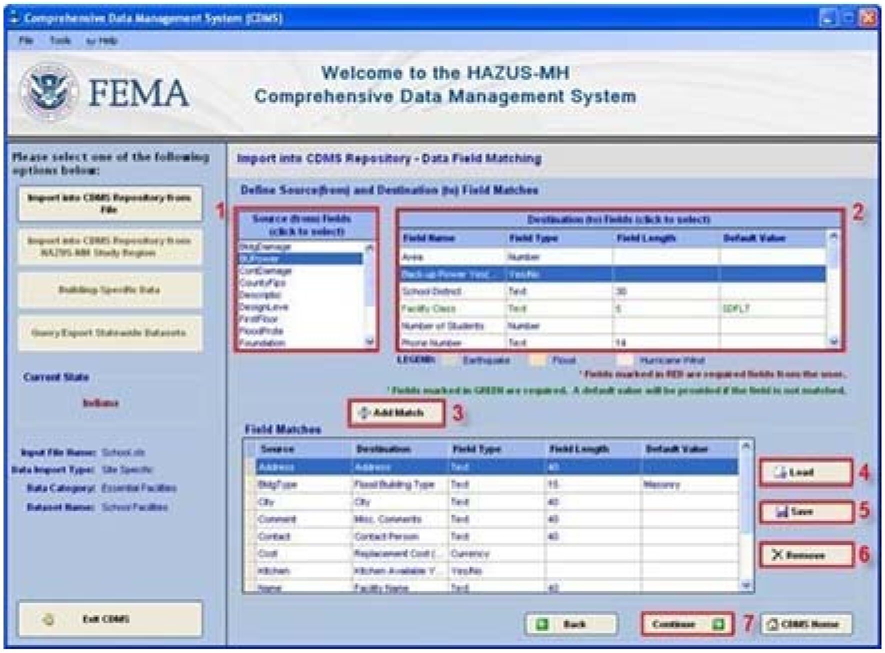
Once the parameters have been defined, the user can move on to the next screen by selecting the **Continue** button at the bottom of the page.

8.5.4 Matching Fields

CDMS must rely on the user to match the import data file source fields to the fields that reside in the Hazus-MH data. The Data Field matching screen allows the user to do just this.

There will be a source list on the left with a list of fields from the source file and there will be a destination field on the right which will list the fields that are in the Hazus data. The system will automatically match up the fields that have the same name and the same characteristics. The user will need to verify the auto matches and will need to match the rest of the fields, if applicable, by selecting one field from the source list and its match from the destination list.

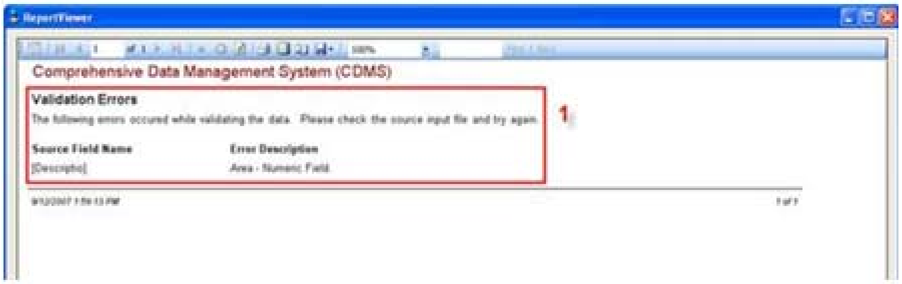
To add the field matches to the list at the bottom of the screen after a field from both lists has been chosen, select the **Add Match** button. Fields marked in **red** are required fields and the user cannot move on to the next screen without matching those fields. Fields that are in **green** are also required, but a default value will be provided if the field cannot be matched. Once all known matches have been made, the user can move on through the import process.



To the right of the list of field matches there are three buttons, **Load**, **Save** and **Remove**. The **Load** button is used if there is a saved set of field matches that the user wants to load into the system to use for the chosen data. Once the **Load** button has been selected, a new window will appear and the user will have to select a file to import. Once a file has been chosen, the data will be loaded into the system and the user will see it in the Field Matching list. When loading the file, the user has to choose a file that was saved with the same category and dataset, otherwise the data will not be valid and the user will get an alert message. To save a list of field matches, the user has to select the **Save** button and give it a file name. Once the list is saved, it can be used with another file that has the same category and dataset. If a match needs to be removed from the list for whatever reason, select the match and select the **Remove** button. Once all known fields have been matched, the user must select the **Continue** button to continue with the import process.

8.5.5 Validation Issues

When data is imported into the CDMS system, the data is validated. The validation process will confirm the imported data and ensures that all required fields have a value and that the fields match correctly. If any data fails validation, a report will appear detailing the invalid data and reason for invalidation[1]



If a validation error occurs, the user must correct the error before the file can be imported properly.

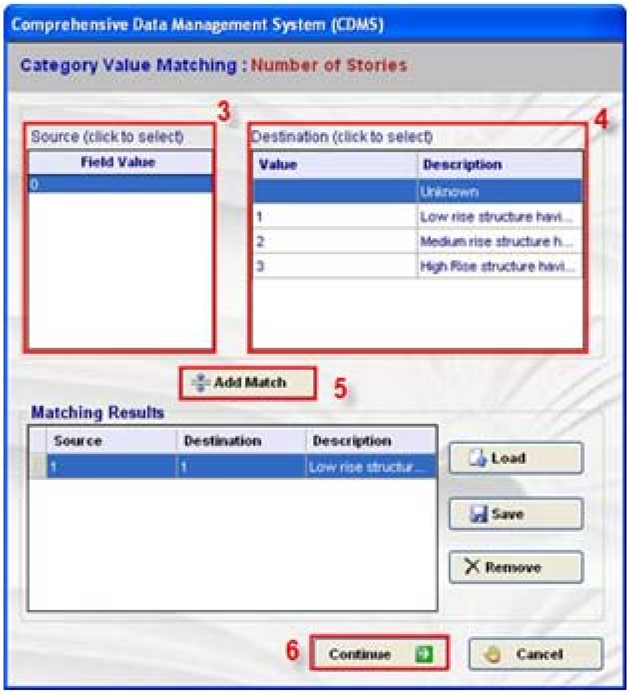
8.5.6 Data Categorization

After fields have been matched for a source file being imported, there may be some fields that need to be categorized into HazusMH specific data. If there are any fields that do need to be categorized, then a window will appear with the list of fields and a message letting the user know that the fields need to be categorized.

Select the **OK** button to continue.

A window will appear for each separate field categorization. The categorization window will be in the same format as the field matching screen.

The user will choose a field from the source list and a field from the destination list and select the **Add Match** button. Once each field on the screen has been matched, the user must select the **Continue** button to move on.

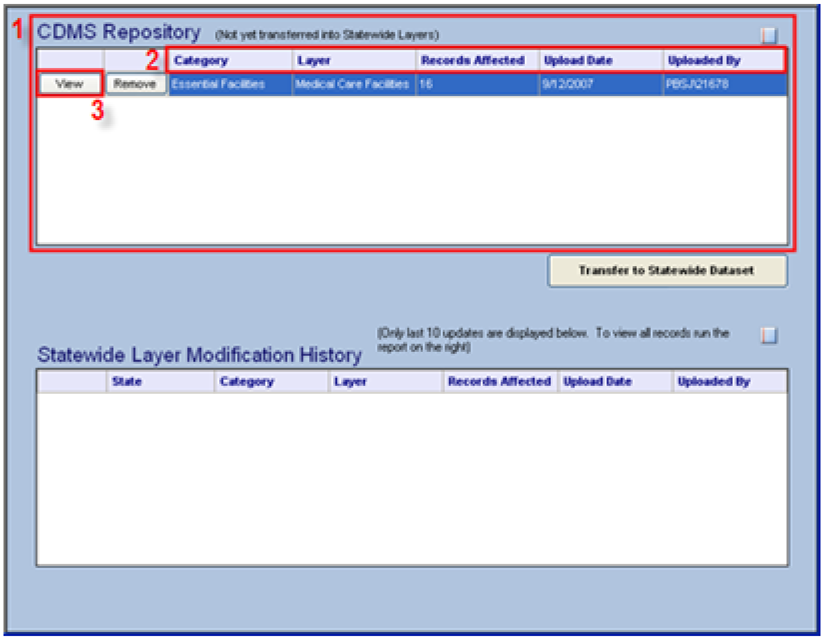


The next field categorization screen will appear and the user will go through the same steps for that field. This will continue until all fields have been categorized, then a window will appear stating that the data was imported successfully.

When the import process completes, the screen will redirect back to the home page showing the new data in the CDMS Repository.

8.5.7 Viewing the Results in the CDMS Repository

Once data has been imported into the CDMS system, it will appear in the CDMS Repository[1] on the CDMS Home screen.



The Category, Layer, Records Affected, Upload Date and Upload By columns will be shown on the home screen. To view individual data layers, the user must select the **View** button to the left of the row.

8.6 Importing and Aggregating General Building Stock Data

This section describes how data may be imported into the CDMS Repository and summarized to provide aggregated data to Hazus-MH statewide datasets. This process replaces the current building import tool within the Hazus-MH system and utilizes building/parcel specific information. There are three possible inputs for the generation of aggregated data these are:

- Providing Pre-Aggregated Data from a File
- Providing Building/Parcel Data from a File
- Utilizing information in the existing Building-Specific data area within CDMS

Providing Pre-aggregated data from a file

A user may provide a file with information which has already been aggregated at either the census block or tract level, the system can provide a straight conversion into existing Hazus-MH aggregate tables. Tables the user may update are:

- Building Counts by Census Block/Tract
- Demographics by Census Block/Tract
- Building Square Footage by Census Block/Tract
- Structure Exposure by Census Block/Tract
- Exposure Content by Census Block/Tract

NOTE: This is ideal when users already maintain their data at the aggregated level.

Providing building/parcel data from a file

Users may wish to import information from one of the following file formats: ESRI Shape File, ESRI Personal Geodatabase, MS Access, and MS Excel.

Users will specify the path for their input file and the system will navigate the user through the field mapping and categorization process, validate the data according to Hazus-MH field types then transfer the data into the CDMS repository tables as defined below:

- Building Counts by Census Block/Tract
- Building Square Footage by Census Block/Tract
- Structure Exposure by Census Block/Tract
- Exposure Content by Census Block/Tract

NOTE: This is ideal when users have a building/parcel file with necessary structural and hazard data.

Utilizing information in the existing Building-Specific data area within CDMS

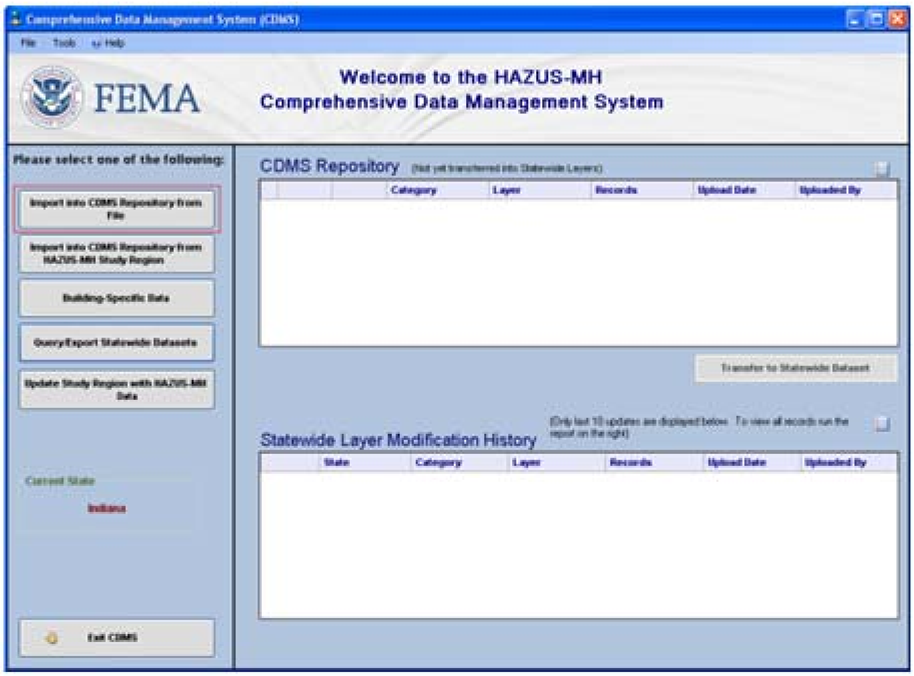
This functionality allows users to export data from their building specific data and then import into the repository using the "Importing Site Specific Data to Aggregate Data" functionality. CDMS will then perform field mapping, categorization and validation before placing aggregated data into the CDMS Repository.

NOTE: This is ideal when users have a building/parcel file without necessary structural and hazard data. They may import their information into Building-Specific data and update structural and hazard data, then aggregate.

8.6.1 Providing Pre-Aggregated Data from a File

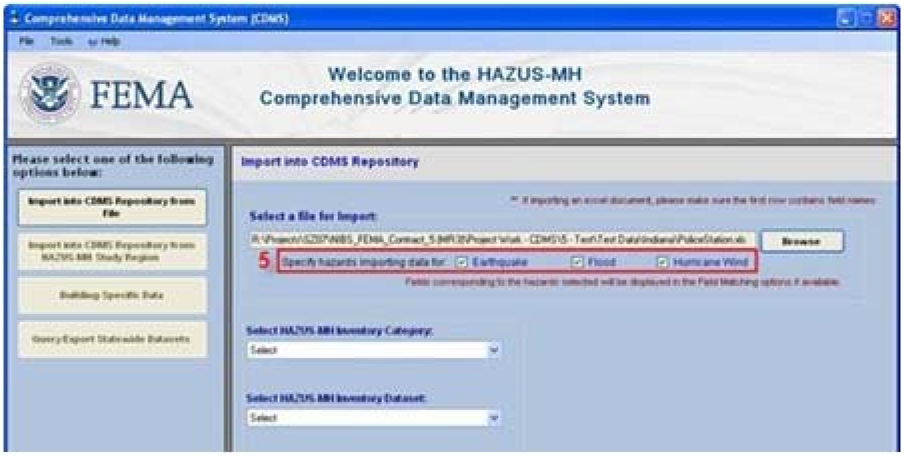
If a user already has pre-aggregated data, they may perform a straight conversion of their data into the CDMS Repository with minimal effort. The following steps describe this process.

- **Select Import into CDMS Repository from File** button on the CDMS Home screen



- Select the **Browse** button to specify the file for data import

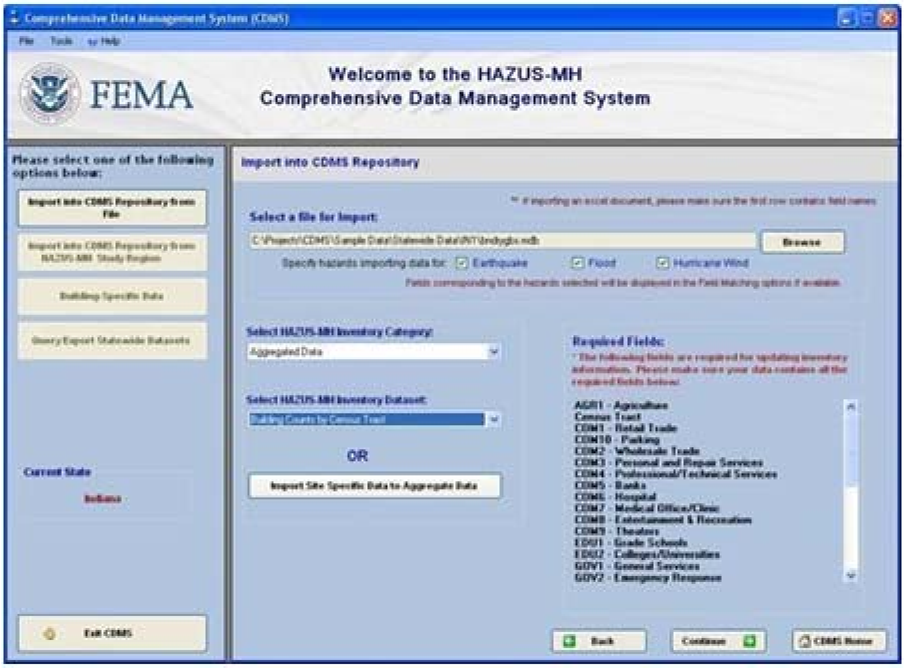
Select the **Open** button and the folder path will appear in the indicated area on the screen. The user will also need choose one or more hazards by using the check boxes under the file path.



All three hazards will automatically be selected since aggregated data does not depend on hazard specific information. Move down to the **Select Hazus-MH Inventory Category**.

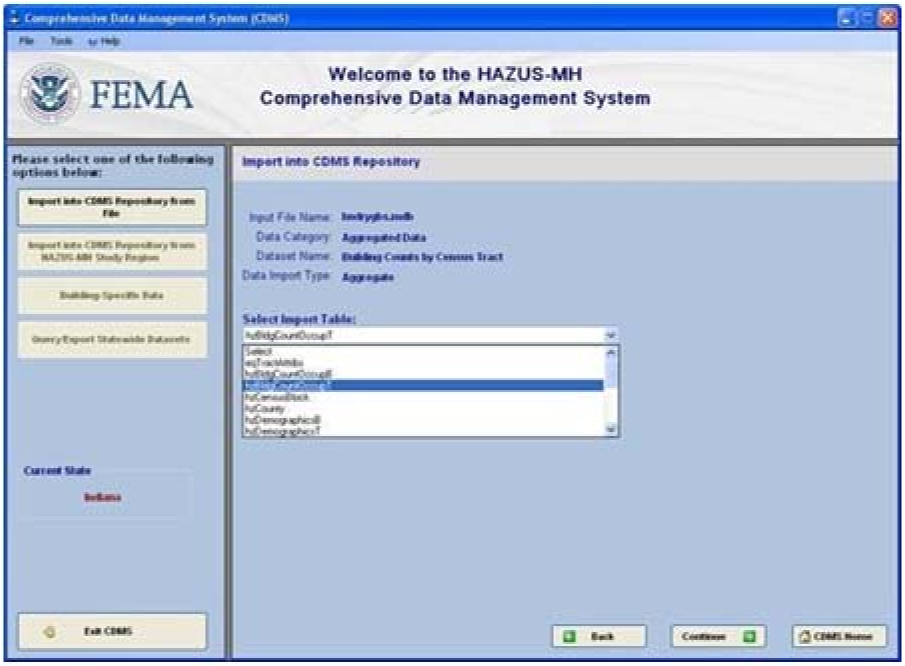
Specifying the Destination

- Select Aggregated Data from the **Select Hazus-MH Inventory Category** dropdown list
- Select an Inventory Data set from the **Select Hazus-MH Inventory Dataset** dropdown list.



Any Required fields will be listed to the right of the screen and the user will select the **Continue** button to move forward through the import process. In the next screen, the user must select the import table.

Selecting the Import Table



If a user imports a shape file the Import Table will be selected automatically. If a MS Access or Excel File was chosen, the user will have a choice of worksheets or tables to use for the import process.

- Select the **Import Table** from the dropdown listing
- Select the **Continue** button

Matching Fields

Because data is distributed by specific occupancy types (RES1, RES2, COM1, COM2…) in the Hazus-MH database, the user must provide field matching to make sure that source/destination field pairs are correct.

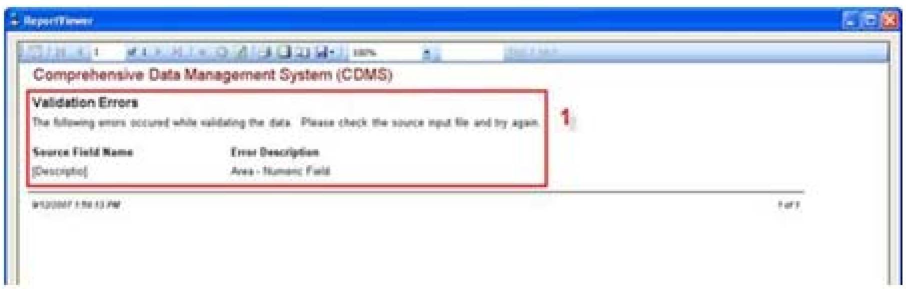
There will be a source list on the left with a list of fields from the source file and there will be a destination list on the right which will list the fields that are in the Hazus data. The system will automatically match up the fields that have the same name and the same characteristics. The user will have to match the rest of the fields by selecting one field from the source list and its match from the destination list. To add the field's matches to the list at the bottom of the screen after a field from both lists has been chosen, select the **Add Match** button. Fields that are marked in **red** are required fields and the user cannot move on to the next screen without matching those fields. Fields that are in **green** are also required, but a default value will be provided if the field cannot be matched. Once all known matches have been made, the user can move on through the import process.

- Select Source Field
- Select Destination Field
- Select Add Match button

To the right of the list of field matches there are three buttons, **Load**, **Save** and **Remove**. The **Load** button is used if there is a saved set of field matches that the user wants to load into the system to use for the chosen data. Once the **Load** button has been selected, a new window will appear and the user will have to select a file to import. Once a file has been chosen, the data will be loaded into the system and the user will see it in the Field Matching list. When loading the file, the user has to choose a file that was saved with the same category and dataset, otherwise the data will not be valid and the user will get an alert message. To save a list of field matches, the user has to select the **Save** button and give it a file name. Once the list is saved, it can be used with another file that has the same category and dataset. If a match needs to be removed from the list for whatever reason, select the match and select the **Remove** button. Once all known fields have been matched, the user has to select the **Continue** button to move on with the import process.

Validation

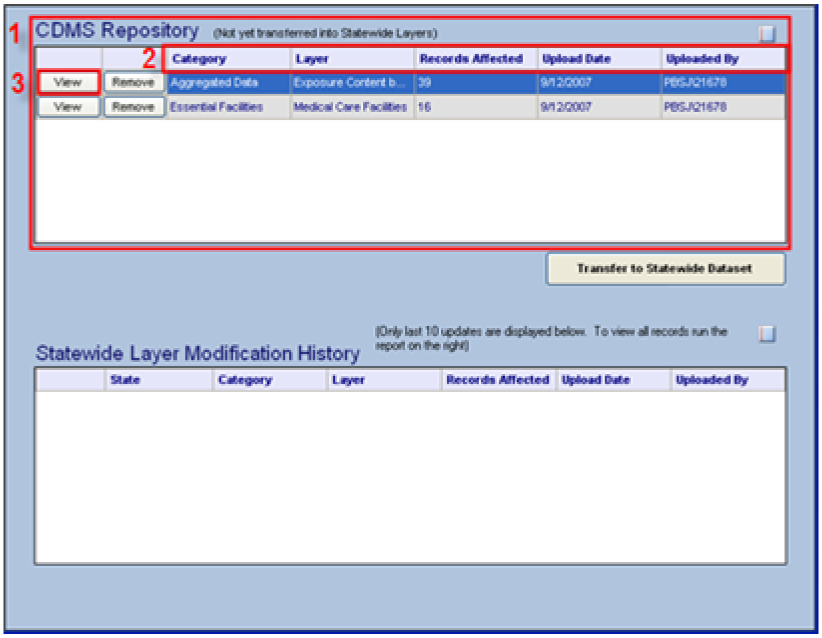
When data is imported into the CDMS system, a process validates the data in the import file by ensuring all the required fields have a value and that the fields match correctly. A report will be presented detailing validation errors (if any).



If a validation error occurs, the user must fix the error before the file can be imported properly.

Viewing the Results in the CDMS Repository

Once any data has been imported into the CDMS system, it will appear in the CDMS Repository[1] on the home screen.



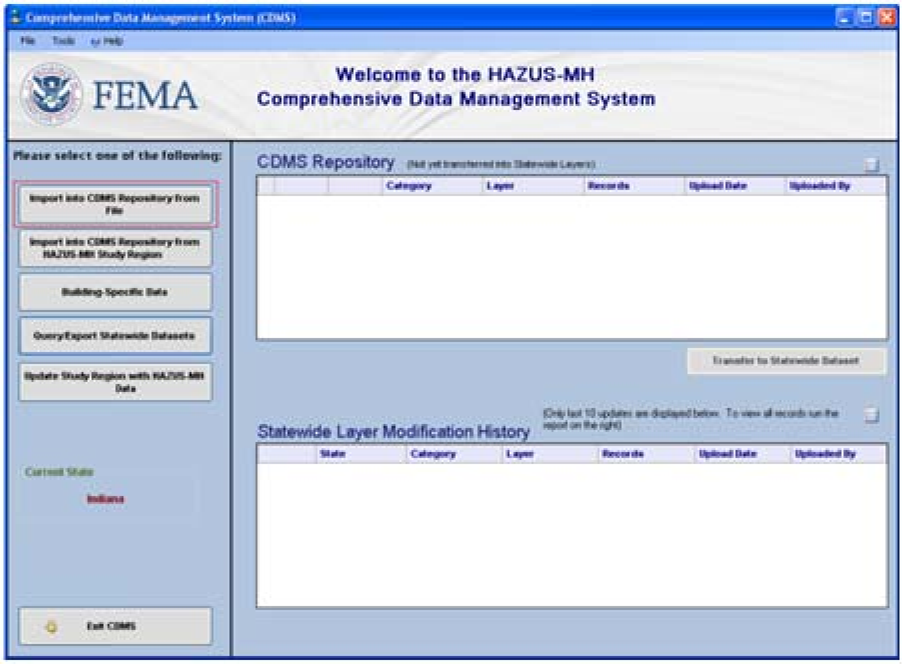
The Category, Layer, Records Affected, Upload Date and Upload By columns will be shown on the home screen. To view individual data layers, the user must select the **View** button to the left of the row.

8.6.2 Providing Building/Parcel Data from a File

Selecting a Source Data File

From the CDMS Home screen:

- Select **the Import into CDMS Repository from File** button



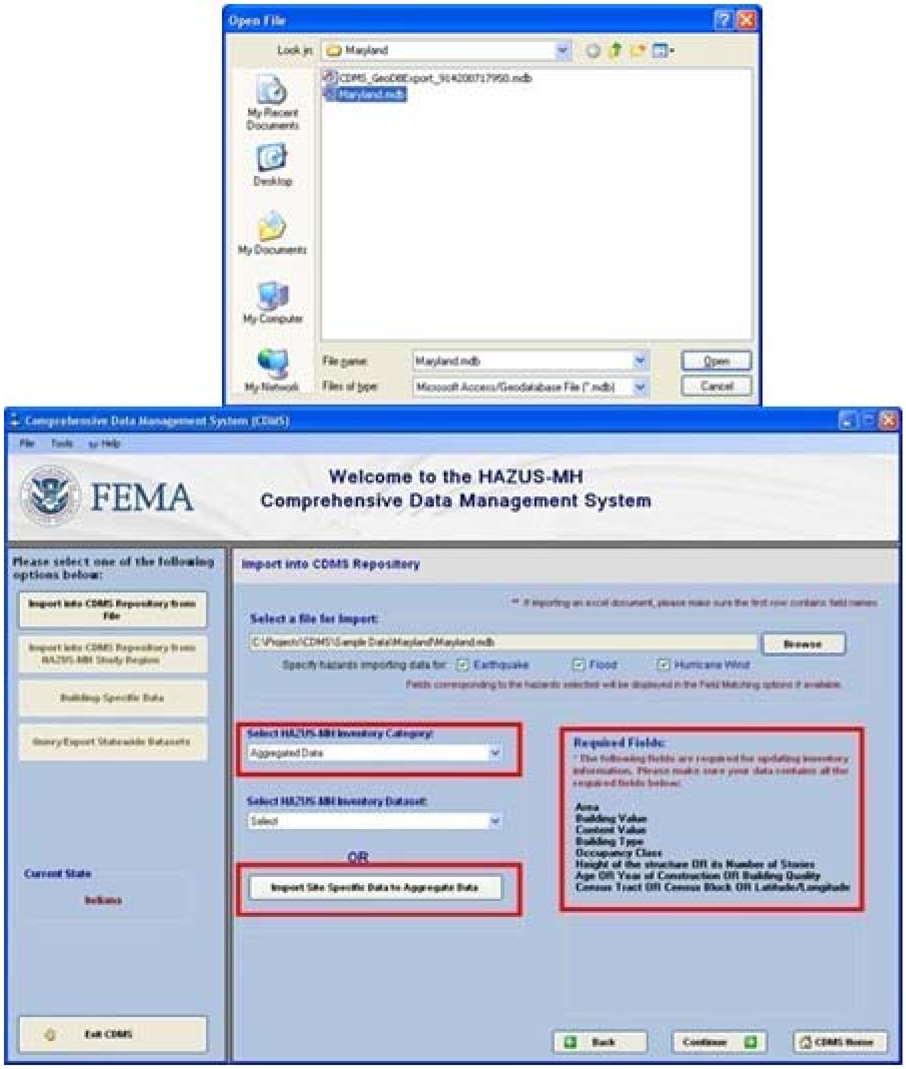
- Select a source file to import. To find a file, select the **Browse** button and select a source file.

Select the **Open** button and the folder path will appear in the indicated area on the screen. The user may also choose one or more hazards by using the check boxes under the file path.

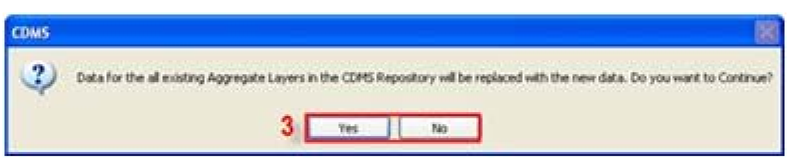
8.6.3

Specifying the Destination

- Select Aggregated Data from the **Select Hazus-MH Inventory Category** dropdown list
- Select **the Import Site Specific Data to Aggregate Data** button.
- Review the Required Fields listing to make sure you have this information in your data files.
- Select the **Continue** button



If there is aggregate data already in the CDMS Repository a warning message will appear telling the user that any existing data in the CDMS Repository will be replaced with the new data. The user should transfer any existing aggregated data to the statewide Hazus-MH database before continuing.

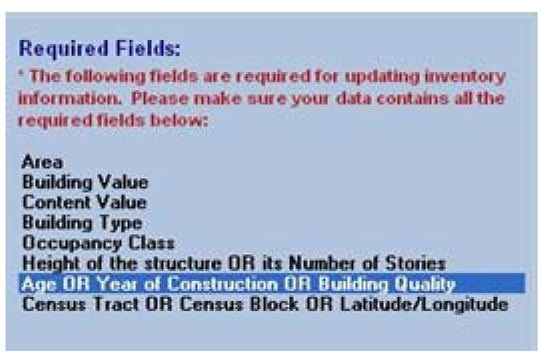


The user must choose the **Yes** button to continue with the import process or select **No** to cancel the process.

Once the Yes option is chosen, a new pop-up window will appear. In this window, the user must select an input table. If a user imports a shape file the Import Table will be selected automatically. If a MS Access or Excel File was chosen the user will have a choice of worksheets or tables to use for the import process.

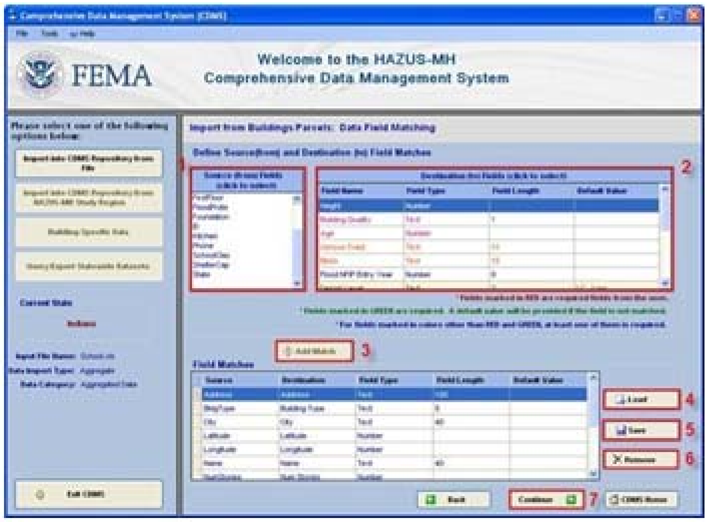
Matching Fields

There will be a source list on the left with a list of fields from the source file and there will be a destination list on the right which will list the fields that are in the Hazus data. The system will automatically match up the fields that have the same name and the same characteristics. The user will have to match the rest of the fields by selecting one field from the source list and its match from the destination list. To add the field's matches to the list at the bottom of the screen after a field from both lists has been chosen, select the **Add Match** button. Fields that are marked in **red** are required fields and the user cannot move on to the next screen without matching those fields. Fields that are in **green** are also required, but a default value will be provided if the field cannot be matched. Once all known matches have been made, the user can move on through the import process.



- Select Source Field
- Select Destination Field
- Select Add Match button

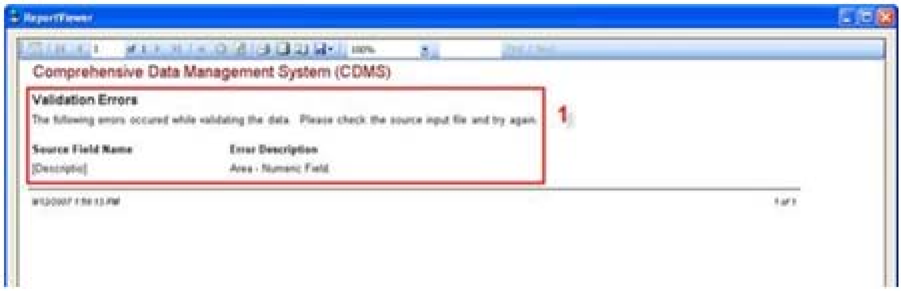
Fields have also been color coded according to groupings of information required for the aggregation process to succeed. For each color grouping the user must supply at least one of the fields. Example: Building Quality and Age and Year of Construction are in purple. The user must provide at least one of these fields to continue.



To the right of the list of field matches there are three buttons, **Load**, **Save** and **Remove**. The **Load** button is used if there is a saved set of field matches that the user wants to load into the system to use for the chosen data. Once the **Load** button has been selected, a new window will appear and the user will have to select a file to import. Once a file has been chosen, the data will be loaded into the system and the user will see it in the Field Matching list. When loading the file, the user has to choose a file that was saved with the same category and dataset, otherwise the data will not be valid and the user will get an alert message. To save a list of field matches, the user has to select the **Save** button and give it a file name. Once the list is saved, it can be used with another file that has the same category and dataset. If a match needs to be removed from the list for whatever reason, select the match and select the **Remove** button. Once all known fields have been matched, the user has to select the **Continue** button to move on with the import process.

Validation

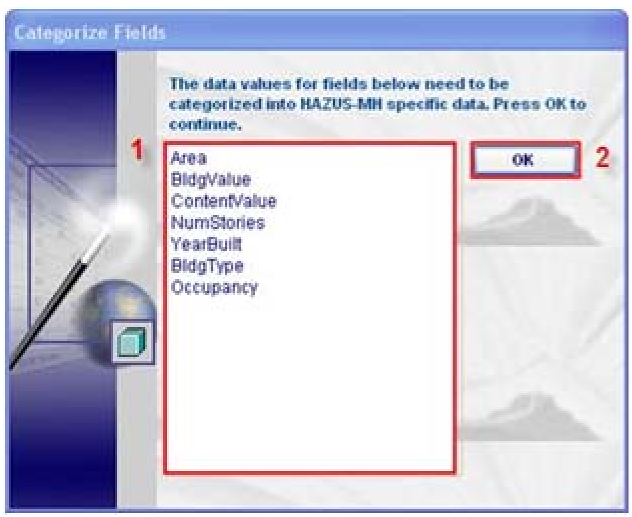
When data is imported into the CDMS system, there is a validation process that ensures that all required fields have a value and that the fields match correctly. If any data fails validation, a detailed report will be generated.



If a validation error occurs, the user must fix the error before the file can be imported properly.

Data Categorization

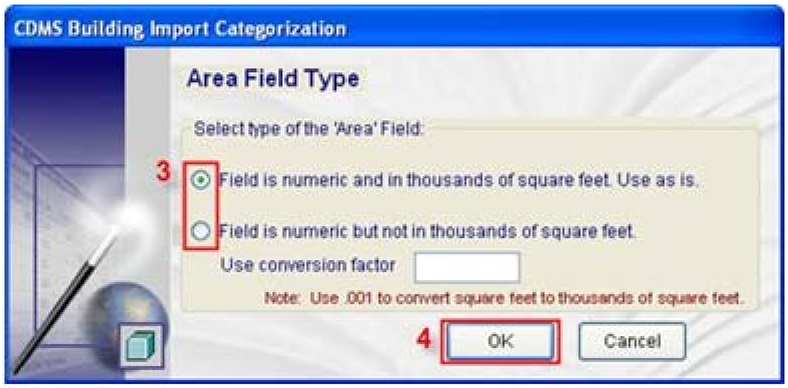
After fields have been matched for data being imported, there may be some fields that need to be categorized into Hazus specific data. A window will appear with the list of fields and a message letting the user know that the fields need to be categorized.



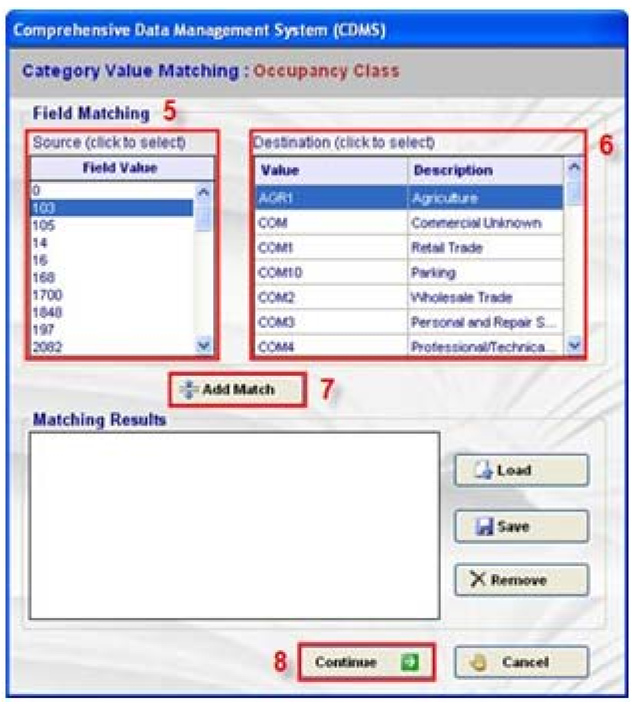
Part of the categorization process is the conversion of data within source fields to Hazus-MH required values.

- Select the **OK** button to continue with the categorization process

For Area, Building Value, Contents Value, Number of Stories, and Year Built, the conversion screen will ask the user to verify the format of their data. The area conversion screen is shown below:



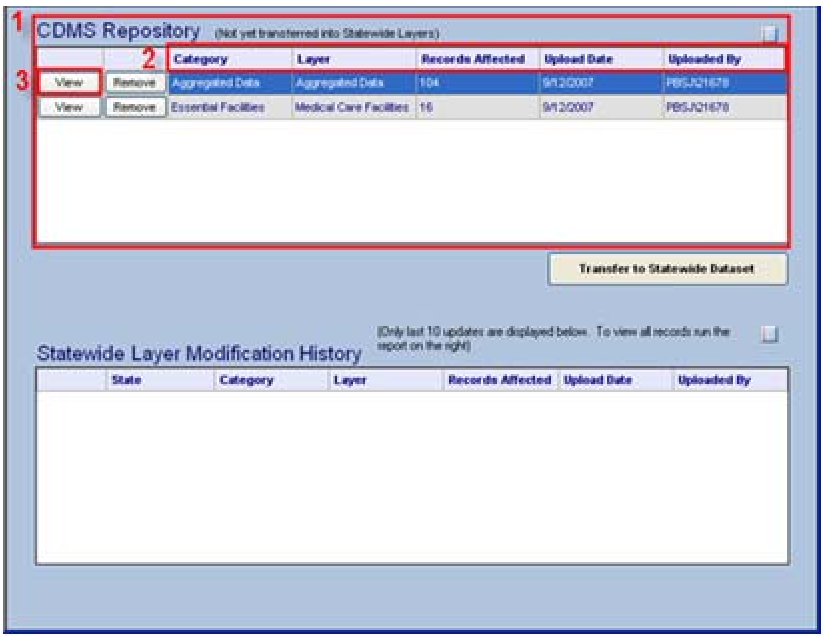
For Building Type and Occupancy Class a window will appear for value categorization. The categorization window will be in the same format as the field matching screen. The user will choose a value from the source list and a value from the destination list and select the **Add Match** button. Once each value on the screen has been matched, the user must select the **Continue** button to move on.



The next field categorization screen will appear and the user will go through the same steps for that field. This will continue until all fields have been categorized. At that point, a final screen will be presented that will allow the user to make choices regarding their General Building Type Mapping schemes.The default choice will use system defaults for any occupancy categories the user did not provide. Another choice is available as well now, which will allow the user to utilize the most recent General Building Type mapping scheme values for defaults. Making this choice will simulate no change in the non-provided occupancies by using the defaults of the last scheme run.

Viewing the Results in the CDMS Repository

After aggregated data has been processed it will appear in the CDMS Repository. The Category, Layer, Records Affected, Upload Date and Upload By columns will be shown on the home screen. To view individual data layers, the user must select the **View** button to the left of the row.



8.7 Aggregating Building-Specific Data

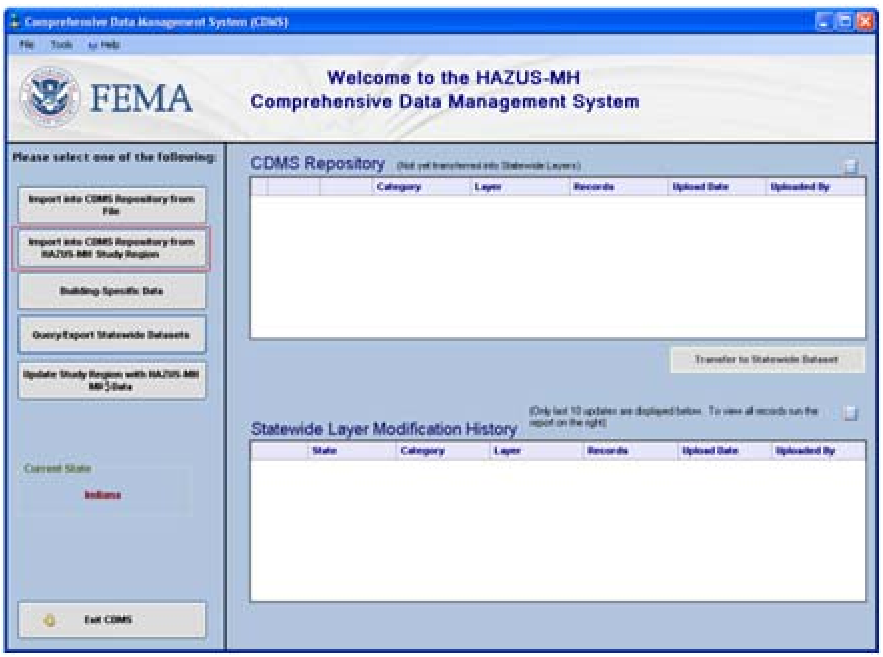
Building-Specific data is data that is created and/or modified in the CDMS system:

- From the Building-Specific Data screen, select the "Export Table" button. To aggregate this data, the data can be reimported into CDMS via the "Importing Site Specific Data to Aggregate Data" function.

8.8 Importing into the CDMS Repository from a Hazus-MH Study Region

CDMS has the ability of connecting to a Hazus-MH Study Region and importing data into the statewide Hazus-MH datasets. This is especially useful if a user has added new features to their study regions and would like to merge the features into the statewide data.

- Select the **Import into CDMS Repository from Hazus-MH Study Region** button from the CDMS Home screen



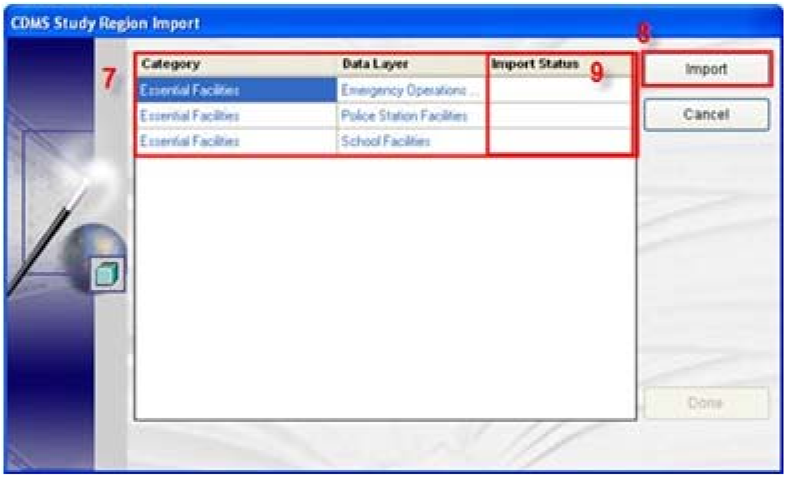
When the Study Region import screen opens:

- Select a Study Region from the dropdown list
    - o The Study Region Hazards will show what hazards were selected for the study region
- Select a Study Region Inventory Category from the dropdown list (i.e. Essential Facilities)

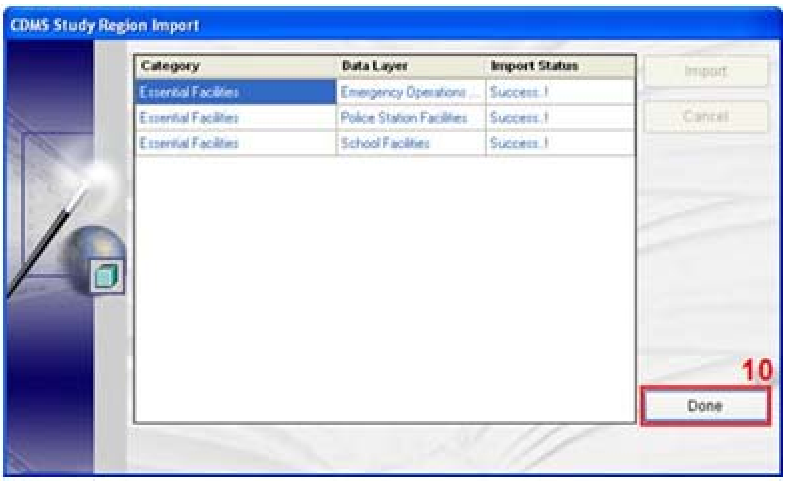
- Select the **Study Region Inventory Category Datasets** from the listing and use the arrow buttons to move them to the **Selected Study Regions** listing

- Select the **Continue** button at the bottom of the screen to move on to the next page.

A pop-up window will appear with a list of the data layers chosen by the user. Select the **Import** button to finish the import process. To the right of each data layer row there is a column titled Import Status, when the data layer is finished importing the word success will appear to let the user know that the import is finished.



When all data layers have been imported the **Done** button will become active at the bottom right corner of the screen.

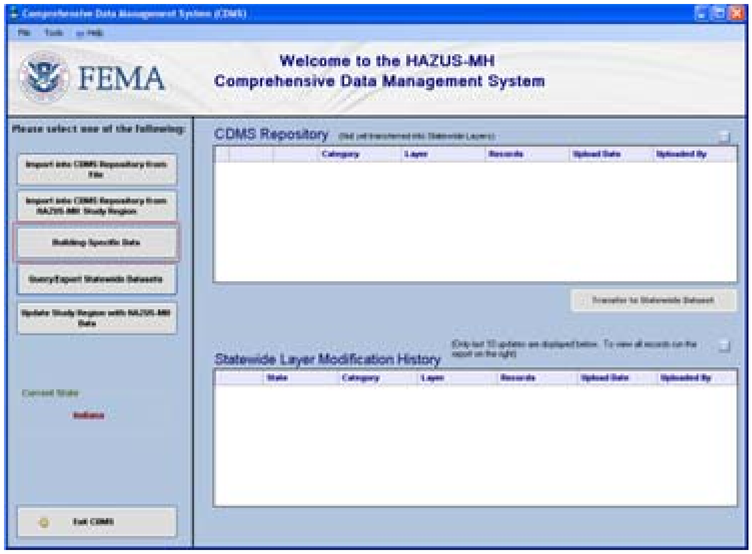


- Select the **Done** button and the pop-up window will close and the CDMS Home page with the data layers imported.

8.9 Adding a New Building

To add a new building the user must navigate to the building-specific data screen. From the home screen, select the Building-Specific Data button from the menu to the left of the page.

- Select the **Building-Specific Data** button from the CDMS Home screen

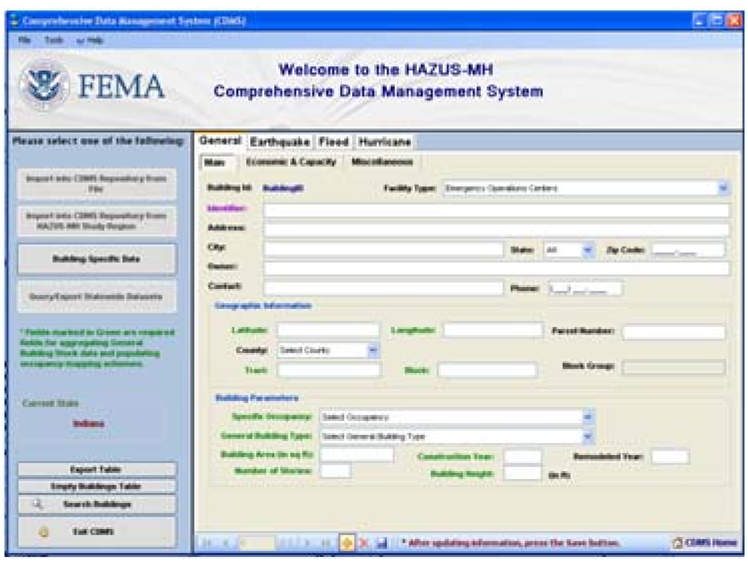


The screen that appears will have four tabs at the top of the screen.

General > **Earthquake** > **Flood** > **Hurricane**

Each tab contains sub tabs with detailed information for the main tab.

Select the  button at the bottom of the screen to add a new building record.

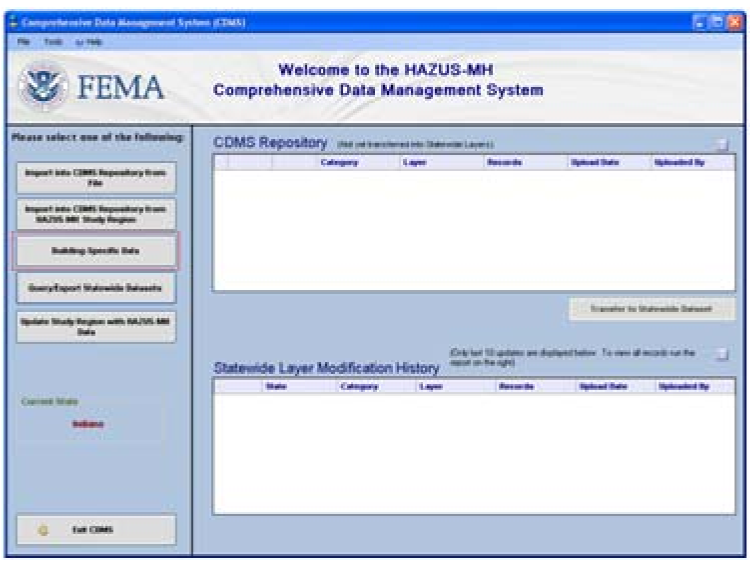


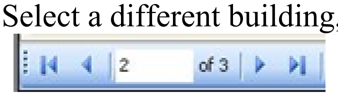
A pop-up window will appear and the user must enter a building identifier and select a building facility type [6] from the drop down list, then select the OK button.

The pop-up window will close and the new building will be shown on the screen. The user will be able to edit the current information for the building as well and save it.

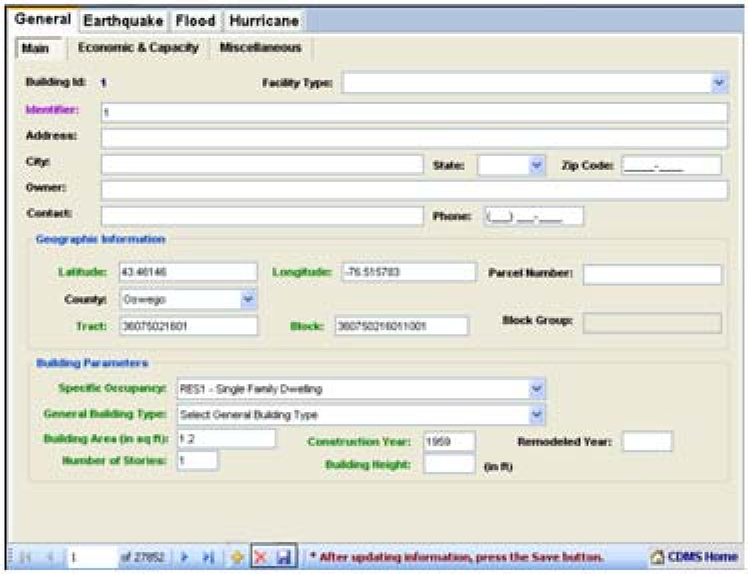
8.10 Editing or Deleting an Existing Building

To edit an existing building in the building-specific data section, the user must select the Building-Specific Data button from the menu on the left side of the home screen.



- Select a different building, use the **left and right arrow** buttons 

- Select the **Save** button  when information has changed for a building
- Select the **Delete** button  to remove the current record



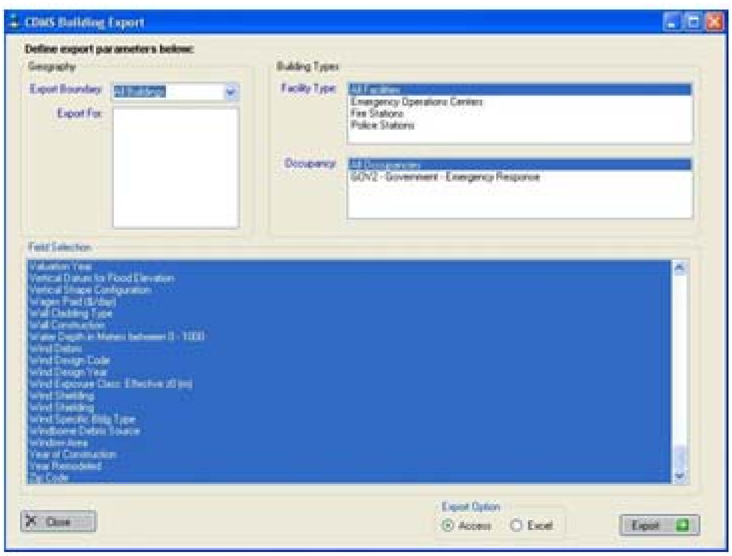
The new or changed information will be saved in the system and available for modification or deletion if necessary.

NOTE: The user should note that items with a green label are required items for performing aggregation activities within CDMS.

8.11 Exporting Building Specific Data

Once the user has navigated to the building specific data screen using the Building Specific Data button on the home screen, the user can view the building specific data that is saved in the system. Data must be input into the forms to be able to export the data. Select the **Export Table** button on the left side of the screen.

A new window will appear and the user must select the criteria to export. All fields are selected by default. By default, the export will be to a Microsoft Access database, however, data may also be exported to Excel by changing the radio button option at the bottom of the screen.

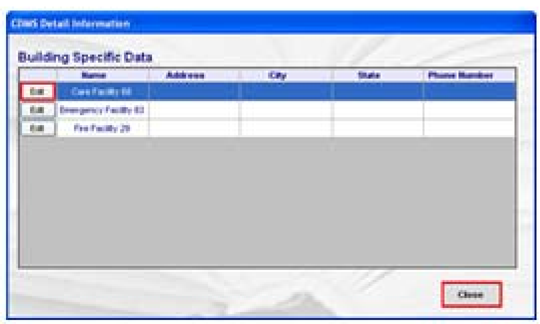


Once the criteria is chosen, select the **Export** button and a Save File window will appear. Select the folder where the data is to be saved and select the **Save** button. The window will disappear and a message box will be displayed confirming export completion. To close the criteria window, select **Cancel** or use the close button in the top right corner of the screen.

8.12 Searching Building Specific Data

While at the building specific data screen, users can search for specific building information that is listed in the tables. To do this, the user must select the Search Buildings button located on the left side of the screen.

A new window will appear and the user will have a list of existing buildings to choose from.



Once the user has found the building to edit, select the Edit button. The buildings listing window will disappear and the user will see the chosen building information shown on the building specific data screen.

8.13 Querying/Export Statewide Datasets

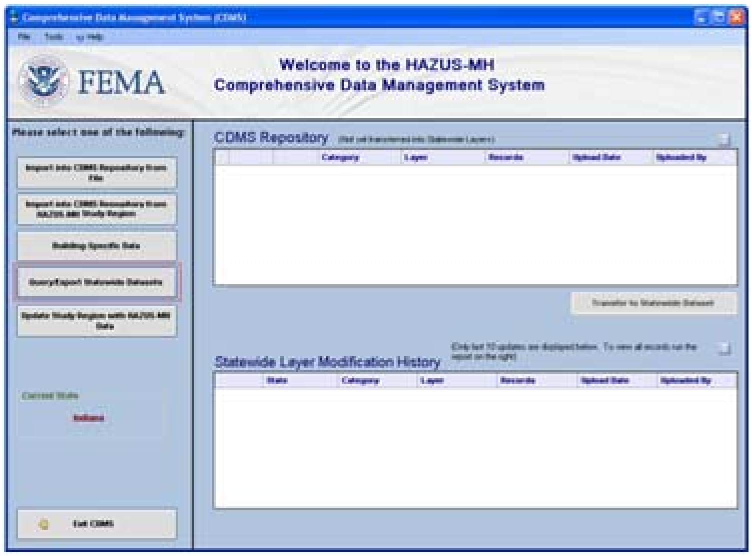
If the user has specified a statewide Hazus-MH data location, the data can be queried, deleted and exported.

- Searching Statewide Geodatabases

- Deleting Statewide Data
- Exporting Search Results to a MS Excel File
- Exporting Search Results to an ESRI Personal Geodatabase File

8.13.1 Searching Statewide Geodatabases

- Select the **Query/Export Statewide Datasets** button from the menu on the left of the home screen.



The Query/Export Statewide Datasets screen will appear and the user should specify the following information:

Geographic Location

- Statewide
- County (1 or more may be selected)
- Census Tract (1 or more may be selected)
- Census Block (1 or more may be selected)

Category Datasets such as:

- Essential Facilities > Police Stations
- Essential Facilities > Schools
- High Potential Loss Facilities > Military Installations

Hazards (Returns general inventory fields plus selected hazard data)

- Flood
- Earthquake
- Hurricane Wind

Use the arrow buttons to move information to the **Selected Geographical Areas** and **Selected Data Layers** boxes. After necessary information has been selected press the **Search** button.

The system will query statewide Hazus-MH datasets and prepare this information in the following screen.

The search summary will display the geographic search criteria. The search results will display individual datasets in a drop down menu along with a record count of the number of features returned. User can use the dropdown list to switch with between dataset.

8.13.2 Deleting Statewide Data

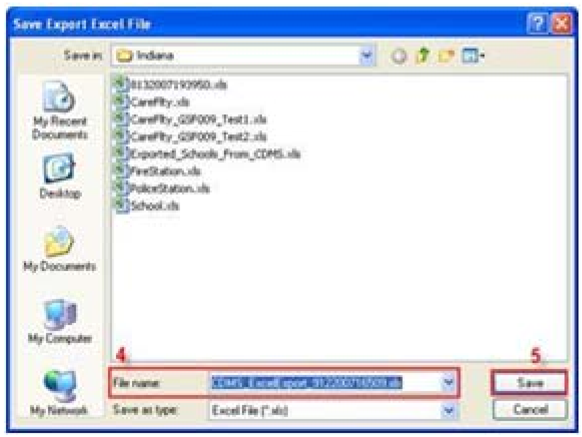
To delete inventory information from a statewide Hazus-MH dataset data must first be queried using the techniques described. On the search results screen, users can select the **Delete** button to remove individual records from statewide Hazus-MH datasets. To remove all records selected, press the **Delete All Records for Selected Inventory** button. In either case a message will appear and ask the user to verify the removal of the data.

8.13.3 Exporting Search Results to a MS Excel File

The data that is shown in the search results listing can be exported to either a MS Excel file or an ESRI Personal Geodatabase file. To export the data to a MS Excel file, select the **Export to MS Excel** button.

The user will specify an option to export only the selected layer, or all layers and then select the **Submit** button.

Enter a file name and choose a folder to save the data in. To save the file, select the Save button and the window will close and the queried list will be visible again.

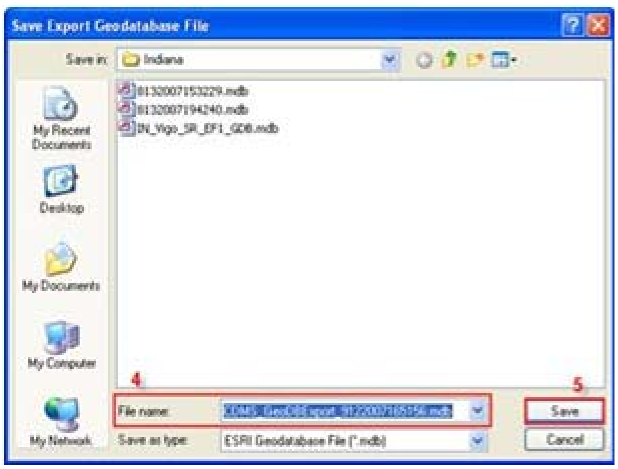


8.13.4 Exporting Search Results to an ESRI Personal Geodatabase File

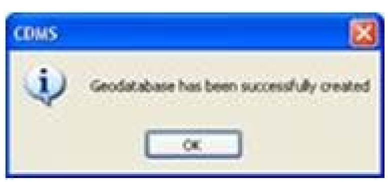
- Select the **Export to Geodatabase** button

Similar to the MS Excel option, the user must make an export choice and select the Submit button.

A new window will appear and the user must enter a file name and choose a folder to save the data in.



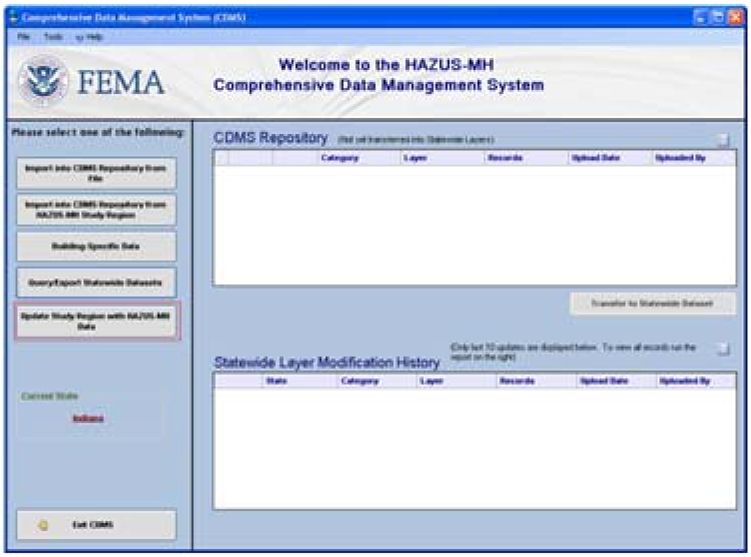
To save the file, select the Save button and the window will close and the queried list will be visible again.



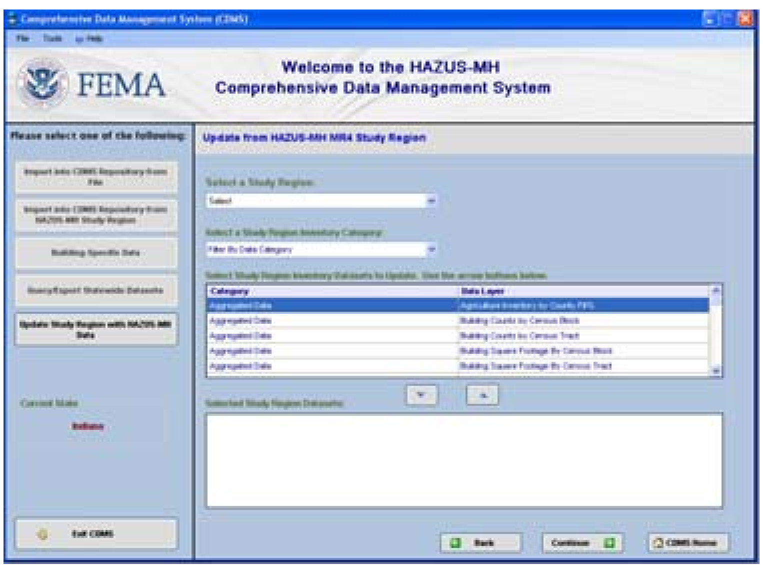
The data can now be loaded into ArcGIS and view by users.

8.14 Updating a Study Region with Hazus-MH Data

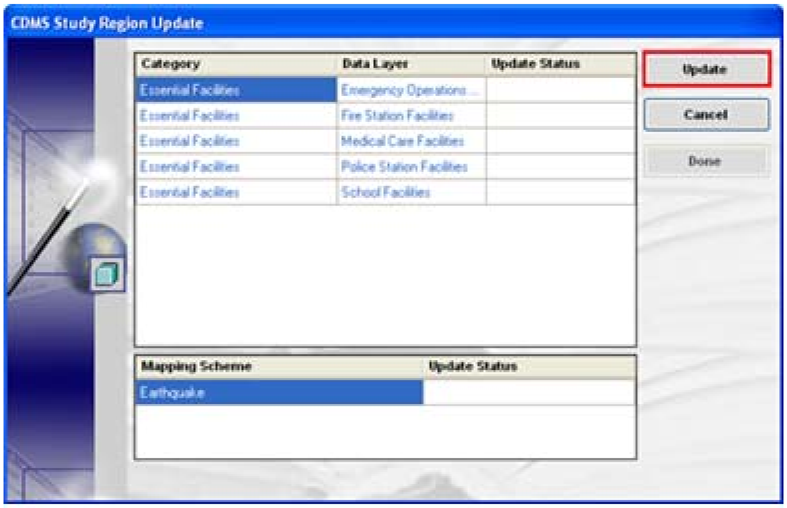
Within CDMS there is a process for users to update a study region with Hazus-MH data. To do this, the user must select the Update Study Region with Hazus-MH Data.



The criteria screen will appear and the user will need to select all the criteria pertaining to the information that needs to be updated.



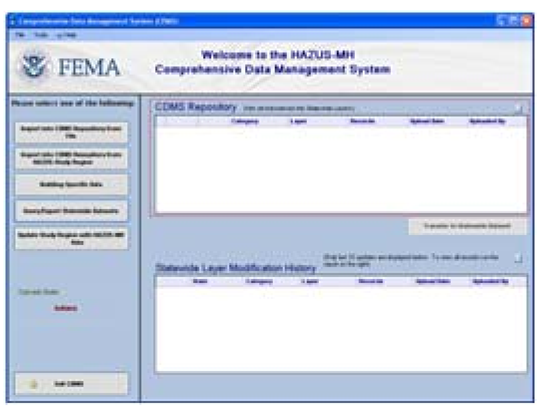
Once the criteria has been chosen, select the Continue button to move on to the next screen.



Select the Update button and the process will begin automatically. The Update Status column will show the progress of each update. Once all the updates are completed, the Done button will become available. Select the Done button to exit out of the update screen.

8.15 CDMS Repository

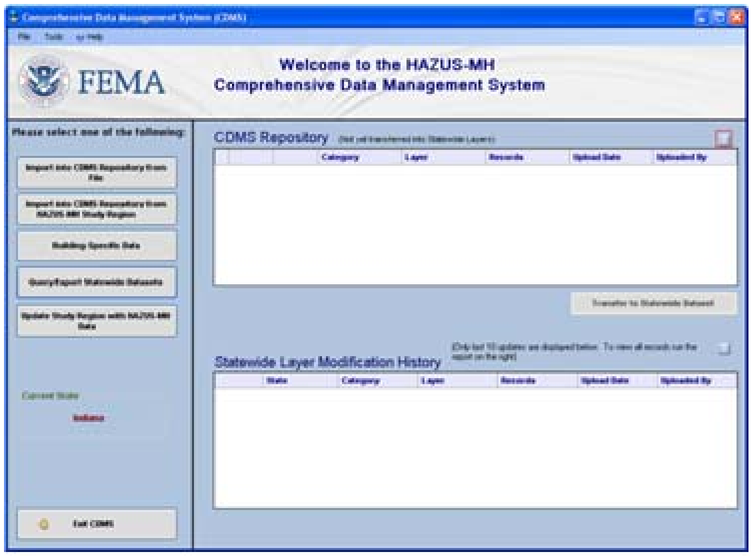
The CDMS Repository holds any data that has been imported and converted to Hazus-MH data structures. Data shown in this window has not been merged with Hazus-MH statewide geodatabases. Any data that is shown in the repository can be viewed and removed by the user. A report can also be generated that will show a summary of the data in the repository.

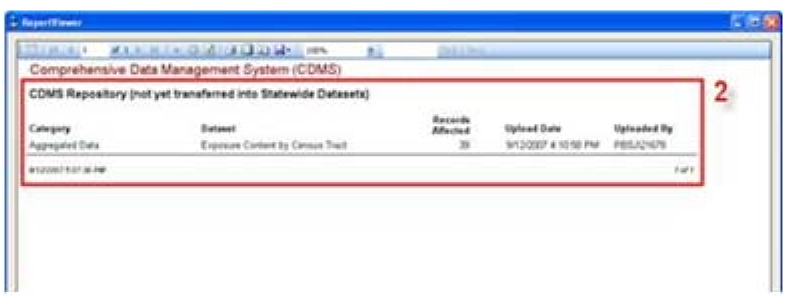


- Viewing a Report of Data in the CDMS Repository
- Viewing Individual Records for a Site Specific Inventory Dataset
- Removing Individual Records for a Site Specific Inventory Dataset
- Viewing Individual Records for an Aggregated Data Dataset
- Removing a Site Specific or Aggregate Dataset from the CDMS Repository

8.15.1 Viewing a Report of Data in the CDMS Repository

To view a report of data in the CDMS Repository, select the report icon above the repository.





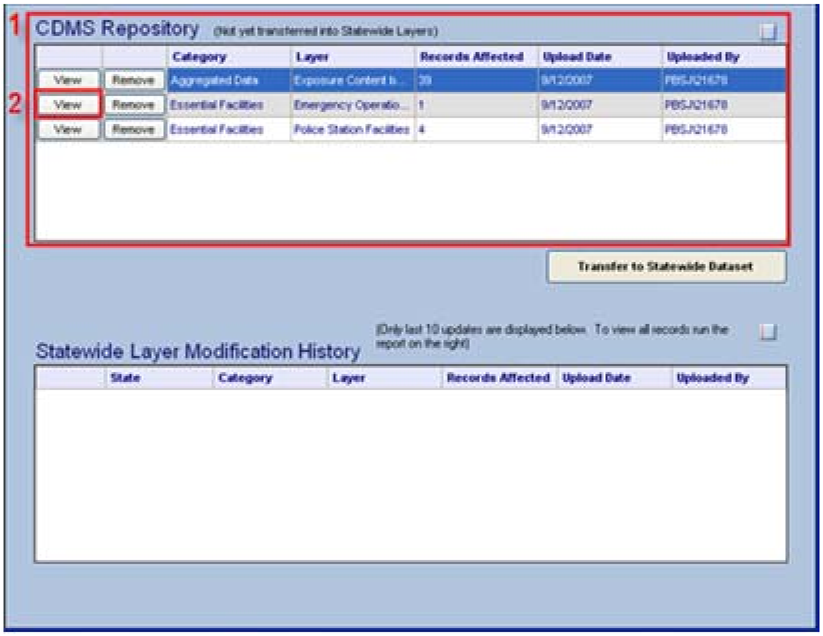
A new window will appear with the data information for datasets within the CDMS Repository.[2]

While viewing this report, the user can print and save the information as needed.

8.15.2 Viewing Individual Records for a Site Specific Inventory Dataset

To view individual record for a layer/dataset loaded into the CDMS repository the CDMS Repository:

- Select the **View** button next to the layer of interest.



A new window will appear with the detailed dataset information shown below.

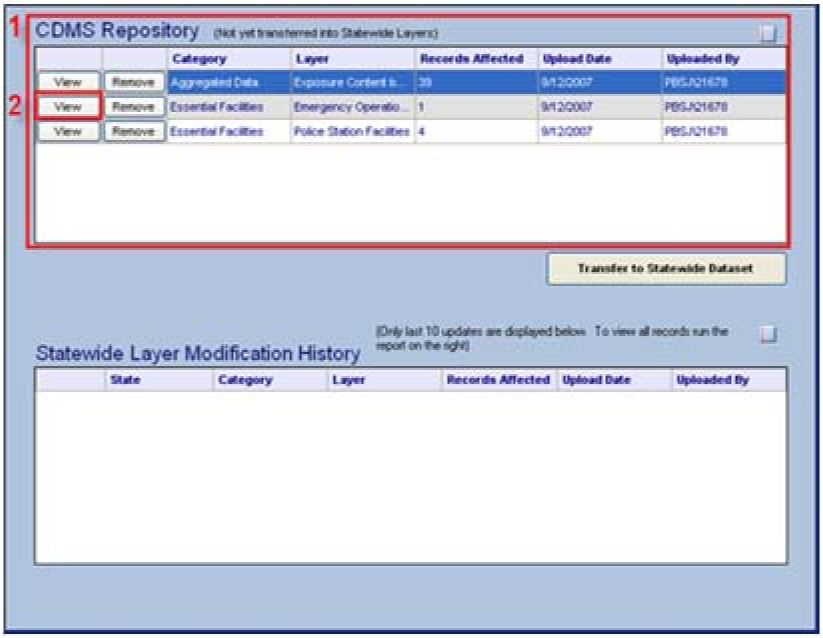
- Sort data by selecting on the column heading above the data
- Use the scroll bars to view all information available

When finished viewing, select the **Close** button in the bottom right corner of the screen and the window will close.

8.15.3 Removing Individual Records for a Site Specific Inventory Dataset

To view individual record for a layer/dataset loaded into the CDMS repository the CDMS Repository:

- Select the **View** button next to the layer of interest.



A new window will appear with the detailed dataset information shown below.

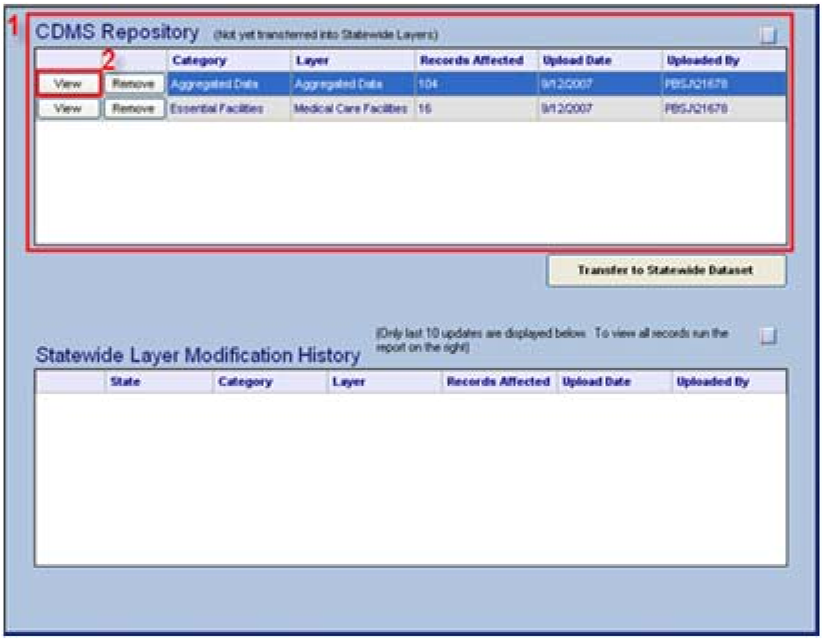
- Sort data by selecting on the column heading above the data
- Use the scroll bars to view all information available
- Select the **Remove** button next to the inventory feature. This record will be removed and will not be available for transfer into Hazus-MH statewide data

The screen will refresh with the datasets erased from system and the user can choose to delete another or close out the window using the **Close** button in the bottom right corner.

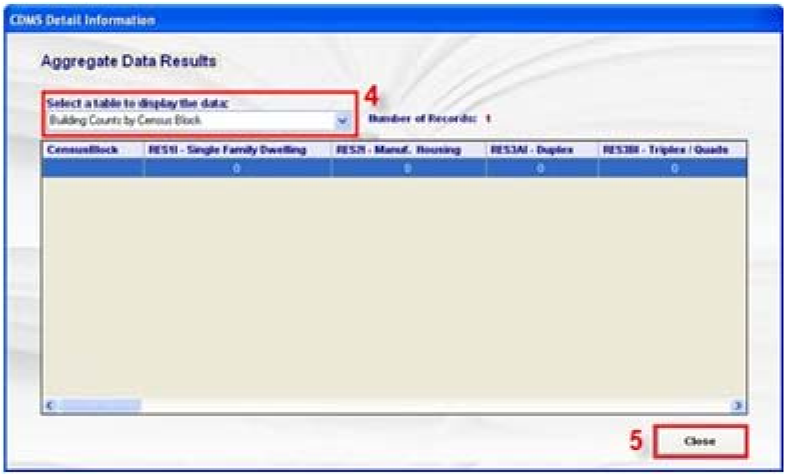
8.15.4 Viewing Individual Records for an Aggregated Data Dataset

Aggregated data imported into the CDMS repository is located under the category Aggregated Data. Select the View button to view detailed information by census block and tract:

- Building Counts
- Square Footage
- Content Exposure
- Building Exposure



A new window will appear with the dataset information shown in a list format. *The data can be filtered using the drop down list at the top of the screen.*

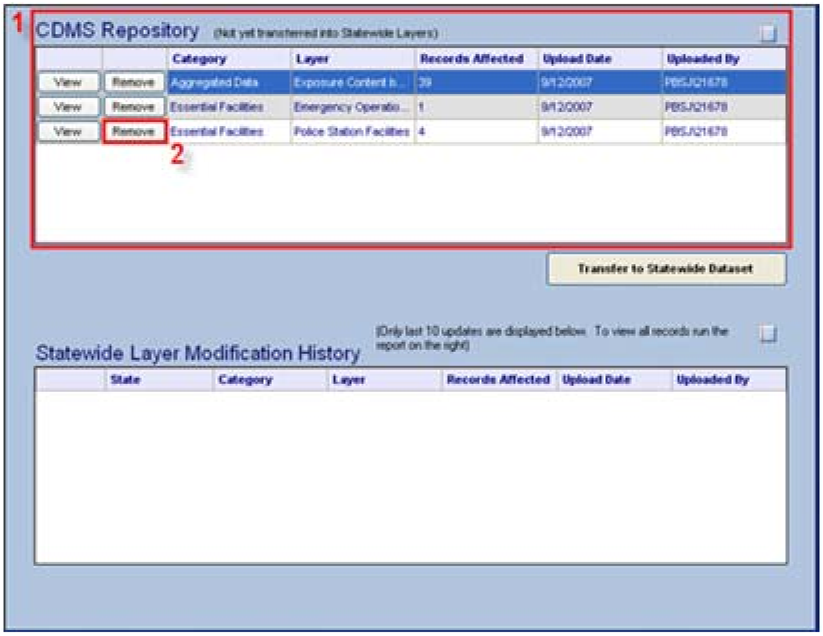


When finished viewing, simply select the Close button[5] in the bottom right corner of the screen and the window will close.

8.15.5 Removing a Site Specific or Aggregate Dataset from the CDMS Repository

Users may remove an entire dataset out of the CDMS Repository. This may happen because new information has been acquired or incorrect information uploaded. To remove a dataset from the CDMS Repository:

- Select the Remove button next to the layer/dataset



Once the Remove button has been selected, the screen will refresh and the dataset will be erased from the system. User will not be able to transfer the removed dataset to the statewide Hazus-MH geodatabases.

8.16 Transferring Data into Hazus-MH Statewide Geodatabases

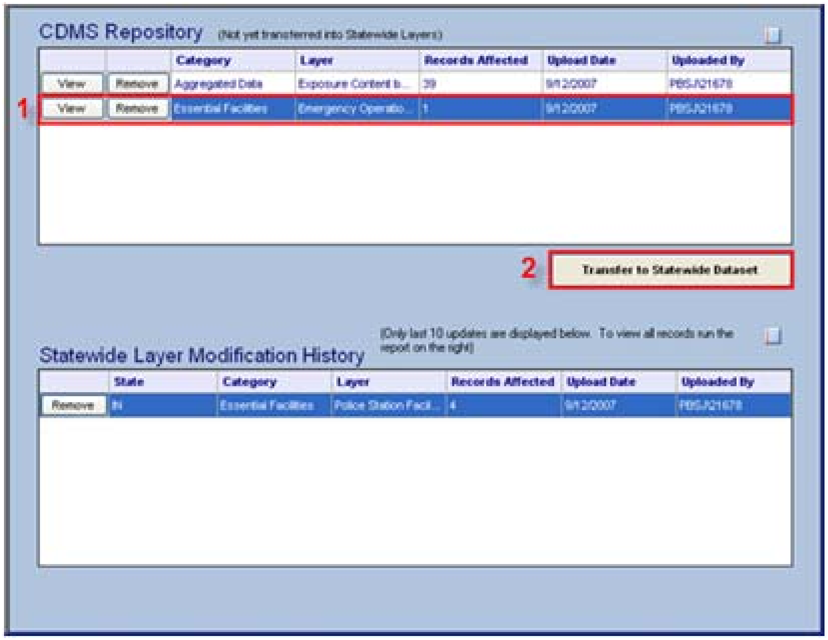
Data residing in the CDMS Repository can be transferred into the statewide Hazus-MH geodatabases for use within the Hazus-MH program. Data residing within the CDMS Repository has already gone through the validation procedures to verify that it meet the minimum Hazus-MH data format requirements.

- Transferring Site Specific Inventory Data into Hazus-MH Statewide Geodatabases
- Transferring Aggregated Data into Hazus-MH Statewide Geodatabases

Note: Data in the CDMS Repository has been verified for format and structure accuracy. but not for geographic correctness. During the transfer process CDMS will check to see that data being transferred will fit within census tracts for the given state. If records exist which are located outside available census tracts, this data will be ignored.

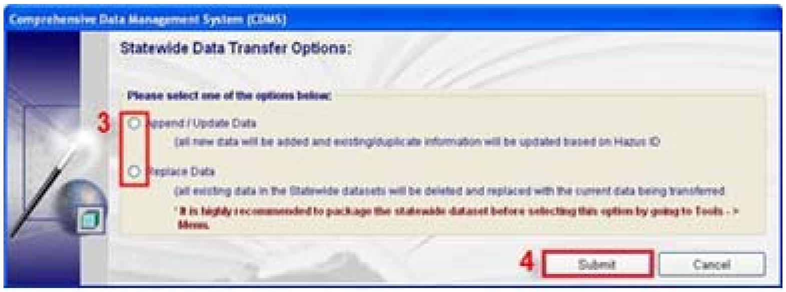
8.16.1 Transferring Site Specific Inventory Data into Hazus-MH Statewide Geodatabases

Site specific inventory data that is in the CDMS Repository can be transferred to statewide geodatabases. The dataset must be selected by selecting the layer name and the user must select the **Transfer to Statewide Dataset** button.



CDMS will request that the user specify an update strategy for data updates. There are two primary options.

- **Append/Update Data**. This option should be used when importing a subset of data into the statewide Hazus-MH datasets. The system will try to match the Hazus-ID to the user specified ID. If a match is found then an update of record will take place. If a match is not found a new record will be added to the statewide datasets. To delete records out of the statewide datasets please review the Query functionality.
- **Replace Data.** Replace data should be used when a total replace of statewide data is occurring. This option will remove all features residing in the Hazus-MH statewide data for the selected layer.

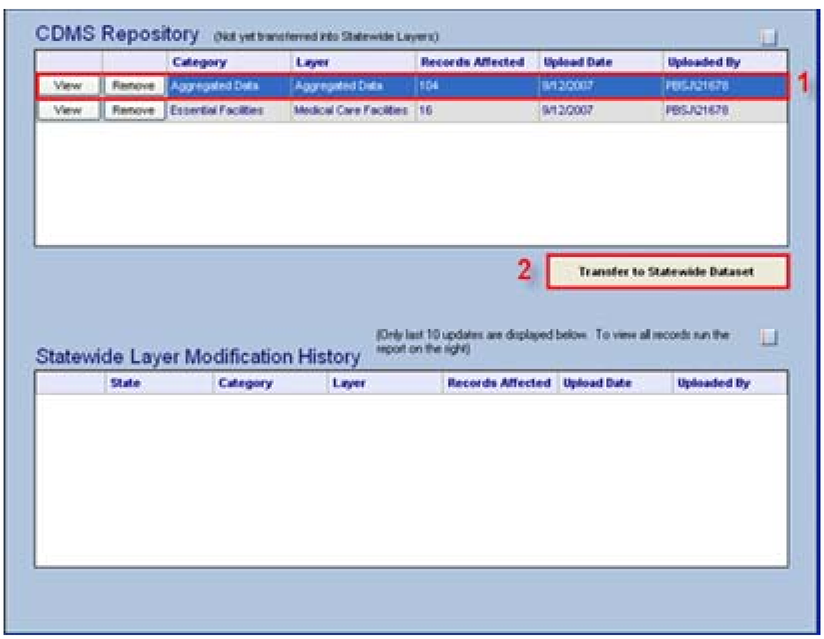


After the data transfer has been completed, a window will appear stating that the dataset was transferred successfully. The dataset will appear in the Statewide Layer Modification History section of the CDMS Home screen.

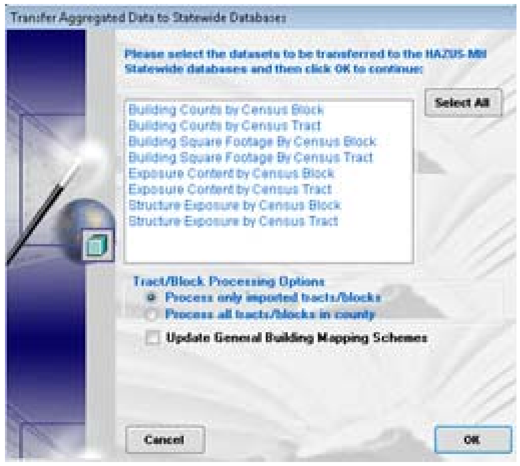
8.16.2 Transferring Aggregated Data into Hazus-MH Statewide Geodatabases

Aggregated data in the CDMS Repository on the CDMS home screen can be transferred to statewide Hazus-MH datasets. CDMS provides update routines to update aggregate information for the selected state.

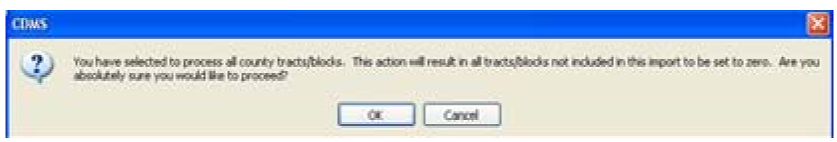
- Select the aggregated dataset layer from the CDMS Repository
- Select the **Transfer to Statewide Geodatabase** button



A window will appear and the user should select the specific aggregate data layers they want to transfer.

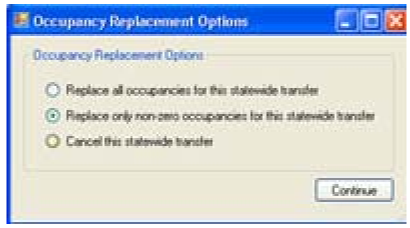


- Select individual datasets or use the Select All button to select all datasets for update
- To update the General Building Mapping schemes, select the appropriate check box.
- Select the tract/block processing options. By default, updates only occur on the tracts/blocks that are included in this update, however, by checking the "Process all tracts/blocks in county, you will receive the following warning.



- If you select the option to process all county tract/blocks, in a few moments, another message will pop up advising the number of counties to be affected by the update. This is offered as a safeguard to prevent inadvertent data updates.

Finally, If you do not select the option to process all county tract/blocks, in a few moments, another message will pop up regarding occupancy count replacement. This screen will give you the option to do a complete replacement of all occupancy counts from the input file, or to update only the non-zero counts.



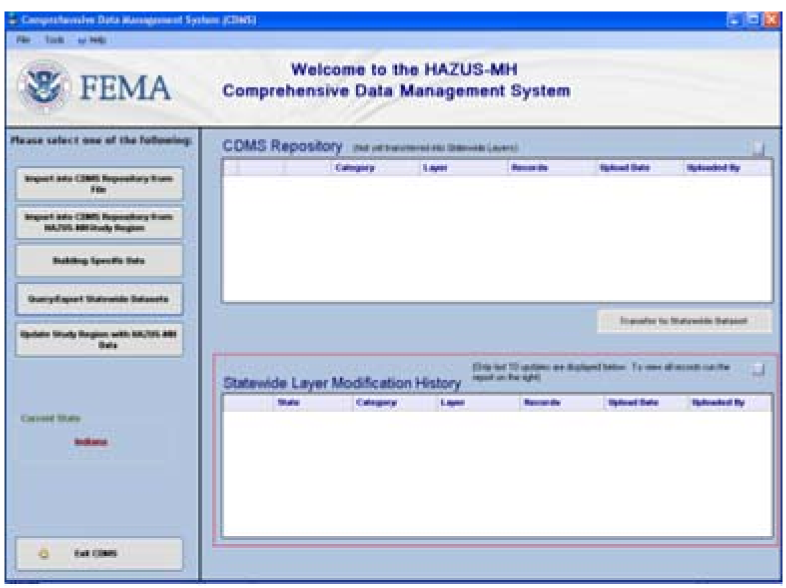
Select the OK button to update statewide Hazus-MH datasets

Once the update routine has finished the user will be notified that the data was transferred successfully and the dataset will appear in the Statewide Layer Modification History.

8.17 Statewide Layer Modification History

The Statewide Layer Modification History is located at the bottom of the CDMS Home screen. This section is where the data is shown after it has been transferred to the statewide Hazus-MH datasets. The information listed can be removed from this section and a report can be generated showing a summary of the data in the Statewide Layer Modification History.

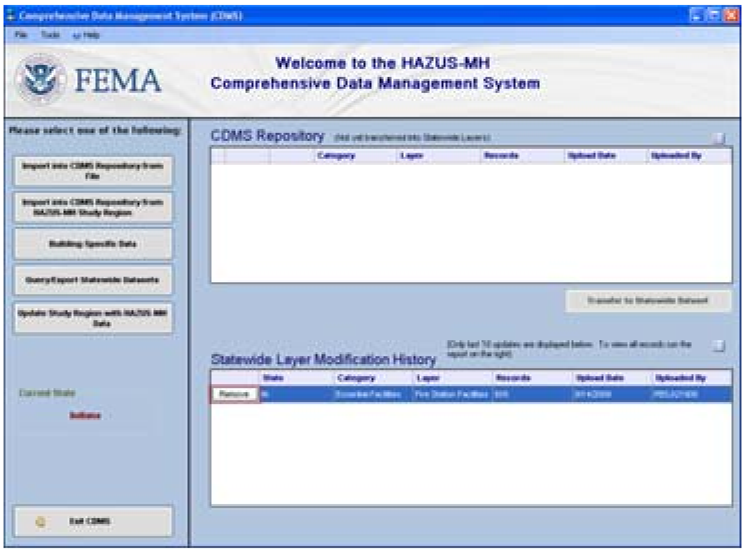
- Removing Data from the Statewide Layer Modification History
- Reporting Statewide Layer Modification History



8.17.1 Removing Data from the Statewide Layer Modification History

When data is transferred to the statewide geodatabases, it is shown in the Statewide Layer Modification History on the CDMS Home screen. Once the data is shown in the history section it can be removed from the section. To remove a dataset from the Statewide Layer Modification History:

- Select the Layer/Dataset of interest by clicking on the name
- Select the **Remove** button in the row of the chosen dataset.

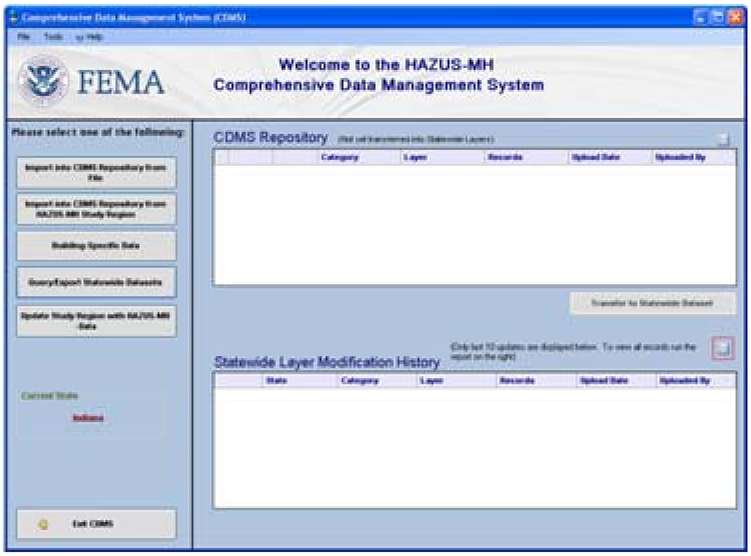


A message will verify with the user that they want to delete the dataset, select the **Yes** button to continue deleting the history.

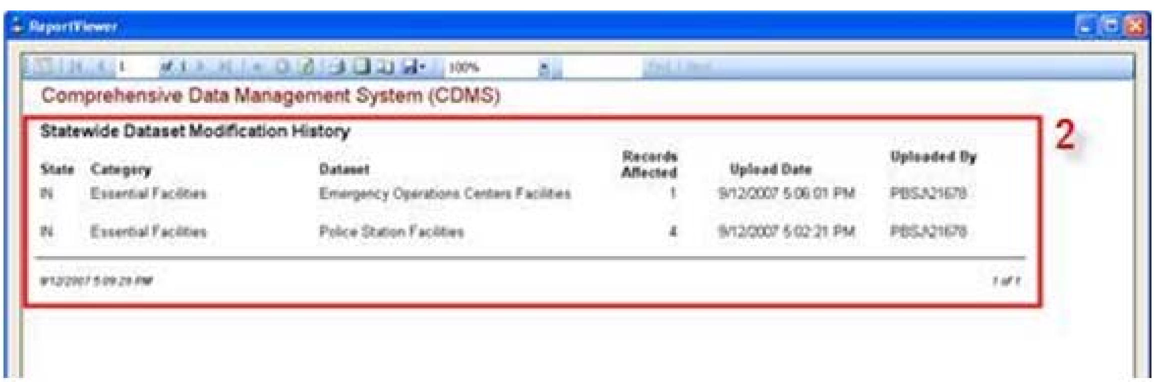
The screen will refresh with the dataset erased from the system. For instruction on how to clear all records at once, please see the section titled Clear Statewide Layer Modification History.

8.17.2 Reporting Statewide Layer Modification History

To view a report of data in the Statewide Layer Modification History, select the report icon above the history section



A report window will appear with the update history of data modification made to statewide Hazus-MH Level 1 data. The report outlines the State, Data Category, Dataset, Number of records affected by the update, transfer date and time and the computer login of the person who performed the transfer.



While viewing this report, the user can print and save the information as need.

Chapter 9. Running Hazus with User Supplied Data

Chapter 9 provides you with a step-by-step discussion of how to perform an analysis if you wish to modify default parameters and data. Before attempting an analysis that will incorporate user-supplied data, follow the steps in Chapter 3 for running an analysis using only the default data.

9.1 Defining the Study Region

The first step in any analysis is defining a study region. Defining a study region was discussed in Section 3.1.

9.2 Defining the Potential Earth Science Hazards

Section 3.2 gave a brief overview of how to define a scenario earthquake. **Hazus** has a number of options for defining the potential earth science hazards (PESH). It also allows you to estimate losses based on one of three characterizations of the earthquake hazard:

- Scenario earthquake (deterministic hazard),
- Probabilistic seismic hazard analysis
- User-supplied map of ground motion

The **deterministic hazard** can be a historical epicenter event, a source event, or an arbitrary event:

- Historical Epicenter Event: The historical epicenter event definition consists of selecting the desired event from the **Hazus** database of 3,500 historical events. The database includes a magnitude and depth, both of which can be overridden. The desired event can be picked either through a list box or graphically from a map.
- Source Event: For the Western United States, the source event definition consists of selecting the desired fault source from the **Hazus** database of faults. The user can override the width, type, magnitude, and rupture length of the selected source event. The user graphically defines the epicenter of the event (on the fault).
- Arbitrary Event: An arbitrary earthquake event is defined by the location of its epicenter and by its magnitude. The epicenter is defined either by entry of latitude and longitude or graphically on a map. The user specifies the magnitude, depth, type, rupture orientation and length (for the Western U.S.) .

The **probabilistic hazard** option allows the user to generate estimates of damage and loss based on probabilistic seismic hazard for eight return periods. An additional option in **Hazus** that is defined through the probabilistic hazard is the **Annualized Loss**. Annualized loss is defined as the expected value of loss in any one year, and is developed by aggregating the losses and their exceedance probabilities. Refer to Chapter 15 of the *Technical Manual* for more details.

The **user-supplied hazard** option requires the user to supply digitized peak ground acceleration (PGA) and spectral acceleration (SA) contour maps. Spectral accelerations at 0.3 second and 0.1 second (SA at 0.3 and SA at 1.0) are needed to define the hazard. The damage and losses are computed based on the user-supplied maps. Refer to **Appendix J** for instructions about how to convert shape file based user supplied hazard maps or shake maps to corresponding geodatabases based user supplied hazard maps that could be used with **Hazus**.

9.2.1 Defining Earthquake Hazard

Figure 9.1 shows the hazard definition menu. Again note that the hazard cannot be defined until the study region has been created (see Section 3.1). Clicking on the **Scenario** option allows you to define the earthquake hazard using the Scenario Wizard, shown in Figure 9.2.

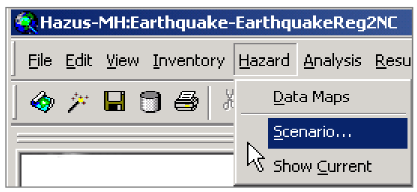


Figure 9.1 Hazard definition menu in Hazus.

If you have not already defined a scenario, the only menu option offered is to define one. The window in Figure 9.2 will open for you to define a deterministic, probabilistic, or user-supplied seismic hazard. When prompted, choose **Define a new scenario** or **Use an already pre-defined scenario** (see Figure 9.3).

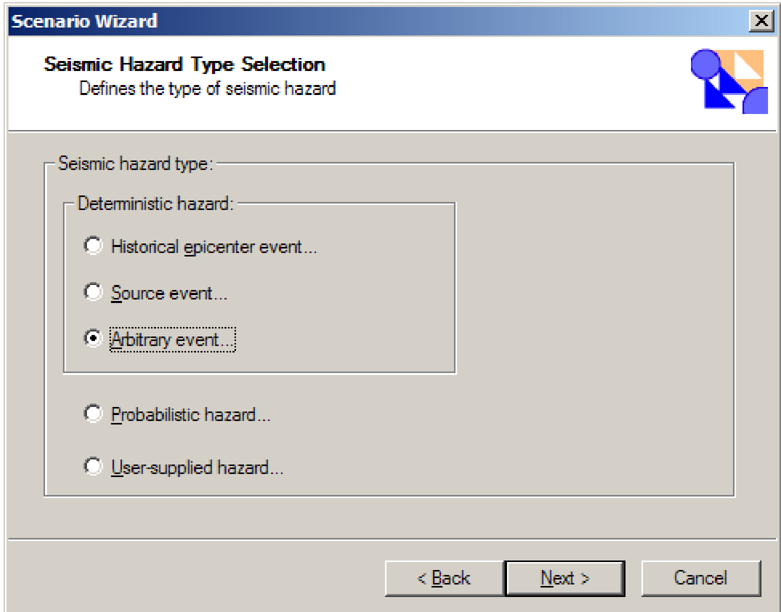


Figure 9.2 Define the ground motion event.

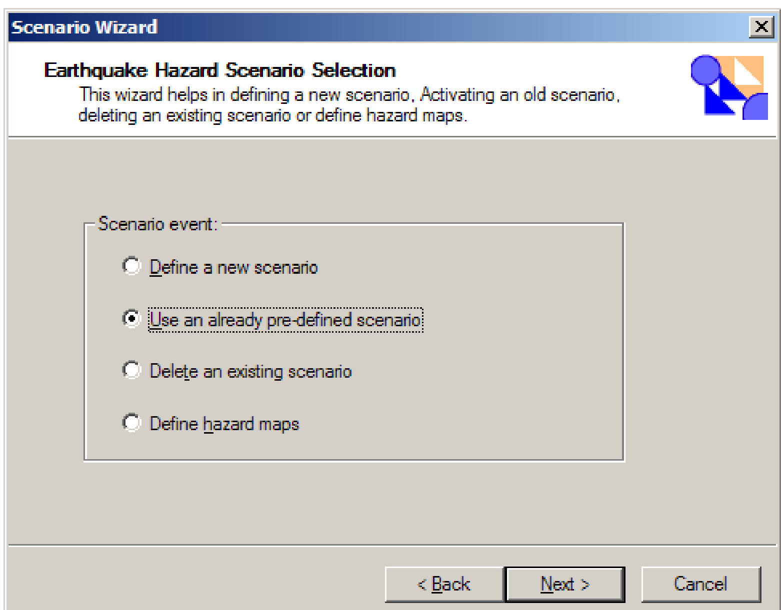


Figure 9.3 Open a pre-defined seismic hazard.

If you have previously run a scenario for a study region and you want to recall this scenario event for analysis on another study region, you can choose a predefined scenario event. When you select **Use an already pre-defined scenario**, you will be prompted with the window shown in Figure 9.4. Use the drop down menu to choose any of the scenarios that have been previously defined.

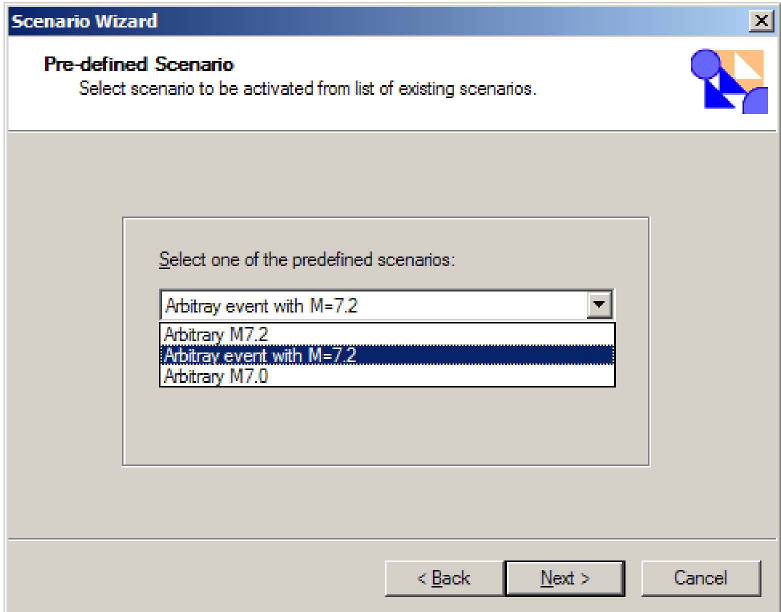


Figure 9.4 Select a pre-defined seismic hazard.

9.2.2 Defining a Deterministic Scenario

The three methods of defining a deterministic scenario are discussed in the following sections.

9.2.2.1 Historical Epicenter

Select the option **Historical epicenter event** from the seismic hazard definition menu shown in Figure 9.2. Click the **Next>** button and a window (see Figure 9.5) displaying the earthquake epicenter database will appear. Choose the historical event from the database and click **Next**.

Alternatively, select the historical epicenter from a map (Figure 9.6) by clicking the right mouse button on the event record of general interest. Select **Map** from the option list and a window will open with historical epicenters plotted (not labeled). Select an epicenter for analysis using the select button on the toolbar. Click the left mouse button once, directly over the epicenter of interest. Choose **Selection Done** to return to the list, where the selected epicenter record will be highlighted. The list will contain epicenter details: fault name, state, magnitude, fault depth (kms), event date, epicenter latitude/longitude, source of event information.

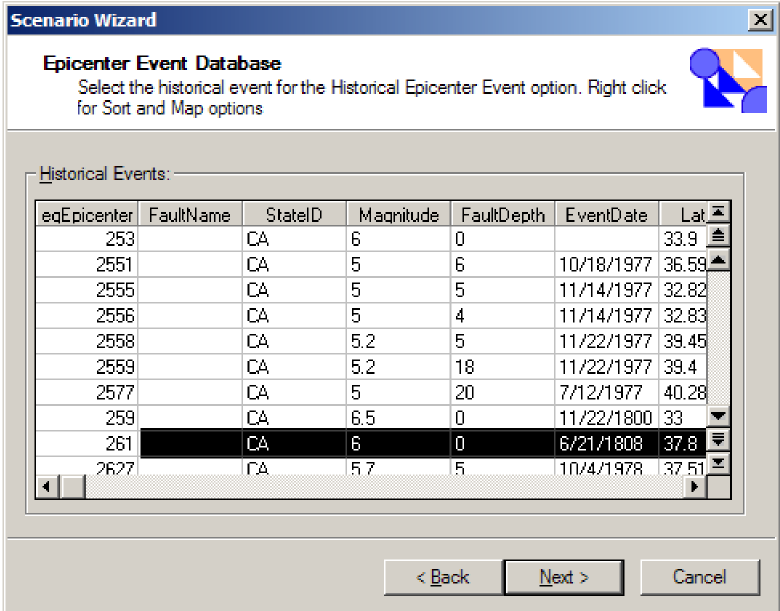


Figure 9.5 Select historical seismic event.

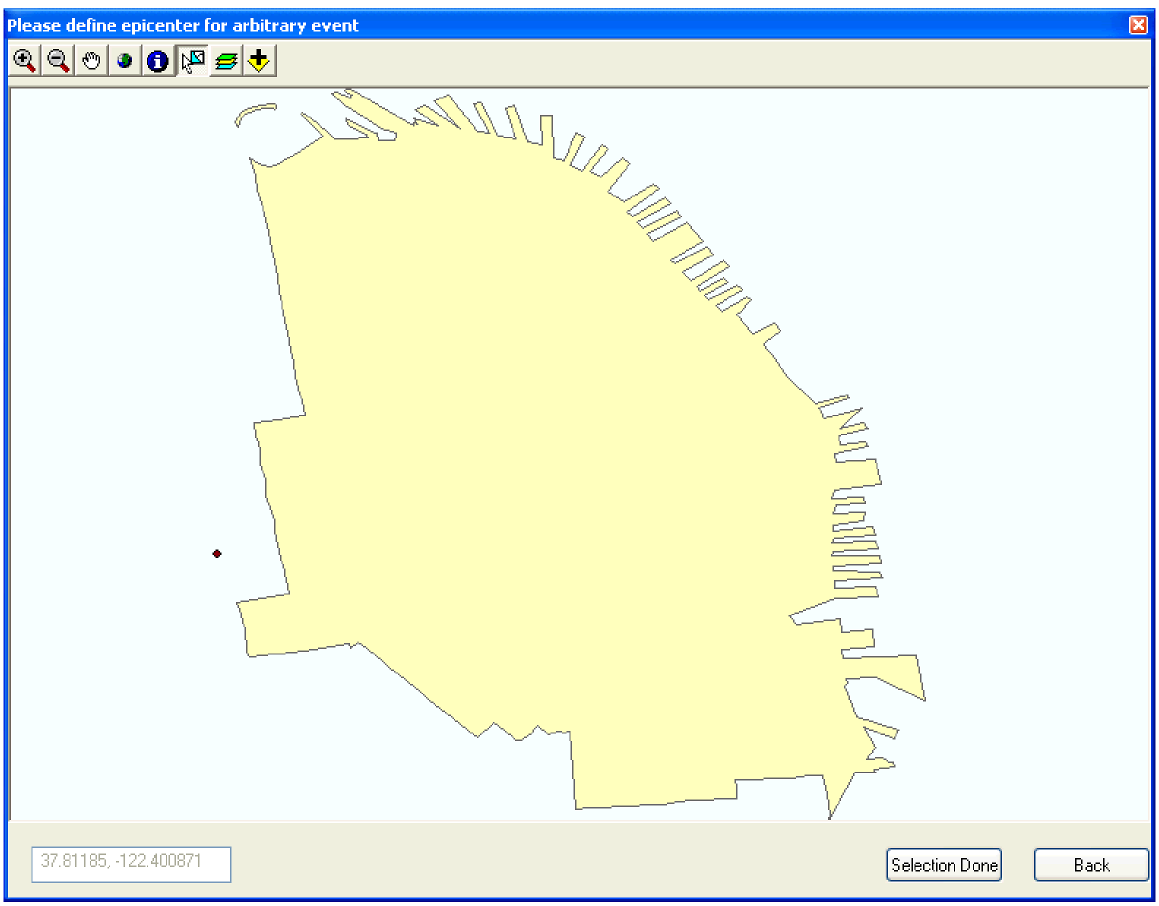


Figure 9.6 Select epicenter from map.

Confirm your event selection by clicking on **Next>**. You will be prompted to select an attenuation function, which may be chosen from the list (see Figure 9.7). The next dialogue window (see Figure 9.8) will allow you to edit additional event parameters. Accept, or edit the seismic event parameters given.

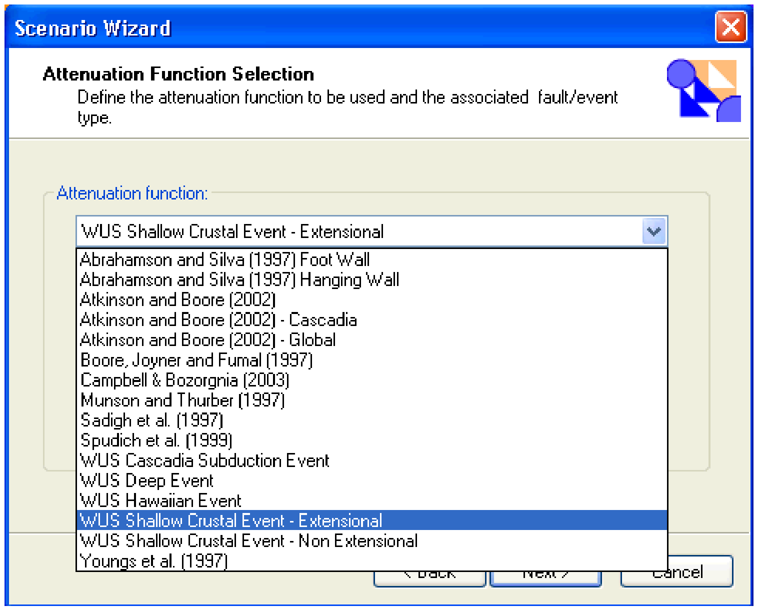


Figure 9.7 Attenuation functions.

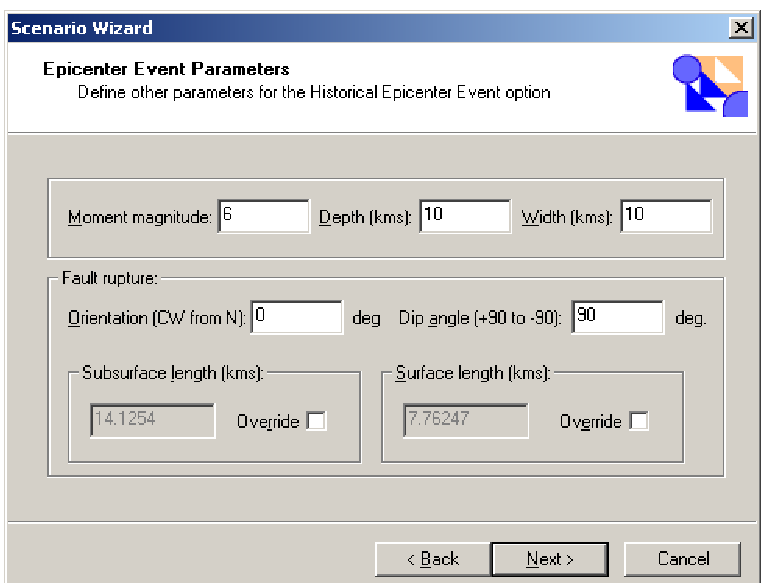


Figure 9.8 Accept or edit epicenter event parameters.

Rupture orientation is measured in degrees (0 to 360) clockwise from North. Rupture length is based on the default magnitude versus rupture length relationship (Wells and

Coppersmith, 1994) unless you choose to override it. If you change the magnitude of the historical earthquake, **Hazus** computes a new rupture length to correspond to the new magnitude.

9.2.2.2 Fault Source Event

A database of faults used by the USGS is supplied with Hazus**. Using the** Hazard|Scenario **menu, select** Define a new earthquake scenario**, and then** Source event**.**

Select a fault when presented with the fault database, as in Figure 9.9, or use the **Map** option (available through the context menu by right-clicking) to select the fault graphically from a map. The scenario earthquake can then be located anywhere along the selected fault. Each source is given a source number and the database is presented so that sources are in numerical order. If you wish to sort the database in some other order, highlight the desired column by clicking on the title at the top of the column and then click **Sort** from the context menu. For example to sort the database in alphabetical order, highlight the fault name column and sort.

Once a source has been selected from the source database, you can define the location of the epicenter. Click the **Define** button in the next wizard page. You will then be presented with a map of sources. The scenario event epicenter is defined by clicking on a location on the map. Magnitude and rupture length are then defined the same as they were in Figure 9.8.

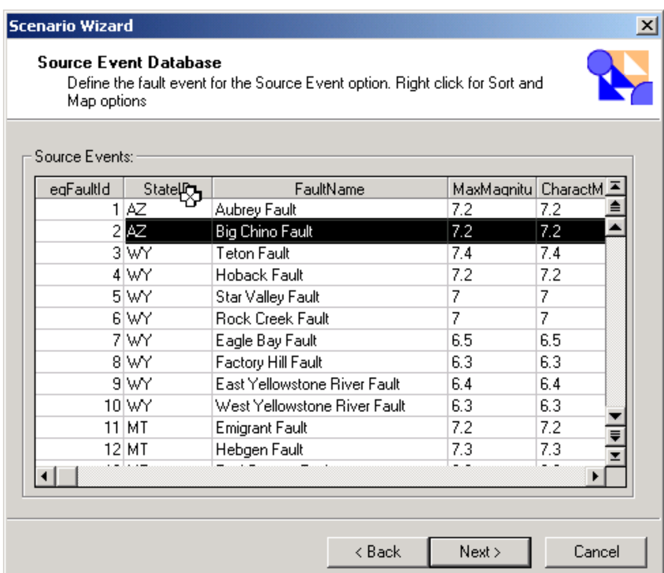


Figure 9.9 Selecting the fault from the Hazus source database.

9.2.2.3 Arbitrary Event

If you have chosen the **Arbitrary event** option (see Figure 9.2), you will use the dialog box shown in Figure 9.10 to define the location, magnitude, epicenter depth, rupture orientation and rupture length. The latitude/longitude of the epicenter can be typed in the data entry fields, or defined on the region map with the **Map** button. Rupture orientation is measured in degrees (0 to 360) clockwise from North.

Rupture length is based on the default magnitude versus rupture length relationship (Wells and Coppersmith, 1994) unless you choose to override it. Only if your analysis is being done for an area in western U.S. and applies an attenuation function for the region, will you be given an option to edit the fault rupture length. When this is the case, you can change the magnitude of the earthquake, then click on the **Override** button. **Hazus** will compute a new rupture length to correspond to the new magnitude.

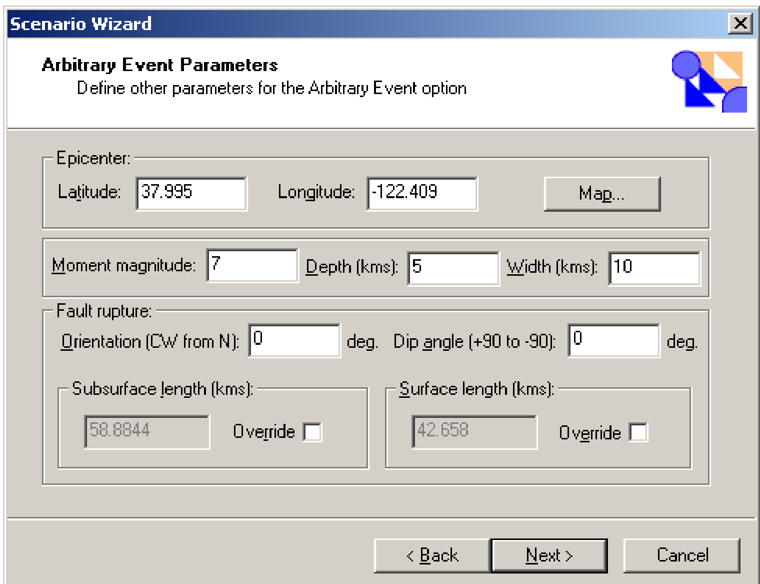


Figure 9.10 Define parameters for an arbitrary event.

9.2.3 Defining Probabilistic Hazard

The user can select a scenario based on ground shaking data derived from the USGS probabilistic seismic hazard curves. The probabilistic analysis option is available for eight return periods[10] of ground shaking. The user specifies the desired return period through the drop down menu in Figure 9.11. Alternatively, the user can select the **Annualized Loss** option (see Figure 9.11) to estimate average annualized losses for the general building stock and casualties. The default assumption is an **M**=7.0 earthquake. If the user has concerns with the appropriateness of the default magnitude assumption, consult a local earth science expert or call the technical support line for **Hazus** at 1-877-283-8789.

[10] The eight return periods are: 100-year, 250-year, 500-year, 750-year, 1000-year, 1500-year, 2000-year, and 2500-year.

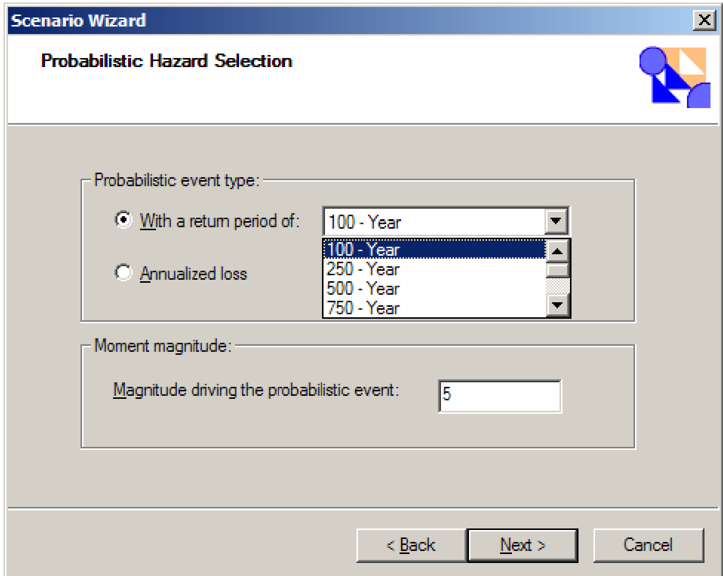


Figure 9.11 Probabilistic Hazard Options window.

9.2.4 User-defined Hazard

The user can supply the ground shaking maps for estimating damage and loss. The ground shaking maps must be in geodatabase format and be added to the list of available data maps defined under using the **Hazus** menu **Hazard|Data Maps** (see Figure 9.12). The following is a list of optional ground shaking and Potential Ground Displacement (PGD) maps that may be used to define the hazards:

Landslide Probability	PGD due to Lateral Spreading from Landslide
Liquefaction Probability	PGD due to Settlement from Liquefaction
Surface Fault Rupture Probability	PGD due to Surface Fault Rupture

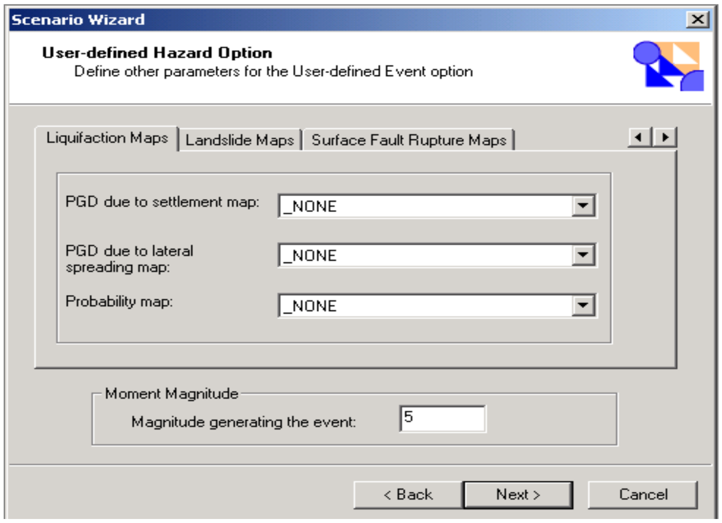


Figure 9.12 Apply user-defined ground shaking maps.

9.2.5 Choosing an Attenuation Function

Hazus contains default attenuation relationships that define how ground motion decreases as a function of distance from the source. For the Western United States, ten attenuation functions are available. For the Eastern United States, four attenuation relationships are available. The user can select any relevant attenuation relationship used in the analysis (see Figure 9.7). Detailed descriptions of the available attenuation relationships are provided in Chapter 4 of the *Technical Manual*.

9.2.6 Selecting An Earthquake Scenario

A scenario earthquake is defined by its size and location and in cases where a fault is well defined, a rupture length. Earthquake size is measured in **Hazus** by moment magnitude (**M**). Location is defined by latitude and longitude. It is important to note that the scenario event does not have to occur within the defined study region. The rupture length is measured in kilometers. **Hazus** uses a relationship between rupture length and magnitude (Wells and Coppersmith, 1994) to estimate the default rupture length.

Rupture length is automatically computed by **Hazus**, but can be overwritten by the user when the analysis is being done in the western states with western attenuation functions. A description of the technical approach to defining an earthquake scenario is provided in Chapter 4 of the *Technical Manual*.

Four approaches to selecting a scenario earthquake are described in the following sections:

Largest Historical Earthquake

Largest Possible Earthquake

Maximum Possible Earthquake + Smaller, More Frequent Event

Earthquake Scenario from a Previous Study

9.2.6.1 Largest Historical Earthquake

One approach is to base the scenario earthquake on the largest earthquake known to have occurred in or near the region. This assumes that if such an earthquake has occurred before, it can occur again. **Hazus** includes a database of historic earthquakes (see Figure 9.5) based on the Global Hypocenter Database available from the National Earthquake Information Center (NEIC, 1992). The NEIC database contains reported earthquakes from 300 BC to 1990. You can access this database by clicking on **Historical epicenter event** (see Figure 9.5), and then selecting an historic earthquake for the scenario event. If several active faults exist in the region, it is appropriate to select maximum historical events from each fault and to perform a loss study for each of these scenarios.

Once an event based on an historical epicenter has been chosen, you can run the analysis with that event or modify the earthquake using the window shown in Figure 9.8. You have the option to change the magnitude, the earthquake depth, the rupture length and the orientation of the rupture. The location of the event cannot be changed if an historical epicenter has been chosen. If you wish to use a different location you must select a different historical event or use the "Arbitrary Event" option.

9.2.6.2 Largest Possible Earthquake

Another approach to selecting a scenario earthquake is to use the largest event that could possibly occur in the study region. This earthquake would be at least as large, and may in fact be larger than the largest historical event. In this case the size of the event would depend on geologic factors such as the type, length and depth of the source. Except in cases where the maximum possible event is well documented in published literature, a seismologist would be required to define this earthquake.

9.2.6.3 Maximum Possible + Smaller Event

In some of the past studies, two levels of earthquakes have been used: an historical maximum earthquake or a maximum possible earthquake, and a smaller earthquake chosen by judgment. The smaller earthquake has often been defined to have a magnitude one unit less than the historical maximum earthquake. Recommendations in the 1989 National Research Panel Report (FEMA, 1989) are that the scenario event should be relatively probable, yet damaging. The Panel found that the use of a very large but very infrequent earthquake could cause rejection of loss estimates. Use of a frequent but small event provides little useful information. The user may wish to select a scenario earthquake that has a probability of occurrence associated with it. An example would be an earthquake that has X% probability of occurrence in the next Y years. This probability can then be used to express the likelihood that the estimated losses will occur.

9.2.6.4 Earthquake Scenario from Previous Study

Another approach is for the user to base loss estimates on an earthquake that was used in a previous loss study. Problems that can occur with this approach are that some previous studies are based upon using **Modified Mercalli Intensity** (MMI) to define the scenario earthquake. Modified Mercalli Intensity is a system for measuring the size of an earthquake (from I to XII) based upon the damage that occurs. For example an MMI of VI indicates that some cracks appear in chimneys, some windows break, small objects fall off shelves and a variety of other things occur. MMI is not based on instrumental recordings of earthquake motions and does not easily correlate with engineering parameters, thus MMI is not used in **Hazus**. A seismologist would be required to convert maps, or other MMI based data to moment magnitude or spectral response for it to be used in **Hazus**.

9.2.7 Viewing the Current Defined Hazard

At any time during data entry, analysis or viewing of results, you can view the parameters that define the selected hazard by clicking on the **Hazard|Show Current** option on the **Hazus** menu bar. An example of the displayed summary is found in Figure 9.13.

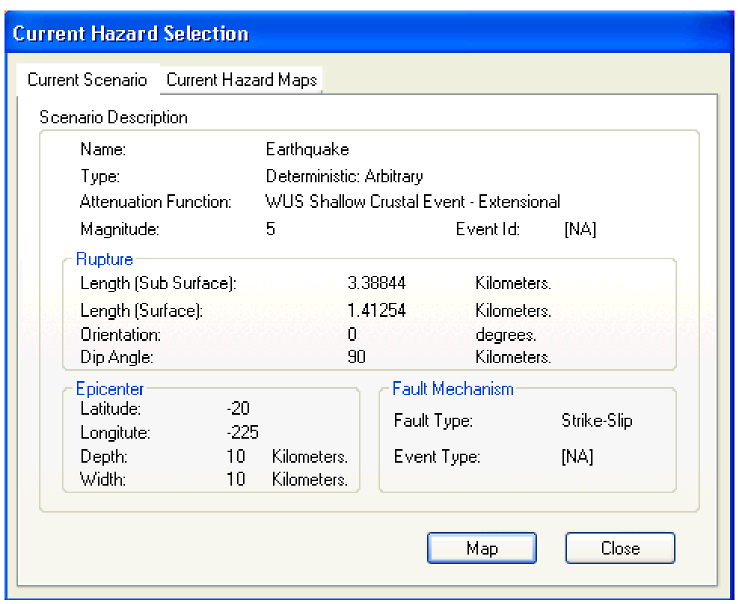


Figure 9.13 Viewing the parameters of the current hazard definition.

9.2.8 Including Site Effects

The type of soil in the study region can affect the amplitude of the ground motion. Soft soils tend to amplify certain frequencies within the ground shaking, resulting in greater damage. To include the effects of soils, the user must supply a soil map. If a soil map is not supplied, **Hazus** bases ground motions on a default soil type. A digitized soil map can be entered into **Hazus** using the steps outlined in Chapter 6. Refer to **Appendix K** for instructions about how to convert shape file based soil map to corresponding geodatabases based soil map that could be used with **Hazus**.

There are a variety of schemes for classifying soils, but only one standardized classification scheme is used in **Hazus**. The site classes are summarized in Table A.1 of Appendix A. The default soil class for **Hazus** is soil Class D. Many available soil maps do not use the classification scheme shown in Table A.1. In this case, a geotechnical engineer or geologist will be required to convert the classification scheme of the available soil map to that shown in Table A.1.

9.2.9 Including Ground Failure

Three types of ground failure are considered in **Hazus**: liquefaction, landsliding and surface fault rupture. Each of these ground failure types are quantified by **permanent ground displacement** (PGD) measured in inches.

Liquefaction is a soil behavior phenomenon in which a saturated soil looses a substantial amount of strength causing the soil to behave somewhat like a liquid. As a result soil may boil up through cracks in the ground and may lose most of its strength and stiffness. This can cause uneven settlement of the soil, or spreading of the soil. The result is that structures founded on soils that have liquefied tend to have more damage than those on other types of soils. This can be particularly significant in the case of lifelines, where roads become bumpy, cracked and unusable or underground pipes break because of liquefaction. Silty and clayey soils tend to be less susceptible than sandy soils to liquefaction-type behaviors.

Permanent ground displacements, due to lateral spreads or flow slides and differential settlement, are commonly considered significant potential hazards associated with liquefaction. Lateral spreads are ground failure phenomena that occur near abrupt topographic features (i.e., free-faces) and on gently sloping ground underlain by liquefied soil. Lateral spreading movements may be on the order of inches to several feet or more, and are typically accompanied by surface fissures and slumping. Flow slides generally occur in liquefied materials found on steeper slopes and may involve ground movements of hundreds of feet. As a result, flow slides can be the most catastrophic of the liquefaction-related ground-failure phenomena. Fortunately, flow slides are much less common occurrences than lateral spreads.

Settlement is a result of particles moving closer together into a denser state. This may occur in both liquefied and non-liquefied zones with significantly larger contributions to settlement expected to result from liquefied soil. Since soil characteristics vary over even relatively small areas, settlements may occur differentially. This differential settlement can cause severe damage to structures and pipelines as it may tend to tear them apart.

9.2.9.1 Liquefaction

To include liquefaction in the analysis, you may specify a liquefaction susceptibility map using the steps outlined in Chapter 6 of this manual. There are three steps involved in the evaluation of liquefaction hazard:

- Characterize liquefaction susceptibility (very low to very high)
- Assign probability of liquefaction
- Assign expected permanent ground deformations

A liquefaction susceptibility map, showing the susceptibility for each census tract, is a result of the first step. An experienced geotechnical engineer, familiar with both the region and with liquefaction, should be consulted in developing this map. The relative liquefaction susceptibility of the soil (geologic conditions) in a region or sub-region is characterized by using geologic map information and the classification system presented in Table 9.1. High resolution (1:24,000 or greater) or lower resolution (1:250,000) geologic maps are generally available for many areas from geologists or regional US Geological Survey offices, state geological agencies, or local government agencies. The geologic maps typically identify the age, the environment of the deposit, and material type for a particular mapped geologic unit. A depth to groundwater map is also a helpful reference. Based on these characteristics, a relative liquefaction susceptibility rating (very low to very high) can be assigned from Table 9.1 to each soil type.

Based on the liquefaction susceptibility and the peak ground acceleration, a probability of liquefaction is assigned during the analysis (see Section 4.2 of the *Technical Manual*). Areas of geologic materials characterized as rock or rock-like are considered for the analysis to present no liquefaction hazard.

Finally, in order to evaluate the potential losses due to liquefaction, an expected permanent ground displacement (PGD) in the form of ground settlement or lateral spreading is assigned. The PGD is based on peak ground acceleration and liquefaction susceptibility. **Hazus** assigns PGD using a procedure derived from experience as discussed in the *Technical Manual*.

Table 9.1 Liquefaction Susceptibility of Sedimentary Deposits

Type of Deposit	General Distribution of Cohesionless Sediments in Deposits	Likelihood that Cohesionless Sediments when Saturated would be Susceptible to Liquefaction (by Age of Deposit)			
		< 500 yr Modern	Holocene < 11 ka	Pleistocene 11 ka - 2 Ma	Pre-Pleistocene 11 ka - 2 Ma
(a) Continental Deposits					
River channel	Locally variable	Very High	High	Low	Very Low
Flood plain	Locally variable	High	Moderate	Low	Very Low
Alluvial fan and plain	Widespread	Moderate	Low	Low	Very Low
Marine terraces and plains	Widespread	---	Low	Very Low	Very Low
Delta and fan-delta	Widespread	High	Moderate	Low	Very Low
Lacustrine and playa	Variable	High	Moderate	Low	Very Low
Colluvium	Variable	High	Moderate	Low	Very Low
Talus	Widespread	Low	Low	Very Low	Very Low
Dunes	Widespread	High	Moderate	Low	Very Low
Loess	Variable	High	High	High	Unknown
Glacial till	Variable	Low	Low	Very Low	Very Low
Tuff	Rare	Low	Low	Very Low	Very Low
Tephra	Widespread	High	High	?	?
Residual soils	Rare	Low	Low	Very Low	Very Low
Sebka	Locally variable	High	Moderate	Low	Very Low
(b) Coastal Zone					
Delta	Widespread	Very High	High	Low	Very Low
Esturine	Locally variable	High	Moderate	Low	Very Low
Beach					
High Wave Energy	Widespread	Moderate	Low	Very Low	Very Low
Low Wave Energy	Widespread	High	Moderate	Low	Very Low
Lagoonal	Locally variable	High	Moderate	Low	Very Low
Fore shore	Locally variable	High	Moderate	Low	Very Low
(c) Artificial					
Uncompacted Fill	Variable	Very High	---	---	---
Compacted Fill	Variable	Low	---	---	---

9.2.9.2 Landslide

As with liquefaction, to include landslide in the analysis you must specify a landslide susceptibility map using the steps outlined in Chapter 6. There are three steps involved in the evaluation of landslide hazard:

1. Characterize landslide susceptibility (I to X))
2. Assign probability of landslide
3. Assign expected permanent ground deformations

A landslide susceptibility map, showing the susceptibility for each census tract, is a result of the first step. An experienced geotechnical engineer, familiar with both the region and with earthquake-caused landsliding, should be consulted in developing this map. The methodology provides basic rules for defined the landslide susceptibility based on the geologic group, ground water level, slope angle and the critical acceleration (a_c). Landslide susceptibility is measured on a scale of I to X, with X being the most susceptible. The geologic groups and associated susceptibilities are summarized in Table 9.2.

Once landslide susceptibility has been determined, **Hazus** provides default values for probability of landsliding and expected PGD as a function of ground acceleration. Chapter 4 of the *Technical Manual* describes the procedure in detail.

Table 9.2 Landslide Susceptibility of Geologic Groups

Geologic Group		Slope Angle, degrees					
		0-10	10-15	15-20	20-30	30-40	>40
(a) DRY (groundwater below level of sliding)							
A	Strongly Cemented Rocks (crystalline rocks and well-cemented sandstone, c' =300 psf, □' = 35°)	None	None	I	II	IV	VI
B	Weakly Cemented Rocks and Soils (sandy soils and poorly cemented sandstone, c' =0, □' = 35°)	None	III	IV	V	VI	VII
C	Argillaceous Rocks (shales, clayey soil, existing landslides, poorly compacted fills, c' =0 □' = 20°)	V	VI	VII	IX	IX	IX

(b) WET (groundwater level at ground surface)							
A	**Strongly Cemented Rocks (crystalline rocks and well-cemented sandstone, c' =300 psf, □' = 35°)**	None	III	VI	VII	VIII	VIII
B	**Weakly Cemented Rocks and Soils (sandy soils and poorly cemented sandstone, c' =0, □' = 35°)**	V	VIII	IX	IX	IX	X
C	**Argillaceous Rocks (shales, clayey soil, existing landslides, poorly compacted fills, c' =0 □' = 20°)**	VII	IX	X	X	X	X

9.2.9.3 Surface Fault Rupture

When an earthquake occurs, it is possible that the fault rupture can extend from its initiation at some depth all the way to the ground surface. Many earthquakes do not exhibit evidence of rupture at the ground surface, particularly in the Eastern United States. Generally, surface fault rupture is observed only in the Western United States and Alaska. When it occurs, displacements due to surface fault rupture can be on the order of several meters and can be a significant contributor to damage if a structure crosses or is built on top of the fault rupture. Pipelines, roadways, bridges and railways that cross faults are vulnerable to surface fault rupture.

Surface fault rupture can be included by selecting the **Ground Failure** when the analysis is run. **Hazus** provides a default relationship between moment magnitude (**M**) and the displacement in meters that can result from surface fault rupture (see the *Technical Manual* for more information). For any location along the fault rupture, fault displacement can occur, however, the amount of fault displacement is described by a probability distribution. Surface fault rupture is presented to the user in the form of PGD contour maps.

9.2.10 Modifying Potential Earthquake Susceptibility Hazard Parameters

Potential ground motion is calculated each time direct and indirect losses are estimated. Default ground motion and ground failure parameters can be modified using the windows shown in Figure 9.14 and Figure 9.15. These windows can be accessed through the **Analysis| Parameters|Hazard** option on the **Hazus** menu bar. The window shown in Figure 9.14 is used to modify soil amplification factors. Soil amplification factors include Potential Ground Acceleration (PGA), Potential Ground Velocity (PGV), and amplification at 0.3 seconds and at 1.0 seconds. These factors are discussed in the *Technical Manual*. It should be noted, however, that these parameters should not be modified unless you have expertise in seismology and geotechnical engineering.

As discussed in the *Technical Manual*, soil does not behave uniformly and in an area with very high susceptibility to liquefaction it is unlikely that the entire area will actually liquefy. In fact, liquefaction may appear in pockets with a large portion of the area remaining unaffected. A parameter is used to define the proportion of a geologic map unit that is likely to liquefy or landslide given its relative susceptibility. The window in Figure 9.15 is used to modify the parameter defaults. These factors are also found in the *Technical Manual*.

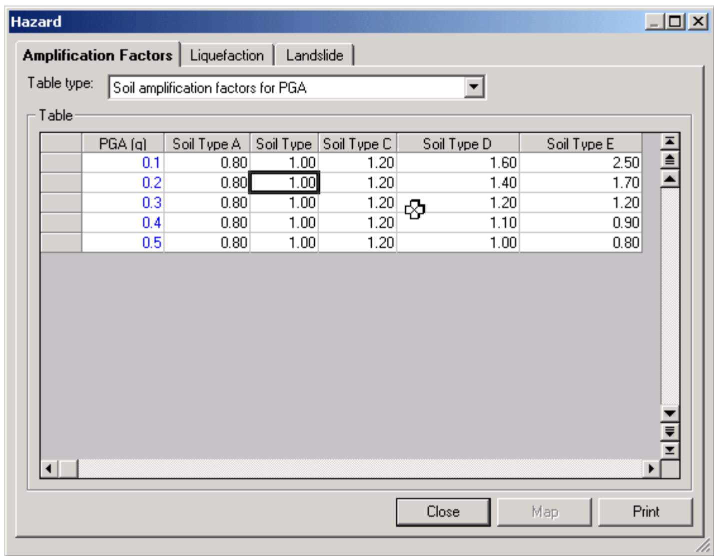


Figure 9.14 Modifying soil amplification factors.

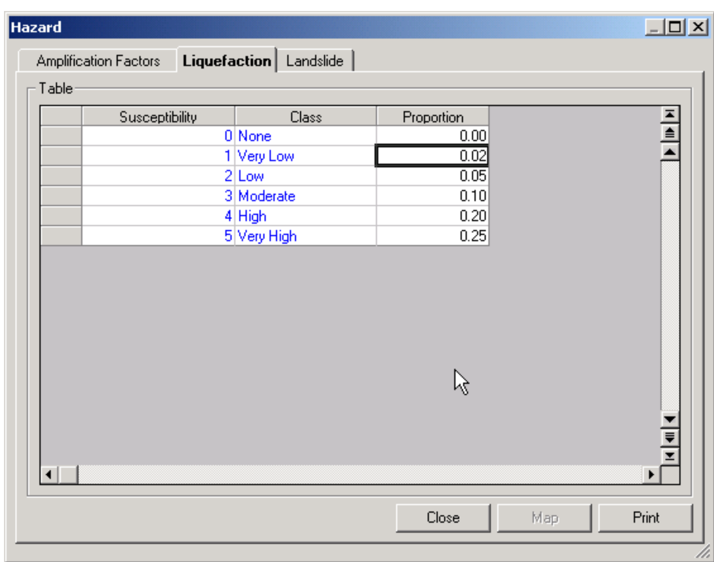


Figure 9.15 Modifying map areas susceptible to liquefaction.

9.3 Direct Physical Damage Analysis

Direct damage is estimated for structural and non-structural inventory; in particular, buildings and lifelines. The analysis menu options allow you to select which types of facilities and lifelines you want to have analyzed. If you want to run the analysis with default inventory and data, simply select the types of facilities to be analyzed. If you want to modify the default inventory before running your analysis, follow the instructions for modifying databases in Chapters 6 and 7 of this manual.

9.3.1 Structural versus Non-structural Damage

Hazus estimates direct damage to structural and non-structural building components separately. Structural components are the walls, columns, beams and floor systems that are responsible for holding up the building. In other words, the structural components are the gravity and lateral load resisting systems. Non-structural building components include building mechanical/electrical systems and architectural components such as partition walls, ceilings, windows and exterior cladding that are not designed as part of the building load carrying system. Equipment that is not an integral part of the building, such as computers, is considered **building contents**.

Damage to structural components affects casualties, building disruption, cost of repair and other losses differently than damage to non-structural components. For example, if the ceiling tiles fall down in a building, business operations can probably resume once the debris is removed. On the other hand, if a column in a building is damaged, there is a life safety hazard until the column is repaired or temporarily shored, possibly resulting in a long-term disruption. It should also be noted that the types of non-structural components in a given building depend on the building occupancy. For example, single-family residences would not have exterior wall panels, suspended ceilings, or elevators, while these items would be found in an office building. Hence, the relative values of non-structural components in relation to overall building replacement value vary with type of occupancy. In the direct economic loss module, estimates of repair and replacement cost are broken down by occupancy to account for differences in types of non-structural components.

Some non-structural components (partition walls and windows) tend to crack and tear apart when the floors of the building move past each other during the earthquake. As can be seen in Figure 9.16, the wall that extends from the first floor to the second floor is pulled out of shape due to the inter-story drift, causing it to crack and tear. In the methodology this is called **drift-sensitive non-structural damage**.

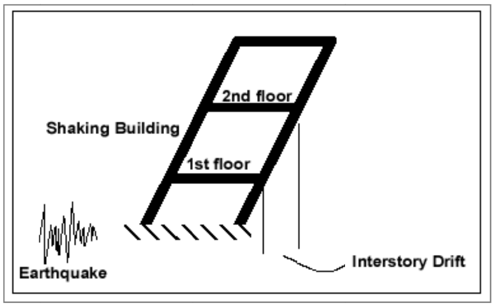


Figure 9.16 Inter-story drift in a shaking building.

Other non-structural components such as mechanical equipment tend to get damaged by falling over or being torn from their supports due to the acceleration of the building. This is similar to being knocked off your feet if someone tries to pull a rug out from under you. In the methodology this is called **acceleration-sensitive non-structural damage**. Of course many non-structural components are affected by both acceleration and drift, but for simplification, components are identified with one or the other as summarized in Table 9.3.

Table 9.3 Building Component Non-structural Damage

Type of Non-structural Damage	
Drift Sensitive	Acceleration Sensitive
• wall partitions • exterior wall panels and cladding • glass • ornamentation	• suspended ceilings • mechanical and electrical equipment • piping and ducts • elevators

9.3.2 Definitions of Damage States - Buildings

Damage estimates are used in **Hazus** to estimate life-safety consequences of building damage, expected monetary losses due to building damage, expected monetary losses which may result as a consequence of business interruption, expected social impacts, and other economic and social impacts. The building damage predictions may also be used to study expected damage patterns in a given region for different scenario earthquakes, for example, to identify the most vulnerable building types, or the areas with the worst expected damage to buildings.

To serve these purposes, damage predictions must be descriptive. The user must be able to glean the nature and extent of the physical damage to a building type from the damage prediction output so that life-safety, societal and monetary losses that result from the damage can be estimated. Building damage can best be described in terms of the nature and extent of damage exhibited by its components (beams, columns, walls, ceilings, piping, HVAC equipment, etc.). For example, such component damage descriptions as "shear walls are cracked", "ceiling tiles fell", "diagonal bracing buckled", or "wall panels fell out", used together with such terms as "some" and "most" would be sufficient to describe the nature and extent of overall building damage.

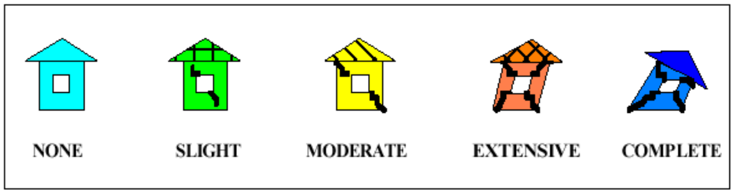


Figure 9.17 The five damage states.

Using the criteria described above, damage is described by five **damage states**: none, slight, moderate, extensive or complete (see Figure 9.17). General descriptions for the structural damage states of 16 common building types are found in the *Technical Manual*. Table 9.4 provides an example of the definitions of damage states for light wood frame buildings. It should be understood that a single damage state could refer to a wide range of damage. For example the **slight** damage state for light wood frame structures may vary from a few very small cracks at one or two windows, to small cracks at all the window and door openings.

Table 9.4 Examples of Structural Damage State Definitions

Wood, Light Frame
Slight : Small plaster or gypsum board cracks at corners of door and window openings and wall-ceiling intersections; small cracks in masonry chimneys and masonry veneer.
Moderate: Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.
Extensive: Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations; small foundations cracks.

Complete: Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

Damage to non-structural components is considered to be independent of building type. This is because partitions, ceilings, cladding, etc., are assumed to incur the same damage when subjected to the same inter-story drift or floor acceleration whether they are in a steel frame building or in a concrete shear wall building. Therefore as shown in the example in Table 9.5, descriptions of non-structural damage states are developed for common non-structural systems, rather than as a function of building type.

Table 9.5 Examples of Non-structural Damage State Definitions

Suspended Ceilings
Slight : A few Ceiling tiles may have moved or fallen down.
Moderate: Falling of tiles is more extensive; in addition the ceiling support framing (t-bars) may disconnect and/or buckle at a few locations; lenses may fall off a few light fixtures.
Extensive: The ceiling system may exhibit extensive buckling, disconnected t-bars and falling ceiling tiles; ceiling may have partial collapse at a few locations and a few light fixtures may fall.
Complete: The ceiling system is buckled throughout and/or has fallen down and requires complete replacement.

9.3.3 Definitions of Damage States - Lifelines

As with buildings, five damage states are defined: none, slight, moderate, extensive and complete. For each component of each lifeline a description of the damage is provided for each damage state. These descriptions are found in Sections 7.1 through 8.6 of the *Technical Manual*. An example of the damage state descriptions for electrical power system distribution circuits is found in Table 9.6

Table 9.6 Damage State Descriptions for Electrical Power System

Damage State	Damage Description
Slight	Failure of 4% of all circuits
Moderate	Failure of 12% of all circuits
Extensive	Failure of 50% of all circuits
Complete	Failure of 80% of all circuits

Damage states can be defined in numerical terms as is the case for distribution circuits or they can be more descriptive as shown in Table 9.7.

Table 9.7 Damage State Descriptions for Electrical Power System

Damage State	**Damage Description**
Slight	Turbine tripping, or light damage to diesel generator, or the building is in the slight damage state.
Moderate	Chattering of instrument panels and racks, or considerable damage to boilers and pressure vessels, or the building is in the moderate damage state.
Extensive	Considerable damage to motor driven pumps, or considerable damage to large vertical pumps, or the building is in the extensive damage state.
Complete	Extensive damage to large horizontal vessels beyond repair, or extensive damage to large motor operated valves, or the building is in the complete damage state.

9.3.4 Fragility Curves - Buildings

Based on the damage state descriptions described in the previous section and using a series of engineering calculations that can be found in the *Technical Manual*, **fragility curves** were developed for each building type. A fragility curve describes the probability of being in a specific damage state as a function of the size of earthquake input. For structural damage the fragility curves express damage as a function of building displacement (see Figure 9.18). The fragility curves express non-structural damage as a function of building displacement or acceleration, depending upon whether they refer to drift-sensitive or acceleration-sensitive damage.

Default fragility curves are supplied with the methodology. It is highly recommended that default curves be used in the loss studies. Modification of these fragility curves requires the input of a structural engineer experienced in the area of seismic design.

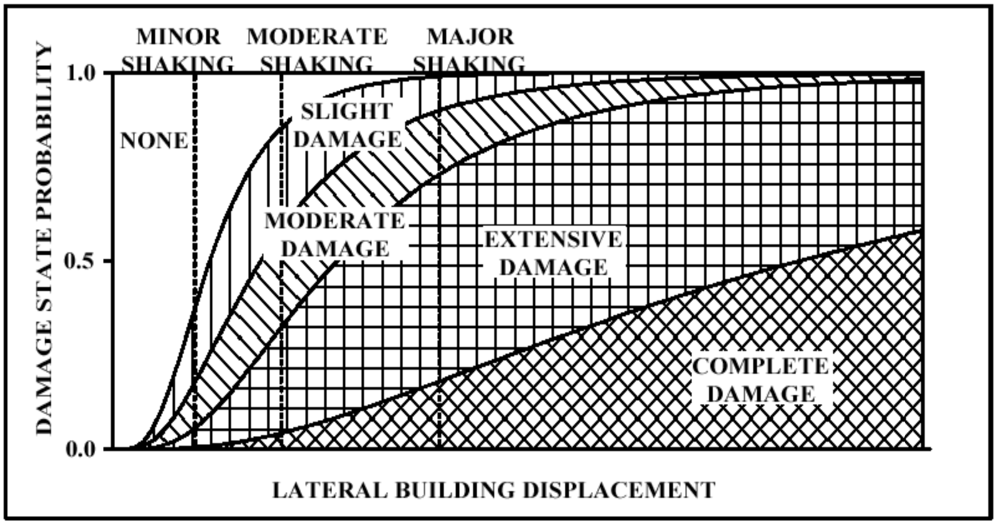


Figure 9.18 Sample building fragility curve.

9.3.5 Fragility Curves - Lifelines

As with buildings, default damage functions (fragility curves) have been developed for all components of all lifeline systems. Typical damage functions are shown in Figure 9.19 and Figure 9.20. The damage functions are provided in terms of PGA (Figure 9.19) and PGD (Figure 9.20). The top curve in Figure 9.19 gives the probability that the damage state is at least slight given that the bridge has been subjected to a specified PGA. For example, if the bridge experiences a PGA of 0.4g, there is a 0.7 probability that the damage will be slight or worse. Figure 9.20 is similar, except it is in terms of PGD. Thus if a bridge experiences a permanent ground deformation of 12 inches, there is a 100 percent chance that it will have at least slight damage and a 70% chance it will have moderate damage or worse.

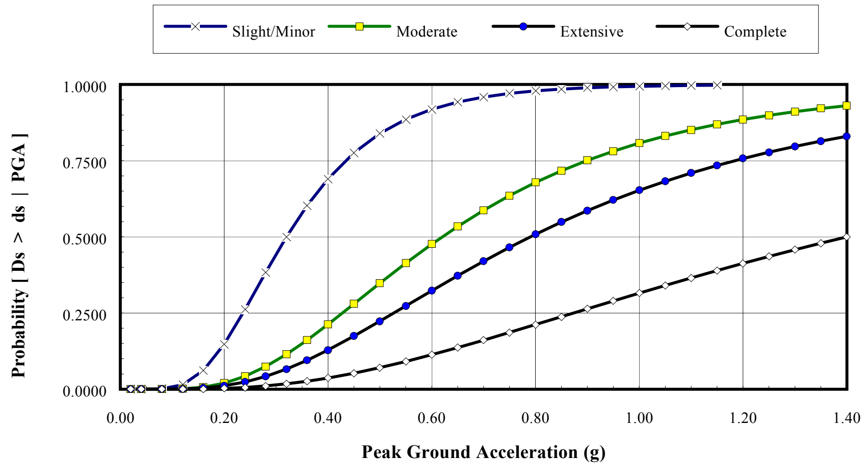


Figure 9.19 Fragility Curves at Various Damage States for Seismically Designed Railway Bridges Subject to Peak Ground Acceleration.

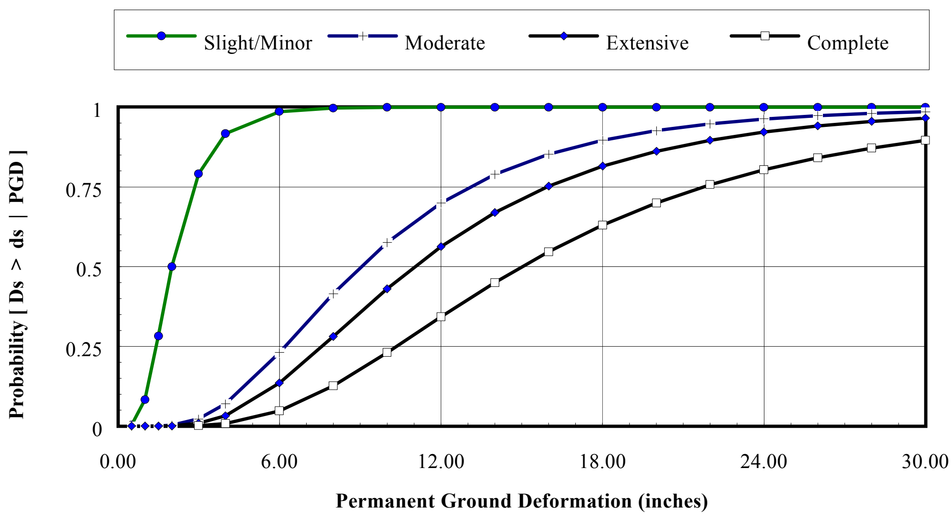


Figure 9.20 Fragility Curves at Various Damage States for Seismically Designed Railway Bridges Subject to Permanent Ground Deformation.

The default damage functions are lognormal with parameters (medians and betas) as defined in the *Technical Manual*. These parameters can also be viewed and modified using **Hazus**. The window for viewing parameters of fragility curves for railway bridge system components is shown in Figure 9.21. In this example, parameters of damage functions for PGA induced damage are displayed. The user can also view parameters for PGD induced damage by moving to the right within the table. The column "PGASlightMedian" contains the median PGA (g's) for the slight damage state. The median is defined as the value at which the probability is 0.99 for all railway bridge classes. Compare the slight damage fragility curve in Figure 9.19 with the parameters for the component RLB1 in Figure 9.21. The column "PGASlightBeta" contains the parameter Beta, which is an indicator the dispersion of the distribution. The larger the Beta the more spread out the fragility curve. The Beta for slight damage to RLB1 is 0.6. While these parameters can be modified, default values should be used unless an expert structural engineer experienced in seismic design is consulted.

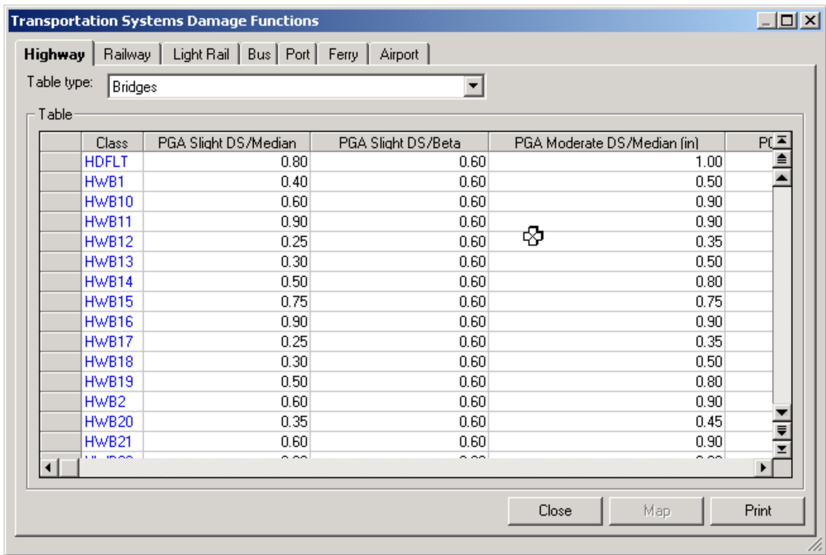


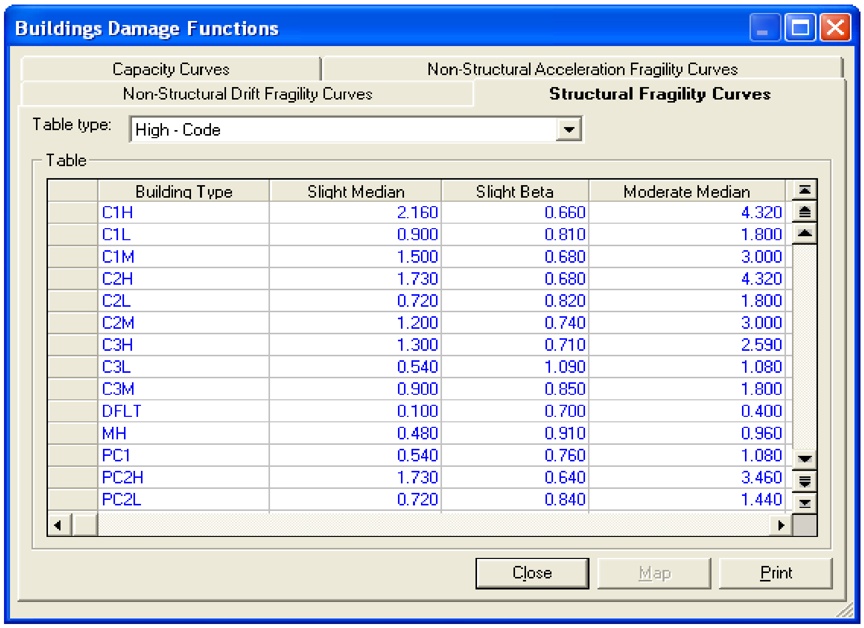
Figure 9.21 Parameters of lognormal damage functions, as viewed in Hazus, for PGA induced damage to highway bridges.

9.3.6 Modifying Fragility Curves

The fragility curves described in the previous section are each characterized by a median and a lognormal standard deviation (β). There are two types of curves: those for which spectral displacement is the parameter describing earthquake demand and those for which spectral acceleration is the parameter. The first type of curve is used for estimating structural damage and drift-sensitive non-structural damage. The second type is for estimating acceleration sensitive non-structural damage.

Default fragility curves are provided for all model building types, essential facility model building types and for all lifeline components. Figure 9.22 shows an example of the parameters of fragility curves for model buildings with a high seismic design level. This window is accessed through the **Analysis|Damage Functions|Buildings** menu. Fragility curves are available for three seismic design levels and three construction standards for both structural and non-structural damage. (Note: Design levels and construction standards are discussed in the *Technical Manual*.) Fragility curves for lifelines are accessed through the **Analysis|Damage Functions| Transportation Systems** menu or the **Analysis| Damage Functions|Utility Systems** menu. Fragility curves are available for both PGA and PGD related damage.

Should you desire to modify the fragility curves, change the mean and beta in this window and then click on the **Close** button. You will be asked to confirm that you want to save your changes. Development of fragility curves is complex and is discussed in detail in the *Technical Manual*. It is strongly recommended that you use the default parameters provided unless you have expertise in the development of fragility curves.



Building Type	Slight Median	Slight Beta	Moderate Median
C1H	2.160	0.660	4.320
C1L	0.900	0.810	1.800
C1M	1.500	0.680	3.000
C2H	1.730	0.680	4.320
C2L	0.720	0.820	1.800
C2M	1.200	0.740	3.000
C3H	1.300	0.710	2.590
C3L	0.540	1.090	1.080
C3M	0.900	0.850	1.800
DFLT	0.100	0.700	0.400
MH	0.480	0.910	0.960
PC1	0.540	0.760	1.080
PC2H	1.730	0.640	3.460
PC2L	0.720	0.840	1.440

Figure 9.22 Parameters of building fragility curves.

9.3.7 Steps for Calculating Damage State Probabilities

There are several steps that are needed to calculate damage state probabilities:

1. Calculate the spectral accelerations and spectral displacements at the site in question. This is in the form of a response spectrum.

2. Modify the response spectrum to account for the increased damping that occurs at higher levels of building response (non-linear behavior).

3. Create a capacity curve for the model building type which shows how the building responds as a function of the laterally applied earthquake load.

4. Overlay the building capacity curve with the modified response spectrum (demand curve). The building displacement is estimated from the intersection of the building capacity curve and the response spectrum.

The estimated building displacement is used to interrogate the fragility curves. Figure 9.23 illustrates the intersection of the building capacity curve and a response spectrum that has been adjusted for higher levels of damping.

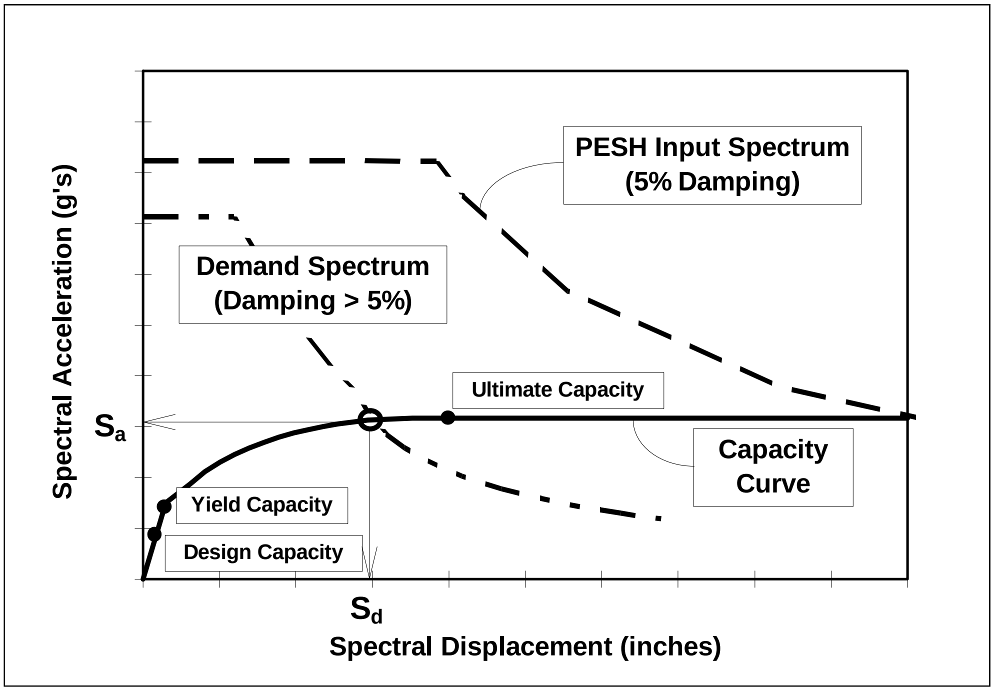
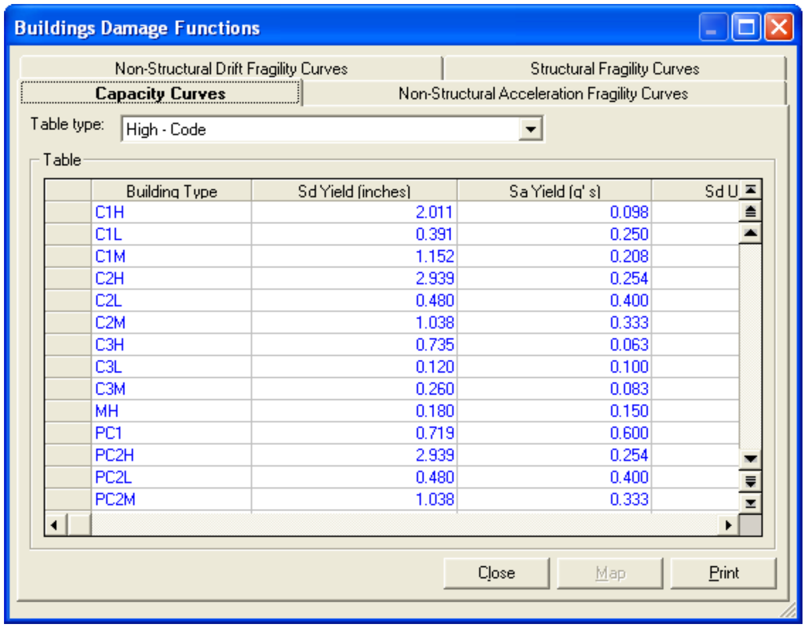


Figure 9.23 Example Capacity Curve and Spectral Demand.

9.3.8 Modifying Capacity Curves

Two points define capacity curves as shown in Figure 9.23: the yield capacity and the ultimate capacity. For general building stock, these parameters can be viewed, as shown in Figure 9.24, by clicking on the **Analysis|Damage Functions|Buildings** menu. Capacity curves are available for three levels of seismic design and three construction standards. Capacity curves are discussed in detail in *the Technical Manual*. To modify the capacity curves, modify the yield capacity, ultimate capacity spectral accelerations, and displacements. The edited values will be saved when you click on the **Close** button. You will be asked to confirm that you want to save your changes. It is strongly recommended that you use the default parameters unless you have expertise in the development of capacity curves.



Building Type	Sd Yield (inches)	Sa Yield (g' s)	Sd U
C1H	2.011	0.098	
C1L	0.391	0.250	
C1M	1.152	0.208	
C2H	2.939	0.254	
C2L	0.480	0.400	
C2M	1.038	0.333	
C3H	0.735	0.063	
C3L	0.120	0.100	
C3M	0.260	0.083	
MH	0.180	0.150	
PC1	0.719	0.600	
PC2H	2.939	0.254	
PC2L	0.480	0.400	
PC2M	1.038	0.333	

Figure 9.24 Parameters of capacity curves for model building types with a high seismic design level.

9.3.9 Restoration Time

The damage state descriptions discussed in Section 9.3 provide a basis for establishing loss of function and repair time of facilities. A distinction should be made between loss of function and repair time. In this methodology, loss of function is defined as the time that a facility is not capable of conducting business. This, in general, will be shorter than repair time because businesses will rent alternative space while repairs and construction are being completed. Loss of function (restoration time) is estimated in the methodology only for essential facilities, transportation lifelines and utility lifelines.

Default restoration functions are provided with the methodology for essential facilities, transportation lifelines and utility lifelines. An example of a set of restoration functions is found in Figure 9.25. Restoration curves describe the fraction of facilities (or components in the case of lifelines) that are expected to be open or operational as a function of time following the earthquake. For example, looking at the curves shown in Figure 9.25, 10 days after the earthquake, about 20% of the facilities that were in the extensive damage state immediately after the earthquake and about 60% of the facilities that were in the moderate damage state immediately after the earthquake, are expected to be functional. Each curve is based on a Normal distribution with a mean and standard deviation. The parameters of the restoration functions are accessed through the **Analysis|Restoration Function** menu and can be viewed and modified in a window such as the one shown in Figure 9.26.

Typing in a new value and then clicking on the Close button will modify parameters for restoration curves. You will be asked to confirm that you want to save your changes.

Restoration curves are based on data published in ATC-13. It is strongly recommended that you use the default parameters unless you have expertise in the development of restoration functions.

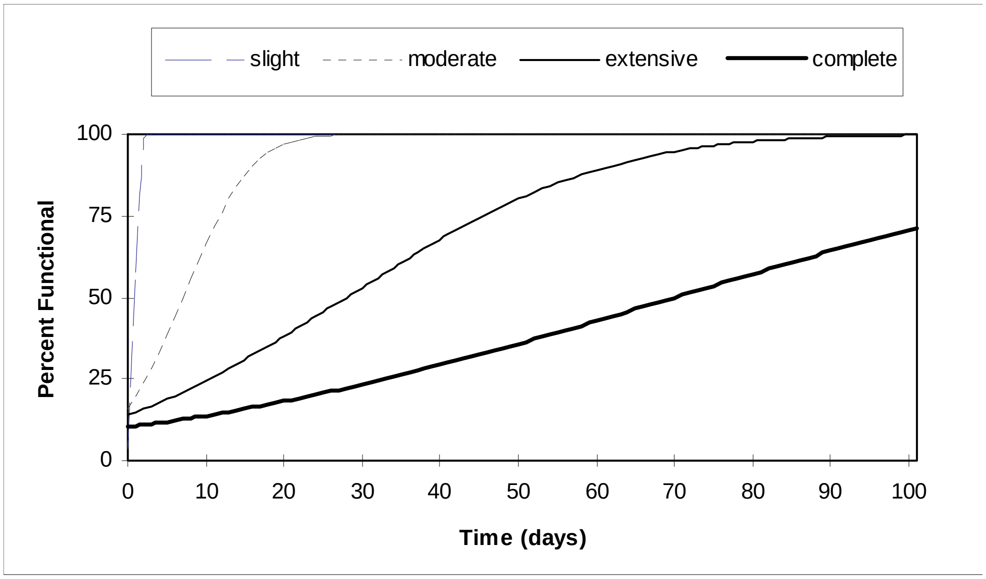
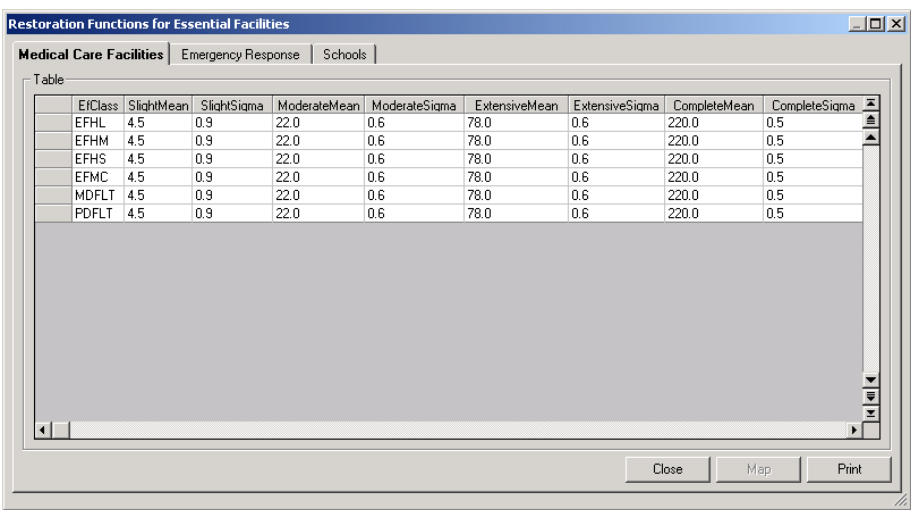


Figure 9.25 Restoration functions for a sample facility type.



EfClass	SlightMean	SlightSigma	ModerateMean	ModerateSigma	ExtensiveMean	ExtensiveSigma	CompleteMean	CompleteSigma
EFHL	4.5	0.9	22.0	0.6	78.0	0.6	220.0	0.5
EFHM	4.5	0.9	22.0	0.6	78.0	0.6	220.0	0.5
EFHS	4.5	0.9	22.0	0.6	78.0	0.6	220.0	0.5
EFMC	4.5	0.9	22.0	0.6	78.0	0.6	220.0	0.5
MDFLT	4.5	0.9	22.0	0.6	78.0	0.6	220.0	0.5
PDFLT	4.5	0.9	22.0	0.6	78.0	0.6	220.0	0.5

Figure 9.26 Reviewing and modifying restoration functions.

9.4 Induced Physical Damage Analysis

Potential indirect or induced physical damage due to ground shaking can be estimated. Induced damages include electrical fire starts, generation of debris, and inundation caused by dam or levee breaching in the aftermath of an earthquake. The **Induced Physical Damage** analysis module is accessible from the **Hazus** menu bar **Analysis| Run**.

9.4.1 Inundation

In order to assess potential losses due to inundation, you must enter an inundation map under **Hazard|Data Maps** menu.

9.4.1.1 Tsunami

Damage, fatalities and fires from inundation due to tsunami can be significant. A tsunami is an ocean wave that is generated as a result of earthquake induced motion of the ocean floor. While the wave can be quite small (almost undetectable) in the open ocean, it can grow to great heights when it reaches land. Tsunamis have occurred in California, Alaska and Hawaii. Since models for estimation of losses from tsunamis are not well established, the methodology is limited to assessment of inundation potential unless an expert is involved.

The first step in the analysis is to identify whether a tsunami hazard exists. To accomplish this, the user must define the following:

1. location of the earthquake source (on-shore or off-shore event)
2. type of faulting expected (strike-slip, normal, reverse faulting)

If the earthquake source is on-shore, there is no tsunami hazard (see Figure 9.27). The same is true if an offshore event occurs that involves primarily strike-slip movement. Alternatively, if the earthquake occurs offshore and there is significant vertical offset that may occur, a tsunami hazard may exist. The focus of this methodology is the assessment of tsunami inundation for nearby seismic events only. While tsunamis can travel thousands of miles and cause damage at great distances from their sources, **Hazus** does not consider tsunamis based on distant events well beyond the study region.

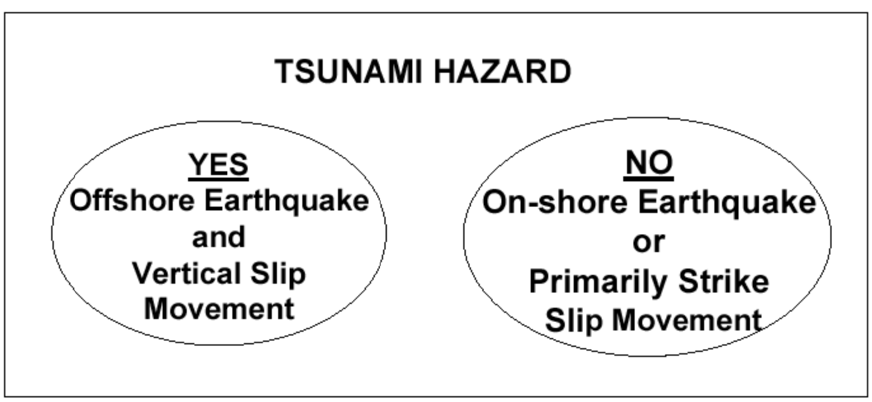


Figure 9.27 Evaluating the tsunami hazard.

If a tsunami hazard is found to exist, the next step is to identify the area that could be subjected to flooding. This is done with an inundation map. Development of an inundation map for a particular earthquake scenario requires the involvement of a hydrologist. In some cases, inundation maps based on previous studies exist and can be entered into **Hazus** to overlay with building and lifeline inventories or population information. Converting maps into the **Hazus** compatible format is discussed in Chapter 6 of this manual.

It should be noted that existing inundation studies must be examined to determine the origin of the seismic events (assumed or real) that generated the tsunami. If existing inundation studies are based only on distant events, the results of these assessments cannot be used as the basis to identify areas potentially vulnerable to tsunami-generated-inundation resulting from regional earthquakes. In addition, the user should determine the size and location of the scenario earthquake that was assumed when estimating the tsunami inundation. This will provide a basis to judge whether the existing inundation map conservatively or non-conservatively estimates the inundation that would be produced by the study earthquake.

9.4.1.2 Seiche

Seiches are waves in a lake or reservoir that are induced because of ground shaking. If the waves are large, damage can occur to facilities along the shore of the lake, or dams can be overtopped. Since models for estimation of losses from these hazards are not well established, **Hazus** is limited to assessment of inundation potential unless an expert is involved.

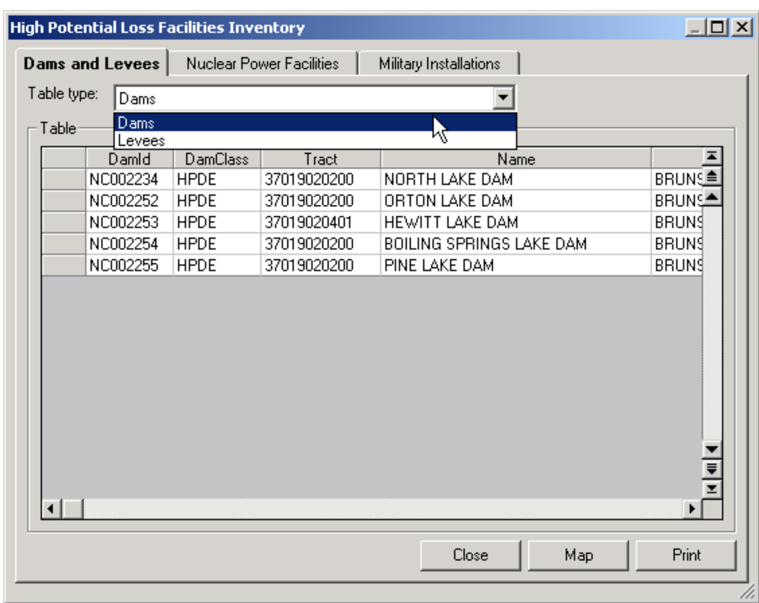


Figure 9.28 Default database of dams supplied with Hazus.

The first step in this inundation analysis consists of developing an inventory of natural or man-made bodies of water where a seiche may be generated. The default database of dams can be used to identify the man-made bodies of water (see Appendix D, Section 5.1.5, and Figure 9.28). For the study region that has been defined, 5 dams are found in the default database. You must generate an inventory of natural water bodies in the study region, since no default database exists. The following criteria can be used to identify natural bodies of water that should be included in the assessment:

1. the lake volume must be greater than 500,000 acre-feet
2. there must be an existing population and/or property located in proximity to the lake shore that could be inundated

If these criteria are not met, the natural lake need not be considered in the study.

Once lakes or reservoirs with potential for generating seiches have been identified, the next step consists of locating and using existing seiche inundation maps to identify areas subject to flooding.

9.4.1.3 Dam or Levee Failure

In general, unless inundation maps already exist, you will limit your treatment of inundation due to dam failure to identifying those dams which have a high potential of causing damage. The database in its default form or augmented with additional data can be mapped to consider their locations. Users are responsible for developing their own inventory of levees, as no default levee inventory exists. If inundation maps exist, they can be input using the menu **Hazard|Data Maps**.

9.4.2 Analysis of Fire Following Earthquake

Fires following earthquakes can cause severe losses. For example, in the 1995 Kobe earthquake more than 10,000,000 square feet of buildings were lost to fires. Fires occurred as a result of ruptured gas pipelines. Fires spread rapidly because of the densely packed construction, narrow streets and the readily available fuel (wood frame structures, gas, and other flammable materials). The large amount of debris blocking the streets prevented fire fighters from accessing areas to fight the fires. Furthermore, broken water lines prevented fire fighters from suppressing the flames. Losses could have been significantly greater had there been strong winds to fuel the fire. The losses from fire can sometimes outweigh the total losses from the direct damage caused by the earthquake, such as collapse of buildings and disruption of lifelines.

Many factors affect the severity of the fires following an earthquake, including but not limited to: ignition sources, types and density of fuel, wind conditions, the presence of ground failure, functionality of water systems, and the ability of fire fighters to suppress the fires. It should be recognized that a complete fire following earthquake (FFE) model requires extensive input with respect to the level of readiness of local fire departments and the types and availability (functionality) of water systems. To reduce the input requirements and to account for simplifications that are being made in the lifeline module, the fire following earthquake model presented in this methodology is somewhat simplified. In particular the model makes simplifying assumptions about the availability of water and fire trucks in modeling fire suppression.

The FFE module performs a series of simulations of fire spread and bases estimates of burned area on the average of the results the simulations:

9.4.2.1 Parameters for the Fire Following Earthquake Module

To run the FFE analysis module you have to adjust the parameters shown in Figure 9.29. Access this window from the **Hazus** menu bar **Analysis|Parameters|Fire Following**. Guidance for editing the parameters follows in the next sections.

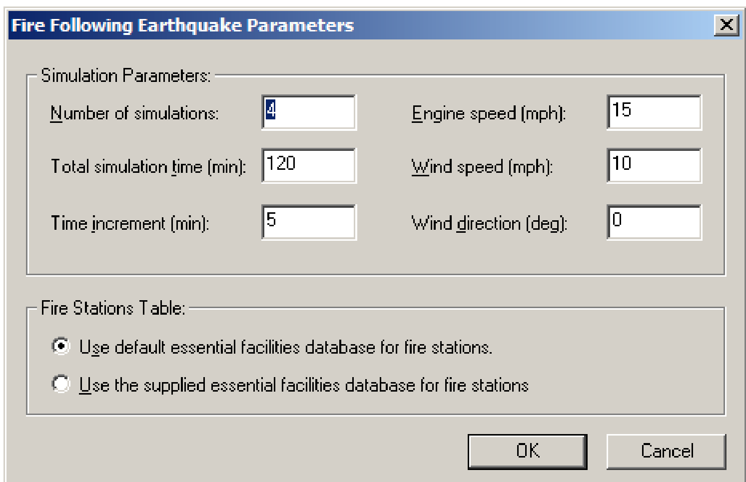


Figure 9.29 Parameter window for fire following earthquake module.

9.4.2.2 Number of Simulations

Since estimates of the burned area are based upon averaging results of multiple simulations of fire spread, you can perform more simulations to improve the reliability of the estimates of burned area. The number of ignitions is based upon PGA and the square footage of inventory, and thus the number of simulations does not affect it. You can specify up to 99 simulations, but 6 to 10 simulations should be sufficient. This module takes some time to run, increasing the number of simulations, increases the run time.

9.4.2.3 Total Simulation Time and Time Increment

The total simulation time is an indicator of how long after the earthquake you want to look at the fire damage. For example if you specify 120 minutes, you will be provided with estimates of the burned area two hours after the occurrence of the earthquake. You can specify a maximum of 9999 minutes. The time increment is used to specify the time periods at which the program should sample and update the simulation. For example if you specify a time increment of 15 minutes, the program will sample at 15, 30, 45 and so on, minutes after the earthquake. You should provide a time increment of 1 to 15 minutes to get sufficiently accurate results.

9.4.2.4 Engine Speed

Engine speed is used in the suppression portion of the simulation. The faster the engines can access the sites of fires, the more quickly fires can be suppressed. Fire engines are slowed down by damaged transportation systems, damaged water or gas pipes or by debris in the road. You may specify a maximum speed of 60 miles per hour.

9.4.2.5 Wind Speed and Direction

High wind speeds will serve to fuel the fire. A calm day (zero wind) will produce the lowest estimates of burned area. You may specify a maximum wind speed of 100 miles per hour. The direction of wind is measured clockwise in degrees (0 to 360) with zero being due north.

9.4.3 Hazardous Materials Analysis Option

Hazardous materials are those chemicals, reagents or substances that exhibit physical or health hazards. Hazardous materials may be in a usable or waste state. Hazardous materials releases can also lead to fires. With specific reference to earthquake-caused hazardous materials incidents, the data thus far indicate that there have been no human casualties. The consequences of these incidents have been fires and contamination of the environment, and have led to economic impacts because of the response and clean-up requirements.

The hazardous materials analysis option has not been activated. A default database listing the types of hazardous materials in your region and locations of sites where hazardous materials are stored can be accessed by using the **Inventory|Hazardous Materials** menu (see Figure 9.30). The sites are mappable within the study region. Additional data can be added using the steps outlined in Section 6.2.

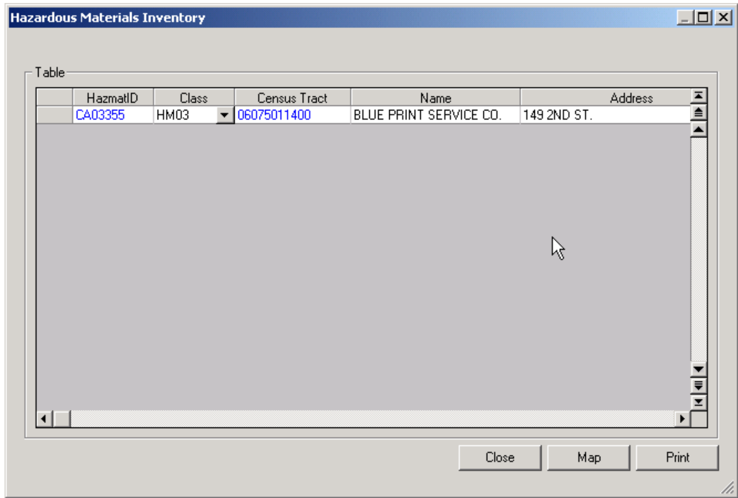


Figure 9.30 Hazardous materials inventory.

9.4.4 Debris Estimates

Very little research has been done to determine the amount of debris generated from earthquakes and other natural disasters. However, anecdotal evidence suggests that removal of debris can be a significant part of the clean up process and, as such, can be costly for a municipality. After Hurricane Hugo, the City of Charleston disposed of so much debris that 17 years were removed from the life of its landfill. Debris can also hinder emergency operations immediately after an earthquake if it is blocking streets, sidewalks or doorways. Where collapses or partial collapses of buildings occur, rescue of victims can be difficult if the walls or floors of the structure come down essentially intact. A short discussion of heavy debris generation and victim extrication can be found in FEMA publication 158 (1988).

9.4.4.1 Types and Sources of Debris

A major source of debris will be structures that have been completely damaged or have collapsed. Debris will include building contents as well as structural and non-structural elements. Completely damaged buildings may still be standing, but the cost of repair could be so high, that these buildings will be torn down and rebuilt. However, even buildings that do not suffer extensive damage can be sources of debris. If damage to the building is slight or moderate, the majority of the damage may be to non-structural elements or contents inside the building. Examples of non-structural debris are suspended ceilings, light fixtures, and partition walls made of plaster or hollow clay tile. In addition, extensive damage could occur to contents of the building such as shelving, equipment, and inventory.

Different types of buildings will generate different types of debris. Unreinforced masonry structures will tend to generate piles of bricks. The bricks result from a collapse of a wall or from damage to some non-structural element such as an unbraced parapet. In single-family dwellings of wood construction, chimneys may separate from the rest of the structure causing them to be torn down and rebuilt. Many steel and concrete frame buildings that were built in the first half of the century have exterior cladding made of brick or terra cotta that may spell off when subjected to earthquake motion. Non-ductile concrete buildings may collapse in a pancake fashion, resulting in a stack of concrete slabs that are not broken up. In a tilt-up building, concrete wall panels, which are usually on the exterior of the structure, may fall outward remaining essentially intact. When the walls fall, the roof (typically of wood or light metal deck) will also collapse. In modern high rise structures, precast panels used for exterior cladding may come loose and fall to the ground or windows may break. Should a steel structure collapse, as one did in Mexico City in 1985, large pieces of twisted steel would result.

In reviewing the types of debris that are generated from an earthquake, the debris can be divided into two types:

- Debris Type 1 Brick, wood and other debris
- Debris Type 2 Wrecked reinforced concrete and steel members

The first type of debris includes everything except wrecked reinforced concrete and steel members. It would include glass, furniture, equipment, and plaster walls, as well as brick and wood. The difference in these two types of debris is that Type 1 can be moved and broken up with a bulldozer or hand held tools. Type 2 would require special treatment to break up the long steel members or the large pieces of concrete before they could be transported. It is likely cranes and other heavy equipment would be needed.

While estimates of debris could include debris due to collapsed bridges and overpasses as well as debris due to buildings, **Hazus** ignores debris generated from collapsed bridges. Due to the simplifications that are introduced in the modeling of transportation systems, and in particular the lack of inventory detail regarding dimensions of individual bridges, any estimation of quantities of bridge debris would contain large uncertainties and might be misleading.

9.4.4.2 Debris Parameters

The debris module will provide an estimate for each census tract of the amount (tons) of debris of each type that will be generated. Estimates of debris are based upon the structural and non-structural damage states that are output from the building damage module. Square footage of each model building type also is required, but is available from the building inventory module. Two additional sets of data are required to estimate the amount of debris that is generated from damaged buildings. These are:

- Weight in tons of structural and non-structural elements per square foot of floor area for each model building type
- The amount of debris generated for each structural and non-structural damage state in terms of percent of weight of elements

Estimates of debris can be generated using the default data supplied with **Hazus**. Figure 9.31 shows the default values of debris weight for each model building type. Clicking on the **Analysis|Parameters|Debris** menu accesses this window. For each model building type there are two unit weight tables. The first table includes Type 1 materials such as brick, wood and other debris, while the second is limited to the Type 2 materials such as reinforced concrete and steel. Both tables use the number of tons of material per 1000 square feet of building area. For example, Figure 9.31 shows that for each 1000 square feet of W1 construction there are 15 tons of Type 1 structural material . These values are based upon assumptions of "typical buildings". These values can be modified to more accurately reflect the buildings in your area if such data is available.

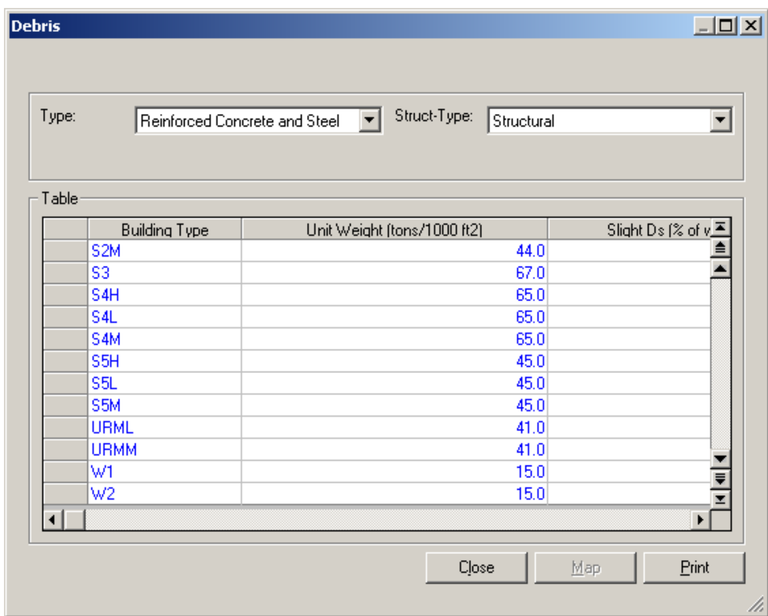
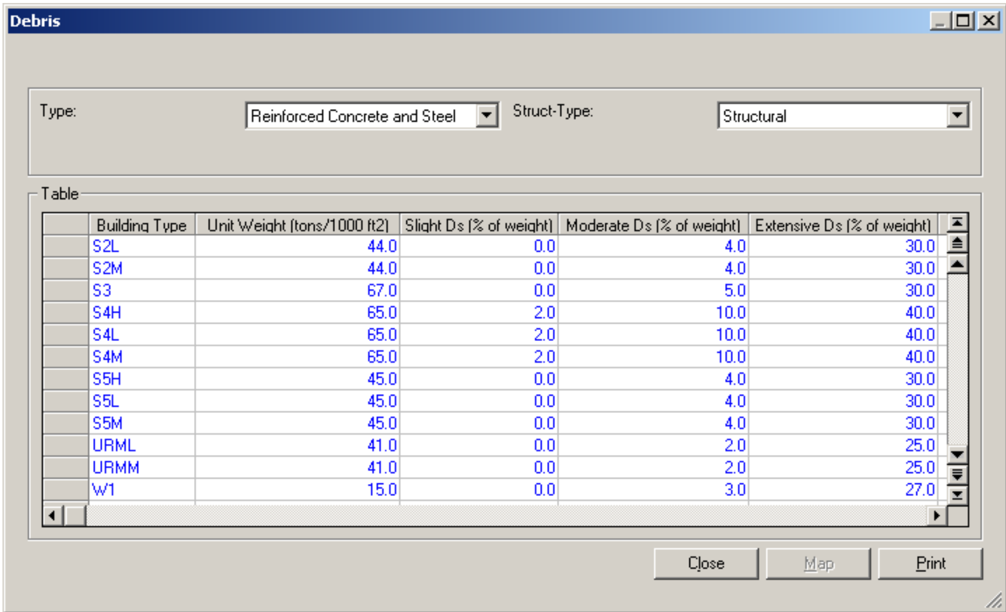


Figure 9.31 Weight of structural and non-structural elements for debris Type 1 in terms of tons per 1000 square feet of building area.

Default values are also provided for Type 1 and Type 2 debris in terms of percentage of weight of elements and the damage state. As shown in Figure 9.32, for low rise steel braced frames (S2L) one can expect to remove debris equal to 30% of the weight of brick and wood if the damage state is extensive. These default values are based upon observations of damage in past earthquakes. These values can be modified to more accurately reflect the buildings in your area if such data is available.



Building Type	Unit Weight (tons/1000 ft2)	Slight Ds (% of weight)	Moderate Ds (% of weight)	Extensive Ds (% of weight)
S2L	44.0	0.0	4.0	30.0
S2M	44.0	0.0	4.0	30.0
S3	67.0	0.0	5.0	30.0
S4H	65.0	2.0	10.0	40.0
S4L	65.0	2.0	10.0	40.0
S4M	65.0	2.0	10.0	40.0
S5H	45.0	0.0	4.0	30.0
S5L	45.0	0.0	4.0	30.0
S5M	45.0	0.0	4.0	30.0
URML	41.0	0.0	2.0	25.0
URMM	41.0	0.0	2.0	25.0
W1	15.0	0.0	3.0	27.0

Figure 9.32 Debris generated in terms of percent of weight of elements for each model building type and each structural and non-structural damage state.

9.5 Running the Direct Social and Economic Loss Modules

The **Direct social and economic loss** modules are used for estimating casualties, displaced households due to loss of housing habitability, short-term shelter needs, and direct economic impacts resulting from damage to buildings and lifelines. Clicking on the **Direct Social Losses** option in the window shown in Figure 9.33 will cause the following menu to appear.

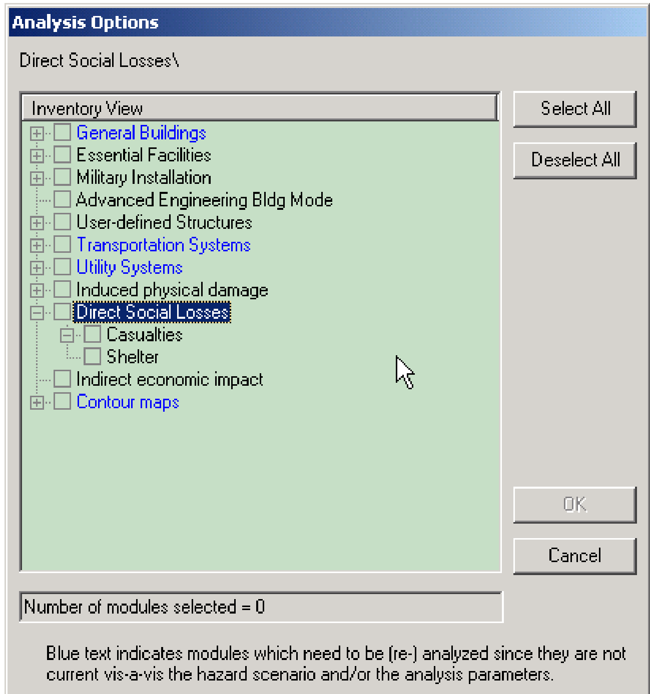


Figure 9.33 Direct economic losses

The direct economic loss option can be selected for each inventory type (general buildings, essential facilities, etc.) Select the types of analyses you wish to run, click on the **Close** button and then click on the **OK** button shown in the window in Figure 9.33. These social and economic analyses can only be run if the **direct physical damage** module is either run simultaneously, or if it has previously been run.

9.5.1 Casualty Estimates

The casualty module calculates the following estimates for each census tract at three times of day (2 AM, 2 PM and 5 PM):

- Single family dwelling (RES1) casualties (Severity 1, 2, 3 and 4)
- Residential (other than RES1) casualties (Severity 1, 2, 3 and 4)
- Commercial casualties (Severity 1, 2, 3 and 4)
- Industrial casualties (Severity 1, 2, 3 and 4)
- Education casualties (Severity 1, 2, 3 and 4)
- Hotel casualties (Severity 1, 2, 3 and 4)
- Commuting casualties (Severity 1, 2, 3 and 4)
- Total casualties (Severity 1, 2, 3 and 4)

The following inputs are needed to obtain estimates of casualties:

- Population distribution by census tract
- Population distribution within census tract
- Building stock inventory
- Damage state probabilities
- Time of day of estimate (2 AM, 2 PM or 5 PM)
- Casualty rates by damage state of model building
- Collapse rates due to collapse of model building/bridge type
- Number of commuters on or under bridges in the census tract

All of this information has already been provided by other modules or is available as a default.

9.5.1.1 Injury Classification Scale

The output from the module consists of a casualty breakdown by injury severity, defined by a four-tier injury severity scale (Coburn, 1992; Cheu, 1994). Table 9.8 defines the injury classification scale used in **Hazus**.

Table 9.8 Injury Classification Scale

Injury Severity	Injury Description
Severity 1	Injuries requiring basic medical aid without requiring hospitalization
Severity 2	Injuries requiring a greater degree of medical care and hospitalization, but not expected to progress to a life threatening status
Severity 3	Injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. The majority of these injuries are a result of structural collapse and subsequent collapse or impairment of the occupants.
Severity 4	Instantaneously killed or mortally injured

Other, more elaborate casualty scales exist. They are based on quantifiable medical parameters such as medical injury severity scores, coded physiologic variables, etc. The selected four-tier injury scale used in **Hazus** is a compromise between the demands of the medical community (in order to plan their response) and the ability of the engineering community to provide the required data. For example, medical professionals would like to have the classification in terms of "Injuries/Illnesses" to account for worsened medical conditions caused by an earthquake (e.g., heart attack). However, currently available casualty assessment methodologies do not allow for a finer resolution in the casualty scale definition.

9.5.1.2 Casualty Rates

In order to estimate the number and severity of the casualties, statistics from previous earthquakes were analyzed to develop relationships that reflect the distribution of injuries one would expect to see resulting from building and bridge damage. These casualty rates were developed for each casualty severity and are multiplied by the exposed population to estimate the number of casualties. An example of a calculation of casualties follows:

Severity 1 casualty rate for low rise Unreinforced masonry buildings (URML) with slight structural damage = 1 in 2,000

Number of people in the study region who were in slightly damaged URML buildings = 50,000

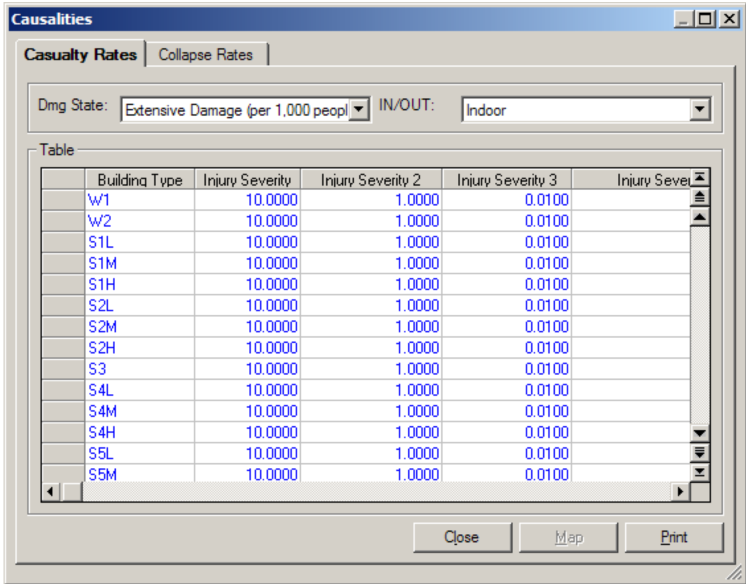
Severity 1 casualties = 50,000□1/2,000 = 25 people

The following default casualty rates are defined by **Hazus** and can be found in the *Technical Manual*:

- Casualty rates by model building type for slight structural damage
- Casualty rates by model building type for moderate structural damage
- Casualty rates by model building type for extensive structural damage
- Casualty rates by model building and bridge types for complete structural damage with no collapse
- Casualty rates after collapse by model building type.

Note that a separate set of casualty rates was developed for entrapped victims, and that collapse is only considered in the case of complete structural damage. It is assumed that in the cases of slight, moderate and extensive structural damage, collapses do not occur and building collapse is unlikely. Casualty rates for both buildings and bridges can be viewed and modified in the window shown in Figure 9.34. Selecting the Analysis|Parameters|Casualties menu accesses this window. These default casualty rates can be modified if improved information is available. To modify values, type in the new numbers and click on the **Close** button. You will be asked to confirm your changes.

It should be noted that complete data does not exist for all model building types and injury severity. Missing data were inferred from reviewing previous studies. Collection of better and more complete casualty statistics would involve a major research study.



Building Type	Injury Severity	Injury Severity 2	Injury Severity 3	Injury Seve
W1	10.0000	1.0000	0.0100	
W2	10.0000	1.0000	0.0100	
S1L	10.0000	1.0000	0.0100	
S1M	10.0000	1.0000	0.0100	
S1H	10.0000	1.0000	0.0100	
S2L	10.0000	1.0000	0.0100	
S2M	10.0000	1.0000	0.0100	
S2H	10.0000	1.0000	0.0100	
S3	10.0000	1.0000	0.0100	
S4L	10.0000	1.0000	0.0100	
S4M	10.0000	1.0000	0.0100	
S4H	10.0000	1.0000	0.0100	
S5L	10.0000	1.0000	0.0100	
S5M	10.0000	1.0000	0.0100	

Figure 9.34 Casualty rates in number of casualties per 1,000 occupants by model building type for the slight structural damage state (indoors).

9.5.1.3 Collapse Rates

When collapses or partial collapses occur, individuals may become trapped under fallen debris or trapped in air pockets amongst the rubble. Casualties tend to be more severe in these cases, and as was discussed in Section 9.5 a separate set of casualty rates was developed for entrapped victims. It should be noted that building collapse rates (in percent of occupants) are developed only for the complete damage state. This is because it is assumed that no collapses or partial collapses occur in the slight, moderate or extensive damage states and collapse in these cases is unlikely. Collapse rates by model building type can be found in the *Technical Manual*. They can also be viewed within **Hazus** as is shown in Figure 9.35. This window is accessed from the **Analysis|Parameters|Casualties** menu. To modify values, type in the new numbers and click on the **Close** button. You will be asked to confirm your changes.

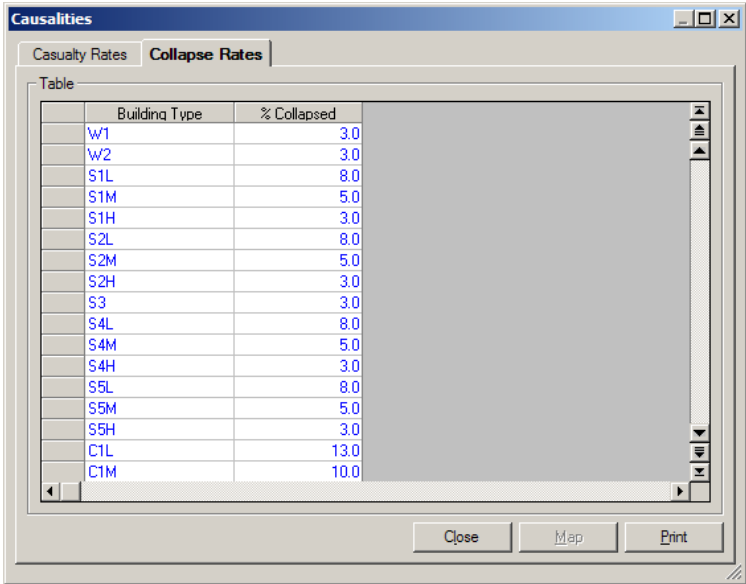


Figure 9.35 Collapse rates for buildings as displayed in Hazus.

9.5.2 Estimates of Displaced Households Due to Loss of Housing Habitability and Short-Term Shelter Needs

Earthquakes can cause loss of function or habitability of buildings that contain housing units resulting in predictable numbers of displaced households. These households will need alternative short-term shelter from family, friends, or public shelters provided by relief organizations such as the Red Cross and Salvation Army. For units where repair takes longer than a few weeks, long-term alternative housing can be achieved through importation of mobile homes, a reduction in vacant units, net emigration from the impacted area, and eventually by the repair or reconstruction of new public and private housing. While the number of people seeking short-term public shelter is of great concern to emergency response organizations, the longer-term impacts on the housing stock are of great concern to local governments. The shelter module provides two estimates:

- The total number of displaced households (due to loss of habitability)
- The number of people requiring short-term shelter

Loss of habitability is calculated directly from damage to the residential occupancy inventory and from loss of water and power. The methodology for calculating short-term shelter requirements recognizes that only a portion of those displaced from their homes will seek public shelter, and some will seek shelter even though their residence may have little, if any, damage.

Households also may be displaced as a result of fire following earthquake, inundation (or the threat of inundation) due to dam failure, and by significant hazardous waste releases. This module does not specifically deal with these issues, but an approximate estimate of displacement due to fire or inundation can be obtained by multiplying the residential inventory in affected census tracts by the areas of fire damage or inundation derived from those modules. No methodology for calculations of damage or loss due to hazardous materials is provided, and the user is confined to identifying locations of sites where hazardous materials are stored. If the particular characteristics of the study region give cause for concern about the possibility of loss of housing from fire, dam failure, or hazardous materials release, it would be advisable to initiate specific in-depth studies directed towards the problem.

All households living in uninhabitable dwellings will seek alternative shelter. Many will stay with friends and relatives or in the family car. Others will stay in hotels. Some will stay in public shelters provided by the Red Cross or others. **Hazus** estimates the number of displaced persons seeking public shelter. In addition, observations from past disasters show that approximately 80% of the pre-disaster homeless will seek public shelter. Finally, data from Northridge indicate that approximately one-third of those in public shelters came from residences with no or insignificant structural damage. Depending on the degree to which infrastructure damage is incorporated into the number of displaced households, that number could be increased by up to 50% to account for "perceived" structural damage as well as lack of water and power.

9.5.2.1 Development of Input for Displaced Households

The following inputs are required to compute the number of uninhabitable dwelling units and the number of displaced households.

- Fraction of dwelling units likely to be vacated if damaged
- Probability that the residential units are without power and/or water immediately after the earthquake.
- Percentage of households affected by utility outages likely to seek alternative shelter.

9.5.2.1.1 Fraction of Dwelling Units Likely to be vacated if damaged:

The number of uninhabitable dwelling units is not only a function of the amount of structural damage but it is also a function of the number of damaged units that are perceived to be uninhabitable by their occupants. All dwelling units located in buildings that are in the complete damage state are considered to be uninhabitable. In addition, dwelling units that are in moderately or extensively damaged multi-family structures can also be uninhabitable due to the fact that renters perceive some moderately damaged and most extensively damaged rental property as uninhabitable. On the other hand, those living in single-family homes are much more likely to tolerate damage and continue to live in their homes. Therefore weighting factors have been developed that describe the fraction of dwellings likely be vacated if they are damaged. These default weighting factors can be viewed and modified as shown in Figure 9.36. To access this window use the **Analysis|Parameters| Shelter** menu.

In this table, the subscript "SF" corresponds to single family dwellings and the subscript MF corresponds to multi-family dwellings. The subscripts M, E, and C correspond to moderate, extensive and complete damage states, respectively. For example, based on these defaults, it is assumed that 90% of multi-family dwellings will be vacated if they are in the extensive damage state (see w_{MFE}). Discussion of how the defaults were developed can be found in the *Technical Manual*.

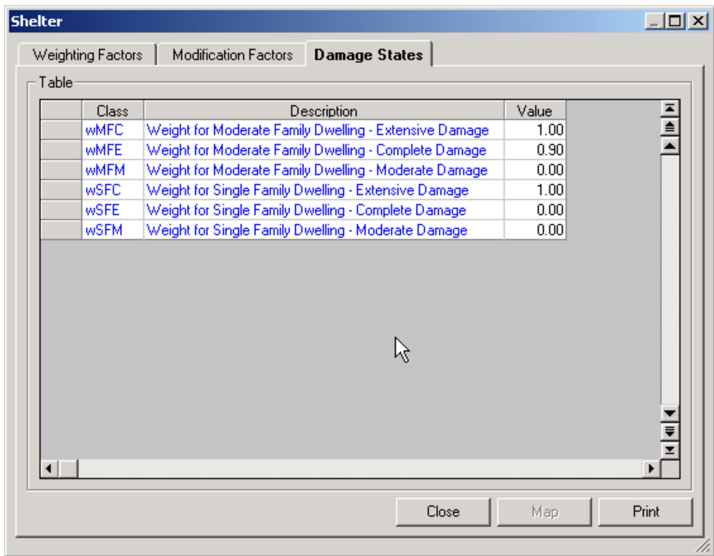


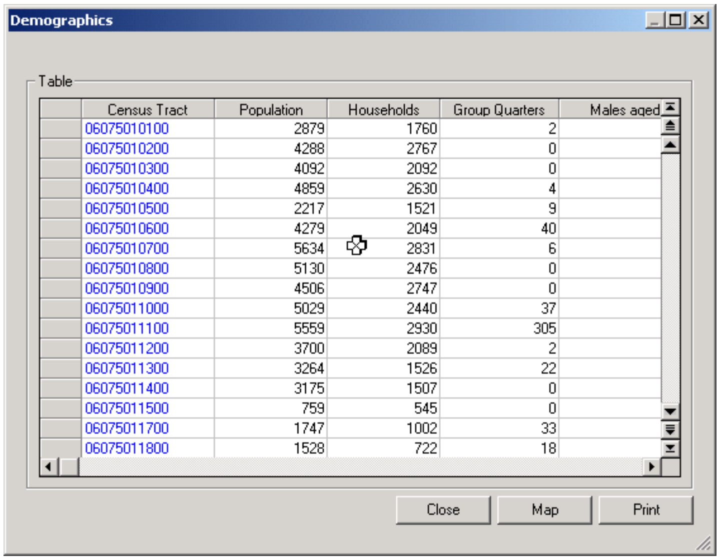
Figure 9.36 Default values for the fraction of dwelling units likely to be vacated if damaged.

9.5.2.2 Development of Input for Shelter Needs

The number of displaced households is combined with the following information to estimate shelter needs:

- Number of people in the census tract
- Number of households in census tract
- Income breakdown of households in census tract
- Ethnicity of households in census tract
- Percentage of homeowners and renters in the census tract
- Age breakdown of households in census tract

All of this information is provided in the default census database. The default census database can be viewed, modified and mapped in the inventory module as shown in Figure 9.37. Figure 9.38 is a map of households with incomes less than $10,000. Highlighting the Income column in the census database and clicking on the **Map** button accomplished this. Note that to see this column you would need to click on the right arrow at the bottom of Figure 9.37.



Census Tract	Population	Households	Group Quarters	Males aged
06075010100	2879	1760	2	
06075010200	4288	2767	0	
06075010300	4092	2092	0	
06075010400	4859	2630	4	
06075010500	2217	1521	9	
06075010600	4279	2049	40	
06075010700	5634	2831	6	
06075010800	5130	2476	0	
06075010900	4506	2747	0	
06075011000	5029	2440	37	
06075011100	5559	2930	305	
06075011200	3700	2089	2	
06075011300	3264	1526	22	
06075011400	3175	1507	0	
06075011500	759	545	0	
06075011700	1747	1002	33	
06075011800	1528	722	18	

Figure 9.37 Demographics data supplied in Hazus.

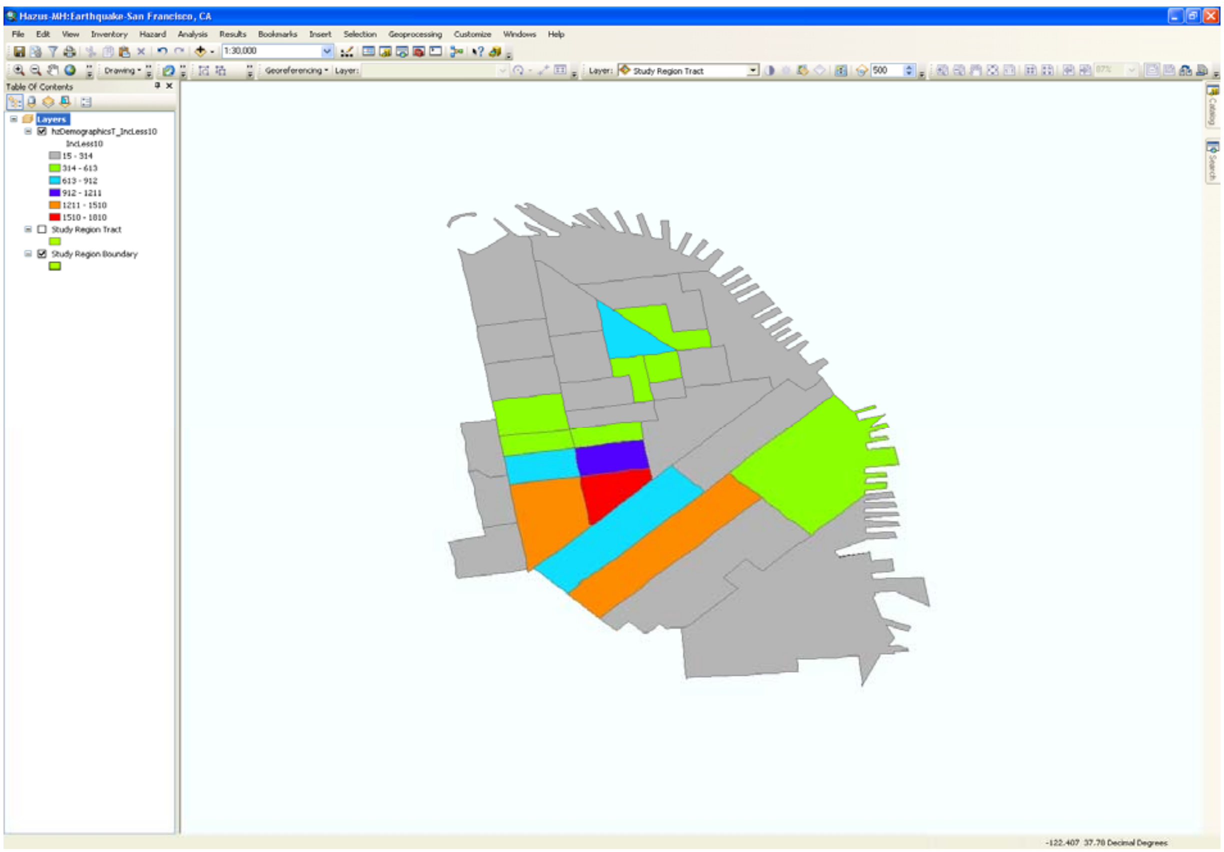


Figure 9.38 Map of households with incomes less than $10,000

Assumptions of the methodology are that the number of people who require short-term housing is a function of income, ethnicity, ownership and age. Based on experience in past disasters, including both hurricanes and earthquakes, those seeking shelter typically have very low incomes, and therefore have fewer options. In addition, they tend to have young children or are over 65. Finally, even given similar incomes, Hispanic populations from Central America and Mexico tend to be more concerned about reoccupying buildings than other groups. This tendency appears to be because of the fear of collapsed buildings instilled from past disastrous earthquakes.

To account for these trends, factors have been developed to represent the fraction of households in each category likely to seek public shelter if their dwellings become uninhabitable. The default values of these factors as shown in Table 9.9 are based upon data from the Northridge earthquake combined with expert opinion (see the *Technical Manual* for more information). From this table you can interpret that 62% of households with incomes less than $10,000 whose dwellings have become uninhabitable will seek public shelter.

Table 9.9 Fraction of Households Likely to Seek Public Shelter

Household Description	Default
Income	
Household Income < $10,000	0.62
$10,000 < Household Income < $15,000	0.42
$15,000 < Household Income < $25,000	0.29
$25,000 < Household Income < $35,000	0.22
$35,000 < Household Income	0.13
Ethnicity	
White	0.24
Black	0.48
Hispanic	0.47
Asian	0.26
Native American	0.26
Ownership	
Own Dwelling Unit	0.40
Rent Dwelling Unit	0.40
Age	
Population Under 16 Years Old	0.40
Population Between 16 and 65 Years Old	0.40
Population Over 65 Years Old	0.40

The factors in Table 9.9 can be viewed and modified in the **Shelter Parameters** window as shown in Figure 9.39. The **Income**, **Ethnicity**, **Ownership** and **Age** buttons can be used to view the various tables.

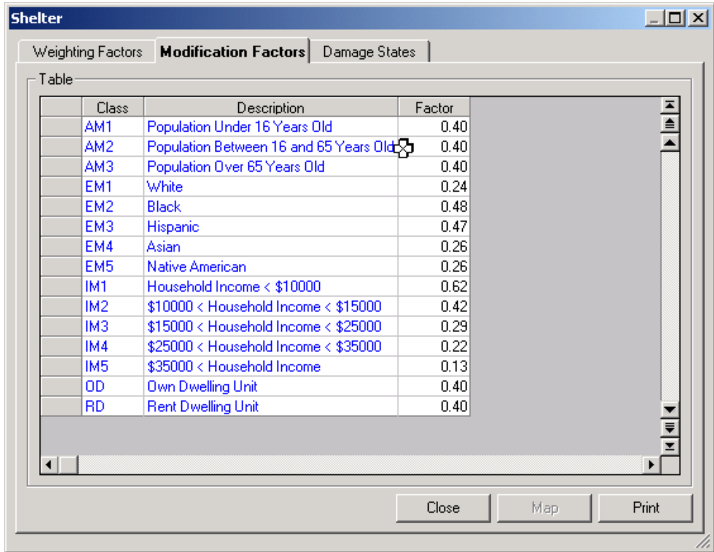


Figure 9.39 Fraction of households likely to seek public shelter as a function of household income.

You have the option to weight the importance of the four factors that affect the fraction of households seeking public shelter: income, ethnicity, ownership and age. The **importance factors** must sum to one. Defaults of the importance factors are shown in Figure 9.40. The default importance factors indicate that no weight will be put on ownership or age, and income will be weighted almost 3 times as much as ethnicity. If you wish to give all classes equal importance, then the factors should all be 0.25.

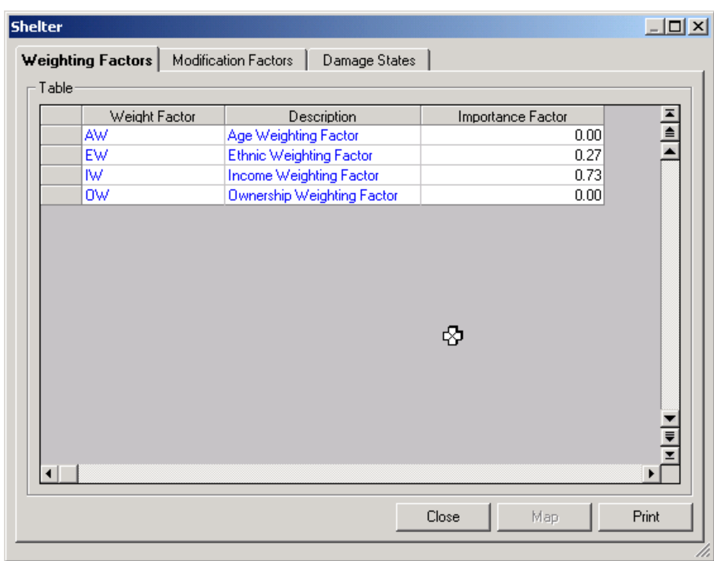


Figure 9.40 Importance Factors for determining shelter needs.

9.5.3 Direct Economic Loss

Estimates of damage to the built environment are converted to dollar loss in this module. Beyond economic losses, whose dollar value can be estimated from the extent of building and lifeline damage, there are a number of common socioeconomic impacts from earthquakes that, though their impact is not readily quantifiable, may represent important earthquake effects. These impacts may vary, depending on socioeconomic aspects of the population at risk and the particular physical topography and layout of the affected region. These are impacts such as:

Psychological and emotional trauma that may affect a variety of populations, such as school children, ethnic groups, recent immigrants, the elderly and the infirm. These effects may influence post-earthquake behavior, for example in the choice of or need for shelter, and require the deployment of large-scale psychological and counseling services. Some of these effects may be of long duration, and may affect children's behavior and adult family and work efficiency.

- Changes in work and leisure travel time patterns caused by bridge or freeway failures. Large increases in travel time may result in hardship and family stress. At a large scale, they may affect the regional economy.
- Changes in community and family structure caused by large-scale housing losses and consequent relocation and demolition.

This methodology does not attempt to estimate such effects. If the user of the methodology is interested in the possible impact of such effects on the community or region under study, it is recommended that they begin by consulting bibliographic sources to obtain an understanding of the possible importance of these impacts for the area of study. A useful discussion of many of these impacts can be found in "The Loma Prieta, California, Earthquake of October 17, 1989 - Public Response" (Bolton, 1993). This publication has bibliographic references that may be useful for further study.

9.5.3.1 Types of Direct Economic Loss

Direct economic losses begin with the cost of repair and replacement of damaged or destroyed buildings. However, building damage will result in a number of consequential losses that, in **Hazus**, are defined as direct. Thus, building-related direct economic losses (which are all expressed in dollars) comprise two groups. The first group consists of losses that are directly derived from building damage:

- Cost of repair and replacement of damaged and destroyed buildings
- Costs of damage to building contents
- Losses of building inventory (contents related to business activities)

The second group consists of losses that are related to the length of time the facility is non-operational (or the immediate economic consequences of damage):

- Relocation expenses (for businesses and institutions)
- Capital-related income losses (a measure of the loss of productivity, services or sales)
- Wage losses (consistent with income loss)
- Rental income losses (to building owners)

Damage to lifeline and transportation systems causes direct economic losses analogous to those caused by building damage. In **Hazus**, direct economic loss for lifelines and transportation systems are limited to the cost of repairing damage to the systems, and estimates of elapsed time for their restoration. No attempt is made to estimate losses due to interruption of customer service or alternative supply services.

Dollar losses due to inundation are not explicitly addressed. **Hazus** estimates the area of inundation and then relates this estimate to the quantity of building stock in the affected census tracts. This estimate in turn can be converted to a dollar value.

In a similar manner, a value for building losses from fire can be estimated by relating the area of fire spread to the volume of construction and construction cost. In both cases, the nature of damage state (which vary from those due to ground shaking damage) are not developed and estimates of dollar loss from these causes should be regarded as very broad estimates. In addition, one must be careful that double counting does not occur when evaluating damages due earthquake, inundation, and fire (for example a collapsed building that burns to the ground in a flood zone).

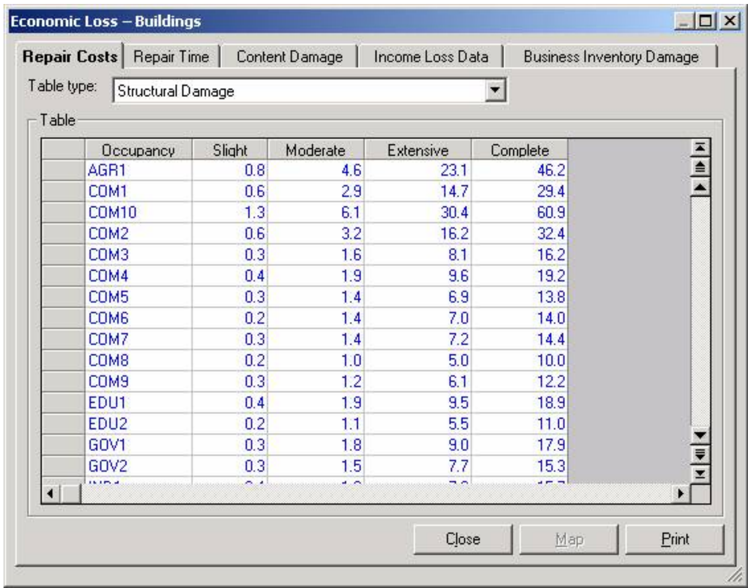
No methodology is provided for estimating losses due to release of hazardous materials.

9.5.3.2 Development of Input for Building Losses

A great deal of default economic data is supplied with **Hazus**, as follows:

- Structural repair costs (%) for each of the damage states, model building types and occupancies
- Non-structural repair costs (%) for all occupancies (both acceleration sensitive and drift sensitive damage)
- Contents damage as a function of damage state
- Annual gross sales or production in $ per square foot for agricultural, commercial and industrial occupancies
- Business inventory as a percentage of gross annual sales for agricultural, commercial and industrial occupancies
- Business inventory damage as a function of damage state for agricultural, commercial and industrial occupancies
- Building cleanup and repair time in days as a function of damage state and occupancy
- Parameters used to estimate facility loss of function for each damage state and occupancy
- Rental costs
- Disruption costs
- Percent of buildings that are owner occupied for each occupancy class
- Capital-related income and wage income in $/day per square foot for each occupancy

These data are described in detail in the *Technical Manual*. With the exception of repair costs, the default data represent typical values for the United States and thus no regional variations are included. You will want to review the default data very carefully and modify the data to best represent the characteristics of your region. The default data can be viewed and modified from within **Hazus**. The window that is used to view and modify economic default data is shown in Figure 9.41. This window is accessed from the **Analysis|Parameters|Buildings-Economic** menu.



Occupancy	Slight	Moderate	Extensive	Complete
AGR1	0.8	4.6	23.1	46.2
COM1	0.6	2.9	14.7	29.4
COM10	1.3	6.1	30.4	60.9
COM2	0.6	3.2	16.2	32.4
COM3	0.3	1.6	8.1	16.2
COM4	0.4	1.9	9.6	19.2
COM5	0.3	1.4	6.9	13.8
COM6	0.2	1.4	7.0	14.0
COM7	0.3	1.4	7.2	14.4
COM8	0.2	1.0	5.0	10.0
COM9	0.3	1.2	6.1	12.2
EDU1	0.4	1.9	9.5	18.9
EDU2	0.2	1.1	5.5	11.0
GOV1	0.3	1.8	9.0	17.9
GOV2	0.3	1.5	7.7	15.3

Figure 9.41 Economic data for estimating building repair costs, contents and business inventory losses, lost income and relocation costs.

9.5.3.2.1 Replacement Costs:

The replacement costs (damage state = complete) were derived from Means Square Foot Costs 2002, for Residential, Commercial, Industrial, and Institutional buildings (Jackson, 1994). The Means publication is a nationally accepted reference on building construction costs, which is published annually. This publication provides cost information for a number of low-rise residential model buildings, and for 70 other residential, commercial, institutional and industrial buildings. These are presented in a format that shows typical costs for each model building, showing variations by size of building, type of building structure, and building enclosure. One of these variations is chosen as "typical" for this typical model, and a breakdown is provided that shows the cost and percentages of each building system or component. A description of how to estimate costs from the Means publication is found in the *Technical Manual*. Since Means is published annually, fluctuations in typical building cost can be tracked and the user can insert the most up-to-date Means typical building cost into the default database. This procedure is outlined in the *Technical Manual*.

In **Hazus**, selected Means models have been chosen from the 70 plus models that represent the 33 occupancy types. The wide range of costs shown, even for a single model, emphasize the importance of understanding that the dollar values shown should <u>only be used to represent costs of large aggregations</u> of building types. If costs for single buildings or small groups (such as a college campus) are desired for more detailed loss analysis, then local <u>building specific</u> cost estimates should be used.

9.5.3.2.2 Building Contents:

Building contents are defined as furniture, equipment that is not integral with the structure, computers, and supplies. Contents do not include inventory or non-structural components such as lighting, ceilings, mechanical and electrical equipment and other fixtures. Unlike Hazus-99, which default values for contents (by occupancy) as a percentage of the replacement value of the facility, in **Hazus**, explicit contents exposure are supplied. The damage to contents is expressed in terms of the percentage of damage to the contents based upon the acceleration-sensitive non-structural damage state of the building. The contents damage percentages are based upon the assumption that for the complete damage state some percentage of contents, 15%, can be retrieved. The default contents damage percentages are the same for all occupancies.

9.5.3.2.3 Business Inventory:

Business inventories vary considerably with occupancy. For example, the value of inventory for a high tech manufacturing facility would be very different from that of a retail store. Thus, the default values of business inventory for this model are derived from annual gross sales by assuming that business inventory is some percentage of annual gross sales. These default values are based on judgment.

9.5.3.2.4 Building Cleanup and Repair Time:

A detailed description of repair times is provided in Section 9.6.3.3.

9.5.3.2.5 Relocation Expenses:

Relocation costs may be incurred when the level of building damage is such that the building or portions of the building are unusable while repairs are being made. While relocation costs may include a number of expenses, **Hazus** only considers disruption costs that may include the cost of shifting and transferring and the rental of temporary space. Relocation expenses are assumed to be incurred only by building owners and measured in $ per square foot per month. A renter who has been displaced from a property due to earthquake damage will cease to pay rent to the owner of the damaged property and will only pay rent to the new landlord. Therefore, the renter has no new rental expenses. It is assumed that the owner of the damaged property will pay the disruption costs for his renter. If the damaged property is owner occupied, then the owner will have to pay for his own disruption costs in addition to the cost of rent while he is repairing his building. Relocation expenses are then a function of the floor area, rental costs per day per square foot, disruption costs, and the expected days of loss of function for each damage state.

9.5.3.2.6 Capital-related Income:

Capital-related income is a measure of the profitability of a commercial enterprise. Income losses occur when building damage disrupts commercial activity. Income losses are the product of floor area, income realized per square foot and the expected days of loss of function for each damage state. The U.S. Department of Commerce's Bureau of Economic Analysis reports regional estimates of capital-related income by economic sector. Capital-related income per square foot of floor space can then be derived by dividing income by the floor space occupied by a specific sector. Income will vary considerably depending on regional economic conditions. Therefore, default values need to be adjusted for local conditions. Default values were derived from information in Table 4.7 of ATC-13.

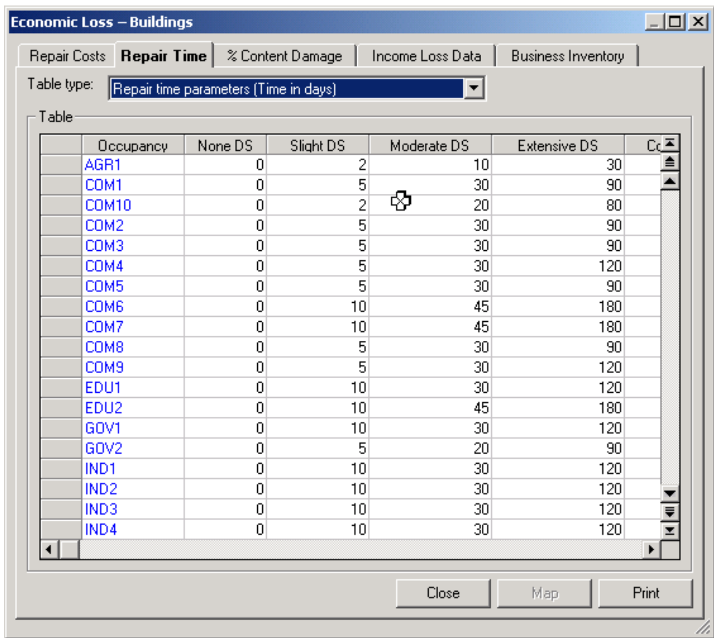
9.5.3.3 Repair and Clean-up Times

The time to repair a damaged building can be divided into two parts: construction and clean-up time, and time to obtain financing, permits and complete a design. For the lower damage states, the construction time will be close to the real repair time. At the higher damage levels, a number of additional tasks must be undertaken that typically will considerably increase the actual repair time. These tasks, which may vary considerably in scope and time between individual projects, include:

- Decision-making (related to businesses of institutional constraints, plans, financial status, etc.)
- Negotiation with FEMA (for public and non-profit), Small Business Administration, etc.
- Negotiation with insurance company, if insured
- Obtaining financing
- Contract negotiation with design firms(s)
- Detailed inspections and recommendations
- Preparation of contract documents
- Obtaining building and other permits
- Bidding/negotiating construction contract
- Start-up and occupancy activities after construction completion

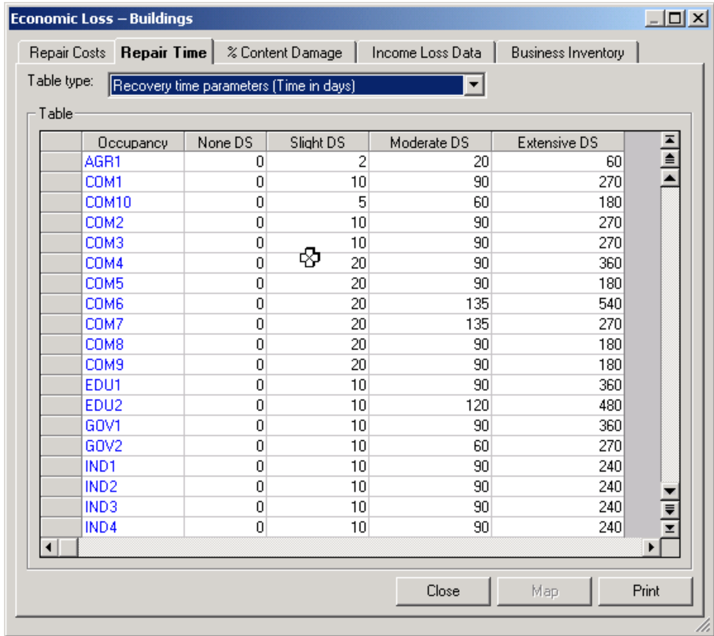
Default building repair and clean-up times are provided with **Hazus**. These default values are broken into two parts: construction time and extended time. The construction time is the time to do the actual construction or repair. The extended time includes construction plus all of the additional delays described above. A discussion of these values is found in the *Technical Manual*. Default values can be viewed and modified using the window shown in Figure 9.42. Repair times are presented as a function of both amount of damage and occupancy class. Clearly there can be a great deal of variability in repair times, but these represent estimates of the median times for actual cleanup and repair. This window is accessed from the **Analysis|Parameters|Buildings-Economic** menu. To modify these values, type in the desired new values and click on the **Close** button. You will be asked to confirm your changes.

Default values of the extended building cleanup and repair times that account for delays in decision-making, financing, inspection etc., are viewed by clicking on the desired table shown in Figure 9.43. Default extended estimates also can be modified.



Occupancy	None DS	Slight DS	Moderate DS	Extensive DS	Cc
AGR1	0	2	10	30	
COM1	0	5	30	90	
COM10	0	2	20	80	
COM2	0	5	30	90	
COM3	0	5	30	90	
COM4	0	5	30	120	
COM5	0	5	30	90	
COM6	0	10	45	180	
COM7	0	10	45	180	
COM8	0	5	30	90	
COM9	0	5	30	120	
EDU1	0	10	30	120	
EDU2	0	10	45	180	
GOV1	0	10	30	120	
GOV2	0	5	20	90	
IND1	0	10	30	120	
IND2	0	10	30	120	
IND3	0	10	30	120	
IND4	0	10	30	120	

Figure 9.42 Default building repair times.

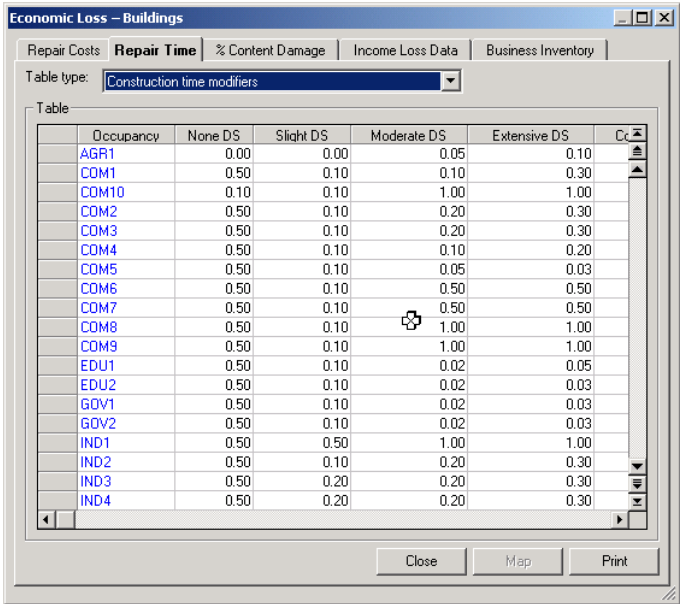


Occupancy	None DS	Slight DS	Moderate DS	Extensive DS
AGR1	0	2	20	60
COM1	0	10	90	270
COM10	0	5	60	180
COM2	0	10	90	270
COM3	0	10	90	270
COM4	0	20	90	360
COM5	0	20	90	180
COM6	0	20	135	540
COM7	0	20	135	270
COM8	0	20	90	180
COM9	0	20	90	180
EDU1	0	10	90	360
EDU2	0	10	120	480
GOV1	0	10	90	360
GOV2	0	10	60	270
IND1	0	10	90	240
IND2	0	10	90	240
IND3	0	10	90	240
IND4	0	10	90	240

Figure 9.43 Default extended building cleanup and repair times.

Repair times differ for similar damage states depending on building occupancy. Simpler and smaller buildings will take less time to repair than more complex, heavily serviced, or larger buildings. It has been also been noted that large well-financed corporations can sometimes accelerate the repair time compared to normal construction procedures.

However, establishment of a more realistic repair time does not translate directly into business or service interruption. For some businesses, building repair time is largely irrelevant, because these businesses can rent alternative space or use spare industrial/commercial capacity elsewhere. Thus Building and Service Interruption Time Multipliers have been developed to arrive at estimates of business interruption for economic purposes. These values are multiplied by the extended building cleanup and repair times. Service and building interruption multipliers can be viewed using the window shown in Figure 9.44.



Occupancy	None DS	Slight DS	Moderate DS	Extensive DS	Cc
AGR1	0.00	0.00	0.05	0.10	
COM1	0.50	0.10	0.10	0.30	
COM10	0.10	0.10	1.00	1.00	
COM2	0.50	0.10	0.20	0.30	
COM3	0.50	0.10	0.20	0.30	
COM4	0.50	0.10	0.10	0.20	
COM5	0.50	0.10	0.05	0.03	
COM6	0.50	0.10	0.50	0.50	
COM7	0.50	0.10	0.50	0.50	
COM8	0.50	0.10	1.00	1.00	
COM9	0.50	0.10	1.00	1.00	
EDU1	0.50	0.10	0.02	0.05	
EDU2	0.50	0.10	0.02	0.03	
GOV1	0.50	0.10	0.02	0.03	
GOV2	0.50	0.10	0.02	0.03	
IND1	0.50	0.50	1.00	1.00	
IND2	0.50	0.10	0.20	0.30	
IND3	0.50	0.20	0.20	0.30	
IND4	0.50	0.20	0.20	0.30	

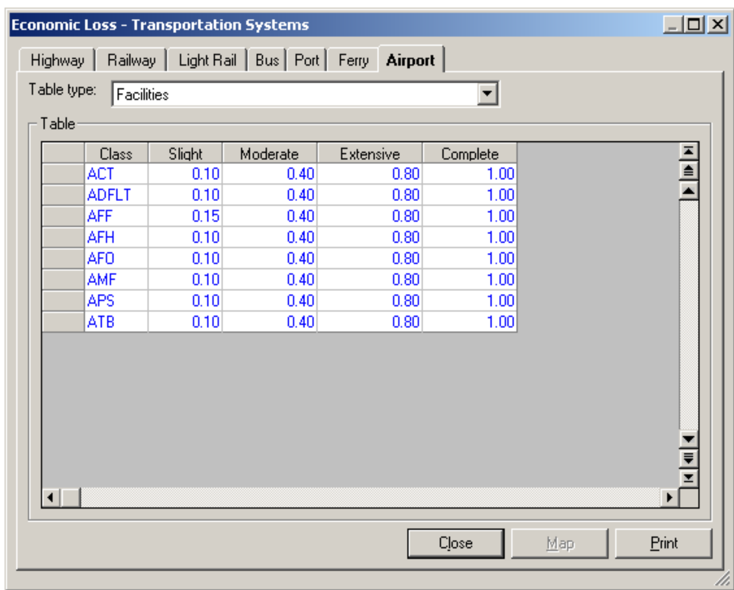
Figure 9.44 Default building and service interruption time multipliers.

Application of the interruption multipliers to the extended building clean up and repair times results in average values for the business or service interruption. For low levels of damage the time loss is assumed to be short, with cleanup by staff, and work can resume while slight repairs are being done. For most commercial and industrial businesses that suffer moderate or extensive damage, the default business interruption time is short on the assumption that businesses will find alternate ways of continuing their activities. Churches will generally find temporary accommodation quickly, and government offices will also resume operating almost at once. It is assumed that hospitals and medical offices can continue operating, perhaps with some temporary rearrangement and departmental relocation, after sustaining moderate damage. However, with extensive damage their loss of function time is assumed to be equal to the total time for repair. For other businesses and facilities, the interruption time is assumed to be equal to, or approaching, the total time for repair. This applies to residential, entertainment, theater, parking, and religious facilities whose revenue or continued service is dependent on the existence and continued operation of the facility.

The median value of repair time applies to a large inventory of facilities. At moderate damage some marginal businesses may close, while others will open after a day's cleanup. Even with extensive damage some businesses will accelerate repair, while a number of others will close or be demolished. For example, one might reasonably assume that a URM building that suffers moderate damage is more likely to be demolished than a newer building that suffers moderate or even extensive damage. If the URM building is a historic structure, its likelihood of survival and repair will probably increase. There will also be a small number of extreme cases: the slightly damaged building that becomes derelict, or the extensively damaged building that continues to function for years with temporary shoring, until an expensive repair is financed and executed.

9.5.3.4 Development of Input for Lifeline Losses

For lifelines, estimates of economic losses are limited to the costs of repair. For each damage state, a default damage ratio has been defined. A damage ratio is the cost of repair as a fraction of the replacement cost. A sample of default damage ratios is shown in Figure 9.45. For example, the cost to repair slight damage to an airport control tower of type ACT is 10% of the replacement cost. This window is accessed from the **Analysis|Parameters|Lifelines-Economic** menu. The damage ratios are defined based upon the model lifeline components discussed in Chapters 7 and 8 of the *Technical Manual*. Development of damage ratios for lifeline components from damage to sub-components is discussed in Section 15.3 of the *Technical Manual*. Damage ratios can be modified to perform sensitivity analyses; however, damage ratios should be kept in the ranges defined in Chapter 15 of the *Technical Manual*.



Class	Slight	Moderate	Extensive	Complete
ACT	0.10	0.40	0.80	1.00
ADFLT	0.10	0.40	0.80	1.00
AFF	0.15	0.40	0.80	1.00
AFH	0.10	0.40	0.80	1.00
AFO	0.10	0.40	0.80	1.00
AMF	0.10	0.40	0.80	1.00
APS	0.10	0.40	0.80	1.00
ATB	0.10	0.40	0.80	1.00

Figure 9.45 Default damage ratios for airport components.

To make estimates of losses to lifelines, damage ratios must be multiplied by replacement costs. Default replacement costs provided with the methodology are mostly based on values found in ATC 13 and ATC-25. Replacement costs can be viewed and modified in the corresponding inventory table (‘Cost’ field). Figure 9.46 shows an example for highway bridges. All cost fields are in thousands of dollars.

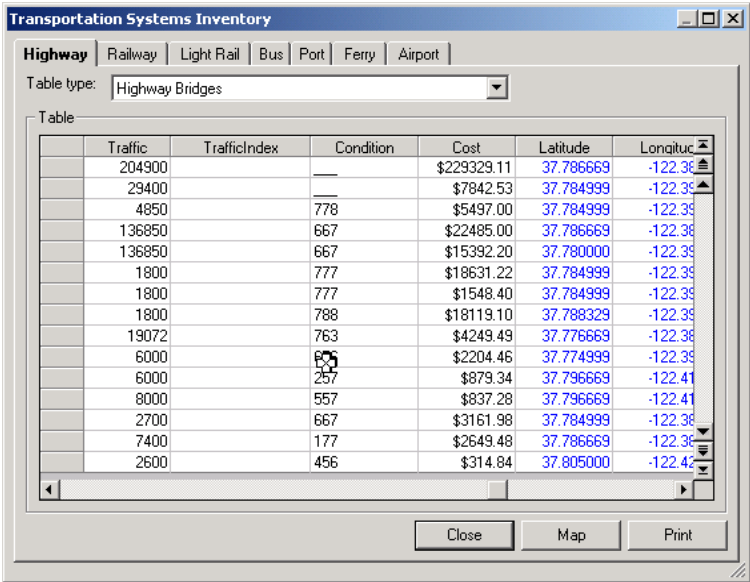


Figure 9.46 Replacement costs for highway bridges inventory.

9.6 Running the Indirect Economic Loss Module

Indirect economic impacts are defined in **Hazus** as the long-term economic impacts on the region that occur as a result of direct economic losses. Examples of indirect economic impacts include changes in unemployment or changes in sales tax revenues.

Earthquakes may produce impacts on economic sectors not sustaining direct damage. Activities that rely on regional markets for their output or that rely on a regional source of supply could experience interruptions in their operations. Such interruptions are called **indirect** economic losses. The extent of these losses depends upon such factors as the availability of alternative sources of supply and markets for products, the length of the production disturbance, and deferability of production.

In a sample economy Company A ships to Company B, and Company B to Company C. C supplies households with a final product and is also a supplier of inputs to A and B. There are two factories producing product B, one of which is destroyed in the earthquake. Indirect damages occur because: 1) direct damage to production facilities and inventories cause supply shortages for firms needing these; 2) because damaged production facilities reduce their demand for inputs from other producers; or 3) because of reductions in government, investment, or export demands for goods and services caused by an earthquake.

The supply shortages caused as a result of losing B could cripple C, providing C is unable to locate alternative sources. Three options are possible: 1) secure additional supplies from outside the region (imports); 2) obtain additional supplies from the undamaged factory (excess capacity); and 3) draw from B's inventories.

Modeling of a regional economy is a very complex problem if it is to include such factors as the ability to replace lost inventory or lost production by products from other regions. The model included with **Hazus** is a simplified model based on a set of equations that were derived from a statistical analysis of a large number of loss scenarios. Therefore, while it will give the user insight into the possible consequences of an earthquake, a more detailed model may be necessary to accurately represent the individual characteristics of a particular region.

To run this module, select the **Indirect economic impact** option in the **Analysis|Run...** menu (see Figure 9.47).

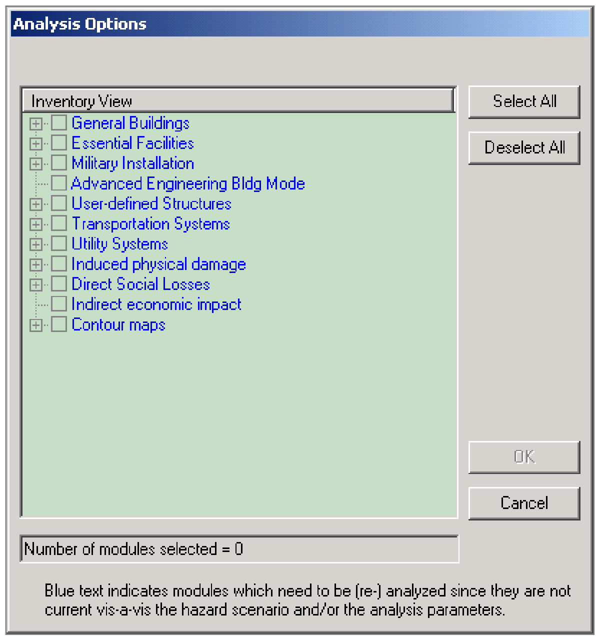


Figure 9.47 Hazus analysis options.

9.6.1 Economic Sectors

To simplify modeling, the regional economy has been divided into 10 sectors as follows:

- Agriculture
- Mining
- Construction
- Manufacturing
- Transportation
- Trade (Wholesale and Retail)
- Finance, Insurance and Real Estate
- Services
- Government
- Other

Changes in payroll, employment, etc., are reported for each of these economic sectors.

9.6.2 Running the Indirect Economic Loss Module with a Synthetic Economy

Estimates of indirect losses can be calculated using a very simplified model of the regional economy. **Hazus** contains twelve built-in "synthetic" economies. These "synthetic economies" are based on aggregating characteristics from a number of regional economies around the country and creating three typical economy types:

- Primarily manufacturing
- Primarily service with manufacturing as the secondary sector
- Primarily service with trade as the secondary sector

Each economy is broken into four size classifications:

- Super (greater than 2 million in employment)
- Large (greater than 0.6 million but less than 2 million in employment)
- Mid Range (greater than 30,000 but less than 0.6 million in employment)
- Low (less than 30,000 in employment)

The indirect economic impact module selects the most appropriate synthetic economy to use for the study region based on user inputs describing the size of the economy (number of employees) and the type of economy. In order to run the module using a synthetic economy, you must identify the type and size of economy using the window shown in Figure 9.48. To access the screen, select the **Indirect economic** option in the **Analysis|Parameters** menu.

The default type of economy is "primarily manufacturing." You should overwrite this if "service/manufacturing" or "service/trade" is a more accurate characterization of your region. The economy type can be determined by evaluating the percent of regional employment in each of the major industries. For further guidance, consult the *Technical Manual*.

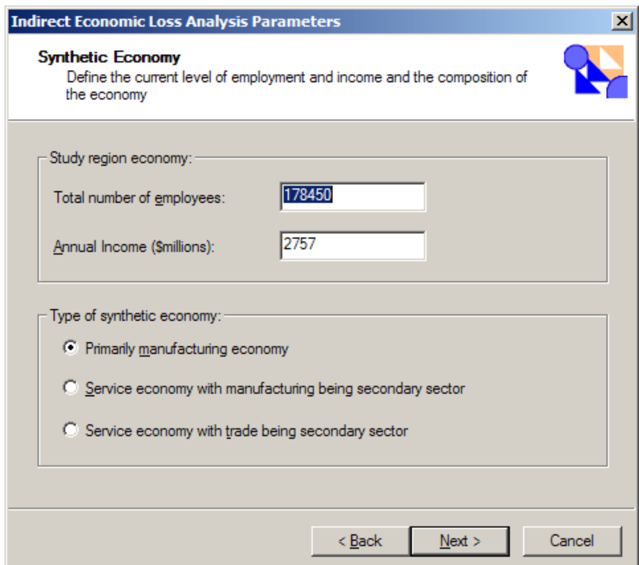


Figure 9.48 Setting parameters for synthetic economy.

Hazus provides a default employment figure based on the counties in the study region. The source of this default data is the Bureau of Economic Analysis. You should review this number against available local information and overwrite it if appropriate. Employment should be measured by place of *work* rather than by place of *residence*. This distinction is especially significant when there is substantial commuting across the region's borders. In addition to employment, the default figure provided for regional income should be reviewed and overwritten if appropriate.

After you have defined the synthetic economy and clicked on the **Next>** button in Figure 9.48 the window in Figure 9.49 will appear. Figures 9.52 through 9.55 allow you to modify economic factors that relate to the general capacity and the economy's ability to restore itself following the earthquake. Default values for all of the factors are provided for use in analysis. However, you should still review at the least the following factors and replace the default values as appropriate:

- Unemployment rate
- Level of outside aid and/or insurance
- Interest rate on loans

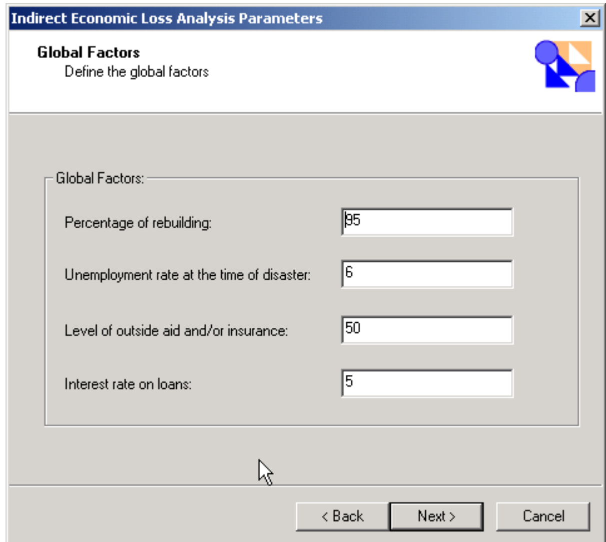


Figure 9.49 Setting the indirect economic factors.

Default values are provided for four global factors as shown in Figure 9.49. The **Percentage of rebuilding** is used by the module to estimate the size of the reconstruction stimulus to the economy. The **Unemployment rate at the time of the disaster** serves as an indicator of excess capacity or slack in the economy; the indirect losses are generally higher when the economy has low unemployment because there is less unused capacity that can help make up for capacity lost due to earthquake damage. The **Level of outside aid and/or insurance** is a major determinant of the long-term income effects of the disaster since the amount of reconstruction funded by borrowing within the region will in the long term cause indebtedness. The **Interest rate on loans** also affects the amount of indebtedness arising from reconstruction financing.

Again, these should be reviewed and modified where appropriate. In some cases you may wish to run several analyses using different values, such as **Level of outside aid and/or insurance**, to investigate the effect of this parameter on indirect economic impacts. When you have finished with the **Factors** tab, click on the **Restoration & Rebuilding** tab to view the screen in Figure 9.50.

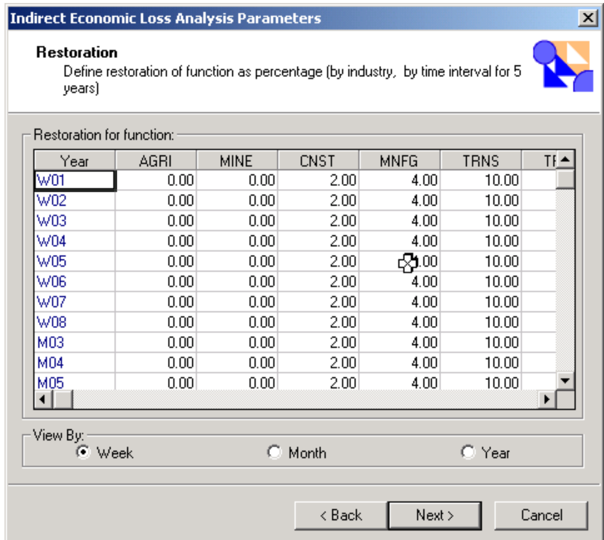


Figure 9.50 Setting the indirect economic restoration and rebuilding factors.

The dialog shows default values for industry restoration functions for each of the first 5 years. Units are in percentage points of industry *loss* of function or production capacity in each year. Default values may be overwritten for consistency with results related to physical damage (See section 16.5.2.2 in the *Technical Manual*).

The rebuilding factors as shown in Figure 9.51 has default values for "% of Total Rebuilding Expenditures" in each of the first 5 years for buildings and lifelines, respectively. In general, most of the rebuilding is expected to occur in the first 1-2 years after the disaster. Lifeline reconstruction expenditures are expected to be made proportionately earlier than buildings reconstruction. Default values can be overwritten for consistency with results on physical damage (See the *Technical Manual* for more information).

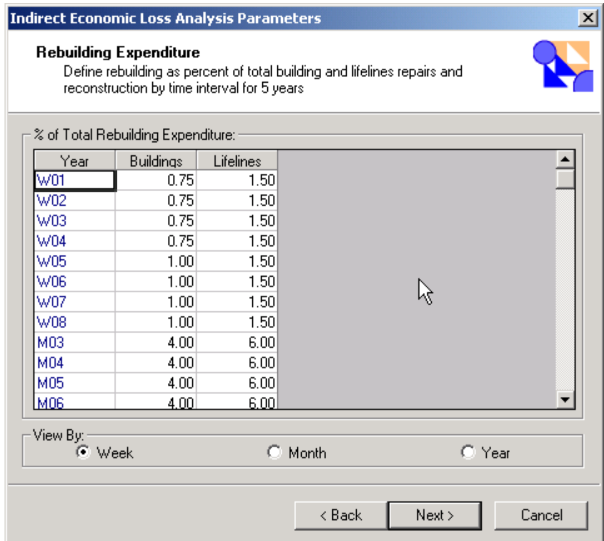


Figure 9.51 Setting the indirect economic rebuilding factors

The last factors that can be altered are the Stimulus Values. By clicking on the Stimulus Values tab, you can access the screen shown in Figure 9.52.

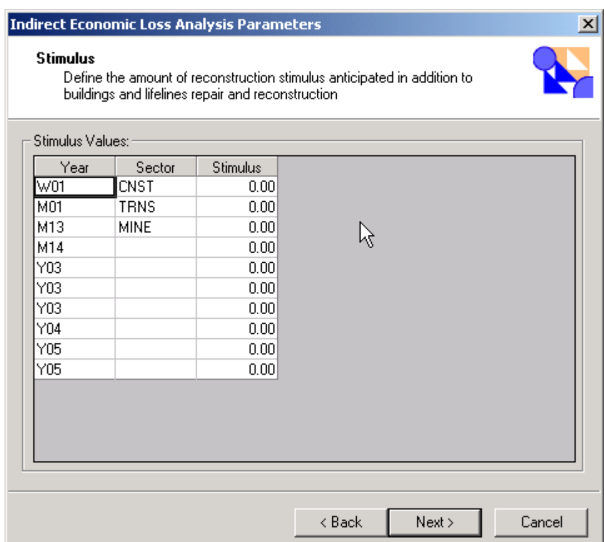


Figure 9.52 Setting the stimulus values

The parameters in Figure 9.58 represent an anticipated stimulus to the economy in addition to repair and reconstruction of buildings and lifelines. The defaults are all zero.

Hazus includes the capability of inputting a higher resolution timeframe for the restorations factors, the rebuilding factors and the stimulus values. In **Hazus** the factors can be specified on a weekly basis for the first 2 months (8 weeks), on a monthly basis for the first 2 years (month 3 through 24), and yearly thereafter (year 3 through 5.)

Click **OK** after completing selections on this screen. This completes the user input requirements. The module can be run by clicking on the **Indirect economic loss** option in the **Analysis|Run...** menu.

9.6.3 Running the Indirect Economic Loss Module with IMPLAN Data

For a more realistic analysis the indirect economic module can use IMPLAN data for modeling the economy. Select **Use IMPLAN data files** from the **Indirect Economic Analysis Type** screen in Figure 9.54. The default employment and income figures on the screen will not be used. Instead, the module will automatically pick off more accurate data from the IMPLAN data files you provide (see the *Technical Manual*). You do not have to make a selection under **Type of Synthetic Economy**.

Click **OK** after completing selections on this screen and the **IMPLAN** Files screen shown in Figure 9.59 will appear.

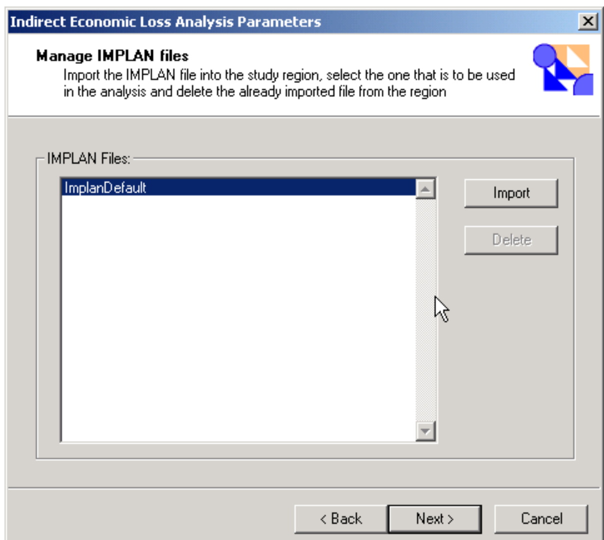


Figure 9.53 Screen for importing IMPLAN files.

The screen contains a box listing available **IMPLAN** files. If the user has not imported any files, only one file labeled **IMPLANDF** (for IMPLAN default) is listed. This indicates the default synthetic economy.

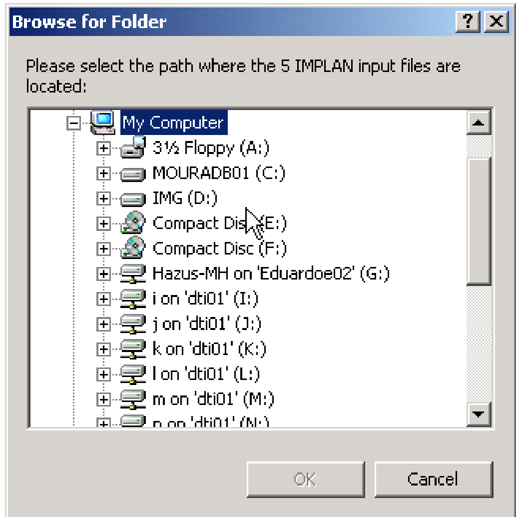


Figure 9.54 Locating IMPLAN files.

Use the **Import** button to import **IMPLAN** files into **Hazus**. Note that **Hazus** only prompts you for the directory that contains the required files. All five files should be located in the same directory. Chapter 16 of the **Hazus** Technical Manual provides the information of the files required by the module.

The newly imported **IMPLAN** file name now appears underneath **IMPLANDF**. Use the mouse to highlight the new **IMPLAN** file, thus selecting it for use in the analysis. Click **OK** and the Indirect Economic Analysis Factors screen will appear.

If you have previously imported an **IMPLAN** data file(s), its name(s) will appear on the list. Remember to highlight the correct file each time before clicking **OK** to ensure that **Hazus** does not return to using the default **IMPLANDF** file.

Follow the steps outlined in Section 9.6.2 for specifying indirect economic analysis factors. Run the module by clicking on the **Indirect economic loss** option in the **Analysis|Run...** menu.

9.7 Dealing with Uncertainty

As was mentioned earlier, **Hazus** does not explicitly include uncertainty. The results obtained will be mean (or average) values of losses, and do not include ranges that would help you estimate bounds on your results. To some extent you can examine the variability of the model by performing a sensitivity analysis.

In a sensitivity analysis you would change inputs or parameters one at a time and see how sensitive the results are to these changes. For example, you might modify the scenario earthquake by one half magnitude up or down and rerun your analysis. Obviously if you increase the magnitude, for example from 6.0 to 6.5, the losses will increase. The question is how much. If the results change a great deal then your model is very sensitive to this input and you should evaluate that input carefully to make sure you are using a reasonable value. This may involve obtaining the advice of an expert. Alternatively, when you write the final report you can provide a range of losses based on the high and low values you obtain from your sensitivity analysis. On the other hand, if the results don't vary significantly, then you don't have to worry a great deal about the exact value of the parameter or input.

Types of inputs that you may wish to alter in your sensitivity analysis are listed below. This list contains suggestions only and is not intended to be comprehensive.

- Magnitude of scenario earthquake (up or down 1/2 magnitude)
- The attenuation relationship used (choose from the relationships supplied with **Hazus**)
- Mix of construction quality levels (inferior, code and superior)
- Repair and replacement costs
- Fire module wind speed and engine speed
- Shelter module utility, modification and weighting factors
- Type of economy in indirect module
- Amount of outside aid in indirect module
- Unemployment rate in indirect module
- Interest rate on loans in indirect module

The user can modify inputs depending on the time and resources available. It is important to remember, though, that you must alter them one at a time if you want to be able to see any trends due to a particular parameter. It is suggested that you set up a system for keeping track of the results so that you understand which inputs produced which results. You might set up a tables such as Table 9.10and Table 9.11 to record inputs and results.

Table 9.10 Sample Table of Sensitivity Analysis Scenarios

Scenario Name	Inputs Magnitude	Const. Quality Mix
Port1	6.0	default
Port2	6.0	new
Port3	6.5	default
Port4	6.5	new
Port5	5.5	default
Port6	5.5	new

Table 9.11 Sample Table of Sensitivity Analysis Results

Value	Port1	Port 2	Port3	Port4	Port5	Port6
Direct Economic Losses						
Cost Structural Damage	$300,000	$310,000	$350,000	$365,000	$260,000	$270,000
Cost Non-Structural Damage	•	•	•	•	•	•
Cost Contents Damage	•	•	•	•	•	•
Inventory Loss	•	•	•	•	•	•
Relocation Loss	•	•	•	•	•	•
Capital Related Income Loss	•	•	•	•	•	•
Wage Losses	•	•	•	•	•	•
Rental Income Loss	•	•	•	•	•	•
Total Loss						
Transportation System Dollar Loss						
Highway						
Railway						
Light Rail						
Bus						
Port						
Ferry						
Airport						
Total Loss						
Utilities System Dollar Loss						
Potable Water						
Waste Water						
Oil						
Natural Gas						
Electric Power						
Communication						
Total Loss						
Casualties						
Severity 1						
Severity 2						
Severity 3						
Severity 4						
Shelter Needs						

Chapter 10. Viewing and Reporting the Results

10.1 Guidance for Reporting Loss Results

There is no single format that is appropriate for presentation of loss study results. The format will depend on the use of the results and the intended audience. The audience can vary from the general public to technical experts. Decision makers such as city council members and other government officials may require only summaries of losses for a region. Emergency response planners may want to see the geographical distribution of all losses and damage for several different earthquake scenarios. **Hazus** provides a great deal of flexibility in presenting results. Results can be presented in a tabular or map form - which maps or tables are selected for reports will depend on the application. In any case, the users of the results should be involved from the beginning in determining the types and formats of the results that best suit their needs.

In previous loss studies, authors of reports have had the difficult task of trying to combine the study results with the theory of how they were calculated. Consequently, reports often seemed overly technical, reducing their readability and usefulness for many audiences. **Hazus** users can refer to the *Technical Manual* that describes all of the theories and equations that provide the basis of any loss estimate. Thus reports do not need to, and probably should not include technical discussions of theory. Instead, reports should focus on describing results in non-technical language that is easily understood by the intended audience.

While no particular format for presenting results can be recommended, several general statements about reporting of results can be made. Reports should serve to clarify the meaning of the loss estimates. As an example, the reporting of economic loss should indicate whether both direct and indirect losses are included in the estimates. The report should indicate whether losses are due only to structural and non-structural damage or if they also include monetary losses resulting from loss of function. Casualty reports should indicate that casualties include only those that result from building damage and bridge collapse and do not include injuries and deaths from fires, flood, hazardous material releases or medical causes such as heart attacks. It should be clarified that in most cases losses are not calculated for specific buildings or facilities, but instead are based on the performances of entire classes of buildings and lifelines. These are just a few examples of the types of clarifications that should appear in reports.

Reports should also clarify for the reader what assumptions were made in developing the scenario and inventory and in calculating losses. For example, were losses based on default inventories or were default inventories augmented? Were default repair costs and repair times used? If not, what values were used? Were soils maps provided or were results based on a default soil type? What assumptions were made in selecting the scenario earthquake? Is it based on an historical event? Is it based on a specified probability of occurrence (e.g. 10% chance in 200 years)? What types of assumptions were made about design and construction quality?

A criticism of past studies is that there has been little qualitative or quantitative treatment of uncertainty. Discussions with users of previous studies have indicated that users need information about where errors in prediction are most likely to occur. While this methodology does not explicitly include a technique for carrying the uncertainty of each variable through the entire set of calculations, sensitivity analyses are useful for providing bounds on loss estimates (see Section 9.7). At a minimum, reports should make some statement about the uncertainty of the input values.

10.2 Module Outputs

Each of the modules of **Hazus** provides the user with a series of outputs. The outputs can be in a numerical or graphical form. Ground motion and failure is calculated at different locations for a specified earthquake scenario. This information by itself may not be very useful for hazard mitigation and emergency planning. However, ground shaking results are used as an input to determine the structural and non-structural damage.

10.3 Potential Earth Science Hazards

Hazus provides information about the expected ground shaking response for a specified event in the given study region. The user may specify a deterministic scenario event. For the purposes of emergency response and preparedness, a scenario event is commonly used to estimate earthquake consequences and losses. The user can also opt for a pseudo-probabilistic approach that can be used to compute expected annual losses. This type of approach may be useful for comparing mitigation strategies. The user can apply an existing ground motion map prepared by an expert.

Table 10.1 summarizes the module outputs for these three options. In all three cases, the user is provided with ground shaking in the study region characterized in terms of peak ground acceleration (PGA) and spectral accelerations (5% damping) at two specific structural periods (0.3 and 1.0 seconds).

Table 10.1 Ground Motion/Site Effects Output

Input	Description of Output	Measure
Deterministic Event	**Hazus** determines census tract ground motion and develops region-wide ground motion contour maps based on a user-defined scenario event.	a) Census Tract Ground Shaking b) PGA Contour Maps c) Spectral Contour Maps
USGS Probabilistic Seismic Hazard Maps	**Hazus** includes spectral contour maps at two seismic hazard levels: 2% probability of exceedance in 50 years and 10% probability of exceedance in 50 years	a) PGA Contour Maps b) Spectral Contour Maps
User-Supplied Ground Shaking Maps	The user supplies region-wide ground motion contour maps which are used as the ground motion inputs to **Hazus**	a) Census Tract Ground Shaking b) PGA Contour Maps c) Spectral Contour Maps

For areas identified as susceptible, **Hazus** provides information concerning the probability of an expected level of permanent ground deformations (PGD) due to the specified scenario event. In this methodology, permanent ground deformation is defined as liquefaction, landsliding and surface fault rupture. PGD are important in estimating losses to and functionality of lifelines. Table 10.2 summarizes the ground deformation outputs. PGD are reported in terms of contour maps of ground deformations (in meters) or site specific PGD.

Table 10.2 Ground Deformation Output

Input	Description of Output	Measure
Liquefaction	**Hazus** determines the probability of and expected level of permanent ground deformations for liquefaction susceptible sites during the deterministic, probabilistic, or user-defined event.	a) PGD Contour Maps b) Location-Specific PGD
Landsliding	**Hazus** determines the probability of and expected level of permanent ground deformations for landsliding susceptible sites during the deterministic, probabilistic, or user-defined event.	a) PGD Contour Maps b) Location-Specific PGD
Surface Fault Rupture	**Hazus** determines the probability of and expected level of permanent ground deformations for surface fault rupture susceptible sites during the deterministic, probabilistic, or user-defined event.	a) PGD Contour Maps b) Location-Specific PGD

Access the potential hazard outputs from the **Results|Ground Motion** menu (See Figure 10.1). Ground motion maps can be viewed in two forms: census tract-based or contour maps. To generate census tract-based maps, **Hazus** evaluates the ground motion at the census tract centroid and then assigns the value to the census tract. The census tract-based information is used to derive the damage and loss estimates for the general building stock. Contour maps that are generated by **Hazus** are for display purposes only. Contour maps that are digitized and entered by the user can be used for further computations.

From the **Ground Motion or Failure** menu, you can plot a variety of maps by choosing one of the options**:** **Ground Motion (By Census Tracts)** or **Contours or Ground Failure Maps**. For the **Ground Motion (By Census Tracts)** option, as shown in Figure 10.2, you can generate acceleration, displacement, velocity, PGV or PGA maps by clicking on the appropriate column of data and then clicking on the **Map** button. Examples of these maps are found in Figures 10.3 and 10.4. For the **Contours or Ground Failure Maps** option, you may plot any of the parameters shown in Figure 10.5 provided that you have already run the specific analysis that you want to plot. Click on your choice in Figure 10.5, followed by the **Map** button.

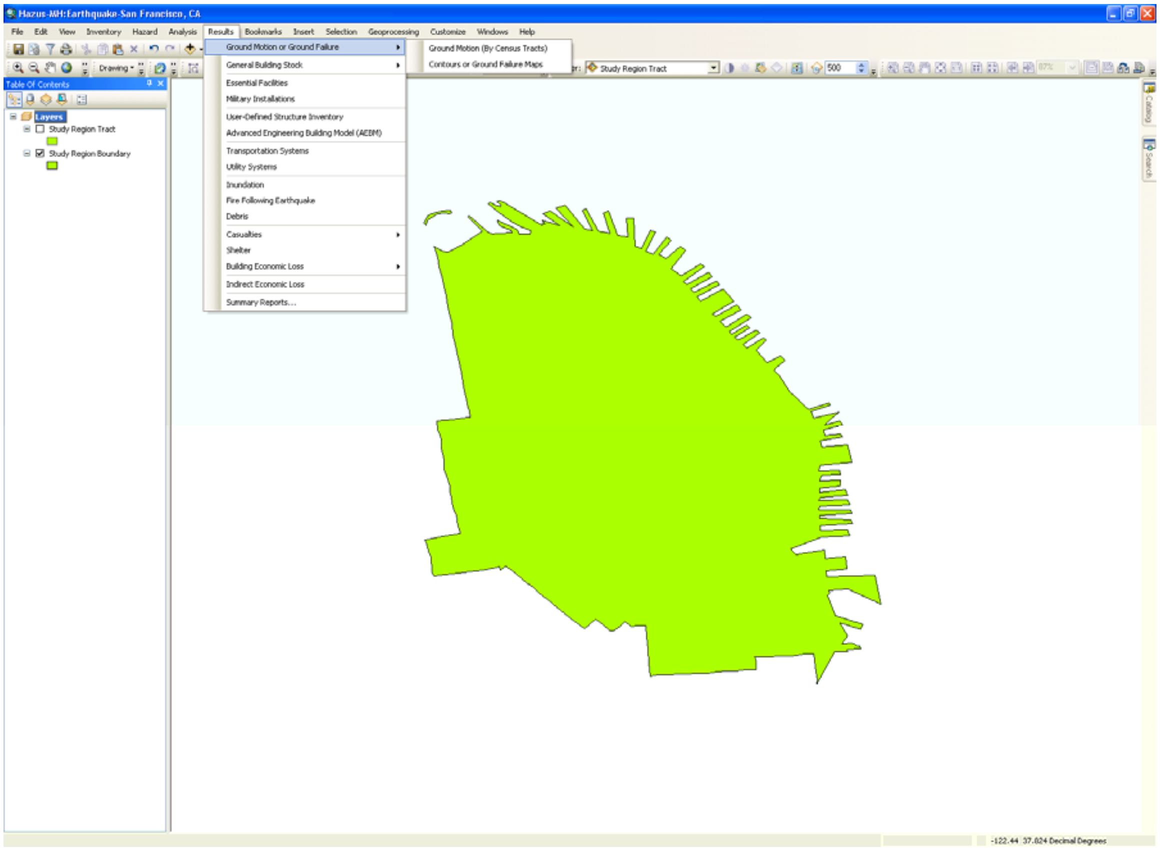
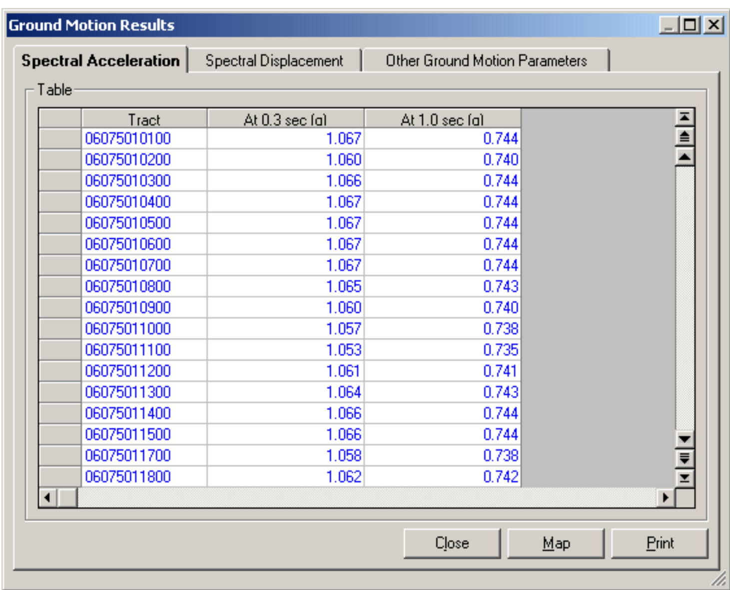


Figure 10.1 Ground motion results.



Tract	At 0.3 sec (g)	At 1.0 sec (g)
06075010100	1.067	0.744
06075010200	1.060	0.740
06075010300	1.066	0.744
06075010400	1.067	0.744
06075010500	1.067	0.744
06075010600	1.067	0.744
06075010700	1.067	0.744
06075010800	1.065	0.743
06075010900	1.060	0.740
06075011000	1.057	0.738
06075011100	1.053	0.735
06075011200	1.061	0.741
06075011300	1.064	0.743
06075011400	1.066	0.744
06075011500	1.066	0.744
06075011700	1.058	0.738
06075011800	1.062	0.742

Figure 10.2 Selecting site-specific data generated in the PESH module

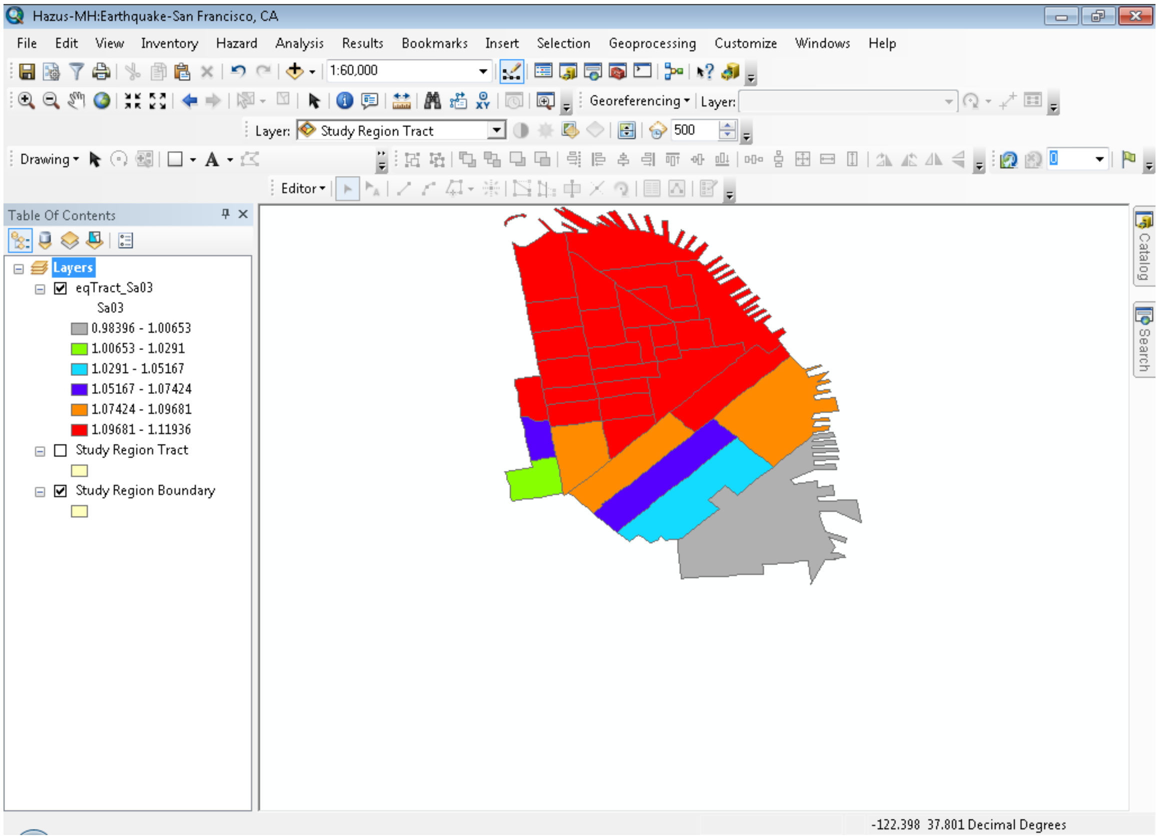


Figure 10.3 Map of 0.3 second spectral acceleration by census tract

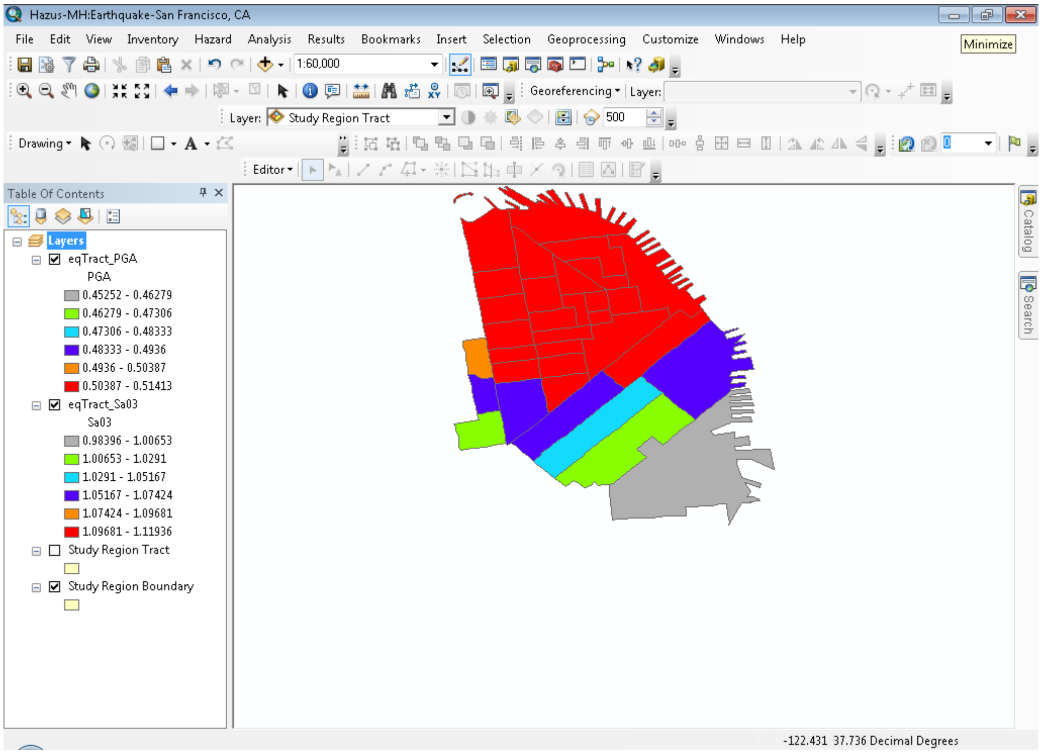


Figure 10.4 Map of peak ground acceleration by census tract.

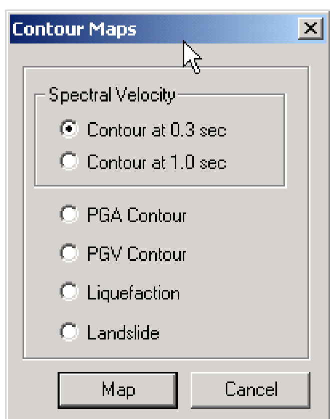


Figure 10.5 Window to select PESH contours for mapping.

10.3.1 Ground Motion Descriptions

Many of the earlier regional loss estimation studies and methods have based losses on MMI and isoseismal maps (maps showing areas of constant MMI). In **Hazus**, Potential Ground Acceleration (PGA), Potential Ground Velocity (PGV) and Spectral Acceleration (SA) characterize ground shaking. The use of spectral acceleration allows **Hazus** to account for possible amplification of building motion and consequently damage due to sympathetic response of a building to the earthquake motions.

Sympathetic response of a building (or amplification of building shaking) is similar to what you experience when on a swing. If you pump your legs at a certain frequency, the swing will go very high and very fast. If the ground motion shakes the building at a certain frequency the building will experience amplification of its motions. Fast shaking excites short buildings and slower shaking excites tall buildings. Presenting ground motion in terms of spectral velocity and spectral acceleration gives information about the frequency of the ground shaking. This in turn can be used to determine which buildings (tall or short) are most excited and thus most damaged by a particular earthquake.

10.4 Direct Physical Damage - General Building Stock

The direct physical damage module of **Hazus** provides information about the level of damage to the study region's general building stock. Damage to the general building stock is not evaluated on a building-by-building basis. Instead, damage is estimated and reported for groups of buildings in each census tract. Damage to the general building stock is defined in terms of the probability that a specific model building type will reach or exceed a specified level of damage when subjected to a given level of ground motion. Damage estimates are then converted in other modules into monetary losses and social losses such as casualties and shelter demands (see, for example, Figure 10.6).

Losses such as the costs of reconstruction, the length of business interruption, the number of people needing shelter and the severity of injuries and number of casualties all depend on the severity of the damage. While estimation of social and economic losses is the ultimate goal of a loss study, some knowledge of the geographical distribution of damage may be helpful in planning for post-earthquake response or in determining strategies for mitigation, for example, if the scenario identifies a particular area where a large number of buildings are likely to collapse, planning for rescue efforts in this area may be important.

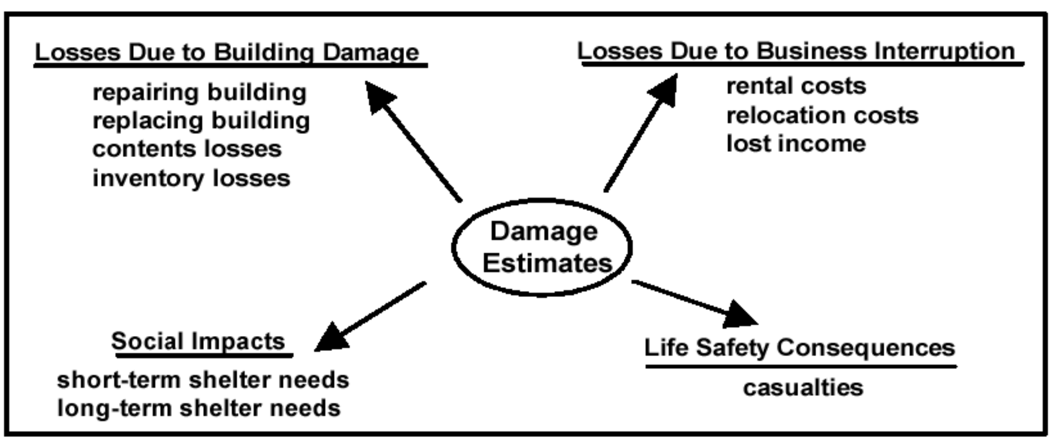


Figure 10.6 Losses calculated from damage estimates.

Damage is described by five damage states (none, slight, moderate, extensive and complete) that are defined in detail in Section 9.3.2. Estimates of earthquake damage are provided in terms of damage state probabilities or building count. For a specified earthquake, the user is provided with the probability of a structural type experiencing a certain level of damage.

For example, for a given earthquake, wood frame structures may have a probability of 0.9 of experiencing no damage and a probability of 0.1 of experiencing slight damage. As shown in Table 10.3, damage state probabilities are provided for structural as well as non-structural damage, where as building counts are only provided for structural damage. To provide the most flexibility to the user, the module delivers damage state probabilities for model building types, specific occupancy classes and general occupancy classes. Results are available in a tabular or map format.

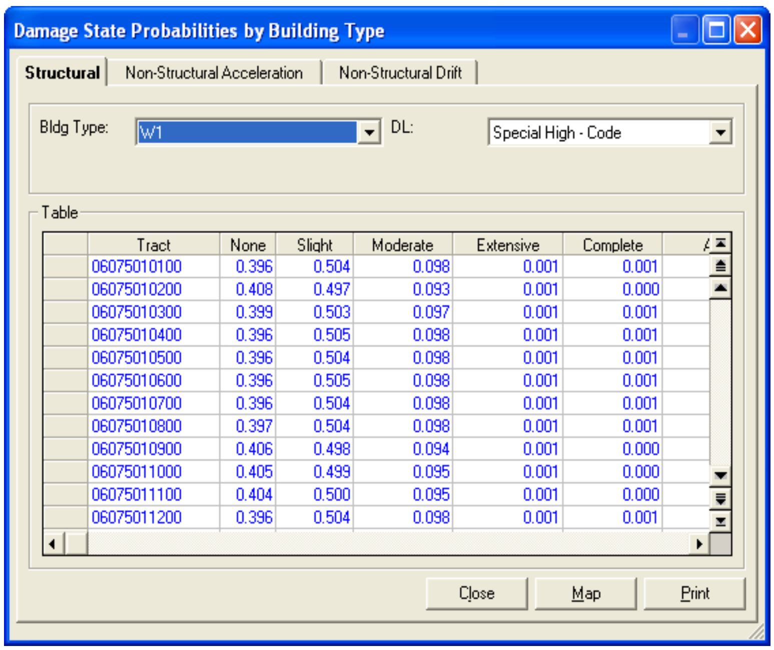
Table 10.3 Direct Physical Damage Outputs - General Building Stock

Input	Description of Output	Measure
Model Building Type	**Hazus** determines the damage state probability for each model building type (36) by census tract in the study region. Results are presented for each design level. Damage state probabilities are determined for i) structural elements, ii) non-structural drift-sensitive elements, and iii) non-structural acceleration-sensitive elements.	a) Structural Damage State Probabilities b) Non-structural Damage State Probabilities c) Structural Damage State Building Counts
General Building Type	**Hazus** determines the damage state probability for each general building type (7) by census tract in the study region. Results are presented for each design level. Damage state probabilities are determined for i) structural elements, ii) non-structural drift-sensitive elements, and iii) non-structural acceleration-sensitive elements.	a) Structural Damage State Probabilities b) Non-structural Damage State Probabilities c) Structural Damage State Building Counts
Specific Occupancy Class	**Hazus** determines the damage state probability for each specific occupancy (28) by census tract in the study region. Results are presented for each design level. Damage state probabilities are determined for i) structural elements, ii) non-structural drift-sensitive elements, and iii) non-structural acceleration-sensitive elements.	a) Structural Damage State Probabilities b) Non-structural Damage State Probabilities c) Structural Damage State Occupancy Counts
General Occupancy Class	**Hazus** determines the damage state probability for each general occupancy (6) by census tract in the study region. Damage state probabilities are determined for I) structural elements, ii) non-structural drift-sensitive elements, and iii) non-structural acceleration-sensitive elements.	a) Structural Damage State Probabilities b) Non-structural Damage State Probabilities c) Structural Damage State Occupancy Counts

The **Results|General Building Stock** menu option is used to assess the output of the damage module. Results are provided in a tabular format (see Figures 10.7 and 10.8) or in a map form (Figures 10.9 and 10.10). In both cases the following information can be displayed:

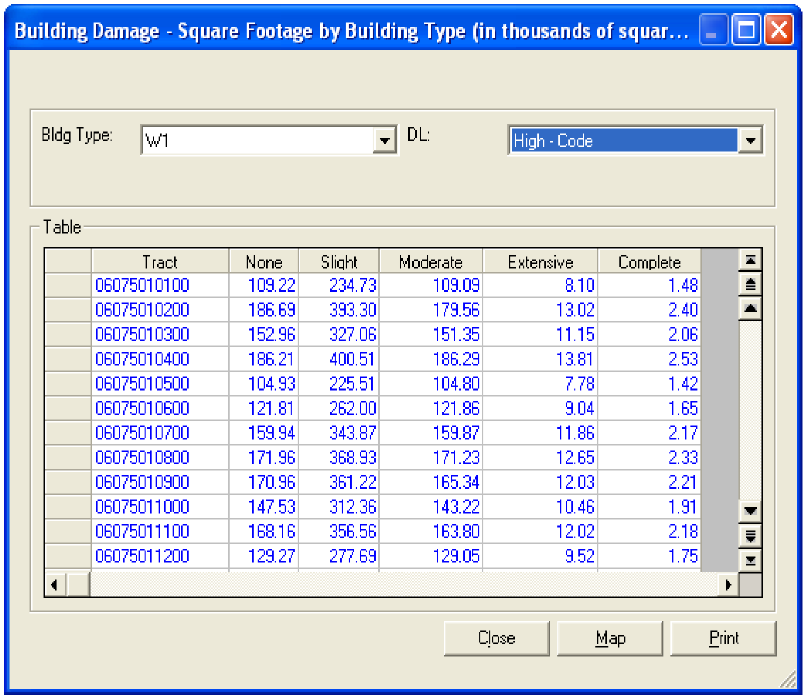
- Probability of none, slight, moderate, extensive or complete structural damage, acceleration sensitive non-structural damage or drift sensitive non-structural damage.
- Probability of at least slight, at least moderate, at least extensive for structural or either type of non-structural damage.

To thematically map a given value, select its column by clicking on the header, and then clicking **Map** and close the dialog.



Tract	None	Slight	Moderate	Extensive	Complete
06075010100	0.396	0.504	0.098	0.001	0.001
06075010200	0.408	0.497	0.093	0.001	0.000
06075010300	0.399	0.503	0.097	0.001	0.001
06075010400	0.396	0.505	0.098	0.001	0.001
06075010500	0.396	0.504	0.098	0.001	0.001
06075010600	0.396	0.505	0.098	0.001	0.001
06075010700	0.396	0.504	0.098	0.001	0.001
06075010800	0.397	0.504	0.098	0.001	0.001
06075010900	0.406	0.498	0.094	0.001	0.000
06075011000	0.405	0.499	0.095	0.001	0.000
06075011100	0.404	0.500	0.095	0.001	0.000
06075011200	0.396	0.504	0.098	0.001	0.001

Figure 10.7 Damage state probabilities by specific building type.



Tract	None	Slight	Moderate	Extensive	Complete
06075010100	109.22	234.73	109.09	8.10	1.48
06075010200	186.69	393.30	179.56	13.02	2.40
06075010300	152.96	327.06	151.35	11.15	2.06
06075010400	186.21	400.51	186.29	13.81	2.53
06075010500	104.93	225.51	104.80	7.78	1.42
06075010600	121.81	262.00	121.86	9.04	1.65
06075010700	159.94	343.87	159.87	11.86	2.17
06075010800	171.96	368.93	171.23	12.65	2.33
06075010900	170.96	361.22	165.34	12.03	2.21
06075011000	147.53	312.36	143.22	10.46	1.91
06075011100	168.16	356.56	163.80	12.02	2.18
06075011200	129.27	277.69	129.05	9.52	1.75

Figure 10.8 Damage state by square footage by building type.

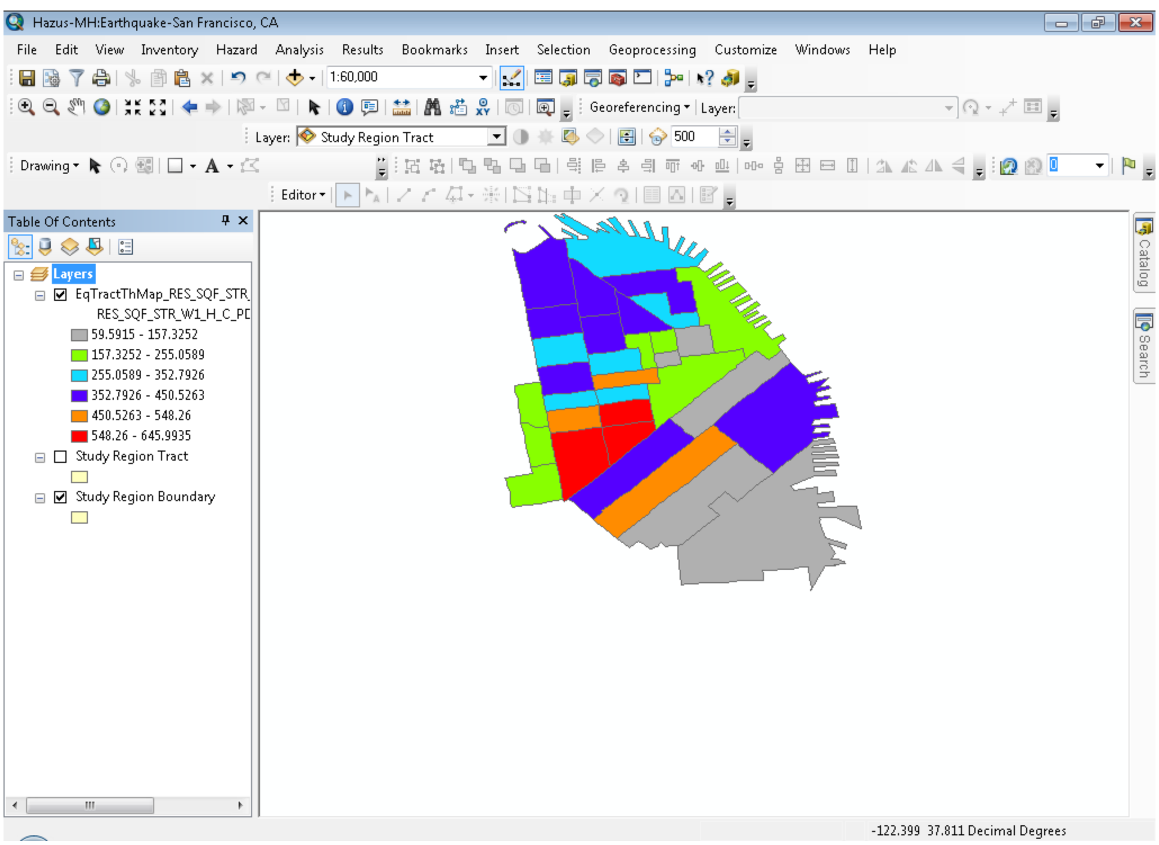


Figure 10.9 Map of probability of slight structural damage.

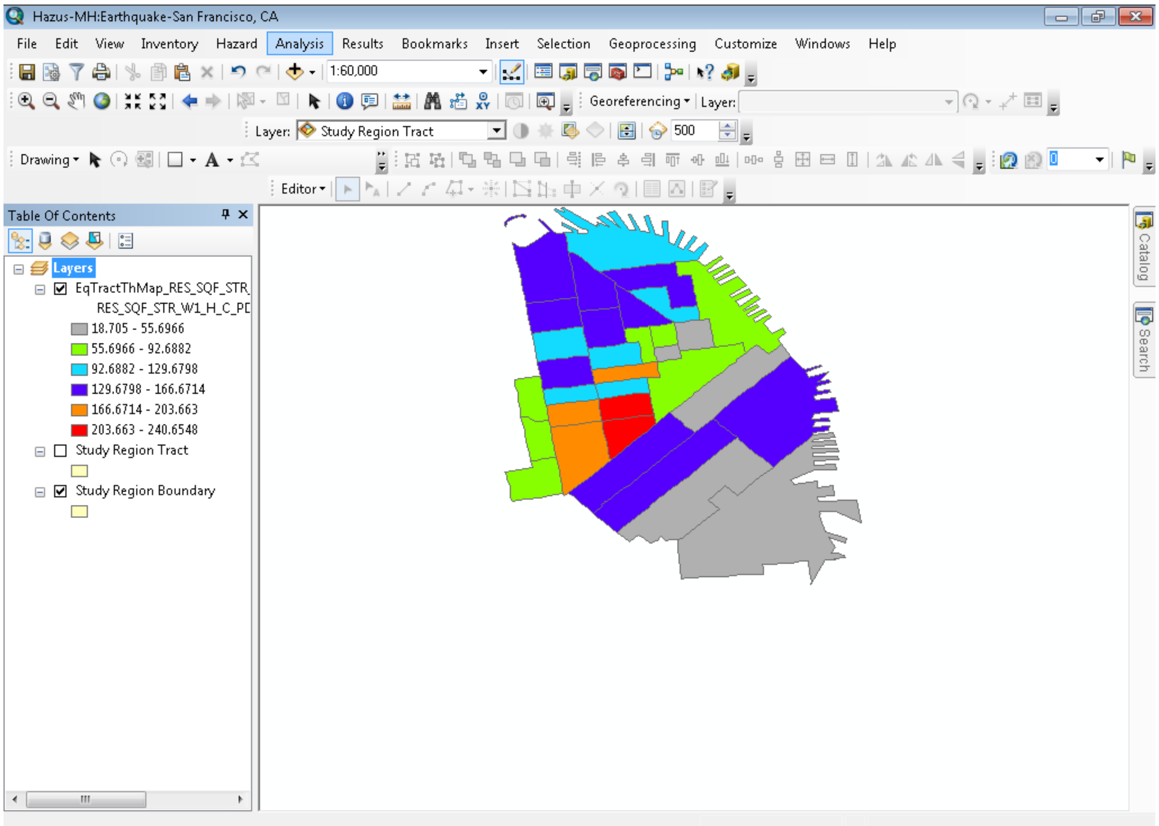


Figure 10.10 Map of moderate structural damage.

10.5 Direct Physical Damage - Essential Facilities

Hazus provides information about the damage state probability of the study region's essential facilities. In contrast to the general building stock, where damage probabilities are calculated for groups of buildings, for essential facilities the damage probabilities are estimated for each individual facility. As with the general building stock, the damage states are none, slight, moderate, extensive and complete. Both structural and non-structural damage is considered. As can be seen in Table 10.4, damage state probabilities are estimated for health care facilities, police and fire stations, emergency operation centers and schools. In addition, loss of beds and facility functionality is computed as a function of time for health care facilities.

Output of the essential facilities damage module can be obtained by using the **Results|Essential Facilities** menu. As with the general building stock, results are provided in a tabular format or in a map form. An example of the functionality of health care facilities is found in Figure 10.11. To thematically map a given value, select its column by clicking on the header, and then clicking **Map**. Click on **Return|Return to Table** to go back to the dialog that displays tabular results.

Table 10.4 Direct Physical Damage Outputs - Essential Facilities

Facility Type	Description of Output	Measure
Health Care Facilities	**Hazus** determines the damage state probabilities for each health care facility in the study region. Damage state probabilities are determined for i) structural elements, ii) non-structural drift-sensitive elements, and iii) non-structural acceleration-sensitive elements. The expected reduction in available beds for each facility is also determined.	a) Structural Damage State Probabilities b) Non-structural Damage State Probabilities c) Loss of Beds and Facility Functionality
Police/Fire Stations Emergency Operations Centers Schools	**Hazus** determines the damage state probabilities for each facility in the study region. Damage state probabilities are determined for i) structural elements, ii) non-structural drift-sensitive elements, and iii) non-structural acceleration-sensitive elements.	a) Structural Damage State Probabilities b) Non-structural Damage State Probabilities c) Functionality at Day 1

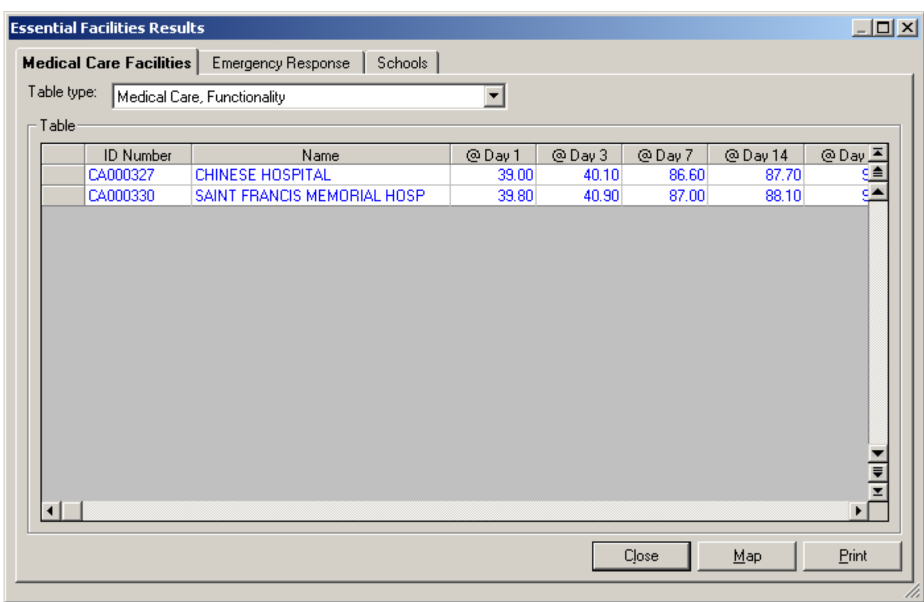


Figure 10.11 Functionality of health care facilities.

10.6 High Potential Loss Facilities

High potential loss facilities tend to be unique and complex facilities that would require in-depth evaluation by structural and geotechnical engineers to assess their vulnerability to earthquakes. These types of facilities are often designed to codes and standards that exceed those for general building stock. Thus, the vulnerability curves that are used for general building stock may be inappropriate for high potential loss facilities. It is likely that the user/engineer will need to define vulnerability curves that are specific to these facilities. Furthermore, often the owners of these facilities have already performed in-depth, site-specific seismic hazard analyses.

For these reasons, **Hazus** is limited to providing information concerning the location of the study region's high potential loss facilities (see Table 10.5). This can serve as a first step in developing mitigation and preparedness efforts. You may opt to perform a vulnerability analysis of a specific facility, and include the results of the special study with the results of the methodology. Locations of the high potential loss facilities and details about them are found in the **Inventory|High Potential Loss Facilities** menu. Results for military facilities are obtained through the **Results|Military Installations** menu.

Table 10.5 Direct physical damage outputs - high potential loss facilities

Component	Description of Output	Measure
Dams	**Hazus** provides the locations of dams in the study region.	List of and locations of dams
Nuclear Facilities	**Hazus** provides the locations of nuclear power facilities in the study region.	List of and locations of nuclear power facilities
Military facilities	**Hazus** determines the damage state probabilities for each facility in the study region. Damage state probabilities are determined for i) structural elements, ii) non-structural drift-sensitive elements, and iii) non-structural acceleration-sensitive elements.	a) Structural Damage State Probabilities b) Non-structural Damage State Probabilities

10.7 Direct Physical Damage - Lifelines

Lifeline systems are vital to the functionality of a community. Damage to these systems after an earthquake can be devastating in terms of the health and safety of the citizens. After the Great Hanshin earthquake in 1995, the water supply system was so severely damaged that people had to rely on trucked-in water. Damage to railway and road systems prevented emergency response personnel from bringing food, water and other supplies into the region. Over 900,000 households were without electricity and 800,000 households without gas in the middle of winter. Damage to roads and blockages of roads due to collapsed buildings prevented police, fire fighters and rescuers from fighting fires and attending to the trapped and injured.

Losses to the community that result from damage to lifelines can be much greater than the costs of repairing the systems. For example, damage to the Kobe harbor, one of the busiest in Japan, stopped the import and export of materials that were essential to the operation of many manufacturing plants in Japan. Factories were forced to close down for lack of materials. Recovery of the region will depend to a great degree on how quickly lifelines can be restored to full functionality. Therefore, assessment of the vulnerability of lifeline systems is a very important part of developing regional emergency preparedness and response plans.

In **Hazus**, damage to lifeline systems is described in terms of damage to components. Detailed systems analyses are not performed, although simplified system analyses are performed for water systems and electric power. Damage is reported in terms of the probability of reaching or exceeding a specified level of damage when subjected to a given level of ground motion or permanent ground deformation. Associated with each damage state is a restoration curve that is used to evaluate the time required to bring the system back to full functionality.

A probability of functionality is defined as the probability, given an initial level of damage after the earthquake, of the component operating at a certain capacity after a specified period of time. For example, a highway bridge might be found to have the following probabilities of damage, based upon experiencing 0.6g peak ground acceleration and 12 inches of permanent ground deformation.

No damage	3% chance
Slight damage	9% chance
Moderate damage	20% chance
Extensive damage	44% chance
Complete damage	24% chance

Based upon this estimate of damage, the expected functionality of the bridge would be:

14% functional after one day,

26% functional after 3-days,

34% functional after 7 days,

39% functional after 30 days, and

60% functional after a 3-month restoration period.

Another interpretation of these results is that after one day, 14% of the bridges of this type would be functional and after 3 months, 60% of these bridges would be functional. Interdependency of the components on overall transportation system functionality is not addressed by the methodology. Lifelines are divided into transportation systems and utility systems. Table 10.6 summarizes the outputs for each of the seven transportation lifeline systems.

Table 10.6 Direct Physical Damage Outputs - Transportation Systems

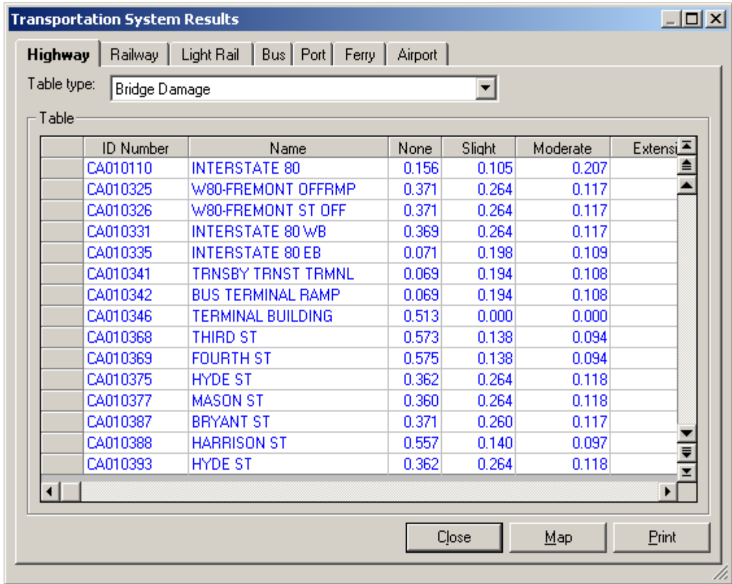
System	Description of Output	Measure
Highway System Railway System Light Rail Bus Ferry Port Airport	a) **Hazus** determines the damage state probability for each transportation system component in the study region. b) **Hazus** determines the probability of functionality for each transportation system component at discrete time intervals.	a) System Damage State Probabilities b) Probability of System Functionality

Table 10.7 summarizes the outputs of **Hazus** for the study region's utility system components. A simplified system analysis is performed for potable water systems and electric power systems. These analyses make simplified assumptions about the serviceability of the systems based on the number of pipe leaks and breaks, or the functionality of medium voltage substations.

Table 10.7 Direct Physical Damage Outputs - Utility Systems

System	Description of Output	Measure
Potable Water	a) **Hazus** determines the damage state probabilities for each potable water component in the study region. b) **Hazus** determines the probability of functionality for each potable water component at discrete time intervals. c) **Hazus** supports simplified potable water system analysis for the study region.	a) System Damage State Probabilities b) System Probability of Functionality c) # of Households without water
Waste Water Natural Gas Oil Pipeline: Crude and Refined Communication	a) **Hazus** determines the damage state probabilities for each system component in the study region. b) **Hazus** determines the probability of functionality for each system component at discrete time intervals.	a) System Damage State Probabilities b) System Probability of Functionality
Electric Power	a) **Hazus** determines the damage state probabilities for each electric power component in the study region. b) **Hazus** determines the probability of functionality for each electric power component at discrete time intervals. c) **Hazus** supports simplified system analysis for the study region.	a) System Damage State Probabilities b) System Probability of Functionality c) # of Households without power

Lifeline damage can be viewed in terms of damage states (condition) or functionality, and can be displayed in a tabular or map format. Figure 10.12 shows a table of the damage to highway bridges for the study region. For each of the bridges in the study region (identified by ID number), the probability of being in one of the five damage states is tabulated. For highway bridge id ca010110, the probability of no damage is 0.068 (almost 7%), slight damage is 0.064, and moderate damage is 0.157. This information can be mapped, as shown in Figure 10.13, by clicking on the **Map** button. Each airport facility is identified by a symbol. The shape (or color) of the symbol is associated with a range of probabilities. Users familiar with ArcGIS, have the option of zooming in on any area and viewing that area more closely as shown in Figure 10.14.



ID Number	Name	None	Slight	Moderate	Extensi
CA010110	INTERSTATE 80	0.156	0.105	0.207	
CA010325	W80-FREMONT OFFRMP	0.371	0.264	0.117	
CA010326	W80-FREMONT ST OFF	0.371	0.264	0.117	
CA010331	INTERSTATE 80 WB	0.369	0.264	0.117	
CA010335	INTERSTATE 80 EB	0.071	0.198	0.109	
CA010341	TRNSBY TRNST TRMNL	0.069	0.194	0.108	
CA010342	BUS TERMINAL RAMP	0.069	0.194	0.108	
CA010346	TERMINAL BUILDING	0.513	0.000	0.000	
CA010368	THIRD ST	0.573	0.138	0.094	
CA010369	FOURTH ST	0.575	0.138	0.094	
CA010375	HYDE ST	0.362	0.264	0.118	
CA010377	MASON ST	0.360	0.264	0.118	
CA010387	BRYANT ST	0.371	0.260	0.117	
CA010388	HARRISON ST	0.557	0.140	0.097	
CA010393	HYDE ST	0.362	0.264	0.118	

Figure 10.12 Lifeline outputs: damage to highway bridges.

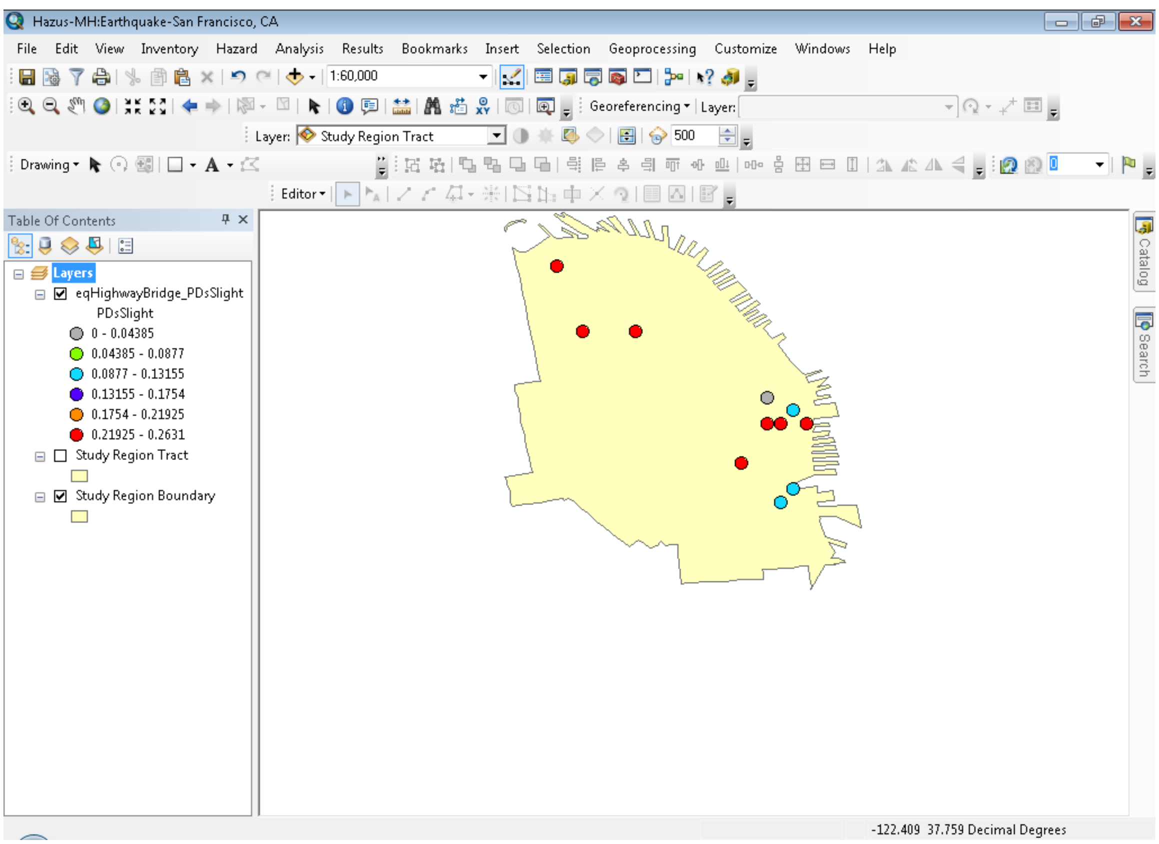


Figure 10.13 Lifeline outputs: map of probability of slight damage to highway bridges for entire study region.

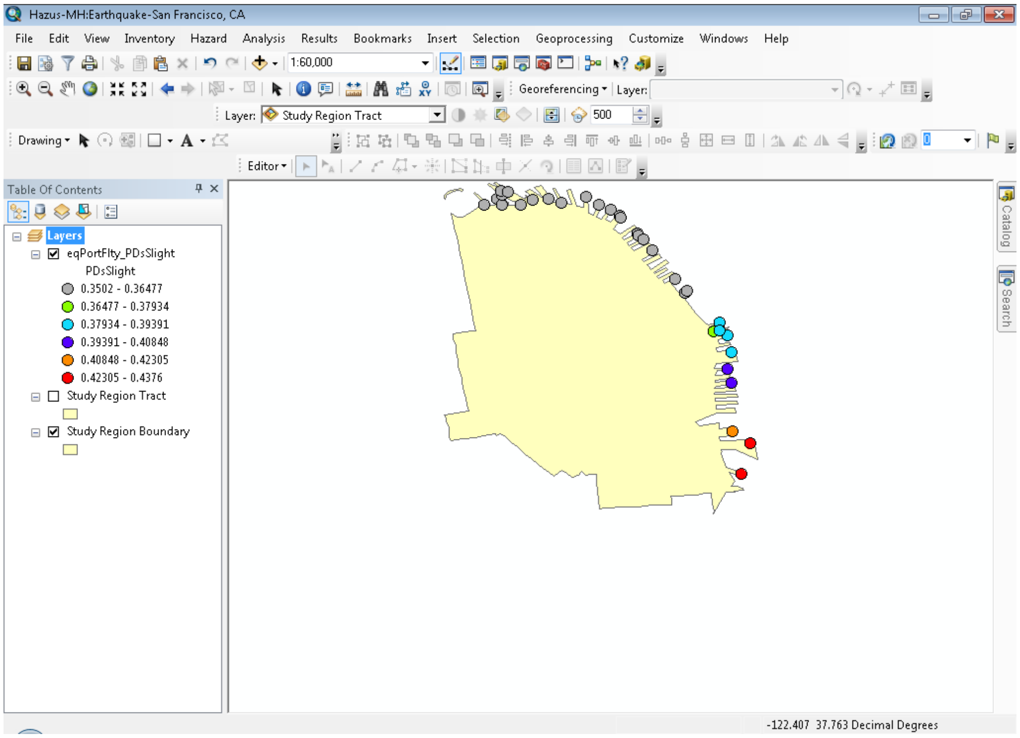


Figure 10.14 Map of probability of slight damage to port facilities for a portion of the study region.

Figure 10.15 shows a table of the functionality of highway bridges at specified periods after the occurrence of the scenario earthquake. According to this table, facility the first bridge would be functional with a 17% probability immediately after the earthquake and functional with a 30% probability after 14 days. Functionality can be mapped by clicking on the **<u>M</u>ap** button. Facilities are mapped as "operational" or "non-operational". The user must specify a "confidence level" above which the facility is considered operational. In Figure 10.16 the "confidence level" is chosen to be 75%, indicating that if the probability of functionality is greater than 75%, the facility will be considered operational. Based on this definition of operational, many of the airport terminals near the epicenter will be non-operational the day after the earthquake.

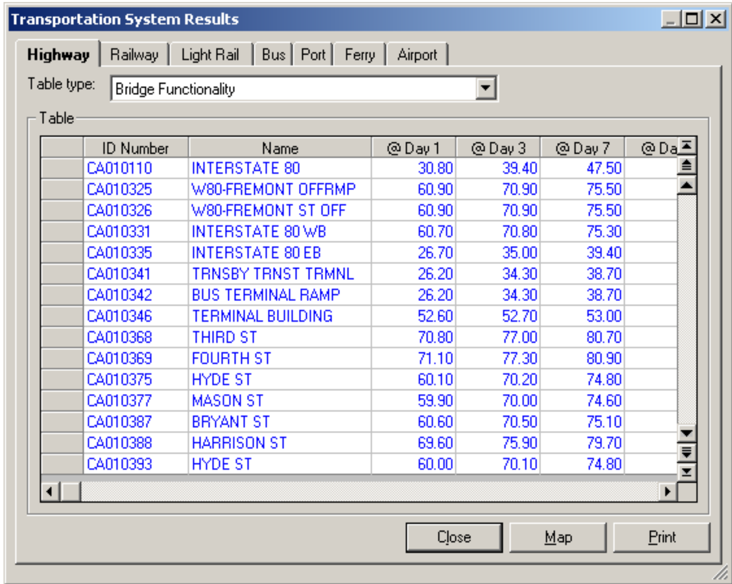


Figure 10.15 Lifeline outputs: functionality of highway bridges reported by number of days since the occurrence of the earthquake.

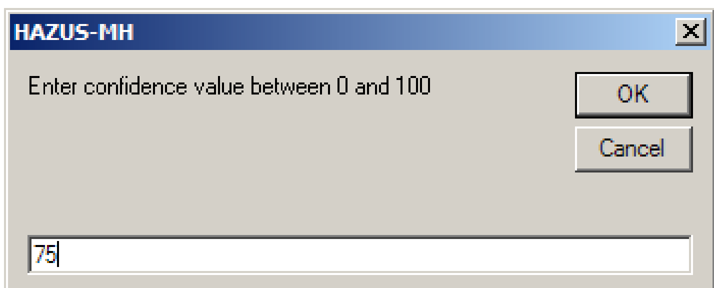


Figure 10.16 Functionality confidence level.

10.8 Induced Physical Damage - Inundation

Hazus includes earthquake-related flooding information helpful in design of programs to reduce the likelihood of dam or levee failure; and to prepare for those floods that may occur. Development of inundation maps requires an understanding of the downstream topography and requires the involvement of an experienced hydrologist. In the case of tsunamis, inundation models are complex, and are in many cases still in the development stage; therefore, **Hazus** does not produce inundation maps.

Instead, as a first step in assessing the risk to a study region, all dams and levees are identified. The existing national inventory of dams that is provided with the software includes a hazard classification (low, significant, high) based on the downstream urban development and potential economic loss. The potential for tsunamis and seiches must be assessed by the user outside of **Hazus** without any estimate of size or consequence. Table 10.8 summarizes the outputs that are available from **Hazus**.

Table 10.8 Induced Physical Damage Outputs - Inundation

Component	Description of Output	Measure
Tsunami	a) The methodology provides rules to determine if tsunamis are a threat to the study region. b) The user can import existing tsunami inundation maps and overlay with population and economic value maps.	a) Qualify Potential Threat b) Exposed Population Exposed Value ($1,000)
Seiche	a) The methodology provides rules to determine if seiches are a threat on any body of water in the study region. b) The user can import existing seiche inundation maps and overlay with population and economic value maps.	a) Qualify Potential Threat b) Exposed Population Exposed Value ($)
Dam Failure	a) **Hazus** displays the location of all dams in the study region and (for the default database) ranks the potential impact of the dam failure. b) The user can import existing dam failure inundation maps and overlay with population and economic value maps.	a) List and Locations of Dams and Quantification of Potential Hazard b) Exposed Population Exposed Value ($)
Levee Failure	a) **Hazus** displays the location of the levees in the study region. b) The user can import existing levee failure inundation maps and overlay with population and economic value maps.	a) List and Locations of Levees b) Exposed Population Exposed Value ($)

For all four types of inundation, **Hazus** has the ability to import existing inundation maps. These can then be overlaid with population density maps or maps of inventory to estimate exposed population and exposed inventory. The output of the inundation module is a display of the inundation maps that were specified in the data maps dialog as shown in Figure 10.17.

Alternatively, you can view a table of population, value and area exposure by census tract using the **Results|Inundation** menu (see Figure 10.18). This output is only available if an inundation map has been specified. Highlighting the appropriate column and clicking on the Map button can map any one of the outputs.

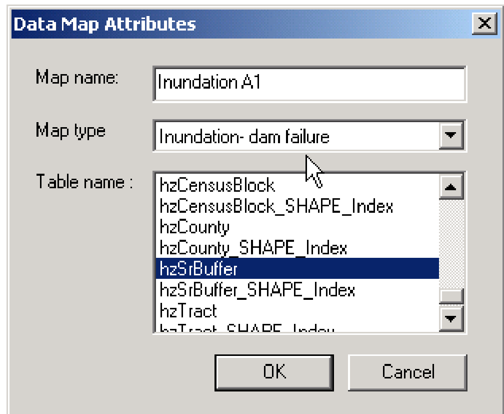


Figure 10.17 Specifying inundation maps.

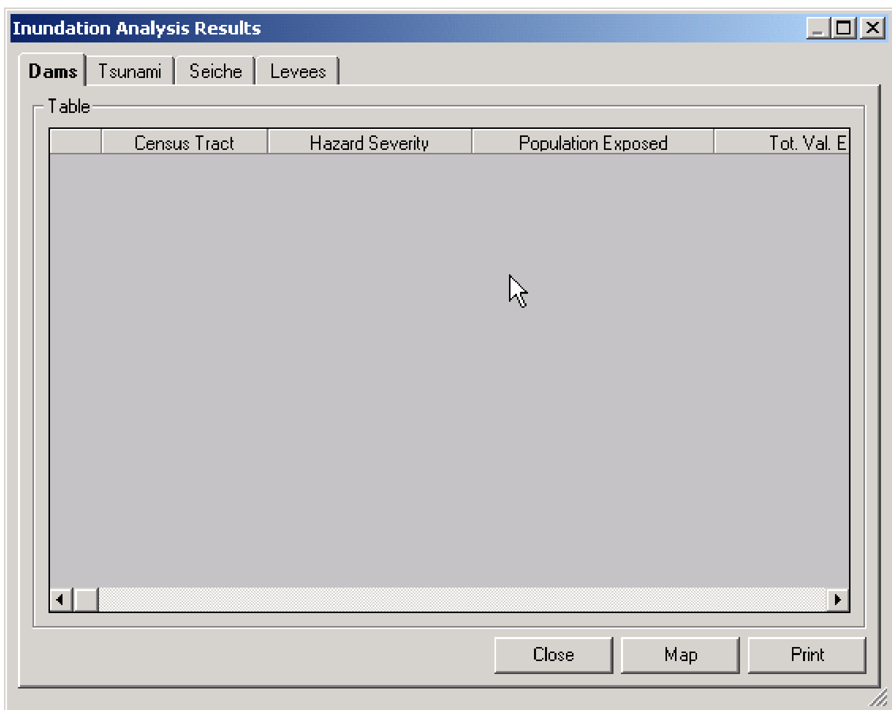


Figure 10.18 Tabulation of exposed population, value and area resulting from inundation map.

10.9 Induced Physical Damage – Hazardous Material Release

Assessment of the consequences of a hazardous materials release requires an understanding of the amounts and types of materials that are released as well as, in some cases, a model of a gaseous plume. A single facility may house many toxic and hazardous materials. Without visiting a facility, assessing the vulnerability of the structure and auditing how materials are stored, it is impossible to give a meaningful estimate of risk. Therefore **Hazus** does not perform any analysis on hazardous.

Locations of hazardous materials facilities can be mapped and overlaid with ground motion, population and inventory maps. This can provide a preliminary assessment of consequences, which can then be followed up with detailed site-specific studies. In addition, the hazardous facility database can be sorted in a variety of ways allowing the user to view only certain types of materials, facilities with large amounts, highly vulnerable facilities, etc. Table 10.9 summarizes the information available on hazardous materials.

Table 10.9 Induced Physical Damage - Hazardous Material Release

Component	Description	Measure
Hazardous Materials Facilities	a) **Hazus** provides the location of the hazardous material facilities located in the study region. b) **Hazus** provides the types and amounts of hazardous materials stored at each location and the health hazard associated with each chemical. c) The user can overlay a map of hazardous material facilities with ground shaking, population, and economic value maps to interrogate the consequences of release at a particular site.	a) List of and Locations of Facilities Containing Hazardous Materials b) Type/Amount of Material Stored at Each Facility

The inventory is the available information on hazardous materials. It can be accessed using the **Inventory|Hazardous Materials** menu. From the Hazardous Material database you can get a listing of the materials and plot site locations as shown in Figures 10.19 and 10.20. Clicking the **Map** button at the bottom of Figure 10.19 generated the output shown in Figure 10.20. The information in the small box at the left-hand side of Figure 10.20 was retrieved using the information tool (**i**) from the ArcMap button toolbar. By using the information tool and clicking on any one of the sites, you can access all of the stored data for that site.

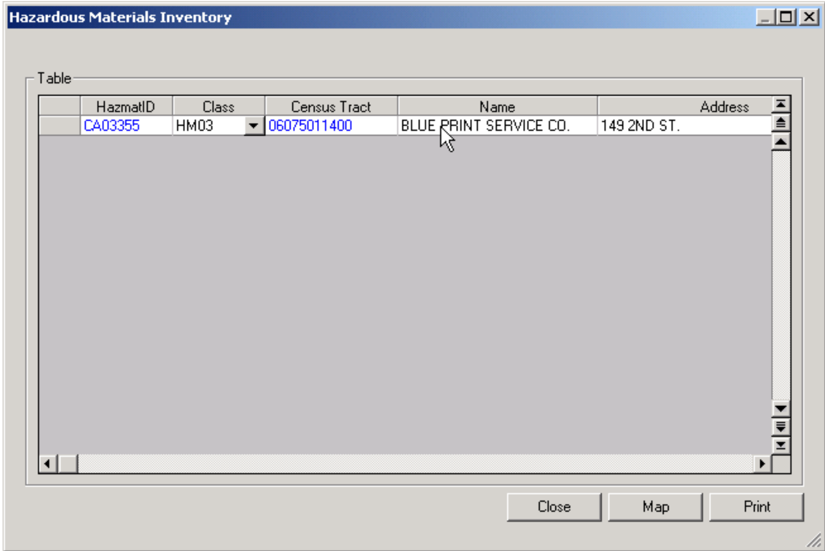


Figure 10.19 Default hazardous material database.

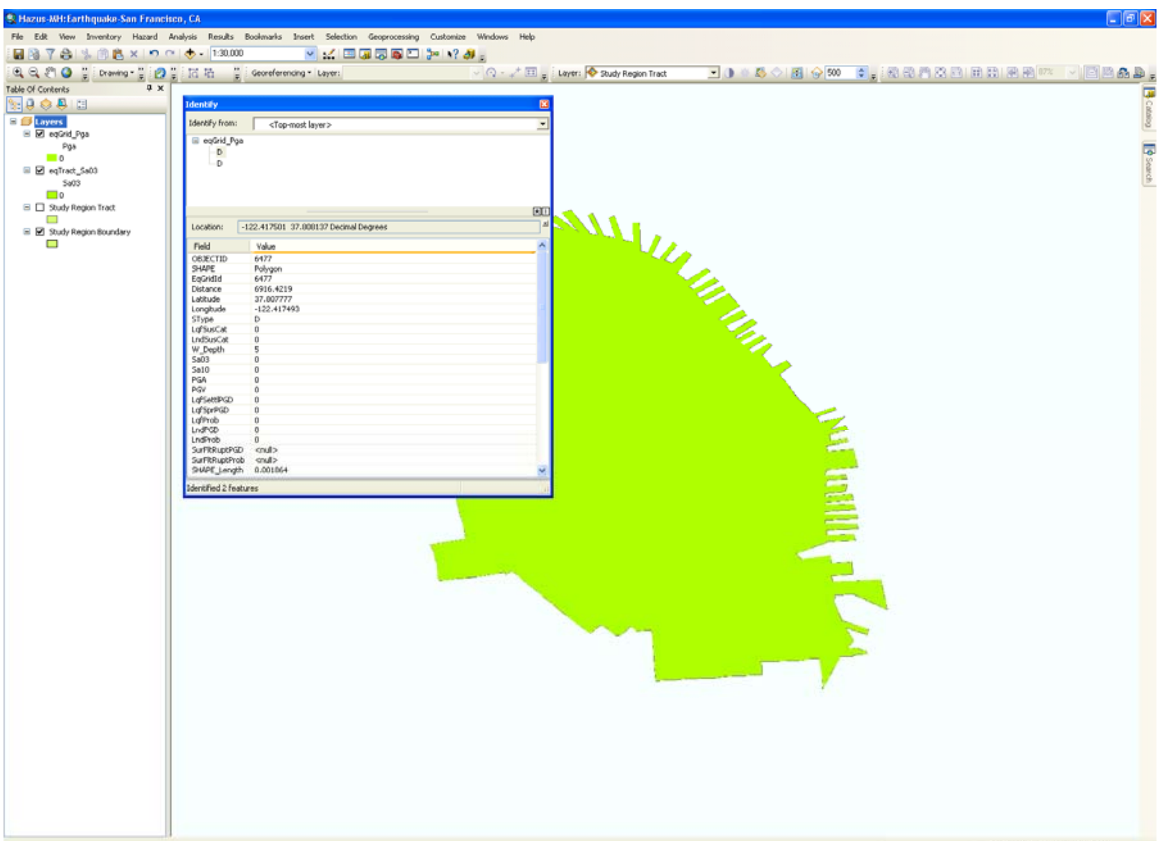


Figure 10.20 Map of default hazardous materials database

10.10 Induced Physical Damage – Fire Following Earthquake

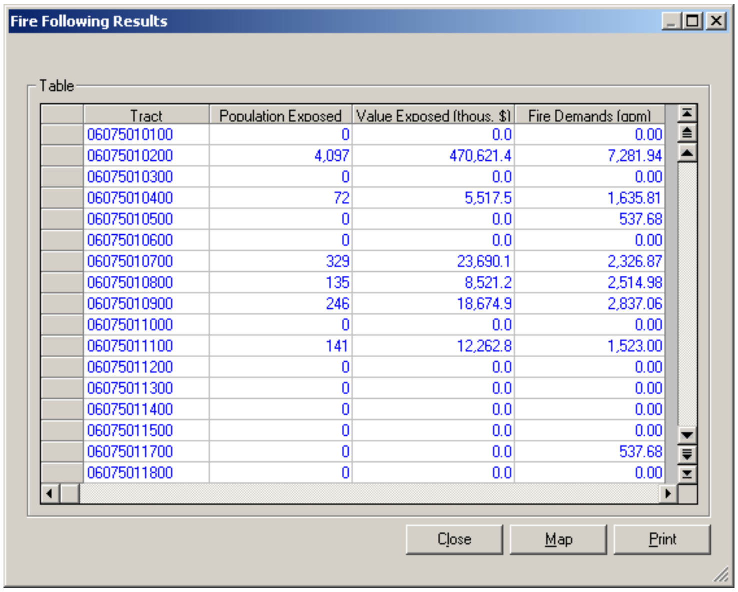
A complete Fire Following Earthquake Model requires extensive input including the types and density of fuel, the number of fire fighting apparatus, the functionality of the water system, the occurrence of hazardous materials releases, wind conditions, and others. To simplify the input, **Hazus** limits the analysis to an estimate of the number of ignitions, an estimate of the size of the potential burned area, and estimates of exposed population and exposed inventory.

Table 10.10 Induced Physical Damage Module Outputs - Fire Following Earthquake

Component	Description of Output	Measure
Ignition	a) **Hazus** determines the expected number of fire ignitions by census tract for the study region.	a) Number of ignitions
Burned Area	a) **Hazus** determines the expected burned area by census tract for the study region. b) Expected burned area is combined with population and economic value to estimate exposed population and inventory.	a) Percentage of Burned Area b) Exposed Population Exposed Value ($)

The outputs from Fire Following Earthquake Model are presented in **Hazus** in a table as shown in Figure 10.21. For each census tract in the study region, the following values are displayed:

- Best estimates of the percent of the census tract that has been burned
- Standard deviation of the estimate of percent of burned area
- Number of ignitions in the census tract
- The population in the census tract that is exposed to fire (% burned area X total population in census tract)
- The value of inventory (in dollars) in the census tract fire exposed to fire (% burned area X total building value in census tract)



Tract	Population Exposed	Value Exposed (thous. $)	Fire Demands (gpm)
06075010100	0	0.0	0.00
06075010200	4,097	470,621.4	7,281.94
06075010300	0	0.0	0.00
06075010400	72	5,517.5	1,635.81
06075010500	0	0.0	537.68
06075010600	0	0.0	0.00
06075010700	329	23,690.1	2,326.87
06075010800	135	8,521.2	2,514.98
06075010900	246	18,674.9	2,837.06
06075011000	0	0.0	0.00
06075011100	141	12,262.8	1,523.00
06075011200	0	0.0	0.00
06075011300	0	0.0	0.00
06075011400	0	0.0	0.00
06075011500	0	0.0	0.00
06075011700	0	0.0	537.68
06075011800	0	0.0	0.00

Figure 10.21 Output of fire following earthquake module.

Highlighting the column and then clicking on the Map button will map any of the columns in Figure 10.21. The "Fire Demand (gpm)" column has been mapped in Figure 10.22. A summary report of the output of the Fire Following Earthquake Model can also be printed to the screen or to a printer.

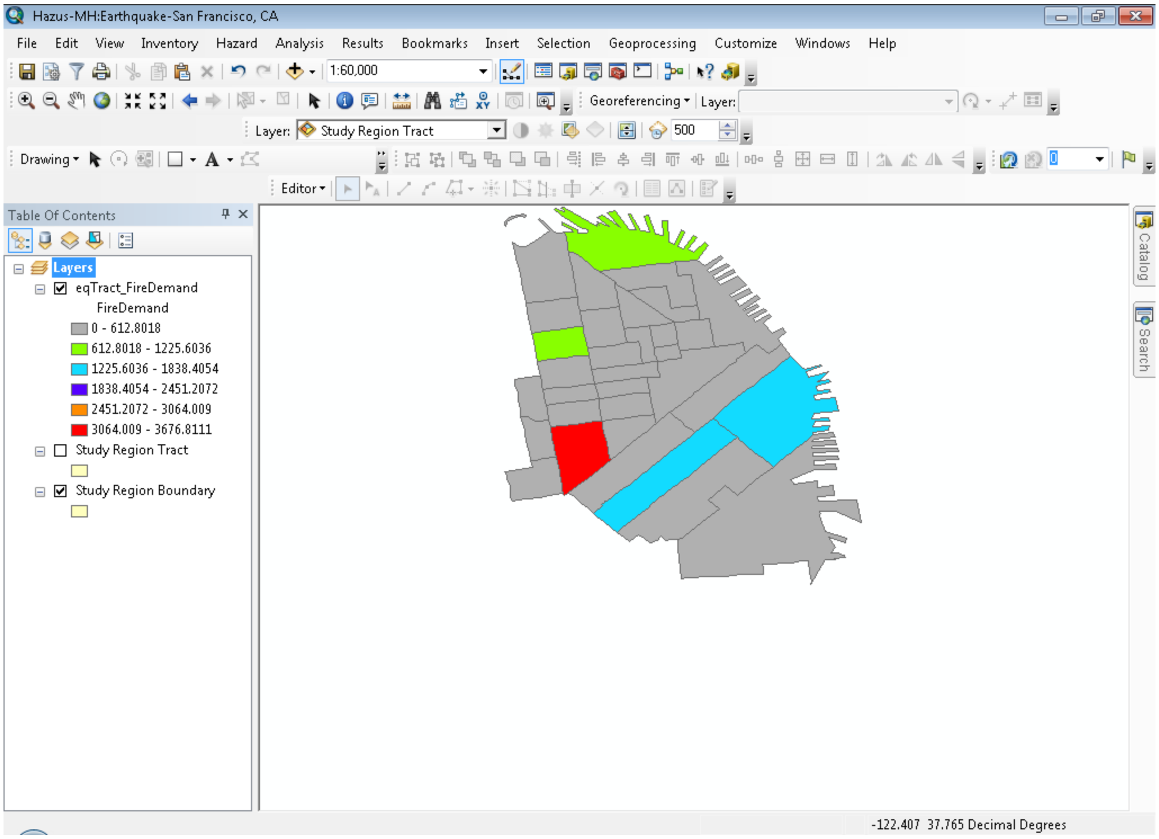


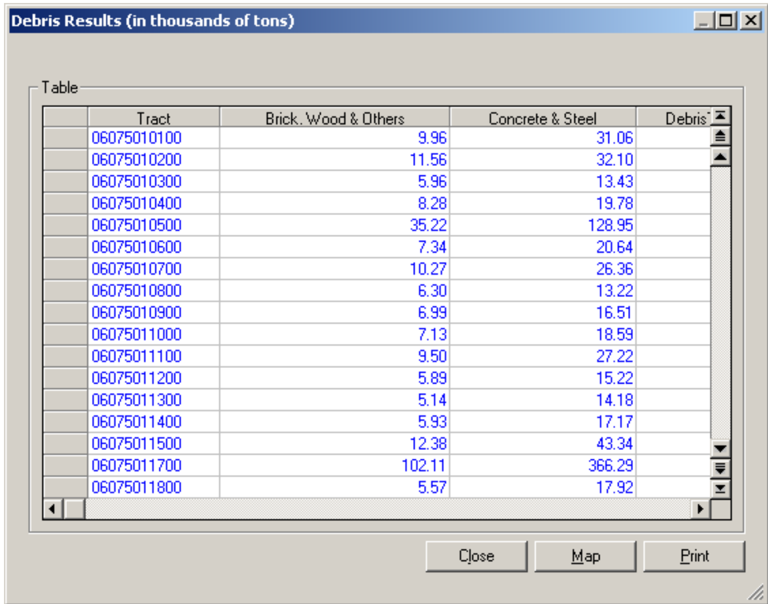
Figure 10.22 Map of fire demand for each census tract.

Hazus provides information about the debris generated during the seismic event to enable users to prepare and to rapidly and efficiently manage debris removal and disposal. As shown in Table 10.11, two types of debris are identified: (1) reinforced concrete and steel that requires special equipment to break it up before it can be transported, and (2) brick, wood and other debris that can be loaded directly onto trucks with bulldozers. For each census tract, **Hazus** determines the amount of debris of each type that is generated.

Table 10.11 Induced Physical Damage Module Outputs - Debris

Component	Description of Output	Measure
Brick, Wood & Others	a) **Hazus** determines the expected amount of brick, wood, and other debris generated in each census tract of the study region.	a) Weight of Debris Generated
Reinforced Concrete & Steel	a) **Hazus** determines the expected amount of reinforced concrete and steel debris generated in each census tract of the study region.	a) Weight of Debris Generated

In **Hazus,** debris results will appear as a table, as shown in Figure 10.23, that can be printed to the screen or the printer. In addition, you will be able to map by census tract the weight of generated debris using the **Map** button, as shown in Figure 10.24.



Tract	Brick, Wood & Others	Concrete & Steel	Debris
06075010100	9.96	31.06	
06075010200	11.56	32.10	
06075010300	5.96	13.43	
06075010400	8.28	19.78	
06075010500	35.22	128.95	
06075010600	7.34	20.64	
06075010700	10.27	26.36	
06075010800	6.30	13.22	
06075010900	6.99	16.51	
06075011000	7.13	18.59	
06075011100	9.50	27.22	
06075011200	5.89	15.22	
06075011300	5.14	14.18	
06075011400	5.93	17.17	
06075011500	12.38	43.34	
06075011700	102.11	366.29	
06075011800	5.57	17.92	

Figure 10.23 Output of the debris module in thousands of tons per census tract.

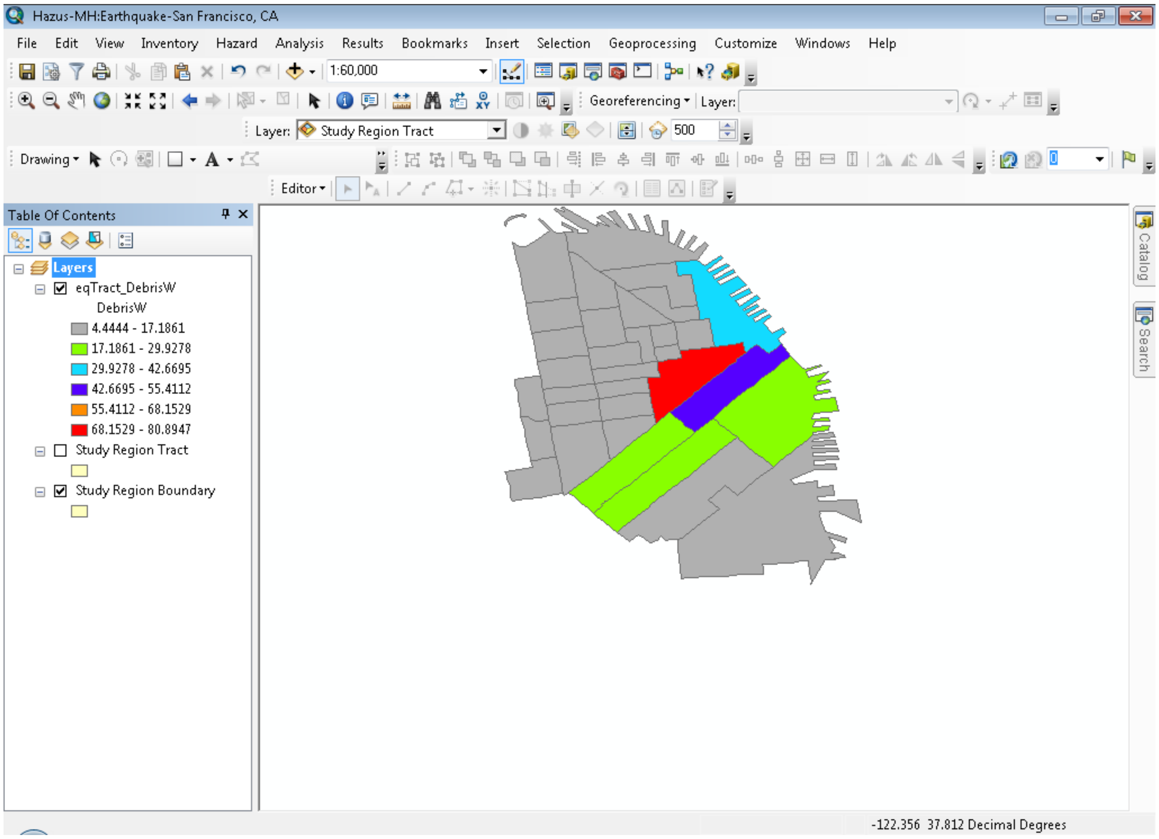


Figure 10.24 Weight of generated wood debris by census tract.

10.11 Direct Economic and Social Losses

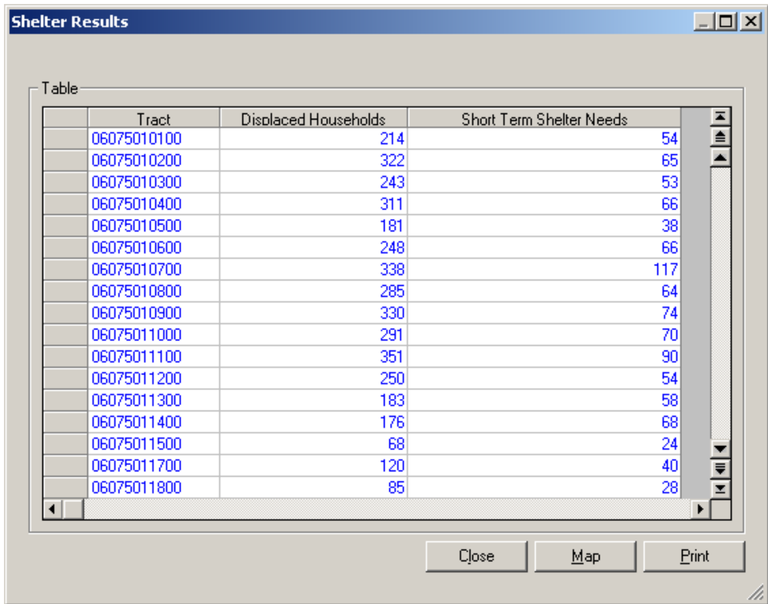
Hazus provides information concerning the estimated number of displaced households and persons requiring temporary shelter to enable the design of programs to temporarily shelter victims.

Table 10.11 Direct Economic and Social Losses Module Outputs - Shelter

Component	Description of Output	Measure
Displaced Households	a) **Hazus** determines the expected number of displaced households by census tract in the study region.	a) Number of Displaced Households
Temporary Shelter	a) **Hazus** determines the expected number of people requiring temporary shelter by census tract in the study region.	a) Number of People Requiring Temporary Shelter

The total number of displaced households for each census tract of the study region is one output of the shelter module. The number of displaced households is used to estimate the short-term shelter needs. Short-term shelter needs are reported in the number of people needing public shelter. The results, as displayed in Figure 10.25, are retrieved using the

<u>R</u>esults|<u>S</u>helter menu. As with all results, these can be thematically mapped by highlighting a column and clicking on the **<u>M</u>ap** button.



Tract	Displaced Households	Short Term Shelter Needs
06075010100	214	54
06075010200	322	65
06075010300	243	53
06075010400	311	66
06075010500	181	38
06075010600	248	66
06075010700	338	117
06075010800	285	64
06075010900	330	74
06075011000	291	70
06075011100	351	90
06075011200	250	54
06075011300	183	58
06075011400	176	68
06075011500	68	24
06075011700	120	40
06075011800	85	28

Figure 10.25 Output of shelter module.

The output of the casualty module is summarized in Table 10.12.

Table 10.12 Direct Economic and Social Losses Module Outputs - Casualties

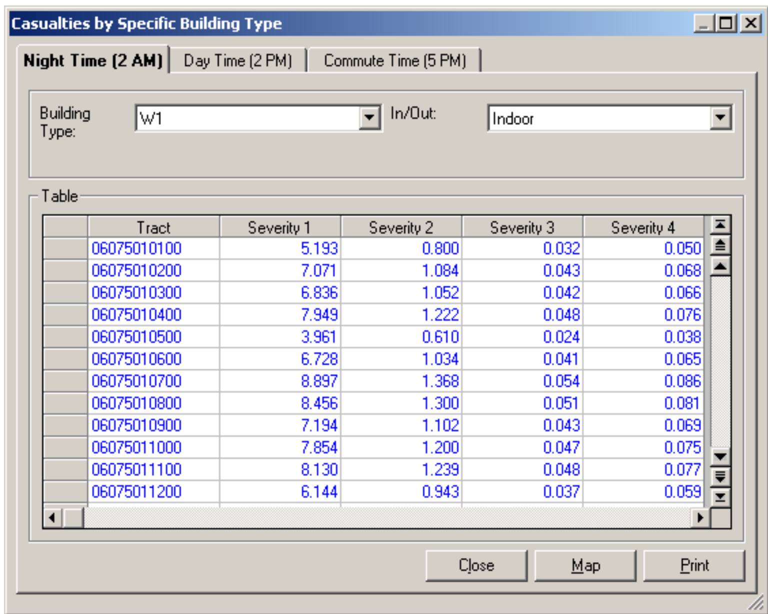
Component	Description of Output	Measure
Casualties	a) **Hazus** determines the expected number of casualties for each casualty severity (medical aid, hospital treatment, life-threatening, death) by census tract for the study region.	a) Number of casualties for each of the four severities

For each census tract, the following results (use **<u>R</u>esults|<u>C</u>asualties** menu) are provided at three times of day (2 AM, 2 PM and 5 PM) by occupancy type or by building type.

- Single family dwellings (RES1) casualties (severity 1, 2, 3 and 4)
- Residential (other than RES1) casualties (severity 1, 2, 3 and 4)
- Commercial casualties (severity 1, 2, 3 and 4)
- Industrial casualties (severity 1, 2, 3 and 4)
- Education casualties (severity 1, 2, 3 and 4)
- Hotel casualties (severity 1, 2, 3 and 4)

- Commuting casualties (severity 1, 2, 3 and 4)
- Total casualties (severity 1, 2, 3 and 4)

As with the other output, highlighting the desired column and clicking on the Map button will map the results.



Tract	Severity 1	Severity 2	Severity 3	Severity 4
06075010100	5.193	0.800	0.032	0.050
06075010200	7.071	1.084	0.043	0.068
06075010300	6.836	1.052	0.042	0.066
06075010400	7.949	1.222	0.048	0.076
06075010500	3.961	0.610	0.024	0.038
06075010600	6.728	1.034	0.041	0.065
06075010700	8.897	1.368	0.054	0.086
06075010800	8.456	1.300	0.051	0.081
06075010900	7.194	1.102	0.043	0.069
06075011000	7.854	1.200	0.047	0.075
06075011100	8.130	1.239	0.048	0.077
06075011200	6.144	0.943	0.037	0.059

Figure 10.26 Output of casualty module showing residential casualties at 2 PM.

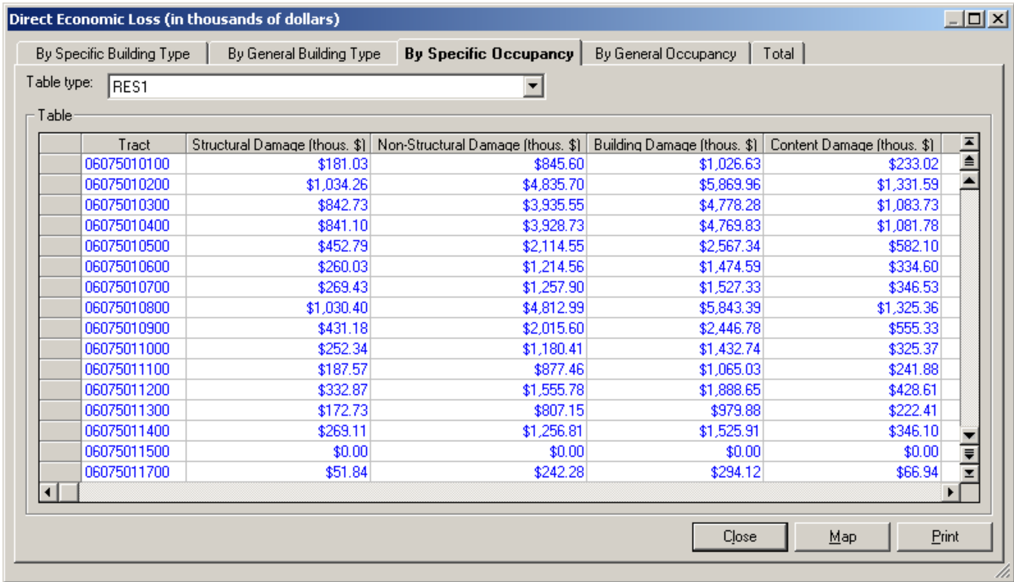
Hazus provides economic loss information to enable users to motivate policy-makers to consider cost-benefit implication of mitigation activities. All default data for direct economic loss estimates are provided in 1994 dollars. You will need to convert 1994 dollars to those that are valid when you run your study. Losses for lifelines are reported separately from losses for buildings.

Table 10.13 Direct Economic and Social Losses Module Outputs - Direct Economic Loss - Buildings

Component	Description of Output	Measure
Repair and Replacement Costs	Hazus determines the expected dollar loss due to the repair and replacement of the general building stock by census tract for the study region.	Dollar Loss
Contents Damage	Hazus determines the expected dollar loss due to contents damage by census tract for the study region.	Dollar Loss
Business Inventory Damage	Hazus determines the expected dollar loss due to business inventory damage by census tract for the study region.	Dollar Loss
Relocation Costs	Hazus determines the expected dollar loss due to business relocation by census tract for the study region.	Dollar Loss
Capital-related Income Loss	Hazus determines the expected business income loss by census tract for the study region.	Dollar Loss
Wage Loss	Hazus determines the expected wage loss by census tract for the study region.	Dollar Loss
Rental Loss	Hazus determines the expected dollar loss due to the repair and replacement of buildings by census tract for the study region.	Dollar Loss

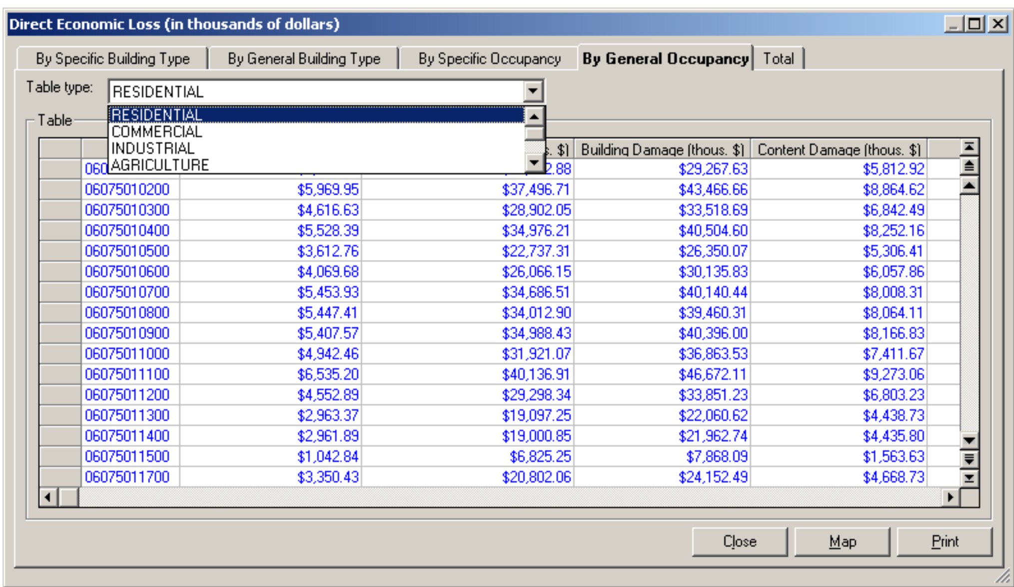
Building loss estimates can be viewed by clicking on the **Results|Buildings Economic Loss** menu. Building losses are summarized in terms of the seven General Occupancy classes (Residential, Commercial, Industrial, Agriculture, Religious, Government and Education), or in terms of the 33 Specific Occupancy Classes. As can be seen in Figure 10.27, the total direct economic losses for each census tract are reported. The total losses include structural and non-structural repair, contents loss, relocation costs, proprietor's income loss and rental loss.

Losses also can be reported by general occupancy. The types reported are structural and non-structural repair, total building costs (the sum of structural and non-structural), contents loss, relocation costs, proprietor's income loss and rental loss. These losses are reported by census tract for each of the seven general occupancy classes as shown in Figure 10.28.



Tract	Structural Damage (thous. $)	Non-Structural Damage (thous. $)	Building Damage (thous. $)	Content Damage (thous. $)
06075010100	$181.03	$845.60	$1,026.63	$233.02
06075010200	$1,034.26	$4,835.70	$5,869.96	$1,331.59
06075010300	$842.73	$3,935.55	$4,778.28	$1,083.73
06075010400	$841.10	$3,928.73	$4,769.83	$1,081.78
06075010500	$452.79	$2,114.55	$2,567.34	$582.10
06075010600	$260.03	$1,214.56	$1,474.59	$334.60
06075010700	$269.43	$1,257.90	$1,527.33	$346.53
06075010800	$1,030.40	$4,812.99	$5,843.39	$1,325.36
06075010900	$431.18	$2,015.60	$2,446.78	$555.33
06075011000	$252.34	$1,180.41	$1,432.74	$325.37
06075011100	$187.57	$877.46	$1,065.03	$241.88
06075011200	$332.87	$1,555.78	$1,888.65	$428.61
06075011300	$172.73	$807.15	$979.88	$222.41
06075011400	$269.11	$1,256.81	$1,525.91	$346.10
06075011500	$0.00	$0.00	$0.00	$0.00
06075011700	$51.84	$242.28	$294.12	$66.94

Figure 10.27 Total building losses reported by specific occupancy class



		. $)	Building Damage (thous. $)	Content Damage (thous. $)
060		2.88	$29,267.63	$5,812.92
06075010200	$5,969.95	$37,496.71	$43,466.66	$8,864.62
06075010300	$4,616.63	$28,902.05	$33,518.69	$6,842.49
06075010400	$5,528.39	$34,976.21	$40,504.60	$8,252.16
06075010500	$3,612.76	$22,737.31	$26,350.07	$5,306.41
06075010600	$4,069.68	$26,066.15	$30,135.83	$6,057.86
06075010700	$5,453.93	$34,686.51	$40,140.44	$8,008.31
06075010800	$5,447.41	$34,012.90	$39,460.31	$8,064.11
06075010900	$5,407.57	$34,988.43	$40,396.00	$8,166.83
06075011000	$4,942.46	$31,921.07	$36,863.53	$7,411.67
06075011100	$6,535.20	$40,136.91	$46,672.11	$9,273.06
06075011200	$4,552.89	$29,298.34	$33,851.23	$6,803.23
06075011300	$2,963.37	$19,097.25	$22,060.62	$4,438.73
06075011400	$2,961.89	$19,000.85	$21,962.74	$4,435.80
06075011500	$1,042.84	$6,825.25	$7,868.09	$1,563.63
06075011700	$3,350.43	$20,802.06	$24,152.49	$4,668.73

Figure 10.28 Types of building losses reported by general occupancy class

The total loss of each type for all economic sectors can be viewed using the window shown in Figure 10.29. This window differs from that shown in Figure 10.28 in that, for example, the total cost of structural damage as reported in Figure 10.29 is the sum of the contents damage for all of the seven general occupancies shown in Figure 10.28.

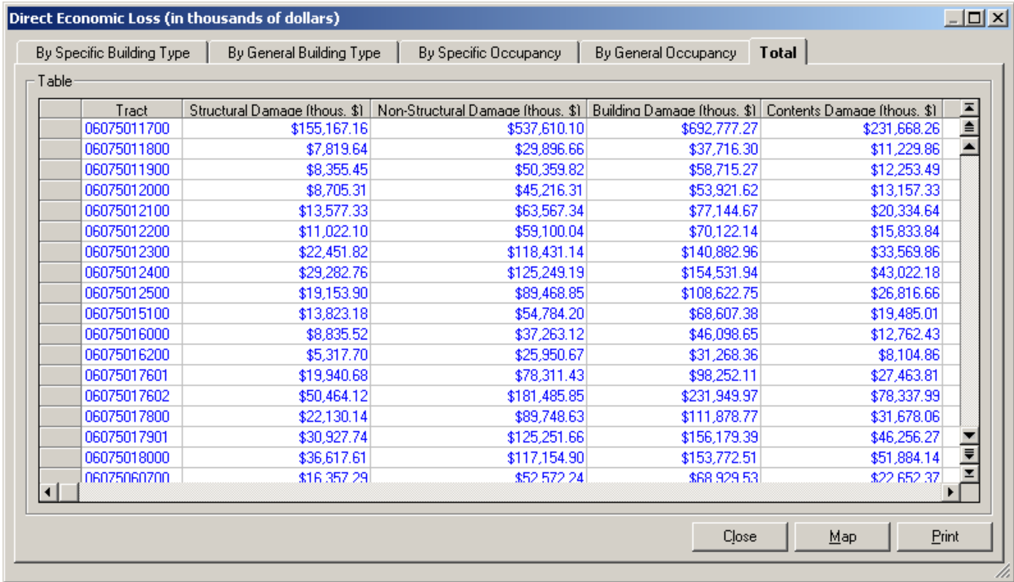


Figure 10.29 Total economic building losses reported by census tract.

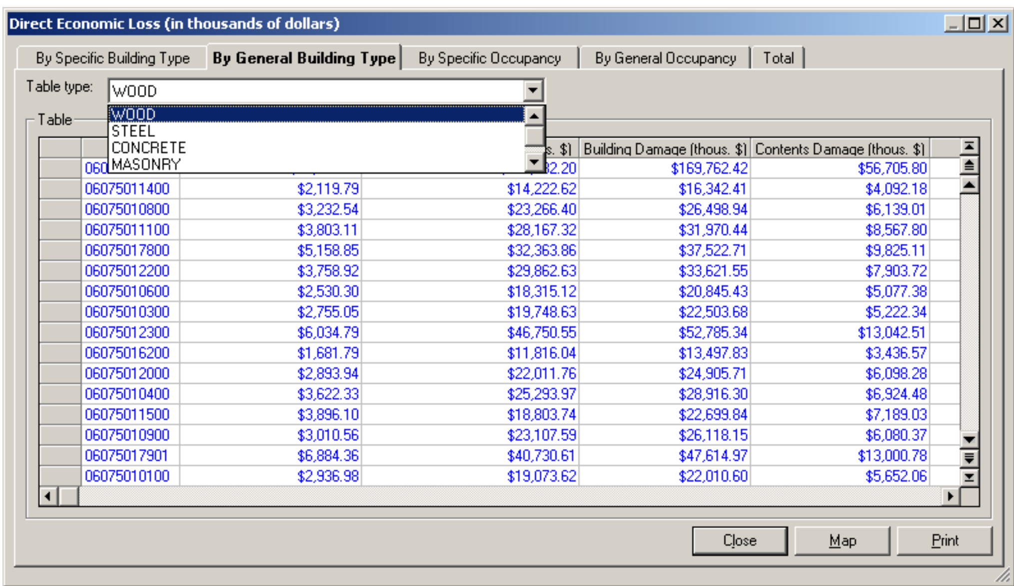


Figure 10.30 Types of building losses reported by general building type

Finally, losses can be reported for each of the 36 specific building classes or the five general building type classes for each census tract as shown in Figure 10.30.

The loss estimates for lifeline systems are summarized in Table 10.14. These are accessed through the **Results|Lifelines Economic Loss** menu.

Table 10.14 Direct economic and social losses module outputs - direct economic loss - lifelines

Component	Description of Output	Measure
Repair and Replacement Costs	The methodology determines the expected dollar loss due to the repair and replacement of lifelines components.	Dollar Loss

Figure 10.31 shows an example of a results window for transportation systems. Losses are reported for each component of the system, for example, in this window, losses are reported for each highway bridge. You can create similar reports for each type of component and each type of lifeline by clicking on the tabs at the top of Figure 10.31 and using the list box next to the label "Table Type". Like all the other results, the results in Figures 10.31 can also be mapped by clicking on the **Map** button.

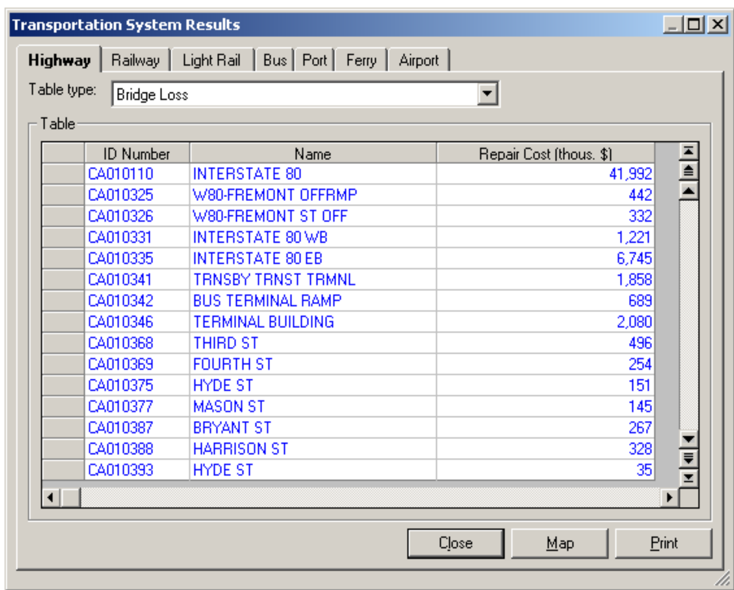


Figure 10.31 Direct economic losses to lifeline components

10.12 Indirect Economic Impacts

Hazus provides information concerning the indirect economic effects of the scenario event to enable financial institutions and government planners to anticipate losses and develop programs to compensate for them. The indirect economic impact information also enables users to motivate policy-makers to consider cost-benefit implications of mitigation activities.

Table 10.15 Indirect economic impacts module outputs

Component	Description of Output	Measure
Economic Output	Indirect output loss as a percentage of original output	Percentage
Employment	Indirect employment loss as a percentage of original employment	Percentage
Income	Indirect income loss as a percentage of original income	Percentage

10.13 Summary Reports

The options to view summaries of the outputs of each of the **Hazus** modules are: Inventory, Building Damage, Lifeline Damage, Induced Damage and Losses as shown in the Figure 10.32. You can pick the summary report from any of the windows below and click on the **View** button to generate the report. Sample summary reports of building damage by general occupancy and building stock exposure by building type are shown in Figures 10.33 and 10.34. Additional information in these reports can be viewed by scrolling to the right. Clicking on the print button can print reports.

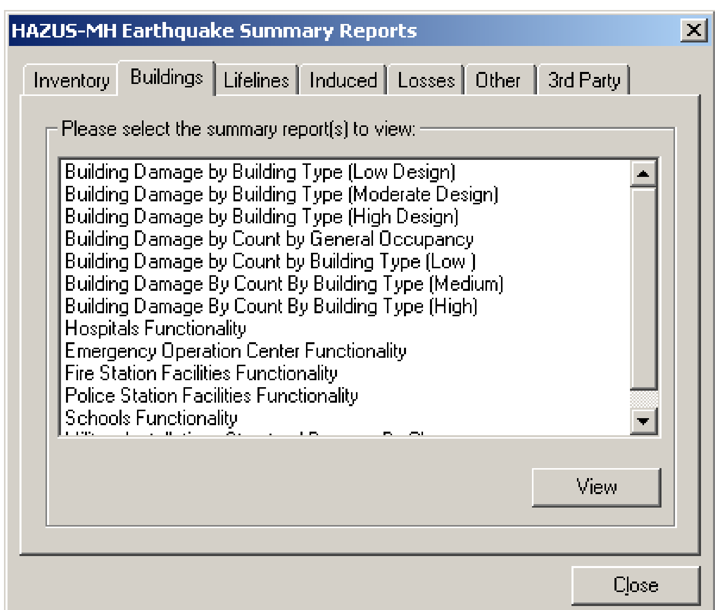
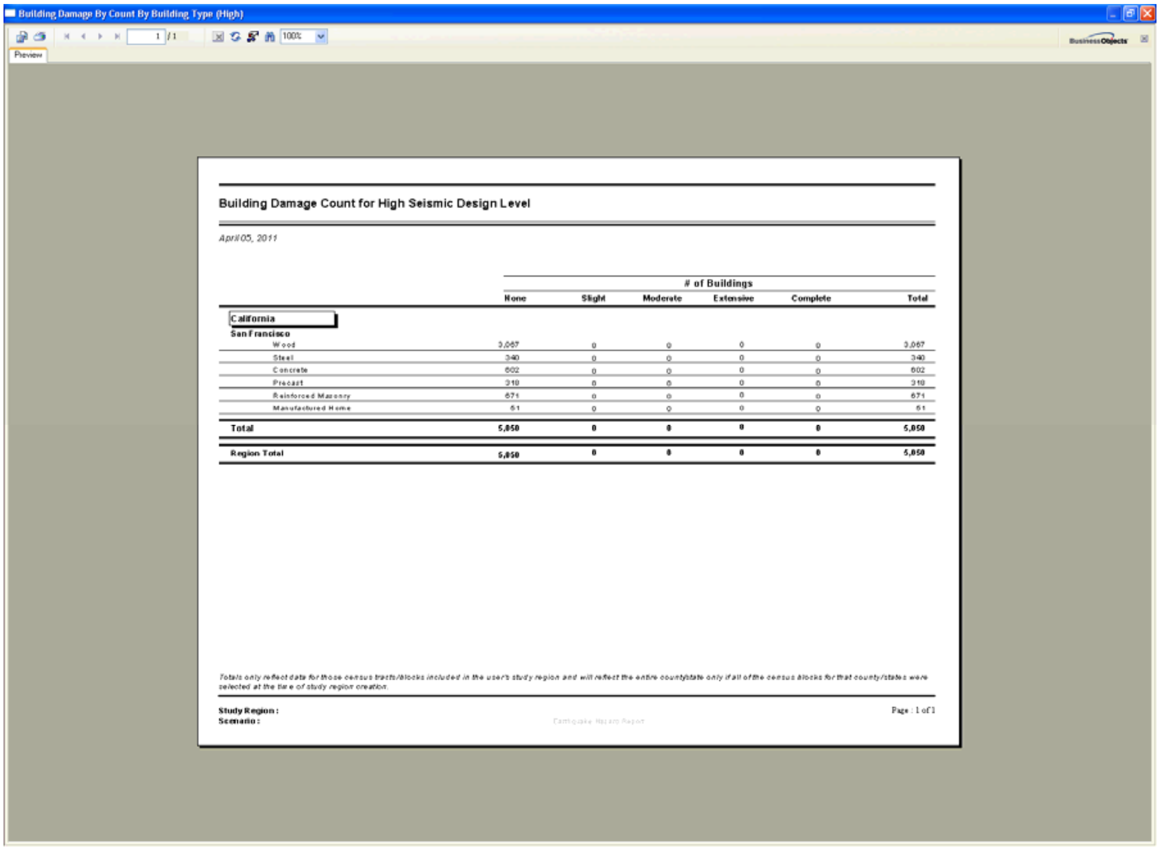


Figure 10.32 Summary report selection window for buildings summary reports.

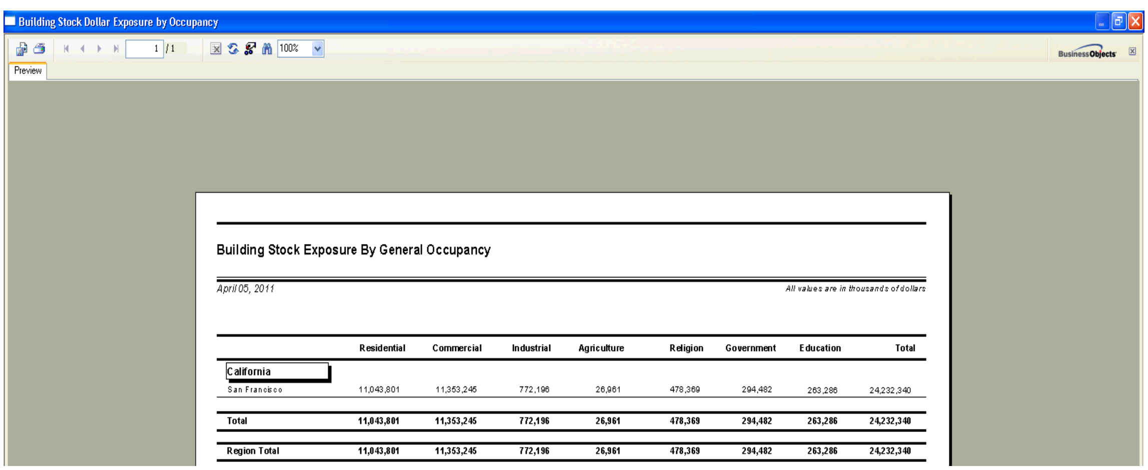


Building Damage Count for High Seismic Design Level

April 05, 2011

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
California						
San Francisco						
Wood	3,067	0	0	0	0	3,067
Steel	340	0	0	0	0	340
Concrete	602	0	0	0	0	602
Precast	318	0	0	0	0	318
Reinforced Masonry	671	0	0	0	0	671
Manufactured Home	51	0	0	0	0	51
Total	**5,050**	**0**	**0**	**0**	**0**	**5,050**
Region Total	**5,050**	**0**	**0**	**0**	**0**	**5,050**

Figure 10.33 Sample summary report of building damage count.



Building Stock Exposure By General Occupancy

April 05, 2011 *All values are in thousands of dollars*

	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
California								
San Francisco	11,043,801	11,353,245	772,196	26,961	478,369	294,482	263,286	24,232,340
Total	**11,043,801**	**11,353,245**	**772,196**	**26,961**	**478,369**	**294,482**	**263,286**	**24,232,340**
Region Total	**11,043,801**	**11,353,245**	**772,196**	**26,961**	**478,369**	**294,482**	**263,286**	**24,232,340**

Figure 10.34 Sample summary report of building stock exposure by occupancy type.

The 20-page **Global Summary Report** is a comprehensive standardized summary report that provides inventory, hazard and analysis results related to the scenario event. Selecting the **Other** tab as shown in Figure 10.35 will access the window that contains the **Global Summary Report**.

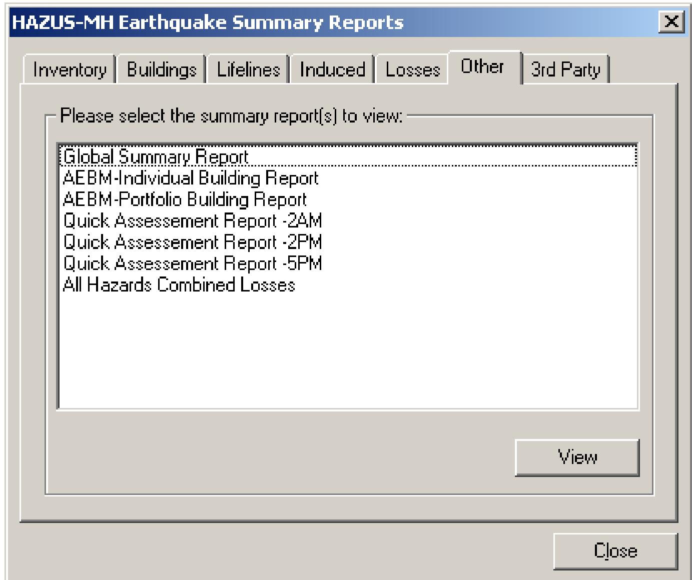


Figure 10.35 The Global Summary report option

The Global Summary Report is organized as follows:

1. General Description of the Region
2. Building and Lifeline Inventory

   2.A Building Inventory

   2.B Critical Facility Inventory

   2.C Transportation and Utility Lifeline Inventory
3. Earthquake Scenario Parameters
4. Direct Earthquake Damage

   4.A Buildings Damage

   4.B Critical Facilities Damage

   4.C Transportation and Utility Lifeline Damage
5. Induced Earthquake Damage

   5.A Fire Following Earthquake

   5.B Debris Generation
6. Social Impact

   6.A Shelter Requirements

   6.B Casualties

7. Economic Loss

   7.A Building Losses

   7.B Transportation and Utility Lifeline Losses

   7.C Long-term Indirect Economic Impacts

The **All Hazards Combined Losses** summary report can be viewed if you have run an annualized loss analysis for all three hazards (earthquake, flood, and hurricane). The report will calculate the combined losses for the given multi-hazard region.

Chapter 11. References

Note to users: Many of these references are difficult to find. However, most of them can be obtained from the libraries maintained at the National Center for Earthquake Engineering Research at Buffalo, the Earthquake Engineering Research Center at the University of California, Berkeley, the National Hazards Research and Applications Center of the University of Colorado and the Natural Hazards Research Program of the American Institute of Architectural Research, AIA/ACSA in Washington D.C.. Publications by Applied Technology Council, Association of Bay Area Governments, the Federal Emergency Management Agency, US Geological Survey, US Census Bureau and other government agencies can be obtained directly from these organizations.

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Appendix A. Installation Verification Document

A.1 Introduction

A.1.1 Purpose

The goal of the document is to show that the Hazus-MH 2.1 product can successfully generate results immediately following product installation.
This document provides a step-by-step procedure that should enable a user to start with a successfully installed Hazus-MH 2.1 product and end up with a summary report.

A.1.2 Scope

This document discusses only the Earthquake model steps required to generate an initial set of results. It does not address installation or any of the other hazards. The study region of interest is San Francisco County, California.

A.1.3 Timing

For reference, in some steps it will say that the step should take between (as example) 3 and 5 minutes. This is to give you an idea of what to expect. The timing is based on a 1.4 GHz PC with 512MB of RAM. Faster or slower computers will vary accordingly.

A.1.4 Assumptions

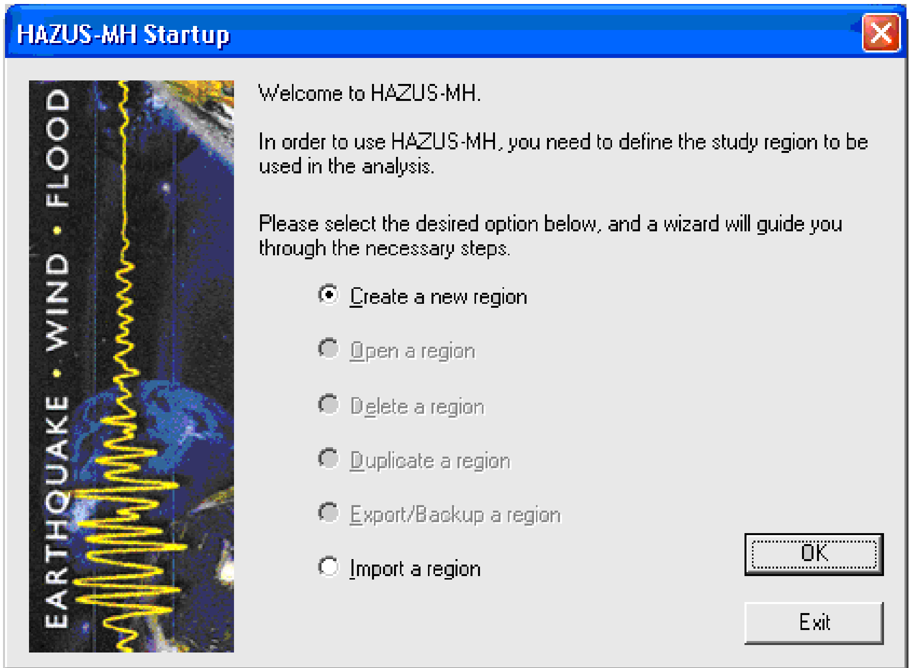
It is assumed that –at this point- the installation of Hazus-MH 2.1 has proceeded with no errors.
It is also assumed that the default data inventory for California (CA) has been copied to the Hazus-MH data inventory folder as specified during the setup. Instructions on how to work with the default data inventory files are included with the ‘Data Inventory” DVD (see Installation Instructions.pdf document).

A.2 Study Region Creation Verification Procedure

This section assumes Hazus-MH has been successfully installed. The following steps will demonstrate that an earthquake study region can be created.

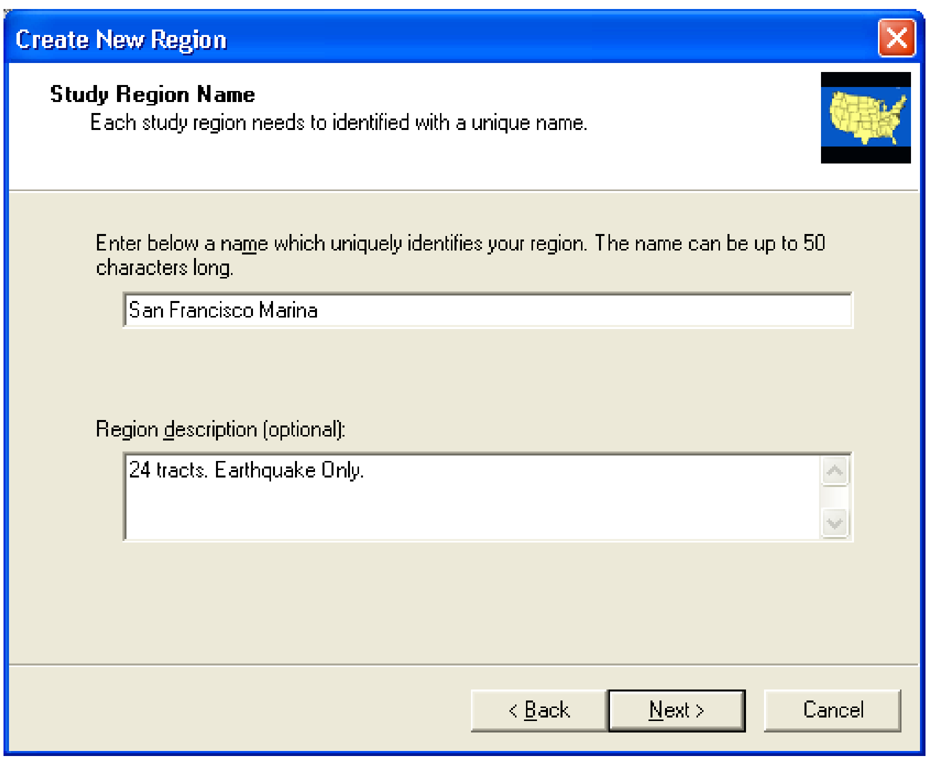
A.2.1 Select “Create a new region”

Start Hazus-MH. Use the region wizard to create a new study region.

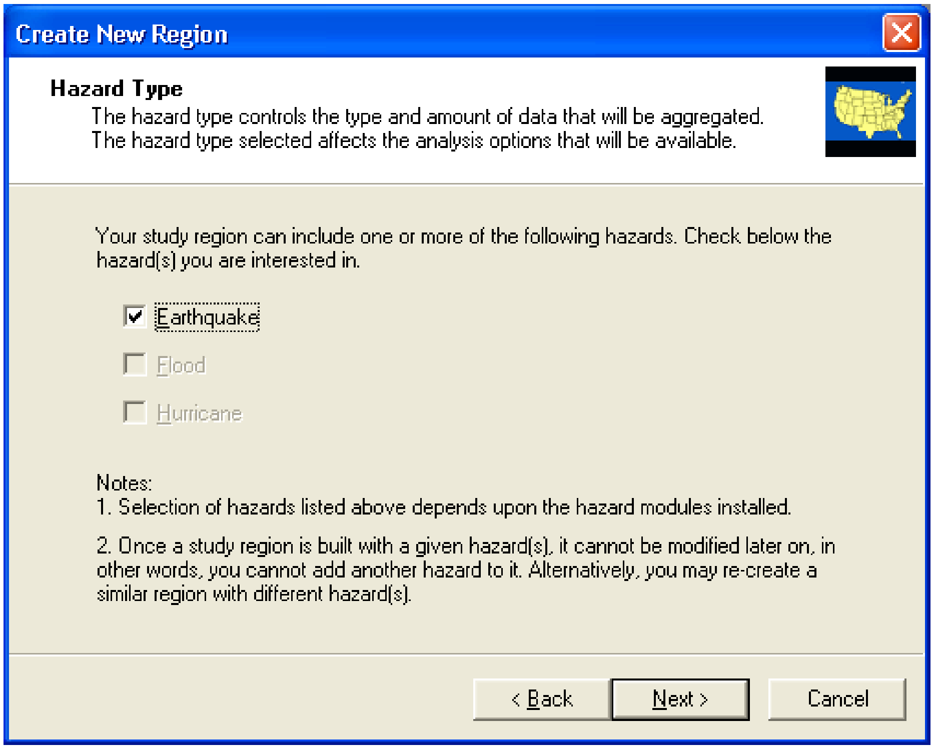


A.2.2 Enter a Name

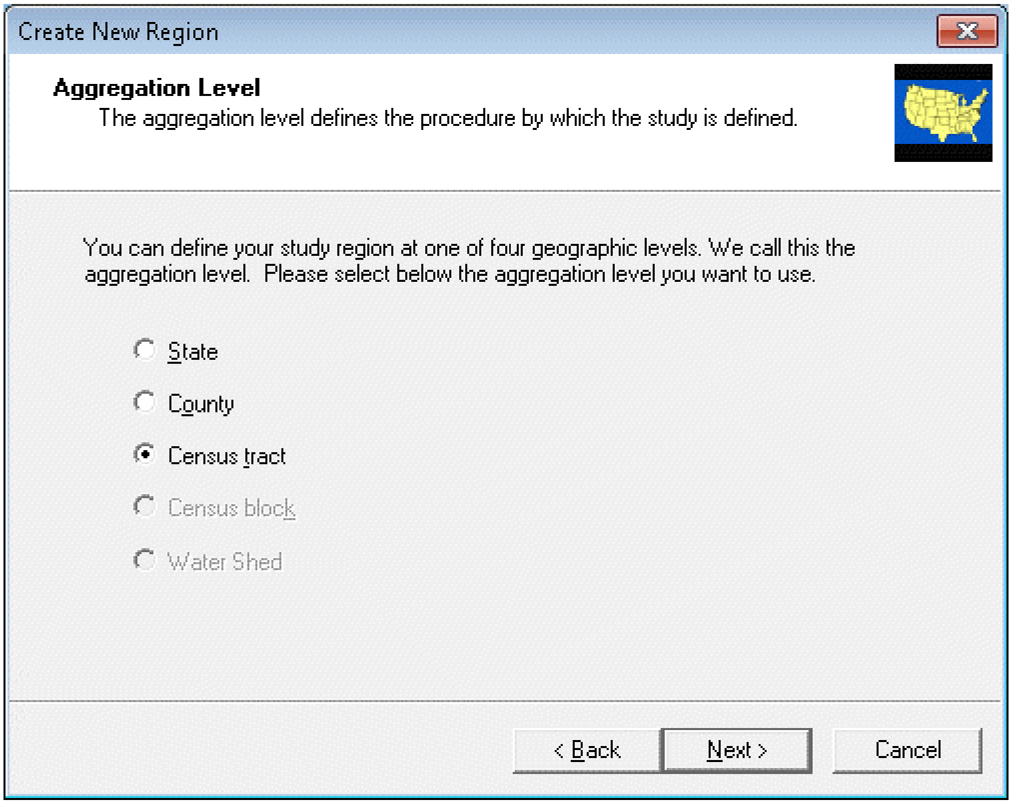
Enter a unique name for the study region, as shown below.



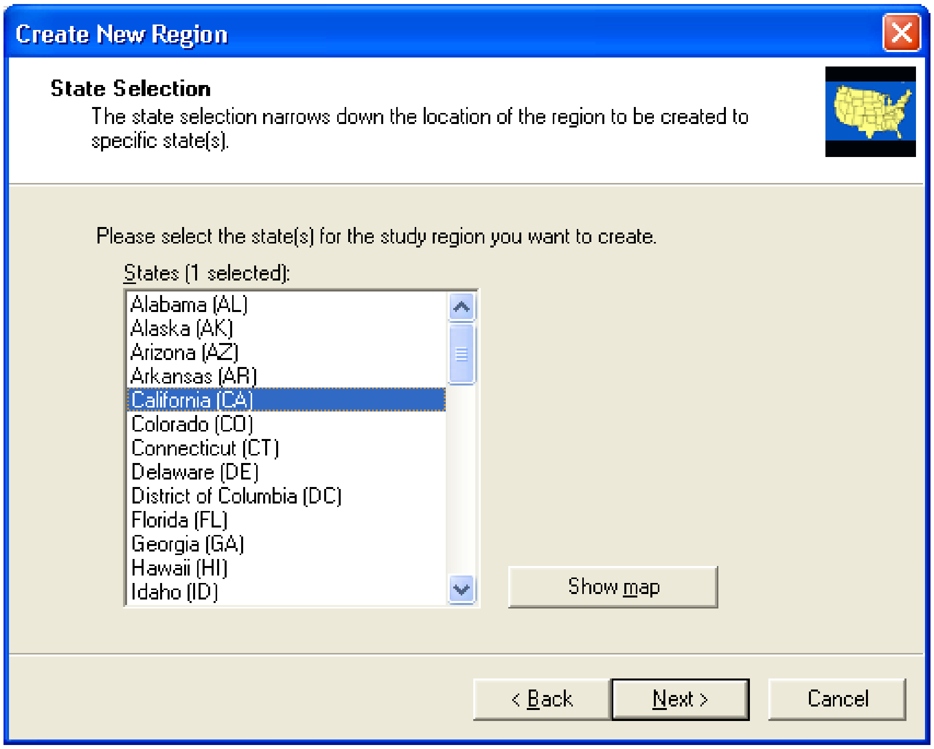
A.2.3 Select Earthquake Hazard



A.2.4 Select Aggregation at Tract Level



A.2.5 Select 'California'

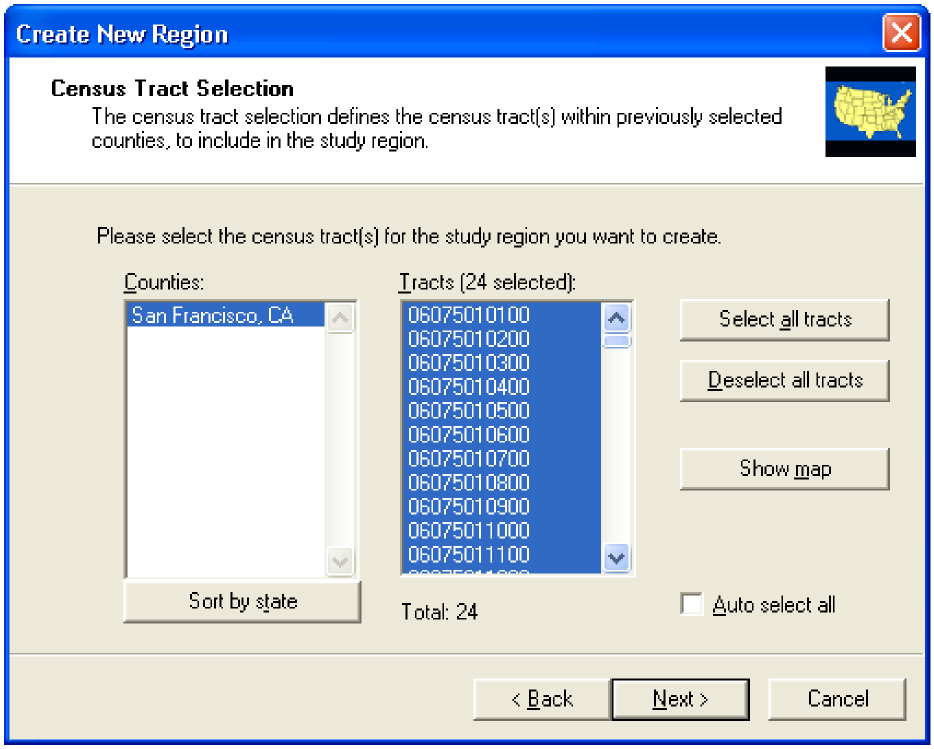


Note: This dialog needs the CA inventory data to have been already installed as per the instructions in the **Getting Started.pdf** document included with the installation.

A.2.6 Select San Francisco County

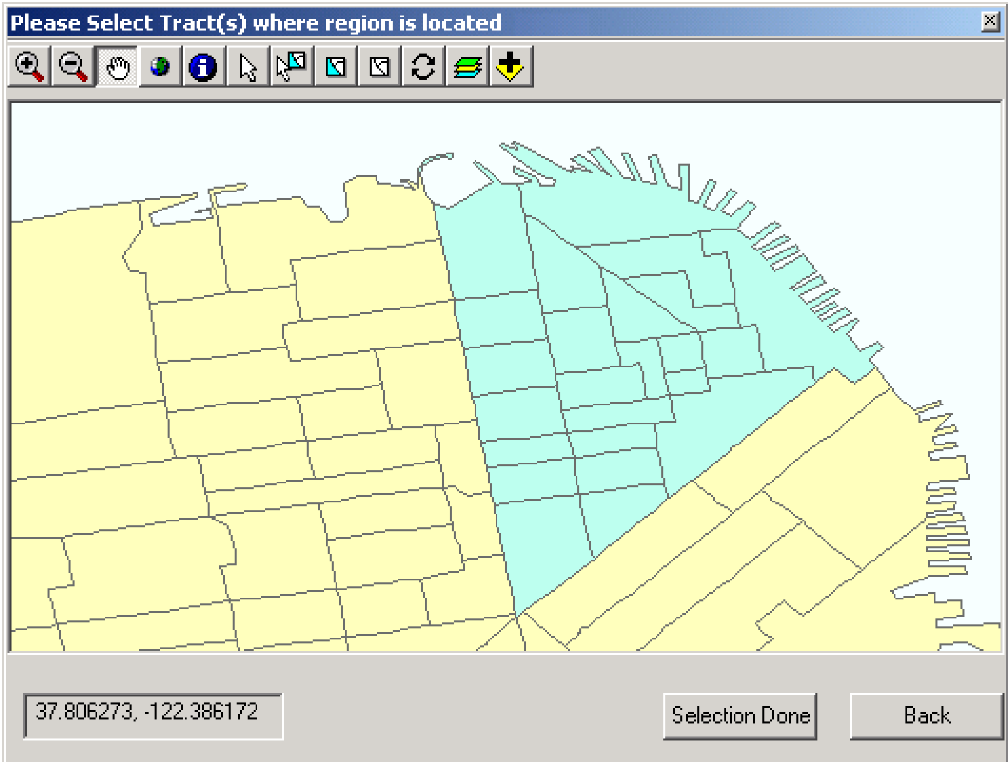
A.2.7 Select the Tracts

Select the first 24 tracts as shown below. While selecting with the mouse, press the “Shift” key or the “Ctrl” key to help with selection (Shift selects all entries from first selection to current selection, Ctrl toggles selects on/off for one entry)

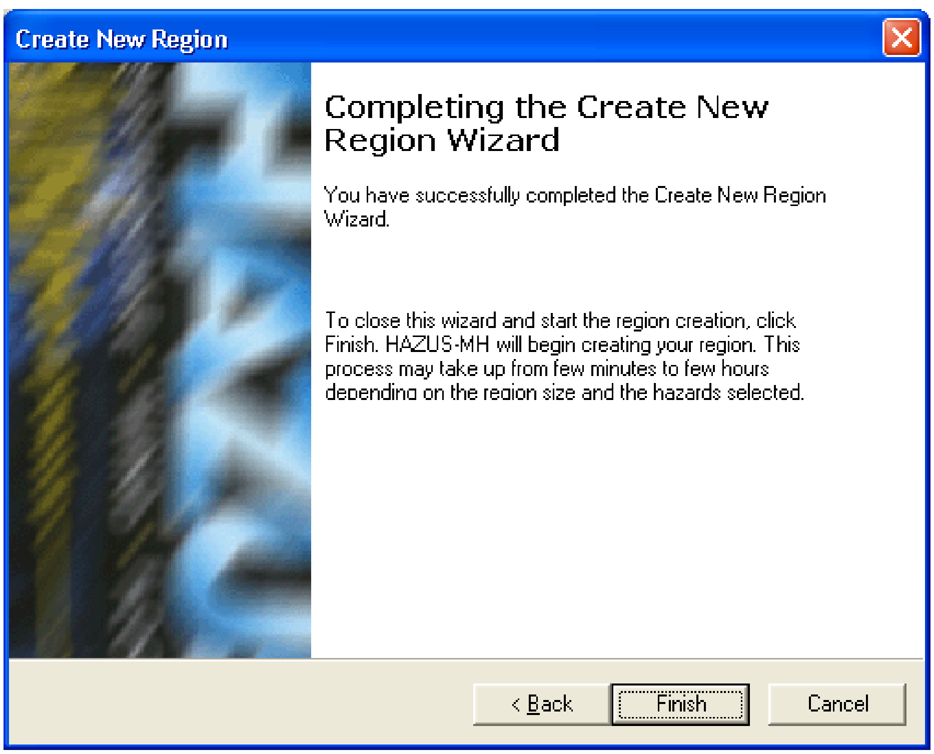


A.2.8 Confirm Selection From Map

Click ‘Show map’ and zoom in to confirm selection as shown below. Click ‘Back’ to return to main dialog.



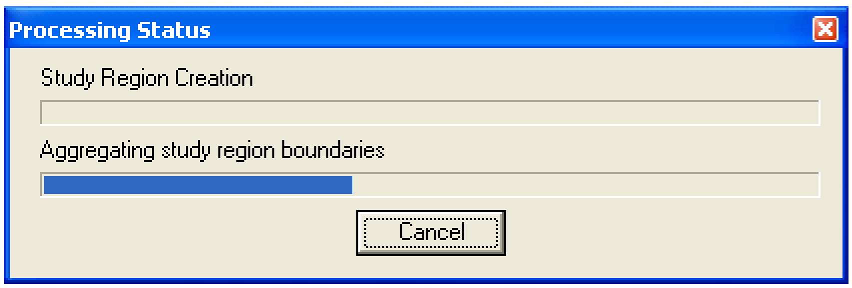
A.2.9 Finish the Wizard



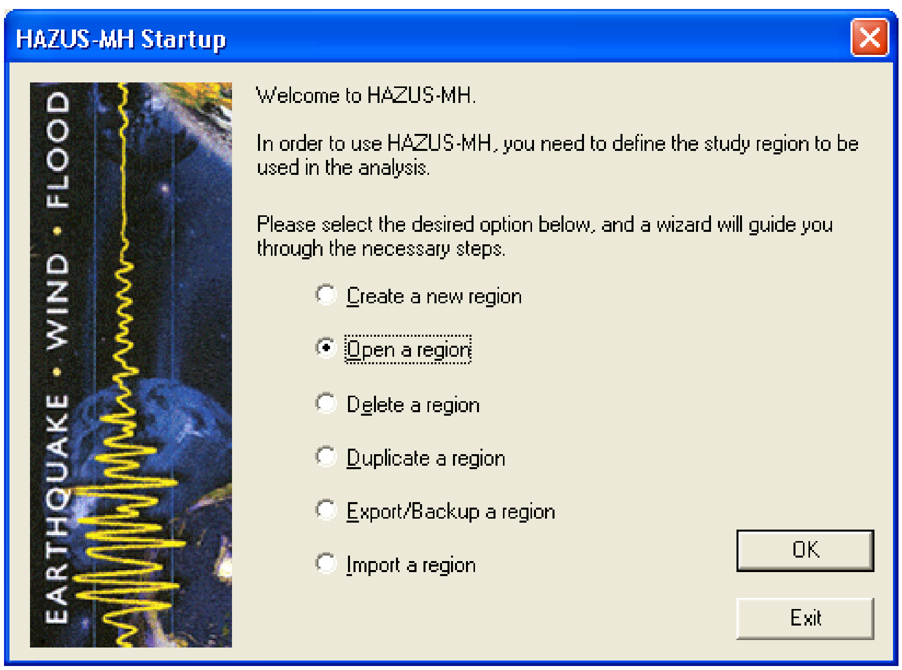
At this point, Hazus-MH may ask for DVD A1, which is the DVD with the California data. If you have it, insert it or insert the "Application DVD". If you already have one of these DVDs in the DVD Drive then Hazus-MH will not ask for the DVD and will directly proceed to the next step.

A.2.10 Wait for Region to be created

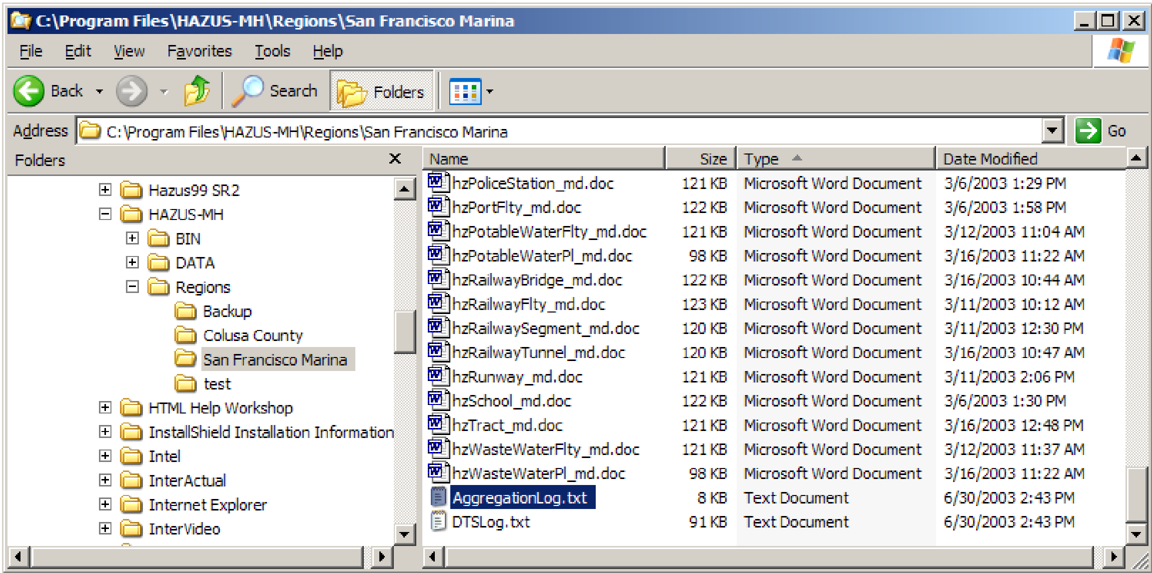
A progress bar will display and the Hazus-MH "shell" will create the study region. It will about 10 minutes to create the study region.



When the study region creation process is complete, you should see the following screen:



A folder with the study region name should be created underneath the folder where regions are kept (the default location is C:\Program Files\Hazus-MH\ but in the example shown below the study regions are stored in C:\Program Files\Hazus-MH\Regions). There should be many files in that folder, but the following 2 files are of particular interest: DTSLog.txt and `AggregationLog.txt`: These files contain details of the steps executed in of the study region creation process. Should anything not work properly, these will be key files to examine.

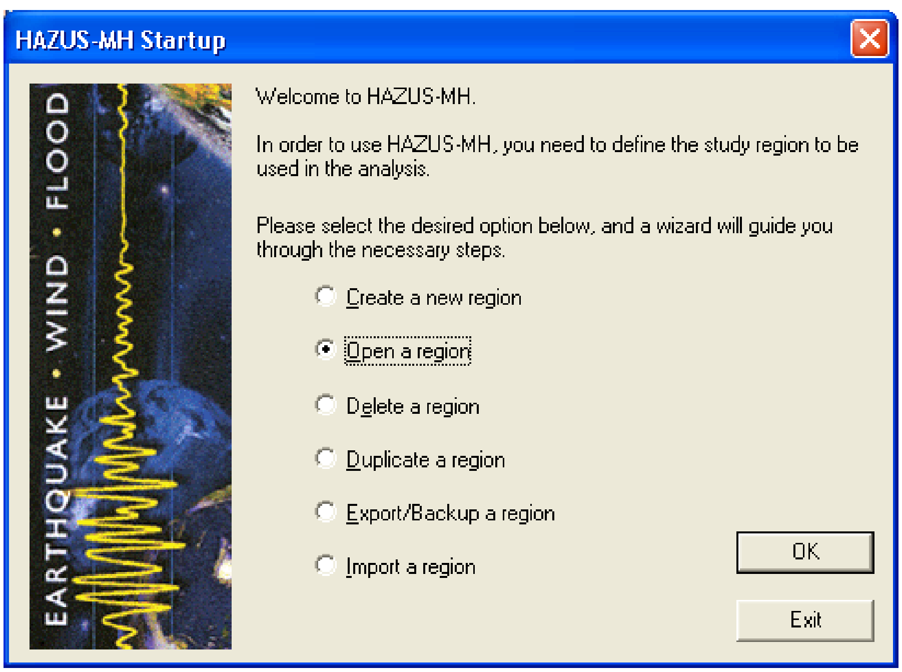


A.3 Study Region Open Verification Procedure

These steps will demonstrate that an earthquake study region can be opened.

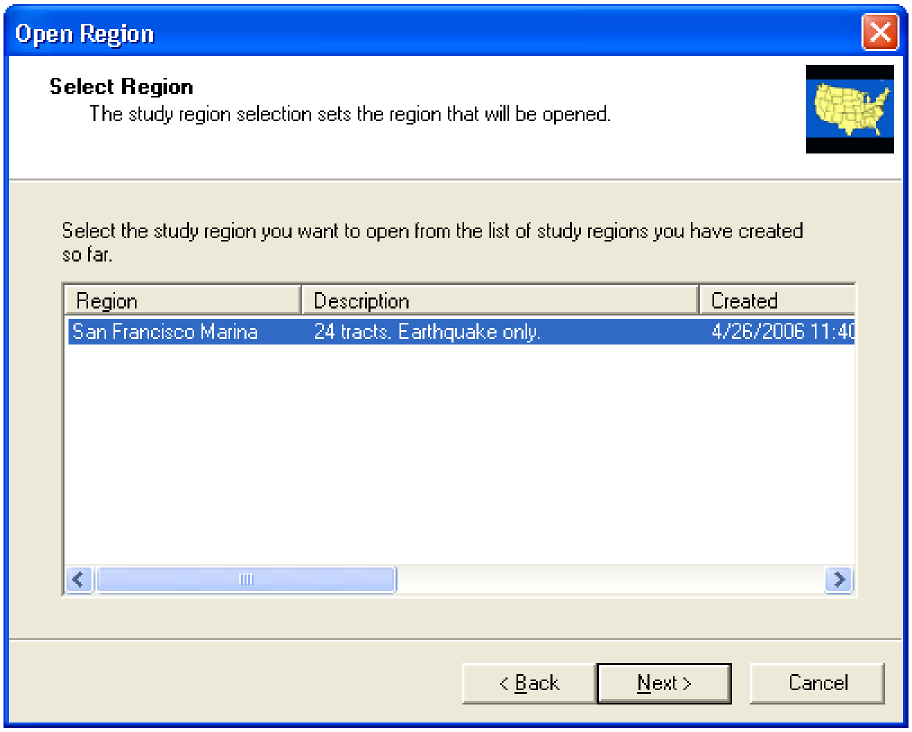
A.3.1 Open the New Region

When the creation process ended, the progress and creation dialogs should have gone away leaving the region wizard dialog on screen. Select “Open a region”.



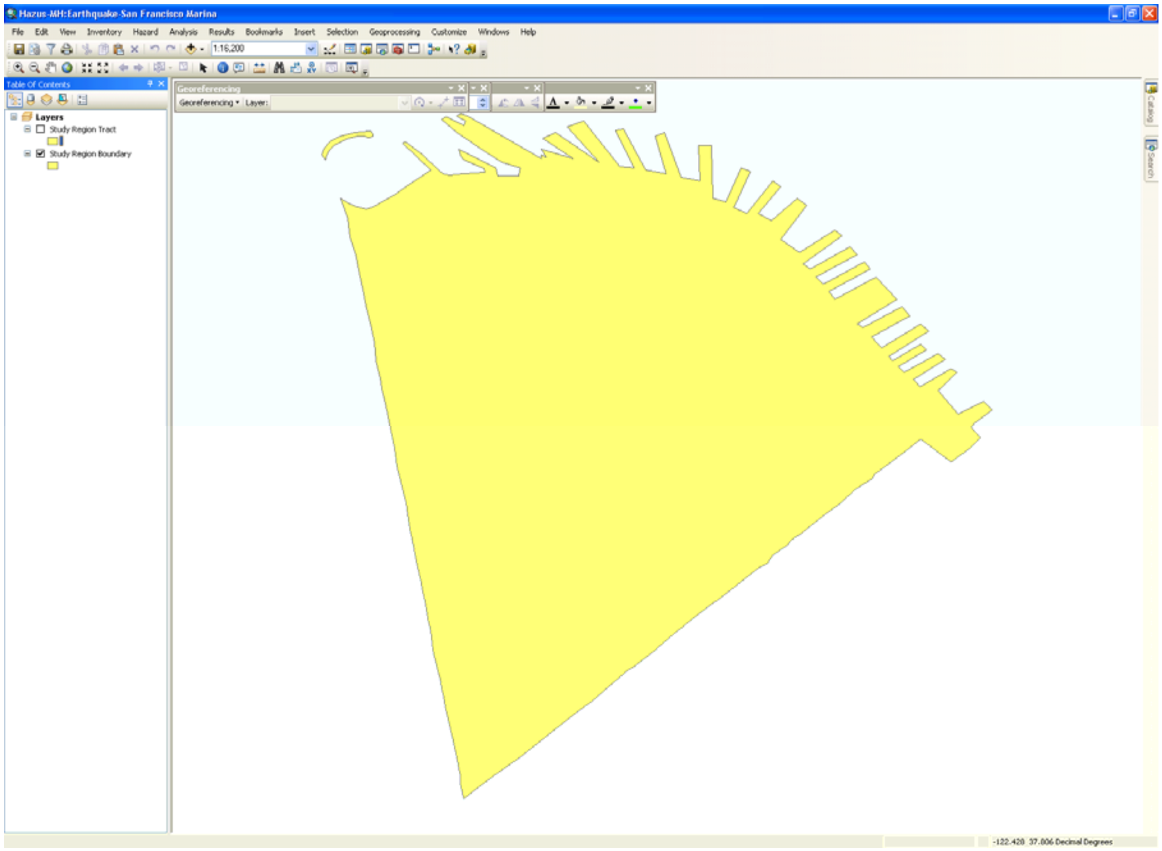
A.3.2 Select the New Region

The region you created will be the only one listed if this is truly the first region created.



A.3.3 Initial Display

Once the region opens it should look like following figure. The key elements to ensure are that the study region name is in the title bar, the Inventory, Hazard, Analysis, and Results menu items exist, and the two default layers are in the table of contents.

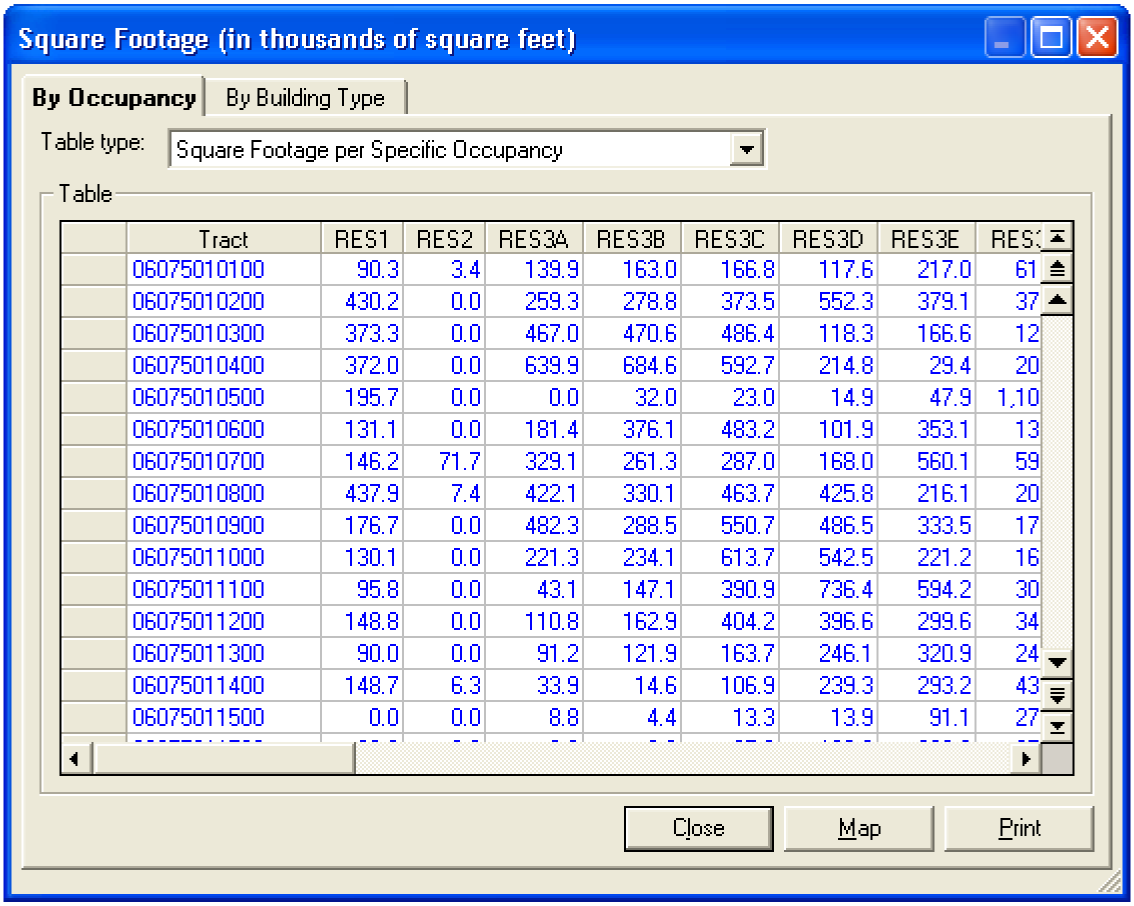


A.4 Inventory Verification

These steps will demonstrate that the Inventory menu items are functional and that inventory and certain occupancy mapping data were created.

A.4.1 General Build Stock Check

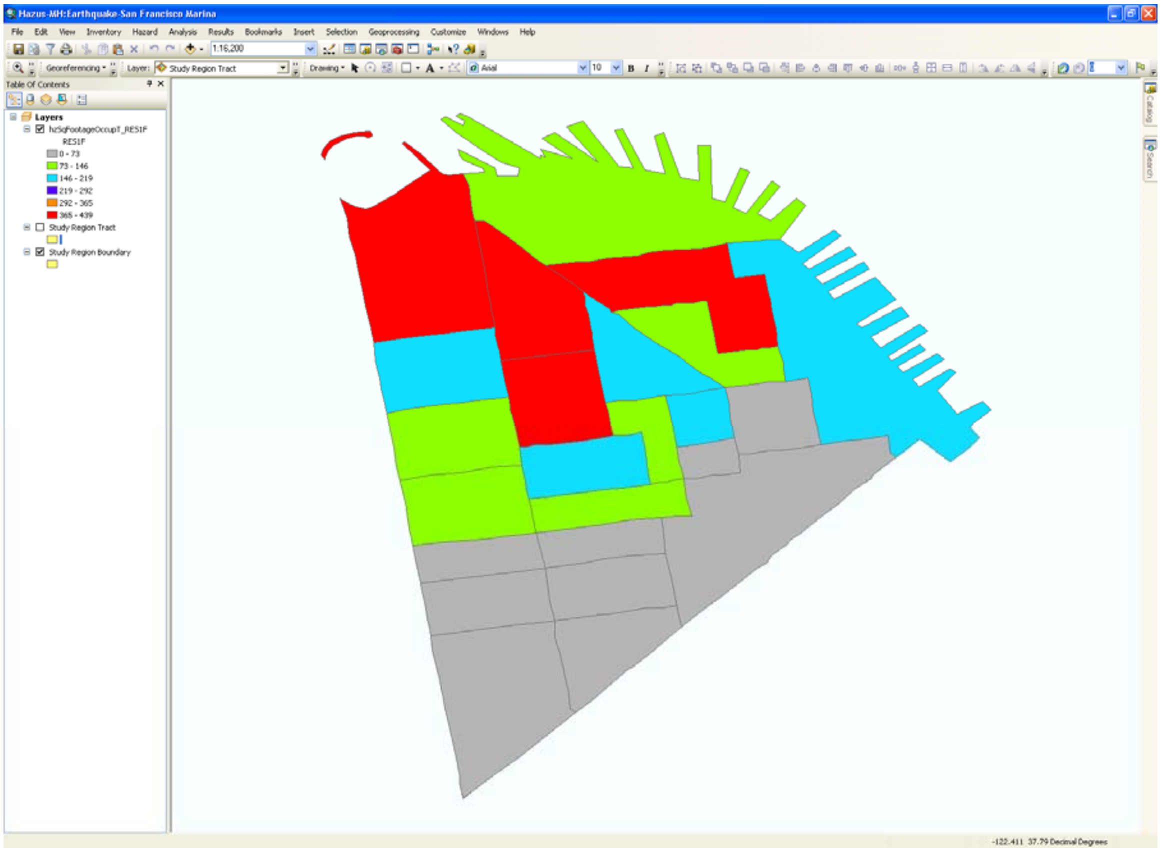
Use menu item Inventory | General Building Stock | Square Footage and ensure this displays. Close the dialog when finished.



Tract	RES1	RES2	RES3A	RES3B	RES3C	RES3D	RES3E	RES3
06075010100	90.3	3.4	139.9	163.0	166.8	117.6	217.0	61
06075010200	430.2	0.0	259.3	278.8	373.5	552.3	379.1	37
06075010300	373.3	0.0	467.0	470.6	486.4	118.3	166.6	12
06075010400	372.0	0.0	639.9	684.6	592.7	214.8	29.4	20
06075010500	195.7	0.0	0.0	32.0	23.0	14.9	47.9	1,10
06075010600	131.1	0.0	181.4	376.1	483.2	101.9	353.1	13
06075010700	146.2	71.7	329.1	261.3	287.0	168.0	560.1	59
06075010800	437.9	7.4	422.1	330.1	463.7	425.8	216.1	20
06075010900	176.7	0.0	482.3	288.5	550.7	486.5	333.5	17
06075011000	130.1	0.0	221.3	234.1	613.7	542.5	221.2	16
06075011100	95.8	0.0	43.1	147.1	390.9	736.4	594.2	30
06075011200	148.8	0.0	110.8	162.9	404.2	396.6	299.6	34
06075011300	90.0	0.0	91.2	121.9	163.7	246.1	320.9	24
06075011400	148.7	6.3	33.9	14.6	106.9	239.3	293.2	43
06075011500	0.0	0.0	8.8	4.4	13.3	13.9	91.1	27

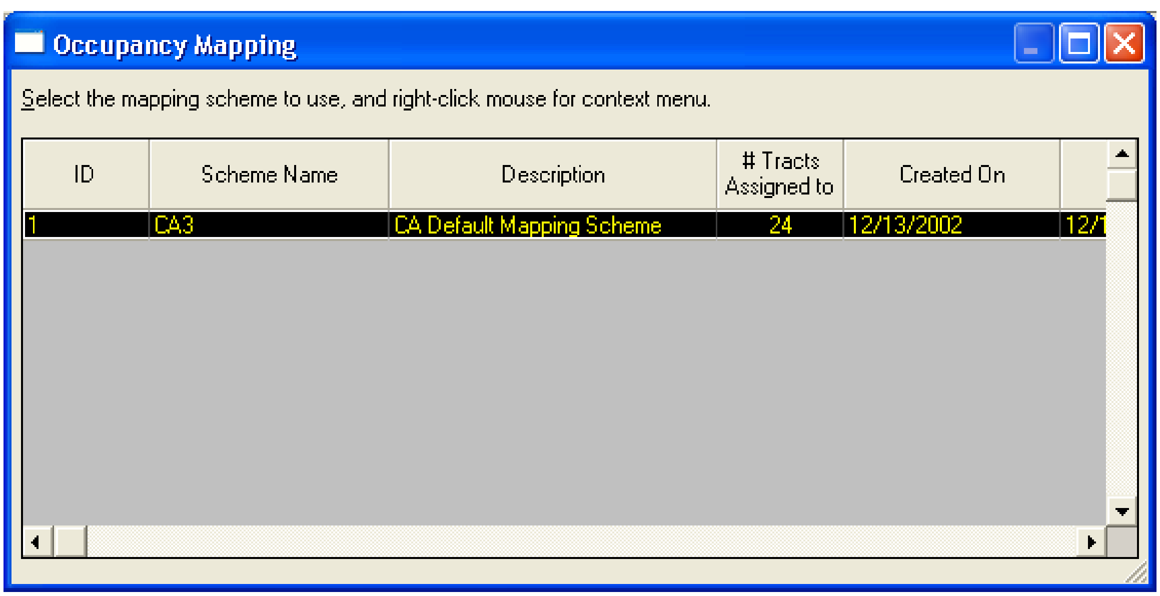
A.4.2 Shade by Res1

Click on the RES1 column header to select column RES1, and press the ‘Map’ button. A new shaded layer should be added to the map and show the distribution of RES1 occupancies. Click ‘Close’ to close the dialog when finished.

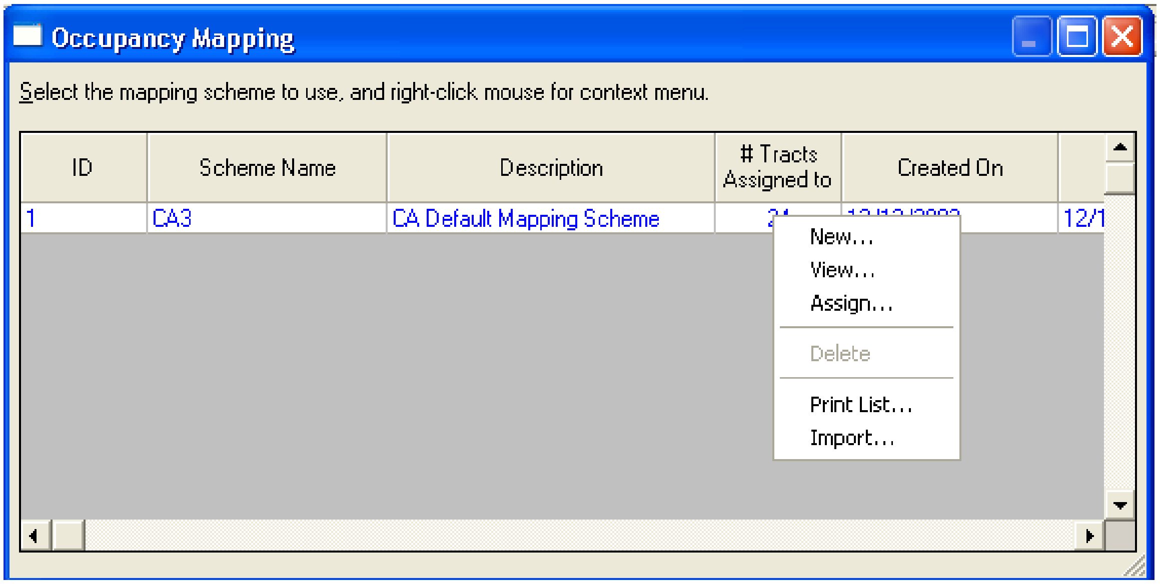


A.4.3 General Building Occupancy Mapping Check

Use menu item Inventory\General Building Stock | General Building Occupancy Mapping and ensure this displays.

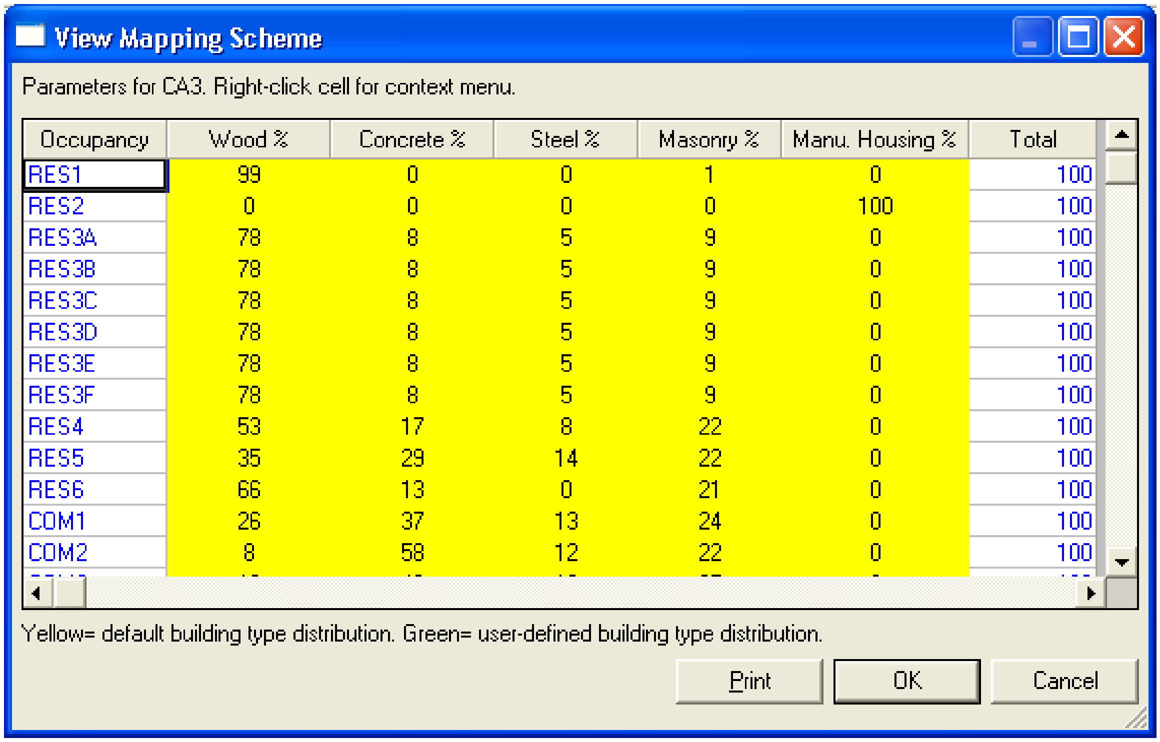


The list has one default mapping scheme called appropriately “CA Default Mapping Scheme”. To view the values associated with this default mapping scheme, right-click the row to get the context menu, and select “View…”.

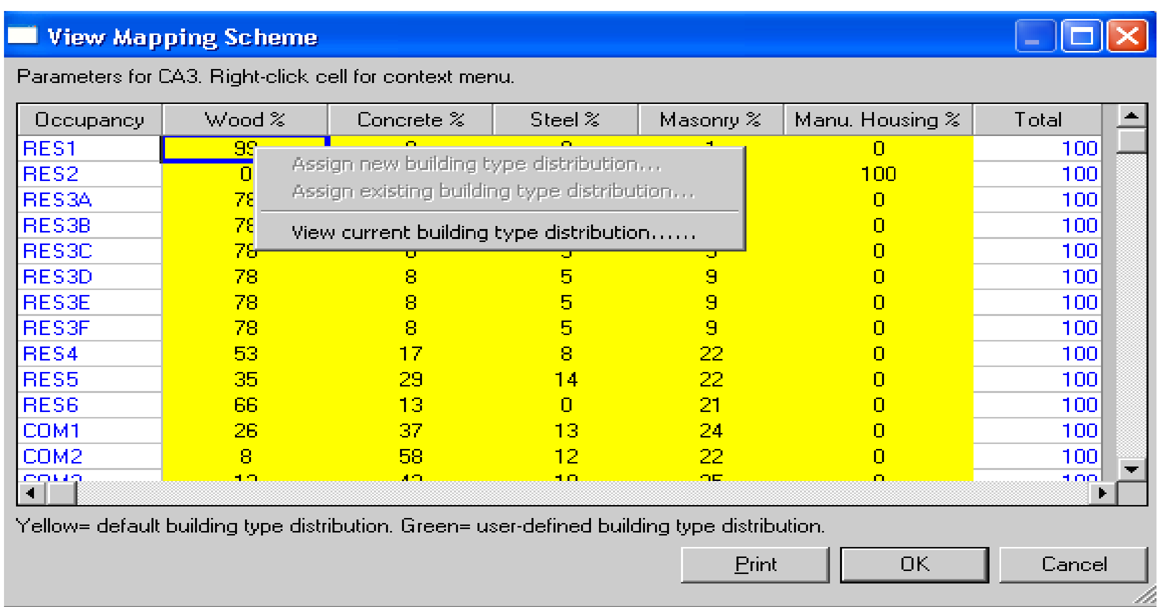


The values for the general mapping schemes are displayed. It shows for example that the distribution for RES1[1] buildings is 99% wood, and 1 % masonry.

[1] RES1 is the specific occupancy class for single family dwellings.



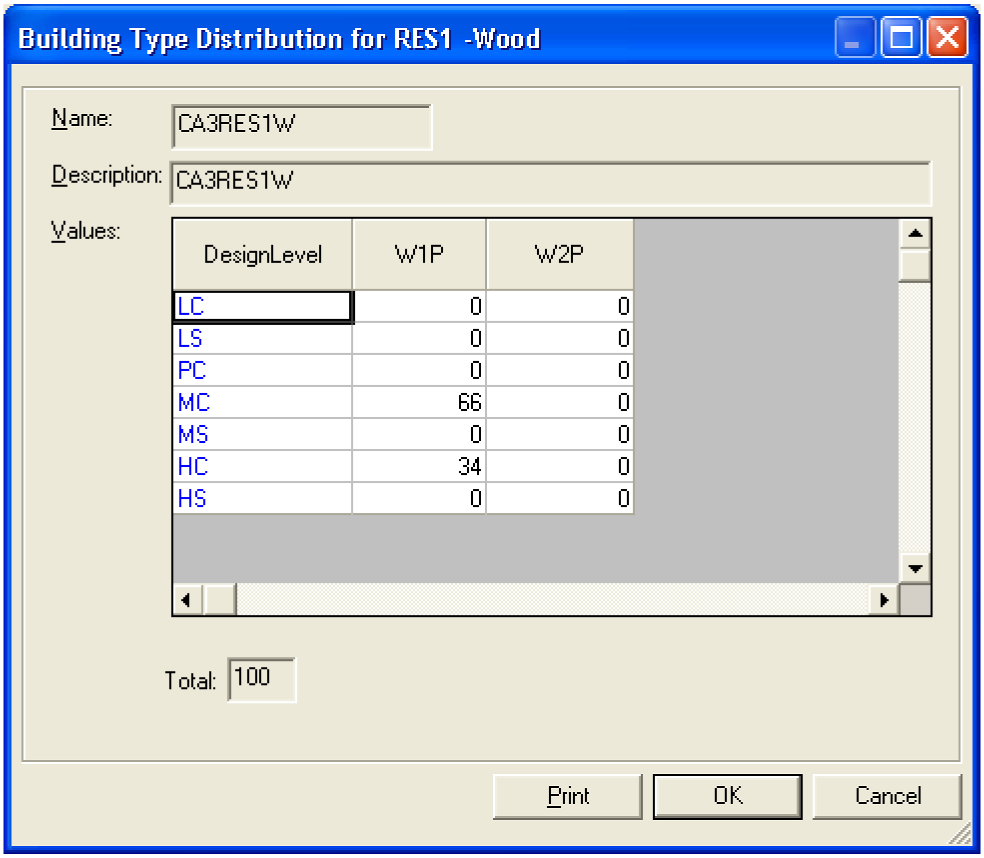
In the earthquake model, wood is further divided into 2 specific building types. The distribution from general building type (wood) into its specific building type is stored in *distribution matrices*. To view the distribution matrix, right-click the cell, and select "View current building type distribution…".



The following dialog shows that the default distribution for wood is as follows:

- 66% is W1 (wood light frame < 5,000 sq.ft.) with building quality up to Code and Medium earthquake design level.

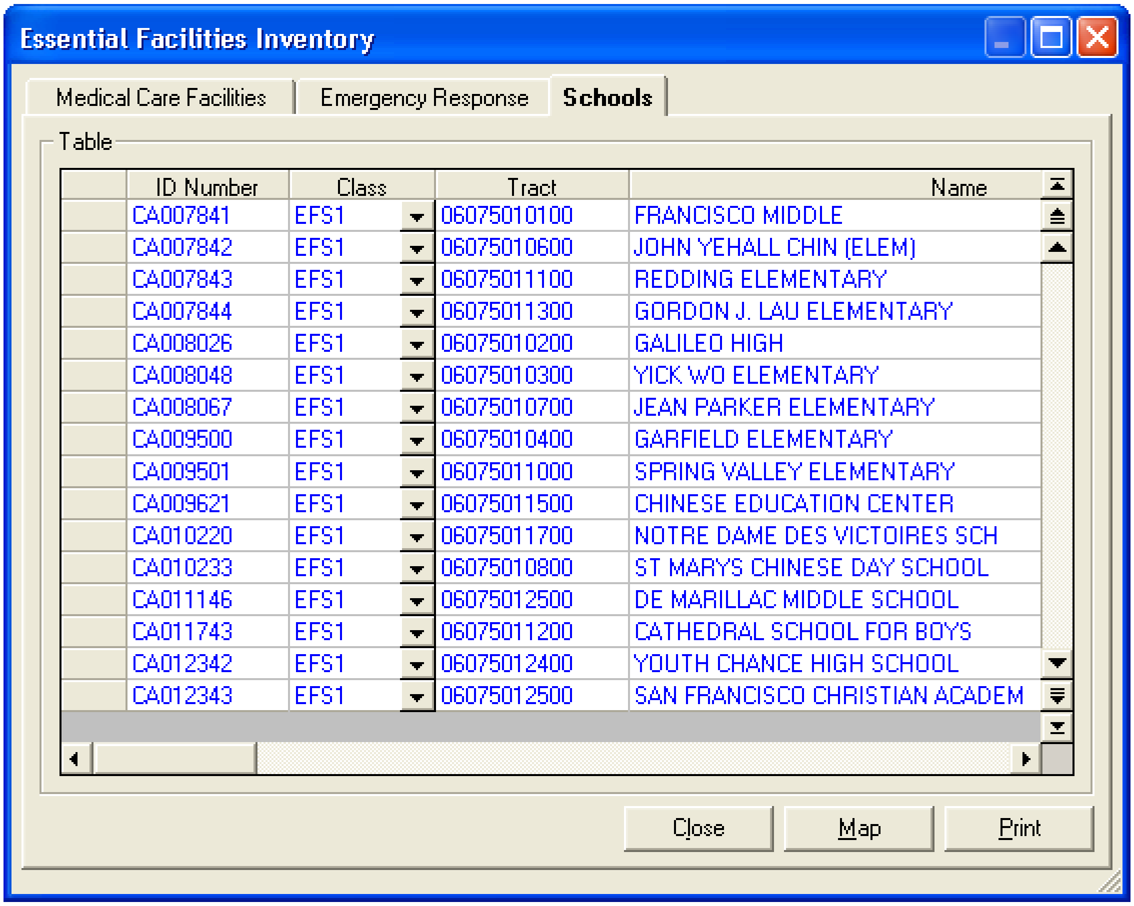
- 34% is W1 with building quality up to Code and High earthquake design level.



Close the dialogs by clicking ‘Cancel’.

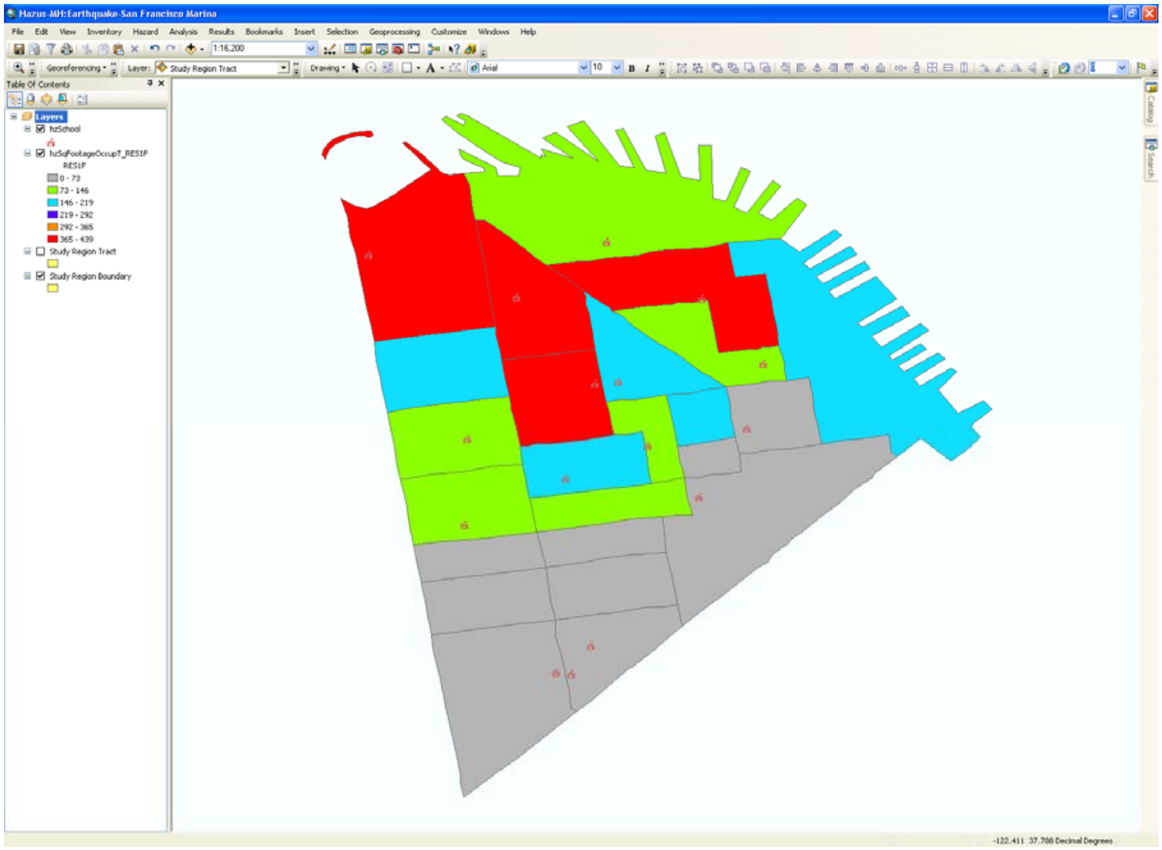
A.4.4 Essential Facilities Check

Select Inventory | Essential Facilities, then click on the Schools tab, and ensure the following dialog displays.



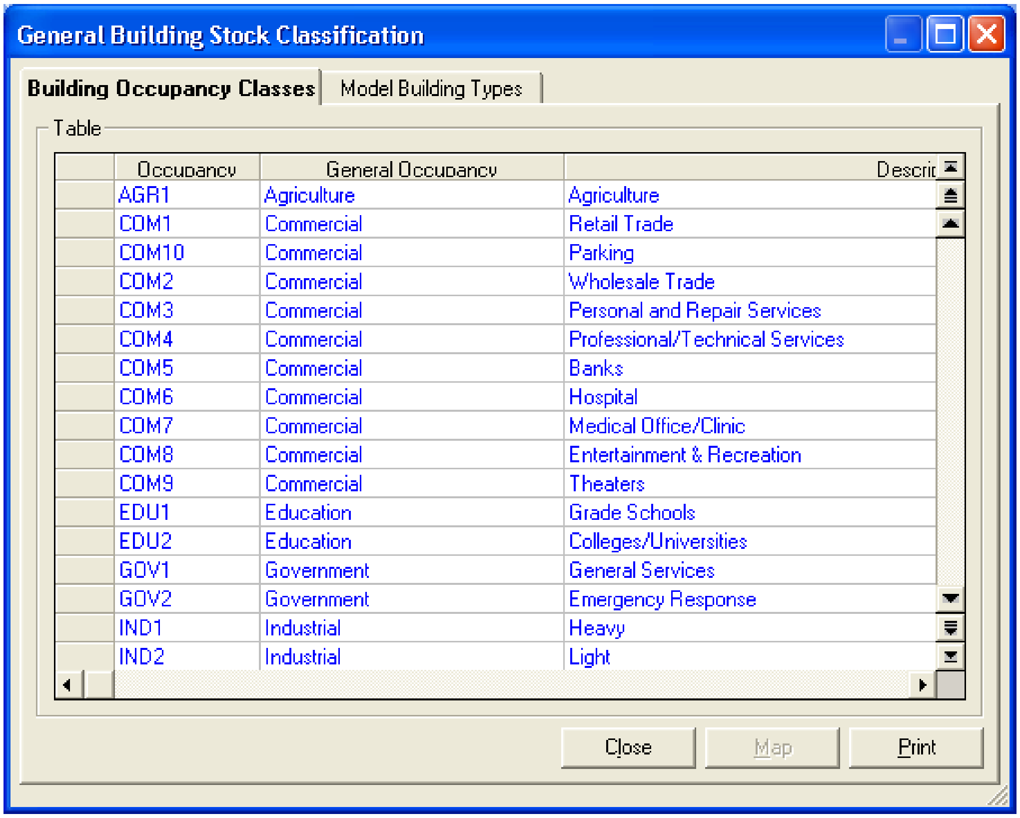
A.4.5 Plot the Schools

Press Map. A new map layer should get added to the TOC (Table of Contents) that shows the location of schools in our study region.



A.4.6 Classification Check

Use menu item Inventory | View Classifications | General Building Stock to ensure the following dialog appears. Close the dialog when finished. This completes the Inventory.



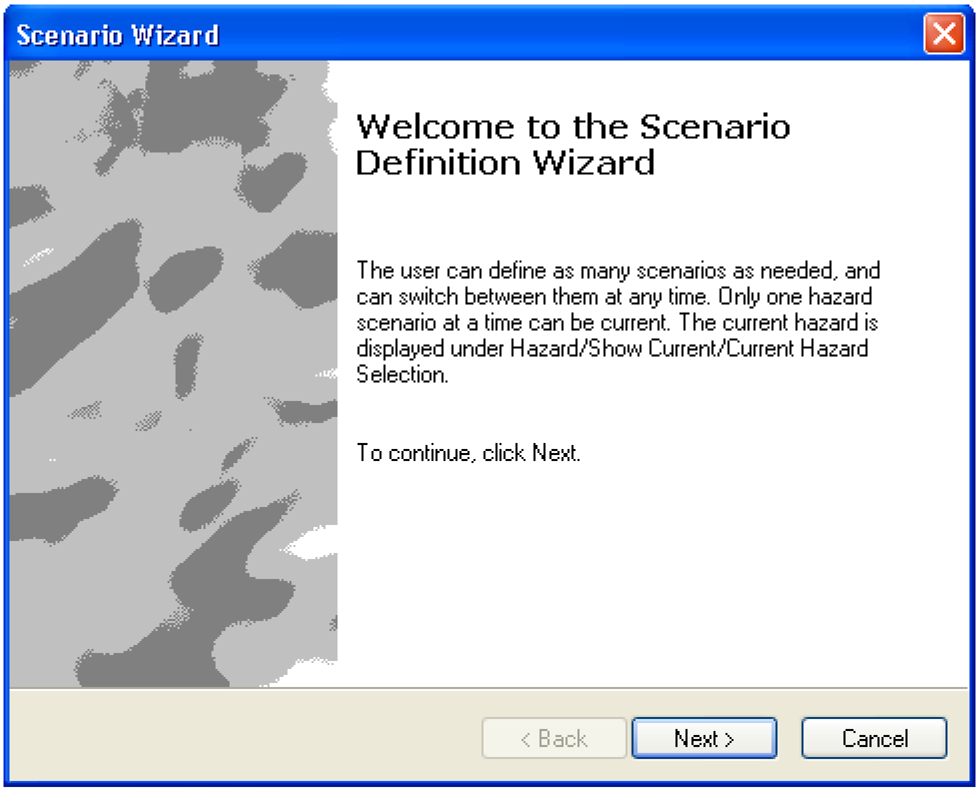
Occupancy	General Occupancy	Descrip
AGR1	Agriculture	Agriculture
COM1	Commercial	Retail Trade
COM10	Commercial	Parking
COM2	Commercial	Wholesale Trade
COM3	Commercial	Personal and Repair Services
COM4	Commercial	Professional/Technical Services
COM5	Commercial	Banks
COM6	Commercial	Hospital
COM7	Commercial	Medical Office/Clinic
COM8	Commercial	Entertainment & Recreation
COM9	Commercial	Theaters
EDU1	Education	Grade Schools
EDU2	Education	Colleges/Universities
GOV1	Government	General Services
GOV2	Government	Emergency Response
IND1	Industrial	Heavy
IND2	Industrial	Light

A.5 Hazard Verification – Deterministic Hazard

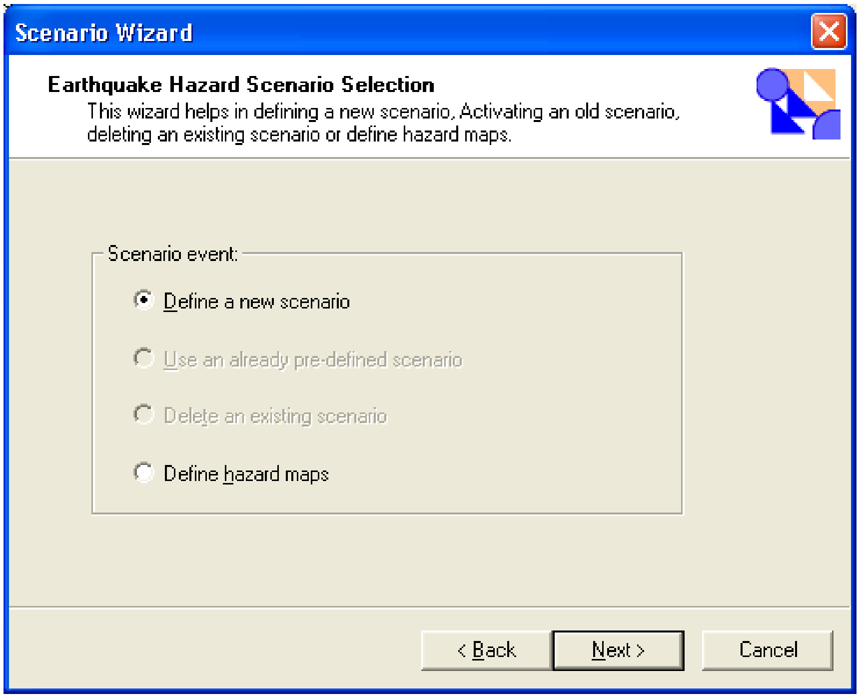
These steps will demonstrate that the arbitrary earthquake event is functioning properly.

A.5.1 Set the Active Scenario to "Arbitrary"

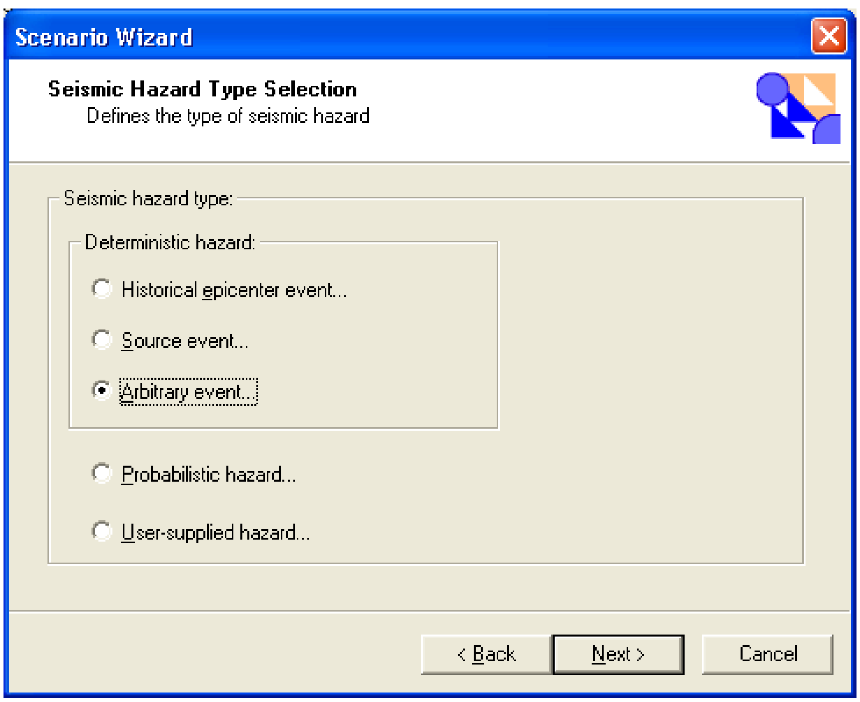
Use the Hazard | Scenario menu to start the scenario wizard:



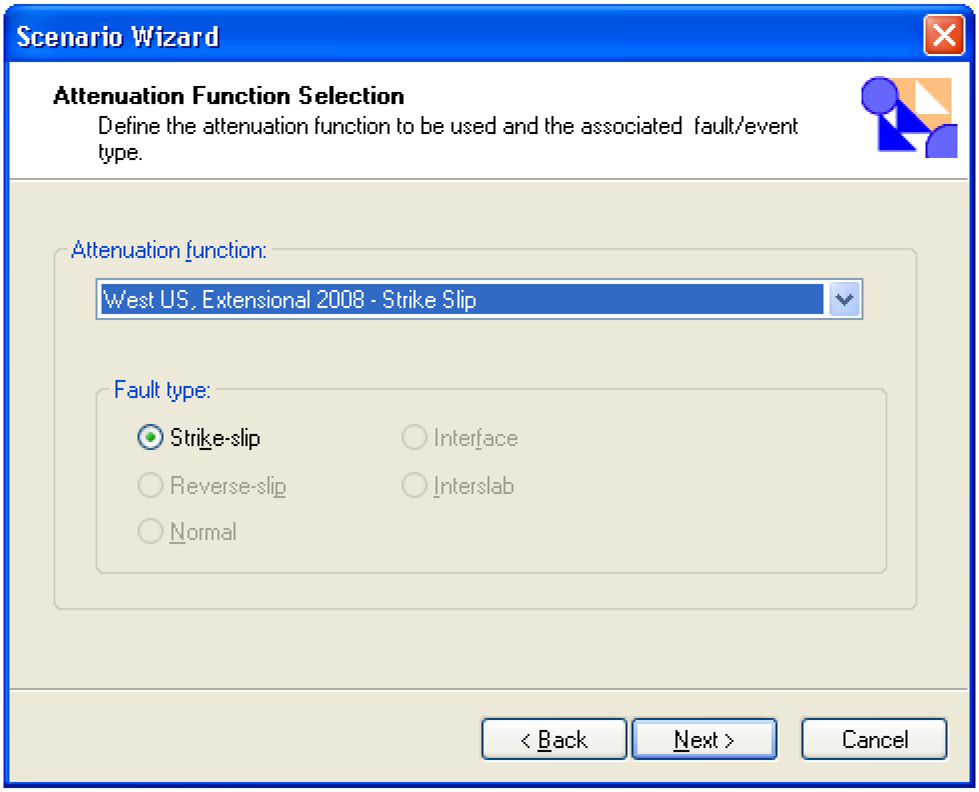
Click the Next button and choose to "Define a new scenario".



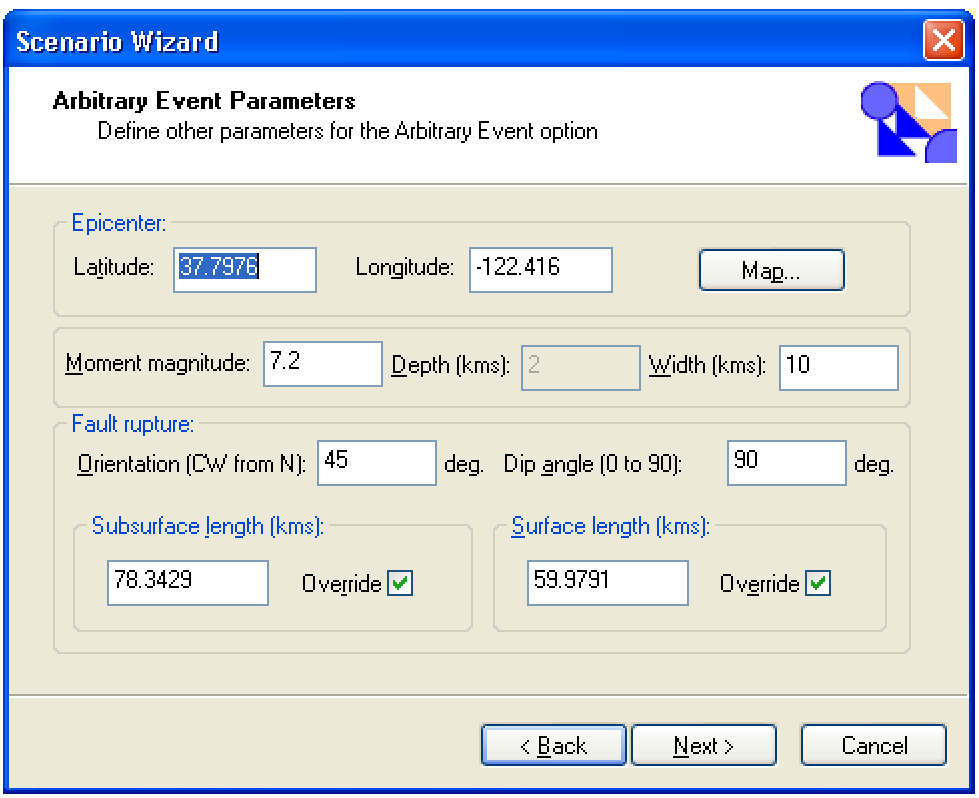
Select the “Arbitrary event” option, and click the Next button.



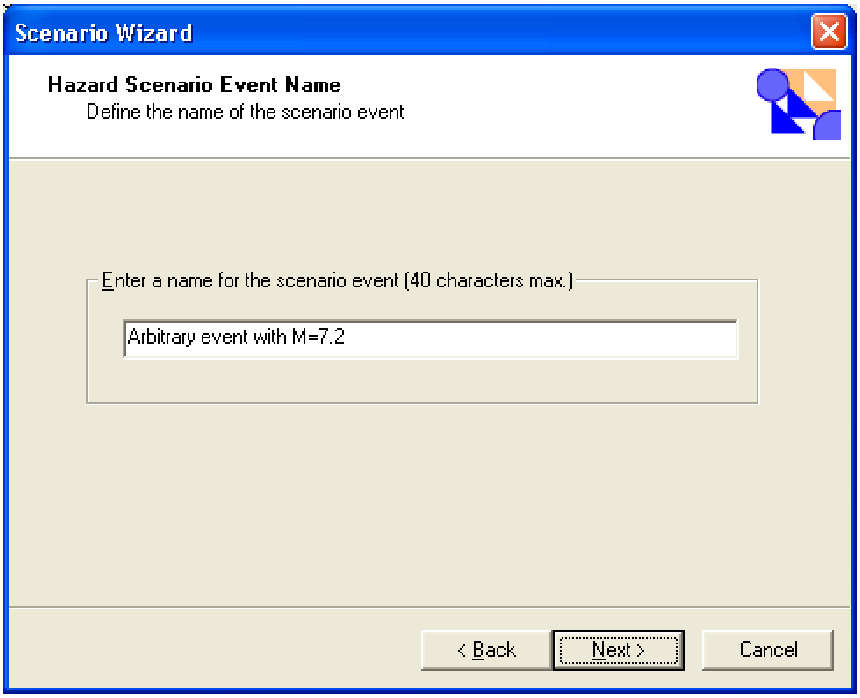
Select to use the “West US, Extensional 20008- Strike Slip” attenuation function.



Define the parameters of the arbitrary event exactly as shows in the following dialog.



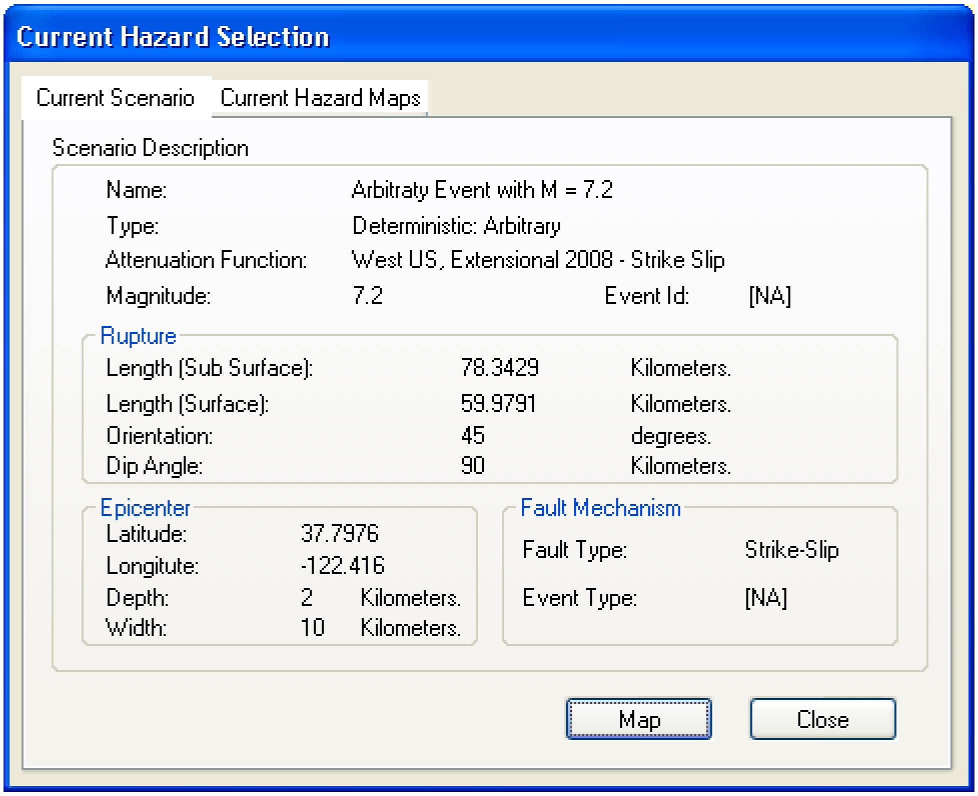
Name the event as follows and click the Next button. Click "Finish" at the last dialog to exit the wizard.



Click 'Next' and 'Finish' to create the scenario.

A.5.2 Show the Current Scenario

Use the Hazard | Show Current Scenario menu to review the current scenario.



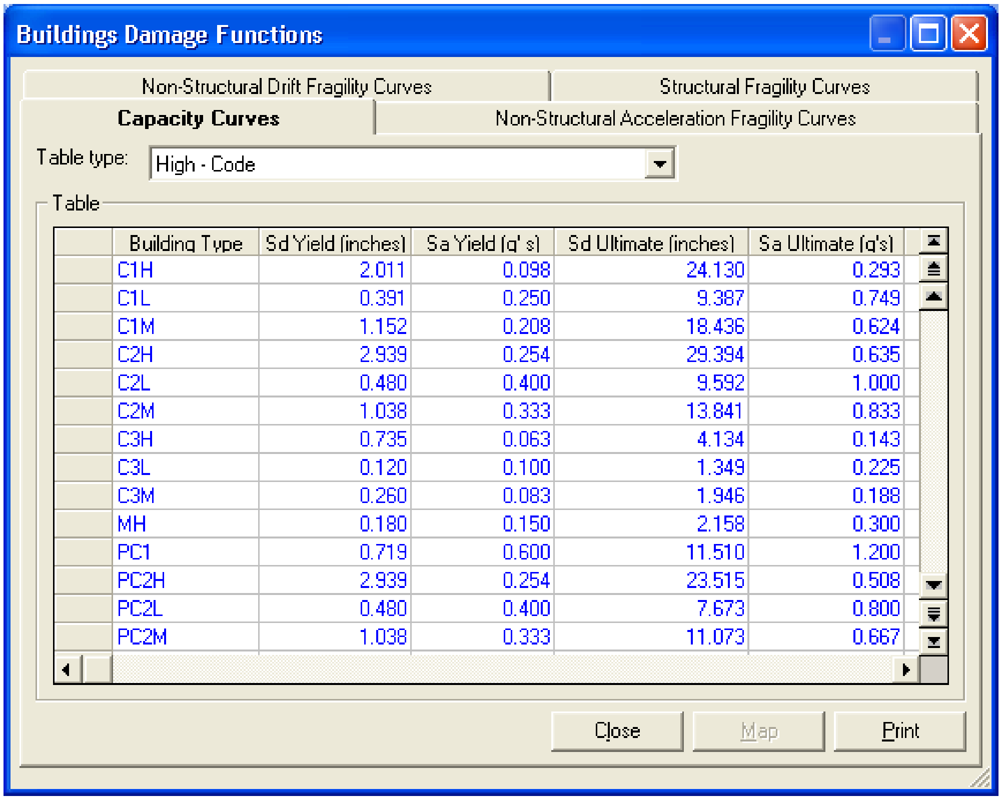
Click the Close button. This completes the Scenario menu.

A.6 Analysis Parameters Verification

These steps will demonstrate that the Analysis Parameters are functioning properly.

A.6.1 View Damage Functions

Click on the Analysis | Damage Functions | Buildings. Scroll to the right and resize some columns to get the screen below.

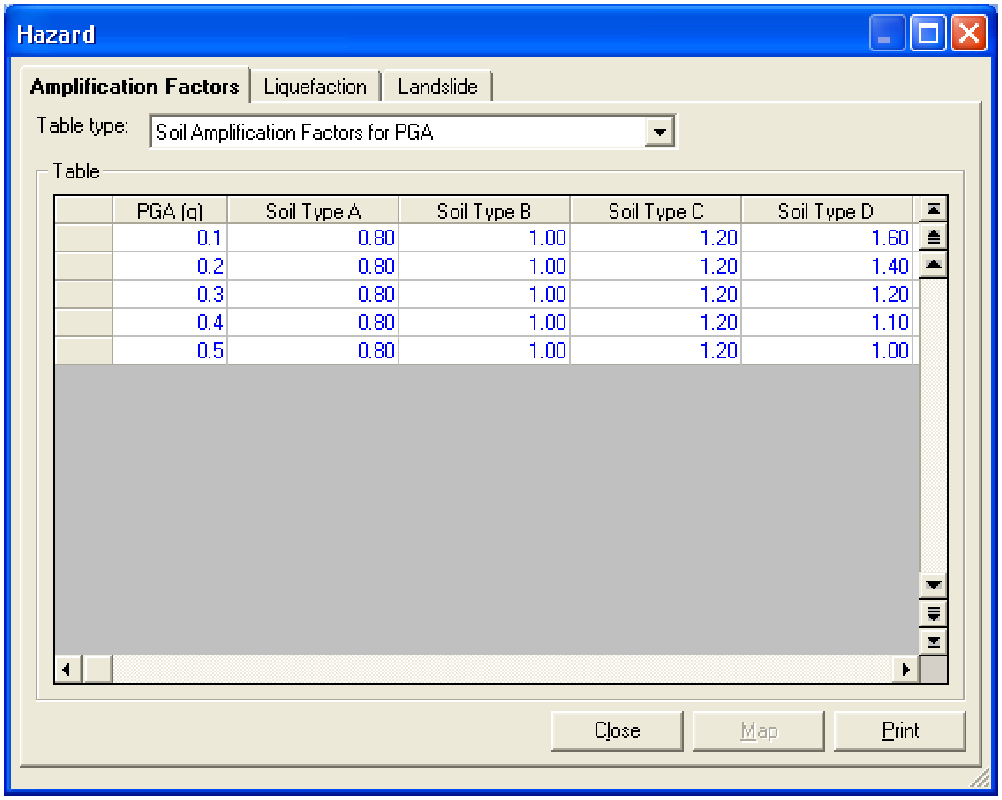


Building Type	Sd Yield (inches)	Sa Yield (g' s)	Sd Ultimate (inches)	Sa Ultimate (g's)
C1H	2.011	0.098	24.130	0.293
C1L	0.391	0.250	9.387	0.749
C1M	1.152	0.208	18.436	0.624
C2H	2.939	0.254	29.394	0.635
C2L	0.480	0.400	9.592	1.000
C2M	1.038	0.333	13.841	0.833
C3H	0.735	0.063	4.134	0.143
C3L	0.120	0.100	1.349	0.225
C3M	0.260	0.083	1.946	0.188
MH	0.180	0.150	2.158	0.300
PC1	0.719	0.600	11.510	1.200
PC2H	2.939	0.254	23.515	0.508
PC2L	0.480	0.400	7.673	0.800
PC2M	1.038	0.333	11.073	0.667

Close the window.

A.6.2 View Hazard Parameters

Click on Analysis | Parameters | Hazard. The following dialog should appear:



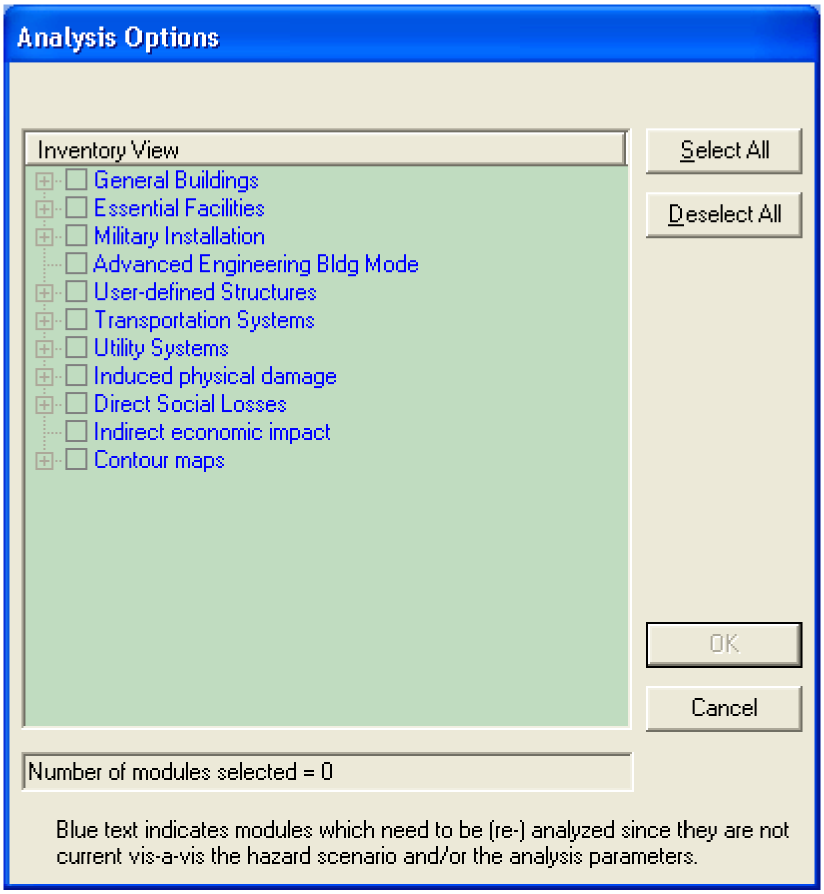
Close the dialog when done.

A.7 Analysis Run Verification

These steps will demonstrate that the Analysis Run Dialog is functioning properly.

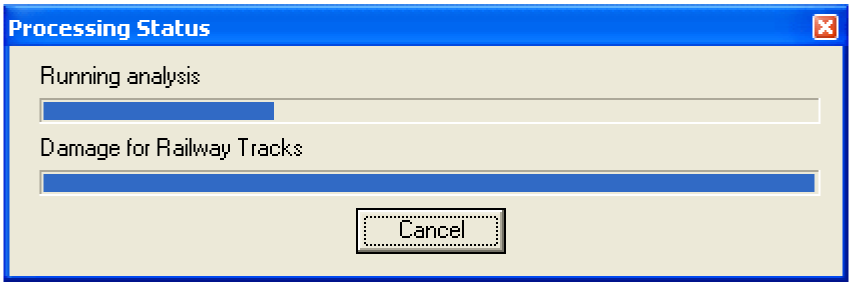
A.7.1 Open the Dialog

Click on the Analysis | Run menu option. This will bring up the analysis options dialog:



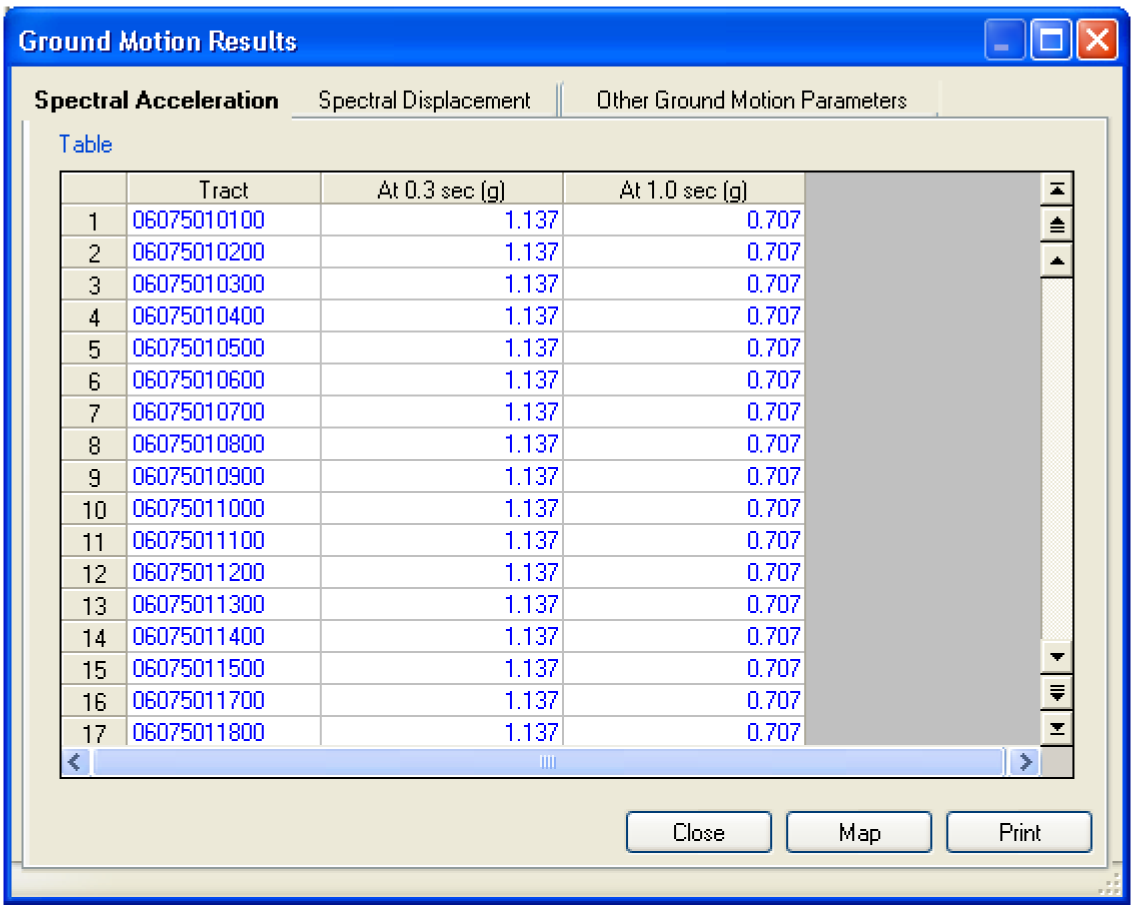
A.7.2 Start the Analysis

Click the "Select All" button and then "Run Analysis" to start the analysis. Answer 'Yes' to the following dialog. Click 'OK' and click 'Yes' to start the analysis. The "Processing Status" dialog is displayed showing the progress of the analysis. Once the analysis is completed, the dialog will close automatically (this scenario analysis will take about 3-5minutes on our typical machine).



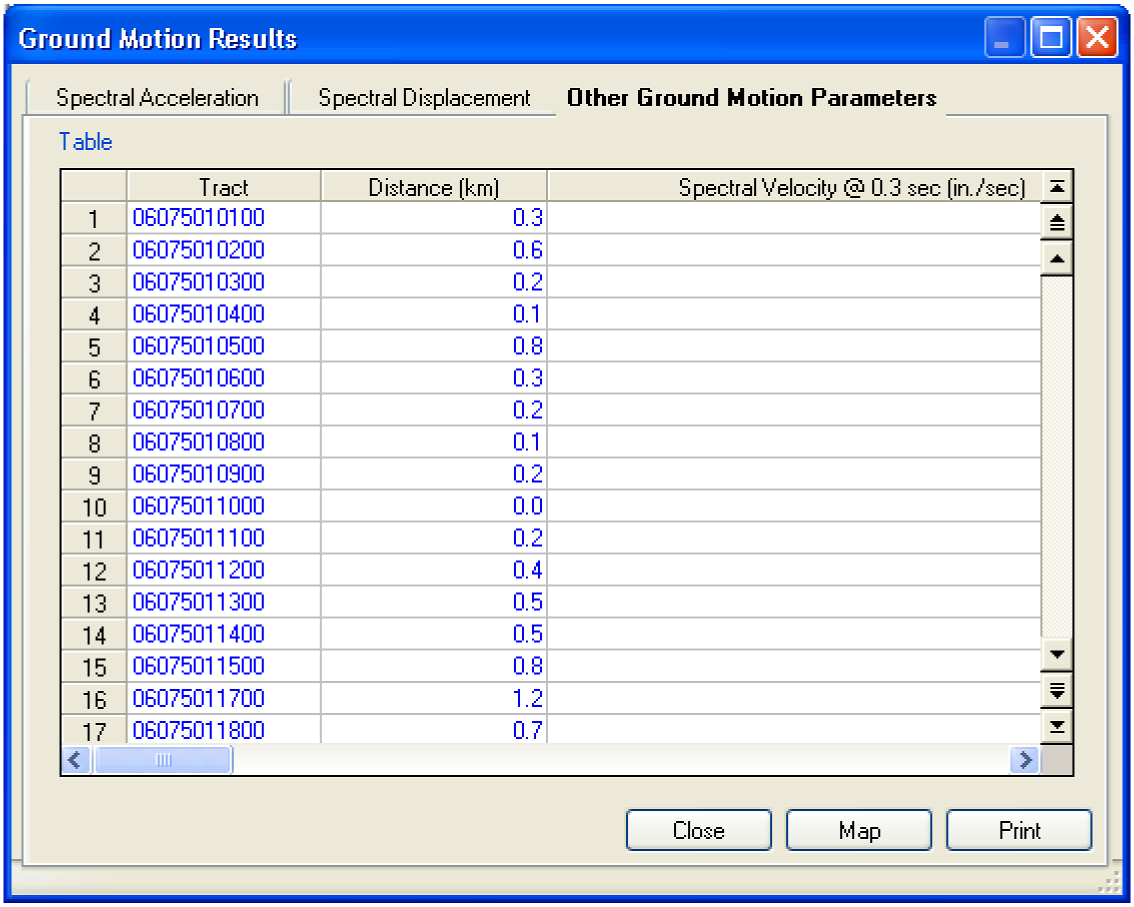
A.7.3 Viewing Ground Motion Results

Click on the Results | Ground Motion or Ground Failure | Ground Motion (By Census tract). This action will open the following dialog:



	Tract	At 0.3 sec (g)	At 1.0 sec (g)
1	06075010100	1.137	0.707
2	06075010200	1.137	0.707
3	06075010300	1.137	0.707
4	06075010400	1.137	0.707
5	06075010500	1.137	0.707
6	06075010600	1.137	0.707
7	06075010700	1.137	0.707
8	06075010800	1.137	0.707
9	06075010900	1.137	0.707
10	06075011000	1.137	0.707
11	06075011100	1.137	0.707
12	06075011200	1.137	0.707
13	06075011300	1.137	0.707
14	06075011400	1.137	0.707
15	06075011500	1.137	0.707
16	06075011700	1.137	0.707
17	06075011800	1.137	0.707

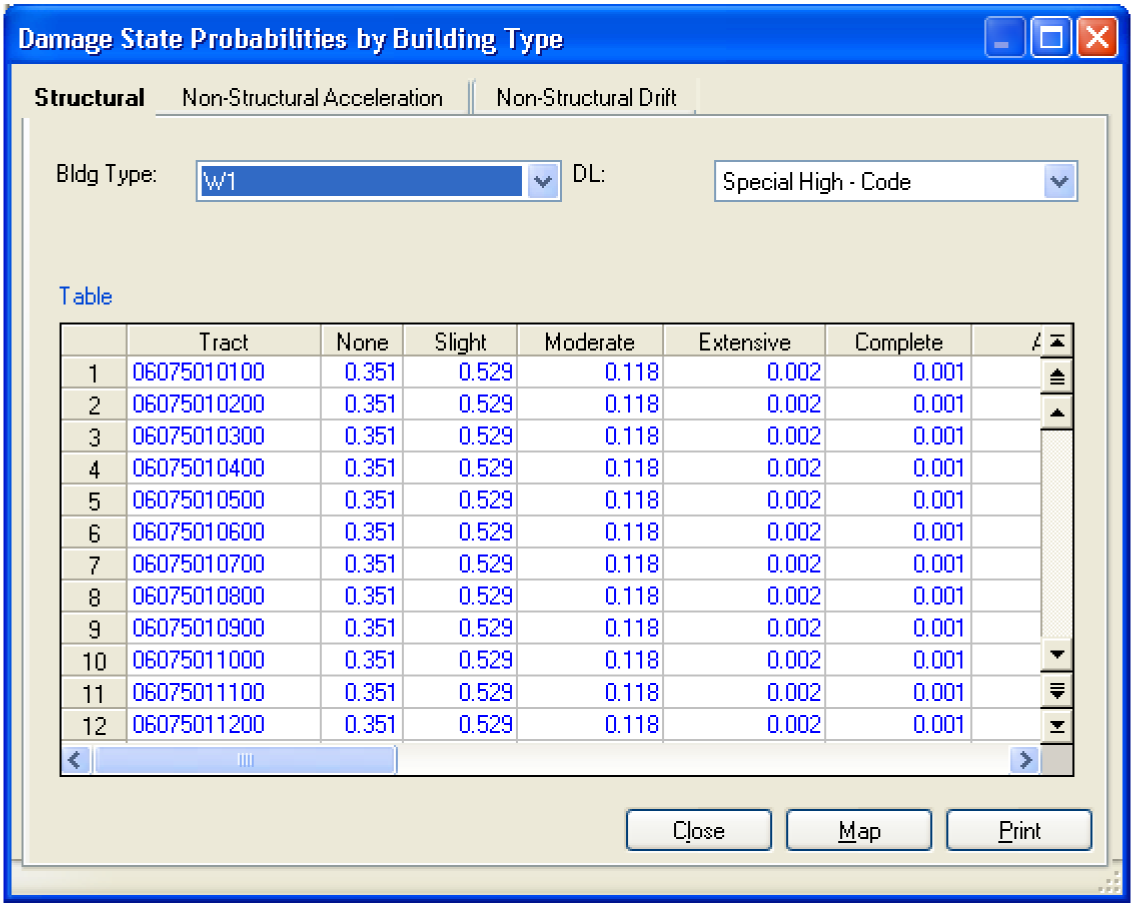
Because of the very small size of the region, the acceleration values are very close for the different tracts. Click the "Other Ground Motion Parameters" tab to get the following dialog.



Distances to the earthquake epicenter range from 30 to 30.2 kilometers.

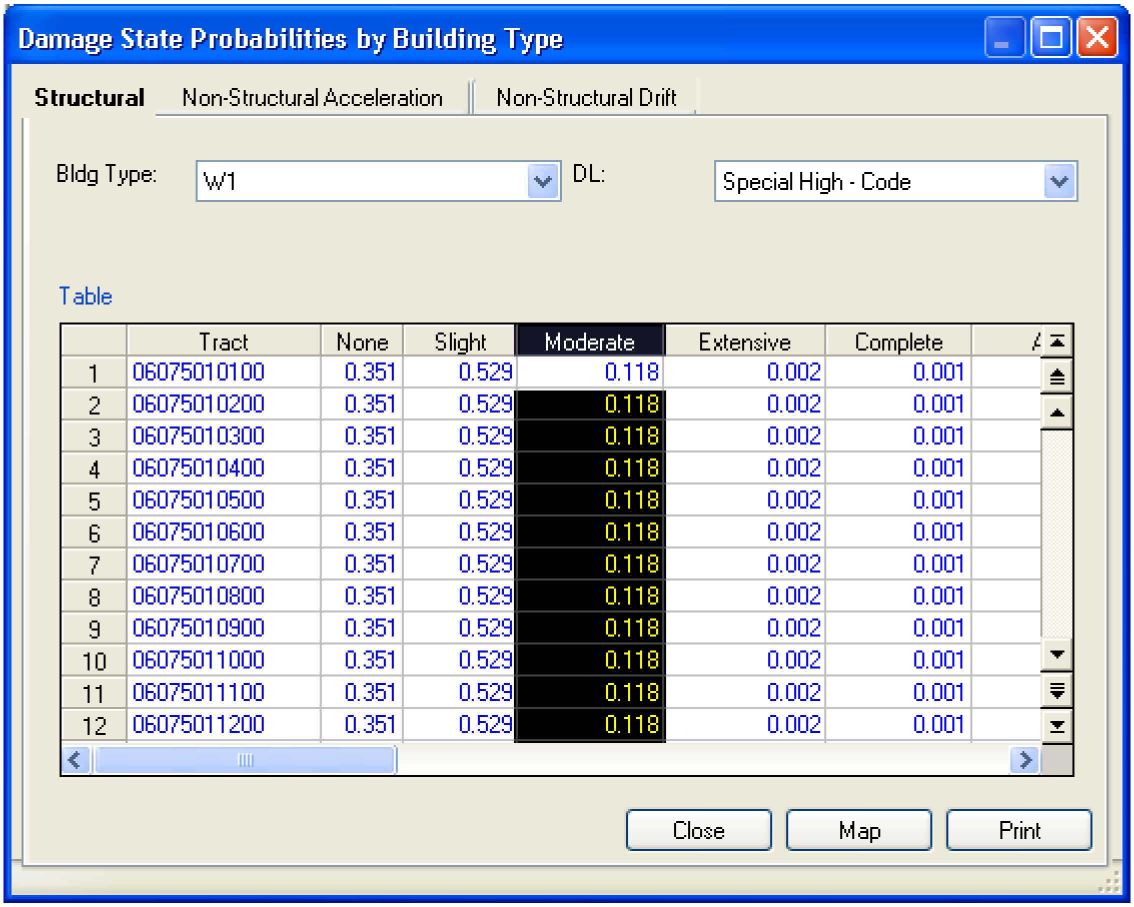
A.7.4 Viewing Building Damage Results

Click on the Results | General Building Stock | By Building Type. This action will open the following dialog:

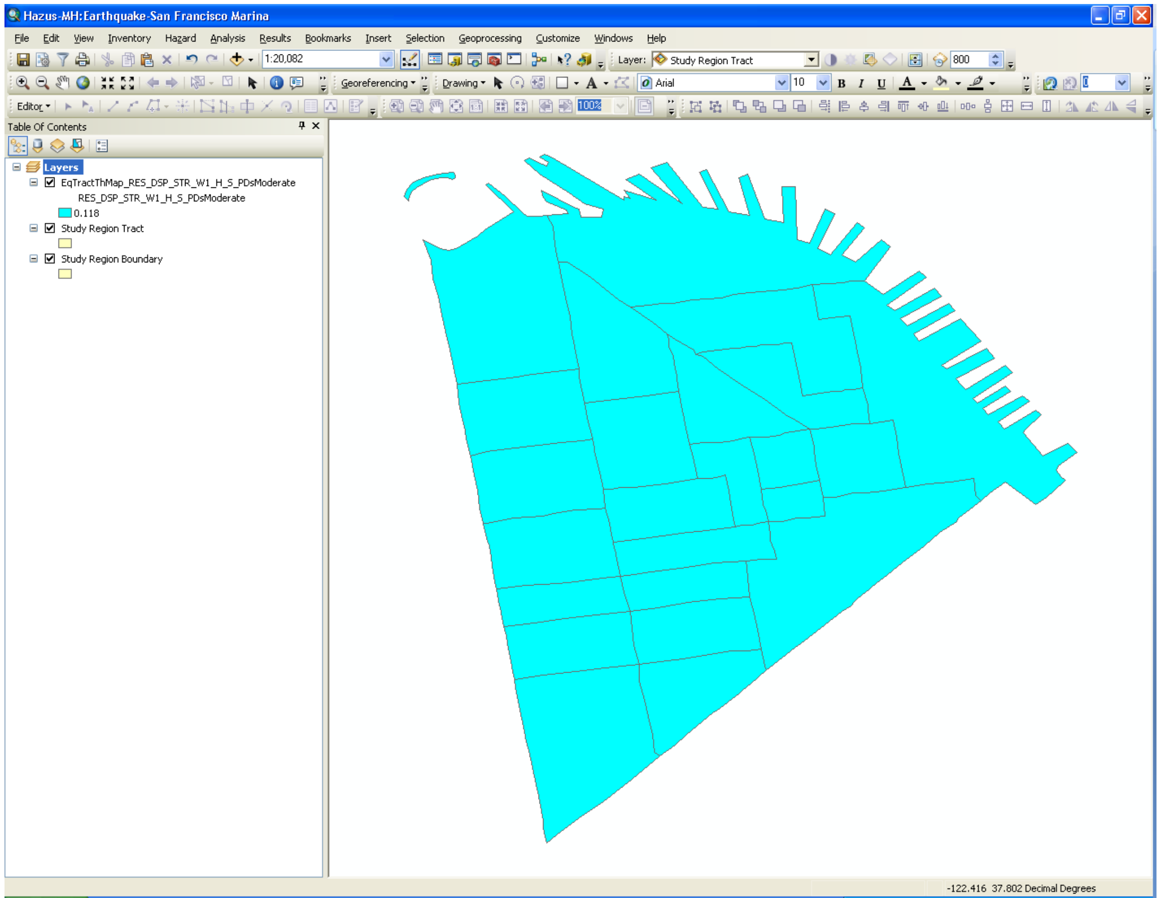


	Tract	None	Slight	Moderate	Extensive	Complete
1	06075010100	0.351	0.529	0.118	0.002	0.001
2	06075010200	0.351	0.529	0.118	0.002	0.001
3	06075010300	0.351	0.529	0.118	0.002	0.001
4	06075010400	0.351	0.529	0.118	0.002	0.001
5	06075010500	0.351	0.529	0.118	0.002	0.001
6	06075010600	0.351	0.529	0.118	0.002	0.001
7	06075010700	0.351	0.529	0.118	0.002	0.001
8	06075010800	0.351	0.529	0.118	0.002	0.001
9	06075010900	0.351	0.529	0.118	0.002	0.001
10	06075011000	0.351	0.529	0.118	0.002	0.001
11	06075011100	0.351	0.529	0.118	0.002	0.001
12	06075011200	0.351	0.529	0.118	0.002	0.001

Select the "Moderate" column and click on the map button. The following map should appear.



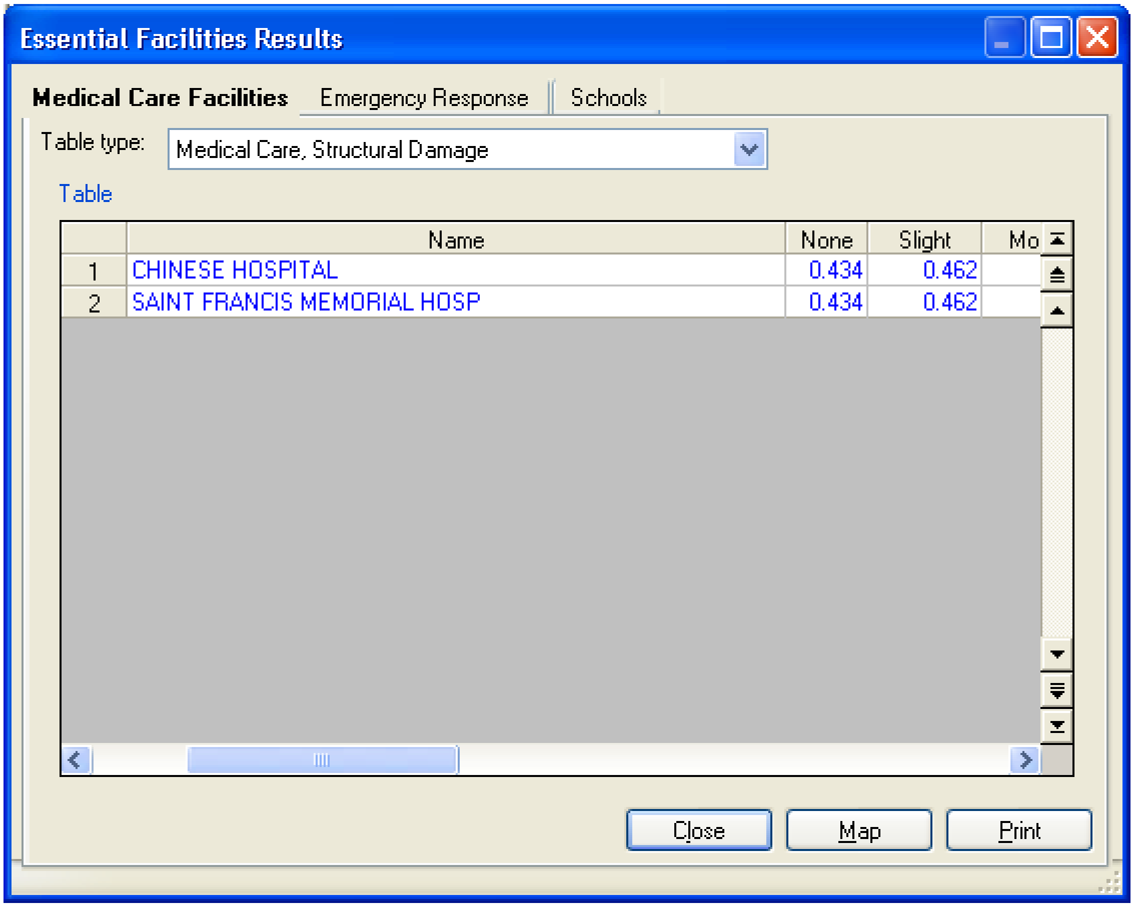
	Tract	None	Slight	Moderate	Extensive	Complete
1	06075010100	0.351	0.529	0.118	0.002	0.001
2	06075010200	0.351	0.529	0.118	0.002	0.001
3	06075010300	0.351	0.529	0.118	0.002	0.001
4	06075010400	0.351	0.529	0.118	0.002	0.001
5	06075010500	0.351	0.529	0.118	0.002	0.001
6	06075010600	0.351	0.529	0.118	0.002	0.001
7	06075010700	0.351	0.529	0.118	0.002	0.001
8	06075010800	0.351	0.529	0.118	0.002	0.001
9	06075010900	0.351	0.529	0.118	0.002	0.001
10	06075011000	0.351	0.529	0.118	0.002	0.001
11	06075011100	0.351	0.529	0.118	0.002	0.001
12	06075011200	0.351	0.529	0.118	0.002	0.001



You can examine other results for any building type and/or design level/building quality combination by simply selecting the option from the two relevant combo-boxes.

A.7.5 Essential Facility Damage

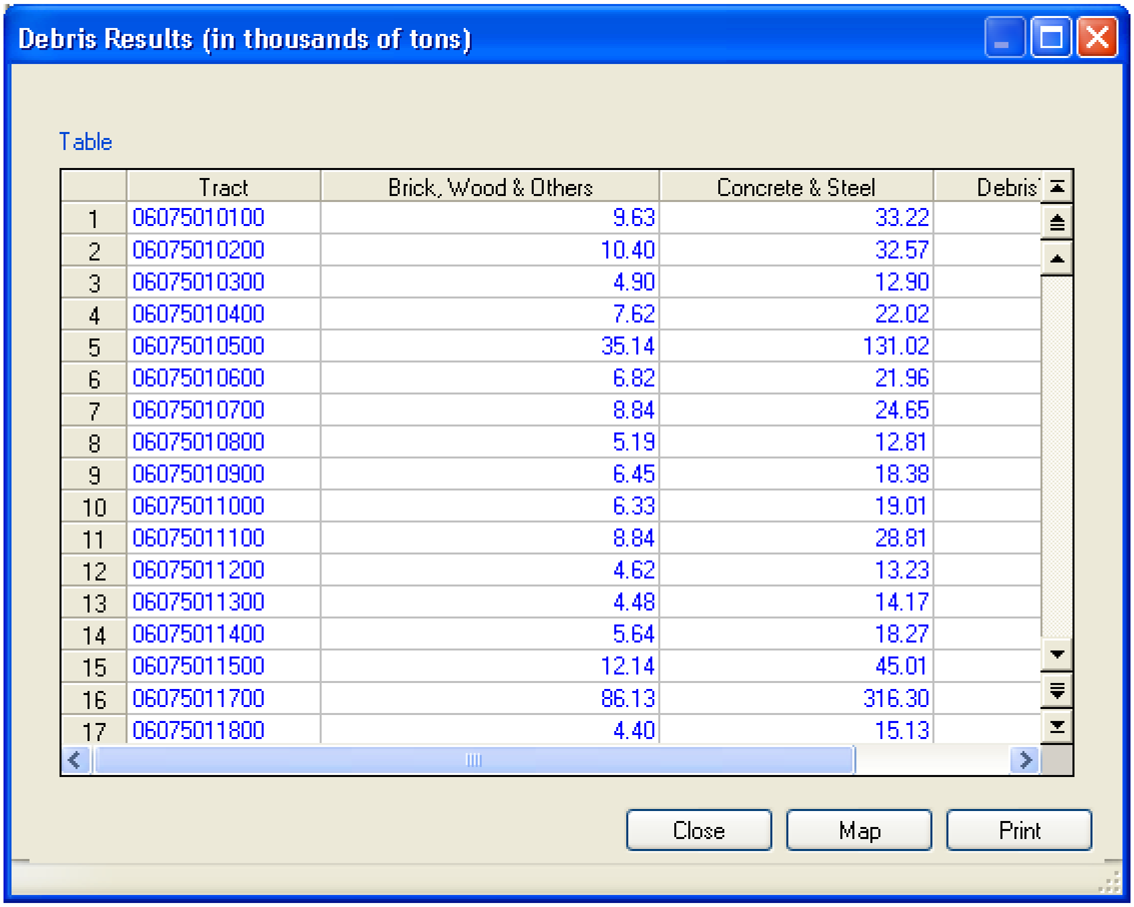
Click on the Results | Essential Facilities menu option. This action will open the following dialog:



You can view the results for the other essential facilities (emergency response and schools) by clicking the relevant tab.

A.7.6 Debris

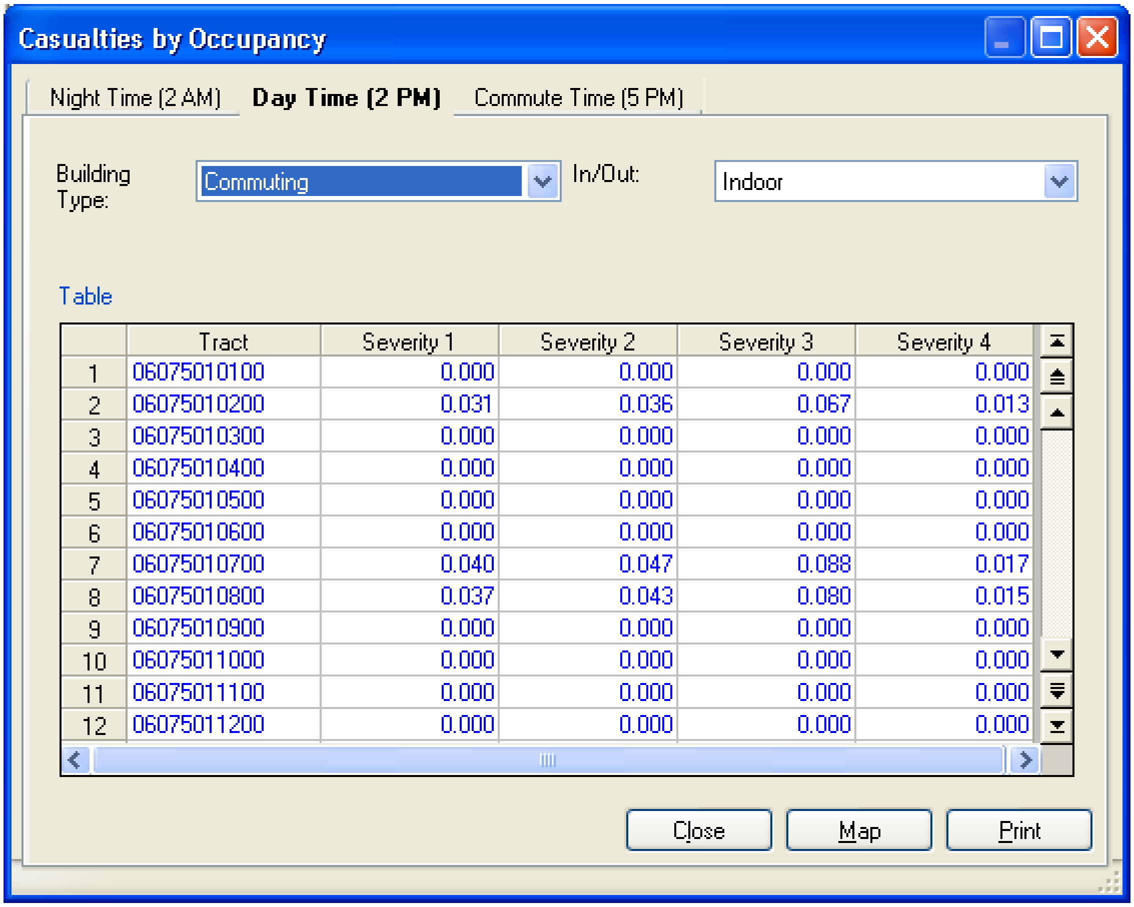
Click on the Results | Debris menu option. This action will open the following dialog:



	Tract	Brick, Wood & Others	Concrete & Steel	Debris
1	06075010100	9.63	33.22	
2	06075010200	10.40	32.57	
3	06075010300	4.90	12.90	
4	06075010400	7.62	22.02	
5	06075010500	35.14	131.02	
6	06075010600	6.82	21.96	
7	06075010700	8.84	24.65	
8	06075010800	5.19	12.81	
9	06075010900	6.45	18.38	
10	06075011000	6.33	19.01	
11	06075011100	8.84	28.81	
12	06075011200	4.62	13.23	
13	06075011300	4.48	14.17	
14	06075011400	5.64	18.27	
15	06075011500	12.14	45.01	
16	06075011700	86.13	316.30	
17	06075011800	4.40	15.13	

A.7.7 Casualties

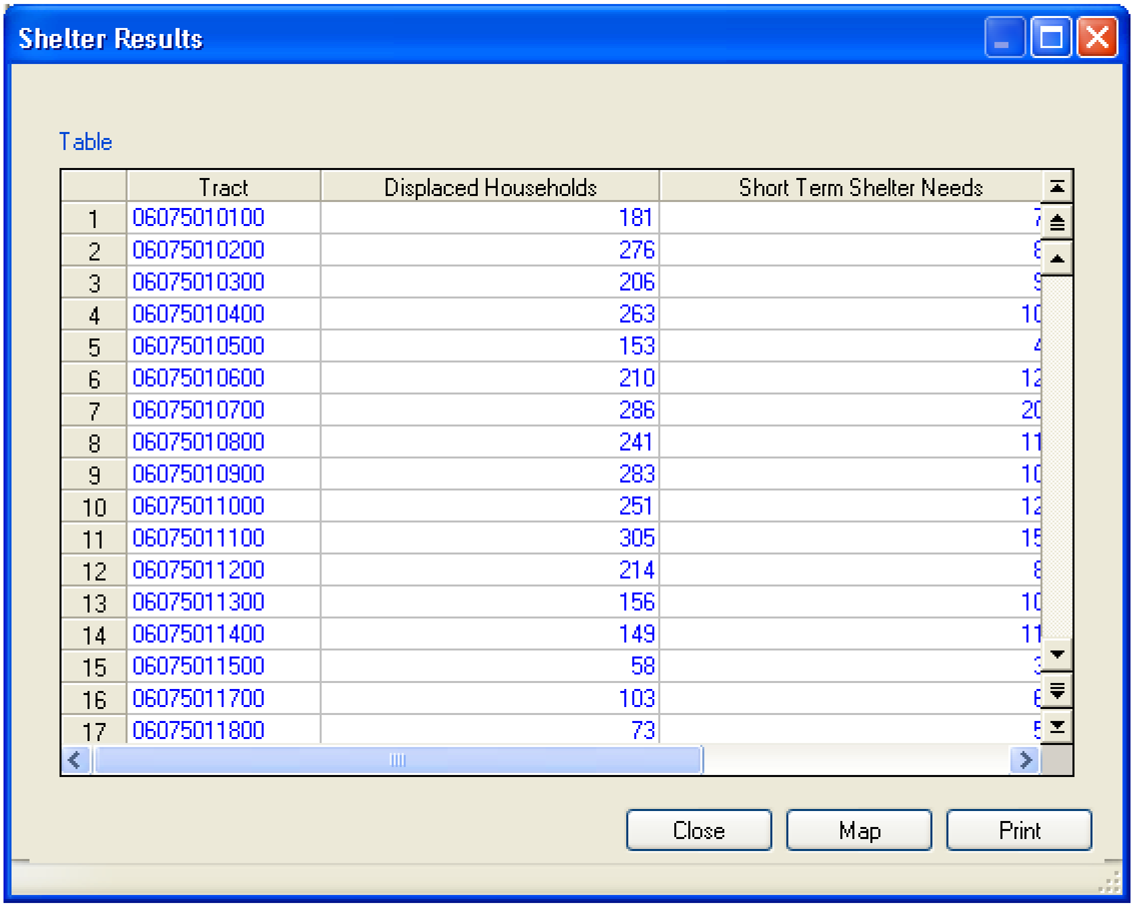
Click on Results | Casualties | By Occupancy. Select to view the indoor commercial casualties at 2PM (the time where most people will be in the offices). The following dialog appears.



	Tract	Severity 1	Severity 2	Severity 3	Severity 4
1	06075010100	0.000	0.000	0.000	0.000
2	06075010200	0.031	0.036	0.067	0.013
3	06075010300	0.000	0.000	0.000	0.000
4	06075010400	0.000	0.000	0.000	0.000
5	06075010500	0.000	0.000	0.000	0.000
6	06075010600	0.000	0.000	0.000	0.000
7	06075010700	0.040	0.047	0.088	0.017
8	06075010800	0.037	0.043	0.080	0.015
9	06075010900	0.000	0.000	0.000	0.000
10	06075011000	0.000	0.000	0.000	0.000
11	06075011100	0.000	0.000	0.000	0.000
12	06075011200	0.000	0.000	0.000	0.000

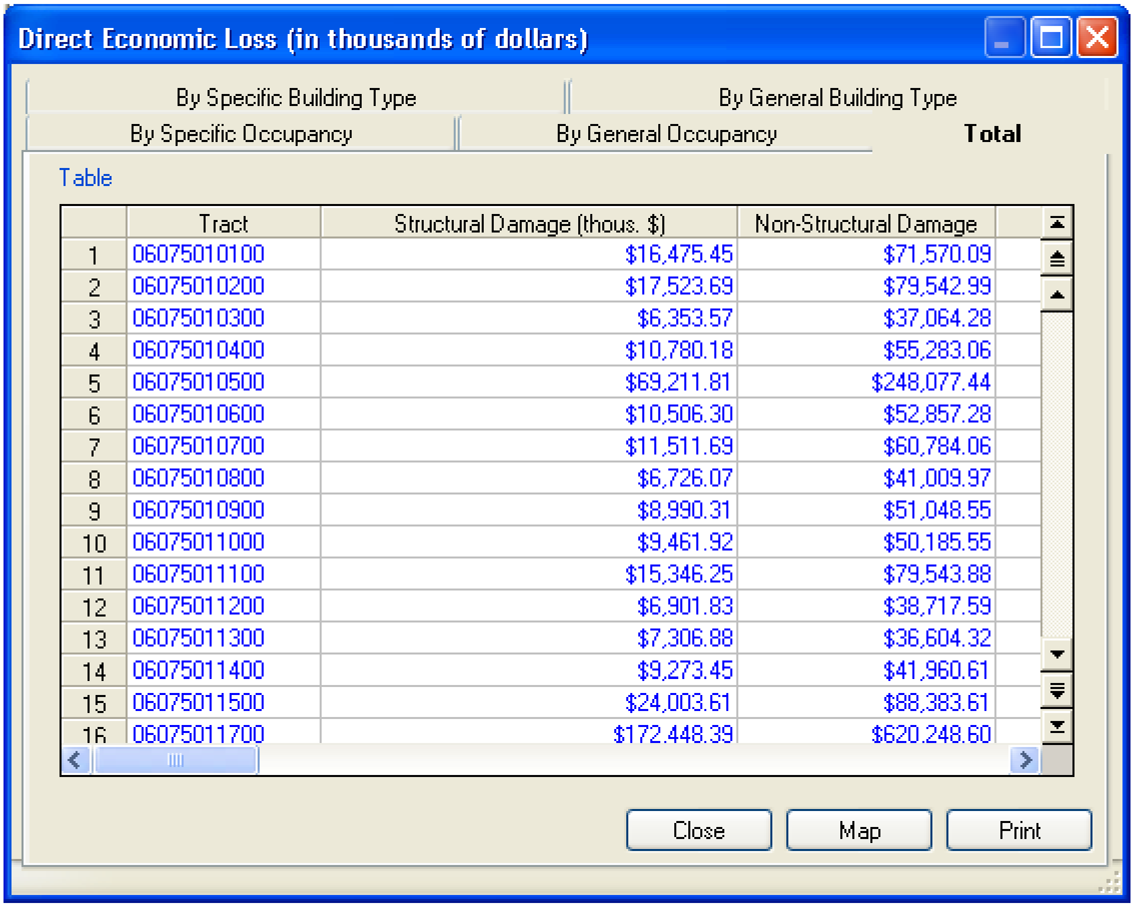
A.7.8 Shelter Requirements

Click on the Results | Shelter menu option. This action will open the following dialog:



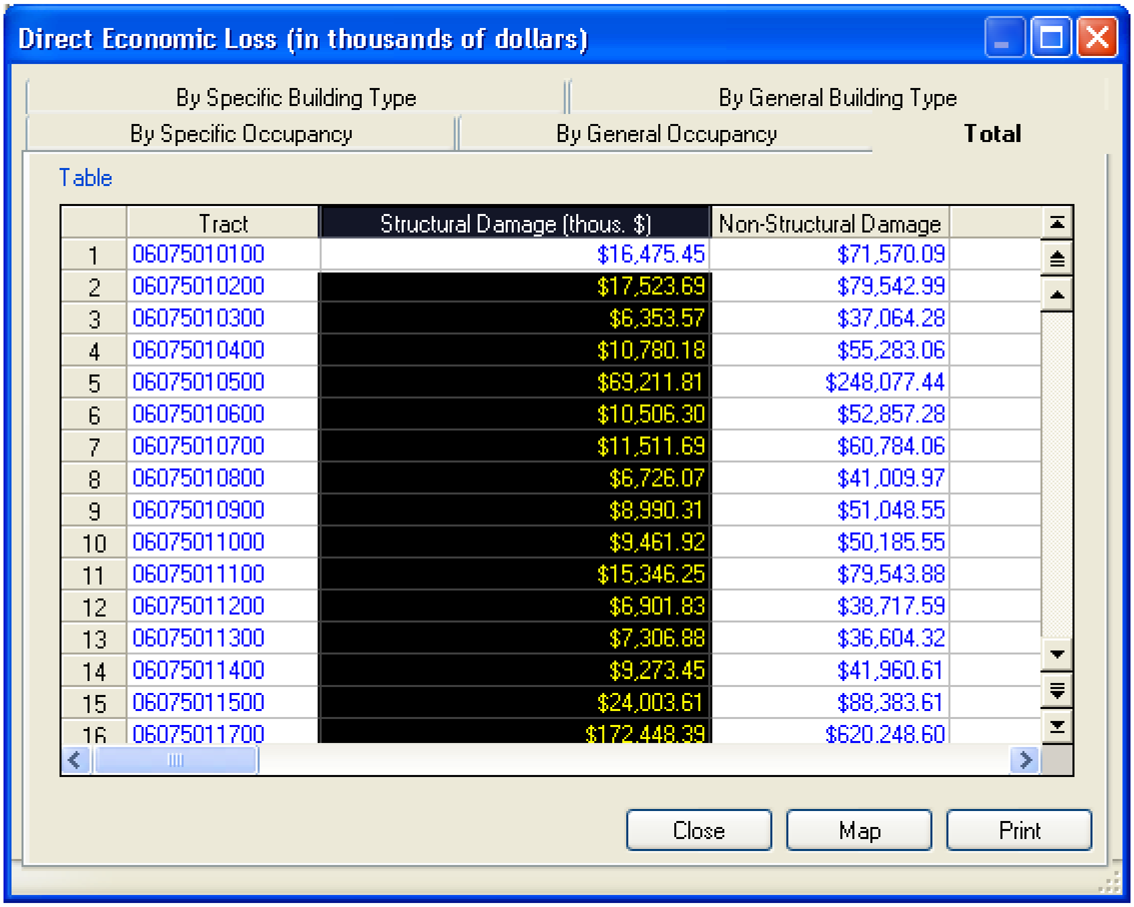
A.7.9 Direct Economic Losses

Click on the Results | General Building Loss | Building Economic Loss | Direct Economic Loss. Select the ‘Total’ tab and resize the columns and the dialog itself to show 3 columns as in the following dialog.



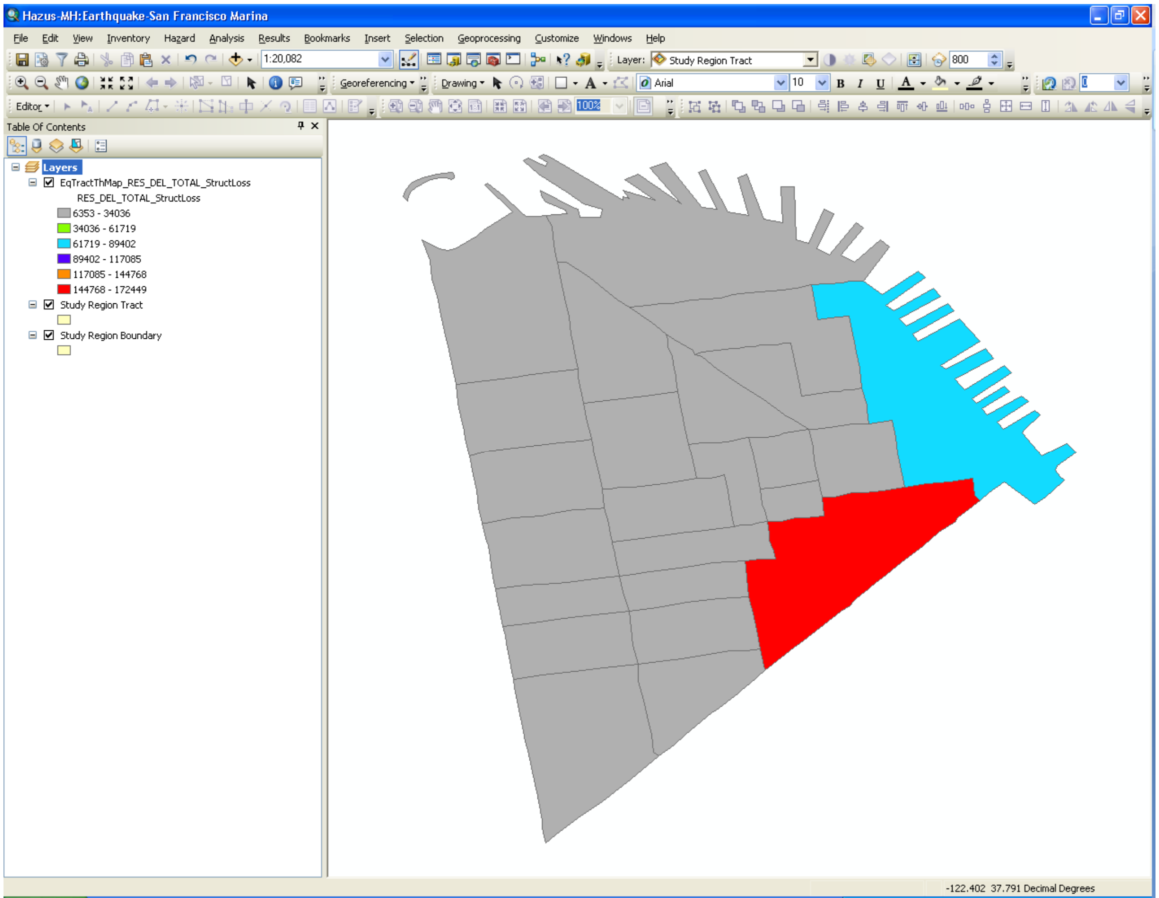
	Tract	Structural Damage (thous. $)	Non-Structural Damage
1	06075010100	$16,475.45	$71,570.09
2	06075010200	$17,523.69	$79,542.99
3	06075010300	$6,353.57	$37,064.28
4	06075010400	$10,780.18	$55,283.06
5	06075010500	$69,211.81	$248,077.44
6	06075010600	$10,506.30	$52,857.28
7	06075010700	$11,511.69	$60,784.06
8	06075010800	$6,726.07	$41,009.97
9	06075010900	$8,990.31	$51,048.55
10	06075011000	$9,461.92	$50,185.55
11	06075011100	$15,346.25	$79,543.88
12	06075011200	$6,901.83	$38,717.59
13	06075011300	$7,306.88	$36,604.32
14	06075011400	$9,273.45	$41,960.61
15	06075011500	$24,003.61	$88,383.61
16	06075011700	$172,448.39	$620,248.60

Select Structural Damage Column and Click Map



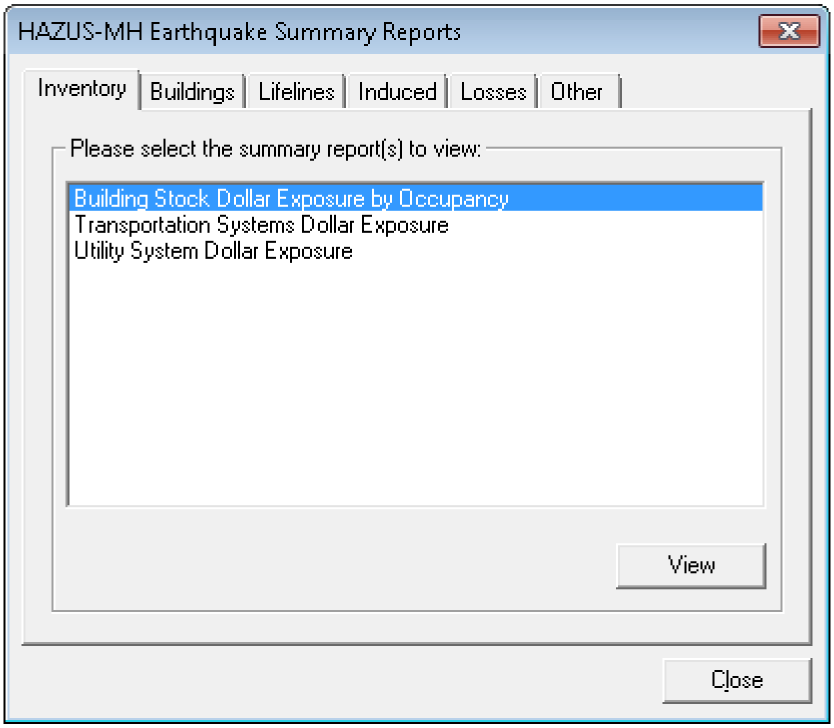
	Tract	Structural Damage (thous. $)	Non-Structural Damage
1	06075010100	$16,475.45	$71,570.09
2	06075010200	$17,523.69	$79,542.99
3	06075010300	$6,353.57	$37,064.28
4	06075010400	$10,780.18	$55,283.06
5	06075010500	$69,211.81	$248,077.44
6	06075010600	$10,506.30	$52,857.28
7	06075010700	$11,511.69	$60,784.06
8	06075010800	$6,726.07	$41,009.97
9	06075010900	$8,990.31	$51,048.55
10	06075011000	$9,461.92	$50,185.55
11	06075011100	$15,346.25	$79,543.88
12	06075011200	$6,901.83	$38,717.59
13	06075011300	$7,306.88	$36,604.32
14	06075011400	$9,273.45	$41,960.61
15	06075011500	$24,003.61	$88,383.61
16	06075011700	$172,448.39	$620,248.60

It will generate thematic map as shown below

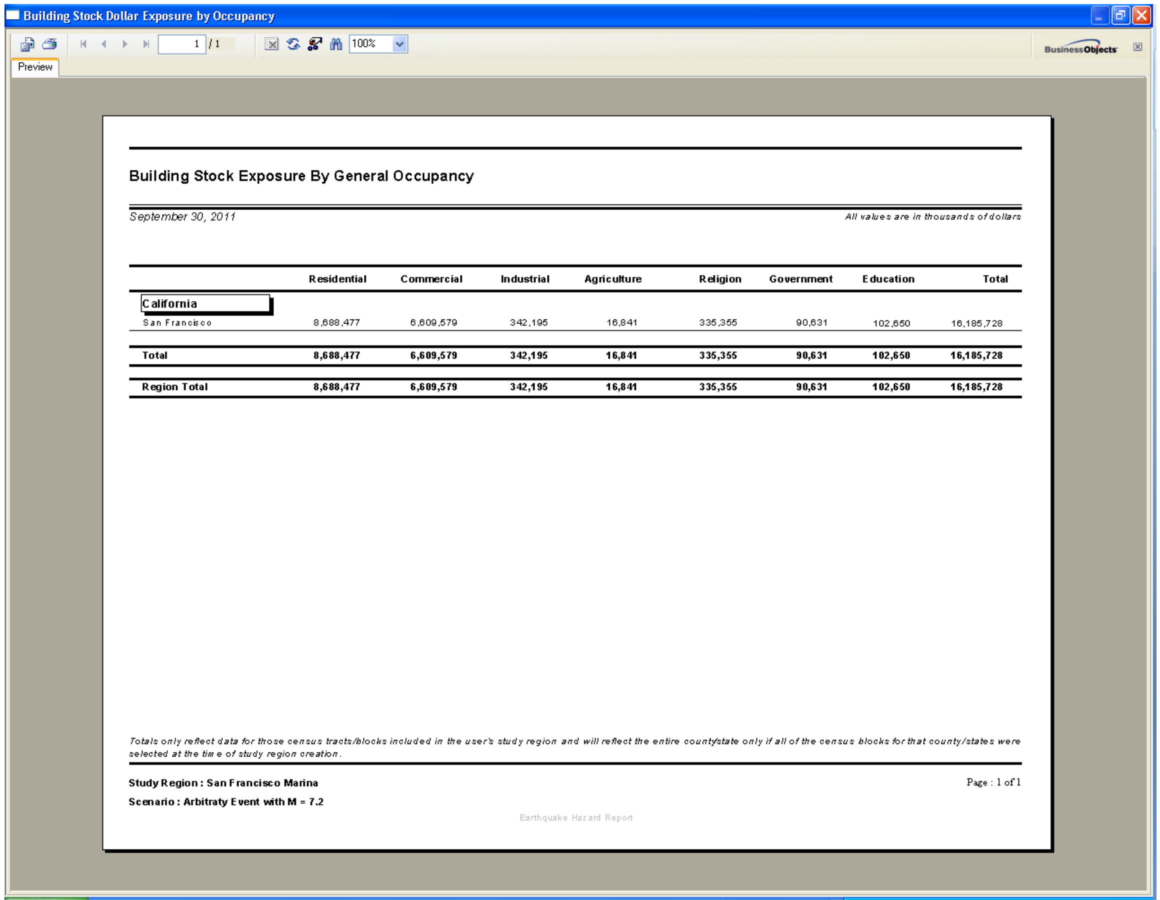


A.7.10 Summary Reports

Click on the Results | Summary Reports menu option. This action will open the following dialog:



Select ‘Building Stock Dollar Exposure by Occupancy’ and click ‘View’. Change the zoom level to 100%.



Building Stock Dollar Exposure by Occupancy

Preview

Building Stock Exposure By General Occupancy

September 30, 2011

All values are in thousands of dollars

	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
California								
San Francisco	8,688,477	6,609,579	342,195	16,841	335,355	90,631	102,650	16,185,728
Total	**8,688,477**	**6,609,579**	**342,195**	**16,841**	**335,355**	**90,631**	**102,650**	**16,185,728**
Region Total	**8,688,477**	**6,609,579**	**342,195**	**16,841**	**335,355**	**90,631**	**102,650**	**16,185,728**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

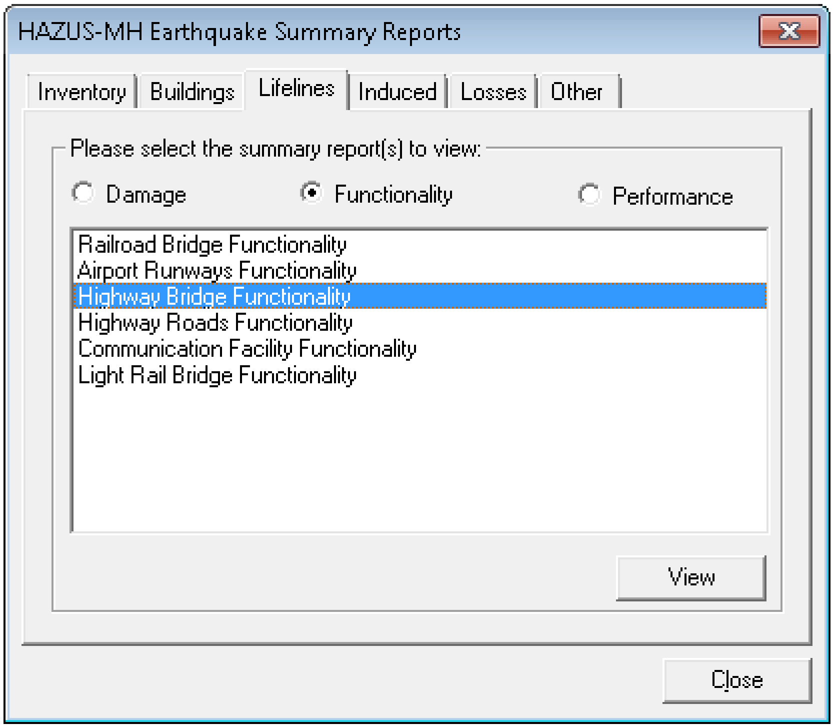
Study Region : San Francisco Marina

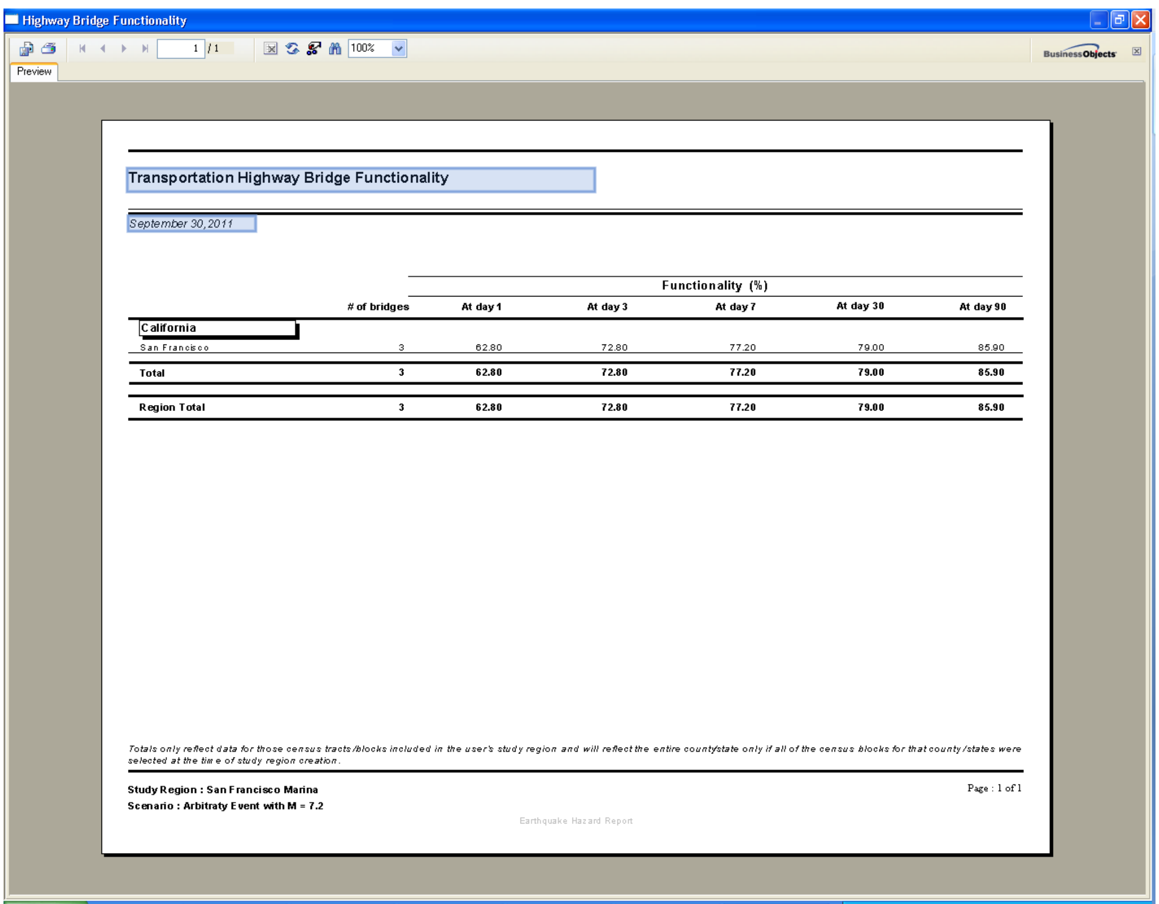
Scenario : Arbitraty Event with M = 7.2

Page : 1 of 1

Earthquake Hazard Report

Close the summary report by clicking the 'x' in the top right corner. Back at the summary report dialog, select the 'Lifelines' tab, 'Functionality' and pick 'Highway Bridge Functionality'. Click 'View' to view the report.


HAZUS-MH Earthquake Summary Reports
Inventory
Buildings
Lifelines
Induced
Losses
Other
Please select the summary report(s) to view:
Damage
Functionality
Performance
Railroad Bridge Functionality
Airport Runways Functionality
Highway Bridge Functionality
Highway Roads Functionality
Communication Facility Functionality
Light Rail Bridge Functionality
View
Close


Highway Bridge Functionality
Preview
Transportation Highway Bridge Functionality
September 30, 2011
Functionality (%)
# of bridges
At day 1
At day 3
At day 7
At day 30
At day 90
California
San Francisco
3
62.80
72.80
77.20
79.00
85.90
Total
Region Total
Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.
Study Region : San Francisco Marina
Scenario : Arbitraty Event with M = 7.2
Page : 1 of 1
Earthquake Hazard Report

This concludes the test cases for the Results menu.

A.8 Conclusion

If you have successfully completed all of the steps in the preceding sections, the Earthquake Model has been installed correctly and is functioning as intended. You may now proceed with further testing of the software.

Appendix B. Classification Systems

Table B.1 Site Classes

(from the 1997 *NEHRP Provisions*)

Site Class	Site Class Description	Shear Wave Velocity (m/sec)	
		Minimum	**Maximum**
A	HARD ROCK Eastern United States sites only	1500	
B	ROCK	760	1500
C	VERY DENSE SOIL AND SOFT ROCK Untrained shear strength $u_s \geq 2000$ psf ($u_s \geq 100$ kPa) or $N \geq 50$ blows/ft	360	760
D	STIFF SOILS Stiff soil with undrained shear strength 1000 psf $\leq u_s \leq$ 2000 psf (50 kPa $\leq u_s \leq$ 100 kPa) or $15 \leq N \leq 50$ blows/ft	180	360
E	SOFT SOILS Profile with more than 10 ft (3 m) of soft clay defined as soil with plasticity index PI > 20, moisture content w > 40% and undrained shear strength u_s < 1000 psf (50 kPa) (N < 15 blows/ft)		180
F	SOILS REQUIRING SITE SPECIFIC EVALUATIONS 1. Soils vulnerable to potential failure or collapse under seismic loading: e.g. liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays (10 ft (3 m) or thicker layer) 3. Very high plasticity clays: (25 ft (8 m) or thicker layer with plasticity index >75) 4. Very thick soft/medium stiff clays: (120 ft (36 m) or thicker layer)		

Table B.2 Structural Building Classifications (Model Building Types)

No.	Label	Description	Height			
			Range		Typical	
			Name	Stories	Stories	Feet
1	W1	Wood, Light Frame (≤ 5,000 sq. ft.)		1 - 2	1	14
2	W2	Wood, Greater than 5,000 sq. ft.		All	2	24
3	S1L	Steel Moment Frame	Low-Rise	1 - 3	2	24
4	S1M		Mid-Rise	4 - 7	5	60
5	S1H		High-Rise	8+	13	156
6	S2L	Steel Braced Frame	Low-Rise	1 - 3	2	24
7	S2M		Mid-Rise	4 - 7	5	60
8	S2H		High-Rise	8+	13	156
9	S3	Steel Light Frame		All	1	15
10	S4L	Steel Frame with Cast-in-Place Concrete Shear Walls	Low-Rise	1 - 3	2	24
11	S4M		Mid-Rise	4 - 7	5	60
12	S4H		High-Rise	8+	13	156
13	S5L	Steel Frame with Unreinforced Masonry Infill Walls	Low-Rise	1 - 3	2	24
14	S5M		Mid-Rise	4 - 7	5	60
15	S5H		High-Rise	8+	13	156
16	C1L	Concrete Moment Frame	Low-Rise	1 - 3	2	20
17	C1M		Mid-Rise	4 - 7	5	50
18	C1H		High-Rise	8+	12	120
19	C2L	Concrete Shear Walls	Low-Rise	1 - 3	2	20
20	C2M		Mid-Rise	4 - 7	5	50
21	C2H		High-Rise	8+	12	120
22	C3L	Concrete Frame with Unreinforced Masonry Infill Walls	Low-Rise	1 - 3	2	20
23	C3M		Mid-Rise	4 - 7	5	50
24	C3H		High-Rise	8+	12	120
25	PC1	Precast Concrete Tilt-Up Walls		All	1	15
26	PC2L	Precast Concrete Frames with Concrete Shear Walls	Low-Rise	1 - 3	2	20
27	PC2M		Mid-Rise	4 - 7	5	50
28	PC2H		High-Rise	8+	12	120
29	RM1L	Reinforced Masonry Bearing Wall s with Wood or Metal Deck Diaphragms	Low-Rise	1-3	2	20
30	RM2M		Mid-Rise	4+	5	50

31 32 33	RM2L RM2M RM2H	Reinforced Masonry Bearing Wall s with Precast Concrete Diaphragms	Low-Rise Mid-Rise High-Rise	1 - 3 4 - 7 8+	2 5 12	20 50 120
34 35	URML URMM	Unreinforced Masonry Bearing Walls	Low-Rise Mid-Rise	1 - 2 3+	1 3	15 35
36	MH	Mobile Homes		All	1	10

Table B.3 Building Occupancy Classes

Label	Occupancy Class	Example Descriptions
	Residential	
RES1	Single Family Dwelling	House
RES2	Mobile Home	Mobile Home
RES3	Multi Family Dwelling RES3A Duplex RES3B 3-4 Units RES3C 5-9 Units RES3D 10-19 Units RES3E 20-49 Units RES3F 50+ Units	Apartment/Condominium
RES4	Temporary Lodging	Hotel/Motel
RES5	Institutional Dormitory	Group Housing (military, college), Jails
RES6	Nursing Home	
	Commercial	
COM1	Retail Trade	Store
COM2	Wholesale Trade	Warehouse
COM3	Personal and Repair Services	Service Station/Shop

COM4	Professional/Technical Services	Offices
COM5	Banks	
COM6	Hospital	
COM7	Medical Office/Clinic	
COM8	Entertainment & Recreation	Restaurants/Bars
COM9	Theaters	Theaters
COM10	Parking	Garages
	Industrial	
IND1	Heavy	Factory
IND2	Light	Factory
IND3	Food/Drugs/Chemicals	Factory
IND4	Metals/Minerals Processing	Factory
IND5	High Technology	Factory
IND6	Construction	Office
	Agriculture	
AGR1	Agriculture	
	Religion/Non/Profit	
REL1	Church/Non-Profit	
	Government	
GOV1	General Services	Office
GOV2	Emergency Response	Police/Fire Station/EOC
	Education	
EDU1	Grade Schools	

EDU2	Colleges/Universities	Does not include group housing

Table B.4 Essential Facilities Classification

Label	Occupancy Class	Description
	Medical Care Facilities	
EFHS	Small Hospital	Hospital with less than 50 Beds
EFHM	Medium Hospital	Hospital with beds between 50 & 150
EFHL	Large Hospital	Hospital with greater than 150 Beds
EFMC	Medical Clinics	Clinics, Labs, Blood Banks
	Emergency Response	
EFFS	Fire Station	
EFPS	Police Station	
EFEO	Emergency Operation Centers	
	Schools	
EFS1	Grade Schools	Primary/ High Schools
EFS2	Colleges/Universities	

Table B.5 High Potential Loss Facilities Classification

Label	Description
	Dams
HPDE	Earth
HPDR	Rock fill
HPDG	Gravity
HPDB	Buttress

HPDA	Arch
HPDU	Multi-Arch
HPDC	Concrete
HPDM	Masonry
HPDS	Stone
HPDT	Timber Crib
HPDZ	Miscellaneous
	Nuclear Power Facilities
HPNP	Nuclear Power Facilities
	Military Installations
HPMI	Military Installations

Table B.6 Highway System Classification

Label	Description
	Highway Roads
HRD1	Major Roads
HRD2	Urban Roads
	Highway Bridges
HWB1	Major Bridge - Length > 150m (Conventional Design)
HWB2	Major Bridge - Length > 150m (Seismic Design)
HWB3	Single Span – (Not HWB1 or HWB2) (Conventional Design)
HWB4	Single Span – (Not HWB1 or HWB2) (Seismic Design)
HWB5	Concrete, Multi-Column Bent, Simple Support (Conventional Design), Non-California (Non-CA)
HWB6	Concrete, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
HWB7	Concrete, Multi-Column Bent, Simple Support (Seismic Design)
HWB8	Continuous Concrete, Single Column, Box Girder (Conventional Design)
HWB9	Continuous Concrete, Single Column, Box Girder (Seismic Design)
HWB10	Continuous Concrete, (Not HWB8 or HWB9) (Conventional Design)
HWB11	Continuous Concrete, (Not HWB8 or HWB9) (Seismic Design)
HWB12	Steel, Multi-Column Bent, Simple Support (Conventional Design), Non-California (Non-CA)
HWB13	Steel, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
HWB14	Steel, Multi-Column Bent, Simple Support (Seismic Design)
HWB15	Continuous Steel (Conventional Design)
HWB16	Continuous Steel (Seismic Design)
HWB17	PS Concrete Multi-Column Bent, Simple Support - (Conventional Design), Non-California
HWB18	PS Concrete, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
HWB19	PS Concrete, Multi-Column Bent, Simple Support (Seismic Design)
HWB20	PS Concrete, Single Column, Box Girder (Conventional Design)

HWB21	PS Concrete, Single Column, Box Girder (Seismic Design)
HWB22	Continuous Concrete, (Not HWB20/HWB21) (Conventional Design)
HWB23	Continuous Concrete, (Not HWB20/HWB21) (Seismic Design)
HWB24	Same definition as HWB12 except that the bridge length is less than 20 meters
HWB25	Same definition as HWB13 except that the bridge length is less than 20 meters
HWB26	Same definition as HWB15 except that the bridge length is less than 20 meters and Non-CA
HWB27	Same definition as HWB15 except that the bridge length is less than 20 meters and in CA
HWB28	All other bridges that are not classified (including wooden bridges)
	Highway Tunnels
HTU1	Highway Bored/Drilled Tunnel
HTU2	Highway Cut and Cover Tunnel

Table B.7 Railway System Classification

Label	Description
	Railway Tracks
RTR1	Railway Tracks
	Railway Bridges
RLB1	Steel, Multi-Column Bent, Simple Support (Conventional Design), Non-California (Non-CA)
RLB2	Steel, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
RLB3	Steel, Multi-Column Bent, Simple Support (Seismic Design)
RLB4	Continuous Steel (Conventional Design)
RLB5	Continuous Steel (Seismic Design)
RLB6	Same definition as HWB1 except that the bridge length is less than 20 meters

RLB7	Same definition as HWB2 except that the bridge length is less than 20 meters
RLB8	Same definition as HWB4 except that the bridge length is less than 20 meters and Non-CA
RLB9	Same definition as HWB5 except that the bridge length is less than 20 meters and in CA
RLB10	All other bridges that are not classified
	Railway Urban Station
RST	Rail Urban Station (with all building type options enabled)
	Railway Tunnels
RTU1	Rail Bored/Drilled Tunnel
RTU2	Rail Cut and Cover Tunnel
	Railway Fuel Facility
RFF	Rail Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)
	Railway Dispatch Facility
RDF	Rail Dispatch Facility (different combinations for with or without anchored components and/or with or without backup power)
	Railway Maintenance Facility
RMF	Rail Maintenance Facility (with all building type options enabled)

Table B.8 Light Rail System Classification

Label	Description
	Light Rail Tracks
LTR1	Light Rail Track
	Light Rail Bridges
LRB1	Steel, Multi-Column Bent, Simple Support (Conventional Design), Non-California (Non-CA)
LRB2	Steel, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
LRB3	Steel, Multi-Column Bent, Simple Support (Seismic Design)
LRB4	Continuous Steel (Conventional Design)
LRB5	Continuous Steel (Seismic Design)
LRB6	Same definition as HWB1 except that the bridge length is less than 20 meters
LRB7	Same definition as HWB2 except that the bridge length is less than 20 meters
LRB8	Same definition as HWB4 except that the bridge length is less than 20 meters and Non-CA
LRB9	Same definition as HWB5 except that the bridge length is less than 20 meters and in CA
LRB10	All other bridges that are not classified
	Light Rail Tunnels

LTU1	Light Rail Bored/Drilled Tunnel
LTU2	Light Rail Cut and Cover Tunnel
	DC Substation
LDC1	Light Rail DC Substation w/ Anchored Sub-Components
LDC2	Light Rail DC Substation w/ Unanchored Sub-Components
	Dispatch Facility
LDF	Light Rail Dispatch Facility (different combinations for with or without anchored components and/or with or without backup power)
	Maintenance Facility
LMF	Maintenance Facility (with all building type options enabled)

Table B.9 Bus System Classification

Label	Description
	Bus Urban Station
BPT	Bus Urban Station (with all building type options enabled)
	Bus Fuel Facility
BFF	Bus Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)
	Bus Dispatch Facility
BDF	Bus Dispatch Facility (different combinations for with or without anchored components and/or with or without backup power)
	Bus Maintenance Facility
BMF	Bus Maintenance Facilities (with all building type options enabled)

Table B.10 Port and Harbor System Classification

Label	Description
	Waterfront Structures
PWS	Waterfront Structures
	Cranes/Cargo Handling Equipment
PEQ1	Stationary Port Handling Equipment
PEQ2	Rail Mounted Port Handling Equipment
	Warehouses
PWH	Port Warehouses (with all building type options enabled)
	Fuel Facility
PFF	Port Fuel Facility Facility (different combinations for with or without anchored components and/or with or without backup power)

Table B.11 Ferry System Classification

Label	Description
	Water Front Structures
FWS	Ferry Waterfront Structures
	Ferry Passenger Terminals
FPT	Passenger Terminals (with all building type options enabled)
	Ferry Fuel Facility
FFF	Ferry Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)
	Ferry Dispatch Facility
FDF	Ferry Dispatch Facility (different combinations for with or without anchored components and/or with or without backup power)
	Ferry Maintenance Facility
FMF	Piers and Dock Facilities (with all building type options enabled)

Table B.12 Airport System Classification

Label	Description
	Airport Control Towers
ACT	Airport Control Tower (with all building type options enabled)
	Airport Terminal Buildings
ATB	Airport Terminal Building (with all building type options enabled)
	Airport Parking Structures
APS	Airport Parking Structure (with all building type options enabled)
	Fuel Facilities
AFF	Airport Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)
	Airport Maintenance & Hangar Facility
AMF	Airport Maintenance & Hangar Facility (with all building type options enabled)
ARW	Airport Runway
	Airport Facilities - Others
AFO	Gliderport, Seaport, Stolport, Ultralight or Baloonport Facilities
AFH	Heliport Facilities

Table B.13 Potable Water System Classification

Label	Description
	Pipelines
PWP1	Brittle Pipe
PWP2	Ductile Pipe
	Pumping Plants
PPPL	Large Pumping Plant (> 50 MGD) [different combinations for with or without anchored components]
PPPM	Medium Pumping Plant (10 to 50 MGD) [different combinations for with or without anchored components]
PPPS	Small Pumping Plant (< 10 MGD) [different combinations for with or without anchored components]
	Wells
PWE	Wells
	Water Storage Tanks (Typically, 0.5 MGD to 2 MGD)
PSTAS	Above Ground Steel Tank
PSTBC	Buried Concrete Tank
PSTGC	On Ground Concrete Tank
PSTGS	On Ground Steel Tank
PSTGW	On Ground Wood Tank
	Water Treatment Plants
PWTL	Large WTP (> 200 MGD) [different combinations for with or without anchored components]
PWTM	Medium WTP (50-200 MGD) [different combinations for with or without anchored components]
PWTS	Small WTP (< 50 MGD) [different combinations for with or without anchored components]

Table B.14 Waste Water System Classification

Label	Description
	Buried Pipelines
WWP1	Brittle Pipe
WWP2	Ductile Pipe
	Waste Water Treatment Plants
WWTL	Large WWTP (> 200 MGD) [different combinations for with or without anchored components]
WWTM	Medium WWTP (50-200 MGD) [different combinations for with or without anchored components]
WWTS	Small WWTP (< 50 MGD) [different combinations for with or without anchored components]
	Lift Stations
WLSL	Large Lift Stations (> 50 MGD) [different combinations for with or without anchored components]
WLSM	Medium Lift Stations (10 MGD - 50 MGD) [different combinations for with or without anchored components]
WLSS	Small Lift Stations (< 10 MGD) [different combinations for with or without anchored components]

Table B.5 Oil System Classification

Label	Description
	Pipelines
OIP1	Welded Steel Pipe with Gas Welded Joints
OIP2	Welded Steel Pipe with Arc Welded Joints
	Refineries
ORFL	Large Refinery (> 500,000 lb./day) [different combinations for with or without anchored components]
ORFM	Medium Refinery (100,000 - 500,000 lb./ day) [different combinations for with or without anchored components]
ORFS	Small Refinery (< 100,000 lb./day) [different combinations for with or without anchored components]
	Pumping Plants
OPP	Pumping Plant [different combinations for with or without anchored components]
	Tank Farms
OTF	Tank Farms with Anchored Tanks [different combinations for with or without anchored components]

Table B.16 Natural Gas System Classification

Label	Description
	Buried Pipelines
NGP1	Welded Steel Pipe with Gas Welded Joints
NGP2	Welded Steel Pipe with Arc Welded Joints
	Compressor Stations
NGC	Compressor Stations [different combinations for with or without anchored components]

Table B.17 Electric Power System Classification

Label	Description
	Transmission Substations
ESSL	Low Voltage (115 KV) Substation [different combinations for with or without anchored components]
ESSM	Medium Voltage (230 KV) Substation [different combinations for with or without anchored components]
ESSH	High Voltage (500 KV) Substation [different combinations for with or without anchored components]
	Distribution Circuits
EDC	Distribution Circuits (either Seismically Designed Components or Standard Components)
	Generation Plants
EPPL	Large Power Plants (> 500 MW) [different combinations for with or without anchored components]
EPPM	Medium Power Plants (100 - 500 MW) [different combinations for with or without anchored components]
EPPS	Small Power Plants (< 100 MW) [different combinations for with or without anchored components]

Table B.18 Communication Classification

Label	Description
	Central Offices
CCO	Central Offices (different combinations for with or without anchored components and/or with or without backup power)
	Stations or Transmitters
CBR	AM or FM radio stations or transmitters
CBT	TV stations or transmitters
CBW	Weather stations or transmitters
CBO	Other stations or transmitters

Table B.19 Mapping of Standard Industrial Codes to NIBS Occupancy Classes

Label	Occupancy Class	Standard Industrial Codes (SIC)
	Residential	
RES1	Single Family Dwelling	
RES2	Mobile Home	
RES3	Multi Family Dwelling	
RES4	Temporary Lodging	70
RES5	Institutional Dormitory	
RES6	Nursing Home	8051, 8052, 8059
	Commercial	
COM1	Retail Trade	52, 53, 54, 55, 56, 57, 59
COM2	Wholesale Trade	42, 50, 51
COM3	Personal and Repair Services	72, 75, 76, 83, 88
COM4	Business/Professional/Technical Services	40, 41, 44, 45, 46, 47, 49, 61, 62, 63, 64, 65, 67, 73, 78 (except 7832), 81, 87, 89
COM5	Depository Institutions	60
COM6	Hospital	8062, 8063, 8069
COM7	Medical Office/Clinic	80 (except 8051, 8052, 8059, 8062, 8063, 8069)
COM8	Entertainment & Recreation	48, 58, 79 (except 7911), 84

COM9	Theaters	7832, 7911
COM10	Parking	
	Industrial	
IND1	Heavy	22, 24, 26, 32, 34, 35 (except 3571, 3572), 37
IND2	Light	23, 25, 27, 30, 31, 36 (except 3671, 3672, 3674), 38, 39
IND3	Food/Drugs/Chemicals	20, 21, 28, 29
IND4	Metals/Minerals Processing	10, 12, 13, 14, 33
IND5	High Technology	3571, 3572, 3671, 3672, 3674
IND6	Construction	15, 16, 17
	Agriculture	
AGR1	Agriculture	01, 02, 07, 08, 09
	Religion/Non-Profit	
REL1	Church/Membership Organizations	86
	Government	
GOV1	General Services	43, 91, 92 (except 9221, 9224) , 93, 94, 95, 96, 97
GOV2	Emergency Response	9221, 9224
	Education	
EDU1	Schools/Libraries	82 (except 8221, 8222)
EDU2	Colleges/Universities	8221, 8222

Appendix C. Descriptions of Model Building Types

Table C.1 lists 36 model building types which have been defined for the methodology. The classification system is based on the classification system of FEMA-178 (1992). By reviewing the table it can be seen that there are 16 basic building types (shown in bold) with some building types being subdivided with respect to height. Each basic building class is defined by a short description of its structural system. These descriptions are based on FEMA-178 and follow Table C.1.

Table C.1 Structural Building Classifications (Model Building Types)

No.	Label	Description	Height
1	W1	Wood, Light Frame (W1)	ALL
2	W2	Wood, Commercial and Industrial (W2)	ALL
		Steel Moment Frame (S1)	
3	S1L	Low-Rise	1-3
4	S1M	Mid-Rise	4-7
5	S1H	High-Rise	8+
		Steel Braced Frame (S2)	
6	S2L	Low-Rise	1-3
7	S2M	Mid-Rise	4-7
8	S2H	High-Rise	8+
9	S3	Steel Light Frame (S3)	
		Steel Frame w/ Cast-in-Place Concrete Shear Walls (S4)	
10	S4L	Low-Rise	1-3
11	S4M	Mid-Rise	4-7
12	S4H	High-Rise	8+
		Steel Frame w/ Unreinforced Masonry Infill Walls (S5)	
13	S5L	Low-Rise	1-3
14	S5M	Mid-Rise	4-7
15	S5H	High-Rise	8+
		Reinforced Concrete Moment Resisting Frame (C1)	
16	C1L	Low-Rise	1-3
17	C1M	Mid-Rise	4-7
18	C1H	High-Rise	8+
		Concrete Shear Walls (C2)	
19	C2L	Low-Rise	1-3
20	C2M	Mid-Rise	4-7
21	C2H	High-Rise	8+
		Concrete Frame Buildings w/ Unreinforced Masonry Infill Walls (C3)	
22	C3L	Low-Rise	1-3
23	C3M	Mid-Rise	4-7
24	C3H	High-Rise	8+

Table C.1 Cont. Structural Building Classifications (Model Building Types)

No.	Label	Description	Height
		Precast-Concrete Tilt-Up Walls (PC1)	
25	PC1	Low-Rise	ALL
		Precast Concrete Frames w/ Concrete Shear Walls (PC2)	
26	PC2L	Low-Rise	1-3
27	PC2M	Mid-Rise	4-7
28	PC2H	High-Rise	8+
		Reinforced Masonry Bearing Walls w/ Wood or Metal Deck	
29	RM1L	Low-Rise	1-3
30	RM1M	Mid-Rise	4+
		Reinforced Masonry Bearing Walls w/ Precast Concrete Diaphragms	
31	RM2L	Low-Rise	1-3
32	RM2M	Mid-Rise	4-7
33	RM2H	High-Rise	8+
		Unreinforced Masonry Bearing Walls (URM)	
34	URML	Low-Rise	1-2
35	URMM	Mid-Rise	3+
36	MH	Mobile Home (MH)	

C.1 Wood, Light Frame (W1):

These are typically single- or multiple-family dwellings. The essential structural feature of these buildings is repetitive framing by wood rafters or joists on wood stud walls. Loads are light and spans are small. These buildings may have relatively heavy masonry chimneys and may be partially or fully covered with masonry veneer. Most of these buildings, especially the single-family residences, are not engineered but constructed in accordance with "conventional construction" provisions of building codes. Hence, they usually have the components of a lateral-force-resisting system even though it may be incomplete. Lateral loads are transferred by diaphragms to shear walls. The diaphragms are roof panels and floors which may be sheathed with wood, plywood or fiberboard sheathing. Shear walls are exterior walls sheathed with boards, stucco, plaster, plywood, gypsum board, particle board, or fiberboard, or interior partition walls sheathed with plaster or gypsum board.

C.2 Wood, Commercial and Industrial (W2):

These buildings usually are commercial or industrial buildings with a floor area of 5,000 square feet or more and with few, if any, interior walls. The essential structural character of these buildings is framing by beams or major horizontally spanning members over columns. These horizontal members may be glued-laminated (glu-lam) wood, solid-sawn wood beams, or wood trusses, or steel beams, or trusses. Lateral loads usually are resisted by wood diaphragms and exterior walls sheathed with plywood, stucco, plaster, or other paneling. The walls may have diagonal rod bracing. Large openings for storefronts and garages often require post-and-beam framing. Lateral load resistance on those lines may be achieved with steel rigid frames (moment frames) or diagonal bracing.

C.3 Steel Moment Frame (S1):

These buildings have a frame of steel columns and beams. In some cases, the beam-column connections have very small moment resisting capacity but, in other cases, some of the beams and columns are fully developed as moment frames to resist lateral forces. Usually the structure is concealed on the outside by exterior walls, which can be of almost any material (curtain walls, brick masonry, or precast concrete panels), and on the inside by ceilings and column furring. Lateral loads are transferred by diaphragms to moment resisting frames. The diaphragms can be almost any material. The frames develop their stiffness by full or partial moment connections. The frames can be located almost anywhere in the building. Usually the columns have their strong directions oriented so that some columns act primarily in one direction while the others act in the other direction. Steel moment frame buildings are typically more flexible than shear wall buildings. This low stiffness can result in large interstory drifts that may lead to relatively greater nonstructural damage.

C.4 Steel Braced Frame (S2):

These buildings are similar to steel moment frame buildings except that the vertical components of the lateral-force-resisting system are braced frames rather than moment frames.

C.5 Steel Light Frame (S3):

These buildings are pre-engineered and prefabricated with transverse rigid frames. The roof and walls consist of lightweight panels, usually corrugated metal. The frames are designed for maximum efficiency, often with tapered beam and column sections built up of light steel plates. The frames are built in segments and assembled in the field with bolted joints. Lateral loads in the transverse direction are resisted by the rigid frames with loads distributed to them by diaphragm elements, typically rod-braced steel roof framing bays. Loads in the longitudinal direction are resisted entirely by shear elements which can be either the roof and wall sheathing panels, an independent system of tension-only rod bracing, or a combination of panels and bracing.

C.6 Steel Frame with Cast-In-Place Concrete Shear Walls (S4):

The shear walls in these buildings are cast-in-place concrete and may be bearing walls. The steel frame is designed for vertical loads only. Lateral loads are transferred by diaphragms of almost any material to the shear walls. The steel frame may provide a secondary lateral-force-resisting system depending on the stiffness of the frame and the moment capacity of the beam-column connections. In modern “dual” systems, the steel moment frames are designed to work together with the concrete shear walls in proportion to their relative rigidities.

C.7 Steel Frame with Unreinforced Masonry Infill Walls (S5):

This is one of the older types of buildings. The infill walls usually are offset from the exterior frame members, wrap around them, and present a smooth masonry exterior with no indication of the frame. Solidly infilled masonry panels, when they fully engage the surrounding frame members (i.e. lie in the same plane), provide stiffness and lateral load resistance to the structure.

C.8 Reinforced Concrete Moment Resisting Frames (C1):

These buildings are similar to steel moment frame buildings except that the frames are reinforced concrete. There is a large variety of frame systems. Some older concrete frames may be proportioned and detailed such that brittle failure of the frame members can occur in earthquakes, leading to partial or full collapse of the buildings. Modern frames in zones of high seismicity are proportioned and detailed for ductile behavior and are likely to undergo large deformations during an earthquake without brittle failure of frame members and collapse.

C.9 Concrete Shear Walls (C2):

The vertical components of the lateral-force-resisting system in these buildings are concrete shear walls that are usually bearing walls. In older buildings, the walls often are quite extensive and the wall stresses are low but reinforcing is light. In newer buildings, the shear walls often are limited in extent, thus generation concerns about boundary members and overturning forces.

C.10 Concrete Frame Buildings with Unreinforced Masonry Infill Walls (C3):

These buildings are similar to steel frame buildings with unreinforced masonry infill walls except that the frame is of reinforced concrete. In these buildings, the shear strength of the columns, after cracking of the infill, may limit the semiductile behavior of the system.

C.11 Precast Concrete Tilt-Up Walls (PC1):

These buildings have a wood or metal deck roof diaphragm, which often is very large, that distributes lateral forces to precast concrete shear walls. The walls are thin but relatively heavy while the roofs are relatively light. Older buildings often have inadequate connections for anchorage of the walls to the roof for out-of-plane forces, and the panel connections often are brittle. Tilt-up buildings usually are one or two stories in height. Walls can have numerous openings for doors and windows of such size that the wall looks more like a frame than a shear wall.

C.12 Precast Concrete Frames with Concrete Shear Walls (PC2):

These buildings contain floor and roof diaphragms typically composed of precast concrete elements with or without cast-in-place concrete topping slabs. The diaphragms are supported by precast concrete girders and columns. The girders often bear on column corbels. Closure strips between precast floor elements and beam-column joints usually are cast-in-place concrete.

Welded steel inserts often are used to interconnect precast elements. Lateral loads are resisted by precast or cast-in-place concrete shear walls. For buildings with precast frames and concrete shear walls to perform well, the details used to connect the structural elements must have sufficient strength and displacement capacity; however, in some cases, the connection details between the precast elements have negligible ductility.

C.13 Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms (RM1):

These buildings have perimeter bearing walls of reinforced brick or concrete-block masonry. These walls are the vertical elements in the lateral-force-resisting system. The floors and roofs are framed either with wood joists and beams with plywood or straight or diagonal sheathing, or with steel beams with metal deck with or without a concrete fill. Wood floor framing is supported by interior wood posts or steel columns; steel beams are supported by steel columns.

C.14 Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms (RM2):

These buildings have bearing walls similar to those of reinforced masonry bearing wall structures with wood or metal deck diaphragms, but the roof and floors are composed of precast concrete elements such as planks or tee-beams and the precast roof and floor elements are supported on interior beams and columns of steel or concrete (cast-in-place or precast). The precast horizontal elements often have a cast-in-place topping.

C.15 Unreinforced Masonry Bearing Walls (URM):

These buildings include structural elements that vary depending on the building's age and, to a lesser extent, its geographic location. In buildings built before 1900, the majority of floor and roof construction consists of wood sheathing supported by wood subframing. In large multistory buildings, the floors are cast-in-place concrete supported by the unreinforced masonry walls and/or steel or concrete interior framing. In unreinforced masonry constructed after 1950 wood floors usually have plywood rather than board sheathing. In regions of lower seismicity, buildings of this type constructed more recently can include floor and roof framing that consists of metal deck and concrete fill supported by steel framing elements. The perimeter walls, and possibly some interior walls, are unreinforced masonry. The walls may or may not be anchored to the diaphragms. Ties between the walls and diaphragms are more common for the bearing walls than for walls that are parallel to the floor framing. Roof ties usually are less common and more erratically spaced than those at the floor levels. Interior partitions that interconnect the floors and roof can have the effect of reducing diaphragm displacements.

C.16 Mobile Homes (MH):

These are prefabricated housing units that are trucked to the site and then placed on isolated piers, jackstands, or masonry block foundations (usually without any positive anchorage). Floors and roofs of mobile homes usually are constructed with plywood and outside surfaces are covered with sheet metal.

Appendix D. Description of Lifeline Components

D.1 Highway Transportation System

Below is a list of highway components which have been defined for the methodology. The list indicates the 3 basic components of the transportation system. Some of these components are subdivided further.

- Highway Roads
- Highway Bridges
- Highway Tunnels

D.1.1 Highway Roads

Highway roads are classified as major roads and urban roads. Major roads include interstate and state highways and other roads with four lanes or more. Parkways are also classified as major roads. Urban roads include inter-city roads and other roads with two lanes.

D.1.2 Bridges

Bridges are classified based on the following structural characteristics:

- Seismic Design
- Number of spans: single vs. multiple span bridges
- Structure type: concrete, steel, others
- Pier type: multiple column bents, single column bents and pier walls
- Abutment type and bearing type: monolithic vs. non-monolithic; high rocker bearings, low steel bearings and neoprene rubber bearings
- Span continuity: continuous, discontinuous (in-span hinges), simply supported.
- The seismic design of a bridge is taken into account in terms of the (*i*) spectrum modification factor, (*ii*) strength reduction factor due to cyclic motion, (*iii*) drift limits, and (*iv*) the longitudinal reinforcement ratio.

This classification scheme incorporates various parameters that affect damage into fragility analysis and provides a means to obtain better fragility curves when data become available.

D.1.3 Tunnels

Tunnels are classified as:

- Bored/Drilled
- Cut & Cover

D.2 Railway Transportation System

Below is a list of railway components which have been defined for the methodology. By reviewing the list it can be seen that there are 7 basic components (shown in bold) with some being subdivided. Each component is defined by a short description below.

- Railway Tracks
- Railway Bridges
- Railway Tunnels
- Railway Urban Station
- Railway Fuel Facility
- Railway Dispatch Facility
- Railway Maintenance Facility

D.2.1 Tracks

The class Railway Tracks refers to the assembly of rails, ties, and fastenings, and the ground on which they rest. Only one classification is adopted for these components.

D.2.2 Bridges

The classes of railway bridges are considered analogous to those of major bridges in highway systems. That is they are considered to have at least one span greater than 500 feet. Railway bridges are classified based on the design criteria adopted in the design of these bridges.

- • Seismically designed/retrofitted bridges
- These bridges are either designed with seismic considerations or were retrofitted to comply with the seismic provisions.
- • Conventionally designed bridges
- These bridges are designed without taking seismic considerations into account.

D.2.3 Tunnels

Tunnels are classified as

- Bored/Drilled
- Cut & Cover

D.2.4 Railway System Facilities

- Railway system facilities include urban and suburban stations, maintenance facilities, fuel facilities, and dispatch facilities.
- **Urban and Suburban stations** are generally key connecting hubs that are important for system functionality. In the western U.S., these buildings are mostly made of reinforced concrete shear walls or moment resisting steel frames, while in the eastern U.S., the small stations are mostly wood and the large ones are mostly masonry or braced steel frames.
- **Fuel facilities** include buildings, tanks (anchored, unanchored, or buried), backup power systems (if available, anchored or unanchored diesel generators), pumps, and other equipment (anchored or unanchored). It should be mentioned that anchored equipment in general refers to equipment designed with special seismic tiedowns or tiebacks, while unanchored equipment refers to equipment designed with no special considerations other than the manufacturer's normal requirements. Above ground tanks are typically made of steel with roofs also made of steel. Buried tanks are typically concrete wall construction with concrete roofs. In total, five types of fuel facilities are considered. These are: fuel facilities with or without anchored equipment and with or without backup power (all combinations), and fuel facilities with buried tanks.
- **Dispatch facilities** consist of buildings, backup power supplies (if available, anchored or unanchored diesel generators), and electrical equipment (anchored or unanchored). In total, four types of dispatch facilities are considered. These are dispatch facilities with or without anchored equipment and with or without backup power (all combinations).
- **Maintenance facilities** are housed in large structures that are not usually critical for system functionality as maintenance activities can be delayed or performed elsewhere. These building structures are often low-rise steel braced frames.

D.3 Light Railway Transportation System

A light rail system consists mainly of six components: tracks, bridges, tunnels, maintenance facilities, dispatch facilities, and DC power substations. These components are listed below.

- Light Rail Tracks
- Light Rail Bridges
- Light Rail Tunnels
- DC Substation
- Dispatch Facility
- Maintenance Facility

D.3.1 Tracks

The class Light Rail Tracks refers to the assembly of rails, ties, and fastenings, and the ground on which they rest. Only one classification is adopted for these components.

D.3.2 Bridges

The classes of light rail bridges are considered analogous to those of bridges in highway systems. Light rail bridges are classified based on the design criteria adopted in the design of these bridges.

- • Seismically designed/retrofitted bridges

These bridges are either designed with seismic considerations or were retrofitted to comply with the seismic provisions.

- • Conventionally designed bridges

These bridges are designed without taking seismic considerations into account.

D.3.3 Tunnels

Tunnels are classified as

- Bored/Drilled
- Cut & Cover

D.3.4 Railway System Facilities

Railway system facilities include DC power substations, dispatch facilities, and maintenance facilities.

- **DC Power Substations** provide DC power used by the light rail electrical distribution system. Light rail systems have low voltage DC power which consists of electrical equipment that converts the local electric utility AC power to DC power. Two types of DC power stations are considered. These are DC power stations with anchored components and DC power stations with unanchored components.
- **Dispatch facilities** consist of buildings, backup power supplies (if available, anchored or unanchored diesel generators), and electrical equipment (anchored or unanchored). In total, four types of dispatch facilities are considered. These are dispatch facilities with or without anchored equipment and with or without backup power (all combinations).
- **Maintenance facilities** are housed in large structures that are not usually critical for system functionality as maintenance activities can be delayed or performed elsewhere. These building structures are often low-rise steel braced frames.

D.4 Bus Transportation System

A bus system consists mainly of four basic components: urban stations, fuel facilities, dispatch facilities, and maintenance facilities. These components are listed below.

- Bus Urban Station
- Bus Fuel Facility
- Bus Dispatch Facility
- Bus Maintenance Facility

D.4.1 Urban and Suburban Stations

Urban and suburban stations are generally key connecting hubs that are important for system functionality. In the western U.S., these buildings are mostly made of reinforced concrete shear walls or moment resisting steel frames, while in the eastern U.S., the small stations are mostly wood and the large ones are mostly masonry or braced steel frames.

D.4.2 Bus System Fuel Facilities

A fuel facility includes buildings, tanks (anchored, unanchored, or buried), backup power systems (if available, anchored or unanchored diesel generators), pumps, and other equipment (anchored or unanchored). It should be mentioned that anchored equipment in general refers to equipment designed with special seismic tiedowns or tiebacks, while unanchored equipment refers to equipment designed with no special considerations other than the manufacturer's normal requirements. Above ground tanks are typically made of steel with roofs also made of steel. Buried tanks are typically concrete wall construction with concrete roofs. In total, five types of fuel facilities are considered. These are: fuel facilities with or without anchored equipment and with or without backup power (all combinations), and fuel facilities with buried tanks.

D.4.3 Bus System Dispatch Facilities

Dispatch facilities consist of buildings, backup power supplies (if available, anchored or unanchored diesel generators), and electrical equipment (anchored or unanchored). In total, four types of dispatch facilities are considered. These are dispatch facilities with or without anchored equipment and with or without backup power (all combinations).

D.4.4 Bus System Maintenance Facilities

Maintenance facilities for bus systems are housed in large structures that are not usually critical for system functionality as maintenance activities can be delayed or performed elsewhere. These building structures are mostly low-rise steel braced frames.

D.5 Port Transportation Systems

A port system consists of four basic components: waterfront structures, cranes/cargo handling equipment, warehouses and fuel facilities as listed below. This section provides a brief description of each.

- Waterfront Structures
- Cranes/Cargo Handling Equipment
- Warehouses
- Fuel Facility

D.5.1 Waterfront Structures

This component includes the wharf, seawalls, and piers that exist in the port system. Waterfront structures typically are supported by wood, steel or concrete piles. Many also have batter piles to resist lateral loads from wave action and impact of vessels. Seawalls are caisson walls retaining earth fill material.

D.5.2 Cranes and Cargo Handling Equipment

These are large equipment items used to load and unload freight from vessels. These can be stationary or mounted on rails.

D.5.3 Port Fuel Facilities

Fuel facilities include buildings, tanks (anchored, unanchored, or buried), backup power systems (if available, anchored or unanchored diesel generators), pumps, and other equipment (anchored or unanchored). It should be mentioned that anchored equipment in general refers to equipment designed with special seismic tiedowns or tiebacks, while unanchored equipment refers to equipment designed with no special considerations other than the manufacturer's normal requirements. Above ground tanks are typically made of steel with roofs also made of steel. Buried tanks are typically concrete wall construction with concrete roofs. In total, five types of fuel facilities are considered. These are: fuel facilities with or without anchored equipment and with or without backup power (all combinations), and fuel facilities with buried tanks.

D.5.4 Warehouses

Warehouses are large buildings usually constructed of structural steel. In some cases, warehouses may be several hundred feet from the shoreline, while in other instances, they may be located on the wharf itself.

D.6 Ferry Transportation System

A ferry system consists of five components: waterfront structures, passenger terminals, fuel facilities, dispatch facilities, and maintenance facilities. This section provides a brief description of each.

- Water Front Structures
- Ferry Passenger Terminals
- Ferry Fuel Facility
- Ferry Dispatch Facility
- Ferry Maintenance Facility

D.6.1 Waterfront Structures

The waterfront structures are located at the points of disembarkation, and they are similar to, although not as extensive as, those of the port transportation system. In some cases the ferry system may be located within the boundary of the port transportation system. The points of disembarkation are located some distance apart from one another, usually on opposite shorelines. The waterfront structures include hydraulic sandfill placement poles and/or piled dock structures.

D.6.2 Passenger Terminals

D.6.3 Fuel and Maintenance Facilities

Fuel and maintenance facilities are usually located at one of the two points of disembarkation. The size of the fuel facility is smaller than that of the port facility. Maintenance facilities are mainly steel braced frame structures.

D.6.4 Dispatch Facilities

In many cases, the dispatch facility is located in the maintenance facility or one of the passenger terminals.

D.7 Airport Transportation System

An airport system consists of six components: control tower, runways, terminal buildings, parking structures, fuel facilities, and maintenance facilities. This section provides a brief description of each.

- Airport Control Towers
- Airport Runways
- Airport Terminal Buildings
- Airport Parking Structures
- Fuel Facilities
- Airport Maintenance & Hangar Facility

D.7.1 Control Tower

The control tower consists of a building and the necessary equipment for air control and monitoring.

D.7.2 Runways

This component consists of well paved "flat and wide surfaces".

D.7.3 Terminal Buildings

These are similar to railway urban stations in that many of the functions performed and services provided to passengers are similar. These are usually constructed of structural steel or reinforced concrete.

D.7.4 Fuel Facilities

A fuel facility includes buildings, tanks (anchored, unanchored, or buried), backup power systems (if available, anchored or unanchored diesel generators), pumps, and other equipment (anchored or unanchored). It should be mentioned that anchored equipment in general refers to equipment designed with special seismic tiedowns or tiebacks, while unanchored equipment refers to equipment designed with no special considerations other than the manufacturer's normal requirements. Above ground tanks are typically made of steel with roofs also made of steel. Buried tanks are typically concrete wall construction with concrete roofs. In total, five types of fuel facilities are considered. These are: fuel facilities with or without anchored equipment and with or without backup power (all combinations), and fuel facilities with buried tanks.

D.7.5 Maintenance Facilities, Hangar Facilities, and Parking Structures

Maintenance facilities are housed in large structures that are not usually critical for system functionality as maintenance activities can be delayed or performed elsewhere. These building structures are mostly low-rise steel braced frames. Hangar facilities and parking structures are usually constructed of structural steel or reinforced concrete.

D.8 Potable Water System

A potable water system typically consists of transmission and distribution pipelines, water treatment plants, wells, storage tanks pumping plants, as listed below. In addition the system consists of terminal reservoirs. In this subsection, a brief description of each of these components is presented.

- Pipelines
- Water Treatment Plants
- Wells
- Water Storage Tanks (Typically, 0.5 MGD to 2 MGD)
- Pumping Plants

D.8.1 Pipelines

- **Transmission Aqueducts:** These transmission conduits are typically large size pipes more than 20 inches in diameter or channels (canals) that convey water from the source such as a reservoir, lake, river to the treatment plant. Transmission pipelines are commonly made of concrete, ductile iron, cast iron, or steel. These could be elevated, at-grade or buried. Elevated or at-grade pipes are typically made of steel (welded or riveted), and they can run in single or multiple lines. Canals are typically lined with concrete, mainly to avoid excessive loss of water by seepage and to control erosion. In addition to concrete lining, expansion joints are usually used to account for swelling and shrinkage under varying temperature and moisture conditions. Damageability of channels is not considered in the loss estimation methodology.
- **Distribution Facilities and Distribution Pipes:** Distribution of water can be accomplished by gravity, or by pumps in conjunction with on-line storage. Except for storage reservoirs located at a much higher elevation than the area being served, distribution of water would necessitate, at least, some pumping along the way. Typically, water is pumped at a relatively constant rate, with flow in excess of consumption being stored in elevated storage tanks. The stored water provides a reserve for fire flow and may be used for general-purpose flow should the electric power fail, or in case of pumping capacity loss.

Distribution pipelines are commonly made of concrete (prestressed or reinforced), asbestos cement, ductile iron, cast iron, steel, or plastic. The selection of material type and pipe size are based on the desired carrying capacity, availability of material, durability, and cost. Distribution pipes represent the network that delivers water to consumption areas. Distribution pipes may be further subdivided into primary lines, secondary lines, and small distribution mains. The primary or arterial mains carry flow from the pumping station to and from elevated storage tanks, and to the consumption areas, whether residential, industrial, commercial, or public. These lines are typically laid out in interlocking loops, and all smaller lines connecting to them are typically valved so that failure in smaller lines does not require shutting off the larger. Primary lines can be up to 36 inches in diameter. Secondary lines are smaller loops within the primary mains and run from one primary line to another. They serve to provide a large amount of water for fire fighting without excessive pressure loss. Small distribution lines represent the mains that supply water to the user and to the fire hydrants.

In this earthquake loss estimation study, the simplified method for water system network performance evaluation applies to a distribution pipe network digitized at the primary level.

D.8.2 Supply Facilities- Water Treatment Plants (WTP)

Water treatment plants are generally composed of a number of physical and chemical unit processes connected in series, for the purpose of improving the water quality. A conventional WTP consists of a coagulation process, followed by a sedimentation process, and finally a filtration process. Alternately, a WTP can be regarded as a system of interconnected pipes, basins, and channels through which the water moves, and where the flow is governed by hydraulic principles. WTP are categorized as follows:

- ***Small water treatment plants***, with capacity ranging from 10 mgd to 50 mgd, are assumed to consist of a filter gallery with flocculation tanks (composed of paddles and baffles) and settling (or sedimentation) basins as main components, chemical tanks (needed in the coagulation and other destabilization processes), a chlorination tank, electrical and mechanical equipment, and elevated pipes.
- ***Medium water treatment plants***, with capacity ranging from 50 mgd to 200 mgd, are also assumed to consist of a filter gallery with flocculation tanks (composed of paddles and baffles) and settling (or sedimentation) basins as main components, chemical tanks (needed in the coagulation and other destabilization processes), a chlorination tank, electrical and mechanical equipment, and elevated pipes.
- ***Large water treatment plants***, with capacity above 200 mgd, are simulated by adding even more redundancy to small treatment plants (i.e., three times as many flocculation, sedimentation, chemical and chlorination tanks/basins).

Water treatment plants are also classified based on whether the subcomponents (equipment and backup power) are anchored or not.

D.8.3 Wells (WE)

Wells typically have a capacity between 1 and 5 mgd. Wells are used in many cities as a primary or supplementary source of water supply. Wells include a shaft from the surface down to the aquifer, a pump to bring the water up to the surface, equipment used to treat the water, and sometimes a building which encloses the well and equipment.

D.8.4 Water Storage Tanks (ST)

Water storage tanks can be elevated steel, on-ground steel (anchored/unanchored), on-ground concrete (anchored/unanchored), buried concrete, or on-ground wood tanks. Typical capacity of storage tanks is in the range of 0.5 mgd to 2 mgd.

D.8.5 Pumping Plants (PP)

Pumping plants are usually composed of a building, one or more pumps, electrical equipment, and in some cases, backup power systems. Pumping plants are classified as either small PP with less than 10 mgd capacity or medium/large PP with more than 10 mgd capacity. Pumping plants are also classified with respect to whether or not the subcomponents (equipment and backup power) are anchored.

D.8.6 Terminal Reservoirs

Terminal reservoirs are typically lakes (man made or natural) and are usually located nearby and upstream of the water treatment plant. Vulnerability of terminal reservoirs and associated dams is marginally assessed in the loss estimation methodology. Therefore, even though reservoirs are an essential part of a potable water system, it is assumed in the analysis of water systems that the amount of water flowing into water treatment plants from reservoirs right after an earthquake is essentially the same as before the earthquake.

D.9 Waste Water System

A waste water system typically consists of collection sewers, interceptors, waste water treatment plants and lift stations as listed below. In this section, a brief description of each of these components is given.

- Buried Pipelines
- Waste Water Treatment Plants
- Lift Stations

D.9.1 Collection Sewers

Collection sewers are generally closed conduits that carry sewage normally with a partial flow. Collection sewers could be sanitary sewers, storm sewers, or combined sewers. Pipe materials that are used for potable water transportation may also be used for wastewater collection. The most commonly used sewer material is clay pipe manufactured with integral bell and spigot ends. These pipes range in size from 4 to 42 inch in diameter. Concrete pipes are mostly used for storm drains and for sanitary sewers carrying noncorrosive sewage (i.e. with organic materials). For the smaller diameter range, plastic pipes are also used.

D.9.2 Interceptors

Interceptors are large diameter sewer mains. They are usually located at the lowest elevation areas. Pipe materials that are used for interceptor sewers are similar to those used for collection sewers.

D.9.3 Lift Stations (LS)

Lift stations are important parts of the waste water system. Lift stations serve to raise sewage over topographical rises. If the lift station is out of service for more than a short time, untreated sewage will either spill out near the lift station, or back up into the collection sewer system.

In this study, lift stations are classified as either small LS (capacity less than 10 mgd) or medium/large LS (capacity greater than 10 mgd). Cases of lift stations with anchored versus unanchored subcomponents are also investigated.

D.9.4 Waste Water Treatment Plants (WWTP)

Three sizes of waste water treatment plants are considered: small (capacity less than 50 mgd), medium (capacity between 50 and 200 mgd), and large (capacity greater than 200 mgd). A WWTP has the same processes existing in a WTP with the addition of secondary treatment subcomponents.

D.10 Oil System

An oil system typically consists of refineries, pumping plants, tank farms, and pipelines as listed below. In this section, a brief description of each of these components is given.

- Pipelines
- Refineries
- Pumping Plants
- Tank Farms

D.10.1 Refineries (RF)

Refineries are an important part of an oil system. They are used for processing crude oil before it can be used. Two sizes of refineries are considered: small, and medium/large.

- ***Small refineries*** have a capacity of less than 100,000 barrels per day. These usually consist of steel tanks on grade, stacks, other electrical and mechanical equipment, and elevated pipes. Stacks are essentially tall cylindrical chimneys.
- ***Medium/Large refineries*** have a capacity of more than 100,000 barrels per day. These also consist of steel tanks on grade, stacks, other electrical and mechanical equipment, and elevated pipes.

D.10.2 Oil Pipelines

Oil pipelines are used for the transportation of oil over long distances. About seventy-five percent of the crude oil is transported throughout the United States by pipelines. A large segment of industry and millions of people could be severely affected by disruption of crude oil supplies. Rupture of crude oil pipelines could lead to a large scale environmental disaster due to pollution of land and rivers. Pipelines are typically made of mild steel with submerged arc welded joints, although older gas welded steel pipe may be present in some systems.

D.10.3 Pumping Plants (PP)

Pumping plants serve to maintain the flow of oil in cross country pipelines. Pumping plants usually use two or more pumps. Pumps can be of either centrifugal or reciprocating type. However, no differentiation is made between these two types of pumps in the analysis of oil systems. There are pumping plants with anchored as well as unanchored subcomponents.

D.10.4 Tank Farms (TF)

Tank farms are facilities which store fuel products. They include tanks, pipes and electric components. There are tank farms with anchored as well as unanchored subcomponents.

D.11 Natural Gas System

A natural gas system typically consists of compressor stations and pipelines as listed below. In this section, a brief description of each of these components is given.

- Buried Pipelines
- Compressor Stations

D.11.1 Compressor Stations

Compressor stations serve to maintain the flow of gas in cross country pipelines. Compressor stations consist of either centrifugal or reciprocating compressors. However, no differentiation is made between these two types of compressors in the analysis of natural gas systems. Cases of compressor stations with anchored versus unanchored subcomponents are also investigated.

D.11.2 Natural Gas Pipelines

Pipelines are typically made of mild steel with submerged arc welded joints, although older lines may have gas welded joints. These are used for the transportation of natural gas over long distances. Many industries and millions of people could be severely affected should disruption of natural gas supplies occur.

D.12 Electric Power System

The only components of an electric power system considered in the loss estimation methodology are substations, distribution circuits, and generation plantsm as listed below. In this section a brief description of each of these components is presented.

- Transmission Substations
- Distribution Circuits
- Generation Plants

D.12.1 Substations

An electric substation is a facility that serves as a source of energy supply for the local distribution area in which it is located, and has the following main functions:

- \- Change or switch voltage from one level to another.
- \- Provide points where safety devices such as disconnect switches, circuit breakers, and other equipment can be installed.
- \- Regulate voltage to compensate for system voltage changes.
- \- Eliminate lightning and switching surges from the system.
- \- Convert AC to DC and DC to AC, as needed.
- \- Change frequency, as needed.

Substations can be entirely enclosed in buildings where all the equipment is assembled into one metal clad unit. Other substations have step-down transformers, high voltage switches, oil circuit breakers, and lightning arrestors located outside the substation building. In the current loss estimation methodology, only transmission (138 kV to 765 kV or higher) and subtransmission (34.5 kV to 161 kV) substations are considered. Substations are also classified based on whether they have anchored or unanchored subcomponents. The substations are classified as:

- High Voltage: he line voltage at these substations is 350 kV or more. These are referred to as 500 kV substations.
- Medium Voltage: The line voltage at these substations is between 150 kV and 350 kV. These are referred to as 230 kV substations.
- Low Voltage: The line voltage at these substations is between 34.5 kV and 150 kV. These are referred to as 115 kV substations.

D.12.2 Distribution Circuits

The distribution system is divided into a number of circuits. A distribution circuit includes poles, wires, in-line equipment and utility-owned equipment at customer sites. A distribution circuit also includes above ground and underground conductors. Distribution circuits either consist of seismically designed components or standard components.

D.12.3 Generation Plants

Power generation plants are facilities where the coal, oil, natural gas, or atom are transformed into electrical energy. These plants produce alternating current (AC) and may be any of the following types:

- - Hydroelectric
- - Steam turbine (fossil fired or nuclear)
- - Combustion turbine
- - Geothermal
- - Solar
- - Wind
- - Compressed air

Generation plant subcomponents include diesel generators, turbines, racks and panels, boilers and pressure vessels, and the building in which these are housed. The size of the generation plant is determined from the number of Megawatts of electric power that the plant can produce under normal operations. Small generation plants have a generation capacity of less than 200 Megawatts. Medium/Large generation plants have a capacity greater than 200 Megawatts. Fragility curves for generation plants with anchored versus unanchored subcomponents are presented.

D.13 Communication System

Only central offices are considered for the loss estimation of the communication systems as listed below. A central office consists of a building, central switching equipment (i.e., digital switches, anchored or unanchored), and back-up power supply (i.e. diesel generators or battery generators, anchored or unanchored) that may be needed to supply the requisite power to the center in case of loss of off-site power.

- Central Offices

Appendix E. Summary of Inventory Databases (Earthquake Module)

General Building Stock

Occupancy Square Footage

Building Type- Occupancy

Essential Facilities

Medical Care Facilities

Emergency Operation Centers

Schools

High Potential Loss Facilities

Dams

Nuclear Power Facilities

Military Installations

Transportation System

Highway Segments

Highway Bridges

Highway Tunnels

Railway Track Segments

Railway Bridges

Railway Tunnels

Railway Facilities

Light Rail Track Segments

Light Rail Bridges

Light Rail Tunnels

Light Rail Facilities

Bus Facilities

Ports and Harbors Facilities

Ferry Facilities

Airports Facilities

Airports Runways

Utility System

Potable Water Pipeline Segments

Potable Water Facilities

Potable Water Distribution Lines

Waste Water Pipeline Segments

Waste Water Facilities

Waste Water Distribution Lines

Oil Pipelines Segments

Oil Systems Facilities

Natural Gas Pipelines Segments

Natural Gas Facilities

Natural Gas Distribution Lines

Electric Power Facilities

Electric Power Distribution Lines

Communication Facilities

Communication Distribution Cables

Hazardous Materials Facilities

Population Inventory

Appendix F: Hazus-MH Data Dictionary

Table of Contents

Contents

F1. Introduction

This data dictionary documents the structure and data elements of the Hazus-MH inventory data set that serves as source for creating study regions. The document is organized in 11 chapters. Chapter 1 introduces the inventory organization and storage as a system of folders and files; lists the major database components or databases and how they are organized by theme; and explains the naming conventions of feature classes and tables. The chapters describe each database separately:

Chapter 2	syBoundary.mdb—System boundaries
Chapter 3	Bndrygbs.mdb—State boundaries
Chapter 4	Ef.mdb—Essential facilities
Chapter 5	TRN.mdb—Transportation systems
Chapter 6	UTIL.mdb—Lifeline utility systems
Chapter 7	HPLF.mdb—High potential loss facilities
Chapter 8	flAg.mdb—Agriculture inventory
Chapter 9	flVEH.mdb—Vehicle inventory (flood hazard specific)
Chapter 10	huTemplateGBS.mdb—Vehicle inventory (hurricane hazard specific)
Chapter 11	MSH.mdb—Occupancy mapping scheme

Each geodatabase section includes an overview of the database and how it is identified; a main table listing the sub-tables and feature classes, including a brief description of each; and a detailed table for each feature class and table. For each feature class and table, the following information is documented:

Identification: Name of feature class or table
Type: ESRI's feature class or table type
Purpose: Entity purpose in the aggregation process or/and analysis
Data: Feature classes and tables field definition
Feature class field definition

Name: Field name. If a field is found in the study region databases, but not in the state database, a value of N/A is included in the column.
Field Type: Contains the field format. If Access field type differs from ESRI field type, Access field type is shown in italics.
Index: Indicates if the field has index. Index properties are provided.
Required: For the aggregation process. Provides an indication of whether a value must be provided other than Null and those specified on Values column.
Values: Identifies valid values for this data element.
Field Description: Provides a human readable description of the field's data element.

F2. Statewide Hazus Data Inventory

Starting with Hazus-MH MR5, the Hazus-MH state-level default databases are stored in a compressed format that allows all the U.S. data to fit in one DVD. Both the setup and the data DVDs can be ordered from the FEMA Distribution Center.
The data for each state is compressed as one self-extracting file named with the state code (CA.EXE for California, GA.EXE for Georgia, and so on).

When uncompressed, the state-specific data consists of:

- A set of geodatabases with feature classes and tables related to all hazards.
- For states considered by the Hurricane (HU) Model, the State folder contains:
- A folder named HU consisting of one Access database—huTemplateGBS.mdb— that contains census tract information relative to terrain, wind speeds, and tree parameters.
- A binary file that contains hurricane event data for probabilistic analysis named XX_HUR_50.BIN where XX is the abbreviation of the state name.

Because Hazus-MH relies in ArcGIS, most default inventory data are stored in ArcGIS geodatabases, which are in Access format. The exceptions are a few Access databases that comprise plain tables. Also, feature classes and tables are organized in geodatabases by theme. For instance, transportation items are contained in a transportation-specific database named "TRN.mdb". Table 2 shows the geodatabases included in Hazus-MH. Each database is discussed in the following chapters.

Table 1: Hazus-MH Inventory Geodatabases

Database Name	Description	Location Relative to Hazus Data DVD1:
syBoundary.mdb	Contains GIS boundary information for the entire United States relative to states, counties, and census tracts.	Located in the root directory of the data inventory folder (c:\Hazus-Data by default)
Bndrygbs.mdb	Contains GIS boundary information for counties, census tracts, and census blocks for a given state. Also contains aggregated data including demographics, building square footage, building counts, structure exposure, and content exposure for a given state.	Located in root/state (e.g., Alabama is AL) folder
Ef.mdb	Contains GIS location and hazard information for essential facilities including schools, hospitals, medical care facilities, police stations, and fire stations.	Located in root/state (e.g., Alabama is AL) folder
flAG.mdb	Contains GIS boundary information for crops grown in areas of the state. Flood (FL) is the only model of the Hazus system to use this database.	Located in root/state (e.g., Alabama is AL) folder
flVEH.mdb	Contains information for daytime and nighttime vehicle inventory by census block for the state. Flood (FL) is the only model of the Hazus software to use this database.	Located in root/state (e.g., Alabama is AL) folder
HPLF.mdb	Contains GIS location and hazard information for high potential loss facilities (HPLF) that include dams, hazardous materials, levees, military installations, and nuclear facilities.	Located in root/state (e.g., Alabama is AL1) folder
MSH.mdb	Contains information for mapping schemes for the Earthquake (EQ) and Flood (FL) models. These mapping schemes refer to construction aspects for buildings.	Located in root/state (e.g., Alabama is AL) folder

[1] The Hazus-MH MR3 installation allows the user to specify the folder where the state data will be copied through the "Choose Data Path" dialog in the installation wizard. By default, the installation wizard will show the data path from where the installation program was launched (usually from a DVD drive). To access data from a location than the DVD drive, users must follow Hazus-MH Technical Manual instructions.

TRN.mdb	Contains GIS location and hazard information for transportation facilities including airports, buses, ferries, highways, light rail, railways, bridges, ports, and runways.	Located in root/state (e.g., Alabama is AL) folder
UTIL.mdb	Contains GIS location and hazard information for utility features and facilities including communications, electric, natural gas, oil, potable water, and wastewater.	Located in root/state (e.g., Alabama is AL1) folder of the DVD
huTemplateGBS.mdb	Contains census tract information for terrain, wind speeds, and tree parameters.	Located in root/state/hu folder of the DVD. This file is only available for costal states which have been setup for hurricanes

While point, line, and polygon features are stored in ESRI feature classes, not all attributes related to a particular entity are stored in the same feature record. Generally, attributes related to all hazards are stored in the feature record in a feature class named with a prefix hz. For instance, police station points are stored in a feature class name hzPoliceStation, while attributes specific to hazards (such as earthquakes and floods) are stored in records in separate tables. Table 3 shows all feature classes and tables with their respective prefix.

Table 2: Feature Classes and Table Prefixes

Prefix	Description	Example
hz	All hazards dataset	hzPoliceStation
eq	Earthquake Model specific dataset	eqPoliceStation
fl	Flood Model specific dataset	flPoliceStation

While point, line, and polygon features are stored in ESRI feature classes, not all attributes related to a particular entity are stored in the same feature record. In general, attributes related to all hazards are stored in the feature record in a feature class named with a prefix hz. For instance, police station points are stored in a feature class name hzPoliceStation while attributes specific to hazards (such as earthquake and flood) are stored in records in separate tables. Table 3 shows all feature classes and tables with their respective prefixes.

F3. System Boundaries: syBoundary.mdb

F.3.1 Database Overview

The syBoundary is an ESRI Access personal geodatabase that contains the definition of state, county, and census tract boundaries in three feature classes. The geographical extent is nationwide, including features for the 50 states, the District of Columbia, and territories. This geodatabase is crucial during the aggregation process. It is used by Create Region Wizard to guide the user through the definition of a region.

F.3.2 Identification

syBoundary.mdb

F.3.3 Database Content

The syBoundary.mdb database includes:

Name	Type	Content
syState	ESRI Feature Class	US Census 2000 state boundaries for the 50 states, the District of Columbia, and territories
syCounty	ESRI Feature Class	US Census 2000 county boundaries for the 50 states, the District of Columbia, and territories
syTract	ESRI Feature Class	US Census 2000 census tract boundaries for the 50 states, the District of Columbia, and territories

F.3.3.1 State Boundaries: syState Feature Class

Identification:	syState
Type:	ESRI Polygon Feature Class
Purpose:	Feature class that plays a crucial role during the aggregation process. It belongs to syBoundary.mdb. Provides the definition of state boundaries and the states available for the region aggregation process.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description

StateFips	Text(2)	T	T	FIPS state code	Federal Information Processing Standard (FIPS) state code
State	Text(2)	T, U, A	T	USPS State name abbreviation	United States Postal Service (USPS) state abbreviation
StateName	Text(40)	F			State name
Region	Short(2) Integer(2)	F	T	1 = Western United States 2= Central Eastern United States	For determining attenuation relationships (EQ Model). See the Hazus-MH Earthquake Model Technical Manual, Chapter 4, Subsection 4.1.1.2, Input Requirements and Output Information, for details.
NumCounties	Short(2) Integer(2)	F	T		Number of counties in the syCounty feature class belonging to the state record
HUState	Short(2) Integer(2)	F	T	0 = Non Hurricane State 1 = Hurricane State	To identify if the State can be aggregated for the HU Model study region. If the value is 1, the state will be available in the Create Region Wizard State List.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.3.3.2 County Boundaries: syCounty Feature Class

Identification:	syCounty
Type:	ESRI Polygon Feature Class
Purpose:	A system boundaries feature class that plays a crucial role during the aggregation process. It belongs to syBoundary.mdb. Provides the definition of county boundaries and the counties available for the region aggregation process.
Data:	

Feature Class Field Definition					
Name	ESRI Type (Size) Access Type (Size)	Index*	Required *	Values	Description
CountyFips	Text(5)	T, U, A	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.
CountyFips3	Text(3)	T, NU, A	T	Three-digit FIPS county code	Last three digits of the FIPS county code
CountyName	Text(40)	T, NU, A	T		County name
State	Text(2)	T, NU, A	T	USPS state abbreviation	USPS state abbreviation
StateFips	Text(2)	T, NU, A	T	FIPS state code	FIPS state code
NumTracts	Short(2) Integer(2)	F	F		Number of tracts in the syTract feature class belonging to the state record
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.3.3.3 Census Tract Boundaries: syTract Feature Class

Identification:	syTract
Type:	ESRI Polygon Feature Class

Purpose:	A system boundaries feature class that plays a crucial role during the aggregation process. It belongs to syBoundary.mdb. Provides the definition of census tract boundaries and the census tract available for the region aggregation process.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
Tract	Text(11)	T, U, A	T	11 digits of the census tract number	11 digits of the census tract number from the 2000 US Census
CountyFips	Text(5)	T, NU, A	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.
Tract6	Text(40)	T, NU, A	T	Census tract six-digit number	Census tract six-digit number from the 2000 US Census
TractArea	Float(4) Single(4)	F	F		Census tract area (in km²)
CenLongit	Double (8) Double (8)	F	F	Longitude decimal degrees	Census tract longitude (centroid)
CenLat	Double (8) Double (8)	F	F	Latitude decimal degrees	Census tract latitude (centroid)
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F4. State Boundaries: Boundary.mdb

F.4.1 Database Overview

The bndrygbs.mdb is an Access personal geodatabase that contains boundary *feature classes and tables* with demographic (population, housing, age, etc.) and building inventory profiles aggregated at the census block and census track levels. The geographical domain of the database is the state. In that case, there is one bndrygbs.mdb database for each state, each one located in the appropriate state folder. County census tracts and census block boundaries are in separate feature classes.

Data stored in individual tables include the following:

- *Square footage by occupancy*. These data are the estimated floor area by specific occupancy (e.g., COM1).
- *Full replacement value by occupancy*. These data provide estimated replacement values by specific occupancy (e.g., RES1).
- *Building count by occupancy*. These data provide an estimated building count by specific occupancy (e.g., IND1).
- *General occupancy mapping*. These data provide general mapping for the general building stock (GBS) inventory data from the specific occupancy to general building type (e.g., wood).
- *Demographics*. These data provide housing and population statistics for the study region.

The content of tables showing the building stock characteristics (e.g., replacement cost, building type, occupancy type, etc.) is used to estimate damages and economic losses. Demographic and housing characteristic are essential for estimating social impacts, such as shelter needs, household displacement, and casualties.

During the creation of a study region, boundary geometry from feature classes is transferred to a geodatabase named RegionBndry.mdb in the Region folder for all hazards.

Demographic, building stock related data, and attributes from the feature classes as well as tables are transferred to the SQL Server database in the Region folder.

F.4.2 Identification

Boundary.mdb

F.4.3 Database Content

The Boundary.mdb database includes:

Name	Type	Content
hzCounty	ESRI Polygon Feature Class	US Census 2000 county boundaries
hzTract	ESRI Polygon Feature Class	US Census 2000 census tract boundaries
hzCensusBlock	ESRI Polygon Feature Class	US Census 2000 census block boundaries
hzDemographicsT	ESRI Table	Demographics by census tract
hzDemographicsB	ESRI Table	Demographics by census block
hzBldgCountOccupT	ESRI Table	Building count by occupancy by census tract
hzBldgCountOccupB	ESRI Table	Building count by occupancy by census tract
hzExposureOccupT	ESRI Table	Building (without content) full replacement value by occupancy by census tract
hzExposureOccupB	ESRI Table	Building (without content) full replacement value by occupancy by census block
hzExposureContentOccupT	ESRI Table	Building content replacement value by occupancy by census tract
hzExposureContentOccupB	ESRI Table	Building content replacement value by occupancy by census block
hzSqFootageOccupT	ESRI Table	Square footage by occupancy by census tract
hzSqFootageOccupB	ESRI Table	Square footage by occupancy by census block
hzMeansCountyLocationFactor	ESRI Table	Means location factors for residential and non-residential occupancies on a county basis

F.4.3.1 County Boundaries: hzCounty

Identification:	hzCounty
Type:	ESRI Polygon Feature Class
Purpose:	A state extent boundaries feature. It belongs to Boundary.mdb. Provides the definition of county boundaries geometry and attributes in one state. Boundary geometries are transferred to a geodatabase named RegionBndry.mdb in the Region folder during the process of creating a new study region. Attributes are also transferred to the SQL Server database in the Region folder during this process. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
CountyFips	Text(5)	T, U, A	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS code; the remaining three digits are the county code.
CountyFips3	Text(3)	T, NU, A	T	Three-digit FIPS county code	Last three digits of the FIPS county code.
CountyName	Text(40)	T, NU, A	T		County name
State	Text(2)	T, NU, A	T	USPS state abbreviation	USPS state abbreviation
StateFips	Text(2)	T, NU, A	T	FIPS state code	FIPS state code
NumAggrTracts	Long(4) Long Integer(4)	F	F		Number of tracts in the hztract feature.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.4.3.2 Census Tract Boundaries: hzTract

Identification:	hzTract
Type:	ESRI Polygon Feature Class
Purpose:	A state extent boundaries feature. It belongs to Boundary.mdb. Provides the definition of census tract boundaries geometry and attributes in one state. Boundary geometries are transferred to a geodatabase named RegionBndry.mdb in the Region folder during the process of creating a new study region. Attributes (e.g., tract number, building scheme Id) are also transferred to the SQL Server database in the Region folder during this process. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
Tract	Text(11)	T, U, A	T	11 digits of the census tract number	11 digits of the census tract number of the US Census 2000
CountyFips	Text(5)	T, NU, A	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.
BldgSchemesId	Text(5)	F	T	EQ specific building scheme according to the available values in table hzGenBldgSchemes in MSH.mdb for the state	EQ specific building scheme according to the available values in table hzGenBldgSchemes in MSH.mdb for the state. See Occupancy Mapping Scheme: MSH.mdb.
Tract6	Text(40)	F	T		Census tract six-digit number of the US Census 2000

TractArea	Float(4) Single(4)	F	N		Census tract area (in km²)
CenLat	Double(8) Double(8)	F	N	Latitude Decimal Degrees	Census tract latitude (centroid)
CenLongit	Double(8) Double(8)	F	N	Longitude Decimal Degrees	Census tract longitude (centroid)
Length	Float(4) Single(4)	F	N		Total length (in kms) of street segment in the census tract. Length is used during the study region creation process to estimate distribution of pipeline length for potable water, wastewater, and natural gas.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.3 Census Block Boundaries: hzCensusBlock

Identification:	hzCensusBlock
Type:	ESRI Polygon Feature Class
Purpose:	A state extent boundaries feature. It belongs to Boundary.mdb. Provides the definition of census block boundaries geometry and attributes in one state. Boundary geometries are transferred to a geodatabase named RegionBndry.mdb in the Region folder during the process of creating a new study region when the flood hazard is included. Attributes (e.g., tract number, building scheme Id) are also transferred to the SQL Server database in the Region folder during this process. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
CensusBlock	Text(15)	T, U, A			15 digits of the census block number
Tract	Text(11)	T, NU, A	T		11 digits of the census tract number
BldgSchemesId	Text(5)	F	T		EQ specific building scheme accord to the available values in table hzGenBldgSchemes in MSH.mdb for the state. See Occupancy Mapping Scheme: MSH.mdb.
BlockType	Text(1)	F	T	R=Riverine C=Coastal L=Lake	Within the Hazus Flood Model, all census blocks have been assigned a code identifying the primary local flood hazard type and a foundation mapping scheme. The default value for all census blocks is “R” (riverine).

					Census blocks immediately adjacent to the Great Lakes are coded as "L" for Great Lakes. Census blocks within the FEMA Q3's for coastal regions are coded as "C" (coastal).
BlockArea	Float(4) Float(4)	F	F		Census block area (in km²)
CenLat	Double(8) Double(8)	F	F	Latitude Decimal Degrees	Census block latitude (centroid)
CenLongit	Double(8) Double(8)	F	F	Longitude Decimal Degrees	Census block longitude (centroid)
PctWithBasemnt	Short(2) Integer(2)	F	F		Percentage of residential units with basements (flood hazard specific field)
Pct1StoryRes1	Short(2) ***Integer(2)***	F	F		Percentage of one-story single-family (flood hazard specific field)
Pct2StoryRes1	Short(2) ***Integer(2)***	F	F		Percentage of two-story, single-family (flood hazard specific field)
Pct3StoryRes1	Short(2) ***Integer(2)***	F	F		Percentage of three-story, single-family (flood hazard specific field)
PctSplitLvlRes1	Short(2) ***Integer(2)***	F	F		Percentage of split level, single-family (flood hazard specific field)
Pct1to2StryRes3	Short(2) ***Integer(2)***	F	F		Percentage of 1-2 story, multi-family (flood hazard specific field)
Pct3to4StryRes3	Short(2) ***Integer(2)***	F	F		Percentage of 3-4-story, multi-family (flood hazard specific field)

Pct5StryplusRes3	Short(2) ***Integer(2)***	F	F		Percentage of 5-story and up multi-family (flood hazard specific field)
PctLowRiseOther	Short(2) ***Integer(2)***	F	F		Percentage of all other occupancies, low-rise (flood hazard specific field)
PctMidRiseOther	Short(2) ***Integer(2)***	F	F		Percentage of all other occupancies, mid-rise (flood hazard specific field)
PctHighRiseOther	Short(2) ***Integer(2)***	F	F		Percentage of all other occupancies, high-rise (flood hazard specific field)
Pct1CarGarage	Short(2) ***Integer(2)***	F	F		Percentage of single-family with 1-car garage (flood hazard specific field)
Pct2CarGarage	Short(2) ***Integer(2)***	F	F		Percentage of single-family with 2-car garage (flood hazard specific field)
Pct3CarGarage	Short(2) ***Integer(2)***	F	F		Percentage of single-family with 3-car garage (flood hazard specific field)
PctCarPort	Short(2) ***Integer(2)***	F	F		Percentage of single-family with carport (flood hazard specific field)
PctNoGarage	Short(2) ***Integer(2)***	F	F		Percentage of single-family with no garage (flood hazard specific field)
IncomeRatio	Float(4) ***Single(4)***	F	F		Ratio of block group to state income (flood hazard specific field)
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.4 Demographics by Census Tract: hzDemographicT

Identification:	hzDemographicT
Type:	ESRI Table
Purpose:	This table provides housing and population statistics at the census tract level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
CensusTract	Text(11)	T, U, A	T	11 digits of the census tract number	11 digits of the census tract number
Population	Long(4) *Long Integer(4)*	F	F		Total population
Households	Long(4) *Long Integer(4)*	F	F		Total households
GroupQuarters	Long(4) *Long Integer(4)*	F	F		Total group quarters
MaleLess16	Long(4) *Long Integer(4)*	F	F		Total number of males under 16 years of age
Male16to65	Long(4) *Long Integer(4)*	F	F		Total number of males aged 16 to 65
MaleOver65	Long(4) *Long Integer(4)*	F	F		Total number of males over age 65
FemaleLess16	Long(4) *Long Integer(4)*	F	F		Total number of females under 16 years of age
Female16to65	Long(4) *Long Integer(4)*	F	F		Total number of females aged 16 to 65
FemaleOver65	Long(4) *Long Integer(4)*	F	F		Total number of females over age 65
MalePopulation	Long(4)	F	F		Total males

	Long Integer(4)				
FemalePopulation	Long(4) ***Long Integer(4)***	F	F		Total females
White	Long(4) ***Long Integer(4)***	F	F		Total white population
Black	Long(4) ***Long Integer(4)***	F	F		Total black population
NativeAmerican	Long(4) ***Long Integer(4)***	F	F		Total Native American population
Asian	Long(4) ***Long Integer(4)***	F	F		Total Asian population
Hispanic	Long(4) ***Long Integer(4)***	F	F		Total Hispanic population
PacifiIslander	Long(4) ***Long Integer(4)***	F	F		Total Pacific Islander population
OtherRaceOnly	Long(4) ***Long Integer(4)***	F	F		Total other race population
IncLess10	Long(4) ***Long Integer(4)***	F	F		Total households with less than $10,000 annual income
Inc10to20	Long(4) ***Long Integer(4)***	F	F		Total households with $10,000 to $20,000 annual income
Inc20to30	Long(4) ***Long Integer(4)***	F	F		Total households with $20,000 to $30,000 annual income
Inc30to40	Long(4) ***Long Integer(4)***	F	F		Total households with $30,000 to $40,000 annual income
Inc40to50	Long(4) ***Long Integer(4)***	F	F		Total households with $40,000 to $50,000 annual income
Inc50to60	Long(4) ***Long Integer(4)***	F	F		Total households with $50,000 to $60,000 annual income
Inc60to75	Long(4) ***Long Integer(4)***	F	F		Total households with $60,000 to $75,000 annual income
Inc75to100	Long(4)	F	F		Total households with

	Long Integer(4)				$75,000 to $100,000 annual income
IncOver100	Long(4) *Long Integer(4)*	F	F		Total households with more than $100,000 annual income
ResidDay	Long(4) *Long Integer(4)*	F	F		Total daytime population
ResidNight	Long(4) *Long Integer(4)*	F	F		Total nighttime population
Hotel	Long(4) *Long Integer(4)*	F	F		Total population in hotels
Visitor	Long(4) *Long Integer(4)*	F	F		Visitor population
WorkingCom	Long(4) *Long Integer(4)*	F	F		Population working in commercial occupations
WorkingInd	Long(4) *Long Integer(4)*	F	F		Population working in industrial occupations
Commuting5PM	Long(4) *Long Integer(4)*	F	F		Population commuting at 5:00 p.m.
OwnerSingleUnits	Long(4) *Long Integer(4)*	F	F		Owner-occupied, single-family units
OwnerMultUnits	Long(4) *Long Integer(4)*	F	F		Owner-occupied, multi-family units
OwnerMultStructs	Long(4) *Long Integer(4)*	F	F		Owner-occupied, multi-family structures
OnwerMHs	Long(4) *Long Integer(4)*	F	F		Owner-occupied, manufactured housing
RenterSingleUnits	Long(4) *Long Integer(4)*	F	F		Renter-occupied single family units
RenterMultUnits	Long(4) *Long Integer(4)*	F	F		Renter-occupied, multi-family units
RenterMultStructs	Long(4) *Long Integer(4)*	F	F		Renter-occupied, multi-family structures
RenterMHs	Long(4) *Long Integer(4)*	F	F		Renter-occupied, manufactured housing
VacantSingleUnits	Long(4) *Long Integer(4)*	F	F		Vacant single-family units
VacantMultUnits	Long(4)	F	F		Vacant multi-family units

	Long Integer(4)				
VacantMultStructs	Long(4) ***Long Integer(4)***	F	F		Vacant multi-family structures
VacantMHs	Long(4) ***Long Integer(4)***	F	F		Vacant manufactured housing
BuiltBefore40	Short(2) ***Integer(2)***	F	F		Housing units built before 1940
Built40to49	Short(2) ***Integer(2)***	F	F		Housing units built between 1940 and 1949
Built50to59	Short(2) ***Integer(2)***	F	F		Housing units built between 1950 and 1959
Built60to69	Short(2) ***Integer(2)***	F	F		Housing units built between 1960 and 1969
Built70to79	Short(2) ***Integer(2)***	F	F		Housing units built between 1970 and 1979
Built80to89	Short(2) ***Integer(2)***	F	F		Housing units built between 1980 and 1989
Built90to98	Short(2) ***Integer(2)***	F	F		Housing units built between 1990 and 1998
BuiltAfter98	Short(2) ***Integer(2)***	F	F		Housing units built after 1998
MedianYearBuilt	Short(2) ***Integer(2)***	F	F		Median year housing built
AvgRent	Long(4) ***Long Integer(4)***	F	F		Average cash rent
AvgValue	Long(4) ***Long Integer(4)***	F	F		Average home value
SchoolEnrollmentKto12	Long(4) ***Long Integer(4)***	F	F		School enrollment up to high school
SchoolEnrollmentCollege	Long(4) ***Long Integer(4)***	F	F		College and university enrollment
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.5 Demographics by Census Block: hzDemographicB

Identification:	hzDemographicB
Type:	ESRI Table
Purpose:	This table provides housing and population statistics at census block level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region when the flood hazard is included. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) ***Access Type (Size)***	Index *	Required*	Values	Description
CensusBlock	Text(15)	T, U, A	T	15 digits of census block number	15 digits of census block number
Population	Long(4) ***Long Integer(4)***	F	F		Total population
Households	Long(4) ***Long Integer(4)***	F	F		Total households
GroupQuarters	Long(4) ***Long Integer(4)***	F	F		Total group quarters
MaleLess16	Long(4) ***Long Integer(4)***	F	F		Total number of males under 16 years of age
Male16to65	Long(4) ***Long Integer(4)***	F	F		Total number of males aged 16 to 65
MaleOver65	Long(4) ***Long Integer(4)***	F	F		Total number of males over age 65
FemaleLess16	Long(4) ***Long Integer(4)***	F	F		Total number of females under 16 years of age
Female16to65	Long(4)	F	F		Total number of females aged

	Long Integer(4)				16 to 65
FemaleOver65	Long(4) *Long Integer(4)*	F	F		Total number of females over age 65
MalePopulation	Long(4) *Long Integer(4)*	F	F		Total males
FemalePopulation	Long(4) *Long Integer(4)*	F	F		Total females
White	Long(4) *Long Integer(4)*	F	F		Total white population
Black	Long(4) *Long Integer(4)*	F	F		Total black population
NativeAmerican	Long(4) *Long Integer(4)*	F	F		Total Native American population
Asian	Long(4) *Long Integer(4)*	F	F		Total Asian population
Hispanic	Long(4) *Long Integer(4)*	F	F		Total Hispanic population
PacifiIslander	Long(4) *Long Integer(4)*	F	F		Total Pacific Islander population
OtherRaceOnly	Long(4) *Long Integer(4)*	F	F		Total other race population
IncLess10	Long(4) *Long Integer(4)*	F	F		Total households with less than $10,000 annual income
Inc10to20	Long(4) *Long Integer(4)*	F	F		Total households with $10,000 to $20,000 annual income
Inc20to30	Long(4) *Long Integer(4)*	F	F		Total households with $20,000 to $30,000 annual income
Inc30to40	Long(4) *Long Integer(4)*	F	F		Total households with $30,000 to $40,000 annual income
Inc40to50	Long(4)	F	F		Total households with $40,000

	Long Integer(4)				to $50,000 annual income
Inc50to60	Long(4) *Long Integer(4)*	F	F		Total households with $50,000 to $60,000 annual income
Inc60to75	Long(4) *Long Integer(4)*	F	F		Total households with $60,000 to $75,000 annual income
Inc75to100	Long(4) *Long Integer(4)*	F	F		Total households with $75,000 to $100,000 annual income
IncOver100	Long(4) *Long Integer(4)*	F	F		Total households with more than $100,000 annual income
ResidDay	Long(4) *Long Integer(4)*	F	F		Total daytime population
ResidNight	Long(4) *Long Integer(4)*	F	F		Total nighttime population
Hotel	Long(4) *Long Integer(4)*	F	F		Total population in hotels
Visitor	Long(4) *Long Integer(4)*	F	F		Visitor population
WorkingCom	Long(4) *Long Integer(4)*	F	F		Population working in commercial occupations
WorkingInd	Long(4) *Long Integer(4)*	F	F		Population working in industrial occupations
Commuting5PM	Long(4) *Long Integer(4)*	F	F		Population commuting at 5:00 p.m.
OwnerSingleUnits	Long(4) *Long Integer(4)*	F	F		Owner-occupied, single-family units
OwnerMultUnits	Long(4) *Long Integer(4)*	F	F		Owner-occupied, multi-family units
OwnerMultStructs	Long(4) *Long Integer(4)*	F	F		Owner-occupied, multi-family structures
OnwerMHs	Long(4) *Long*	F	F		Owner-occupied, manufactured housing

	Integer(4)				
RenterSingleUnits	Long(4) *Long Integer(4)*	F	F		Renter-occupied, single-family units
RenterMultUnits	Long(4) *Long Integer(4)*	F	F		Renter-occupied, multi-family units
RenterMultStructs	Long(4) *Long Integer(4)*	F	F		Renter-occupied, multi-family structures
RenterMHs	Long(4) *Long Integer(4)*	F	F		Renter-occupied, manufactured housing
VacantSingleUnits	Long(4) *Long Integer(4)*	F	F		Vacant single-family units
VacantMultUnits	Long(4) *Long Integer(4)*	F	F		Vacant multi-family units
VacantMultStructs	Long(4) *Long Integer(4)*	F	F		Vacant multi-family structures
VacantMHs	Long(4) *Long Integer(4)*	F	F		Vacant manufactured housing
BuiltBefore40	Short(2) *Integer(2)*	F	F		Housing units built before 1940
Built40to49	Short(2) *Integer(2)*	F	F		Housing units built between 1940 and 1949
Built50to59	Short(2) *Integer(2)*	F	F		Housing units built between 1950 and 1959
Built60to69	Short(2) *Integer(2)*	F	F		Housing units built between 1960 and 1969
Built70to79	Short(2) *Integer(2)*	F	F		Housing units built between 1970 and 1979
Built80to89	Short(2) *Integer(2)*	F	F		Housing units built between 1980 and 1989
Built90to98	Short(2) *Integer(2)*	F	F		Housing units built between 1990 and 1998
BuiltAfter98	Short(2) *Integer(2)*	F	F		Housing units built after 1998

MedianYearBuilt	Short(2) ***Integer(2)***	F	F		Median year housing built
AvgRent	Long(4) ***Long Integer(4)***	F	F		Average cash rent
AvgValue	Long(4) ***Long Integer(4)***	F	F		Average home value
SchoolEnrollmentKto12	Long(4) ***Long Integer(4)***	F	F		School enrollment up to high school
SchoolEnrollmentCollege	Long(4) ***Long Integer(4)***	F	F		College and university enrollment
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.6 Building Count by Census Tract: hzBldgCountOccupT

Identification:	hzBldgCountOccupT				
Type:	ESRI Table				
Purpose:	This table provides building count by occupancy at the census tract level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) ***Access Type (Size)***	Index *	Required*	Values	Description
CensusTract	Text(11)	T, U, A	T		11 digits of the census tract number
RES1I	Short(2) ***Integer(2)***	F	F		Single family dwellings
RES2I	Short(2) ***Integer(2)***	F	F		Manufactured housing
RES3AI	Short(2) ***Integer(2)***	F	F		Duplex - 1 to 2 units
RES3BI	Short(2) ***Integer(2)***	F	F		Duplex - 3 to 4 units
RES3CI	Short(2) ***Integer(2)***	F	F		Duplex - 5 to 9 units
RES3DI	Short(2) ***Integer(2)***	F	F		Duplex - 10 to 19 units
RES3EI	Short(2) ***Integer(2)***	F	F		Duplex - 20 to 49 units
RES3FI	Short(2) ***Integer(2)***	F	F		Duplex - more than 50 units
RES4I	Short(2) ***Integer(2)***	F	F		Temporary lodging
RES5I	Short(2) ***Integer(2)***	F	F		Institutional dormitories
RES6I	Short(2) ***Integer(2)***	F	F		Nursing homes
COM1I	Short(2) ***Integer(2)***	F	F		Retail trade

COM2I	Short(2) ***Integer(2)***	F	F		Wholesale trade
COM3I	Short(2) ***Integer(2)***	F	F		Personal and repairs services
COM4I	Short(2) ***Integer(2)***	F	F		Professional and technical services
COM5I	Short(2) ***Integer(2)***	F	F		Banks
COM6I	Short(2) ***Integer(2)***	F	F		Hospitals
COM7I	Short(2) ***Integer(2)***	F	F		Medical office and clinic
COM8I	Short(2) ***Integer(2)***	F	F		Entertainment and recreation
COM9I	Short(2) ***Integer(2)***	F	F		Theaters
COM10I	Short(2) ***Integer(2)***	F	F		Parking garages
IND1I	Short(2) ***Integer(2)***	F	F		Heavy industrial
IND2I	Short(2) ***Integer(2)***	F	F		Light industrial
IND3I	Short(2) ***Integer(2)***	F	F		Food/drugs/chemicals
IND4I	Short(2) ***Integer(2)***	F	F		Metal/minerals processing
IND5I	Short(2) ***Integer(2)***	F	F		High technology
IND6I	Short(2) ***Integer(2)***	F	F		Construction facilities and offices
AGR1I	Short(2) ***Integer(2)***	F	F		Agriculture facilities and offices
REL1I	Short(2) ***Integer(2)***	F	F		Churches and non-profit organizations
GOV1I	Short(2) ***Integer(2)***	F	F		Government - general services
GOV2I	Short(2) ***Integer(2)***	F	F		Government - emergency response
EDU1I	Short(2) ***Integer(2)***	F	F		Grade schools and administrative offices
EDU2I	Short(2) ***Integer(2)***	F	F		Colleges and universities

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.4.3.7 Building Count by Census Block: hzBldgCountOccupB

Identification:	hzBldgCountOccupB				
Type:	ESRI Table				
Purpose:	This table provides building count by occupancy at census block level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region when the flood hazard is included. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) ***Access Type (Size)***	Index *	Required*	Values	Description
CensusBlock	Text(15)	T, U, A	T	15 digits of the census block number	15 digits of the census block number
RES1I	Short(2) ***Integer(2)***	F	F		Single-family dwellings
RES2I	Short(2) ***Integer(2)***	F	F		Manufactured housing
RES3AI	Short(2) ***Integer(2)***	F	F		Duplex - 1 to 2 units
RES3BI	Short(2) ***Integer(2)***	F	F		Duplex - 3 to 4 units
RES3CI	Short(2) ***Integer(2)***	F	F		Duplex - 5 to 9 units
RES3DI	Short(2) ***Integer(2)***	F	F		Duplex - 10 to 19 units
RES3EI	Short(2) ***Integer(2)***	F	F		Duplex - 20 to 49 units
RES3FI	Short(2) ***Integer(2)***	F	F		Duplex - more than 50 units
RES4I	Short(2) ***Integer(2)***	F	F		Temporary lodging
RES5I	Short(2) ***Integer(2)***	F	F		Institutional dormitories
RES6I	Short(2) ***Integer(2)***	F	F		Nursing homes
COM1I	Short(2)	F	F		Retail trade

	Integer(2)				
COM2I	Short(2) ***Integer(2)***	F	F		Wholesale trade
COM3I	Short(2) ***Integer(2)***	F	F		Personal and repair services
COM4I	Short(2) ***Integer(2)***	F	F		Professional and technical services
COM5I	Short(2) ***Integer(2)***	F	F		Banks
COM6I	Short(2) ***Integer(2)***	F	F		Hospitals
COM7I	Short(2) ***Integer(2)***	F	F		Medical office and clinic
COM8I	Short(2) ***Integer(2)***	F	F		Entertainment and recreation
COM9I	Short(2) ***Integer(2)***	F	F		Theaters
COM10I	Short(2) ***Integer(2)***	F	F		Parking garages
IND1I	Short(2) ***Integer(2)***	F	F		Heavy industrial
IND2I	Short(2) ***Integer(2)***	F	F		Light industrial
IND3I	Short(2) ***Integer(2)***	F	F		Food/drugs/chemicals
IND4I	Short(2) ***Integer(2)***	F	F		Metal/minerals processing
IND5I	Short(2) ***Integer(2)***	F	F		High technology
IND6I	Short(2) ***Integer(2)***	F	F		Construction facilities and offices
AGR1I	Short(2) ***Integer(2)***	F	F		Agriculture facilities and offices
REL1I	Short(2) ***Integer(2)***	F	F		Churches and non-profit organizations
GOV1I	Short(2) ***Integer(2)***	F	F		Government - general services
GOV2I	Short(2) ***Integer(2)***	F	F		Government - emergency response
EDU1I	Short(2) ***Integer(2)***	F	F		Grade schools and administrative offices

EDU2I	Short(2) ***Integer(2)***	F	F		Colleges and universities
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.8 Building Replacement Value by Census Tract: hzExposureOccupT

Identification:		hzExposureOccupT			
Type:		ESRI Table			
Purpose:		This table provides building (without content) full replacement value by occupancy at the census tract level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.			
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) ***Access Type (Size)***	Index *	Require d*	Values	Description
CensusTract	Text(11)	T, U, A	F	11 digits of the census tract number	11 digits of the census tract number
RES1I	Long(4) ***Long Integer(4)***	F	F		Single-family dwellings
RES2I	Long(4) ***Long Integer(4)***	F	F		Manufactured housing
RES3AI	Long(4) ***Long Integer(4)***	F	F		Duplex - 1 to 2 units
RES3BI	Long(4) ***Long Integer(4)***	F	F		Duplex - 3 to 4 units
RES3CI	Long(4) ***Long Integer(4)***	F	F		Duplex - 5 to 9 units
RES3DI	Long(4) ***Long Integer(4)***	F	F		Duplex - 10 to 19 units
RES3EI	Long(4) ***Long Integer(4)***	F	F		Duplex - 20 to 49 units
RES3FI	Long(4) ***Long Integer(4)***	F	F		Duplex - more than 50 units
RES4I	Long(4) ***Long Integer(4)***	F	F		Temporary lodging
RES5I	Long(4) ***Long Integer(4)***	F	F		Institutional dormitories
RES6I	Long(4) ***Long Integer(4)***	F	F		Nursing homes

COM1I	Long(4) ***Long Integer(4)***	F	F		Retail trade
COM2I	Long(4) ***Long Integer(4)***	F	F		Wholesale trade
COM3I	Long(4) ***Long Integer(4)***	F	F		Personal and repair services
COM4I	Long(4) ***Long Integer(4)***	F	F		Professional and technical services
COM5I	Long(4) ***Long Integer(4)***	F	F		Banks
COM6I	Long(4) ***Long Integer(4)***	F	F		Hospitals
COM7I	Long(4) ***Long Integer(4)***	F	F		Medical office and clinic
COM8I	Long(4) ***Long Integer(4)***	F	F		Entertainment and recreation
COM9I	Long(4) ***Long Integer(4)***	F	F		Theaters
COM10I	Long(4) ***Long Integer(4)***	F	F		Parking garages
IND1I	Long(4) ***Long Integer(4)***	F	F		Heavy industrial
IND2I	Long(4) ***Long Integer(4)***	F	F		Light industrial
IND3I	Long(4) ***Long Integer(4)***	F	F		Food/drugs/chemicals
IND4I	Long(4) ***Long Integer(4)***	F	F		Metal/minerals processing
IND5I	Long(4) ***Long Integer(4)***	F	F		High technology
IND6I	Long(4) ***Long Integer(4)***	F	F		Construction facilities and offices
AGR1I	Long(4) ***Long Integer(4)***	F	F		Agriculture facilities and offices
REL1I	Long(4) ***Long Integer(4)***	F	F		Churches and non-profit organizations
GOV1I	Long(4) ***Long Integer(4)***	F	F		Government - general services
GOV2I	Long(4) ***Long Integer(4)***	F	F		Government - emergency response
EDU1I	Long(4) ***Long Integer(4)***	F	F		Grade schools and administrative offices

EDU2I	Long(4) ***Long Integer(4)***	F	F		Colleges and universities
* T=True, F=False, U=Unique, NU=Non-Unique, A=Ascending, D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.9 Building Replacement Value by Census Block: hzExposureOccupB

Identification:	hzExposureOccupB				
Type:	ESRI Table				
Purpose:	This table provides building (without content) full replacement value by occupancy at the census block level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region when the flood hazard is included. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
CensusBlock	Text(15)	T, U, A	T	15 digits of the census block number	15 digits of the census block number
RES1I	Long(4) *Long Integer(4)*	F	F		Single-family dwellings
RES2I	Long(4) *Long Integer(4)*	F	F		Manufactured housing
RES3AI	Long(4) *Long Integer(4)*	F	F		Duplex - 1 to 2 units
RES3BI	Long(4) *Long Integer(4)*	F	F		Duplex - 3 to 4 units
RES3CI	Long(4) *Long Integer(4)*	F	F		Duplex - 5 to 9 units
RES3DI	Long(4) *Long Integer(4)*	F	F		Duplex - 10 to 19 units
RES3EI	Long(4) *Long Integer(4)*	F	F		Duplex - 20 to 49 units
RES3FI	Long(4) *Long Integer(4)*	F	F		Duplex - more than 50 units
RES4I	Long(4) *Long Integer(4)*	F	F		Temporary lodging
RES5I	Long(4) *Long Integer(4)*	F	F		Institutional dormitories
RES6I	Long(4) *Long Integer(4)*	F	F		Nursing homes
COM1I	Long(4)	F	F		Retail trade

	Long Integer(4)				
COM2I	Long(4) ***Long Integer(4)***	F	F		Wholesale trade
COM3I	Long(4) ***Long Integer(4)***	F	F		Personal and repair services
COM4I	Long(4) ***Long Integer(4)***	F	F		Professional and technical services
COM5I	Long(4) ***Long Integer(4)***	F	F		Banks
COM6I	Long(4) ***Long Integer(4)***	F	F		Hospitals
COM7I	Long(4) ***Long Integer(4)***	F	F		Medical office and clinic
COM8I	Long(4) ***Long Integer(4)***	F	F		Entertainment and recreation
COM9I	Long(4) ***Long Integer(4)***	F	F		Theaters
COM10I	Long(4) ***Long Integer(4)***	F	F		Parking garages
IND1I	Long(4) ***Long Integer(4)***	F	F		Heavy industrial
IND2I	Long(4) ***Long Integer(4)***	F	F		Light industrial
IND3I	Long(4) ***Long Integer(4)***	F	F		Food/drugs/chemicals
IND4I	Long(4) ***Long Integer(4)***	F	F		Metal/minerals processing
IND5I	Long(4) ***Long Integer(4)***	F	F		High technology
IND6I	Long(4) ***Long Integer(4)***	F	F		Construction facilities and offices
AGR1I	Long(4) ***Long Integer(4)***	F	F		Agriculture facilities and offices
REL1I	Long(4) ***Long Integer(4)***	F	F		Churches and non-profit organizations
GOV1I	Long(4) ***Long Integer(4)***	F	F		Government - general services
GOV2I	Long(4) ***Long Integer(4)***	F	F		Government - emergency response
EDU1I	Long(4) ***Long Integer(4)***	F	F		Grade schools and administrative offices

EDU2I	Long(4) ***Long Integer(4)***	F	F		Colleges and universities
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.10 Content Replacement Value by Census Tract: hzExposureContentOccupT

Identification:	hzExposureContentOccupT				
Type:	ESRI Table				
Purpose:	This table provides building content replacement value by occupancy at the census tract level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) ***Access Type (Size)***	Index *	Required*	Values	Description
CensusTract	Text(11)	T, U, A	T	11 digits of the census tract number	11 digits of the census tract number
RES1I	Long(4) ***Long Integer(4)***	F	F		Single-family dwellings
RES2I	Long(4) ***Long Integer(4)***	F	F		Manufactured housing
RES3AI	Long(4) ***Long Integer(4)***	F	F		Duplex - 1 to 2 units
RES3BI	Long(4) ***Long Integer(4)***	F	F		Duplex - 3 to 4 units
RES3CI	Long(4) ***Long Integer(4)***	F	F		Duplex - 5 to 9 units
RES3DI	Long(4) ***Long Integer(4)***	F	F		Duplex - 10 to 19 units
RES3EI	Long(4) ***Long Integer(4)***	F	F		Duplex - 20 to 49 units
RES3FI	Long(4) ***Long Integer(4)***	F	F		Duplex - more than 50 units
RES4I	Long(4) ***Long Integer(4)***	F	F		Temporary lodging
RES5I	Long(4) ***Long Integer(4)***	F	F		Institutional dormitories
RES6I	Long(4)	F	F		Nursing homes

	Long Integer(4)				
COM1I	Long(4) *Long Integer(4)*	F	F		Retail trade
COM2I	Long(4) *Long Integer(4)*	F	F		Wholesale trade
COM3I	Long(4) *Long Integer(4)*	F	F		Personal and repair services
COM4I	Long(4) *Long Integer(4)*	F	F		Professional and technical services
COM5I	Long(4) *Long Integer(4)*	F	F		Banks
COM6I	Long(4) *Long Integer(4)*	F	F		Hospitals
COM7I	Long(4) *Long Integer(4)*	F	F		Medical office and clinic
COM8I	Long(4) *Long Integer(4)*	F	F		Entertainment and recreation
COM9I	Long(4) *Long Integer(4)*	F	F		Theaters
COM10I	Long(4) *Long Integer(4)*	F	F		Parking garages
IND1I	Long(4) *Long Integer(4)*	F	F		Heavy industrial
IND2I	Long(4) *Long Integer(4)*	F	F		Light industrial
IND3I	Long(4) *Long Integer(4)*	F	F		Food/drugs/chemicals
IND4I	Long(4) *Long Integer(4)*	F	F		Metal/minerals processing
IND5I	Long(4) *Long Integer(4)*	F	F		High technology
IND6I	Long(4) *Long Integer(4)*	F	F		Construction facilities and offices
AGR1I	Long(4) *Long Integer(4)*	F	F		Agriculture facilities and offices
REL1I	Long(4) *Long Integer(4)*	F	F		Churches and non-profit organizations
GOV1I	Long(4) *Long Integer(4)*	F	F		Government - general services
GOV2I	Long(4) *Long Integer(4)*	F	F		Government - emergency response
EDU1I	Long(4)	F	F		Grade schools and administrative

	Long Integer(4)				offices
EDU2I	Long(4) ***Long Integer(4)***	F	F		Colleges and universities
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.11 Content Replacement Value by Census Block: hzExposureContentOccupB

Identification:	hzExposureContentOccupB				
Type:	ESRI Table				
Purpose:	This table provides building content replacement value by occupancy at the census block level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region when the flood hazard is included. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
CensusBlock	Text(15)	T, U, A	T	15 digits of the census block number	15 digits of the census block number
RES1I	Long(4) *Long Integer(4)*	F	F		Single-family dwellings
RES2I	Long(4) *Long Integer(4)*	F	F		Manufactured housing
RES3AI	Long(4) *Long Integer(4)*	F	F		Duplex - 1 to 2 units
RES3BI	Long(4) *Long Integer(4)*	F	F		Duplex - 3 to 4 units
RES3CI	Long(4) *Long Integer(4)*	F	F		Duplex - 5 to 9 units
RES3DI	Long(4) *Long Integer(4)*	F	F		Duplex - 10 to 19 units
RES3EI	Long(4) *Long Integer(4)*	F	F		Duplex - 20 to 49 units
RES3FI	Long(4) *Long Integer(4)*	F	F		Duplex - more than 50 units
RES4I	Long(4) *Long Integer(4)*	F	F		Temporary lodging
RES5I	Long(4) *Long Integer(4)*	F	F		Institutional dormitories
RES6I	Long(4) *Long Integer(4)*	F	F		Nursing homes

COM1I	Long(4) ***Long Integer(4)***	F	F		Retail trade
COM2I	Long(4) ***Long Integer(4)***	F	F		Wholesale trade
COM3I	Long(4) ***Long Integer(4)***	F	F		Personal and repair services
COM4I	Long(4) ***Long Integer(4)***	F	F		Professional and technical services
COM5I	Long(4) ***Long Integer(4)***	F	F		Banks
COM6I	Long(4) ***Long Integer(4)***	F	F		Hospitals
COM7I	Long(4) ***Long Integer(4)***	F	F		Medical office and clinic
COM8I	Long(4) ***Long Integer(4)***	F	F		Entertainment and recreation
COM9I	Long(4) ***Long Integer(4)***	F	F		Theaters
COM10I	Long(4) ***Long Integer(4)***	F	F		Parking garages
IND1I	Long(4) ***Long Integer(4)***	F	F		Heavy industrial
IND2I	Long(4) ***Long Integer(4)***	F	F		Light industrial
IND3I	Long(4) ***Long Integer(4)***	F	F		Food/drugs/chemicals
IND4I	Long(4) ***Long Integer(4)***	F	F		Metal/minerals processing
IND5I	Long(4) ***Long Integer(4)***	F	F		High technology
IND6I	Long(4) ***Long Integer(4)***	F	F		Construction facilities and offices
AGR1I	Long(4) ***Long Integer(4)***	F	F		Agriculture facilities and offices
REL1I	Long(4) ***Long Integer(4)***	F	F		Churches and non-profit organizations
GOV1I	Long(4) ***Long Integer(4)***	F	F		Government - general services
GOV2I	Long(4) ***Long Integer(4)***	F	F		Government - emergency response
EDU1I	Long(4)	F	F		Grade schools and administrative

	Long Integer(4)				offices
EDU2I	Long(4) ***Long Integer(4)***	F	F		Colleges and universities
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.12 Square Footage Value by Census Tract: hzSqFootageOccupT

Identification:	hzSqFootageOccupT
Type:	ESRI Table
Purpose:	This table provides square footage value by occupancy at census tract level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
CensusTract	Text(11)	T, U, A	T	11 digits of the census tract number	11 digits of the census tract number
RES1F	Float	F	F		Single-family dwellings
RES2F	Float	F	F		Manufactured housing
RES3AF	Float	F	F		Duplex - 1 to 2 units
RES3BF	Float	F	F		Duplex - 3 to 4 units
RES3CF	Float	F	F		Duplex - 5 to 9 units
RES3DF	Float	F	F		Duplex - 10 to 19 units
RES3EF	Float	F	F		Duplex - 20 to 49 units
RES3FF	Float	F	F		Duplex - more than 50 units
RES4F	Float	F	F		Temporary lodging
RES5F	Float	F	F		Institutional dormitories
RES6F	Float	F	F		Nursing homes
COM1F	Float	F	F		Retail trade
COM2F	Float	F	F		Wholesale trade
COM3F	Float	F	F		Personal and repair services
COM4F	Float	F	F		Professional and technical services
COM5F	Float	F	F		Banks
COM6F	Float	F	F		Hospitals
COM7F	Float	F	F		Medical office and clinic

COM8F	Float	F	F		Entertainment and recreation
COM9F	Float	F	F		Theaters
COM10F	Float	F	F		Parking garages
IND1F	Float	F	F		Heavy industrial
IND2F	Float	F	F		Light industrial
IND3F	Float	F	F		Food/drugs/chemicals
IND4F	Float	F	F		Metal/minerals processing
IND5F	Float	F	F		High technology
IND6F	Float	F	F		Construction facilities and offices
AGR1F	Float	F	F		Agriculture facilities and offices
REL1F	Float	F	F		Churches and non-profit organizations
GOV1F	Float	F	F		Government - general services
GOV2F	Float	F	F		Government - emergency response
EDU1F	Float	F	F		Grade schools and administrative offices
EDU2F	Float	F	F		Colleges and universities
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.13 Square Footage Value by Census Block: hzSqFootageOccupB

Identification:	hzSqFootageOccupB
Type:	ESRI Table
Purpose:	This table provides square footage value by occupancy at census block level for the study region. It belongs to Boundary.mdb. Data are transferred to the SQL Server database in the Region folder during the process of creating a new study region when the flood hazard is included. Data are subsequently used for Hazus-MH estimation of hazards, damages, and losses, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) ***Access Type (Size)***	Index *	Require d*	Values	Description
CensusBlo	Text(15)	T, U,	T	15 digits of the	15 digits of the census block

ck		A		census block number	number
RES1F	Float	F	F		Single-family dwellings
RES2F	Float	F	F		Manufactured housing
RES3AF	Float	F	F		Duplex - 1 to 2 units
RES3BF	Float	F	F		Duplex - 3 to 4 units
RES3CF	Float	F	F		Duplex - 5 to 9 units
RES3DF	Float	F	F		Duplex - 10 to 19 units
RES3EF	Float	F	F		Duplex - 20 to 49 units
RES3FF	Float	F	F		Duplex - more than 50 units
RES4F	Float	F	F		Temporary lodging
RES5F	Float	F	F		Institutional dormitories
RES6F	Float	F	F		Nursing homes
COM1F	Float	F	F		Retail trade
COM2F	Float	F	F		Wholesale trade
COM3F	Float	F	F		Personal and repair services
COM4F	Float	F	F		Professional and technical services
COM5F	Float	F	F		Banks
COM6F	Float	F	F		Hospitals
COM7F	Float	F	F		Medical office and clinic
COM8F	Float	F	F		Entertainment and recreation
COM9F	Float	F	F		Theaters
COM10F	Float	F	F		Parking garages
IND1F	Float	F	F		Heavy industrial
IND2F	Float	F	F		Light industrial
IND3F	Float	F	F		Food/drugs/chemicals
IND4F	Float	F	F		Metal/minerals processing
IND5F	Float	F	F		High technology
IND6F	Float	F	F		Construction facilities and offices
AGR1F	Float	F	F		Agriculture facilities and offices
REL1F	Float	F	F		Churches and non-profit organizations
GOV1F	Float	F	F		Government - general services
GOV2F	Float	F	F		Government - emergency

					response
EDU1F	Float	F	F		Grade schools and administrative offices
EDU2F	Float	F	F		Colleges and universities
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.4.3.14 County Location Factor: hzMeansCountyLocationFactor

Identification:	hzMeansCountyLocationFactor				
Type:	ESRI table				
Purpose:	The Hazus Means-based location factor at the county level used to "localize" national costs to reflect local conditions.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) ***Access Type (Size)***	Index *	Required*	Values	Description
CountyFips	Text(5)	F	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the FIPS state code; the remaining three digits are the county code.
MeansAdjRes	Double	F	F		Means location factors for residential occupancies on a county basis
MeansAdjNonRes	Double	F	F		Means location factors for non-residential occupancies on a county basis
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5 Essential Facilities: EF.mdb

F.5.1 Database Overview

The EF.mdb is an Access personal geodatabase that contains (1) feature classes for essential facilities with fields that are relevant for all hazards and (2) tables with information specific to the EQ and FL Models. Essential facilities are those that provide services to the community and should be functional after an earthquake, flood, or hurricane event. Essential facilities include:

- Fire stations
- Police stations
- Emergency centers
- Care facilities (hospitals and medical clinics)
- Schools (K-12 and colleges)

The geographical domain of the database is the state. In that case, there is one EF.mdb database for each state, each located in the appropriate State folder.

During the creation of a study region, for all hazards, essential facilities geometries from feature classes are transferred to a geodatabase named EF.mdb in the Region folder. Feature classes are named with the prefix hz, meaning they are relevant across all Hazus-MH Models. Police stations, for instance, are stored in hzPoliceStation feature class with fields containing information common to all hazards, such as name and address. This information is transferred to a table with the same name (for police station, hzPoliceStation) in the SQL Server database in the Region folder.

Hazard specific tables are named with the prefix eq (earthquake) and fl (flood), such as eqPoliceStation and flPoliceStation. The information is transferred to tables with the same name in the SQL Server database in the Region folder. There is a one-to-one relationship between hz tables and the corresponding eq and fl tables through a unique identifier.

F.5.2 Identification

EF.mdb

F.5.3 Database Content

The EF.mdb database includes:

Name	Type	Content
hzCareFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of hospitals and medical clinics
hzEmergencyCtr	ESRI Point Feature Class	Geometry (point features) and all-hazards information of emergency operation centers (EOC)
hzFireStation	ESRI Point Feature Class	Geometry (point features) and all-hazards information of fire stations
hzPoliceStation	ESRI Point Feature Class	Geometry (point features) and all-hazards information of police stations
hzSchool	ESRI Point Feature Class	Geometry (point features) and all-hazards information of schools and colleges
eqCareFlty	ESRI Table	Earthquake specific information for hospitals and medical clinics
eqEmergencyCtr	ESRI Table	Earthquake specific information for EOCs
eqFireStation	ESRI Table	Earthquake specific information for fire stations
eqPoliceStation	ESRI Table	Earthquake specific information for police stations
eqSchool	ESRI Table	Earthquake specific information for schools and colleges
flCareFlty	ESRI Table	Flood specific information for hospitals and medical clinics
flEmergencyCtr	ESRI Table	Flood specific information for EOCs
flFireStation	ESRI Table	Flood specific information for fire stations
flPoliceStation	ESRI Table	Flood specific information for police stations
flSchool	ESRI Table	Flood specific information for schools and colleges

F.5.3.1 Care Facilities Feature Class: hzCareFlty

Identification:	hzCareFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to EF.mdb. Provides the geometry of hospitals and medical clinics. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named EF.mdb in the Region folder. Field information is transferred to a table with the same name (hzCareFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
CareFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this hzCareFlty feature class with the associated eqCareFlty and flCareFlty tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
EfClass	Text(5)	T, NU, A	T, UC	EFHL=Large hospital EFHM=Medium hospital EFHS=Small hospital EFMC=Medical clinic MDFLT=Default value	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing the loss estimations produced by the EQ model.
Tract	Text(11)	T, NU,	T	11 digits of the	Census tract number of the

		A		census tract number	2000 US Census
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
State	Text(2)	F	F		USPS state abbreviation
Contact	Text(40)	F	F		Name of contact person for the facility
PhoneNumber	Text(14)	F	F		Phone number to contact the facility
Use	Text(10)	F	F		Use
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
BackupPower	Short(1) *Yes/No(1)*	F	F	0=No 1=Yes	Availability of backup power
NumBeds	Long(4) *Long Integer(4)*	F	F		Maximum number of available patient beds
AhaId	Text(7)	F	F		American Hospital Association (AHA) hospital identification number, if AHA data used
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.2 Earthquake Specific Care Facilities Table: eqCareFlty

Identification:	eqCareFlty
Type:	ESRI Table
Purpose:	Belongs to EF.mdb. Provides Earthquake Model specific information for hospitals and medical clinics. During the creation of a study region, the table content is transferred to another table with the same name (eqCareFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqCareFlty for each record in hzCareFlty with the same CareFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
CareFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this eqCareFlty feature class with the associated hzCareFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for descriptions of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code	Building codes in effect in the area. See the Earthquake Technical Manual, Chapters 3

				LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	and 5, for design levels.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is found in the table for future extensibility of the earthquake model but does not need to be populated at this time.
SoilType	Text(1)	F	T	A = Soil type A B = Soil type B C = Soil type C D = Soil type D E = Soil type E	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines conditions where the structure is located. This is based on shear wave velocity. See Earthquake User Manual, Appendix B, Table B.1, for details.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility locattion. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0.

					Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.3 Flood Specific Care Facilities Table: flCareFlty

Identification:	flCareFlty
Type:	ESRI Table
Purpose:	Belongs to EF.mdb. Provides Flood Model specific information of hospitals and medical clinics. During the creation of a study region, the table content is transferred to another table with the same name (flCareFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flCareFlty for each record in hzCareFlty with same CareFltyId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
CareFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this flCareFlty feature class with the associated hzCareFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
BldgType	Text(15)	F	F	Null, Masonry, Concrete, Wood, Steel, ManufHousing	General building type
DesignLevel	Text(1)	F	F	Null 0 = Pre-FIRM 1 = Post-FIRM	Design level (Pre/Post FIRM)
FoundationType	Text(1)	F	F	Null 1 = Basement 2 = Crawl 3 = Fill	Foundation type (e.g., slab, pile)

				4 = Pier 5 = Pile 6 = Slab 7 = SolidWall	
FirstFloorHt	Float(4) *Single(4)*	F	F		First floor height
BldgDamage FnId	Text(10)	F	F		Default building damage function id
ContDamage FnId	Text(10)	F	F		Default content damage function id
FloodProtect ion	Short(2) *Integer(2)*	F	F		Flood protection return period
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.4 Emergency Operation Center Feature Class: hzEmergencyCtr

Identification:	hzEmergencyCtr
Type:	ESRI Point Feature Class
Purpose:	Belongs to EF.mdb. Provides the geometry of EOCs. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named EF.mdb in the Region folder. Field information is transferred to a table with the same name (hzEmergencyCtr) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
EocId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this hzEmergencyCtr feature class with the associated eqEmergencyCtr and flEmergencyCtr tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
EfClass	Text(5)	T, NU, A	T, UC	EDFLT = Default EFEO = Emergency Operation Centers See Appendix B, Table B-3	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ model.
Tract	Text(11)	T, NU, A	T	11 digits of the census tract number	11 digits of the census tract number
Name	Text(40)	F	F		Facility name

Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Statea	Text(2)	F	F		USPS state abbreviation
Contact	Text(40)	F	F		Name of contact person for the facility
PhoneNumber	Text(14)	F	F		Phone number to contact the facility
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year the structure was built
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
BackupPower	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Availability of backup power
ShelterCapacity	Short(2) *Integer(2)*	F	F		Shelter capacity. This is for informational purposes only and is not used in any Hazus-MH calculations. This is the total number of persons who can be sheltered in this facility
Area	Float(4) *Single(4)*	F	F		AHA hospital id number, if AHA data are used
Kitchen	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether a kitchen is available in the facility
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.5.3.5 Earthquake Specific Emergency Center Table: eqEmergencyCtr

Identification:	eqEmergencyCtr
Type:	ESRI Table
Purpose:	Belongs to EF.mdb. Provides Earthquake Model specific information of EOCs. During the creation of a study region, the table content is transferred to another table with the same name (eqEmergencyCtr) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqEmergencyCtr for each record in hzEmergencyCtr with same EocId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
EocId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this eqEmergencyCtr feature class with the associated hzEmergencyCtr in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B-2	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about

				PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	design levels.
FoundationType	Text(1)	F	T		Foundation type (e.g., slab, pile). This field is found in the table for future extensibility of the Earthquake Model, but does not need to be populated at this time.
SoilType	Text(1)	F	T	See Appendix B, Table B.1	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines structure location conditions. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility locattion. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.6 Flood Specific Emergency Center Facilities Table: flEmergencyCtr

Identification:	flEmergencyCtr
Type:	ESRI Table
Purpose:	Belongs to EF.mdb. Provides Flood Model specific information of EOCs. During the creation of a study region, the table content is transferred to another table with the same name (flEmergencyCtr) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flEmergencyCtr for each record in hzEmergencyCtr with same EocId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
EocId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this flEmergencyCtr feature class with the associated hzEmergencyCtr in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
BldgType	Text(15)	F	F	Null, Masonry, Concrete, Wood, Steel, ManufHousing	General building type
DesignLevel	Text(1)	F	F	Null 0 = Pre-FIRM 1 = Post-FIRM	Design level (Pre/Post FIRM)
FoundationType	Text(1)	F	F	Null 1 = Basement 2 = Crawl 3 = Fill	Foundation type (e.g., slab, pile)

				4 = Pier 5 = Pile 6 = Slab 7 = SolidWall	
FirstFloorHt	Float(4) *Single(4)*	F	F		First-floor height
BldgDamage FnId	Text(10)	F	F		Default building damage function id
ContDamage FnId	Text(10)	F	F		Default content damage function id
FloodProtect ion	Short(2) *Integer(2)*	F	F		Flood protection return period
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.7 Fire Stations Feature Class: hzFireStation

Identification:	hzFireStation				
Type:	ESRI Point Feature Class				
Purpose:	Belongs to EF.mdb. Provides the geometry of fire stations. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named EF.mdb in the Region folder. Field information is transferred to a table with the same name (hzFireStation) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
FireStationId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this hzFireStation feature class with the associated eqFireStation and flFireStation tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
EfClass	Text(5)	T, NU, A	T, UC	EDFLT = Default EFFS = Fire Station	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City

Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Statea	Text(2)	F	F		USPS state abbreviation
Contact	Text(40)	F	F		Contact name of person for the facility
PhoneNumber	Text(14)	F	F		Phone number to contact the facility
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
BackupPower	Short(1) *Yes/No(1)*	F	F	0=No 1=Yes	Availability of backup power
ShelterCapacity	Short(2) *Integer(2)*	F	F		Shelter capacity. This is for informational purposes only and is not used in any Hazus-MH calculations. This is the total number of persons who can be sheltered in this facility.
Area	Float(4) *Single(4)*	F	F		AHA hospital id number, if AHA data are used.
Kitchen	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether a kitchen is available in the facility.
NumTrucks	Short(2) *Integer(2)*	F	F		Number of fire trucks in a fire station
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.5.3.8 Earthquake Specific Fire Stations Table: eqFireStation

Identification:	eqFireStation
Type:	ESRI Table
Purpose:	Belongs to EF.mdb. Provides Earthquake Model specific information of fire stations. During the creation of a study region, the content of the table is transferred to another table with the same name (eqFireStation) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqFireStation for each record in hzFireStation with same FireStationId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
FireStationId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this eqFireStation feature class with the associated hzFireStation in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and, for detailed information about design levels.

				HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the Earthquake Model but does not need to be populated at this time.
SoilType	Text(1)	F	T	See Appendix B, Table B.1	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines structure location conditions. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility locattion. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.9 Flood Specific Fire Station Facilities Table: flFireStation

Identification:	flFireStation				
Type:	ESRI Table				
Purpose:	Belongs to EF.mdb. Provides Flood Model specific information of fire stations. During creation of a study region, the table content is transferred to another table with the same name (flFireStation) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flFireStation for each record in hzFireStation with same FireStationId unique identifier.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
FireStationId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this flFireStation feature class with the associated hzFireStation in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
BldgType	Text(15)	F	F	Null, Masonry, Concrete, Wood, Steel, ManufHousing	General building type
DesignLevel	Text(1)	F	F	Null 0 = Pre-FIRM 1 = Post-FIRM	Design level (Pre/Post FIRM)
FoundationType	Text(1)	F	F	Null 1 = Basement 2 = Crawl 3 = Fill	Foundation type (e.g., slab, pile)

				4 = Pier 5 = Pile 6 = Slab 7 = SolidWall	
FirstFloorHt	Float(4) *Single(4)*	F	F		First-floor height
BldgDamage FnId	Text(10)	F	F		Default building damage function id
ContDamage FnId	Text(10)	F	F		Default content damage function id
FloodProtection	Short(2) *Integer(2)*	F	F		Flood protection return period
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.10 Police Station Feature Class: hzPoliceStation

Identification:	hzPoliceStation				
Type:	ESRI Point Feature Class				
Purpose:	Belongs to EF.mdb. Provides the geometry of police stations. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named EF.mdb in the Region folder. Field information is transferred to a table with the same name (hzPoliceStation) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
PoliceStation Id	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this hzPoliceStation feature class with the associated eqPoliceStation and flPoliceStation tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
EfClass	Text(5)	T, NU, A	T, UC	EDFLT = Default EFFS = Police Station See Appendix B, Table B.4	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address

City	Text(40)	F	F		City
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Statea	Text(2)	F	F		USPS state abbreviation
Contact	Text(40)	F	F		Name of contact person for the facility
PhoneNumber	Text(14)	F	F		Phone number to contact the facility
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
BackupPower	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Availability of backup power
ShelterCapacity	Short(2) *Integer(2)*	F	F		Shelter capacity. This is for informational purposes only and is not used in any Hazus-MH calculations. This is the total number of persons who can be sheltered in this facility.
Area	Float(4) *Single(4)*	F	F		AHA hospital id number, if AHA data are used.
Kitchen	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether a kitchen is available in the facility.
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.5.3.11 Earthquake Specific Police Stations Table: eqPoliceStation

Identification:	eqPoliceStation
Type:	ESRI Table
Purpose:	Belongs to EF.mdb. Provides Earthquake Model specific information of police stations. During the creation of a study region, the table content is transferred to another table with the same name (eqPoliceStation) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqPoliceStation for each record in hzPoliceStation with same PoliceStationId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
PoliceStationId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this eqPoliceStation feature class with the associated hzPoliceStation in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels

				HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not need to be populated at this time.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the structure location conditions. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility locattion. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicator of the landslide susceptibility of the facility location. See Earthquake Technical Manual (Section, 4.2 Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.12 Flood Specific Police Station Facilities Table: flPoliceStation

Identification**:**	flPoliceStation
Type**:**	ESRI Table
Purpose**:**	Belongs to EF.mdb. Provides Flood Model specific information of police stations. During the creation of a study region, the table content is transferred to another table with the same name (flPoliceStation) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flPoliceStation for each record in hzPoliceStation with same PoliceStationId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
PoliceStationId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this flPoliceStation feature class with the associated hzPoliceStation in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
BldgType	Text(15)	F	F	Null, Masonry, Concrete, Wood, Steel, ManufHousing	General building type
DesignLevel	Text(1)	F	F	Null 0 = Pre-FIRM 1 = Post-FIRM	Design level (Pre/Post FIRM)
FoundationType	Text(1)	F	F	Null 1 = Basement 2 = Crawl 3 = Fill	Foundation type (e.g., slab, pile)

				4 = Pier 5 = Pile 6 = Slab 7 = SolidWall	
FirstFloorHt	Float(4) *Single(4)*	F	F		First-floor height
BldgDamage FnId	Text(10)	F	F		Default building damage function id
ContDamage FnId	Text(10)	F	F		Default content damage function id
FloodProtection	Short(2) *Integer(2)*	F	F		Flood protection return period
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.13 Schools Feature Class: hzSchool

Identification:	hzSchool
Type:	ESRI Point Feature Class
Purpose:	Belongs to EF.mdb. Provides the geometry of schools, colleges, and universities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named EF.mdb in the Region folder. Field information is transferred to a table with the same name (hzSchool) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
SchoolId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this hzSchool feature class with the associated eqSchool and flSchool tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
EfClass	Text(5)	T, NU, A	T, UC	EDFLT = Default EFS1 = Grade School EFS2 = College/ University	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the census tract number	Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address

City	Text(40)	F	F		City
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Statea	Text(2)	F	F		USPS state abbreviation
Contact	Text(40)	F	F		Name of contact person for the facility
PhoneNumber	Text(14)	F	F		Phone number to contact the facility
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
NumStudents	Short(2) *Integer(2)*	F	F		Number of students in facility
BackupPower	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Availability of backup power
ShelterCapacity	Short(2) *Integer(2)*	F	F		Shelter capacity. This is for informational purposes only and is not used in any Hazus-MH calculations. This is the total number of persons who can be sheltered in this facility
Area	Float(4) *Single(4)*	F	F		AHA hospital id number, if AHA data are used
District	Text(30)	F	F		Name of school district
Kitchen	Short(1) *Yes/No(1)*	F	F	0=No 1=Yes	Indicates whether a kitchen is available in the facility
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase;

LC=Lowercase

F.5.3.14 Earthquake Specific School Table: eqSchool

Identification:	eqSchool				
Type:	ESRI Table				
Purpose:	Belongs to EF.mdb. Provides Earthquake Model specific information of schools, colleges, and universities. During the creation of a study region, the table content is transferred to another table with the same name (eqSchool) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqSchool for each record in hzSchool with same SchoolId unique identifier.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
SchoolId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this eqSchool feature class with the associated hzSchool in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in HAZUS earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about

				PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	design levels.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is found in the table for future extensibility of the earthquake model, but does not need to be populated at this time.
SoilType	Text(1)	F	T, UC	See Appendix B, table B-1	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines structure location conditions. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility locattion. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicator of the landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.5.3.15 Flood Specific Schools Facilities Table: flSchool

Identification:	**flSchool**
Type:	ESRI Table
Purpose:	Belongs to EF.mdb. Provides Flood Model specific information of schools, colleges, and universities. During the creation of a study region, the table content is transferred to another table with the same name (flSchool) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flSchool for each record in hzSchool with same SchoolId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
SchoolId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this flSchool feature class with the associated hzSchool in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
BldgType	Text(15)	F	F	Null, Masonry, Concrete, Wood, Steel, ManufHousing	General building type
DesignLevel	Text(1)	F	F	Null 0 = Pre-FIRM 1 = Post-FIRM	Design level (Pre/Post FIRM)
FoundationType	Text(1)	F	F	Null 1 = Basement 2 = Crawl	Foundation type (e.g., slab, pile)

				3 = Fill 4 = Pier 5 = Pile 6 = Slab 7 = SolidWall	
FirstFloorHt	Float(4) *Single(4)*	F	F		First-floor height
BldgDamage FnId	Text(10)	F	F		Default building damage function id
ContDamage FnId	Text(10)	F	F		Default content damage function id
FloodProtect ion	Short(2) *Integer(2)*	F	F		Flood protection return period
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6 Transportation Systems: TRN.mdb

F.6.1 Database Overview

The TRN.mdb is an Access personal geodatabase that contains feature *classes* for transportation systems with fields relevant to all hazards; it also contains *tables* with information specific to the EQ and FL Models. Transportation systems include:

Highway segments, bridges, and tunnels

Railway tracks, bridges, and tunnels

Railway facilities

Light rail tracks, bridges, and tunnels

Light rail facilities

Bus stations

Ports

Ferries

Airports and runways

The geographical domain of the database is the state. In that case, there is one TRN.mdb database for each state, each located in the appropriate State folder.

The current version of the Flood Model provides only the level of damage to the bridge network and the subsequent bridge functionality. The Hurricane Model does not provide damage or loss estimates for transportation systems.

During the creation of a study region, for all hazards, transportation system geometries from feature classes are transferred to a geodatabase named TRN.mdb in the Region folder. Feature classes are named with the prefix *hz* that means that are relevant across all Hazus-MH Models. Highway bridges, for instance, are stored in *hzHighwayBridge* feature class with fields containing information common to all hazards, such as name and address. This information is transferred to a table with the same name (for highway bridges, *hzHighwayBridge*) in the SQL Server database in the Region folder.

Hazard specific tables are named with the prefix *eq* (earthquake) and *fl* (flood), such as *eqHighwayBridge* and *flHighwayBridge*. The information is transferred to tables with the same name in the SQL Server database in the Region folder. There is a one-to-one relationship between *hz* tables and the corresponding *eq* and *fl* tables through a unique identifier.

F.6.2 Identification

TRN.mdb

F.6.3 Database Content

The TRN.mdb database includes:

Name	Type	Content
hzAirportFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of airports related facilities. Airport transportation systems consist of control towers, runways, terminal buildings, parking structures, and fuel, maintenance, and hangar facilities.
hzBusFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of bus transportation facilities. Bus transportation systems consist of urban stations, fuel facilities, dispatch facilities, and maintenance facilities.
hzFerryFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of ferry facilities. Ferry systems consist of waterfront structures, passenger terminals, fuel facilities, dispatch facilities, and maintenance facilities.
hzHighwayBridge	ESRI Point Feature Class	Geometry (point features) and all-hazards information of highway bridges
hzHighwaySegment	ESRI Line Feature Class	Geometry (line features) and all-hazards information highways
hzHighwayTunnel	ESRI Point Feature Class	Geometry (point features) and all-hazards information of highway tunnels
hzLightRailBridge	ESRI Point Feature Class	Geometry (point features) and all-hazards information of light rail bridges
hzLightRailFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of light rail transportation facilities. Like railways, light rail systems are composed of tracks, bridges, tunnels, and facilities. The major difference between the two is the power supply, with light rail systems operating with DC power substations.
hzLightRailSegment	ESRI Line Feature Class	Geometry (line features) and all-hazards information of light rail tracks
hzLightRailTunnel	ESRI Point Feature Class	Geometry (point features) and all-hazards information of light rail tunnels
hzPortFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of port and harbor facilities

hzRailFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of railway transportation facilities
hzRailwayBridge	ESRI Point Feature Class	Geometry (point features) and all-hazards information of railway bridges
hzRailwaySegment	ESRI Line Feature Class	Geometry (line features) and all-hazards information of railway tracks
hzRailwayTunnel	ESRI Point Feature Class	Geometry (point features) and all-hazards information of railway tunnels
hzRunway	ESRI Point Feature Class	Geometry (point features) and all-hazards information of airport runways
eqAirportFlty	ESRI Table	Earthquake specific information for airports facilities
eqBusFlty	ESRI Table	Earthquake specific information for bus facilities
eqFerryFlty	ESRI Table	Earthquake specific information for ferry facilities
eqHighwayBridge	ESRI Table	Earthquake specific information for highway bridges
eqHighwaySegment	ESRI Table	Earthquake specific information for highway segments
eqHighwayTunnel	ESRI Table	Earthquake specific information for highway tunnels
eqLightRailBridge	ESRI Table	Earthquake specific information for light rail bridges
eqLightRailFlty	ESRI Table	Earthquake specific information for light rail facilities
eqLightRailSegment	ESRI Table	Earthquake specific information for light rail segments
eqLightRailTunnel	ESRI Table	Earthquake specific information for light rail tunnels
eqPortFlty	ESRI Table	Earthquake specific information for port and harbor facilities
eqRailFlty	ESRI Table	Earthquake specific information for railway facilities
eqRailwayBridge	ESRI Table	Earthquake specific information for railway bridges
eqRailwaySegment	ESRI Table	Earthquake specific information for railway segments
eqRailwayTunnel	ESRI Table	Earthquake specific information for railway tunnels
eqRunway	ESRI Table	Earthquake specific information for airport runways
flExposureTransport	ESRI Table	Flood specific table (not used and not required)
flHighwayBridge	ESRI Table	Flood specific information for highway bridges
flLightRailBridge	ESRI Table	Flood specific information for light rail bridges
flRailwayBridge	ESRI Table	Flood specific information for railway bridges

F.6.3.1 Airports Feature Class: hzAirportFlty

Identification:	hzAirportFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of airports. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzAirportFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
AirportFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzAirportFlty* feature class with the associated *eqAirportFlty* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TranspFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.12.	Indicates facility classification. Used by Hazus-MH to identify appropriate damage curve to assess loss estimations produced by the EQ model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact person
PhoneNumber	Text(14)	F	F		Facility contact phone number
Use	Text(10)	F	F		Use

YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
Cost	Double(8) Currency (8)	F	F		Replacement cost (in thousands)
Cargo	Long(4) Long Integer(4)	F	F		Capacity of cargo that the facility handles (tons/day)
NumFlights	Short(2) Integer(2)	F	F		Capacity of flights per day that the facility can handle
NumPassengers	Short(2) Integer(2)	F	F		Number of passengers per day
BackupPower	Short(1) Yes/No(1)	F	F	0 = No 1 = Yes	Availability of backup power
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.2 Earthquake Specific Airports Table: eqAirportFlty

Identification:	eqAirportFlty
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of airports. During the creation of a study region, the table content is transferred to another table with the same name (eqAirportFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqAirportFlty for each record in hzAirportFlty with same AirportFltyId unique identifier
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
AirportFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eqAirportFlty* feature class with the associated *hzAirportFlty* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
Anchor	Short(1) Yes/No(1)	F	F	0 = No 1 = Yes	Indicates whether facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not need to be populated at this time.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.

				Code MS = Special Moderate-Code LS = Special Low-Code	
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines structure location conditions. This is based on shear wave velocity. See Appendix B, Table B.1, for details
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2 Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2 Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.3 Bus Facilities Feature Class: hzBusFlty

Identification:	hzBusFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of bus transportation facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzBusFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
BusFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzBusFlty* feature class with the associated *eqBusFlty* table. The standard format adopted by Hazus is SSxxxxxx where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TranspFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.9.	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F			Facility name
Address	Text(40)	F			Physical address
City	Text(40)	F			City
Statea	Text(2)	F			USPS state abbreviation
Zipcode	Text(10)	F			Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F			Facility owner name
Contact	Text(40)	F			Facility contact person
PhoneNumber	Text(14)	F			Facility contact phone number
Use	Text(10)	F			Use
YearBuilt	Short(2)	F		Null or	Year structure was built

	Integer(2)			(≥ 1500 and ≤ 2100)	
Cost	Double(8) Currency(8)	F			Replacement cost (in thousands). This field is for informational purposes and has no bearing on any computation.
BackupPower	Short(1) Yes/No(1)	F		0 = No 1 = Yes	Availability of backup power
Traffic	Long(4) Long Integer(4)	F			Daily traffic (buses/day). This field is for informational purposes and has no bearing on any computation.
Latitude	Double(8) Double(8)	F	Y	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	Y	Longitude decimal degrees	Longitude
Comment	Text(40)	F			Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.4 Earthquake Specific Bus Facilities Table: eqBusFlty

Identification:	eqBusFlty
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of bus transportation facilities. During the creation of a study region, the table content is transferred to another table with the same name (eqBusFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqBusFlty for each record in hzBusFlty with same BusFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
BusFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eqBusFlty* feature class with the associated *hzBusFlty* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
Anchor	Short(1) Yes/No(1)	F	F	0 = No 1 = Yes	Indicates whether facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not need to be populated at this time.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.

				Moderate-Code LS = Special Low-Code	
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines conditions of the structure location. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2 Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.5 Ferry Facilities Feature Class: hzFerryFlty

Identification:	hzFerryFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of ferry transportation system facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzFerryFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
FerryFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzFerryFlty* feature class with the associated *eqFerryFlty* table. The standard format adopted by Hazus is SSxxxxxx where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TranspFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B-11.	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing the loss estimations produced by the EQ model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact person name
PhoneNumber	Text(14)	F	F		Contact person phone number
Use	Text(10)	F	F		Use
YearBuilt	Short(2)	F	F	Null or	Year structure was built

	Integer(2)			(≥ 1500 and ≤ 2100)	
NumStories	Short(1) Byte(1)	F	F		Number of stories
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands). This field is for informational purposes and has no bearing on any computation.
BackupPower	Short(1) Yes/No(1)	F	F	0=No 1=Yes	Availability of backup power
Traffic	Long(4) Long Integer(4)	F	F		Daily traffic (ferry/day). This field is for informational purposes and has no bearing on any computation
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique, NU=Non-Unique, A=Ascending, D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.6 Earthquake Specific Ferry Facilities Table: eqFerryFlty

Identification:	eqFerryFlty
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of ferry transportation system facilities. During the creation of a study region, is transferred to a table with the same name (eqFerryFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqFerryFlty for each record in hzFerryFlty with same FerryFltyId unique identifier
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
FerryFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*Ferry*Flty* feature class with the associated *hz*Ferry*Flty* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for a complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.
Anchor	Short(1) Yes/No(1)	F	F	0 = No 1 = Yes	Indicates whether the facility is anchored to provide additional resistance to seismic forces.
FoundationT	Text(1)	F	F		Foundation type (e.g., slab, pile).

ype					This field is in the table for future extensibility of the Earthquake Model, but does not need to be populated at this time.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions of the structure location. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.7 Highway Bridges Feature Class: hzHighwayBridge

Identification:	hzHighwayBridge
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of highway bridges. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzHighwayBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
HighwayBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzHighwayBridge* feature class with the associated *eqHighwayBridge* and fl*HighwayBridge* tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
BridgeClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.6.	Indicates bridge classification. It is used by Hazus-MH to identify the appropriate damage curve to assess loss estimations produced by the EQ model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner name
BridgeType	Text(8)	F	F		Structural types based on the FHWA classification scheme in the source database. This field is for informational purposes and has no bearing on the computation of results.
Width	Double(8) Double(8)	F	F		Bridge width (in meters)
NumSpans	Short(1)	F	F		Number of spans

	Byte(1)				
Length	Long(4) Long Integer(4)	F	F		Bridge length (in meters)
MaxSpanLength	Double(8) Double(8)	F	F		Maximum span length (in meters)
SkewAngle	Double(8) Double(8)	F	F		Skew angle (in degrees)
SeatLength	Double(8) Double(8)	F	F		Seat length (in meters)
SeatWidth	Double(8) Double(8)	F	F		Seat width (in meters)
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year built
YearRemodeled	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year remodeled
PierType	Text(10)	F	F		Pier type based on FHWA classification scheme in the source database
FoundationType	Text(1)	F	F		Foundation type based on FHWA classification scheme in the source database.
ScourIndex	Text(1)	F	F		This field is significant for flood analysis, and is the second part of the bridge specific occupancy in the bridge damage function tables[2]. This field is not used in the EQ or HU Model

[2] If the bridge is considered inundated then, the scour index is checked. If the scour index is in (4, 5, 6, 7, 8, 9, T, N) then no analysis is performed as the engineering study has determined that the bridge will not be subjected to scour. If the scour index is in (U, 1, 2, 3) then an analysis must be performed.

					calculations.
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (cars per day)
TrafficIndex	Text(2)	F	F		Traffic index
Condition	Text(3)	F	F		General condition rating based on the FHWA classification scheme in the source database
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.8 Earthquake Specific Highway Bridge Table: eqHighwayBridge

Identification:	eqHighwayBridge
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of highway bridges. During the creation of a study region, the table content is transferred to another table with the same name (eqHighwayBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqHighwayBridge for each record in hzHighwayBridge with same HighwayBridgeId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
HighwayBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*HighwayBridge feature class with the associated *hz*HighwayBridge in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null or ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.6.3.9 Flood Specific Highway Bridge Table: flHighwayBridge

Identification:	flHighwayBridge
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Flood Model specific information of highway bridges. During the creation of a study region, the content of the table is transferred to another table with the same name (flHighwayBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flHighwayBridge for each record in hzHighwayBridge with same HighwayBridgeId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
HighwayBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*HighwayBridge feature class with the associated *hz*HighwayBridge in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
Elevation	Double(8) Double(8)	F	F		Elevation of bridge deck

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.6.3.10 Highway Roads Feature Class: hzHighwaySegment

Identification:	hzHighwaySegment
Type:	ESRI Line Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of highway roads. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Fields information is transferred to a table with the same name (hzHighwaySegment) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
HighwaySegId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzHighwaySegment* feature class with the associated *eqHighwaySegment* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SegmentClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.6.	Indicates highway road classification. It is used by Hazus-MH to identify the appropriate damage curve to assess the loss estimations produced by the EQ model.
CountyFips	Text(5)	T, NU, A	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner name
Length	Short(2) Integer(2)	F	F		Highway segment length (in kilometers)
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (cars per day)
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)

NumLanes	Short(2) Integer(2)	F	F		Number of lanes
Pavement	Text(10)	F	F		Pavement type based on the FHWA classification scheme in the source database. This field is for informational purposes and has no bearing on the computation of results.
Width	Double(8) Double(8)	F	F		Highway segment width (in meters)
Capacity	Long(4) Long Integer(4)	F	F		Daily capacity (cars/day)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.11 Earthquake Specific Highway Roads Table: eqHighwaySegment

Identification:	eqHighwaySegment
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of highway roads. During the creation of a study region, the table content is transferred to a table with the same name (eqHighwaySegment) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqHighwaySegment for each record in hzHighwaySegment with same HighwaySegId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
HighwaySegId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*HighwaySegment feature class with the associated *hz*HighwaySegment in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.6.3.12 Highway Tunnel Feature Class: hzHighwayTunnel

Identification:	hzHighwayTunnel
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of highway tunnels. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzHighwayTunnel) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
HighwayTunnelId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzHighwayTunnel* feature class with the associated *eqHighwayTunnel* table. The standard format adopted by Hazus is SSxxxxxx where SS is the State name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
TunnelClass	Text(5)	T, NU, A	T, UC	See Appendix 6, Table B.6.	Indicates tunnel classification. It is used by Hazus-MH to identify the appropriate damage curve to assess loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner name
Type	Text(5)	F	F		Structural types based on the FHWA classification scheme in the source database. This field is for informational purposes and has no bearing on the computation of results.
Width	Double(8) Double(8)	F	F		Bridge width (in meters)
Length	Long(4) Long	F	F		Bridge length (in meters)

	Integer(4)				
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (cars per day)
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.13 Earthquake Specific Highway Tunnel Table: eqHighwayTunnel

Identification:	eqHighwayTunnel
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of highway tunnels. During the creation of a study region, the table content is transferred to a table with the same name (eqHighwayTunnel) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqHighwayTunnel for each record in hzHighwayTunnel with same HighwayTunnelId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
HighwayTunnelId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*HighwayTunnel feature class with the associated *hz*HighwayTunnel in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SoilType	Text(1)	N	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines structure location conditions. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase;					

LC=Lowercase

F.6.3.14 Light Rail Bridges Feature Class: hzLightRailBridge

Identification:	hzLightRailBridge
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of light rail bridges. During the creation of a study region, for all hazards, geometries are transfer to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzLightRailBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
LightRailBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzLightRailBridge* feature class with the associated *eqLightRailBridge* and *flLightRailBridge* tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the State name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
BridgeClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.8.	Indicates bridge classification. It is used by Hazus-MH to identify appropriate damage curve to assess the loss estimations produced by the EQ model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner name
BridgeType	Text(8)	F	F		Structural types based on the FHWA classification scheme in the source database. This field is for informational purposes and has no bearing on the computation of results.
Width	Double(8) Double(8)	F	F		Bridge width (in meters)
NumSpans	Short(1)	F	F		Number of spans

	Byte(1)				
Length	Long(4) Long Integer(4)	F	F		Bridge length (in meters)
MaxSpanLength	Double(8) Double(8)	F	F		Maximum span length (in meters)
SkewAngle	Double(8) Double(8)	F	F		Skew angle (in degrees)
SeatLength	Double(8) Double(8)	F	F		Seat length (in meters)
SeatWidth	Double(8) Double(8)	F	F		Seat width (in meters)
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year built
YearRemodeled	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year remodeled
PierType	Text(10)	F	F		Pier type based on FHWA classification scheme in the source database
FoundationType	Text(1)	F	F		Foundation type based on FHWA classification scheme in the source database
ScourIndex	Text(1)	F	F		This field is significant to flood analysis and is the second part of the bridge specific occupancy in the bridge damage function tables[3]. This field is not used in the

[3] If the bridge is considered inundated then, the scour index is checked. If the scour index is in (4, 5, 6, 7, 8, 9, T, N) then no analysis is performed as the engineering study has determined that the bridge will not be subjected to scour. If the scour index is in (U, 1, 2, 3) then an analysis must be performed.

					earthquake or hurricane model calculations.
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (trains/day)
TrafficIndex	Text(2)	F	F		Traffic index
Condition	Text(3)	F	F		General condition rating based on FHWA classification scheme in the source database
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.15 Earthquake Specific Light Rail Bridge Table: eqLightRailBridge

Identification:	eqLightRailBridge
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of light rail bridges. During the creation of a study region, the table content is transferred to another table with the same name (eqLightRailBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqLightRailBridge for each record in hzLightRailBridge with same LightRailBridgeId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
LightRailBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*LightRailBridge feature class with the associated *hz* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.6.3.16 Flood Specific Light Rail Bridge Table: flLightRailBridge

Identification:	flLightRailBridge
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Flood Model specific information of light rail bridges. During the creation of a study region, the table content is transferred to a table with the same name (flLightRailBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flLightRailBridge for each record in hzLightRailBridge with same LightRailBridgeId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
LightRailBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*LightRailBridge feature class with the associated *hz*LightRailBridge in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
Elevation	Double(8) Double(8)	F	F		Elevation of bridge deck

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.6.3.17 Light Rail Facility Feature Class: hzLightRailFlty

Identification:	hzLightRailFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of light rail facilities. During the creation of a study region, for all hazards, geometries are transfer to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzLightRailFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
LightRailFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzLightRailFlty* feature class with the associated *eqLightRailFlty* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TranspFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.8.	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve to assess loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Owner name of the facility
Contact	Text(40)	F	F		Contact name of person for the facility
PhoneNumber	Text(14)	F	F		Phone number to contact the

					facility
Use	Text(10)	F	F		Use
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
NumStories	Short(1) Byte(1)	F	F		Number of stories
Cost	Double(8) Currency (8)	F	F		Replacement cost (in thousands)
BackupPower	Short(1) Yes/No(1)	F	F	0 = No 1=Yes	Availability of backup power
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (trains/day)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.18 Earthquake Specific Light Rail Facilities Table: eqLightRailFlty

Identification:	eqLightRailFlty
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of light rail facilities. During the creation of a study region, the table content is transferred to a table with the same name (eqLightRailFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqLightRailFlty for each record in hzLightRailFlty with same LightRailFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
LightRailFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*LightRailFlty feature class with the associated *hz*LightRailFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
Anchor	Short(1) Yes/No(1)	F	F	0 = No 1 = Yes	Indicates whether the facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the Earthquake Model, but does not need to be populated at this time.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels

				MS = Special Moderate-Code LS = Special Low-Code	
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, of the Earthquake User Manual for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.19 Light Rail Tracks Feature Class: hzLightRailSegment

Identification:	hzLightRailSegment
Type:	ESRI Line Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of light rail tracks. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzLightRailSegment) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
LightRailSegId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzLightRailSegment* feature class with the associated *eqLightRailSegment* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SegmentClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.8.	Indicates highway road classification. It is used by Hazus-MH to identify the appropriate damage curve to assess the loss estimations produced by the EQ Model.
CountyFips	Text(5)	T, NU, A	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.
Name	Text(40)	F	F		Track segment name
Owner	Text(25)	F	F		Owner of track segment
Length	Short(2) Integer(2)	F	F		Section length (in kms)
NumTracks	Short(1) Byte(1)	F	F		Number of tracks
Traffic	Long(4)	F	F		Average daily traffic (trains/day)

	Long Integer(4)				
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Comment	Text(40)	F	F		Comments
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.20 Earthquake Specific Light Rail Tracks Table: eqLightRailSegment

Identification:	eqLightRailSegment
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of highway roads. During the creation of a study region, the table content is transferred to another table with the same name (eqLightRailSegment) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqLightRailSegment for each record in hzLightRailSegment with same LightRailSegId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
LightRailSegId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*LightRailSegment feature class with the associated *hz*LightRailSegment in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.3.21 Light Rail Tunnel Feature Class: hzLightRailTunnel

Identification:	hzLightRailTunnel
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of light rail tunnels. During the creation of a study region, for all hazards, geometries are transfer to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzLightRailTunnel) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
LightRailTu nnelId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzLightRailTunnel* feature class with the associated *eqLightRailTunnel* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TunnelClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.8.	Indicates tunnel classification. It is used by Hazus-MH to identify the appropriate damage curve to assess loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner name
Type	Text(5)	F	F		Structural types based on FHWA classification scheme in the source database. This field is for informational purposes and has no bearing on the computation of results.
Width	Double(8) Double(8)	F	F		Bridge width (in meters)
Length	Long(4) Long	F	F		Bridge length (in meters)

	Integer(4)				
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (trains/day)
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.22 Earthquake Specific Light Rail Tunnel Table: eqLightRailTunnel

Identification:	eqLightRailTunnel
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of light rail tunnels. During the creation of a study region, the table content is transferred to a table with the same name (eqLightRailTunnel) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqLightRailTunnel for each record in hzLightRailTunnel with same LightRailTunnelId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
LightRailTunnelId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*LightRailTunnel feature class with the associated *hz*LightRailTunnel in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1 for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase;					

LC=Lowercase

F.6.3.23 Port and Harbor Facilities Feature Class: hzPortFlty

Identification:	hzPortFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of ports and harbors facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzPortFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
PortFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzPortFlty* feature class with the associated *eqPortFlty* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TranspFltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, table B-10	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve to assess the loss estimations produced by the EQ model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact name
PhoneNumber	Text(14)	F	F		Facility contact phone number
Use	Text(10)	F	F		Use
YearBuilt	Short(2) Integer(2)	F	F	Null or ($\geq$ 1500 and $\leq$	Year structure was built

				2100)	
BackupPower	Short(1) Yes/No(1)	F	F	0 = No 1 = Yes	Availability of backup power
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Capacity	Long(4) Long Integer(4)	F	F		Capacity (tons/day)
NumBerths	Short(2) Integer(2)	F	F		Number of berths
NumCranes	Short(2) Integer(2)	F	F		Number of cranes
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.24 Earthquake Specific Care Facilities Table: eqPortFlty

Identification:	eqPortFlty
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of ports and harbors facilities. During the creation of a study region, the table content is transferred to another table with the same name (eqPortFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqPortFlty for each record in hzPortFlty with same PortFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
PortFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eqPortFlty* feature class with the associated *hzPortFlty* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not need to be populated at this time.

SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, of the Earthquake User Manual for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.25 Railway Facility Feature Class: hzRailFlty

Identification:	hzRailFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of railway transportation facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzRailFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
RailFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzRailFlty* feature class with the associated *eqRailFlty* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TranspFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B-7	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve to assess the loss estimations produced by the EQ Model
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact name
PhoneNumber	Text(14)	F	F		Facility phone number
Use	Text(10)	F	F		Use
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤	Year structure was built

				2100)	
NumStories	Short(1) Byte(1)	F	F		Number of stories
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
BackupPower	Short(1) Yes/No(1)	F	F	0 = No 1 = Yes	Availability of backup power
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (trains/day)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.26 Earthquake Specific Railway Facilities Table: eqRailFlty

Identification:	eqRailFlty
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of light rail facilities. During the creation of a study region, the content of the table is transferred to a table with the same name (eqRailFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqLightRailFlty for each record in hzRailFlty with same RailFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
RailFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*RailFlty feature class with the associated *hz*RailFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.
Anchor	Short(1) Yes/No(1)	F	F	0 = No 1 = Yes	Indicates whether facility is anchored to provide additional resistance to seismic forces.
FoundationT	Text(1)	F	F		Foundation type (e.g., slab, pile).

ype					This field is found in the table for future extensibility of the EQ Model, but does not need to be populated at this time.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.27 Railway Bridges Feature Class: hzRailwayBridge

Identification:	hzRailwayBridge
Type:	ESRI Point Feature Class
Purpose	Belongs to TRN.mdb. Provides the geometry of railway bridges. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzRailwayBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
RailwayBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzRailwayBridge* feature class with the associated *eqRailwayBridge* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
BridgeClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.7.	Indicates bridge classification. It is used by Hazus-MH to identify the appropriate damage curve to assess the loss estimations produced by the EQ Model
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner name
BridgeType	Text(8)	F	F		Structural types based on the FHWA classification scheme in the source database. This field is for informational purposes and has no bearing on the computation of results.
Width	Double(8) Double(8)	F	F		Bridge width (in meters)
NumSpans	Short(1) Byte(1)	F	F		Number of spans

Length	Long(4) Long Integer(4)	F	F		Bridge length (in meters)
MaxSpanLength	Double(8) Double(8)	F	F		Maximum span length (in meters)
SkewAngle	Double(8) Double(8)	F	F		Skew angle in degrees
SeatLength	Double(8) Double(8)	F	F		Seat length (in meters)
SeatWidth	Double(8) Double(8)	F	F		Seat width (in meters)
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year built
YearRemodeled	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year remodeled
PierType	Text(10)	F	F		Pier type based on FHWA classification scheme in the source database
FoundationType	Text(1)	F	F		Foundation type based on FHWA classification scheme in the source database
ScourIndex	Text(1)	F	F		This field is significant to flood analysis and is the second part of the bridge specific occupancy in the bridge damage function tables[4]. This field is not used in the EQ or HU Model calculations

[4] If the bridge is considered inundated then, the scour index is checked. If the scour index is in (4, 5, 6, 7, 8, 9, T, N) then no analysis is performed as the engineering study has determined that the bridge will not be subjected to scour. If the scour index is in (U, 1, 2, 3) then an analysis must be performed.

Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (trains/day)
TrafficIndex	Text(2)	F	F		Traffic index
Condition	Text(3)	F	F		General condition rating based on the FHWA classification scheme in the source database
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.28 Earthquake Specific Railway Bridge Table: eqRailwayBridge

Identification:	eqRailwayBridge
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of railway bridges. During the creation of a study region, the table content is transferred to a table with the same name (eqRailwayBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqRailwayBridge for each record in hzRailwayBridge with same RailwayBridgeId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
RailwayBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*RailwayBridge feature class with the associated *hz* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.6.3.29 Flood Specific Railway Bridge Table: flRailwayBridge

Identification:	flRailwayBridge
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Flood Model specific information of railway bridges. During the creation of a study region, the table content is transferred to a table with the same name (flRailwayBridge) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flRailwayBridge for each record in hzRailwayBridge with same RailwayBridgeId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
RailwayBridgeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*RailwayBridge feature class with the associated *hz*RailwayBridge in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
Elevation	Double(8) Double(8)	F	F		Elevation of bridge deck

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.6.3.30 Railway Tracks Feature Class: hzRailwaySegment

Identification:	hzRailwaySegment
Type:	ESRI Line Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of railway tracks. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzRailwaySegment) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
RailwaySegId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzRailwaySegment* feature class with the associated *eqRailwaySegment* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SegmentClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.7.	Indicates highway road classification. It is used by Hazus-MH to identify the appropriate damage curve to assess loss estimations produced by the EQ Model
CountyFips	Text(5)	T, NU, A	T		Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.
Name	Text(40)	F	F		Track segment name
Owner	Text(25)	F	F		Track segment owner
Length	Short(2) Integer(2)	F	F		Section length (in kms)
NumTracks	Short(1) Byte(1)	F	F		Number of tracks
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (trains/day)

Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Comment	Text(40)	F	F		Comments
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.31 Earthquake Specific Railway Tracks Table: eqRailwaySegment

Identification:	eqRailwaySegment
Type:	ESRI Table
Purpose	Belongs to TRN.mdb. Provides Earthquake Model specific information of railway tracks. During the creation of a study region, the table content is transferred to a table with the same name (eqRailwaySegment) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqRailwaySegment for each record in hzRailwaySegment with same RailwaySegId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
RailwaySegId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*RailwaySegment feature class with the associated *hz*RailwaySegment in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.6.3.32 Railway Tunnel Feature Class: hzRailwayTunnel

Identification:	hzRailwayTunnel
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of railway tunnels. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzRailwayTunnel) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
RailwayTunnelId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzRailwayTunnel* feature class with the associated *eqRailwayTunnel* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TunnelClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.7.	Indicates tunnel classification. It is used by Hazus-MH to identify the appropriate damage curve to assess loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner name
Type	Text(5)	F	F		Structural types based on the FHWA classification scheme in the source database. This field is for informational purposes and has no bearing on the computation of results.
Width	Double(8) Double(8)	F	F		Bridge width (in meters)
Length	Long(4) Long	F	F		Bridge length (in meters)

	Integer(4)				
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
Traffic	Long(4) Long Integer(4)	F	F		Average daily traffic (trains/day)
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.33 Earthquake Specific Railway Tunnel Table: eqRailwayTunnel

Identification:	eqRailwayTunnel
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of railway tunnels. During the creation of a study region, the table content is transferred to a table with the same name (eqRailwayTunnel) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqRailwayTunnel for each record in hzRailwayTunnel with same RailwayTunnelId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
RailwayTunnelId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*RailwayTunnel feature class with the associated *hz*RailwayTunnel in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase;					

LC=Lowercase

F.6.3.34 Airport Runways Feature Class: hzRunway

Identification:	hzRunway
Type:	ESRI Point Feature Class
Purpose:	Belongs to TRN.mdb. Provides the geometry of airport runways location. There are one or more runway records for each record in *hzAirportFlty* feature class. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named TRN.mdb in the Region folder. Field information is transferred to a table with the same name (hzRunway) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
RunwayId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzRunway* feature class with the associated *eqRunway* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
TranspFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.12.	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve to assess loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Name of runway
AirportId	Text(8	F	F		The AirportId value in *hzAirportFlty* feature class to what the record is related
RunwayLength	Double(8) Double(8)	F	F		Runway length (in meters)
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Capacity	Long(4) Long	F	F		Capacity (flights/day)

	Integer(4)				
Pavement	Text(10)	F	F		Pavement type
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.6.3.35 Earthquake Specific Airports Runway Table: eqRunway

Identification:	eqRunway
Type:	ESRI Table
Purpose:	Belongs to TRN.mdb. Provides Earthquake Model specific information of airports. During the creation of a study region, the table content is transferred to a table with the same name (eqRunway) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqRunway for each record in hzRunway with same RunwayId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
RunwayId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eqRunway* feature class with the associated *hzRunway* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase;					

LC=Lowercase

F.7 Lifeline Utility Systems: UTIL.mdb

F.7.1 Database Overview

The UTIL.mdb is an Access personal geodatabase that contains feature *classes* for lifeline utility systems with fields relevant for all hazards; it also contains *tables* with information specific to the Earthquake and Flood Models. Lifeline utility systems include potable water, wastewater, oil, natural gas, electric power, and communication systems.

The geographical domain of the database is the state. In that case, there is one UTIL.mdb database for each state, each located in the appropriate State folder.

The current version of the Flood Model does not provide damage or loss estimates for communication systems.

During the creation of a study region, for all hazards, utility systems geometries from feature classes are transferred to a geodatabase named UTIL.mdb in the Region folder. Feature classes are named with the prefix *hz,* meaning they are relevant across all Hazus-MH Models. Potable water facilities, for instance, are stored in the *hzPotableWaterFlty* feature class with fields containing information common to all hazards, such as name and address. This information is transferred to a table with the same name (for potable water facilities, *hzPotableWaterFlty*) in the SQL Server database in the Region folder.

Hazard specific tables are named with the prefix *eq* (earthquake) and *fl* (flood): *eqPotableWaterFlty* and *flPotableWaterFlty*. The information is transferred to tables with the same name in the SQL Server database in the Region folder. There is a one-to-one relationship between *hz* tables and the corresponding *eq* and *fl* tables through a unique identifier.

F.7.2 Identification

UTIL.mdb

F.7.3 Database Content

The UTIL.mdb database includes:

Name	Type	Content
hzCommunicationFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of communication related facilities. A communication facilities system consists of central offices, stations, and transmitters
hzElectricPowerFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of electric power facilities. An electric power facilities system consists of substations, distribution circuits, generation plants, and transmission towers.
hzNaturalGasFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of natural gas compressor stations
hzNaturalGasPl	ESRI Line Feature Class	Geometry (line features) and all-hazards information of natural gas pipelines
hzOilFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information for oil system facilities including refineries, pumping plants, and tank farms
hzOilPl	ESRI Line Feature Class	Geometry (line features) and all-hazards information of oil pipelines
hzPotableWaterFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of potable water facilities including water treatment plants, wells, storage tanks, and pumping stations
hzPotableWaterPl	ESRI Line Feature Class	Geometry (line features) and all-hazards information of potable water pipelines
hzWasteWaterFlty	ESRI Point Feature Class	Geometry (point features) and all-hazards information of wastewater facilities including wastewater treatment plants and lift stations
hzWasteWaterPl	ESRI Line Feature Class	Geometry (line features) and all-hazards information of wastewater pipelines
eqCommunicationFlty	ESRI Table	Earthquake specific information for communication related facilities
eqElectricPowerFlty	ESRI Table	Earthquake specific information for electric power facilities
eqNaturalGasDL	ESRI Table	Earthquake specific information for natural gas distribution pipelines by census tract
eqNaturalGasFlty	ESRI Table	Earthquake specific information for natural gas facilities
eqNaturalGasPl	ESRI Table	Earthquake specific information for natural gas pipelines
eqOilFlty	ESRI Table	Earthquake specific information for oil facilities
eqOilPl	ESRI Table	Earthquake specific information for airport oil pipelines
eqPotableWaterDL	ESRI Table	Earthquake specific information for potable water distribution pipelines by census tract
eqPotableWaterFlty	ESRI Table	Earthquake specific information for potable water facilities
eqPotableWaterPl	ESRI Table	Earthquake specific information for potable water pipelines
eqWasteWaterDL	ESRI Table	Earthquake specific information for wastewater distribution pipelines by census tract
eqWasteWaterFlty	ESRI Table	Earthquake specific information for wastewater facilities
eqWasteWaterPl	ESRI Table	Earthquake specific information for wastewater pipelines
flElectricPowerFlty	ESRI Table	Flood specific information for electric power facilities
flExposureUtil	ESRI Table	Flood specific table (not used and not required)
flNaturalGasFlty	ESRI Table	Flood specific information natural gas facilities
flNaturalGasPl	ESRI Table	Flood specific information for natural gas pipelines
flOilFlty	ESRI Table	Flood specific information for oil facilities

flOilPl	ESRI Table	Flood specific information for oil pipelines
flPotableWaterFlty	ESRI Table	Flood specific information for potable water facilities
flPotableWaterPl	ESRI Table	Flood specific information for potable water pipelines
flWasteWaterFlty	ESRI Table	Flood specific information for wastewater facilities
flWasteWaterPl	ESRI Table	Flood specific information for wastewater pipelines

F.7.3.1 Communication Facilities Feature Class: hzCommunicationFlty

Identification:	hzCommunicationFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of communication facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzCommunicationFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
CommunicationFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzCommunicationFlty* feature class with the associated *eqCommunicationFlty* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.18.	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact name
PhoneNumber	Text(14)	F	F		Facility contact phone number
Use	Text(10)	F	F		Use

YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
BackupPower	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Availability of backup power
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.2 Earthquake Specific Communication Facilities Table: eqCommunicationFlty

Identification:	eqCommunicationFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of communication facilities. During the creation of a study region, the table content is transferred to a table with the same name (eqCommunicationFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqCommunicationFlty for each record in hzCommunicationFlty with same CommunicationFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
CommunicationFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*CommunicationFlty feature class with the associated *hz*CommunicationFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model

					building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based upon shear wave velocity. See Appendix B, Table B.1, for details.
Anchor	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether the facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the Earthquake Model, but does not need to be populated at this time.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See

					Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.3 Electric Power Facilities Feature Class: hzElectricPowerFlty

Identification:	hzElectricPowerFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of electric power facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzElectricPowerFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
ElectricPowerF ltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzElectricPowerFlty* feature class with the associated *eqElectricPowerFlty and flElectricPowerFlty* tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.17.	Indicates the facility classification. It is used by Hazus-MH to identify the appropriate damage curve to assess loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU,	T	11 digits of the Census tract	2000 US Census tract number

		A		number	
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact person
PhoneNumber	Text(14)	F	F		Facility contact phone number
Use	Text(10)	F	F		Use
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
Capacity	Long(4) *Long Integer(4)*	F	F		Volts/Watts
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.4 Earthquake Specific Electric Power Facilities Table: eqElectricPowerFlty

Identification:	eqElectricPowerFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of electric power facilities. During the creation of a study region, the table content is transferred to a table with the same name (eqElectricPowerFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqElectricPowerFlty for each record in hzElectricPowerFlty with same ElectricPowerFltyId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
ElectricPowerFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*ElectricPowerFlty feature class with the associated *hz*ElectricPowerFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.

DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.
Anchor	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not need to be populated at this time
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based upon shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See

					Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	N	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.5 Flood Specific Electric Power Facilities Table: flElectricPowerFlty

Identification:	flElectricPowerFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of electric power facilities. During the creation of a study region, the table content is transferred to a table with the same name (flElectricPowerFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flElectricPowerFlty for each record in hzElectricPowerFlty with same ElectricPowerFltyId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
ElectricPowerFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*ElectricPowerFlty feature class with the associated *hz*ElectricPowerFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilIndicator	Short(2) *Integer(2)*	F	F		Utility Indicator. This field is not used in the current version (MR3) of Hazus-MH.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile)
EquipmentHt	Double(8) *Currency(8)*	F	F		Average height of electrical equipment (measured in feet from the floor)
FloodProtection	Short(2)	F	F		Flood return period (in years) for

	Integer(2)				which the structure is protected
UtilDamageFnId	Text(10)	F	F		Originally intended to allow users to define facility specific damage curves. Utility damage functions are not used in version MR3 of Hazus.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.6 Natural Gas Facilities Feature Class: hzNaturalGasFlty

Identification:	hzNaturalGasFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of natural gas facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzNaturalGasFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
NaturalGasFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hz*NaturalGasFlty feature class with the associated *eq*NaturalGasFlty and *fl*NaturalGasFlty tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.16.	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing the loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU,	T	11 digits of the Census tract	2000 US Census tract number

		A		number	
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Name of the facility owner
Contact	Text(40)	F	F		Name of contact person for the facility
PhoneNumber	Text(14)	F	F		Phone number to contact the facility
Use	Text(10)	F	F		Use
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year the structure was built
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
BackupPower	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Availability of backup power
Capacity	Float(4) *Single(4)*	F	F		Millions of cubic feet per day
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude Decimal Degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.7 Earthquake Specific Natural Gas Facilities Table: eqNaturalGasFlty

Identification:	eqNaturalGasFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of natural gas facilities. During the creation of a study region, the content of the table is transferred to a table with the same name (eqNaturalGasFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqNaturalGasFlty for each record in hzNaturalGasFlty with same NaturalGasFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
NaturalGasFlty Id	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*NaturalGasFlty feature class with the associated *hz*NaturalGasFlty in a one-to-one relationship. The standard format adopted by HAZUS is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2 for the complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for

				Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	detailed information about design levels.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
Anchor	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether the facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the EQ Model, but does not need to be populated at this time.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.

WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.8 Flood Specific Natural Gas Facilities Table: flNaturalGasFlty

Identification:	flNaturalGasFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of natural gas facilities. During the creation of a study region, the table content is transferred to a table with the same name (flNaturalGasFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flNaturalGasFlty for each record in hzNaturalGasFlty with same NaturalGasFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
NaturalGasFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*NaturalGasFlty feature class with the associated *hz*NaturalGasFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilIndicator	Short(2) *Integer(2)*	F	F		Utility Indicator. This field is not used in the current version MR3 of Hazus-MH.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile)
EquipmentHt	Double(8) *Currency(8)*	F	F		Average height of electrical equipment (measured in feet from the floor)
FloodProtection	Short(2) *Integer(2)*	F	F		Flood return period (in years) for which the structure is protected.

UtilDamageFnId	Text(10)	F	F		Originally intended to allow users to define facility specific damage curves. Utility damage functions are not used in version MR3 of Hazus-MH.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.9 Natural Gas Pipelines Feature Class: hzNaturalGasPl

Identification:	hzNaturalGasPl
Type:	ESRI Line Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of natural gas pipelines. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzNaturalGasPl) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type(Size)*	Index *	Require d*	Values	Description
NaturalGasPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzNaturalGasPl* feature class with the associated *eqNaturalGasPl* and *flNaturalGasPl* tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
PipelinesClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.16.	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve to assess the loss estimations produced by the EQ Model.
CountyFips	Text(5)	T, NU, A	T	Five digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three are digits the county code.

Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner
Material	Text(10)	F	F		Material type
Diameter	Double(8) *Currency(8)*	F	F		Diameter (in inches)
PipeLength	Float(4) *Single(4)*	F	F		Length of the segment (in kms)
Joint	Text(10)	F	F		Join type
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year the structure was built
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
SourceId	Long(4) *Long Integer(4)*	F	F		Identification of the source
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.10 Earthquake Specific Natural Gas Pipeline Table: eqNaturalGasPl

Identification:	eqNaturalGasPl				
Type:	ESRI Table				
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of natural gas pipelines. It includes the unique id (NaturalGasPlId) for each record in hzNaturalGasPl. During the creation of a study region, the table content is transferred to a table with the same name (eqNaturalGasPl) in the SQL Server database in the Region folder. The SQL server table includes additional fields that are populated subsequently. There must be one record in eqNaturalGasPl for each record in hzNaturalGasPl with same NaturalGasPLId unique identifier.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
NaturalGasPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*NaturalGasPl feature class with the associated *hz*NaturalGasPl in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.11 Flood Specific Natural Gas Pipeline Table: flNaturalGasPl

Identification:	flNaturalGasPl
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of natural gas pipelines. During the creation of a study region, the table content is transferred to another table with the same name (flNaturalGasPl) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flNaturalGasPl for each record in hzNaturalGasPl with same NaturalGasPlId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type(Size) *Access Type(Size)*	Index *	Required*	Values	Description
NaturalGasPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*NaturalGasPl feature class with the associated *hz*NaturalGasPl in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SystemId	Text(5)	F	F		Utility indicator. This field is not used in the current version MR3 of Hazus-MH.
VulnbltyToScour	Text(10)	F	F		Vulnerability to scour. Field for future development.
IDUpperJunction	Short(2) *Integer(2)*	F	F		Field for future development
IDLowerJuncti	Short(2)	F	F		Field for future development

on	*Integer(2)*				
DamageFnId	Text(10)	F	F		Field for future development
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.12 Oil Facilities Feature Class: hzOilFlty

Identification:	hzOilFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of Oil facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzOilFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type(Size)*	Index *	Required*	Values	Description
OilFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hz*OilFlty feature class with the associated *eq*OilFlty and *fl*OilFlty tables. The standard format adopted by Hazus is SSxxxxxx where SS is the state name abbreviation (upper case) and xxxxxx, is a sequential number from 000001 to 999999.
UtilFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.15.	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name

Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact
PhoneNumber	Text(14)	F	F		Facility phone number
Use	Text(10)	F	F		Use
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year the structure was built
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
BackupPower	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Availability of backup power
Capacity	Float(4) *Single(4)*	F	F		Thousands of barrels per day
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.13 Earthquake Specific Oil Facilities Table: eqOilFlty

Identification:	eqOilFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of oil facilities. During the creation of a study region, the table content is transferred to a table with the same name (eqOilFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqOilFlty for each record in hzOilFlty with same OilFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
OilFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*OilFlty feature class with the associated *hz*OilFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for the complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-	Building codes in effect in the area. See Earthquake Technical

				Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Manual, Chapters 3 and 5, for detailed information about design levels.
Anchor	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether the facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not need to be populated at this time.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B-1	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based upon shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.

WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.14 Flood Specific Oil Facilities Table: flOilFlty

Identification:	flOilFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of oil facilities. During the creation of a study region, the table content is transferred to a table with the same name (flOilFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flOilFlty for each record in hzOilFlty with same OilFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
OilFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*OilFlty feature class with the associated *hz*OilFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilIndicator	Short(2) *Integer(2)*	F	F		Utility indicator. This field is not used in the current version MR3 of Hazus-MH.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile)
EquipmentHt	Double(8) *Currency(8)*	F	F		Average height of electrical equipment (measured in feet from the floor)
FloodProtection	Short(2) *Integer(2)*	F	F		Flood return period (in years) for which the structure is protected.

UtilDamageFnId	Text(10)	F	F		Originally intended to allow users to define facility specific damage curves. Utility damage functions are not used in version MR3 of Hazus-MH
NumStories	Short(2) *Integer(2)*	F	F		Number of stories
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.15 Oil Pipelines Feature Class: hzOilPl

Identification:	hzOilPl
Type:	ESRI Line Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of oil pipelines. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzOilPl) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
OilPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzOilPl* feature class with the associated *eqOilPl* and *flOilPl* tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
PipelinesClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B 15.	This field is used to indicate the facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model.
CountyFips	Text(5)	T, NU, A	YT	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.

Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner name
Material	Text(10)	F	F		Material type
Diameter	Double(8) *Currency(8)*	F	F		Diameter (in inches)
PipeLength	Float(4) *Single(4)*	F	F		Length of the segment (in kms)
Joint	Text(10)	F	F		Join type
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
SourceId	Long(4) *Long Integer(4)*	F	F		Identification of the source
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.16 Earthquake Specific Oil Pipeline Table: eqOilPl

Identification:	eqOilPl
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of oil pipelines. It includes the unique id (OilPlId) for each record in hzOilPl. During the creation of a study region, the content of the table is transferred to a table with the same name (eqOilPl) in the SQL Server database in the Region folder. The SQL server table includes additional fields that are populated subsequently. There must be one record in eqOilPl for each record in hzOilPl with same OilPLId unique identifier
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
OilPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*OilPl feature class with the associated *hz*OilPl in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.7.3.17 Flood Specific Oil Pipeline Table: flOilPl

Identification:	flOilPl
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of oil pipelines. During the creation of a study region, the table content is transferred to a table with the same name (flOilPl) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flOilPl for each record in hzOilPl with same OilPlId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
OilPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*OilPl feature class with the associated *hz*OilPl in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
SystemId	Text(5)	F	F		Utility indicator. This field is not used in the current version (MR3) of Hazus-MH.
VulnbltyToScour	Text(10)	F	F		Vulnerability to scour. Field for future development.
IDUpperJunction	Short(2) *Integer(2)*	F	F		Field for future development

IDLowerJunction	Short(2) *Integer(2)*	F	F		Field for future development
DamageFnId	Text(10)	F	F		Field for future development
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.18 Potable Water Facilities Feature Class: hzPotableWaterFlty

Identification:	hzPotableWaterFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of potable water facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzPotableWaterFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
PotableWaterFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hz*PotableWaterFlty feature class with the associated *eq*PotableWaterFlty and *fl*PotableWaterFlty tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.1.3	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number

Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact person
PhoneNumber	Text(14)	F	F		Facility contact phone number
Use	Text(10)	F	F		Use
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
SystemId	Text(5)	F	F		Identifier for potable water system.
GClass	Text(1)	F	F		For network analysis. Hazus-MH does not include a tool to analyze potable water networks such as POWSAN included in Hazus 99.
BackupPower	Short(1) *Yes/No(1)*	F	F	0=No 1=Yes	Availability of backup power
YearUpgraded	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year the structure was upgraded
Capacity	Long(4) *Long Integer(4)*	F	F		Capacity (million gallons/day)
Demand	Float(4) *Single(4)*	F	F		Demand (million gallons/day)
Latitude	Double(8)	F	F	Latitude decimal	Latitude

	Double(8)			degrees	
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.19 Earthquake Specific Potable Water Facilities Table: eqPotableWaterFlty

Identification:	eqPotableWaterFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of potable water facilities. During the creation of a study region, the table content is transferred to a table with the same name (eqPotableWaterFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqPotableWaterFlty for each record in hzPotableWaterFlty with same PotableWaterFltyId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
PotableWaterFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*PotableWaterFlty feature class with the associated *hz*PotableWaterFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-	Building codes in effect in the area. See Earthquake Technical

				Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Manual, Chapters 3 and 5, for detailed information about design levels.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
Anchor	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether the facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not need to be populated at this time.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for

					liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.20 Flood Specific Potable Water Facilities Table: flPotableWaterFlty

Identification:	flPotableWaterFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of potable water facilities. During the creation of a study region, the table content is transferred to a table with the same name (flPotableWaterFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flPotableWaterFlty for each record in hzPotableWaterFlty with same PotableWaterFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
PotableWaterFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*PotableWaterFlty feature class with the associated *hz*PotableWaterFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilIndicator	Short(2) *Integer(2)*	F	F		Utility indicator. This field is not used in the current version MR3 of Hazus-MH.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile)
EquipmentHt	Double(8) *Currency(8)*	F	F		Average height of electrical equipment (measured in feet from the floor).

FloodProtection	Short(2) *Integer(2)*	F	F		Flood return period (in years) for which the structure is protected.
UtilDamageFnId	Text(10)	F	F		Originally intended to allow users to define facility specific damage curves. Utility damage functions are not used in version MR3 of Hazus-MH.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.21 Potable Water Pipelines Feature Class: hzPotableWaterPl

Identification:	hzPotableWaterPl
Type:	ESRI Line Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of potable water pipelines. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzPotableWaterPl) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
PotableWaterPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzPotableWaterPl* feature class with the associated *eqPotableWaterPl* and *flPotableWaterPl* tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
PipelinesClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.13.	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ model.
CountyFips	Text(5)	T, NU, A	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits

					are the county code.
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner
Material	Text(10)	F	F		Material type
Diameter	Double(8) *Currency(8)*	F	F		Diameter (in inches)
PipeLength	Float(4) *Single(4)*	F	F		Length of the segment (in kms)
Joint	Text(10)	F	F		Join type
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
SourceId	Long(4) *Long Integer(4)*	F	F		Identification of the source
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.22 Earthquake Specific Potable Water Pipeline Table: eqPotableWaterPl

Identification:	eqPotableWaterPl				
Type:	ESRI Table				
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of potable water pipelines. It includes the unique id (PotableWaterPlId) for each record in hzPotableWaterPl. During the creation of a study region, the table content is transferred to a table with the same name (eqPotableWaterPl) in the SQL Server database in the Region folder. The SQL server table includes additional fields that are populated subsequently. There must be one record in eqPotableWaterPl for each record in hzPotableWaterPl with same PotableWaterPLId unique identifier.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
PotableWaterPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*PotableWaterPl feature class with the associated *hz*PotableWaterPl in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
GClass	Text(1)	F	F		For network analysis **
Status	Double(8) *Currency(8)*	F	F		For network analysis **
UpNode	Text(5)	F	F		For network analysis **
DownNode	Text(5)	F	F		For network analysis **
Roughness	Double(8)	F	F		For network analysis **

	Currency(8)				
MinLoss	Double(8) *Currency(8)*	F	F		For network analysis **

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

** Hazus-MH does not include a tool for analyzing potable water networks such as POWSAN (Potable Water System Analysis Model) included in Hazus 99.

F.7.3.23 Flood Specific Potable Water Pipeline Table: flPotableWaterPl

Identification:	flPotableWaterPl
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of potable water pipelines. During the creation of a study region, the table content is transferred to a table with the same name (flPotableWaterPl) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flPotableWaterPl for each record in hzPotableWaterPl with same PotableWaterPlId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
PotableWaterPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*PotableWaterPl feature class with the associated *hz*PotableWaterPl in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
SystemId	Text(5)	F	F		Utility indicator. This field is not used in the current version MR3 of Hazus-MH
VulnbltyToScour	Text(10)	F	F		Vulnerability to scour. Field for future development.
IDUpperJunction	Short(2) *Integer(2)*	F	F		Field for future development

IDLowerJunction	Short(2) *Integer(2)*	F	F		Field for future development
DamageFnId	Text(10)	F	F		Field for future development
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.24 Potable Water Distribution Pipes Table: eqPotableWaterDL

Identification:	eqPotableWaterDL				
Type:	ESRI Table				
Purpose:	Belongs to UTIL.mdb. Provides total length of potable water distribution pipelines aggregated by census tract. Only the Earthquake Model estimates damage, losses and functionality for the pipeline components of the potable water system. During the creation of a study region, the content of the table is transferred to a table with the same name (eqPotableWaterDL) in the SQL Server database in the Region folder. The SQL server table includes additional fields that are populated subsequently. There must be one record in eqPotableWaterDL for each record in hzTract feature class in the State syBoundary.mdb.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
Tract	Text(11)	T, U, A	T, UC		11 digits of the 2000 US Census tract number
DuctilePipe	Float(4) *Single(4)*	F	F		Total length of ductile distribution pipes (in kms)
BrittlePipe	Float(4) *Single(4)*	F	F		Total length of brittle distribution pipes (in kms)
TotalPipe	Float(4) *Single(4)*	F	F		Total length of distribution pipes (in kms)
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.25 Waste Water Facilities Feature Class: hzWasteWaterFlty

Identification:	hzWasteWaterFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of wastewater facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzWasteWaterFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
WasteWaterFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hz*WasteWaterFlty feature class with the associated *eq*WasteWaterFlty and *fl*WasteWaterFlty tables. The standard format adopted by Hazus is SSxxxxxx where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilFcltyClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.14.	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model.
Tract	Text(11)	T, NU,	T	11 digits of the Census tract	2000 US Census tract number

		A		number	
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact name
PhoneNumber	Text(14)	F	F		Facility phone number
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
Use	Text(10)	F	F		Use
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
BackupPower	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Availability of backup power
Capacity	Long(4) *Long Integer(4)*	F	F		Capacity (million gallons/day)
GClass	Text(1)	F	F		For network analysis. Hazus-MH does not include a tool to analyze water networks such as POWSAN included in Hazus 99.
NumStories	Short(1) *Byte(1)*	F	F		Number of stories
SystemId	Text(5)	F	F		Identifier for the waste water system
YearUpgraded	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was upgraded

Demand	Float(4) *Single(4)*	F	F		Demand (million gallons/day)
Latitude	Double(8) *Double(8)*	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) *Double(8)*	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.26 Earthquake Specific Waste Water Facilities Table: eqWasteWaterFlty

Identification:	eqWasteWaterFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of waste water facilities. During the creation of a study region, the table content is transferred to a table with the same name (eqWasteWaterFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqWasteWaterFlty for each record in hzWasteWaterFlty with same WasteWaterFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
WasteWaterFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*WasteWaterFlty feature class with the associated *hz*WasteWaterFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B-2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.

DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.
Anchor	Short(1) *Yes/No(1)*	F	F	0 = No 1 = Yes	Indicates whether the facility is anchored to provide additional resistance to seismic forces.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not need to be populated at this time.
SoilType	Text(1)	F	T, UC	See Appendix B, table B.1	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based upon shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) *Byte(1)*	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual

					(Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) *Single(4)*	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.27 Flood Specific Waste Water Facilities Table: flWasteWaterFlty

Identification:	flWasteWaterFlty
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of waste water facilities. During the creation of a study region, the table content is transferred to a table with the same name (flWasteWaterFlty) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flWasteWaterFlty for each record in hzWasteWaterFlty with same WasteWaterFltyId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
WasteWaterFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*WasteWaterFlty feature class with the associated *hz*WasteWaterFlty in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
UtilIndicator	Short(2) *Integer(2)*	F	F		Utility indicator. This field is not used in the current version MR3 of Hazus-MH.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile)
EquipmentHt	Double(8) *Currency(8)*	F	F		Average height of electrical equipment (measured in feet from the floor)
FloodProtection	Short(2)	F	F		Flood return period (in years) for

	Integer(2)				which the structure is protected
UtilDamageFnId	Text(10)	F	F		Originally intended to allow users to define facility specific damage curves. Utility damage functions are not used in version MR3 of Hazus-MH.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.28 Waste Water Pipelines Feature Class: hzWasteWaterPl

Identification:	hzWasteWaterPl
Type:	ESRI Line Feature Class
Purpose:	Belongs to UTIL.mdb. Provides the geometry of waste water pipelines. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named UTIL.mdb in the Region folder. Field information is transferred to a table with the same name (hzWasteWaterPl) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH estimation of hazards, damages, and loss of functionality, as well as mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
WasteWaterPlId	Text(8)	T, U,A	T, UC		Unique identifier for each record. It relates this *hzWasteWaterPl* feature class with the associated *eqWasteWaterPl* and *flWasteWaterPl* tables. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
PipelinesClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.14.	Indicates facility classification. It is used by Hazus-MH to identify the appropriate damage curve for assessing loss estimations produced by the EQ Model.
CountyFips	Text(5)	T, NU, A	T	Five-digit FIPS county code	Five-digit FIPS County code. First two digits are the state FIPS; the remaining three digits

					the county code.
Name	Text(40)	F	F		Facility name
Owner	Text(25)	F	F		Facility owner
Material	Text(10)	F	F		Material type
Diameter	Double(8) *Currency(8)*	F	F		Diameter (in inches)
PipeLength	Float(4) *Single(4)*	F	F		Length of the segment (in kms)
Joint	Text(10)	F	F		Join type
YearBuilt	Short(2) *Integer(2)*	F	F	Null or (≥ 1500 and ≤ 2100)	Year the structure was built
Cost	Double(8) *Currency(8)*	F	F		Replacement cost (in thousands)
SourceId	Long(4) *Long Integer(4)*	F	F		Identification of the source
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.29 Earthquake Specific Waste Water Pipeline Table: eqWasteWaterPl

Identification:	eqWasteWaterPl
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Earthquake Model specific information of waste water pipelines. It includes a unique id (WasteWaterPlId) for each record in hzWasteWaterPl. During the creation of a study region, the table content is transferred to a table with the same name (eqWasteWaterPl) in the SQL Server database in the Region folder. The SQL server table includes additional fields that are populated subsequently. There must be one record in eqWasteWaterPl for each record in hzWasteWaterPl with same WasteWaterPLId unique identifier.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type Size)*	Index *	Required*	Values	Description
WasteWaterPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eq*WasteWaterPl feature class with the associated *hz*WasteWaterPl in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.7.3.30 Flood Specific Waste Water Pipeline Table: flWasteWaterPl

Identification:	flWasteWaterPl
Type:	ESRI Table
Purpose:	Belongs to UTIL.mdb. Provides Flood Model specific information of waste water pipelines. During the creation of a study region, the table content is transferred to a table with the same name (flWasteWaterPl) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH Flood Model estimation of hazards, damages, and loss of functionality. There must be one record in flWasteWaterPl for each record in hzWasteWaterPl with same WasteWaterPlId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type Size)*	Index*	Required*	Values	Description
WasteWaterPlId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *fl*WasteWaterPl feature class with the associated *hz*WasteWaterPl in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
SystemId	Text(5)	F	F		Utility indicator. This field is not used in the current version MR3 of Hazus-MH
VulnbltyToScour	Text(10)	F	F		Vulnerability to scour. Field for future development.
IDUpperJunction	Short(2) *Integer(2)*	F	F		Field for future development

IDLowerJunction	Short(2) *Integer(2)*	F	F		Field for future development
DamageFnId	Text(10)	F	F		Field for future development
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.7.3.31 Waste Water Distribution Pipes Table: eqWasteWaterDL

Identification:	eqWasteWaterDL				
Type:	ESRI Table				
Purpose:	Belongs to UTIL.mdb. Provides total length of waste water distribution pipelines aggregated by census tract. Only the Earthquake Model estimates damage, losses and functionality for the pipeline components of the waste water system. During the creation of a study region, the table content is transferred to a table with the same name (eqWasteWaterDL) in the SQL Server database in the Region folder. The SQL server table includes additional fields that are populated subsequently. There must be one record in eqWasteWaterDL for each record in hzTract feature class in the State syBoundary.mdb.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
Tract	Text(11)	T, U, A	T, UC	11 digits of the census tract number	11 digits of the census tract number
DuctilePipe	Float(4) *Single(4)*	F	F		Total length of ductile distribution pipes (in kms)
BrittlePipe	Float(4) Single(4)	F	F		Total length of brittle distribution pipes (in kms)
TotalPipe	Float(4) *Single(4)*	F	F		Total length of distribution pipes (in kms)
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.8 High Potential Loss Facilities: HPLF.mdb

F.8.1 Database Overview

HPLF.mdb is an Access personal geodatabase that contains feature *classes* for HPLF with fields relevant to all hazards and *tables* with information specific to Earthquake Model. HPLFs are those likely to cause severe loss if damaged. Damage and loss estimation calculations for HPLFs are not performed by Hazus-MH.

HPLFs include nuclear power plants, dams, levees, and some military installations. Hazardous material facilities and levees are also included in HPLF.mdb. Hazardous material facilities contain substances that can pose significant hazards because of their toxicity, radioactivity, flammability, explosiveness, or reactivity. Similar to other facilities with high potential loss, Hazus-MH models do not estimate losses caused by hazardous material releases and levee failures based on the inventory data.

The geographical domain of the database is the state. In that case, there is one HPLF.mdb database for each state, each located in the appropriate State folder.

During the creation of a study region, for all hazards, HPLF geometries from feature classes are transferred to a geodatabase named HPLF.mdb in the Region folder. Feature classes are named with the prefix *hz* that means that are relevant across all Hazus-MH models. Dams, for instance, are stored in *hzDams* feature class with fields containing information common to all hazards. This information is transferred to a table with the same name (for dams, *hzDams*) in the SQL Server database in the Region folder.

Hazard specific tables are named with the prefix *eq* (earthquake) such as *eqDams*. The information is transferred to tables with the same name in the SQL Server database in the Region folder. There is a one-to-one relationship between *hz* tables and the corresponding *eq* table through a unique identifier.

F.8.2 Identification

HPLF.mdb

F.8.3 Database Content

The HPLF.mdb database includes:

Name	Type	Content
hzDams	ESRI Point Feature Class	Geometry (point features) and all-hazards information of dams structures
hzHazmat	ESRI Point Feature Class	Geometry (point features) and all-hazards information of hazardous material facilities
hzLevees	ESRI Line Feature Class	Geometry (line features) and all-hazards information of levees
hzMilitary	ESRI Point Feature Class	Geometry (point features) and all-hazards information of military facilities
hzNuclearFlty	ESRI Line Feature Class	Geometry (line features) and all-hazards information for nuclear facilities
eqDams	ESRI Table	Earthquake specific information for dam structures
eqHazmat	ESRI Table	Earthquake specific information for hazardous material facilities
eqLevees	ESRI Table	Earthquake specific information for levees
eqMilitary	ESRI Table	Earthquake specific information for military installations
eqNuclearFlty	ESRI Table	Earthquake specific information for nuclear facilities

F.8.3.1 Dams Feature Class: hzDams

Identification:	hzDams
Type:	ESRI Point Feature Class
Purpose:	Belongs to HPLF.mdb. Provides the geometry of dam facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named HPLF.mdb in the Region folder. Field information is transferred to a table with the same name (hzDams) in the SQL Server database in the Region folder.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
DamId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzDams* feature class with the associated *eqDams* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
DamClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B.5.	Indicates facility classification
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
CountyName	Text(30)	F	F		County where facility is located
Owner	Text(25)	F	F		Facility owner
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
River	Text(30)	F	F		Name of river on which dam is located
NearCity	Text(30)	F	F		Nearest city downstream from dam
DistanceCity	Float(4) Single(4)	F	F		Distance of nearest city downstream from dam (in miles)
Purpose	Text(10)	F	F		Purposes for which reservoir is used
YearCompl	Short(2)	F	F	Null or	Year original main dam structure

	Integer(2)			(≥ 1500 and ≤ 2100)	was completed
DamLength	Float(4) Single(4)	F	F		Dam length, in feet (defined as length along top of dam)
DamHeight	Float(4) Single(4)	F	F		Dam height, in feet (defined as vertical distance between the lowest point on the crest of the dam and the lowest point in the original streambed)
StructHeight	Float(4) Single(4)	F	F		Structural height of the dam, in feet (defined as the vertical distance from the lowest point of the excavated foundation to the top of the dam)
MaxDischarge	Float(4) Single(4)	F	F		Maximum storage, in acre-feet (defined as the total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage)
HydroHeight	Float(4) Single(4)	F	F		Hydraulic height of dam, in feet, (defined as the vertical difference between the maximum design water level and the lowest point in the original streambed)
MaxStorage	Float(4) Single(4)	F	F		Maximum storage, in acre-feet (defined as the total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage)
NormStorage	Float(4) Single(4)	F	F		Normal storage, in acre-feet (defined as the total storage space in a reservoir below the normal retention level, including

					dead and inactive storage and excluding any flood control or surcharge storage)
SurfaceArea	Float(4) Single(4)	F	F		Surface area, in acres, of the impoundment at its normal retention level
DrainArea	Float(4) Single(4)	F	F		Drainage area of the dam, in square miles (defined as the area that drains to the reservoir)
Hazard	Text(1)	F	F		Code indicating the potential hazard to the downstream area resulting from failure or malfunctioning of the dam or facilities: L = Low S = Significant H = High
EAP	Text(2)	F	F		Code indicating whether the dam has an emergency action plan (EAP) developed by the dam owner. An EAP is defined as a plan of action to be taken to reduce the potential for property damage and loss of life in an area affected by a dam failure or large flood. Y =Yes N = No NR = Not required by submitting agency
SpillType	Float(4) Single(4)	F	F		Code that describes spillway type: C = Controlled U = Uncontrolled

					N = None
Volume	Float(4) Single(4)	F	F		Total number of cubic yards occupied by the materials used in the dam structure. Portions of powerhouse, locks, and spillways are included only if they are an integral part of the dam and required for structural stability.
NATID	Text(7)	F	F		The official National Inventory of Dams identification number for the dam (formerly known as the National ID)
PrimaryAgency	Text(20)	F	F		Primary source agency from which the data was derived.
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.8.3.2 Earthquake Specific Dams Table: eqDams

Identification:	eqDams
Type:	ESRI Table
Purpose:	Belongs to HPLF.mdb. Provides Earthquake Model specific information of dams. During the creation of a study region, the table content is transferred to a table with the same name (*eqDams*) in the SQL Server database in the Region folder. There must be one record in *eqDams* for each record in *hzDams* with same *DamId* unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
DamId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eqDams* feature class with the associated *hzDams* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase;					

LC=Lowercase

F.8.3.3 Hazardous Material Facilities Feature Class: hzHazmat

Identification:	hzHazmat
Type:	ESRI Point Feature Class
Purpose:	Belongs to HPLF.mdb. Provides the geometry of hazardous material facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named HPLF.mdb in the Region folder. Field information is transferred to a table with the same name (*hzHazmat*) in the SQL Server database in the Region folder.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
HazmatId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hHazmat* feature class with the associated *eqHazmat* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
HplfClass	Text(5)	T, NU, A	T, UC		Indicates facility classification
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Facility address
City	Text(40)	F	F		City
Statea	Text(2)	F	F		USPS state abbreviation
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067--564 or 300672564
Contact	Text(40)	F	F		Facility contact person
PhoneNumber	Text(14)	F	F		Facility phone number
Owner	Text(25)	F	F		Facility owner
Cas	Text(10)	F	F		Chemical Abstract Service (CAS) number for hazardous material
ChemicalName	Text(20)	F	F		Proper chemical name associated with the CAS number of the

					hazardous material
ChemicalQuant	Long(4) Long Integer(4)	F	F		Quantity (in pounds) of the chemical at a hazardous materials facility
SIC	Text(10)	F	F		Standard Industrial Code
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
EPAID	Text(2)	F	F		Environmental Protection Agency (EPA) ID
PerAmount	Float(4) Single(4)	F	F		Amount of chemical (in pounds) allowed by permit.
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.8.3.4 Earthquake Specific Hazardous Material Facilities Table: eqHazmat

Identification:	eqHazmat
Type:	ESRI Table
Purpose:	Belongs to HPLF.mdb. Provides Earthquake Model specific information of hazardous material facilities. During the creation of a study region, the table content is transferred to a table with the same name (*eqHazmat*) in the SQL Server database in the Region folder. There must be one record in eqHazmat for each record in hzHazmat with same HazmatId unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
HazmatId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eqHazmat* feature class with the associated *hzHazmat* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	N	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	N	T, UC	HC = High-Code MC = Moderate -Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual, Chapters 3 and 5, for detailed information about design levels.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for future extensibility of the earthquake model, but does not

					need to be populated at this time.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.8.3.5 Levees Feature Class: hzLevees

Identification:	hzLevees
Type:	ESRI Line Feature Class
Purpose:	Belongs to HPLF.mdb. Provides the geometry of levees. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named HPLF.mdb in the Region folder. Field information is transferred to a table with the same name (hzLeveest) in the SQL Server database in the Region folder.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
LeveeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzLevees* feature class with the associated *eqLevees* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (Upper case) and xxxxxx is a sequential number from 000001 to 999999.
CountyFips	Text(5)	T, NU, A	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.8.3.6 Earthquake Specific Levees Table: eqLevees

Identification:	eqLevees
Type:	ESRI Table
Purpose:	Belongs to HPLF.mdb. Provides Earthquake Model specific information of levees. During the creation of a study region, the table content is transferred to a table with the same name (*eqLevee*) in the SQL Server database in the Region folder. There must be one record in eqLevees for each record in *hzLevees* with same *LeveeId* unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
LeveeId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eqLevee* feature class with the associated *hzLevee* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase;					

LC=Lowercase

F.8.3.7 Military Facilities Feature Class: hzMilitary

Identification:	hzMilitary
Type:	ESRI Point Feature Class
Purpose:	Belongs to HPLF.mdb. Provides the geometry of military facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named HPLF.mdb in the Region folder. Field information is transferred to a table with the same name (*hzMilitary*) in the SQL Server database in the Region folder.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
MilitaryFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzMilitary* feature class with the associated *eqMilitary* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
HplfClass	Text(5)	T, N U, A	T, UC	See Appendix B, Table B.5.	Indicates facility classification
Tract	Text(11)	T, N U, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Facility address
City	Text(40)	F	F		City
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Statea	Text(2)	F	F		USPS state abbreviation
Contact	Text(40)	F	F		Facility contact person
PhoneNumber	Text(14)	F	F		Facility phone number
NumStories	Short(1) Byte(1)	F	F		Number of stories
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤	Year structure was built

				2100)	
Owner	Text(25)	F	F		Facility owner name
ShelterCapacity	Short(2) Integer(2)	F	F		Shelter capacity. For informational purposes only and not used in any Hazus-MH calculations. Total number of persons who can be sheltered in this facility.
Use	Text(10)	F	F		Facility use
BldgCost	Double(8) Currency(8)	F	F		Building replacement cost (in thousands)
ContentCost	Double(8) Currency(8)	F	F		Content replacement cost (in thousands)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.8.3.8 Earthquake Specific Military Table: eqMilitary

Identification:	eqMilitary
Type:	ESRI Table
Purpose:	Belongs to HPLF.mdb. Provides Earthquake Model specific information of military facilities. During the creation of a study region, the table content is transferred to a table with the same name (*eqSchool*) in the SQL Server database in the Region folder. There must be one record in *eqMilitary* for each record in *hzMilitary* with same *MilitaryId* unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
MilitaryFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *eqMilitary* feature class with the associated *hzMilitary* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	N	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	N	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual , Chapters 3 and 5, for detailed information about design levels.
FoundationType	Text(1)	F	F		Foundation type (e.g., slab, pile). This field is in the table for

					future extensibility of the earthquake model, but does not need to be populated at this time.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.8.3.9 Nuclear Power Plants Feature Class: hzNuclearFlty

Identification:	hzNuclearFlty
Type:	ESRI Point Feature Class
Purpose:	Belongs to HPLF.mdb. Provides the geometry of nuclear power plant facilities. During the creation of a study region, for all hazards, geometries are transferred to a geodatabase named HPLF.mdb in the Region folder. Field information is transferred to a table with the same name (*hzNuclearFlty*) in the SQL Server database in the Region folder.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
NuclearFltyId	Text(8)	T, U, A	T, UC		Unique identifier for each record. It relates this *hzNuclearFlty* feature class with the associated *eqNuclearFlty* table. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
HplfClass	Text(5)	T, NU, A	T, UC	See Appendix B, Table B-5.	Indicates facility classification
Tract	Text(11)	T, NU, A	T	11 digits of the Census tract number	2000 US Census tract number
Name	Text(40)	F	F		Facility name
Address	Text(40)	F	F		Physical address
City	Text(40)	F	F		City
Zipcode	Text(10)	F	F		Zip code; for instance, 30067 or 30067-2564 or 300672564
Statea	Text(2)	F	F		USPS state abbreviation
Owner	Text(25)	F	F		Facility owner name
Contact	Text(40)	F	F		Facility contact person
PhoneNumber	Text(14)	F	F		Facility phone number
YearBuilt	Short(2) Integer(2)	F	F	Null or (≥ 1500 and ≤ 2100)	Year structure was built
NumStories	Short(1)	F	F		Number of stories

	Byte(1)				
Cost	Double(8) Currency(8)	F	F		Replacement cost (in thousands)
Latitude	Double(8) Double(8)	F	F	Latitude decimal degrees	Latitude
Longitude	Double(8) Double(8)	F	F	Longitude decimal degrees	Longitude
Capacity	Long(4) Long Integer(4)	F	F		Volts/Watts
Comment	Text(40)	F	F		Comments
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.8.3.10 Earthquake Specific Nuclear Power Plant Facilities Table: eqNuclearFlty

Identification:	eqNuclearFlty
Type:	ESRI Table
Purpose:	Belongs to HPLF.mdb. Provides Earthquake Model specific information of nuclear power plant facilities. During the creation of a study region, the table content is transferred to a table with the same name (*eqNuclearFlty*) in the SQL Server database in the Region folder. Data are subsequently used for Hazus-MH EQ Model estimation of hazards, damages, and loss of functionality. There must be one record in eqNuclearFlty for each record in *hzNuclearFlty* with same *NuclearFltyId* unique identifier.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
NuclearFltyId	Text(8)	T, U,A	T, UC		Unique identifier for each record. It relates this *eqNuclearFlty* feature class with the associated *hzNuclearFlty* in a one-to-one relationship. The standard format adopted by Hazus is SSxxxxxx, where SS is the state name abbreviation (upper case) and xxxxxx is a sequential number from 000001 to 999999.
eqBldgType	Text(4)	F	T, UC	See Appendix B, Table B.2.	The building type that will be modeled in Hazus earthquake scenarios. See Appendix B, Table B.2, for complete description of available model building types.
DesignLevel	Text(2)	F	T, UC	HC = High-Code MC = Moderate-Code LC = Low-Code PC = Pre-Code HS = Special High-Code MS = Special Moderate-Code LS = Special Low-Code	Building codes in effect in the area. See Earthquake Technical Manual , Chapters 3 and 5, for detailed information about design levels.
SoilType	Text(1)	F	T, UC	See Appendix B, Table B.1.	National Earthquake Hazard Reduction Program (NEHRP) soil classification that defines the conditions where the structure is

					located. This is based on shear wave velocity. See Appendix B, Table B.1, for details.
LqfSusCat	Short(1) Byte(1)	F	F	Null or 0 to 5	Indicates liquefaction susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
LndSusCat	Short(1) Byte(1)	F	F	Null or 0 to 10	Indicates landslide susceptibility of the facility location. See Earthquake Technical Manual (Section 4.2, Ground Failure) for liquefaction discussion.
WaterDepth	Float(4) Single(4)	F	F	Null ≥ 0	Water table depth in feet. Values must be greater than 0. Range: 0 – 300 meters.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.9 Agriculture Inventory: flAG.mdb

F.9.1 Database Overview

flAG.mdb is an Access personal geodatabase that provides information about distributions of crop type, price, and harvest cost of agriculture products. The information is used by the Flood Model to determine the direct physical damage to agriculture.

The geographical domain of the database is the state. In that case, there is one flAG.mdb database for each state, each located in the appropriate State folder.

flAG.msb contains a feature class (flAgMap) with polygons (defining crop distribution and extent) and a table (flAgricultureInventory) that provides crop type, units of measurement, unit price, and harvest cost of agriculture products for each polygon.

During the creation of a flood study region, features from feature class flAgMap are transferred to a geodatabase named flAG.mdb in the Region folder. Data from table flAgricultureInventory are transferred to a table named flAgricultureInventory in the SQL Server database in the Region folder.

F.9.2 Identification

flAG.mdb

F.9.3 Database Content

The flAG.mdb database includes:

Name	Type	Content
flAgMap	ESRI Polygon Feature Class	Geometry (polygon features) and information of crops
flAgricultureInventory	ESRI Table	This table provides distributions of crop type, units of measurement, unit price, and harvest cost for agriculture products

F.9.3.1 Agriculture Crop Feature Class: flAgMap

Identification:	flAgMap
Type:	ESRI Polygon Feature Class
Purpose:	Belongs to flAG.mdb. Provides the geometry of crop polygons. During the creation of a study region, features are transferred to a geodatabase named flAG.mdb in the Region folder.
Data:	

Feature Class Field Definition					
Name	ESRI Type (Size) Access Type (Size)	Index *	Require d*	Values	Description
PolygonId	Text(25)	F	T		Sub County Polygon ID
LUCODE	Short(2) Integer(2)	F			Land use code
Name	Text(20	F	T		County name
FIPS	Text(5)	F	T		Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.
ST	Text(2)	T, NU, A	T		FIPS state code
ST_NAME	Text(2)	T, NU, A	T		USPS state abbreviation
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.9.3.2 Agriculture Inventory Table: flAgricultureInventory

Identification:	flAgricultureInventory
Type:	ESRI Table
Purpose:	Belongs to flAG.mdb. Provides Flood Model with information about agriculture crops. During the creation of a study region, the table content is transferred to a table with the same name (*flAgricultureInventory*) in the SQL Server database in the Region folder.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) Access Type (Size)	Index *	Required*	Values	Description
CropType	Text(50)	F	T		Crop type
CountyFIPS	Text(5)	F	T	Five-digit FIPS county code	Five-digit FIPS county code. First two digits are the state FIPS; the remaining three digits are the county code.
PolygonId	Text(25)	F	T		Sub county polygon ID
AvgAnnualYield	Double(8) Double(8)	F	F		Annual average crop yield
Unit	Text(10)	F	F		Unit of measurement for crop
UnitPrice	Double(8) Double(8)	F	F		Price per unit of measurement
HarvestCost	Double(8) Double(8)	F	F		Cost to harvest crop

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.10 Vehicles Inventory: flVeh.mdb

F.10.1 Database Overview

flVeh.mdb is an Access personal geodatabase that provides distributions and costs (replacement value) of vehicles by census block. The information is used by the Flood Model for estimating the dollar cost of flood related damages to motor vehicles due to flood events.

The geographical domain of the database is the state. In that case, there is one flVeh.mdb database for each state, each located in the appropriate State folder.

flVeh.msb contains two tables: one named flNightVehicleInv that provides nighttime vehicle information and one named flDayVehicleInv that provides daytime vehicle information.

During the creation of a flood study region, records from both tables are copied to tables with the same names in the SQL Server database in the Region folder.

F.10.2 Identification

flVeh.mdb

F.10.3 Database Content

The flVeh.mdb database includes:

Name	Type	Content
flNightVehicleInv	ESRI Table	This table provides nighttime vehicle information
flDayVehicleInv	ESRI Table	This table provides daytime vehicle information

F.10.3.1 Nighttime Vehicles Table: flNightVehicleInv

Identification:	flNightVehicleInv
Type:	ESRI table
Purpose:	Belongs to flVeh.mdb. Provides distributions and costs of vehicles at nighttime. During the creation of a study region, records are copied to a table named flNightVehicleInv in the SQL Server database in the Region folder.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type(Size)	Index*	Required*	Values	Description
CensusBlock	Text(15)	N	T	15 digits of the Census block number	15 digits of the Census block number
TotalVehicle	Long(4) Long Integer(4)	F	F		Total vehicles count
Cars	Long(4) Long Integer(4)	F	F		Total count cars
LightTrucks	Long(4) Long Integer(4)	F	F		Total count light trucks
HeavyTrucks	Long(4) Long Integer(4)	F	F		Total count heavy trucks
TotalExp	Double(8) Double(8)	F	F		Total vehicle exposure
TValNewCars	Double(8) Double(8)	F	F		Total value new cars
TValUsedCars	Double(8) Double(8)	F	F		Total value used cars
TValNewLightTrucks	Double(8) Double(8)	F	F		Total value new light trucks
TValUsedLightTrucks	Double(8) Double(8)	F	F		Total value used light trucks
TValNewHeavyTrucks	Double(8) Double(8)	F	F		Total value new heavy trucks
TValUsedHeavy	Double(8)	F	F		Total value used heavy trucks

Trucks	Double(8)				
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.10.3.2 Daytime Vehicles Table: flDayVehicleInv

Identification:	flDayVehicleInv
Type:	ESRI table
Purpose:	Belongs to flVeh.mdb. Provides distributions and costs of vehicles at daytime. During the creation of a study region, records are copied to a table named flDayVehicleInv in the SQL Server database in the Region folder.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) Access Type (Size)	Index*	Required*	Values	Description
CensusBlock	Text(15)	N	T	15 digits of the Census block number	15 digits of the 2000 US Census block number
TotalVehicle	Long(4) Long Integer(4)	F	F		Total vehicles count
Cars	Long(4) Long Integer(4)	F	F		Total count cars
LightTrucks	Long(4) Long Integer(4)	F	F		Total count light trucks
HeavyTrucks	Long(4) Long Integer(4)	F	F		Total count heavy trucks
TotalExp	Double(8) Double(8)	F	F		Total vehicle exposure
TValNewCars	Double(8) Double(8)	F	F		Total value new cars
TValUsedCars	Double(8) Double(8)	F	F		Total value used cars
TValNewLightTrucks	Double(8) Double(8)	F	F		Total value new light trucks
TValUsedLightTrucks	Double(8) Double(8)	F	F		Total value used light trucks
TValNewHeavyTrucks	Double(8) Double(8)	F	F		Total value new heavy trucks
TValUsedHeavy	Double(8)	F	F		Total value used heavy trucks

Trucks	Double(8)				
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.11 Hurricane Model Database: huTemplateGBS.mdb

F.11.1 Database Overview

huTemplateGBS.mdb is an Access database that provides Hurricane Model parameter values by census tract. The geographical domain of the database is the state. In that case, there is one huTemplateGBS.mdb database for each state, each located in a folder named *hu* in the appropriate State folder.

huTemplateGBS.mdb has four tables that provide critical Hurricane Model information about hazard and exposure (e.g., terrain condition, tree inventory, wind specific mapping schemes, gust wind speed by return period, distance to coast, etc.) by census tract.

During the creation of a flood study region, records from all tables are copied to tables with the same name in the SQL Server database in the Region folder.

F.11.2 Identification

huTemplateGBS.mdb

F.11.3 Database Content

The huTemplateGBS.mdb database includes:

Name	Type	Content
huHazardMapWindSpeed	ESRI Table	This table provides estimated gust (3-second) wind speed by census tract for different return periods.
huTerrain	ESRI Table	This table provides terrain characterization (surface roughness) by census tract.
huTract	ESRI Table	This table provides Hurricane Model specific mapping scheme name by census tract. Values for parameters *distance to coast* and *wind grid index* are included for each census tract.
huTreeParameters	ESRI Table	This table provides tree coverage parameter values by census tract.

F.11.3.1 Peak Gust Wind Speed by Return Period Table: huHazardMapWindSpeed

Identification:	huHazardMapWindSpeed
Type:	Access Table
Purpose:	Belongs to huTemplateGBS.mdb. Provides estimated peak gust (3-second) wind speed by census tract for different return periods. Records are transferred to the SQL Server database in the Region folder during the aggregation process. Data are subsequently used for Hazus-MH wind speed mapping
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
Tract	Text(11)	F	T	11 digits of the census tract number	11 digits of the 2000 US Census tract number
f10yr	Float(4) *Single(4)*	F	F		Estimated gust (3-seconds) wind speed to be exceeded only once every 10 years
f20yr	Float(4) *Single(4)*	F	F		Estimated gust (3-seconds) wind speed to be exceeded only once every 20 years
f50yr	Float(4) *Single(4)*	F	F		Estimated gust (3-seconds) wind speed to be exceeded only once every 50 years
f100yr	Float(4) *Single(4)*	F	F		Estimated gust (3-seconds) wind speed to be exceeded only once every 100 years
f200yr	Float(4) *Single(4)*	F	F		Estimated gust (3-seconds) wind speed to be exceeded only once every 200 years
f500yr	Float(4) *Single(4)*	F	F		Estimated gust (3-seconds) wind speed to be exceeded only once every 500 years
f1000yr	Float(4) *Single(4)*	F	F		Estimated gust (3-seconds) wind speed to be exceeded only once every 1000 years
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.11.3.2 Terrain Characterization Table: huTerrain

Identification:	huTerrain				
Type:	Access Table				
Purpose:	Belongs to huTemplateGBS.mdb. Provides surface roughness values by census tract and wind grid. Records are transferred to the SQL Server database in the Region folder during the aggregation process.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
Tract	Text(11)	F	T	11 digits of the census tract number	11 digits of the 2000 US Census tract number
SURFACEROUGHNESS	Float(4) *Single(4)*	F	F		Surface roughness value. See Hurricane Model Technical Manual, Chapter 3, Surface Roughness Modeling.
SRIndex	Float(4) *Single(4)*	F	F		Surface roughness index. See Hurricane Model Technical Manual, Chapter 3, Surface Roughness Modeling.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.11.3.3 Tree Characteristics Distribution Table: huTreeParameters

Identification:	huTreeParameters
Type:	Access Table
Purpose:	Belongs to huTemplateGBS.mdb. Provides tree parameters values by census tract. Records are transferred to the SQL Server database in the Region folder during the aggregation process.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
Tract	Text(11)	N	T	11 digits of the census tract number	11 digits of the 2000 US Census tract number
PreDomTreeType	Text(20)	F	F	Null Deciduous Coniferous Mixed	Predominant tree type: deciduous, coniferous, mixed
StemsPerAcre	Long(4) *Long Integer(4)*	F	F		Number of trees per acre
TreeHeightLess40	Float(4) *Single(4)*	F	F		Percentage of trees with height less than 40 feet
TreeHeight40To60	Float(4) *Single(4)*	F	F		Percentage of trees with height 40 feet to 60 feet
TreeHeightGreater60	Float(4) *Single(4)*	F	F		Percentage of trees with height greater than 60 feet
TreeCollectionFactor	Float(4) *Single(4)*	F	F		Tree collection factor. A factor to estimate eligible tree debris for collection.
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.11.3.4 Hurricane Model Census Tract Table: huTract

Identification:	huTract
Type:	Access Table
Purpose:	Belongs to huTemplateGBS.mdb. This table provides Hurricane Model specific building and occupancy mapping scheme names by census tract. Values for parameters distance to coast and wind grid index are included for each census tract Records are transferred to the SQL Server database in the Region folder during the aggregation process. Data are subsequently used for Hazus-MH wind speed mapping.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required *	Values	Description
Tract	Text(11)	F	T		11 digits of the 2000 US Census tract number
huBldgSchemeName	Float(4) *Single(4)*	F	T		Hurricane Model building scheme name
huOccMapSchemeName	Float(4) *Single(4)*	F	T		Hurricane Model occupancy mapping scheme name
DistToCoast	Float(4) *Single(4)*	F	F		Distance to coast (in miles)
SURFACEROUGHNESS	Float(4) *Single(4)*	F	F		Surface roughness value. See Hurricane Model Technical Manual, Chapter 3, Surface Roughness Modeling.
WindGridIndex	Float(4) *Single(4)*	F	F		Wind grid index

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.12 Occupancy Mapping Scheme: MSH.mdb

F.12.1 Database Overview

Occupancy mapping schemes are sets of tables (matrices) that inform the distribution of building characteristics by occupancy to Hazus-MH. MSH.mdb is the Access database that provides mapping scheme tables for Hazus-MH damage and loses assessment. There are two sets of mapping schemes tables. One set provides the percentage distribution of building by building types and occupancy. An example would be to specify that RES1 (single-family dwellings) is 80 percent wood and 20 percent masonry. The other set, specific to the Flood Model, provides the percentage distribution of pre-FIRM and post-FIRM by foundation type for each occupancy type.

The geographical domain of the database is the state. In that case, there is one MSH.mdb database for each state, each located in the appropriate State folder.

During the creation of a study region, for all hazards, records from tables with prefix *hz* (hzGenBldgScheme and hzGenBldgSchemes) are appended to tables with the same name in the SQL Server database in the Region folder. The table hzGenBldgSchemes portrays the available schemes for a particular state, while hzGenBldgScheme defines the distribution of general building types (wood, steel, etc.) for each of these schemes by occupancy. Although originally designed for the Earthquake Model, the distribution of general building type as presented in hzGenBldgScheme table is commonly used across all Hazus-MH Models.

Tables with prefix *eq* in their names are specific to the EQ Model. One table for each general building type (wood, steel, etc.) portrays the distribution of specific building types by design level. Records from these tables are appended to tables with the same name in the SQL Server database in the Region folder if an EQ region is aggregated.

Flood specific tables have names with prefix *fl*. Records from these tables are appended to tables with the same name in the SQL Server database in the Region folder when a flood region is aggregated.

F.12.1.1 Occupancy Mapping Scheme for Building Type

While information about replacement value, building count, and square footage by occupancy is explicitly depicted in tables (by census tract and by census block) in bndrygbs.mdb (see State Boundaries: Boundary.mdb), building type distribution by occupancy is handled differently.

Two sets of tables deal with the distribution of building types by occupancy. One set takes care of general building type distribution (e.g., wood, concrete, and masonry) and another set takes care of specific building type distribution (e.g., wood light frame [W1] or concrete share wall low-rise [C2L]).

In terms of general building type, the table named *hzGenBldgSchemes* acts as bookkeeper, listing all building schemes available for a particular state. Building scheme, in this context, refers to a particular mapping of the distribution of general building types. In both feature classes previously discussed—hzTract (Census Tract Boundaries) and hzCensusBlock (Census Block Boundaries) in the State Boundaries (Boundary.mdb) geodatabase—a field specifies the appropriate building scheme identifier to be applied to determine the distribution of building type.

Figure 1 shows that there are two building schemes available in the Hazus-MH default database for Illinois. The use of the state abbreviation for the building scheme identifier (BldgSchemeID) is not required. Instead, any alphanumeric string can be used (that is, up to 10 characters length).

Figure 1: Available Default Building Schemes for Illinois

hzGenBldgSchemes : Table

OBJECTID	BldgSchemesId	SchemeName	Description	Created	Updated	MappingType
1	IL1	IL1	IL Default Mapping Scheme (based on low seismic des	12/13/2002	12/13/2002	D
2	IL2	IL2	IL Default Mapping Scheme (based on moderate seism	12/13/2002	12/13/2002	D
utoNumber)						

Record: 1 of 2

As shown in Figure 2, for each of these building schemes, there will be 33 records (one for each occupancy type in Hazus-MH) in a table named *hzGenBldgScheme* that define the distribution in percentage by general building type: wood, masonry, steel, concrete, and manufactured home.

Figure 2: General Mapping Schemes by Occupancy for Illinois

hzGenBldgScheme : Table

OBJECTID	GenBldgSchemeID	BldgSchemesId	Occupancy	Total	WPct	CPct	SPct	MPct	HPct
1	IL1	IL1	RES1	100	77	1	0	22	0
2	IL2	IL1	RES2	100	0	0	0	0	100
3	IL3	IL1	RES3A	100	75	0	0	25	0
4	IL4	IL1	RES3B	100	75	0	0	25	0
5	IL5	IL1	RES3C	100	75	0	0	25	0
6	IL6	IL1	RES3D	100	75	0	0	25	0
7	IL7	IL1	RES3E	100	75	0	0	25	0
8	IL8	IL1	RES3F	100	75	0	0	25	0
9	IL9	IL1	RES4	100	50	0	0	50	0
10	IL10	IL1	RES5	100	20	45	0	35	0
11	IL11	IL1	RES6	100	90	0	0	10	0
12	IL12	IL1	COM1	100	30	10	30	30	0
13	IL13	IL1	COM2	100	10	30	30	30	0
14	IL14	IL1	COM3	100	30	10	30	30	0
15	IL15	IL1	COM4	100	30	10	30	30	0
16	IL16	IL1	COM5	100	30	10	30	30	0
17	IL17	IL1	COM6	100	0	70	10	20	0

Record: 1 of 66

In this way, Hazus-MH will realize that for a particular tract or block with building scheme IL1 assigned; for instance, 77 percent of buildings classified as occupancy type RES1 are wood structures. As shown in Figure 1, the field BldgSchemeID refers to a record in *hzGenBldgScheme*. The value IL1 in field GenBldgSchemeId uniquely identifies the general building scheme of RES1 for Building Scheme IL1[5] while value IL2 in the field GenBldgSchemeId uniquely identifies the general building scheme of RES1 for the same building scheme IL1.

As noted, a second set of tables maps the *specific* building type by design level. In terms of specific building type, a table named *eqSpcBldgSchemes* will act as the bookkeeper for all specific building schemes available for a particular state. Specific building schemes, in this context, refer to a particular mapping of the distribution of specific building types. Figure 3 shows several records in eqSpcBldgSchemes that are available in Hazus-MH default database for Illinois. Again, the use of the state abbreviation for the specific building scheme identifier (eqSpcBldgSchemeID) is not required.

Figure 3: Available Default Specific Building Schemes for Illinois

[5] The user must be aware that naming convention may result in confusions. In Hazus-MH default inventory, the same naming convention (State abbreviation plus a number) is used for identifying building schemes in table *hzGenBldgScheme* (field BldgSchemeID) and for the record that refers to the general building scheme for occupancy type RES1 in *hzGenBldgSchemes* table (field GenBldgSchemeID) However, both are identifying different items and, as previously stated, the use of the State abbreviation is not required. Instead, any alphanumeric string can be used (up to 10 characters length).

eqSpcBldgSchemes : Table

OBJECTID	eqSpcBldgSchemesId	SchemeName	Description	BldgTypeSource	Created	Updated	MappingType
1	IL1	IL1RES1W	IL1RES1W	W	2/21/2003	2/21/2003	D
2	IL2	IL1RES2W	IL1RES2W	W	2/21/2003	2/21/2003	D
3	IL3	IL1RES3AW	IL1RES3AW	W	2/21/2003	2/21/2003	D
4	IL4	IL1RES3BW	IL1RES3BW	W	2/21/2003	2/21/2003	D
5	IL5	IL1RES3CW	IL1RES3CW	W	2/21/2003	2/21/2003	D
6	IL6	IL1RES3DW	IL1RES3DW	W	2/21/2003	2/21/2003	D
7	IL7	IL1RES3EW	IL1RES3EW	W	2/21/2003	2/21/2003	D
8	IL8	IL1RES3FW	IL1RES3FW	W	2/21/2003	2/21/2003	D
9	IL9	IL1RES4W	IL1RES4W	W	2/21/2003	2/21/2003	D
10	IL10	IL1RES5W	IL1RES5W	W	2/21/2003	2/21/2003	D
11	IL11	IL1RES6W	IL1RES6W	W	2/21/2003	2/21/2003	D

Record: 1 of 330

By default, there are 165 records in Hazus-MH for each building scheme available in hzGenBldgSchemes; however, there can be fewer or more as necessary. Each set of 165 records consists of 33 subsets (representatives of the 33 specific occupancy class) and five records (one for each general building type like wood, concrete, etc.). For instance, the Specific Building Scheme IL1 (Figure 3) refers to RES1-wood buildings. Details of the distribution of building types for each scheme is stored in five tables, one for each general building type. In this way, wood type schemes are stored in a table named eqWBldgTypeMp, while concrete type schemes are stored in a table named eqCBldgTypeMp.

Figure 4 shows the specific building type distribution for wood from the EqWBldgTypeMp table for Illinois. Using the example in the paragraph above, wood for RES1 is mapped to 100 percent W1 (wood light-frame) with design level low code for the rest of combination building type/design level. By definition, the percentages must total 100. This subset of tables is exclusive to the EQ Model, as the prefix in the names indicates.

Figure 4: Specific Building Type Scheme (Wood) from EqWbldgtypemp Table

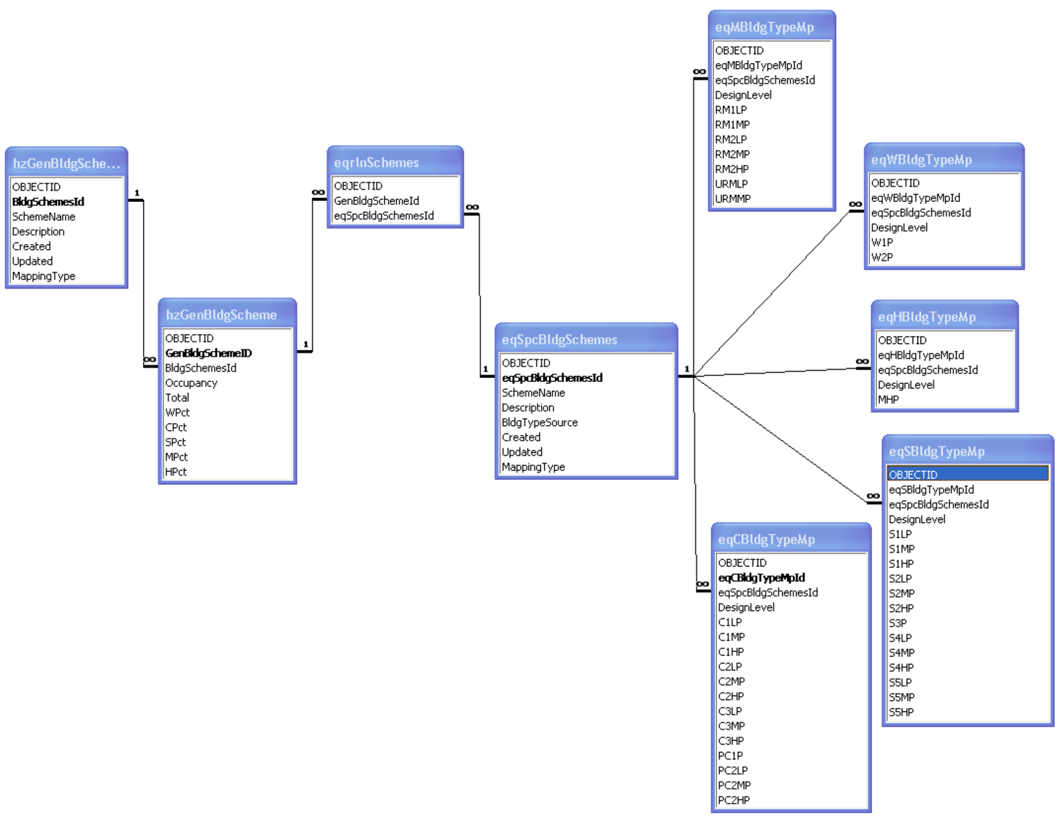
eqWBldgTypeMp : Table

OBJECTID	eqWBldgTypeM	eqSpcBldgSchemesId	DesignLevel	W1P	W2P
1	IL1	IL1	LC	100	0
2	IL2	IL1	LS	0	0
3	IL3	IL1	PC	0	0
4	IL4	IL1	MC	0	0
5	IL5	IL1	MS	0	0
7	IL6	IL1	HC	0	0
8	IL7	IL1	HS	0	0

Record: 5 of 462

Figure 5 shows the relationship between the occupancy mapping scheme tables discussed above.

Figure 5: Occupancy Mapping Scheme Relationship in Hazus-MH



There is a many-to-many relationship between the general mapping schemes (hzGenBldgScheme) and the specific mapping schemes (eqSpcBldgSchemes). This relationship is stored in the table eqrlnSchemes. In this way, two general schemes (as specified in hzGenBldgSchemes) can share the same scheme definition in eqSpcBldgSchemes for a particular occupancy/building type distribution (for instance, Res1/W2). Figure 6 shows a partial view of Illinois eqInScheme table. For general building scheme IL1 (RES1) in hzGenBldgScheme (see Figure 2), there are five specific building type (field eqSpcBldgSchemeID): IL1 (RES1-Wood), IL34 (RES1-Concrete), etc.

Figure 6: Partial view of eqInScheme table.

eqrInSchemes : Table

OBJECTID	GenBldgSchemeId	eqSpcBldgSchemesId
1	IL1	IL1
2	IL1	IL34
3	IL1	IL67
4	IL1	IL100
5	IL1	IL133
6	IL2	IL2
7	IL2	IL35
8	IL2	IL68
9	IL2	IL101
10	IL2	IL134
11	IL3	IL3
12	IL3	IL36
13	IL3	IL69

Record: 1 of 330

F.12.1.2 Flood Model Mapping Scheme

First floor elevation (as determined from foundation type) is another key parameter for the estimation of flood damage. Information on foundation types for the general building stock is provided by a foundation mapping scheme consisting of a set of tables that depicts how foundation type and first floor elevations are distributed by specific occupancy.

Figure 7: Specific Building Type Scheme (Wood) from Eqcbldgtypemp Table.

SchemeId	Soccup	FoundationType	PreFirmDist	PreFirmHt	PostFirmDist	PostFirmHt	HazardType
ALR00001	RES1	Pile	0	7	0	8	R
ALR00001	RES1	Pier	0	5	0	6	R
ALR00001	RES1	SolidWall	0	7	0	8	R
ALR00001	RES1	Basement	25	4	25	4	R
ALR00001	RES1	Crawl	49	3	49	4	R
ALR00001	RES1	Fill	0	2	0	2	R
ALR00001	RES1	Slab	26	1	26	1	R
ALR00001	RES2	Pile	0	7	0	8	R
ALR00001	RES2	Pier	0	5	0	6	R
ALR00001	RES2	SolidWall	0	7	0	8	R
ALR00001	RES2	Basement	25	4	25	4	R
ALR00001	RES2	Crawl	49	3	49	4	R
ALR00001	RES2	Fill	0	2	0	2	R
ALR00001	RES2	Slab	26	1	26	1	R
ALR00001	RES3A	Pile	0	7	0	8	R
ALR00001	RES3A	Pier	0	5	0	6	R
ALR00001	RES3A	SolidWall	0	7	0	8	R
ALR00001	RES3A	Basement	25	4	25	4	R
ALR00001	RES3A	Crawl	49	3	49	4	R
ALR00001	RES3A	Fill	0	2	0	2	R
ALR00001	RES3A	Slab	26	1	26	1	R
ALR00001	RES3B	Pile	0	7	0	8	R

Conversely, the scheme identifier of the occupancy mapping scheme for building type is not assigned in the hzCensusBlock (Census Block Boundaries) feature class directly, but there is a table (flSchemeMapping) in MSH.mdb assigned to each census block number in the state a scheme identifier.

F.12.2 Identification

MSH.mdb

F.12.3 Database Content

The MSH.mdb database includes:

Name	Type	Content
hzGenBldgSchemes	ESRI Table	hzGenBldgSchemes holds a list of all the mapping schemes available in the state. This table is a bookkeeping table that holds items such as the name of the scheme and the date it was created.
hzGenBldgScheme	ESRI Table	hzGenBldgScheme is the table with values for general building type associated with all mapping schemes in hzGenBldgSchemes. There are 33 records—one for each specific occupancy class (Res1, Res2, Com6, etc.)—for each scheme available in hzGenBldgSchemes. For each record, the percentage of building by general building

		type (wood, concrete, etc.) is summarized.
eqrlnSchemes	ESRI Table	There is a many-to-many relationship between the general mapping schemes (hzGenBldgScheme) and the specific mapping schemes (eqSpcBldgSchemes); this relationship is stored in the table eqrlnSchemes. In this way, two general schemes (as specified in hzGenBldgSchemes) can share the same scheme definition in eqSpcBldgSchemes for a particular occupancy/building type distribution (for instance, Res1/W2).
eqSpcBldgSchemes		eqSpcBldgSchemes is the equivalent of hzGenBldgSchemes, but applies to the specific building type distribution.
eqCBldgTypeMp	ESRI Table	eqCBldgTypeMp portrays the percentage of specific concrete building type (for instance, C1LP and C1MP) by design level. Each record in eqSpcBldgSchemes for concrete building type has five related records (one for each design level type) in eqCBldgTypeMp.
eqHBldgTypeMp	ESRI Table	eqHBldgTypeMp portrays the percentage of specific manufactured home building type (MHP) by design level. Each record in eqSpcBldgSchemes for manufactured home building type has five related records (one for each design level type) in eqHBldgTypeMp.
eqMBldgTypeMp	ESRI Table	eqMBldgTypeMp portrays the percentage of specific masonry building type (for instance, RM1LP and RM1MP) by design level. Each record in eqSpcBldgSchemes for masonry building type has five related records (one for each design level type) in eqMBldgTypeMp.
eqWBldgTypeMp	ESRI Table	eqWBldgTypeMp portrays the percentage of specific wood building type (for instance, W1P and W2P) by design level. Each record in eqSpcBldgSchemes for wood building type has five related records (one for each design level type) in eqWBldgTypeMp.
eqSBldgTypeMp	ESRI Table	eqSBldgTypeMp portrays the percentage of specific

		steel building type (for instance, S1LP and S1MP) by design level. Each record in eqSpcBldgSchemes for steel building type has five related records (one for each design level type) in eqSBldgTypeMp.
flSchemeInfo	ESRI Table	flSchemeInfo holds a list of all mapping schemes available in the state. This table is a bookkeeping table holding items such as scheme name and creation date.
flSchemeCoastal	ESRI Table	flSchemeCoastal portrays the distribution (expressed in percentages) of foundation types (pile, pier, solid wall, etc.) by occupancy with the building's first floor elevation for each foundation type in coastal areas. Elevation and percentage distribution is provided for pre-FIRM and post-FIRM conditions.
flSchemeGLakes	ESRI Table	flSchemeGLakes portray the distribution (expressed in percentages) of foundation types (pile, pier, solid wall, etc.) by occupancy with the building's first floor elevation for each foundation type in Great Lakes areas. Elevation and percentage distribution is provided for pre-FIRM and post-FIRM conditions
flschemeRiverine	ESRI Table	flschemeRiverine portrays the distribution (expressed in percentages) of foundation types (pile, pier, solid wall, etc.) by occupancy with the building's first floor elevation for each foundation type in areas with riverine hazard). Elevation and percentage distribution is provided for pre-FIRM and post-FIRM conditions.
flSchemeMapping	ESRI Table	flSchemeMapping assigns scheme type to each census block in a state.

F.12.3.1 Building Schemes Catalog: hzGenBldgSchemes

Identification:	hzGenBldgSchemes
Type:	ESRI Table
Purpose:	This table holds a list of all mapping schemes available in the state. This table is a bookkeeping table holding items such as the scheme name and date of creation.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
BldgSchemesId	Text(10)	F	T		Building scheme unique ID
SchemeName	Text(30)	F	T		Building scheme name
Description	Text(100)	F	N		Scheme description
Created	Date *Date/Time*	F	T		Scheme creation date
Updated	Date *Date/Time*	F	T		Scheme modification date
MappingType	Text(2)	F	T, UC	D=Default UE=User-defined in Earthquake Model UF=User-defined in Flood Model UH=User-defined in hurricane Model BT=BIT mapping scheme	Source of scheme (Default, user-defined, or BIT)

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.12.3.2 General Building Schemes: hzGenBldgScheme

Identification:	hzGenBldgSchemes
Type:	ESRI Table
Purpose:	This table provides percentages for general building type associated with all the mapping schemes in hzGenBldgSchemes. There are 33 records—one for each specific occupancy class (Res1, Res2, Com6, etc.)—for each scheme available in hzGenBldgSchemes. For each record, the percentage of building by general building type (wood, concrete, etc.) is summarized.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
GenBldgSchemeID	Text(10)	F	T		General building scheme unique ID
BldgSchemesId	Text(30)	F	T		Foreign key to BldgSchemesId field in hzGenBldgSchemes table
Occupancy	Text(5)	F	T, UC	RES1, RES2, RES3A, RES3B, RES3C, RES3D, RES3E, RES3F, RES4, RES5, RES6, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, COM10, IND1, IND2, IND3, IND4, IND5, IND6, AGR1, REL1, GOV1, GOV2, EDU1, EDU2	Occupancy type
Total	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Total
WPct	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage wood
CPct	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage concrete
SPct	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage steel
MPct	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage masonry

HPct	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage manufactured homes
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.3 EQ Building Scheme Relationships Table: eqrlnSchemes

Identification:	hzGenBldgSchemes
Type:	ESRI Table
Purpose:	This table keeps a many-to-many relationship between the general mapping schemes (hzGenBldgScheme) and the specific mapping schemes (eqSpcBldgSchemes). In this way, two general schemes (as specified in hzGenBldgSchemes) can share the same scheme definition in eqSpcBldgSchemes for a particular occupancy/building type distribution (for instance, Res1/W2).
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
GenBldgSchemeId	Text(10)	F	T		Building scheme ID in hzGenBldgSchemes table. There must be records in hzGenBldgSchemes with this ID.
eqSpcBldgSchemesId	Text(10)	F	T		Specific building type Scheme ID in eqSpcBldgSchemes table. There must be a record in eqSpcBldgSchemesId with this ID.

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.12.3.4 EQ Specific Building Type Schemes Catalog: eqSpcBldgSchemes

Identification:	eqSpcBldgSchemes
Type:	ESRI Table
Purpose:	This table holds a list of all specific building type schemes available in the state in tables qSpcBldgSchemes, eqCBldgTypeMp, eqHBldgTypeMp, eqMBldgTypeMp, and eqSBldgTypeMp. This table is a bookkeeping table holding items such as scheme name and creation date.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type(Size)*	Index*	Required*	Values	Description
eqSpcBldgSchemesId	Text(10)	F	T		Specific building type scheme unique ID
SchemeName	Text(30)	F	T		Specific building type scheme name
Description	Text(100)	F	F		Scheme description
BldgTypeSource	Text(1)	F	F	Null W=Wood S=Steel C=Concrete M=Masonry H=Manufactured Home	Building type source
Created	Date *Date/Time*	F	F		Scheme creation date
Updated	Date *Date/Time*	F	F		Scheme modification date
MappingType	Text(1)	F	T, UC	D=Default UE=User-defined in Earthquake Model UF=User-defined in Flood Model UH=User-defined in hurricane Model BT=BIT mapping scheme	Scheme source (default, user-defined, or BIT)
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.5 EQ Wood Specific Building Type Scheme: eqWBldgTypeMp

Identification:	eqWBldgTypeMp
Type:	ESRI Table
Purpose:	eqWBldgTypeMp portrays the percentage of specific wood building type by design level.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
eqWBldgTypeMpId	Text(10)	F	T		General building scheme unique ID
eqSpcBldgSchemesId	Text(30)	F	T		Foreign key to BldgSchemesId field in hzGenBldgSchemes table
DesignLevel	Text(2)	F	F, UC	Null, HC, MC, LC, PC, HS, MS, MS, LS, LS	Building design level. See Appendix C.
W1P	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of wood light frame out of wood structures
W2P	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage wood, commercial, and industrial out of wood structures

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.12.3.6 EQ Concrete Specific Building Type Scheme: eqCBldgTypeMp

Identification:	eqCBldgTypeMp
Type:	ESRI Table
Purpose:	eqCBldgTypeMp portrays the percentage of specific concrete building by design level.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
eqCBldgTypeMpId	Text(10)	F	T		General building scheme unique ID
eqSpcBldgSchemesId	Text(30)	F	T		This is a foreign key to BldgSchemesId field in hzGenBldgSchemes table
DesignLevel	Text(2)	F	F,UC	Null, HC, MC, LC, PC, HS, MS, MS, LS, LS	Building design level. See Appendix C.
C1LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete moment frame, low-rise, out of concrete structures
C1MP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete moment frame, mid-rise, out of concrete structures
C1HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete moment frame, high-rise, out of concrete structures
C2LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete shear wall, low-rise, out of concrete structures
C2MP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete shear wall, mid-rise, out of concrete structures
C2HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete shear wall, high-rise, out of concrete structures
C3LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete frame with unreinforced masonry infill walls, low-rise, out of concrete structures
C3MP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete frame with unreinforced masonry infill

					walls, mid-rise, out of concrete structures
C3HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of concrete frame with unreinforced masonry infill walls, high-rise, out of concrete structures
PC1P	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of precast concrete tilt-up walls out of concrete structures
PC2LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of precast concrete frames with concrete shear walls, low-rise, out of concrete structures
PC2MP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of precast concrete frames with concrete shear walls, mid-rise, out of concrete structures
PC2HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of precast concrete frames with concrete shear walls, high-rise, out of concrete structures
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.7 EQ Steel Specific Building Type Scheme: eqSBldgTypeMp

Identification:	eqSBldgTypeMp
Type:	ESRI Table
Purpose:	eqSBldgTypeMp portrays the percentage of specific steel building by design level.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required *	Values	Description
eqCBldgTypeMpId	Text(10)	F	T		General building scheme unique ID
eqSpcBldgSchemesId	Text(30)	F	T		Foreign key to BldgSchemesId field in hzGenBldgSchemes table
DesignLevel	Text(2)	F	F,UC	Null, HC, MC, LC, PC, HS, MS, MS, LS, LS	Building design level. See Appendix C.
S1LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel moment frame, low-rise, out of steel structures
S1MP	Short(2) Integer(2)	F	F	Null or between 0 and 100	Percentage of steel moment frame, mid-rise, out of steel structures
S1HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel moment frame, high-rise, out of steel structures
S2LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel braced frame, low-rise, out of steel structures
S2MP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel braced frame, mid-rise, out of steel structures
S2HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel braced frame, high-rise, out of steel structures
S3P	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel light frame with unreinforced masonry infill walls low-rise, out of steel structures
S4LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel frame with cast-in-place concrete shear walls, mid-rise, out of steel structures
S4MP	Short(2)	F	F	Null or between	Percentage of steel frame with

	Integer(2)			0 and 100	cast-in-place concrete shear walls, high-rise, out of steel structures
S4HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel frame with cast-in-place concrete shear walls out of steel structures
S5LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel frame with unreinforced masonry infill walls, low-rise, out of steel structures
S5MP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel frame with unreinforced masonry infill walls, mid-rise, out of steel structures
S5HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of steel frame with unreinforced masonry infill walls, high-rise, out of steel structures
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.8 EQ Masonry Specific Building Type Scheme: eqMBldgTypeMp

Identification:	eqMBldgTypeMp
Type:	ESRI Table
Purpose:	eqMBldgTypeMp portrays the percentage of specific masonry building by design level.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
eqCBldgTypeMpId	Text(10)	F	T		General building scheme unique ID
eqSpcBldgSchemesId	Text(30)	F	T		Foreign key to BldgSchemesId field in hzGenBldgSchemes table
DesignLevel	Text(2)	F	F, UC	Null, HC, MC, LC, PC, HS, MS, MS, LS, LS	Building design level. See Appendix C.
RM1LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of reinforced masonry bearing walls with wood or metal deck diaphragms, low-rise, out of masonry structures
RM1MP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of reinforced masonry bearing walls with wood or metal deck diaphragms, mid-rise, out of masonry structures
RM2LP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of reinforced masonry bearing walls with precast concrete diaphragms, high-rise, out of masonry structures
RM2MP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of reinforced masonry bearing walls with precast concrete diaphragms, low-rise, out of masonry structure
RM2HP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of reinforced masonry bearing walls with precast concrete diaphragms, mid-rise, out of masonry structures
URMLP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of unreinforced masonry bearing walls, high-rise, out of masonry structures
URMMP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of unreinforced masonry bearing walls, low-rise,

					out of masonry structures
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.9 EQ Manufactured Homes Specific Building Type Scheme: eqHBldgTypeMp

Identification:	eqHBldgTypeMp
Type:	ESRI Table
Purpose:	eqHBldgTypeMp portrays the percentage of specific manufactured home building by design level.
Data:	

Feature Class Field Definition

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required *	Values	Description
eqCBldgTypeMpId	Text(10)	F	T		General building scheme unique ID
eqSpcBldgSchemesId	Text(30)	F	T		Foreign key to BldgSchemesId field in hzGenBldgSchemes table
DesignLevel	Text(2)	F	F UC	Null, HC, MC, LC, PC, HS, MS, MS, LS, LS	Building design level. See Appendix C.
MHP	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of manufactured home structures

* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase

F.12.3.10 Flood Schemes Catalog: flSchemeInfo

Identification:	flSchemeInfo				
Type:	ESRI Table				
Purpose:	This table holds a list of Flood Model related mapping schemes available in the state. It is a bookkeeping table holding items such as scheme name and date of its creation.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required*	Values	Description
SchemeId	Text(8)	F	T		Building scheme unique ID
SchemeName	Text(50)	F	T		Building scheme name
Created	Date *Date/Time*	F	T		Scheme creation date
Updated	Date *Date/Time*	F	T		Scheme modification date
Editable	Short(2) *Integer(2)*	F	T	0=No 1=Yes	Provides information about if the scheme is editable
Description	*Text(100)*	F	F		Scheme description
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.11 Flood Riverine Scheme: flSchemeRiverin

Identification:	flSchemeRiverine
Type:	ESRI Table
Purpose:	flschemeRiverine portrays the distribution (expressed in percentages) of foundation types (pile, pier, solid wall, etc.) by occupancy with the building's first floor elevation for each foundation type in areas with riverine hazard. Elevation and percentage distribution is provided for pre-FIRM and post-FIRM conditions.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index *	Required *	Values	Description
SchemeId	Text(10)	F	T		Scheme unique ID
SOccup	Text(5)	F	T, UC	RES1, RES2, RES3A, RES3B, RES3C, RES3D, RES3E, RES3F, RES4, RES5, RES6, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, COM10, IND1, IND2, IND3, IND4, IND5, IND6, AGR1, REL1, GOV1, GOV2, EDU1, EDU2	Occupancy type
FoundationType	Text(10)	F	T	Pile, Pier, SolidWall, Basement, Crawl, Fill, Slab	Building foundation type
PreFirmDist	Short(2) *Integer(2)*	F	N	Null or between 0 and 100	Percentage of structures built before FIRM was made for the community
PreFirmHt	Short(2) *Integer(2)*	F	N		Height of first floor of structures built before a FIRM was made for the community
PostFirmDist	Short(2) *Integer(2)*	F	N	Null or between 0 and 100	Percentage of structures built after a FIRM was made for the community

PostFirmHt	Short(2) Integer(2)	F	N		Height of first floor of structures built after FIRM was made for the community
HazardType	Text(1)	F	T	R=Riverine C=Coastal L=Great Lake	Hazard type
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.12 Flood Coastal Scheme: flSchemeCoastal

Identification:	flSchemeCoastal
Type:	ESRI Table
Purpose:	flSchemeCoastal portrays the distribution (expressed in percentages) of foundation types (pile, pier, solid wall, etc.) by occupancy with the building's first floor elevation for each foundation type in areas with coastal hazard. Elevation and percentage distribution is provided for pre-FIRM and post-FIRM conditions
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
SchemeId	Text(10)	F	T		Scheme unique ID
SOccup	Text(5)	F	T, UC	RES1, RES2, RES3A, RES3B, RES3C, RES3D, RES3E, RES3F, RES4, RES5, RES6, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, COM10, IND1, IND2, IND3, IND4, IND5, IND6, AGR1, REL1, GOV1, GOV2, EDU1, EDU2	Occupancy type
FoundationType	Text(10)	F	T	Pile, Pier, Solid Wall, Basement, Crawl, Fill, Slab	Building foundation type
PreFirmDist	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of structures built before FIRM was made for the community
PreFirmHt	Short(2) *Integer(2)*	F	F		Height of first floor of structures built before FIRM was made for the community
PostFirmDistAZone	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of structures built in Zone A after FIRM was made for the community
PostFirmHtAZone	Short(2)	F	F		Height of first floor of structures

	Integer(2)				in Zone A built after FIRM was made for the community
PostFirmDistVZone	Short(2) *Integer(2)*			Null or between 0 and 100	Percentage of structures built in Zone V after FIRM was made for the community
PostFirmHtVZone	Short(2) *Integer(2)*				Height of first floor of structures in Zone V built after FIRM was made for the community
HazardType	Text(1)	F	T	R=Riverine C=Coastal L=Great Lake	Hazard type
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.13 Flood Great Lakes Scheme: flSchemeGLakes

Identification:	flSchemeGLake
Type:	ESRI Table
Purpose:	flSchemeGLake portrays the distribution (expressed in percentages) of foundation types (pile, pier, solid wall, etc.) by occupancy with the building's first floor elevation for each foundation type in Great Lakes area. Elevation and percentage distribution is provided for pre-FIRM and post-FIRM conditions.
Data:	
Feature Class Field Definition	

Name	ESRI Type (Size) *Access Type (Size)*	Index*	Required*	Values	Description
SchemeId	Text(10)	F	T		Scheme unique ID
SOccup	Text(5)	F	T, UC	RES1, RES2, RES3A, RES3B, RES3C, RES3D, RES3E, RES3F, RES4, RES5, RES6, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, COM10, IND1, IND2, IND3, IND4, IND5, IND6, AGR1, REL1, GOV1, GOV2, EDU1, EDU2	Occupancy type
FoundationType	Text(10)	F	T	Pile, Pier, Solid Wall, Basement, Crawl, Fill, Slab	Building foundation type
PreFirmDist	Long(4) *Long Integer(4)*	F	F	Null or between 0 and 100	Percentage of structures built before FIRM was made for the community
PreFirmHt	Long(4) *Long Integer(4)*	F	F		Height of first floor of structures built before FIRM was made for the community
PostFirmDistAZone	Short(2) *Integer(2)*	F	F	Null or between 0 and 100	Percentage of structures built in Zone A after FIRM was made for the community

PostFirmHtAZone	Short(2) *Integer(2)*	F	F		Height of first floor of structures in Zone A built after FIRM was made for the community
PostFirmDistVZone	Short(2) *Integer(2)*			Null or between 0 and 100	Percentage of structures built in Zone V after FIRM was made for the community
PostFirmHtVZone	Short(2) *Integer(2)*				Height of first floor of structures in Zone V built after FIRM was made for the community
HazardType	Text(1)	F	T	R=Riverine C=Coastal L=Great Lake	Hazard type
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.12.3.14 Census Block Scheme Definition: flSchemeMapping

Identification:	flSchemeGLake				
Type:	ESRI Table				
Purpose:	flSchemeMapping assigns scheme type to each census block in a state.				
Data:					
Feature Class Field Definition					
Name	ESRI Type (Size) *Access Type (Size)*	Index *	Require d*	Values	Description
CensusBlock	Text(15)	T, U, A			15 digits of the census block number
SchemeId	Text(10)	F	T		Scheme unique ID
EntryDate	Short(2) *Integer(2)*	F	F		Community FIRM entry date; year is formatted *yyyy* (for instance, 2003)
UDPrePct	Short(2) *Integer(2)*	F	F		
* T=True; F=False; U=Unique; NU=Non-Unique; A=Ascending; D=Descending; UC=Uppercase; LC=Lowercase					

F.13 Acronyms and Abbreviations

AHA	American Hospital Association
BIT	Building-Data Import Tool
CAS	Chemical Abstract Service
EF	Essential Facilities
EOC	Emergency Operation Centers
EPA	Environmental Protection Agency
EQ	Earthquake
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIPS	Federal Information Processing Standard
FIRM	Flood Insurance Rate Map
FL	Flood
GBS	General Building Stock
GIS	Geographic Information System
Hazus-MH MR3	Hazard United States-Multihazard Maintenance Release 3
HPLF	High Potential Loss Facilities
HU	Hurricane
NEHRP	National Earthquake Hazard Reduction Program
POWSAN	Potable Water System Analysis Model
USPS	United States Postal Service

F.14 Classification Systems

Table F.14.1 Site Classes

Site Class	Site Class Description	Shear Wave Velocity (m/sec)	
		Minimum	Maximum
A	Hard Rock Eastern United States sites only	1500	
B	Rock	760	1500
C	Very Dense Soil and Soft Rock Untrained shear strength $u_s \geq 2000$ psf ($u_s \geq 100$ kPa) or $N \geq 50$ blows/ft	360	760
D	Stiff Soils Stiff soil with undrained shear strength 1000 psf $\leq u_s \leq$ 2000 psf (50 kPa $\leq u_s \leq$ 100 kPa) or $15 \leq N \leq 50$ blows/ft	180	360
	Soft Soils Profile with more than 10 ft (3 m) of soft clay defined as soil with plasticity index PI > 20, moisture content w > 40% and undrained shear strength u_s < 1000 psf (50 kPa) (N < 15 blows/ft)		180
F	Soils Requiring Site specific Evaluations 1. Soils vulnerable to potential failure or collapse under seismic loading: e.g. liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays (10 ft (3 m) or thicker layer) 3. Very high plasticity clays: (25 ft (8 m) or thicker layer with plasticity index >75) 4. Very thick soft/medium stiff clays: (120 ft (36 m) or thicker layer)		
Source: 1997 National Earthquake Hazard Reduction Program (NEHRP) Provisions			

Table F.14.2 Structural Building Classifications

No.	Label	Description	Height			
			Range		Typical	
			Name	Stories	Stories	Feet
1	W1	Wood, Light Frame (≤ 5,000 sq.ft.)		1 - 2	1	14
2	W2	Wood, Greater than 5,000 sq. ft.		All	2	24
3	S1L	Steel Moment Frame	Low-Rise	1 - 3	2	24
4	S1M		Mid-Rise	4 - 7	5	60
5	S1H		High-Rise	8+	13	156
6	S2L	Steel Braced Frame	Low-Rise	1 - 3	2	24
7	S2M		Mid-Rise	4 - 7	5	60
8	S2H		High-Rise	8+	13	156
9	S3	Steel Light Frame		All	1	15
10	S4L	Steel Frame with Cast-in-Place Concrete Shear Walls	Low-Rise	1 - 3	2	24
11	S4M		Mid-Rise	4 - 7	5	60
12	S4H		High-Rise	8+	13	156
13	S5L	Steel Frame with Unreinforced Masonry Infill Walls	Low-Rise	1 - 3	2	24
14	S5M		Mid-Rise	4 - 7	5	60
15	S5H		High-Rise	8+	13	156
16	C1L	Concrete Moment Frame	Low-Rise	1 - 3	2	20
17	C1M		Mid-Rise	4 - 7	5	50
18	C1H		High-Rise	8+	12	120
19	C2L	Concrete Shear Walls	Low-Rise	1 - 3	2	20
20	C2M		Mid-Rise	4 - 7	5	50
21	C2H		High-Rise	8+	12	120
22	C3L	Concrete Frame with Unreinforced Masonry Infill Walls	Low-Rise	1 - 3	2	20
23	C3M		Mid-Rise	4 - 7	5	50
24	C3H		High-Rise	8+	12	120
25	PC1	Precast Concrete Tilt-Up Walls		All	1	15
26	PC2L	Precast Concrete Frames with	Low-Rise	1 - 3	2	20

27	PC2M	Concrete Shear Walls	Mid-Rise	4 - 7	5	50
28	PC2H		High-Rise	8+	12	120
29	RM1L	Reinforced Masonry Bearing Wall s with Wood or Metal Deck Diaphragms	Low-Rise	1-3	2	20
30	RM2M		Mid-Rise	4+	5	50
31	RM2L	Reinforced Masonry Bearing Wall s with Precast Concrete Diaphragms	Low-Rise	1 - 3	2	20
32	RM2M		Mid-Rise	4 - 7	5	50
33	RM2H		High-Rise	8+	12	120
34	URML	Unreinforced Masonry Bearing Walls	Low-Rise	1 - 2	1	15
35	URMM		Mid-Rise	3+	3	35
36	MH	Mobile Homes		All	1	10

Table F.14.3 Building Occupancy Classes

Label	Occupancy Class	Example Descriptions
	Residential	
RES1	Single Family Dwelling	House
RES2	Mobile Home	Mobile Home
RES3	Multi Family Dwelling RES3A Duplex RES3B 3-4 Units RES3C 5-9 Units RES3D 10-19 Units RES3E 20-49 Units RES3F 50+ Units	Apartment/Condominium
RES4	Temporary Lodging	Hotel/Motel
RES5	Institutional Dormitory	Group Housing (military, college), Jails
RES6	Nursing Home	
	Commercial	
COM1	Retail Trade	Store
COM2	Wholesale Trade	Warehouse
COM3	Personal and Repair Services	Service Station/Shop
COM4	Professional/Technical Services	Offices
COM5	Banks	
COM6	Hospital	
COM7	Medical Office/Clinic	
COM8	Entertainment & Recreation	Restaurants/Bars
COM9	Theaters	Theaters
COM10	Parking	Garages
	Industrial	
IND1	Heavy	Factory
IND2	Light	Factory

IND3	Food/Drugs/Chemicals	Factory
IND4	Metals/Minerals Processing	Factory
IND5	High Technology	Factory
IND6	Construction	Office
	Agriculture	
AGR1	Agriculture	
	Religion/Non/Profit	
REL1	Church/Non-Profit	
	Government	
GOV1	General Services	Office
GOV2	Emergency Response	Police/Fire Station/EOC
	Education	
EDU1	Grade Schools	
EDU2	Colleges/Universities	Does not include group housing

Table F.14.4 Essential Facilities Classification

Label	Occupancy Class	Description
	Medical Care Facilities	
EFHS	Small Hospital	Hospital with less than 50 Beds
EFHM	Medium Hospital	Hospital with beds between 50 & 150
EFHL	Large Hospital	Hospital with greater than 150 Beds
EFMC	Medical Clinics	Clinics, Labs, Blood Banks
	Emergency Response	
EFFS	Fire Station	
EFPS	Police Station	
EFEO	Emergency Operation Centers	
	Schools	
EFS1	Grade Schools	Primary/ High Schools
EFS2	Colleges/Universities	

Table F.14.5 High Potential Loss Facilities Classification

Label	Description
	Dams
HPDE	Earth
HPDR	Rock fill
HPDG	Gravity
HPDB	Buttress
HPDA	Arch
HPDU	Multi-Arch
HPDC	Concrete
HPDM	Masonry
HPDS	Stone
HPDT	Timber Crib
HPDZ	Miscellaneous
	Nuclear Power Facilities
HPNP	Nuclear Power Facilities
	Military Installations
HPMI	Military Installations

Table F.14.6 Highway System Classification

Label	Description
	Highway Roads
HRD1	Major Roads
HRD2	Urban Roads
	Highway Bridges
HWB1	Major Bridge - Length > 150m (Conventional Design)
HWB2	Major Bridge - Length > 150m (Seismic Design)
HWB3	Single Span – (Not HWB1 or HWB2) (Conventional Design)
HWB4	Single Span – (Not HWB1 or HWB2) (Seismic Design)
HWB5	Concrete, Multi-Column Bent, Simple Support (Conventional Design), Non-California (Non-CA)
HWB6	Concrete, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
HWB7	Concrete, Multi-Column Bent, Simple Support (Seismic Design)
HWB8	Continuous Concrete, Single Column, Box Girder (Conventional Design)
HWB9	Continuous Concrete, Single Column, Box Girder (Seismic Design)
HWB10	Continuous Concrete, (Not HWB8 or HWB9) (Conventional Design)
HWB11	Continuous Concrete, (Not HWB8 or HWB9) (Seismic Design)
HWB12	Steel, Multi-Column Bent, Simple Support (Conventional Design), Non-California (Non-CA)
HWB13	Steel, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
HWB14	Steel, Multi-Column Bent, Simple Support (Seismic Design)
HWB15	Continuous Steel (Conventional Design)
HWB16	Continuous Steel (Seismic Design)
HWB17	PS Concrete Multi-Column Bent, Simple Support - (Conventional Design), Non-California
HWB18	PS Concrete, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
HWB19	PS Concrete, Multi-Column Bent, Simple Support (Seismic Design)
HWB20	PS Concrete, Single Column, Box Girder (Conventional Design)
HWB21	PS Concrete, Single Column, Box Girder (Seismic Design)
HWB22	Continuous Concrete, (Not HWB20/HWB21) (Conventional Design)

HWB23	Continuous Concrete, (Not HWB20/HWB21) (Seismic Design)
HWB24	Same definition as HWB12 except that the bridge length is less than 20 meters
HWB25	Same definition as HWB13 except that the bridge length is less than 20 meters
HWB26	Same definition as HWB15 except that the bridge length is less than 20 meters and Non-CA
HWB27	Same definition as HWB15 except that the bridge length is less than 20 meters and in CA
HWB28	All other bridges that are not classified (including wooden bridges)
	Highway Tunnels
HTU1	Highway Bored/Drilled Tunnel
HTU2	Highway Cut and Cover Tunnel

Table F.14.7 Railway System Classification

Label	Description
	Railway Tracks
RTR1	Railway Tracks
	Railway Bridges
RLB1	Steel, Multi-Column Bent, Simple Support (Conventional Design), Non-California (Non-CA)
RLB2	Steel, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
RLB3	Steel, Multi-Column Bent, Simple Support (Seismic Design)
RLB4	Continuous Steel (Conventional Design)
RLB5	Continuous Steel (Seismic Design)
RLB6	Same definition as HWB1 except that the bridge length is less than 20 meters
RLB7	Same definition as HWB2 except that the bridge length is less than 20 meters
RLB8	Same definition as HWB4 except that the bridge length is less than 20 meters and Non-CA
RLB9	Same definition as HWB5 except that the bridge length is less than 20 meters and in CA
RLB10	All other bridges that are not classified
	Railway Urban Station
RST	Rail Urban Station (with all building type options enabled)
	Railway Tunnels
RTU1	Rail Bored/Drilled Tunnel
RTU2	Rail Cut and Cover Tunnel
	Railway Fuel Facility
RFF	Rail Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)
	Railway Dispatch Facility
RDF	Rail Dispatch Facility (different combinations for with or without anchored components and/or with or without backup power)
	Railway Maintenance Facility
RMF	Rail Maintenance Facility (with all building type options enabled)

Table F.14.8 Light Rail System Classification

Label	Description
	Light Rail Tracks
LTR1	Light Rail Track
	Light Rail Bridges
LRB1	Steel, Multi-Column Bent, Simple Support (Conventional Design), Non-California (Non-CA)
LRB2	Steel, Multi-Column Bent, Simple Support (Conventional Design), California (CA)
LRB3	Steel, Multi-Column Bent, Simple Support (Seismic Design)
LRB4	Continuous Steel (Conventional Design)
LRB5	Continuous Steel (Seismic Design)
LRB6	Same definition as HWB1 except that the bridge length is less than 20 meters
LRB7	Same definition as HWB2 except that the bridge length is less than 20 meters
LRB8	Same definition as HWB4 except that the bridge length is less than 20 meters and Non-CA
LRB9	Same definition as HWB5 except that the bridge length is less than 20 meters and in CA
LRB10	All other bridges that are not classified
	Light Rail Tunnels
LTU1	Light Rail Bored/Drilled Tunnel
LTU2	Light Rail Cut and Cover Tunnel
	DC Substation
LDC1	Light Rail DC Substation w/ Anchored Sub-Components
LDC2	Light Rail DC Substation w/ Unanchored Sub-Components
	Dispatch Facility
LDF	Light Rail Dispatch Facility (different combinations for with or without anchored components and/or with or without backup power)
	Maintenance Facility
LMF	Maintenance Facility (with all building type options enabled)

Table F.14.9 Bus System Classification

Label	Description
	Bus Urban Station
BPT	Bus Urban Station (with all building type options enabled)
	Bus Fuel Facility
BFF	Bus Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)
	Bus Dispatch Facility
BDF	Bus Dispatch Facility (different combinations for with or without anchored components and/or with or without backup power)
	Bus Maintenance Facility
BMF	Bus Maintenance Facilities (with all building type options enabled)

Table F.14.10 Port and Harbor System Classification

Label	Description
	Waterfront Structures
PWS	Waterfront Structures
	Cranes/Cargo Handling Equipment
PEQ1	Stationary Port Handling Equipment
PEQ2	Rail Mounted Port Handling Equipment
	Warehouses
PWH	Port Warehouses (with all building type options enabled)
	Fuel Facility
PFF	Port Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)

Table F.14.11 Ferry System Classification

Label	Description
	Water Front Structures
FWS	Ferry Waterfront Structures
	Ferry Passenger Terminals
FPT	Passenger Terminals (with all building type options enabled)
	Ferry Fuel Facility
FFF	Ferry Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)
	Ferry Dispatch Facility
FDF	Ferry Dispatch Facility (different combinations for with or without anchored components and/or with or without backup power)
	Ferry Maintenance Facility
FMF	Piers and Dock Facilities (with all building type options enabled)

Table F.14.12 Airport System Classification

Label	Description
	Airport Control Towers
ACT	Airport Control Tower (with all building type options enabled)
	Airport Terminal Buildings
ATB	Airport Terminal Building (with all building type options enabled)
	Airport Parking Structures
APS	Airport Parking Structure (with all building type options enabled)
	Fuel Facilities
AFF	Airport Fuel Facility (different combinations for with or without anchored components and/or with or without backup power)
	Airport Maintenance & Hangar Facility
AMF	Airport Maintenance & Hangar Facility (with all building type options enabled)
ARW	Airport Runway
	Airport Facilities - Others
AFO	Gliderport, Seaport, Stolport, Ultralight or Balloonport Facilities
AFH	Heliport Facilities

Table F.14.13 Potable Water System Classification

Label	Description
	Pipelines
PWP1	Brittle Pipe
PWP2	Ductile Pipe
	Pumping Plants
PPPL	Large Pumping Plant (> 50 MGD) [different combinations for with or without anchored components]
PPPM	Medium Pumping Plant (10 to 50 MGD) [different combinations for with or without anchored components]
PPPS	Small Pumping Plant (< 10 MGD) [different combinations for with or without anchored components]
	Wells
PWE	Wells
	Water Storage Tanks (Typically, 0.5 MGD to 2 MGD)
PSTAS	Above Ground Steel Tank
PSTBC	Buried Concrete Tank
PSTGC	On Ground Concrete Tank
PSTGS	On Ground Steel Tank
PSTGW	On Ground Wood Tank
	Water Treatment Plants
PWTL	Large WTP (> 200 MGD) [different combinations for with or without anchored components]
PWTM	Medium WTP (50-200 MGD) [different combinations for with or without anchored components]
PWTS	Small WTP (< 50 MGD) [different combinations for with or without anchored components]

Table F.14.14 Waste Water System Classification

Label	Description
	Buried Pipelines
WWP1	Brittle Pipe
WWP2	Ductile Pipe
	Waste Water Treatment Plants
WWTL	Large WWTP (> 200 MGD) [different combinations for with or without anchored components]
WWTM	Medium WWTP (50-200 MGD) [different combinations for with or without anchored components]
WWTS	Small WWTP (< 50 MGD) [different combinations for with or without anchored components]
	Lift Stations
WLSL	Large Lift Stations (> 50 MGD) [different combinations for with or without anchored components]
WLSM	Medium Lift Stations (10 MGD - 50 MGD) [different combinations for with or without anchored components]
WLSS	Small Lift Stations (< 10 MGD) [different combinations for with or without anchored components]

Table F.14.15 Oil System Classification

Label	Description
	Pipelines
OIP1	Welded Steel Pipe with Gas Welded Joints
OIP2	Welded Steel Pipe with Arc Welded Joints
	Refineries
ORFL	Large Refinery (> 500,000 lb./day) [different combinations for with or without anchored components]
ORFM	Medium Refinery (100,000 - 500,000 lb./ day) [different combinations for with or without anchored components]
ORFS	Small Refinery (< 100,000 lb./day) [different combinations for with or without anchored components]
	Pumping Plants
OPP	Pumping Plant [different combinations for with or without anchored components]
	Tank Farms
OTF	Tank Farms with Anchored Tanks [different combinations for with or without anchored components]

Table F.14.16 Natural Gas System Classification

Label	Description
	Buried Pipelines
NGP1	Welded Steel Pipe with Gas Welded Joints
NGP2	Welded Steel Pipe with Arc Welded Joints
	Compressor Stations
NGC	Compressor Stations [different combinations for with or without anchored components]

Table F.14.17 Electric Power System Classification

Label	Description
	Transmission Substations
ESSL	Low Voltage (115 KV) Substation [different combinations for with or without anchored components]
ESSM	Medium Voltage (230 KV) Substation [different combinations for with or without anchored components]
ESSH	High Voltage (500 KV) Substation [different combinations for with or without anchored components]
	Distribution Circuits
EDC	Distribution Circuits (either Seismically Designed Components or Standard Components)
	Generation Plants
EPPL	Large Power Plants (> 500 MW) [different combinations for with or without anchored components]
EPPM	Medium Power Plants (100 - 500 MW) [different combinations for with or without anchored components]
EPPS	Small Power Plants (< 100 MW) [different combinations for with or without anchored components]

Table F.14.18 Communication Classification

Label	Description
	Central Offices
CCO	Central Offices (different combinations for with or without anchored components and/or with or without backup power)
	Stations or Transmitters
CBR	AM or FM radio stations or transmitters
CBT	TV stations or transmitters
CBW	Weather stations or transmitters

CBO	Other stations or transmitters

15. New Design Level

Design level is a combination of Seismic Design Level and Building Quality and is explicitly considered in the earthquake model. The table below shows how Seismic Design Level and Building Quality are combined to obtain the seven design levels used by the methodology.

New Code	Description	Old Code Combination	
		BldgQuality	DesignLevel
HC	High – Code	Code	High
MC	Moderate - Code	Code	Moderate
LC	Low – Code	Code	Low
PC	Pre – Code	Inferior	Low
HS	Special High – Code	Superior	High
MS	Special Moderate – Code	Superior	Moderate
MS	Special Moderate – Code	Inferior	High
LS	Special Low – Code	Superior	Low
LS	Special Low – Code	Inferior	Moderate

Appendix G. Questionnaire for Assessing Characteristics of Regional Building Stock

Workshop to Evaluate the Design and Construction of Local Region

G.1 Part 1: General Information

Name: ____**Date**: ______

Region or regions you represent: __________________________________

Type of Experience in Region **Number of Years Experience**

(e.g. designer, inspector, planner, plan checker

contractor, etc.)

____	_____________
____	_____________
____	_____________
____	_____________

G.2 Part 2: Specific Design and Construction Practices for the Region

Review the Model Building Types in the Appendix. Do these Model Building Types completely represent the construction types in your region? That is, describe any building types which you cannot map into the Model Building Types.

Which building code is currently in effect in your region? ____________________

Are there building types that are unique to your region or that typify your region (e.g. brownstone, Victorian, adobe block)? Please give a description of these building types and what makes them unique.

Is there a year that you can identify for your region when Unreinforced Masonry (URM) ceased to be built?____________________

Is there a year that you can identify in which Reinforced Masonry (RM) began to be built?

Represent the distribution of construction of RM and URM on the graph below.

When did you start to build Steel Moment Resistant Frames in your region?

____

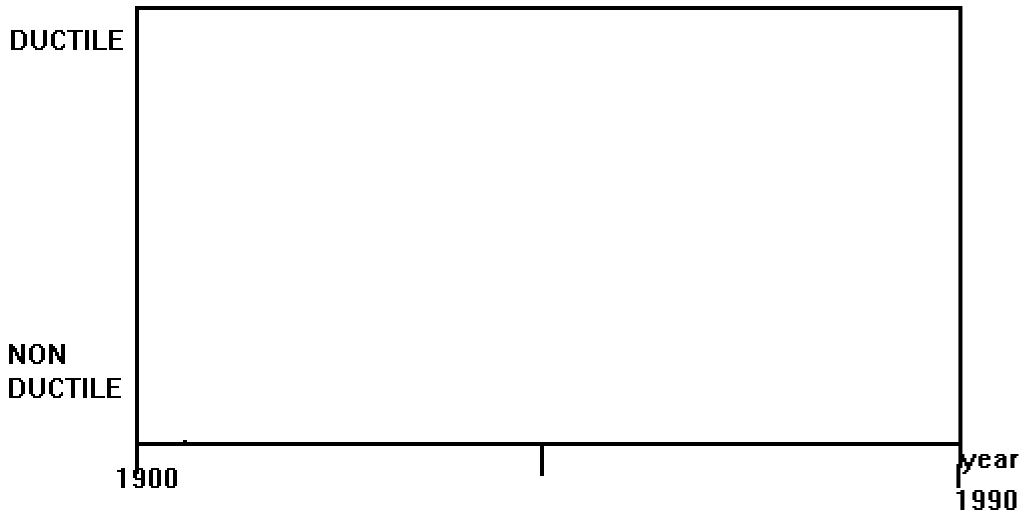
____

When did you start to build ductile concrete in your region?

____

____

What is the distribution of ductile versus non-ductile concrete frames for your region:



When did you stop building steel frames with URM infill walls?

____

____

For high rise structures (8+ stories) in your region can you provide a distribution of structural type over time (steel, concrete, masonry).

For low rise large wholesale/light industrial structures in your region can you provide a distribution of structural type over time (steel, reinforced concrete, masonry, tilt-up, wood).

Reviewing the model building types as described Appendix A, can you identify important "benchmark" years? These would be years when significant code changes occurred in your region so that the performance of the structures, when subjected to natural hazards such as wind earthquake and flood, improved? Some examples might be required bolting of the structure to the foundation, required use of hurricane clips, or improved connection of tilt-up walls to roof diaphragms.

Year	Improvement	Code Requiring Improvement
_______	______________________________	______________________________
_______	______________________________	______________________________
_______	______________________________	______________________________
_______	______________________________	______________________________
_______	______________________________	______________________________
_______	______________________________	______________________________
_______	______________________________	______________________________

Can you identify when significant changes in building practices occurred in your region that effect the calculation of vulnerability of buildings to natural hazards such as wind, earthquake and flood? Some examples might be introduction of a new building type such as tilt-ups, discontinued use of a particular building material, discontinued use of cripple walls, significant housing development during a particular era.

____

The current NIBS/FEMA methodology divides structures into three groups (pre-1950, 1950-1970, post-1970). Based upon your answers to the previous questions does this age breakdown make sense for your region? If not can you suggest something that better reflects the design and construction practices of your region? It can have more than three age groupings.

Is there any other information particular to your region that you feel is important assessing building vulnerability?

G.3 Part3: Occupancy to General Building Type Relationships for the Local Region

For several states in your region as shown below, insurance data suggests that the mix of building types in terms of percentage of total square footage is:

State ____________:

	Wood Frame	Masonry	Rfd. Concrete	Steel	Light Metal	Mobile Home
Residential						
Commercial						

State ____________:

	Wood Frame	Masonry	Rfd. Concrete	Steel	Light Metal	Mobile Home
Residential						

Commercial						

State ____________:

	Wood Frame	Masonry	Rfd. Concrete	Steel	Light Metal	Mobile Home
Residential						
Commercial						

State ____________:

	Wood Frame	Masonry	Rfd. Concrete	Steel	Light Metal	Mobile Home
Residential						
Commercial						

Based upon your experience, do these relationships look reasonable? If not which numbers are you questioning?

____

____

____

Use the table below to enter an improved distribution of building types for each occupancy.

Improved General Occupancy to Building Type Relationship for The Local Region

	Wood Frame	Masonry	Reinforced Concrete	Steel	Light Metal	Mobile Home
Residential						
Commercial						

Occupancy to model building type relationships have been developed for several counties based on the analysis of county assessor's records. The occupancy to model building type relationships are based upon percentage of total square footage for each occupancy. You'll note for certain occupancies such as government and non-profit agencies, assessor's files do not provide adequate information to establish a relationship. The occupancy to model building type relationships are found in the Appendix. Please review the appendix and identify which county best reflects your region.

County ____

Based upon your experience, what distributions do you think need revision?

Occupancy **Problem**

________ _______

Please enter your improved estimates of occupancy to model building type relationships in the tables below.

URBAN

Label	Class	Wood Frame	Steel	Concrete	Masonry	Mobile Home
RES1	Single Family Dwelling					
RES2	Mobile Home					
RES3	Multi Family Dwelling					
RES4	Temporary Lodging					
RES5	Institutional Dormitory					
RES6	Nursing Home					
COM1	Retail Trade					
COM2	Wholesale Trade					
COM3	Personal and Repair Services					
COM4	Professional/Technical Srv					
COM5	Banks					
COM6	Hospital					
COM7	Medical Office/Clinic					
COM8	Entertainment & Recreation					
COM9	Theaters					
COM10	Parking					
IND1	Heavy					
IND2	Light					
IND3	Food/Drugs/Chemicals					
IND4	Metals/Minerals Processing					

IND5	High Technology					
IND6	Construction					
AGR	Agriculture					
REL	Church/Non Profit					
GOV1	General Services					
GOV2	Emergency Services					
ED1	Schools/Libraries					
ED2	Colleges/ Universities					

SUBURBAN

Label	Class	Wood Frame	Steel	Concrete	Masonry	Mobile Home
RES1	Single Family Dwelling					
RES2	Mobile Home					
RES3	Multi Family Dwelling					
RES4	Temporary Lodging					
RES5	Institutional Dormitory					
RES6	Nursing Home					
COM1	Retail Trade					
COM2	Wholesale Trade					
COM3	Personal and Repair Services					
COM4	Professional/Technical Srv					
COM5	Banks					
COM6	Hospital					
COM7	Medical Office/Clinic					
COM8	Entertainment & Recreation					
COM9	Theaters					
COM10	Parking					
IND1	Heavy					
IND2	Light					
IND3	Food/Drugs/Chemicals					
IND4	Metals/Minerals Processing					
IND5	High Technology					
IND6	Construction					

AGR	Agriculture					
REL	Church/Non Profit					
GOV1	General Services					
GOV2	Emergency Services					
ED1	Schools/Libraries					
ED2	Colleges/ Universities					

G.4 Part 4: General to Specific Occupancy Relationship for the Local Region

Based upon your experience, how would steel frames in your region be distributed among the five types listed below?

Steel Frame Distribution by Percentage of Total Square Footage

	Steel Moment Frame	**Steel Braced Frame**	**Steel Light Frame**	**Steel Frame w/ Cast-in-Place Concrete Shear Walls**	**Steel Frame w/ Unreinforced Masonry Infill Walls**	**Other (Specify)**
Low rise						
Mid rise						
High rise						

Confidence: ____

Is there either an age or occupancy factor that would cause you to skew your answers. For example a particular occupancy uses a unique structural type or does not use one of the types listed above. If so state your skewed answer in the table below

Factor Affecting Distribution ___________________________________

Steel Frame Distribution by Percentage of Total Square Footage

	Steel Moment Frame	Steel Braced Frame	Steel Light Frame	Steel Frame w/ CIP Concrete Shear Walls	Steel Frame w/ URM Infill Walls	Other
Low rise						
Mid rise						
High rise						

Factor Affecting Distribution ___________________________________

Steel Frame Distribution by Percentage of Total Square Footage

	Steel Moment Frame	Steel Braced Frame	Steel Light Frame	Steel Frame w/ CIP Concrete Shear Walls	Steel Frame w/ URM Infill Walls	Other
Low rise						
Mid rise						
High rise						

Factor Affecting Distribution ____________________________________

Steel Frame Distribution by Percentage of Total Square Footage

	Steel Moment Frame	Steel Braced Frame	Steel Light Frame	Steel Frame w/ CIP Concrete Shear Walls	Steel Frame w/ URM Infill Walls	Other
Low rise						
Mid rise						
High rise						

Based upon your experience, how would concrete structures in your region be distributed among the five types listed below?

Concrete Distribution by Percentage of Total Square Footage

	Concrete Moment Frames	**Concrete Shear Walls**	**Concrete Frames w/ URM Infill Walls**	**Precast-Concrete Tilt-Up Walls**	**Precast Concrete Frames w/ Concrete Shear Walls**	**Other (Specify)**
Low rise						
Mid rise						
High rise						

Confidence: ____

Is there either an age or occupancy factor that would cause you to skew your answers. For example a particular occupancy uses a unique structural type or does not use one of the types listed above. If so state your skewed answer in the table below

Factor Affecting Distribution ___________________________________

Concrete Distribution by Percentage of Total Square Footage

	Concrete Moment Frames	Concrete Shear Walls	Concrete Frames URM Infill Walls	Precast-Concrete Tilt-Up Walls	Precast Concrete Frames w/ Concrete Shear Walls	Other
Low rise						
Mid rise						
High rise						

Factor Affecting Distribution ___________________________________

Concrete Distribution by Percentage of Total Square Footage

	Concrete Moment Frames	Concrete Shear Walls	Concrete Frames URM Infill Walls	Precast-Concrete Tilt-Up Walls	Precast Concrete Frames w/ Concrete Shear Walls	Other
Low rise						
Mid rise						
High rise						

Factor Affecting Distribution ___________________________________

Concrete Distribution by Percentage of Total Square Footage

	Concrete Moment Frames	Concrete Shear Walls	Concrete Frames URM Infill Walls	Precast-Concrete Tilt-Up Walls	Precast Concrete Frames w/ Concrete Shear Walls	Other
Low rise						
Mid rise						
High rise						

Based upon your experience, how would masonry structures in your region be distributed among the three types listed below?

Masonry Distribution by Percentage of Total Square Footage

	Reinforced Masonry Walls w/ Wood/ Metal Deck Diaphragms	Reinforced Masonry Walls w/ PC Diaphragms	Unreinforced Masonry (URM) Bearing Walls	Other
Low rise				
Mid rise				
High rise				

Confidence: ___________________________________

Is there either an age or occupancy factor that would cause you to skew your answers. For example a particular occupancy uses a unique structural type or does not use one of the types listed above. If so state your skewed answer in the table below

Factor Affecting Distribution ___________________________________

Masonry Distribution by Percentage of Total Square Footage

	Reinforced Masonry Walls w/ Wood/ Metal Deck Diaphragms	Reinforced Masonry Walls w/ PC Diaphragms	Unreinforced Masonry (URM) Bearing Walls	Other
Low rise				
Mid rise				
High rise				

Factor Affecting Distribution ___________________________________

Masonry Distribution by Percentage of Total Square Footage

	Reinforced Masonry Walls w/ Wood/ Metal Deck Diaphragms	Reinforced Masonry Walls w/ PC Diaphragms	Unreinforced Masonry (URM) Bearing Walls	Other
Low rise				
Mid rise				
High rise				

Factor Affecting Distribution ___________________________________

Masonry Distribution by Percentage of Total Square Footage

	Reinforced Masonry Walls w/ Wood/ Metal Deck Diaphragms	Reinforced Masonry Walls w/ PC Diaphragms	Unreinforced Masonry (URM) Bearing Walls	Other
Low rise				
Mid rise				
High rise				

Appendix H. Hazardous Materials Classification and Permit Amounts

The most widely used detailed classification scheme is the one that has been developed by the National Fire Protection Association, and is presented in the 1991 Uniform Fire Code, among other documents. This classification scheme is shown in Table H1. Sixty material types have been defined (HM01 to HM60). The hazards posed by the various materials are divided into two major categories: Physical Hazards and Health Hazards. Depending upon the exact nature of the hazard, these two major categories are divided into subcategories. Examples are poison, carcinogen, mildly toxic, moderately toxic or skin irritant. These subcategories of hazards, with their definitions, and examples of materials that fall within each category, are contained in Appendix 11A and 11B of the Technical Manual. A more detailed description of these categories, with more extensive examples can be found in Appendix VI-A of the 1991 Uniform Fire Code.

Table H1 also contains minimum quantities of the materials that must be on site to require permitting according to the Uniform Fire Code. It should be noted that the minimum permit quantities may vary depending upon whether the chemical is stored inside or outside of a building. For facilities that have hazardous materials, but in quantities less than those listed in Table H1, it is anticipated that releases of these small quantities will not put significant immediate demands on health and emergency services, thus you may wish to exclude them from the database.

Table H1 Classification of Hazardous Materials and Permit Amounts

Label	Material Type	Permit Amount		Hazard Type
		Inside Building	Outside Building	Remarks
HM01	Carcinogens	10 lbs	10 lbs	Health
HM02	Cellulose nitrate	25 lbs	25 lbs	Physical
HM03	Combustible fibers	100 cubic ft	100 cubic ft	Physical
	Combustible liquids			Physical
HM04	Class I	5 gallons	10 gallons	
HM05	Class II	25 gallons	60 gallons	
HM06	Class III-A	25 gallons	60 gallons	
HM07	Corrosive gases	Any amount	Any amount	Health [1]
HM08	Corrosive liquids	55 gallons	55 gallons	Physical; Health
	Cryogens			
HM09	Corrosive	1 gallon	1 gallon	Health
HM10	Flammable	1 gallon	60 gallons	Physical
HM11	Highly toxic	1 gallon	1 gallon	Health
HM12	Nonflammable	60 gallons	500 gallons	Physical
HM13	Oxidizer (including oxygen)	50 gallons	50 gallons	Physical
HM14	Highly toxic gases	Any amount	Any amount	Health; [1]
HM15	Highly toxic liquids & solids	Any amount	Any amount	Health
HM16	Inert	6,000 cubic ft	6,000 cubic ft	Physical; [1]
HM17	Irritant liquids	55 gallons	55 gallons	Health
HM18	Irritant solids	500 lbs	500 lbs	Health
HM19	Liquefied petroleum gases	> 125 gallons	> 125 gallons	Physical
HM20	Magnesium	10 lbs	10 lbs	Physical
HM21	Nitrate film	(Unclear)	(Unclear)	Health
HM22	Oxidizing gases (including oxygen)	500 cubic feet	500 cubic feet	Physical [1]
	Oxidizing liquids			Physical
HM23	Class 4	Any amount	Any amount	
HM24	Class 3	1 gallon	1 gallon	
HM25	Class 2	10 gallons	10 gallons	
HM26	Class 1	55 gallons	55 gallons	
	Oxidizing solids			Physical
HM27	Class 4	Any amount	Any amount	
HM28	Class 3	10 lbs	10 lbs	
HM29	Class 2	100 lbs	100 lbs	
HM30	Class 1	500 lbs	500 lbs	
	Organic peroxide liquids and solids			Physical
HM31	Class I	Any amount	Any amount	
HM32	Class II	Any amount	Any amount	
HM33	Class III	10 lbs	10 lbs	
HM34	Class IV	20 lbs	20 lbs	
	Other health hazards			Health
HM35	Liquids	55 gallons	55 gallons	
HM36	Solids	500 lbs	500 lbs	
HM37	Pyrophoric gases	Any amount	Any amount	Physical [1]
HM38	Pyrophoric liquids	Any amount	Any amount	Physical

HM39	Pyrophoric solids	Any amount	Any amount	Physical
HM40	Radioactive materials	1 m Curie in unsealed source	1 m Curie in sealed source	Health [1]
HM41	Sensitizer, liquids	55 gallons	55 gallons	Health
HM42	Sensitizer, solids	500 lbs	500 lbs	Health
HM43	Toxic gases	Any amount	Any amount	Health [1]

Table H1 Classification of Hazardous Materials and Permit Amounts (Cont.)

Label	**Material Type**	**Permit Amount**		**Hazard Type**
		Inside Building	**Outside Building**	**Remarks**
HM44	Toxic liquids	50 gallons	50 gallons	Health
HM45	Toxic solids	500 lbs	500 lbs	Health
HM46	Unstable gases (reactive)	Any amount	Any amount	Physical[1]
	Unstable liquids (reactive)			Physical
HM47	Class 4	Any amount	Any amount	
HM48	Class 3	Any amount	Any amount	
HM49	Class 2	5 gallons	5 gallons	
HM50	Class 1	10 gallons	10 gallons	
	Unstable solids (reactive)			Physical
HM51	Class 4	Any amount	Any amount	
HM52	Class 3	Any amount	Any amount	
HM53	Class 2	50 lbs	50 lbs	
HM54	Class 1	100 lbs	100 lbs	
	Water-reactive liquids			Physical
HM55	Class 3	Any amount	Any amount	
HM56	Class 2	5 gallons	5 gallons	
HM57	Class 1	10 gallons	10 gallons	
	Water-reactive solids			Physical
HM58	Class 3	Any amount	Any amount	
HM59	Class 2	50 pounds	50 pounds	
HM60	Class 1	100 pounds	100 pounds	

[1] Includes compressed gases

Appendix I. Glossary of Terms

Attenuation Relationship - A relationship that describes how ground motions (acceleration and velocities) decrease as a function of distance from the earthquake source.

Building Period - Buildings tend to shake at different speeds. The period tells us how long it takes for a building to shake back and forth one time. Tall buildings have longer periods on the order of 1 to 4 seconds. Short buildings move back and forth very rapidly and have periods on the order of 0.1 to 0.4 seconds. The building frequency is also a measure of the speed at which a building shakes.

Building Frequency - The building frequency is the reciprocal of the period, that is it is a measure of how many times the building shakes back and forth every second. If a building has a period of 2 seconds, its frequency is 0.5 Hz (cycles per second).

CAS - Chemical Abstracts Service registry number. This is a numeric designation assigned by the American Chemical Society's Chemical Abstracts Service that uniquely identifies a specific chemical compound.

Damage Ratio - Cost of repair as a fraction of replacement cost.

Direct Economic Loss - In this methodology the costs of structural and non-structural repair, damage to building contents, loss of building inventory, relocation expenses, lost wages and lost income.

GIS (geographic information system) - Software tool for displaying, analyzing and manipulating spatially related data. Data is stored in layers which can be overlaid and combined to map data.

Hazus - A software package developed to estimate losses estimates due to natural hazards for the United States. The name is derived from *Hazards U.S.*

Indirect Economic Loss - In this methodology the long-term regional economic effects.

Liquefaction - A phenomenon where due to shaking, soil losses its strength and essentially acts like a liquid.

MMI (Modified Mercalli Intensity) - A system for measuring the damage that occurs in an earthquake. The scale is measured from I to XII. A I is not felt by people and a XII causes essentially total damage to the built environment.

NEHRP -National Earthquake Hazards Reduction Program

PESH (potential earth science hazards) - In this methodology PESH is that group of physical attributes and consequences that describe the potential damageability of the earthquake. These include the ground motion (PGA, PGV, spectral acceleration, spectral velocity), ground failure (liquefaction, landslide and surface fault rupture), tsunami and seiche.

PGA - Peak Ground Acceleration. The largest acceleration that can be expected at a particular site due to an earthquake.

PGD - Permanent Ground Deformation - This is a quantification of the ground failure that occurs as a result of liquefaction, landslides and surface fault rupture. It is measured in inches and describes how far the surface of the ground moves.

PGV - Peak Ground Velocity

Seiche - Waves in a lake or reservoir that are induced because of ground shaking.

Shear Waves - Shear waves (S waves) are one of the many types of waves that are generated by an earthquake. Each type of wave shakes the ground differently (some fast, some slow, some up and down, some sideways).

Shear Wave Velocity - Shear waves travel through different types of soils at different velocities (speeds). Shear wave travel more quickly through rock and hard soils and more slowly through soft soils. The shear wave velocity can then be used as a measure of the type of soil.

Spectral Acceleration - The acceleration of earthquake motion at a specified building period. See definition of spectral velocity

Spectral Velocity - The velocity of earthquake motion at a specified building period. Earthquake shaking is a complex mixture of movements at different frequencies. Some of the shaking is fast and some of it is slow. Different buildings respond to different types of shaking. Short buildings tend to respond to fast shaking and tall buildings respond to slower shaking. Thus if an earthquake has a lot of fast shaking we would expect it to excite low rise buildings. By breaking apart the earthquake shaking and looking at one part at a time, in terms of building period, we can see which buildings will experience higher levels of motion.

Thematic Map - A map that uses color, patterns and/or symbols to graphically represent characteristics of a set of data. Graphical representations include shaded ranges, shaded individual values, bar charts, pie charts, graduated symbols and dot density.

TIGER files- Topologically Integrated Geographic Encoding and Referencing system. This is a system developed by the U.S. Census Bureau that can be used for inventory development. Files contain roads, streets, railways, waterways and census boundaries. See Section 6.8.5.

Tsunami - Tsunami translates as “harbor wave.” These ocean waves can be caused by the direct effects of subduction earthquake and the secondary effects of earthquake triggered submarine landslides. Their heights can be greater than 10 meters.

Appendix J: GeoDatabase based Shake Maps

J.1 Introduction

J.1.1 Purpose

The goal of the document is to show how the USGS Shake Maps (based on shp files) could be converted into GeoDatabase based Shake Maps.

J.1.2 Scope

This document describes how SHP file based Shake Maps could be converted into GeoDatabase based Shake Maps in a step by step way. The focus is entirely on what is important to make the new GeoDatabases work with Hazus-MH. This document should not be used as a resource for converting SHP files to GeoDatabases.

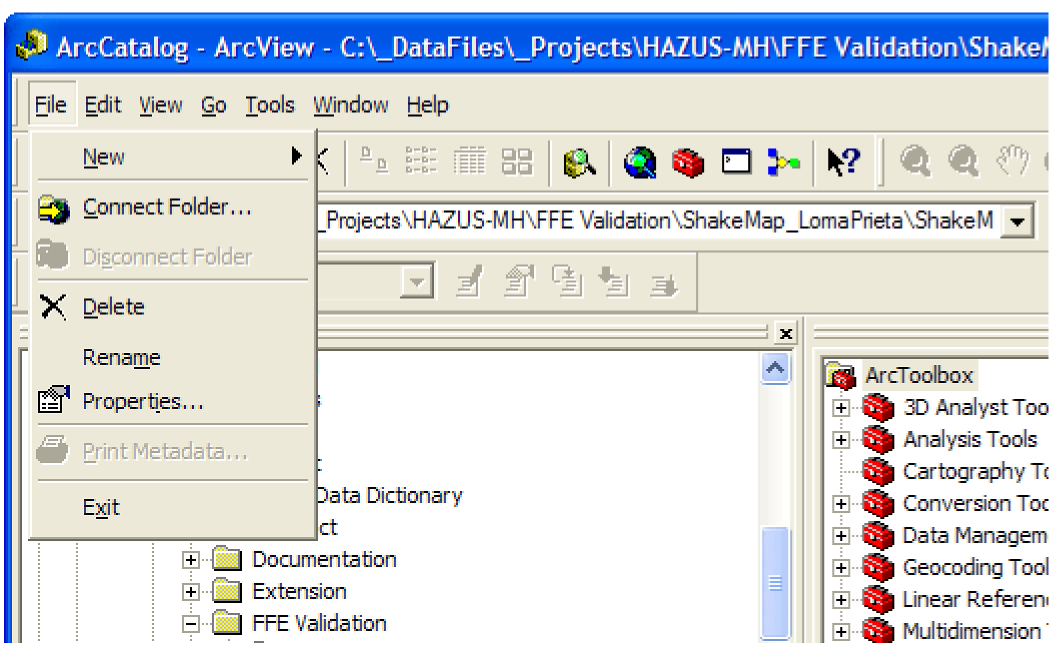
J.2 Prerequisites

ArcGIS 9.3 or later (ArcMap and ArcCatalog) should be installed on the computer.

J.3 Creating GeoDatabase based Shake Maps

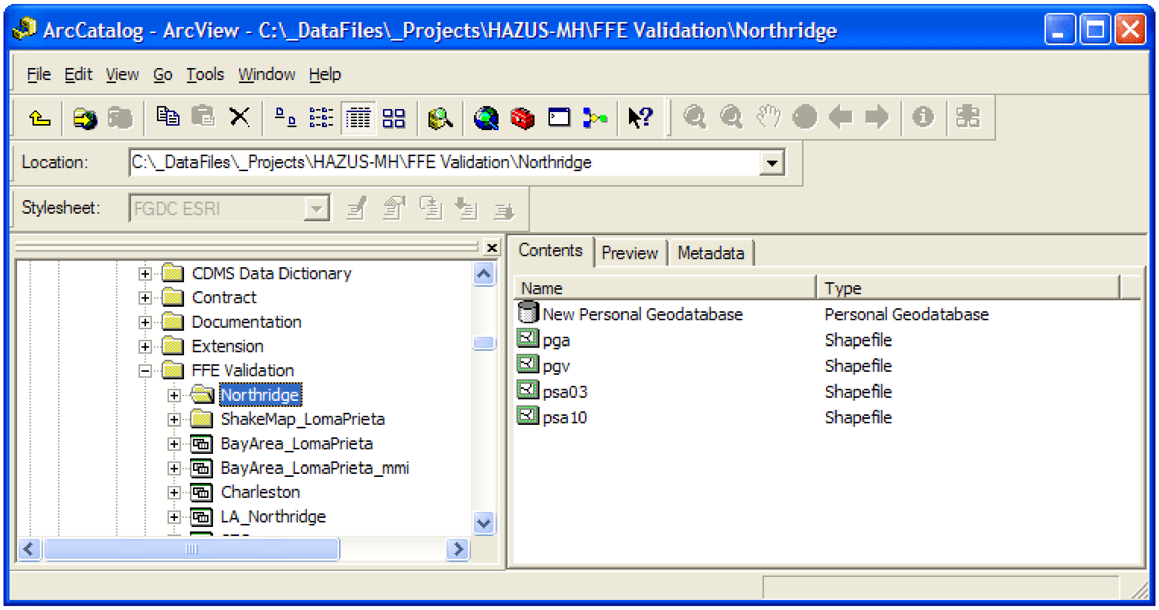
1) Launch ArcCatalog from the Start menu.

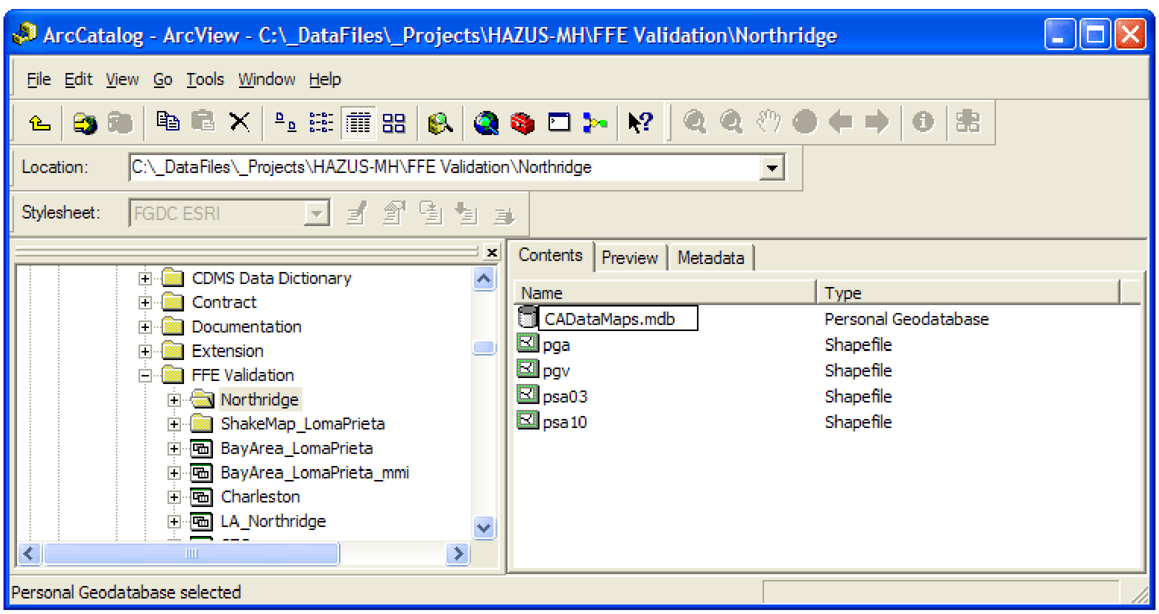
2) Click on the folder where the new Geogatabase is to be created. In case the folder is not available in ArcCatalog click on **File>Connect Folder** menu and select the folder where the Geodatabase is to be created. Once OK button is pressed on that dialog the folder will be visible in ArcCatalog.



3) Select the folder in TOC in ArcCatalog where the geodatabase is to be created (the one added in the above step), Click on **File>New>Personal Geodatabase** menu to create the new personal geodatabase. By default the name appears as "New Personal Geodatabse"

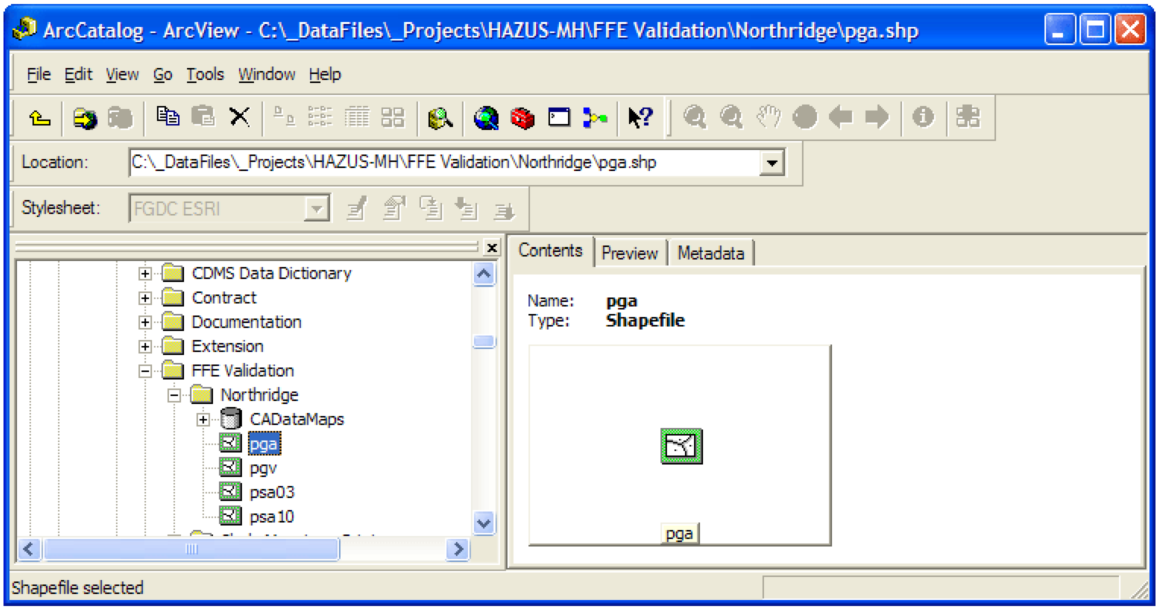
Change the name using F2 key to what you want for example "CaDataMaps"



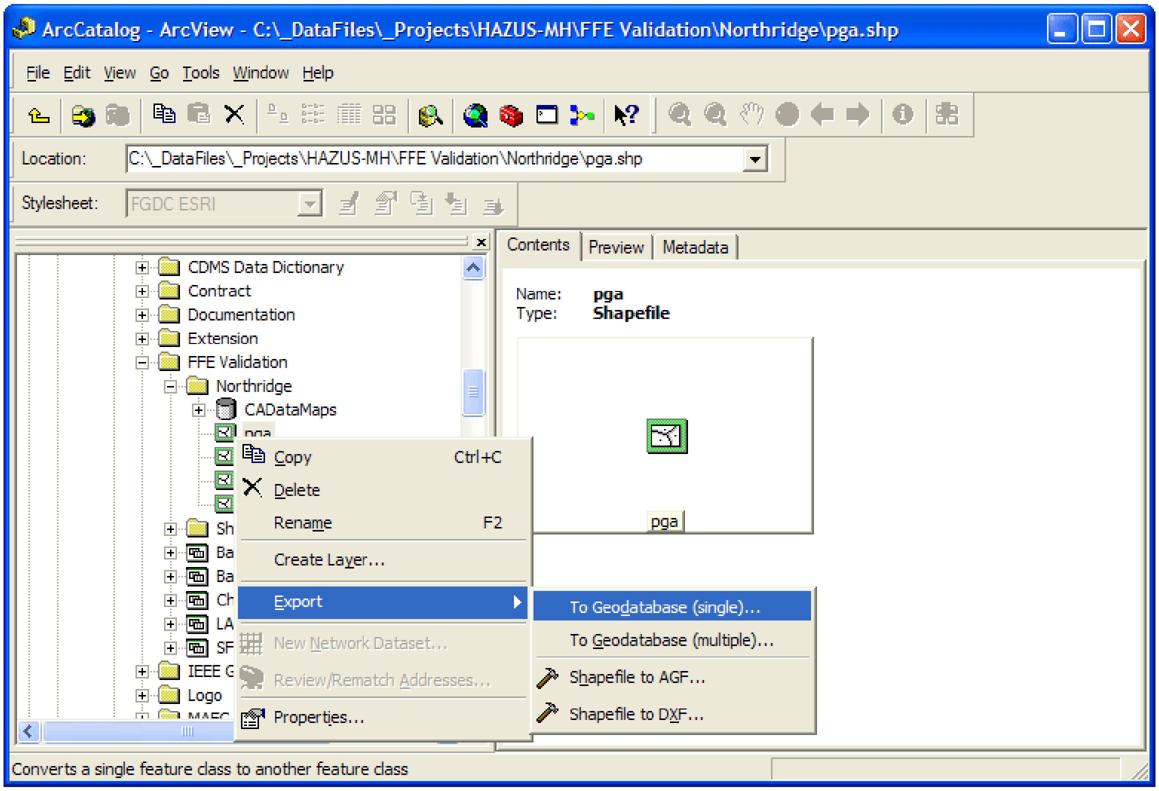


4) Select the folder where the shake maps are located in ArcCatalog's TOC. If the folder is not available in the TOC click on **File>Connect Folder** menu and select the folder where the shake maps are located, press the OK button and the folder will be visible in ArcCatalog's TOC.

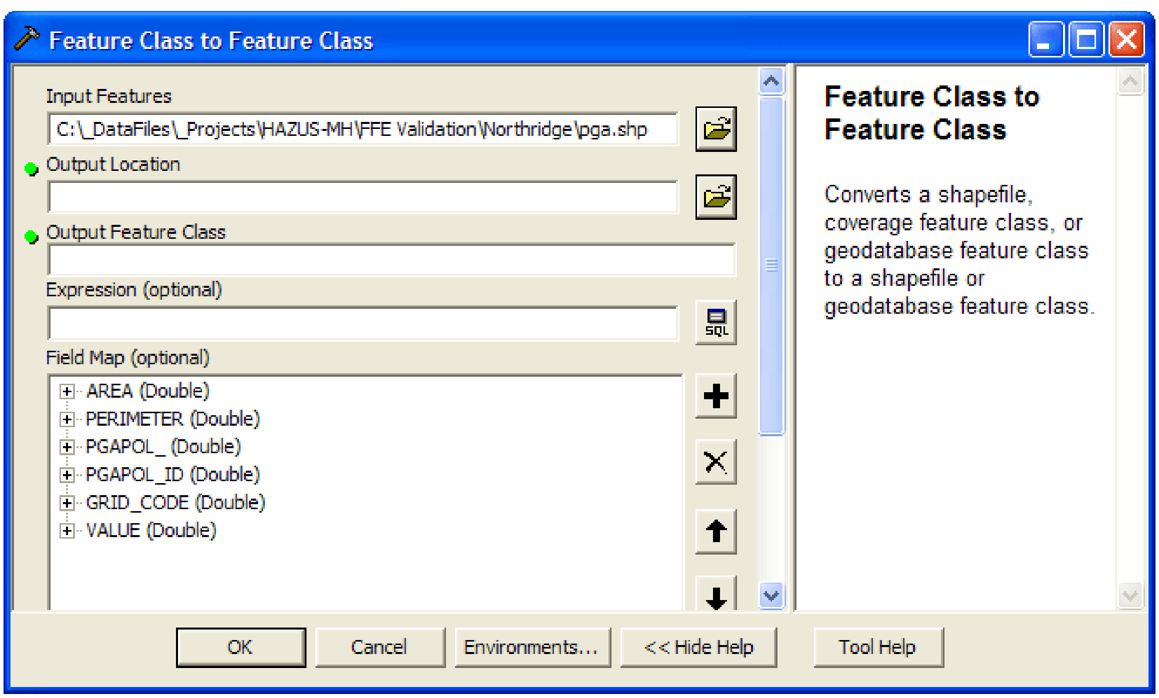
5) Select the Shape file which is to be exported under the connected folder in TOC as shown below:



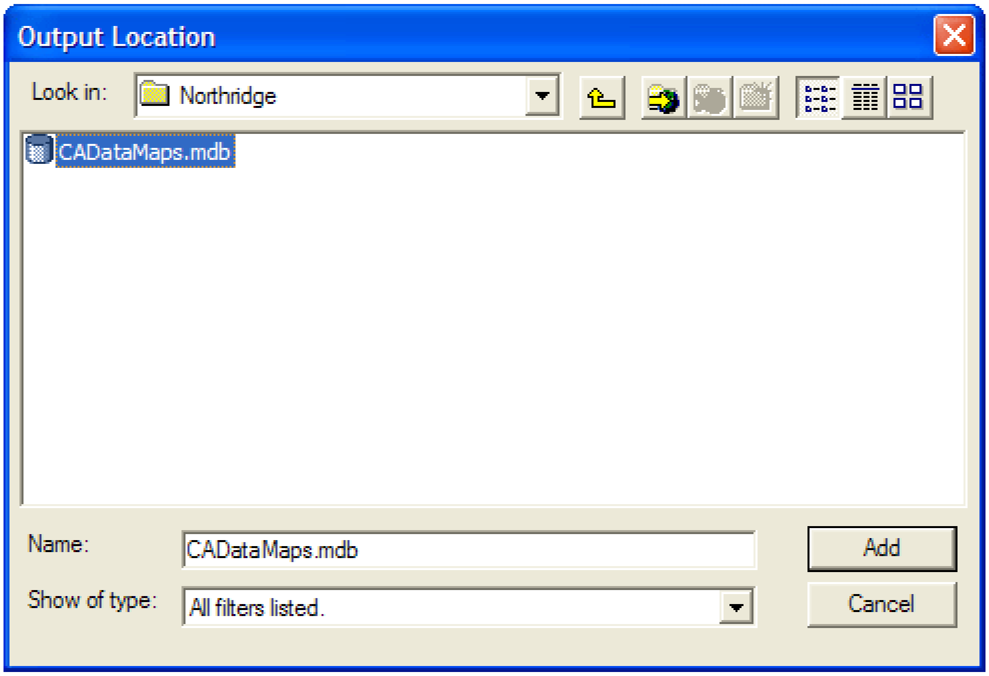
6) Right click and select first option under Export **To geodatabase (single)…** as shown



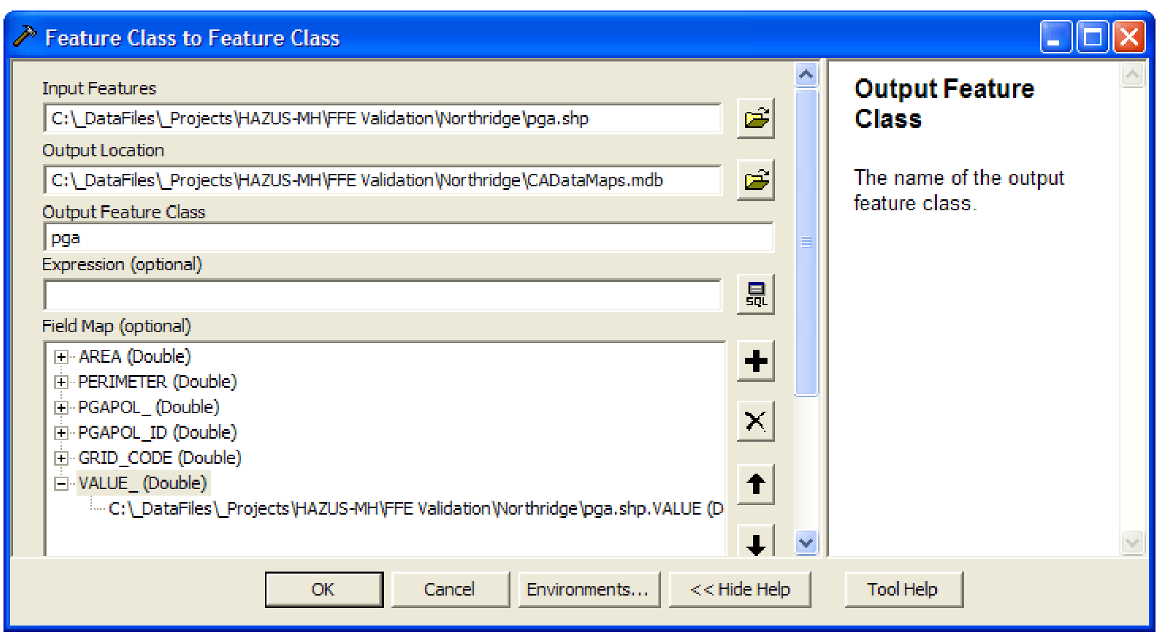
7) The Export option will show the following dialog



8) Click on the browse button for the **Output Location** and select the geodatabase created in step 3.



Give the output feature class a name. In our example, since we are importing PGA data, we gave the feature class the name **pga**



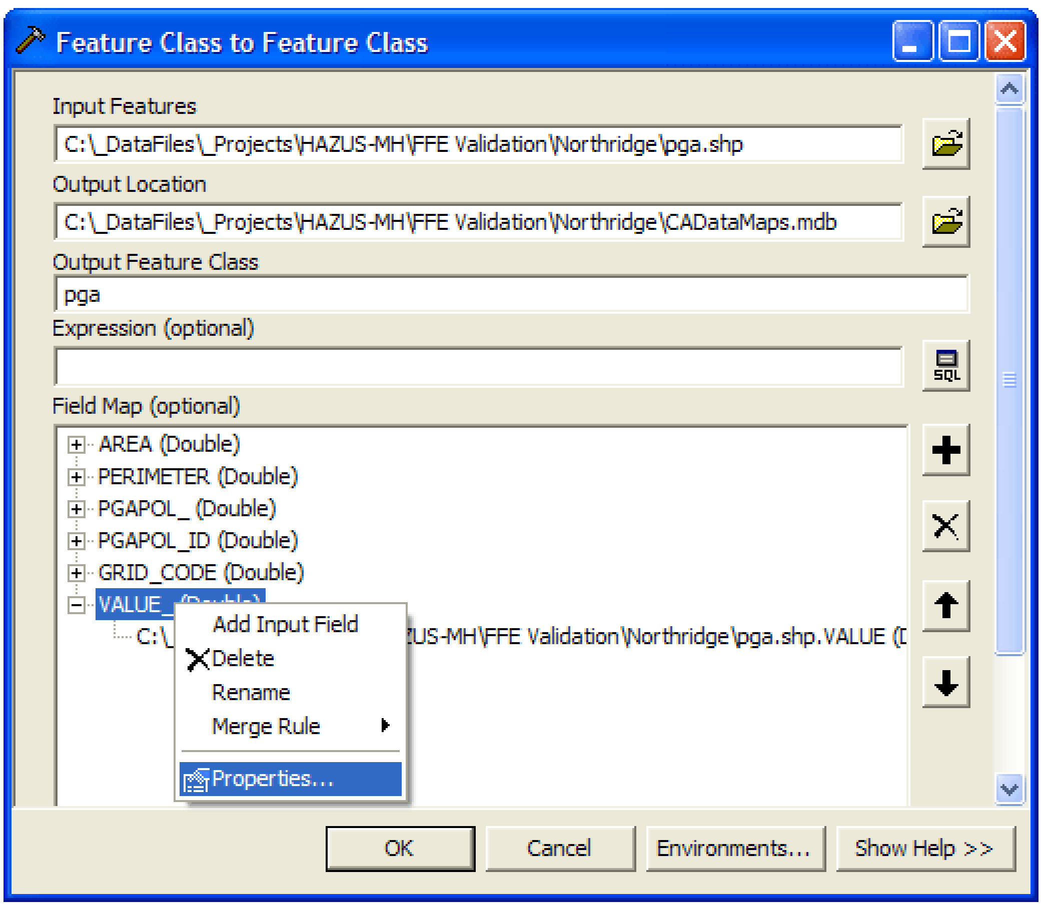
9) The **Field Map (optional)** listbox shows the fields in the input file. Minimal shake maps input requirements in Hazus-MH are the spatial object and the value associated with it. Other fields can be kept in the input file but are not required.

As shown below, Hazus-MH always expects the value field to be named ParamValue.

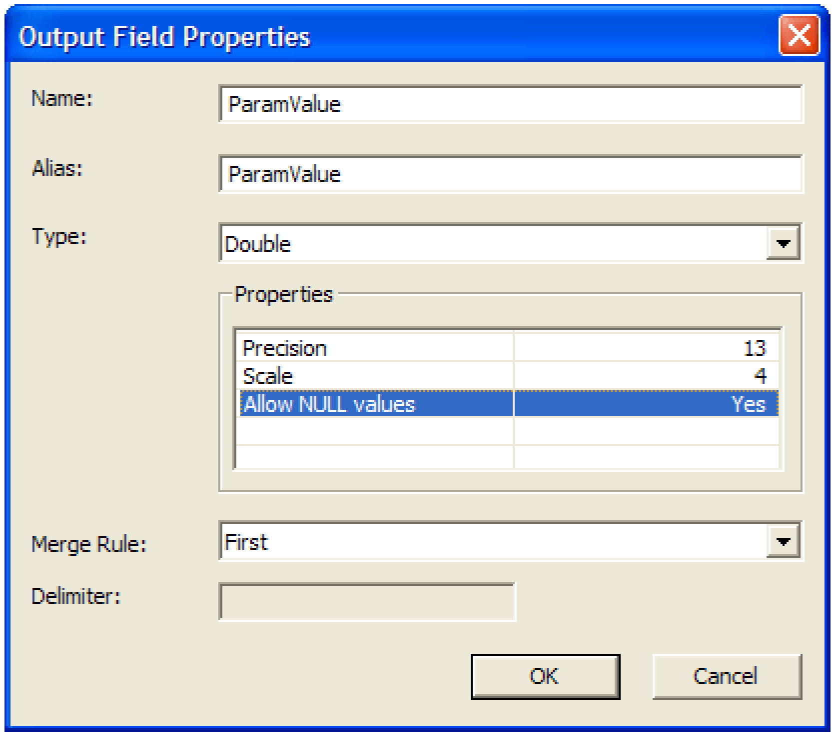
Type of Map	Correct Field Name	Field Type	Valid Values
All user defined Scenario Maps (Shake Maps)	ParamValue	Decimal	Values must be Greater than 0

So in our example the **VALUE_** field is the field that has the pga value, and it needs to be renamed.

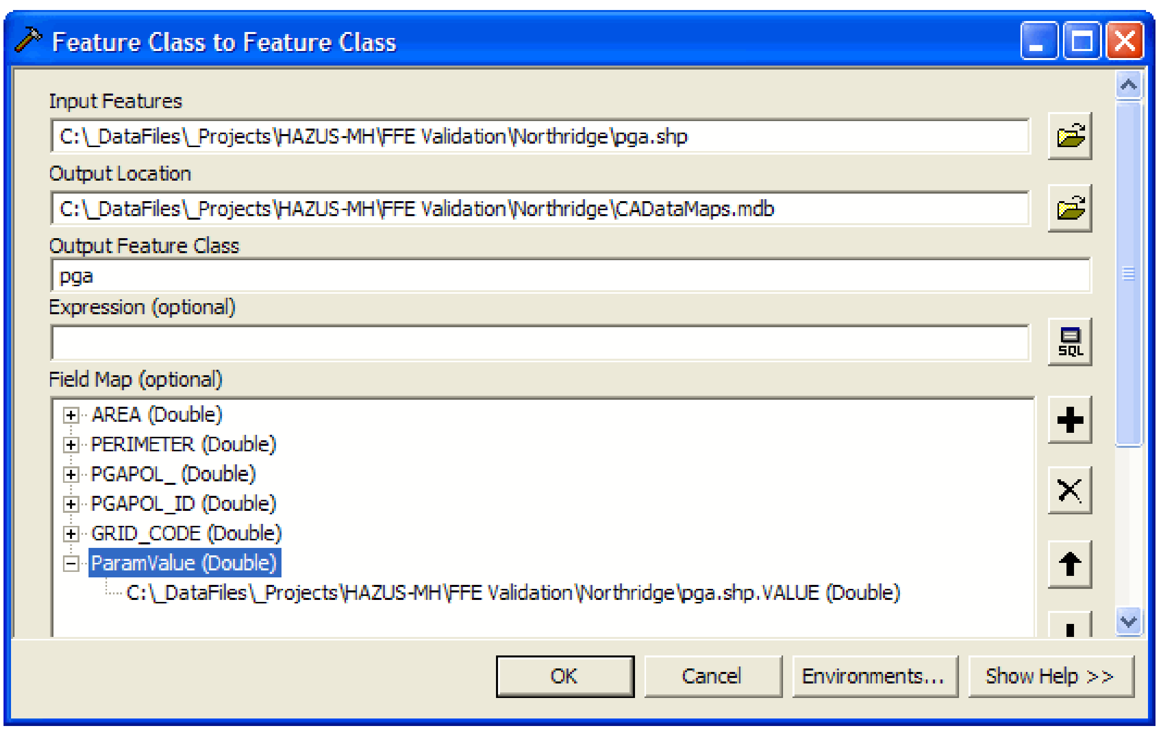
10) Right-click the field VALUE_, and select Properties.



Edit the entries as follows:



11) Now Click OK.

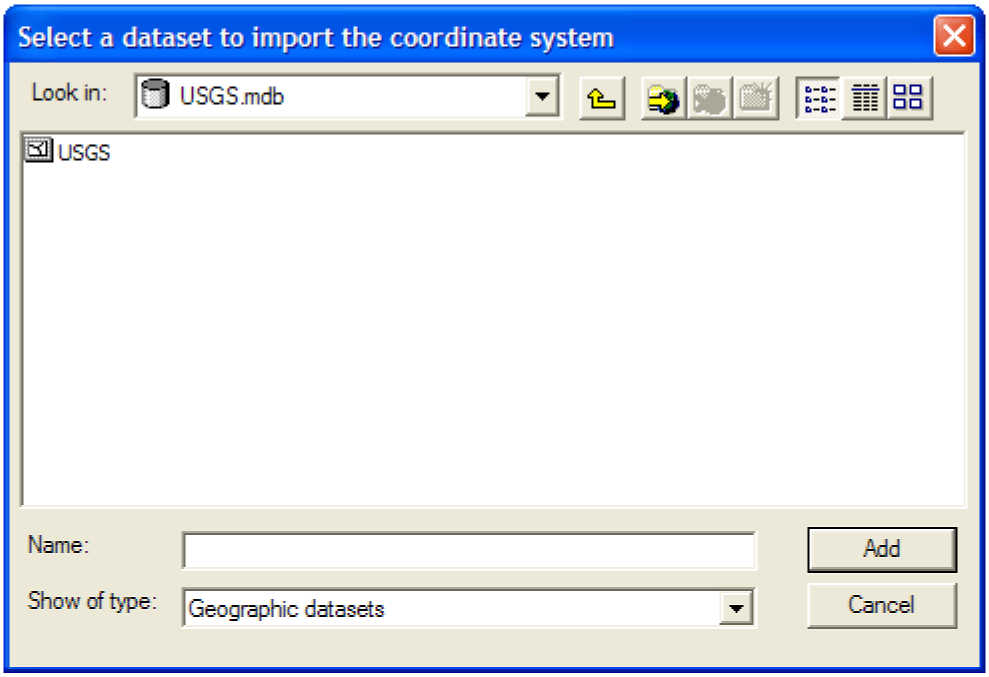


12) Click the **Environments…** button.

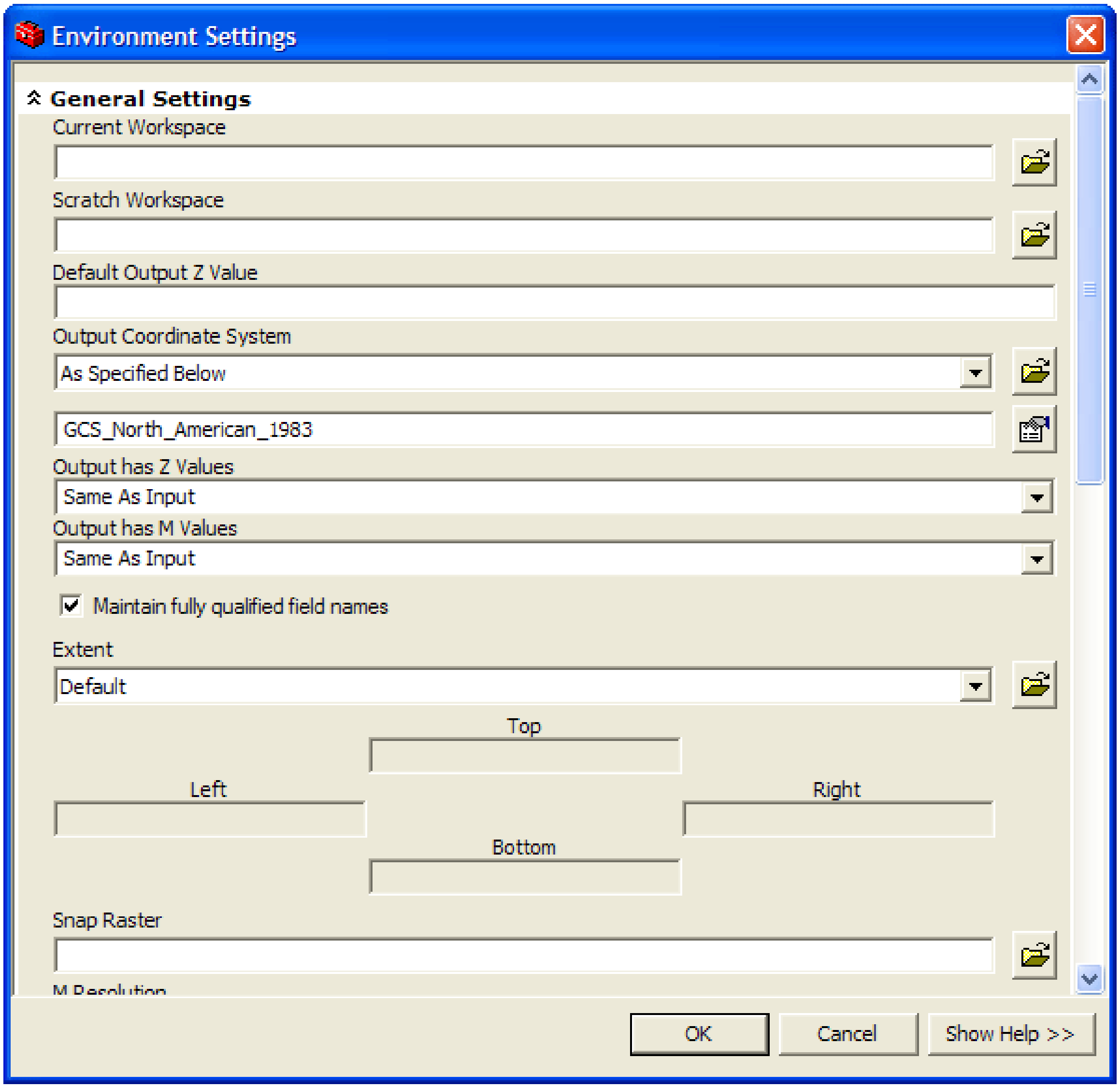
13) Select General Settings and click the browse button for the **Output Coordinate System**

14) Navigate to the <HAZUS-MH>\DATA folder and select "USGS.MDB" and then select USGS feature class.

NOTE: <HAZUS-MH> represents the folder where Hazus-MH is installed (by default, it is c:\Program Files\HAZUS-MH).

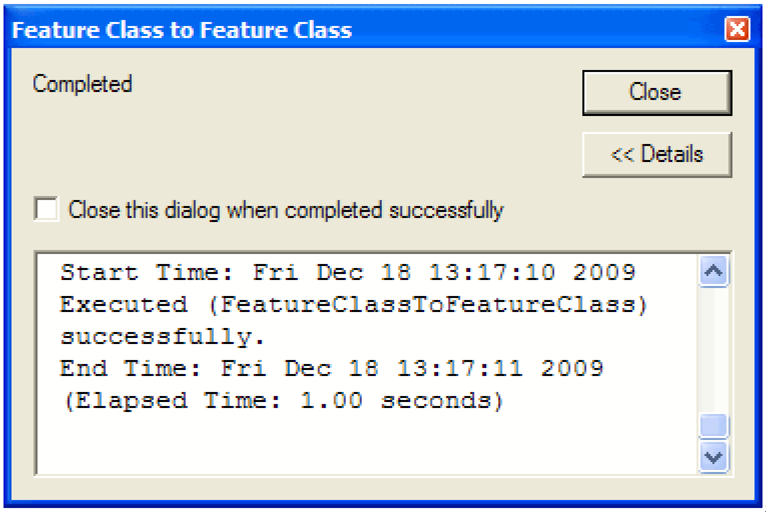


15) Click Add. The **Environment Settings** dialog should look like the following:



Click OK.

16) Click OK again. The conversion process starts showing a progress bar, and when done, the following dialog is shown.



,

17) Click Close. The conversion process is complete. Now the CADatamaps.mdb data can be used in Hazus-MH as a user-defined hazard.

Appendix K: GeoDatabase based Hazard Data Maps

K.1 Introduction

K.1.1 Purpose

The goal of the document is to show how the Hazard (Soil, Liquefaction, Landslide and Water Depth) Maps based on shp files could be converted into GeoDatabase based Hazard Maps.

K.1.2 Scope

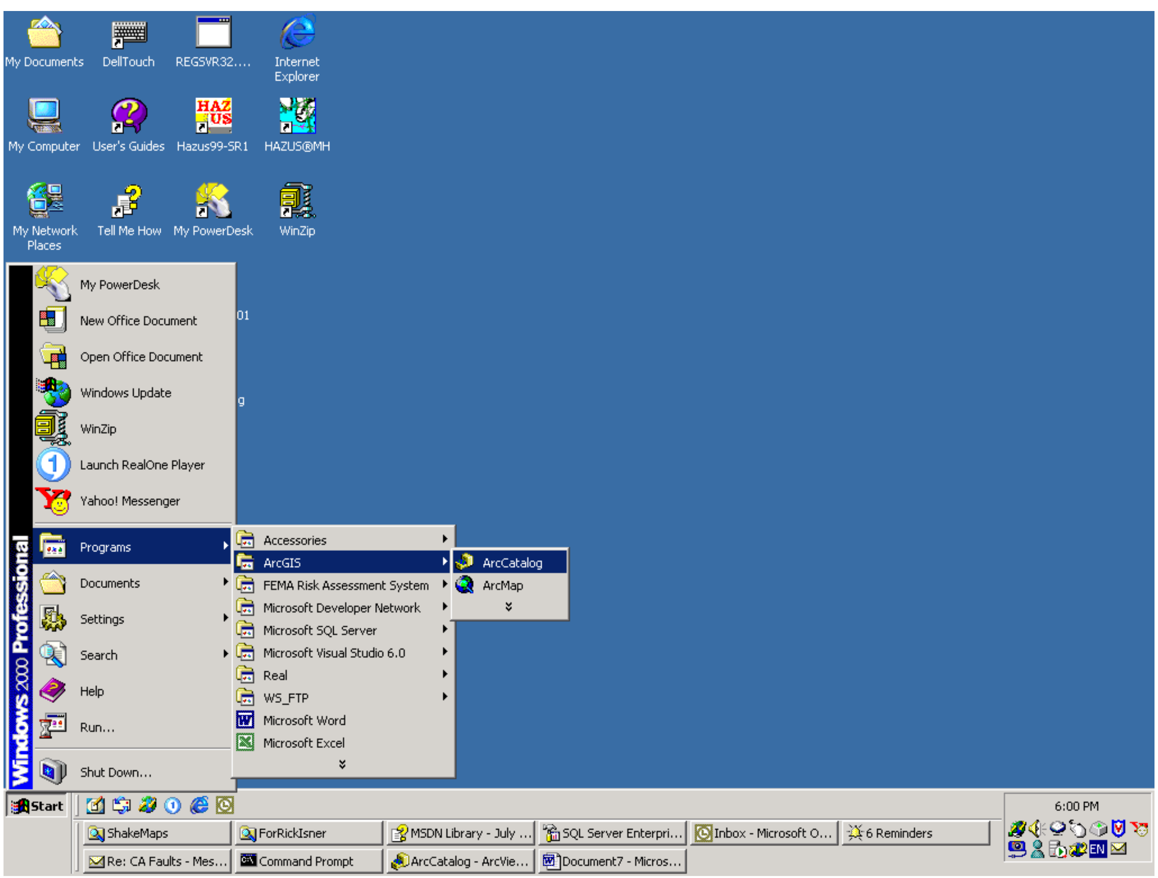
This document describes how SHP file based Hazard Maps could be converted into GeoDatabase based Hazard Maps in a step by step way. The focus is entirely on what is important to make the new GeoDatabases work with Hazus-MH. This document should not be used as a resource for converting SHP files to GeoDatabases.

K.2 Prerequisites

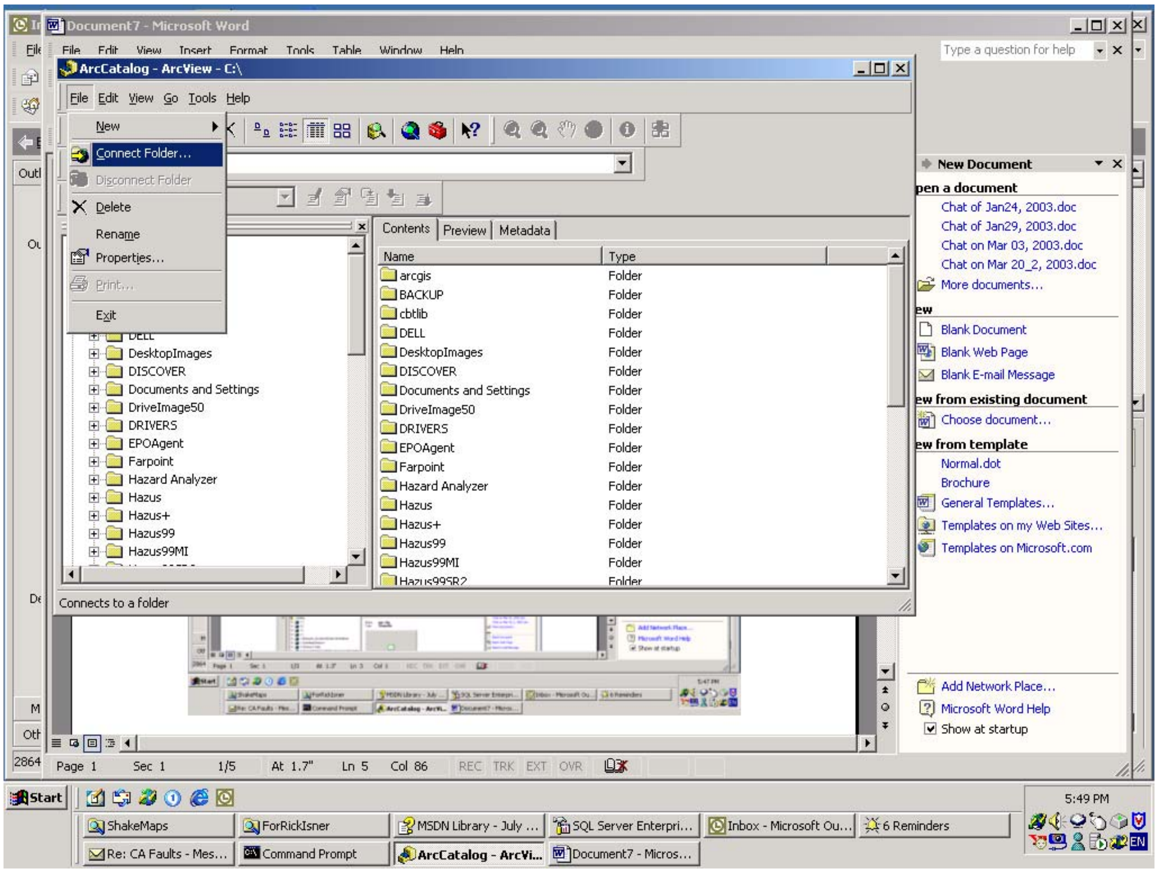
ArcGIS 9.3 (ArcMap and ArcCatalog) should be installed on the computer.

K.3 Creating GeoDatabase based Hazard Data Maps

1) Launch ArcCatalog from the Start menu.

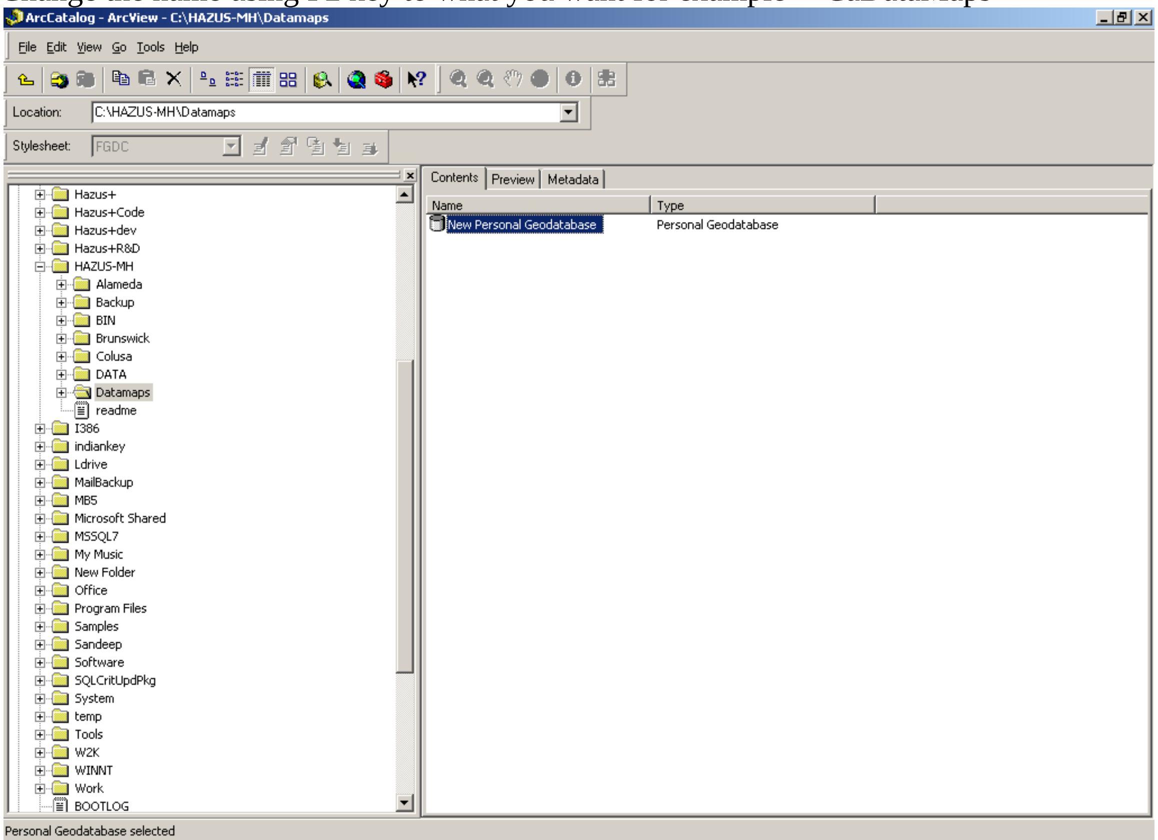


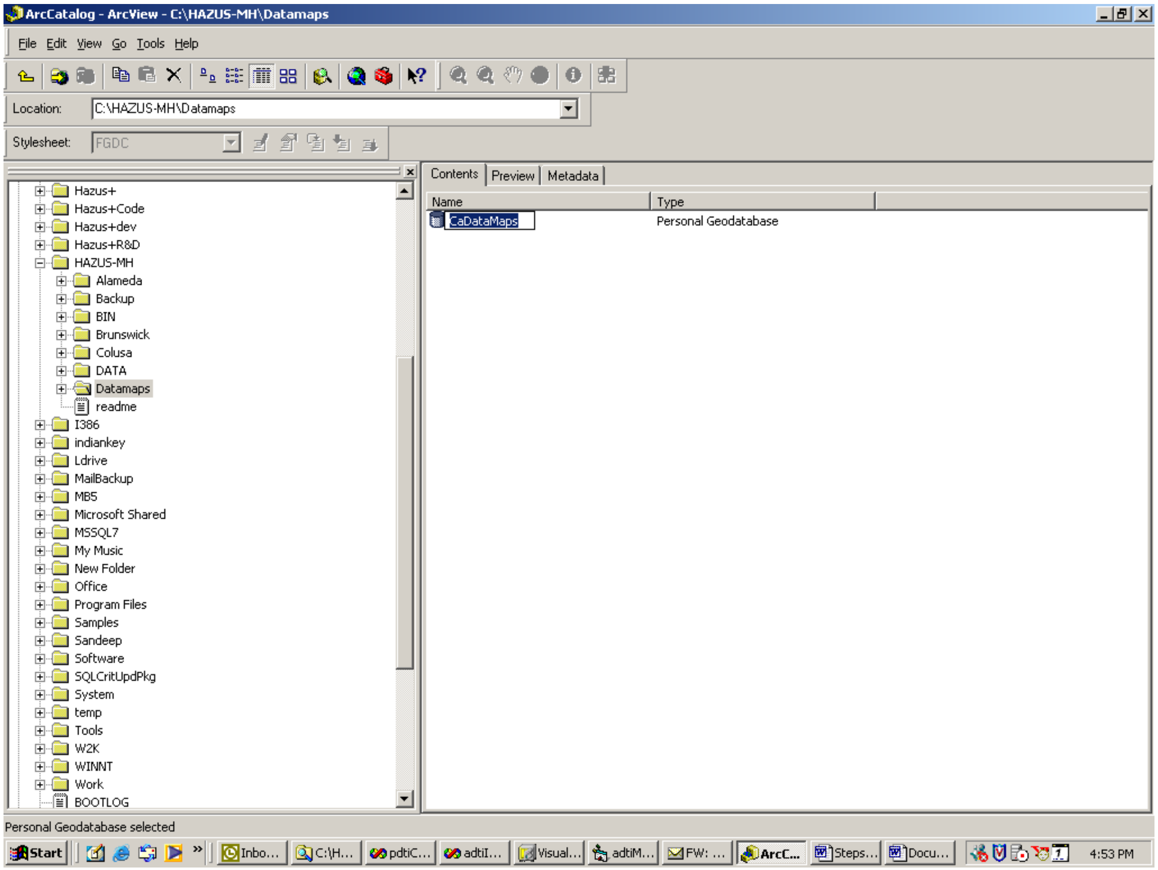
2) Click on the folder where the new Geo-Database is to be created. In case the folder is not available in ArcCatalog click on **File>Connect Folder** menu and select the folder where the Geo-Database is to be created. Once OK button is pressed on that dialog the folder will be visible in ArcCatalog



3) Select the Folder in TOC of the Arc catalog where the Geo-Database is to be created (the one added in the above step), Click on **File>New>Personal GeoDatabase** menu to create the new personal geodatabase.
By default the name appears as "New Personal Geodatabse"

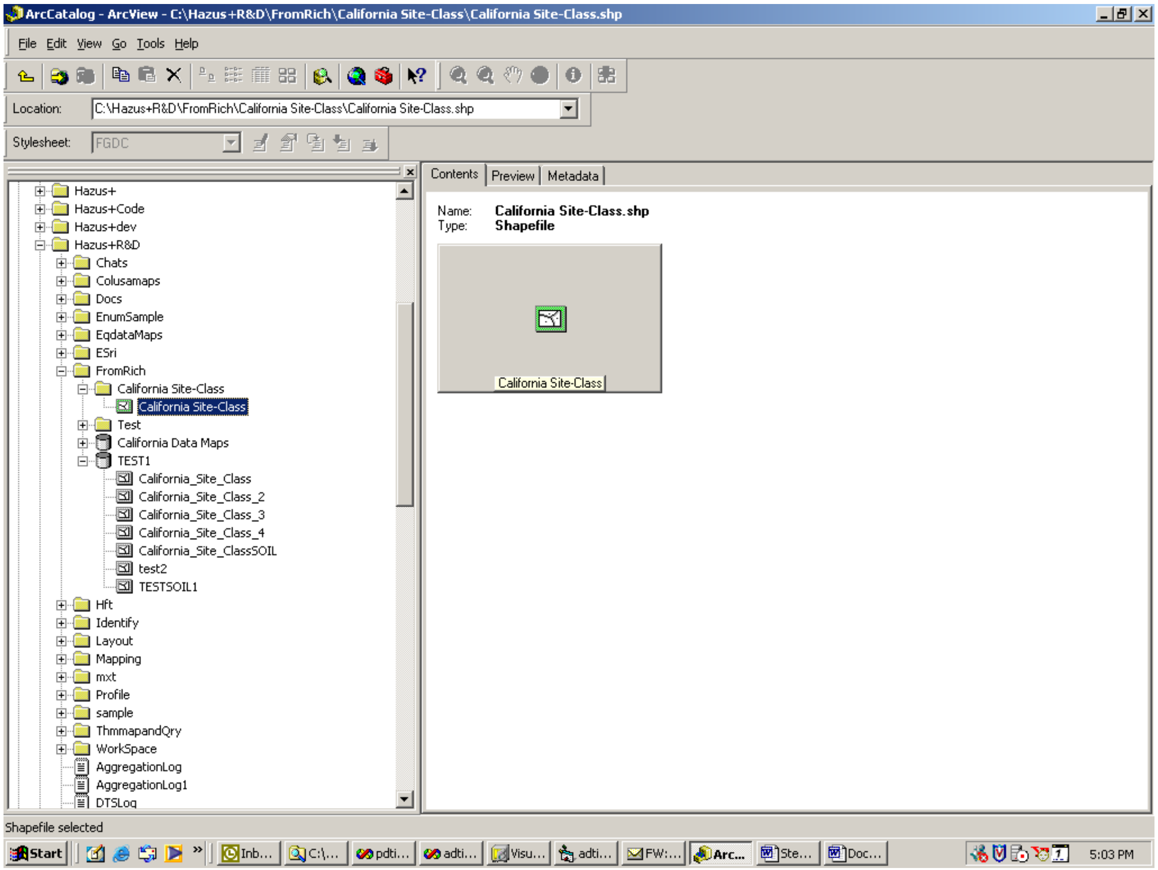
Change the name using F2 key to what you want for example "CaDataMaps"



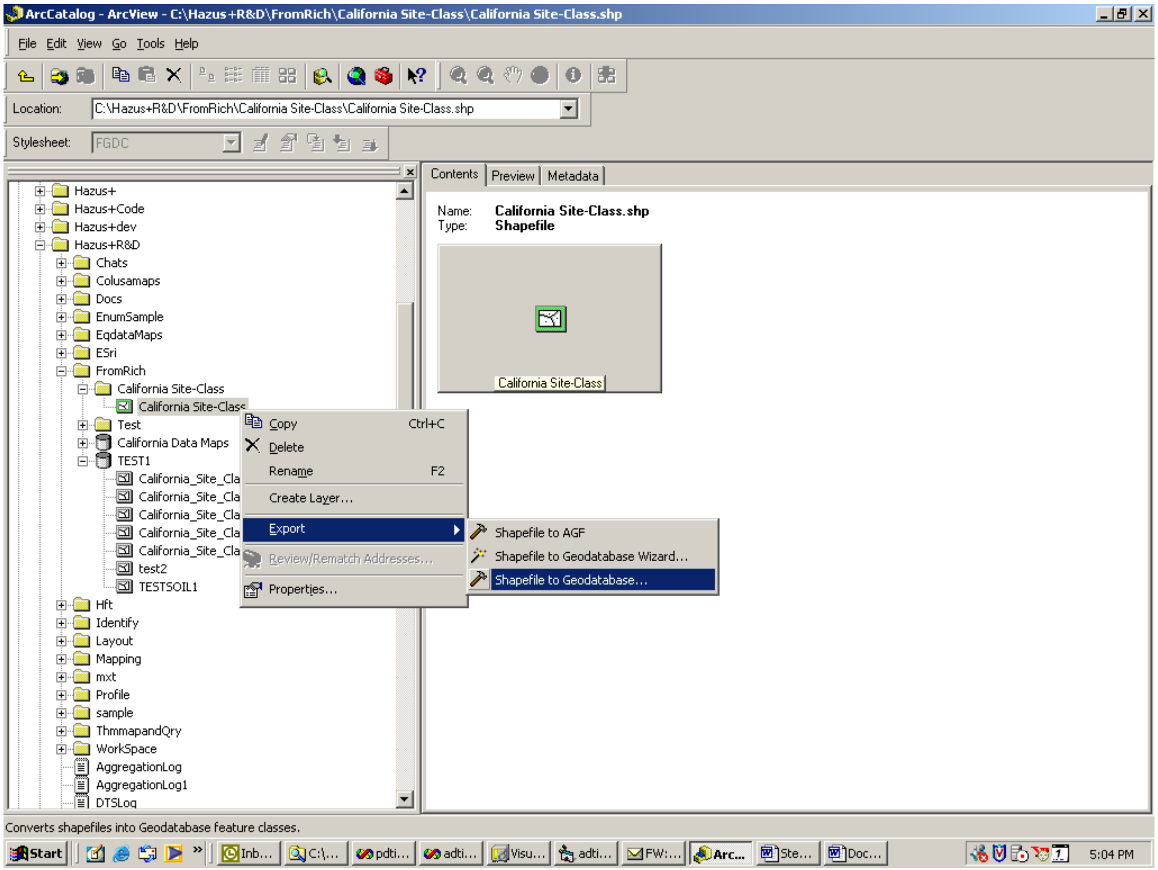

ArcCatalog - ArcView - C:\HAZUS-MH\Datamaps
File Edit View Go Tools Help
Location: C:\HAZUS-MH\Datamaps
Stylesheet: FGDC
Hazus+
Hazus+Code
Hazus+dev
Hazus+R&D
HAZUS-MH
Alameda
Backup
BIN
Brunswick
Colusa
DATA
Datamaps
readme
I386
indiankey
Ldrive
MailBackup
MBS
Microsoft Shared
MSSQL7
My Music
New Folder
Office
Program Files
Samples
Sandeep
Software
SQLCritUpdPkg
System
temp
Tools
W2K
WINNT
Work
BOOTLOG
Contents
Preview
Metadata
Name
Type
CaDataMaps
Personal Geodatabase
Personal Geodatabase selected
Start
4:53 PM

4) Select the folder where the hazard data maps are located in ArcCatalog’s TOC. In the folder is not available in the TOC click on **File>Connect Folder** menu and select the folder where the hazard data maps are located, press the OK button and the folder will be visible in ArcCatalog’s TOC.

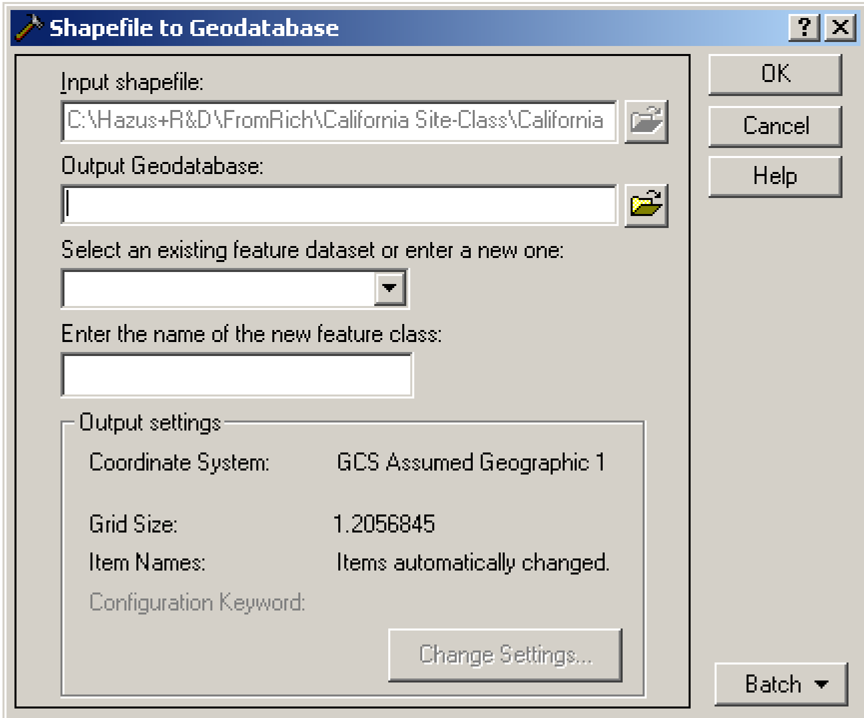
5) Select the Shape file which is to be exported under the connected folder in TOC as shown



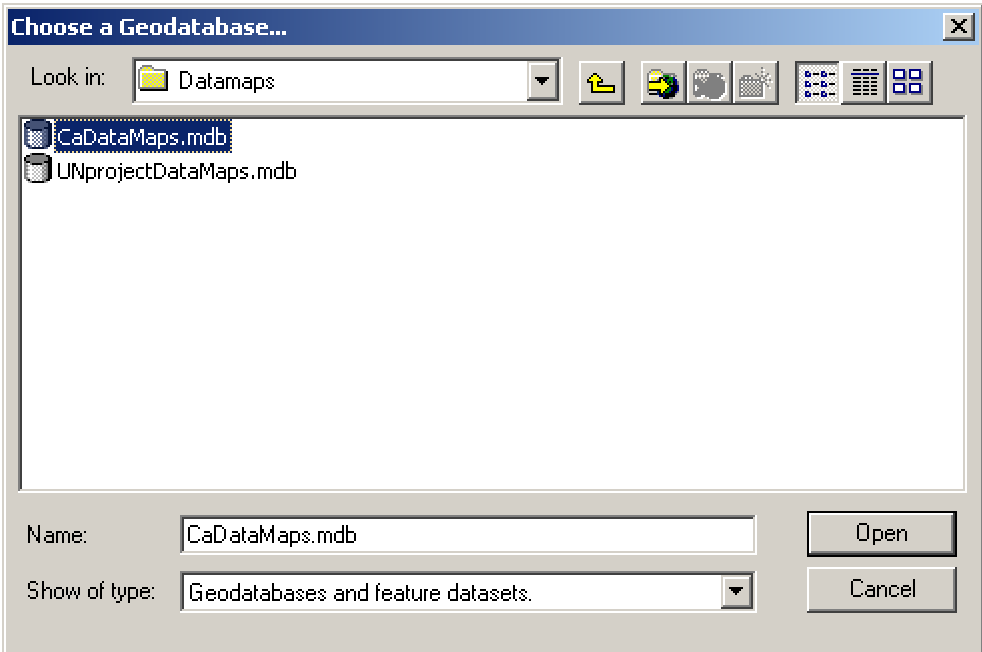
6) Right click and select third option under Export (shape file to geo database) as shown



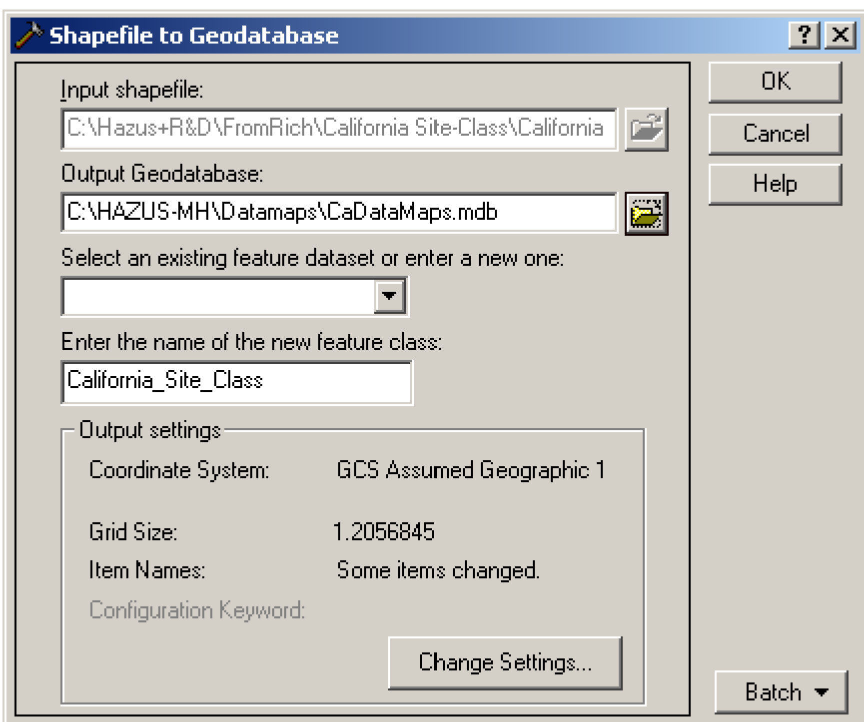
7) The Export option will show a dialog as follows:



8) Click on the browse button for the Out put Geo data base and select the geo database created in step 3.

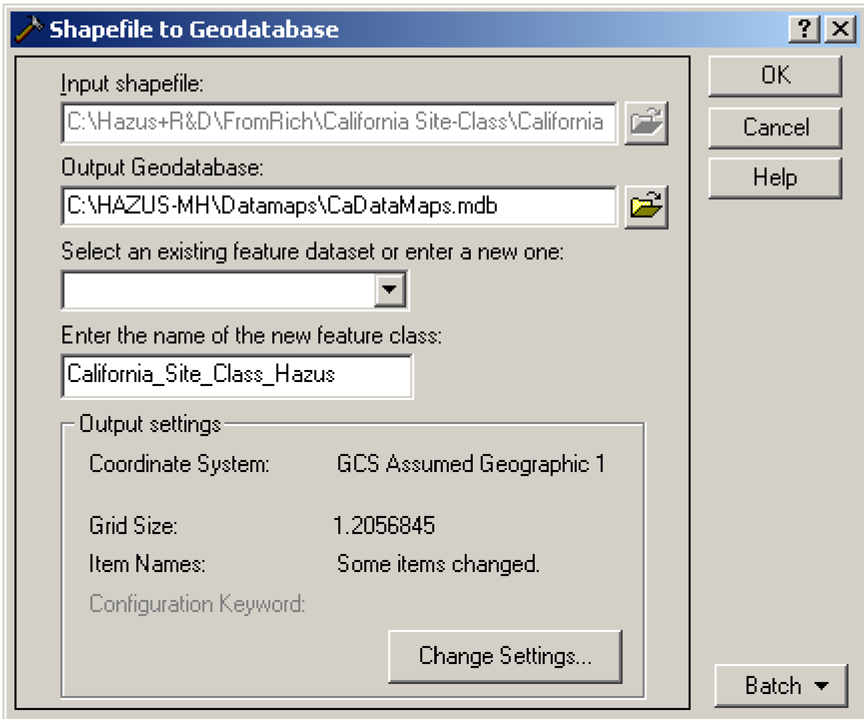


Clicking Open button will launch the following dialog:

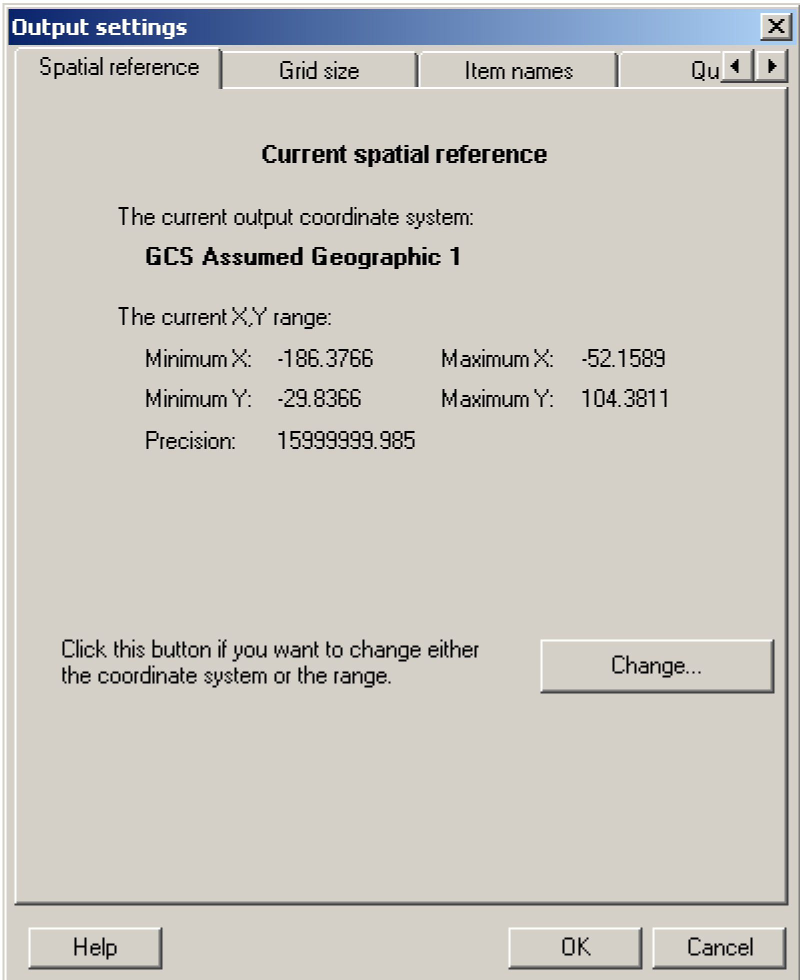


Leave the third option "*Select an existing feature dataset…*" empty

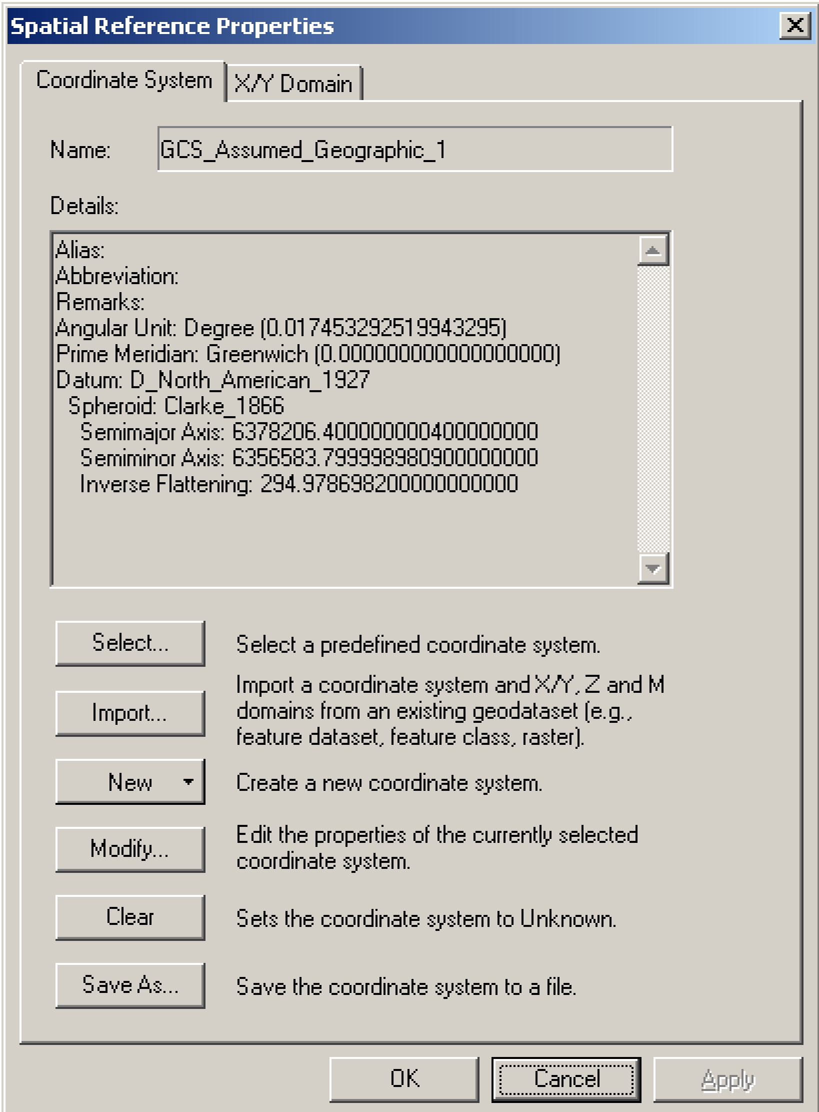
To change the name of the Out put feature class modify the edit box under “*Select an existing feature dataset…*”. For example name has been changed to California_Site_Class_HAZUS



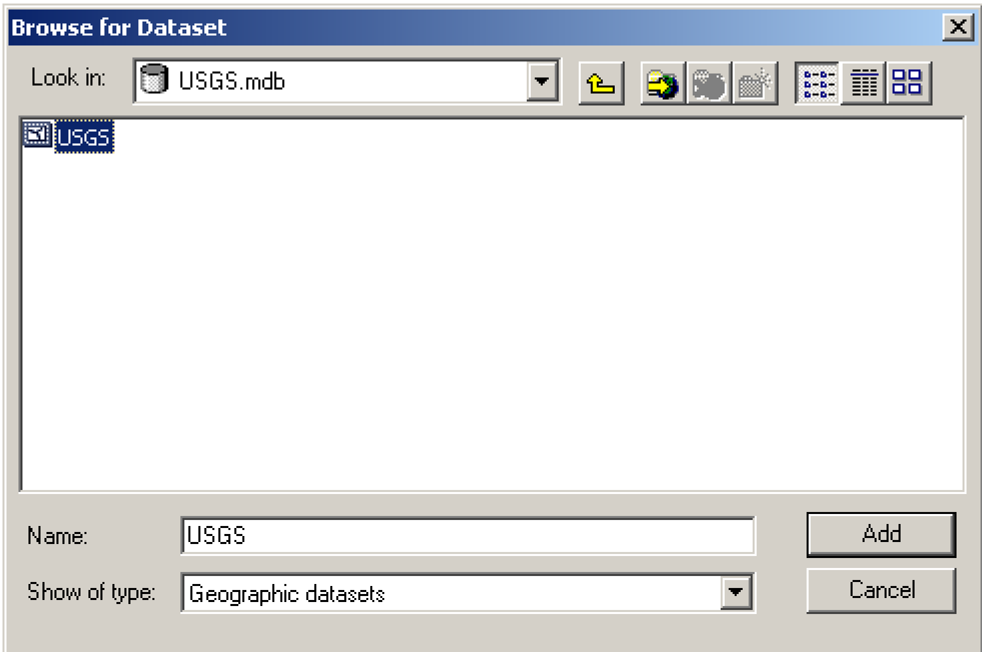
9) Now Click the Change Settings button, it shows setting options as follows:



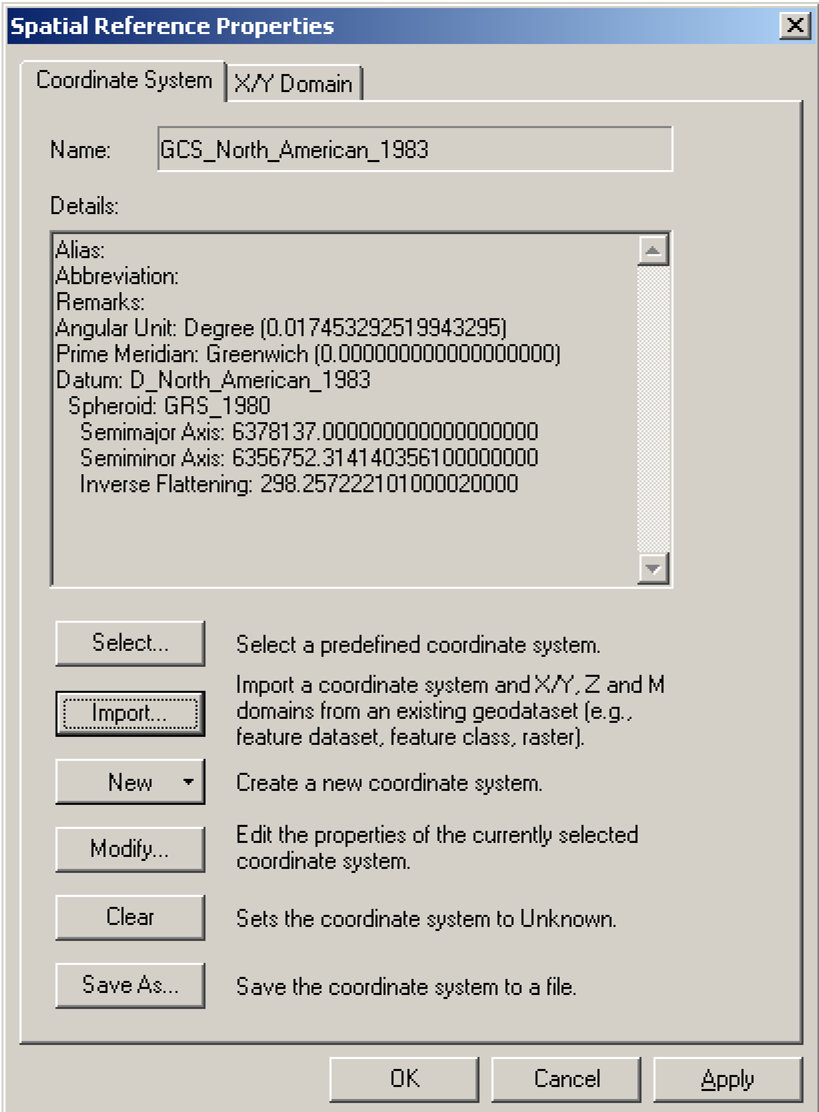
10) Click Change button on the Spatial Reference Tab



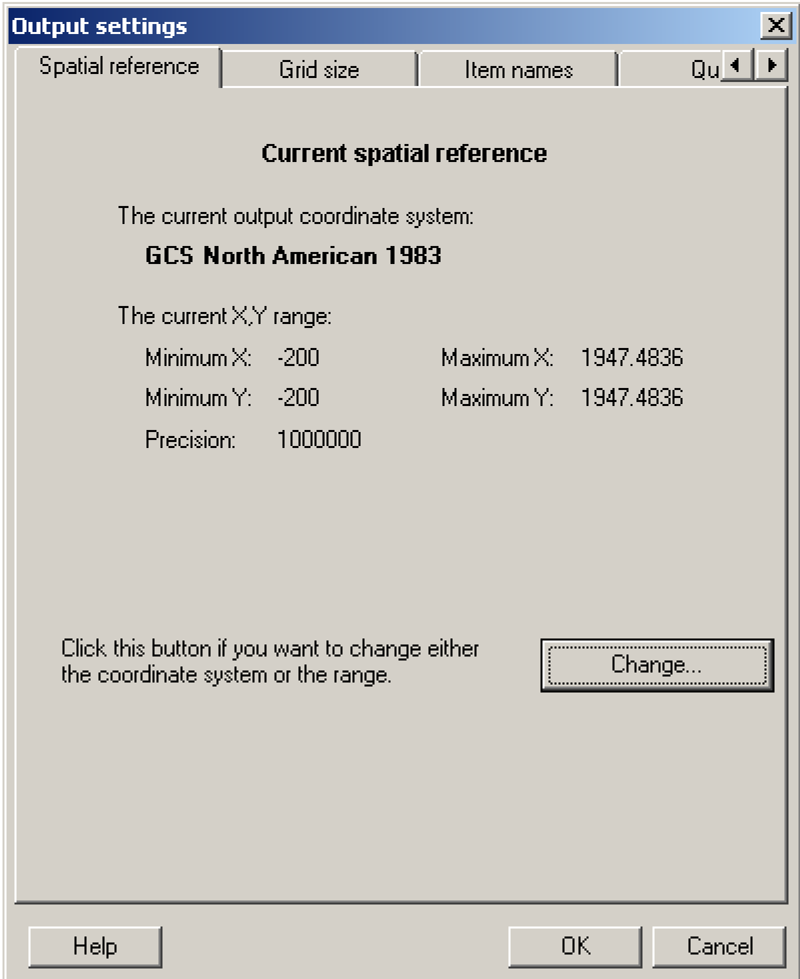
11) Click on Import Button and Browse to <HAZUS-MH>\DATA folder and select "USGS.MDB" and then select USGS feature class.
NOTE: <HAZUS-MH> represents the folder where Hazus-MH is installed.



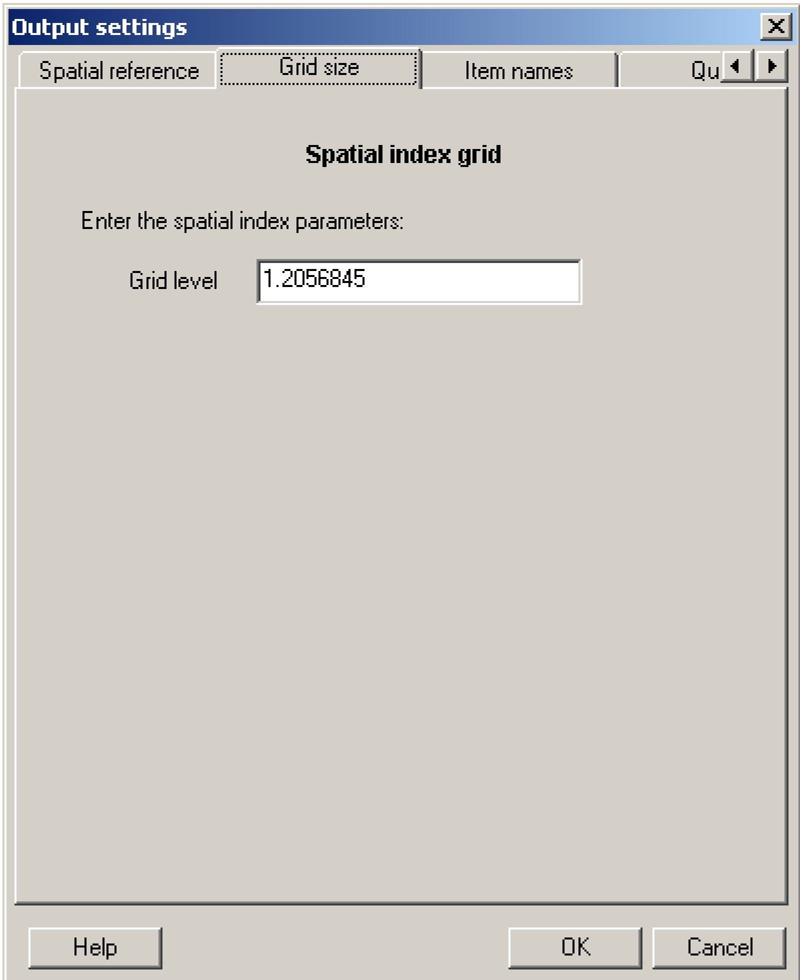
12) Click Add button and the new Settings will be reflected as follows:



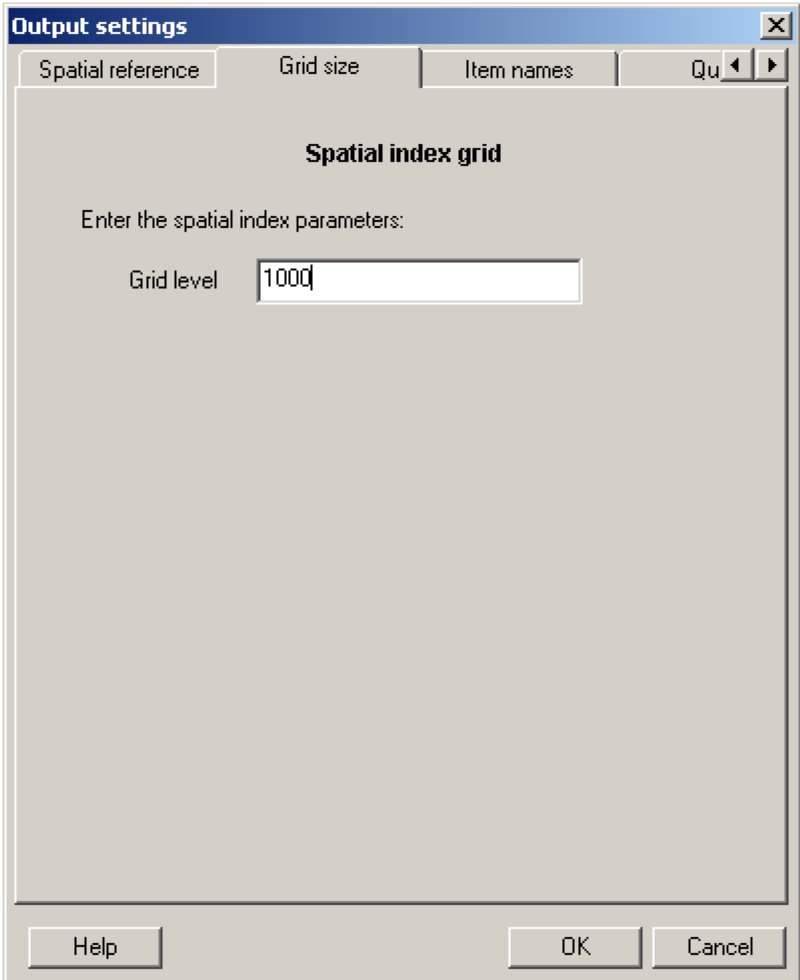
13) Click Apply and then OK and new Spatial reference Tab will be displayed as follows:



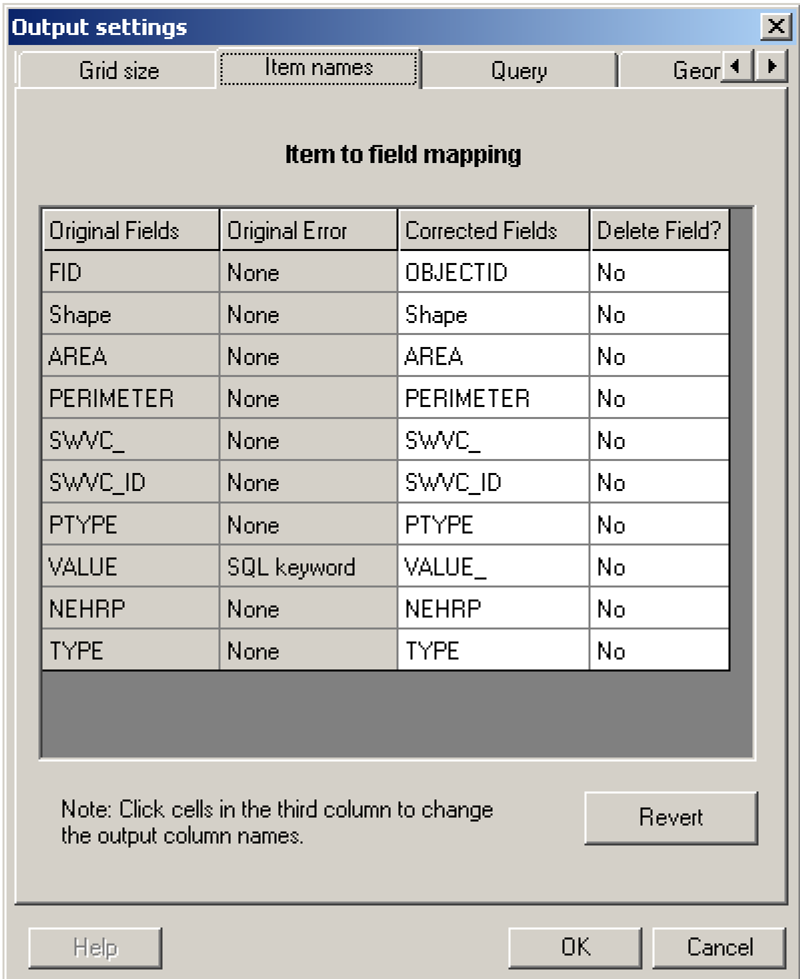
14) Now Click on the “GRID SIZE” tab, it will show the original Grid Size



Change Grid Level to 1000 as shown below:


Output settings
Spatial reference
Grid size
Item names
Qu
Spatial index grid
Enter the spatial index parameters:
Grid level
1000
Help
OK
Cancel

15) DON'T CLICK OK, instead Click on "Item Names" Tab which has the details of all the columns in the source feature class or shape file.

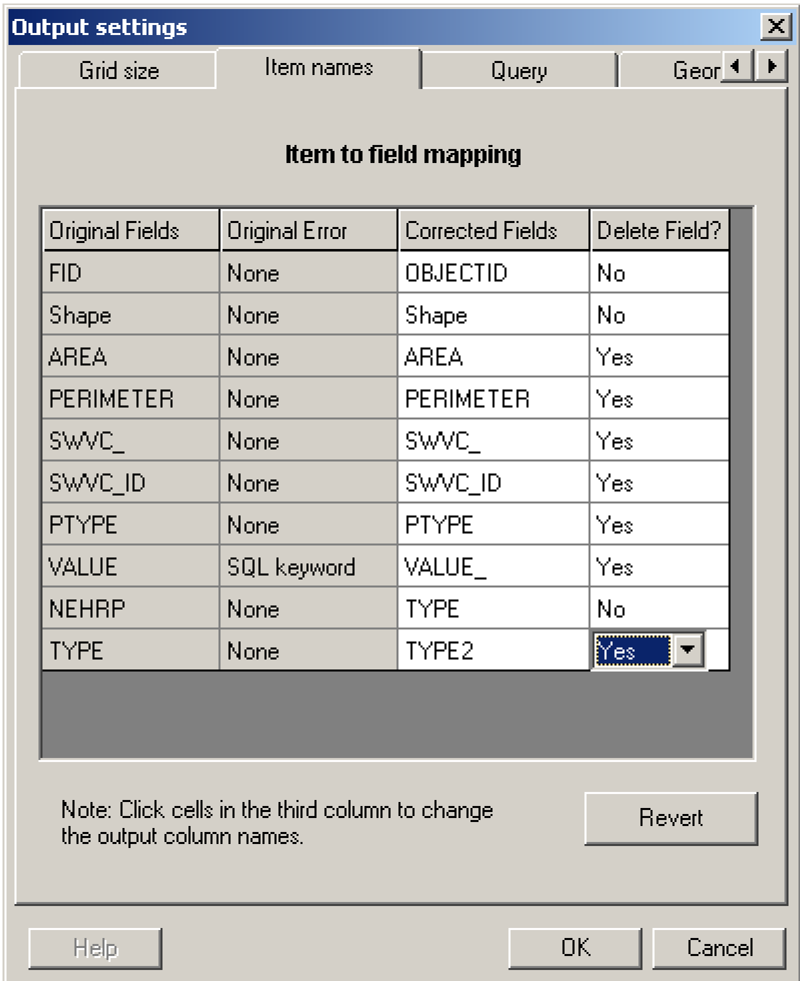


16) Now change the Setting under *Delete Field* column on the dialog to YES for all fields other than
FID (Object Id),
Shape and
Hazard Specific field.

The following table summarizes the various hazard specific fields names, their types and the ranges of values that Hazus-MH expects. These should be used in the Corrected Fields column in the above dialog for the corresponding maps.

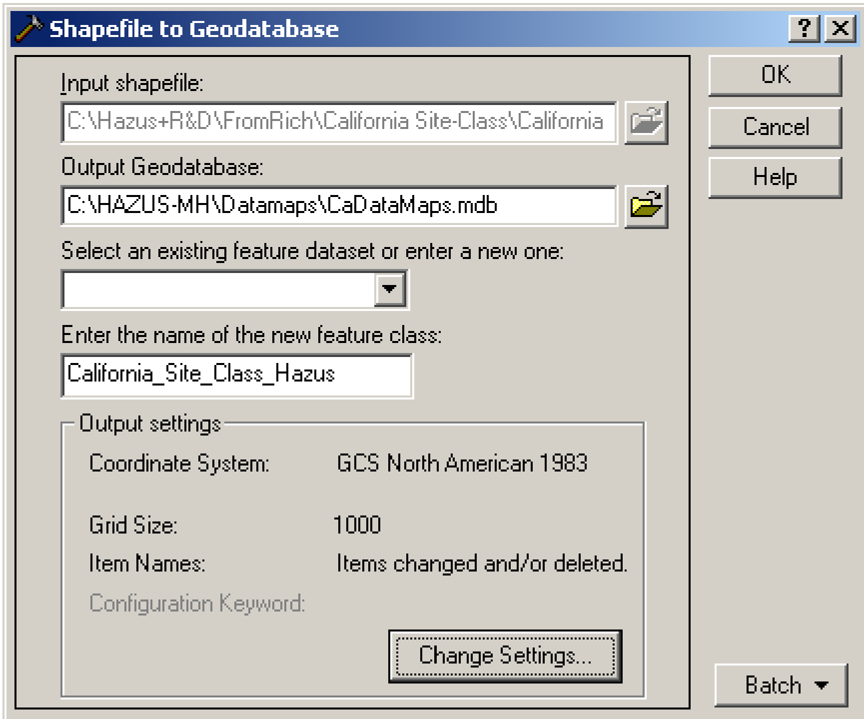
S. N	Type of Map	Correct Field Name	Field Type	Valid Values
1	SOIL	Type	Text (1)	A, B, C, D ,E
2	Liquefaction Susceptibility Map	Type	Numeric (1,0)	0 to 5
3	Landslide Susceptibility map	Type	Numeric (2,0)	0 to 10
4	Water Depth map	Type	Decimal	Values must Greater than 0

In our example, which is a soil map, the ***NEHRP*** field represents the ***TYPE*** for the Soil map, so the *Corrected Field* corresponding to the *Original Field* NEHRP was modified to **TYPE** that is expected by Hazus-MH for soil type. This is shown in the next figure.

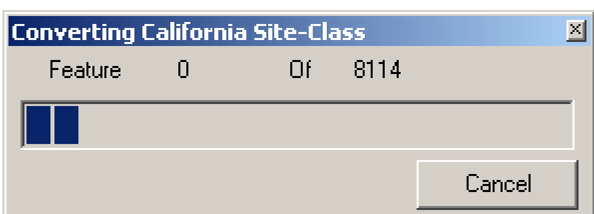


Similarly in case of Liquefaction Map the name of the field that contains the liquefaction susceptibility category should be **TYPE Numeric(1, 0),** in case of Landslide Map the name of the field that contains the landslide susceptibility category should be **TYPE Numeric(1, 0)** and in case of Water Depth Map the name of the field that contains the water depth should be **TYPE Decimal.**

17) Now Click OK and on next screen which is same as



Click OK, it will show the progress bar while exporting



Once the Progress bar disappears, Export is over and the map has been successfully converted for use with Hazus-MH..

Appendix L: Running Hazus-MH with SQL Server 2008 R2

L.1 Introduction

Hazus-MH uses SLQ Server 2008 R2 Express edition as the database engine. The express edition is a free and lightweight version of SQL Server 2008 R2, and therefore has several limitations including a 8-GB database-size limit.

The purpose of this document is to show how Hazus-MH can be configured to run with a full version of SQL Server 2008 R2 and also how to configure Hazus-MH back to run with the SQL Server Express-based default installation.

There are several[1] *full* editions of SQL Server 2008 R2 that lift the 8-GB database limit. A special Developer edition is also available (refer to Microsoft's web site for the differences between the different editions).

Hazus-MH has been tested to run with the ***Express Edition and SQL Server 2008 R2 Developer Edition*** only. Hazus-MH has not been explicitly tested to run with the other editions of SQL Server 2008 R2 (Enterprise, Workgroup, Standard and others).

Hazus-MH neither does it install nor does it include any of the full versions of SQL Server 2008 R2. Before Hazus-MH can be configured to run with any of the full editions of SQL Server, the user needs to purchase and install SQL Server 2008 R2 separately.

L.2 Purpose

This document describes all the steps[2] that the user needs to perform to configure Hazus-MH to run with SQL Server 2008 R2. This document doesn't explain how to install and run Hazus-MH. For that, refer to the Chapter 2 of the User's Manual.

L.3 Steps to Configure Hazus-MH to Run with SQL-Server 2008 R2

1. Install Hazus-MH then launch it at least one time and close it.

2. Open the windows registry. To do this, click the "Start" button and type "regedit" in the Run window edit box (Figure L-1) and click the "OK" button to open the Registry Editor.

[1] As of September 2011, Microsoft had no less than 9 other different editions of SQL Server 2008 R2 in addition to the Express edition.

[2] Steps detailed in this document apply to Windows 7. Instructions should be very similar under Windows XP.

Figure L-1

3. Navigate through the folders listed in the Registry Editor to the location: [HKEY_LOCAL_MACHINE\SOFTWARE\FEMA\HAZUS-MH\General] in Registry Editor Window (Figure L-2 below).

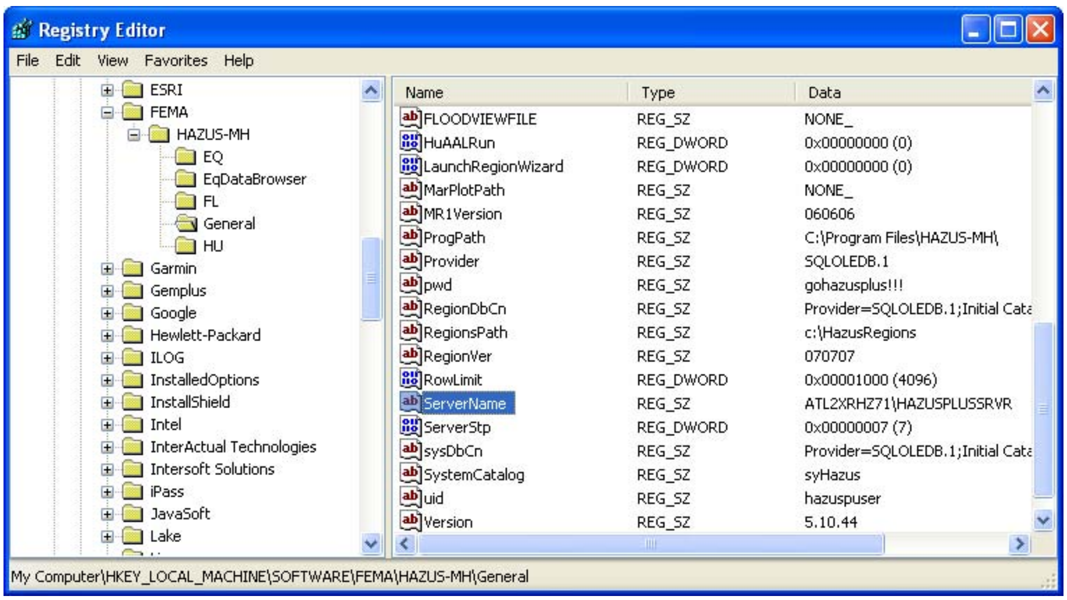


Figure L-2

4. Double click on “ServerName” (shown highlighted above in Figure L-2) and enter the name of the new SQL Server 2008 R2 instance. The name is in the format <computername>/<instancename>. For example, if the machine name is ATLHW32P91 and the instance name is SQL2008[3], then the registry enter should show ATLHW32P91 \SQL2008. Open the SQL Server Management Studio from Start|All Programs|Programs|Microsoft SQL Server 2008 R2|SQL Server Management Studio on windows menu.

5. Under SQL Server double click Security folder and select Logins and right click the mouse. From the Popup menu select New Login as shown in Figure L-3.

---

[3] The instance name is specified during the SQL Server 2008 R2 installation.

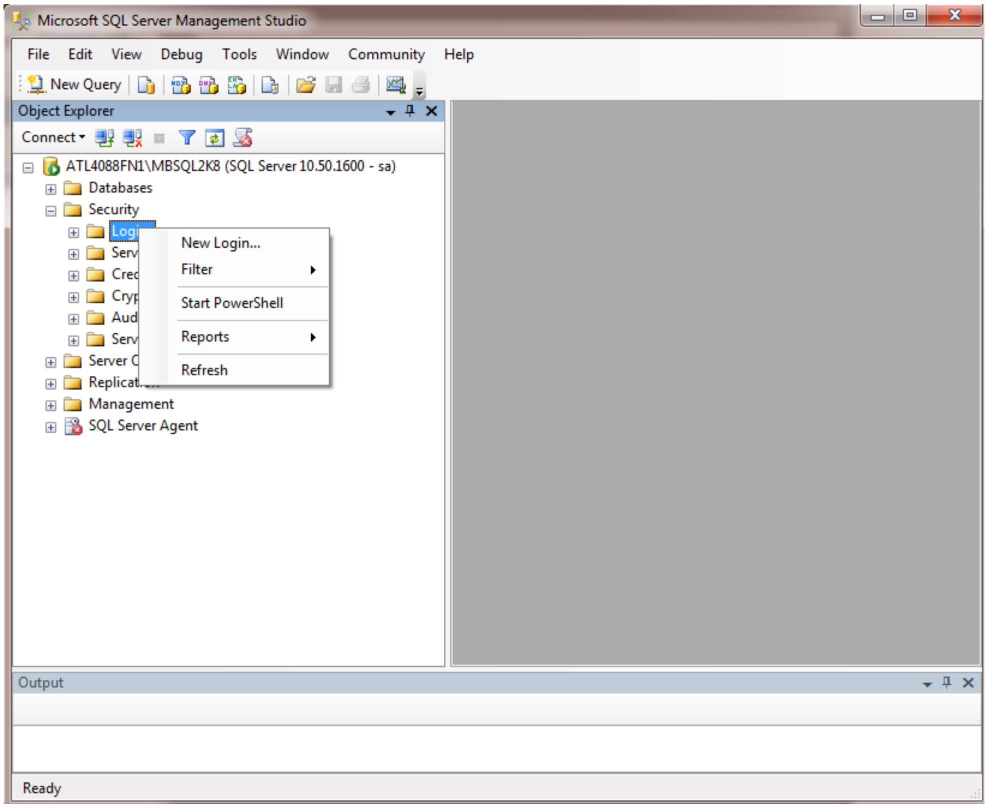


Figure L-3

6. In "SQL Server Properties -New Login" dialog enter “hazuspuser” in the name field without parentheses as shown in Figure L-4.

7. Click SQL Server Authentication option. Enter the password " “gohazusplus_01" without parentheses.

8. Uncheck the “User must change password at next login” option if it is checked.

You can get the names in 7 and 8 above by copying them from registry [HKEY_LOCAL_MACHINE\SOFTWARE\FEMA\HAZUS-MH\General] (see Figure L-2)

a. For Name field copy it from **uid** in the registry and past it in the appropriate field.

b. For Password copy it from **pwd** in the registry and past it in the appropriate field.

c. It's better to copy these values from registry to avoid typos.

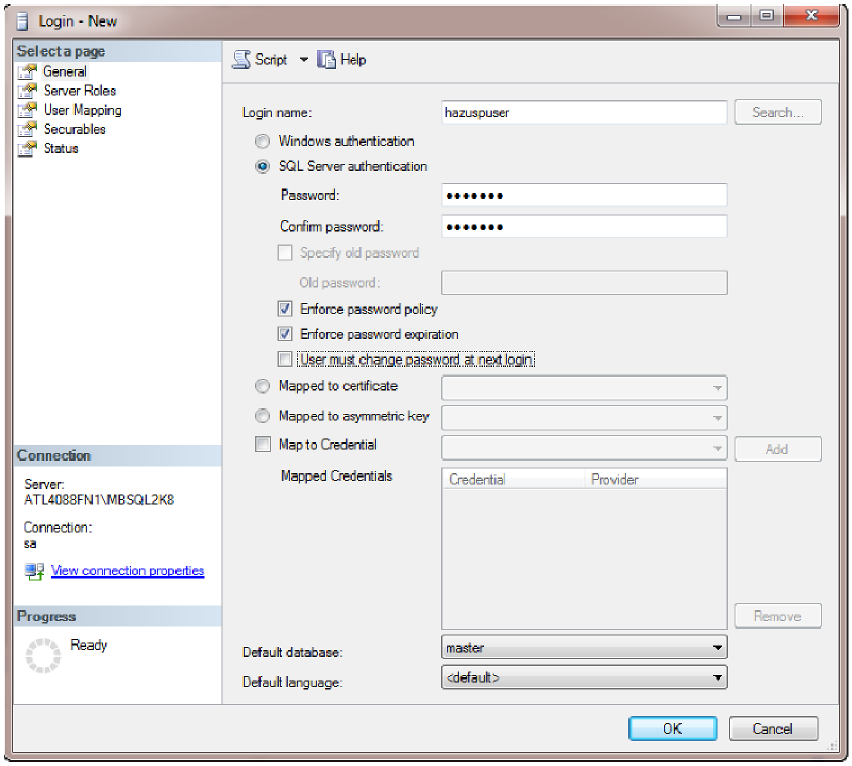


Figure L-4

9. After that Click Server Roles Tab and check sysadmin. Click OK (Figure L-5).

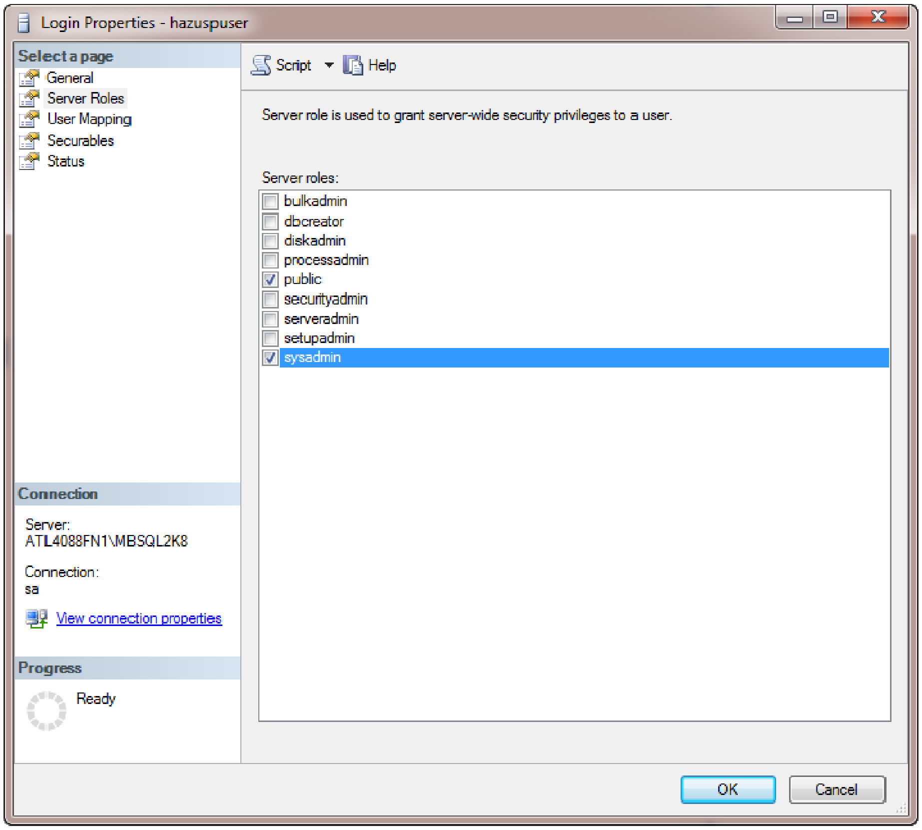


Figure L-5

10. Confirm password “gohazusplus_01” and Click OK.

11. Now connect to the HAZUSPLUSSRVR installed by Hazus-MH via the Management studio. To do that Click the “Connect” button at the top left corner of the SQL Server Management Studio and select Database Engine… option (Figure L-6)

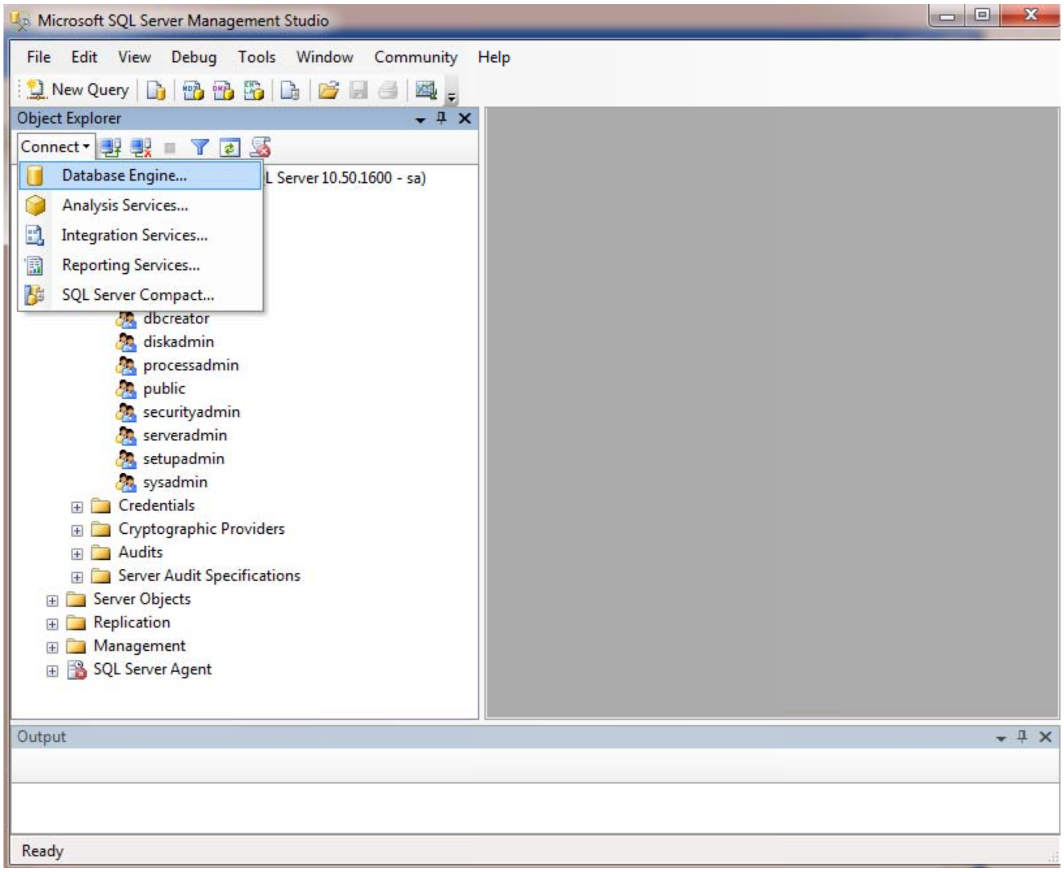


Figure L-6

12. For **Server name** select or type in YourComputerName\HAZUSPLUSSRVR.

13. Select Windows Authentication for the **Authentication**

14. Click on the **Connect** button..

Figure L-7

15. Now, the new database server will be visible on the Management Studio as shown in Figure L-8.

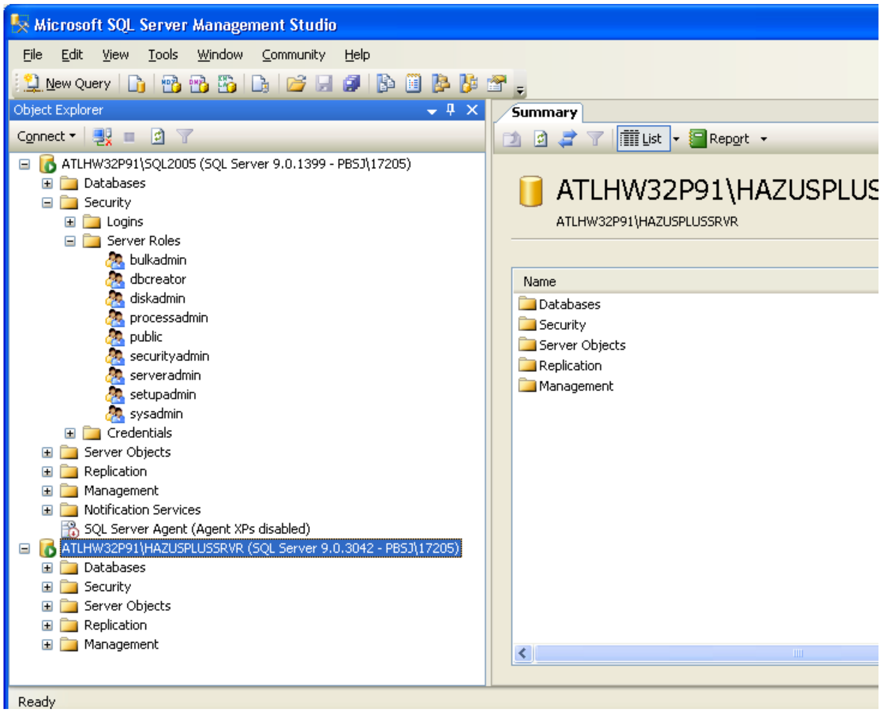


Figure L-8

16. Next navigate to Databases folder under HAZUSPLUSSRVR Server and expand it. Select syHazus database, Right click on it and Task | Detach and click OK (Figure L-9).

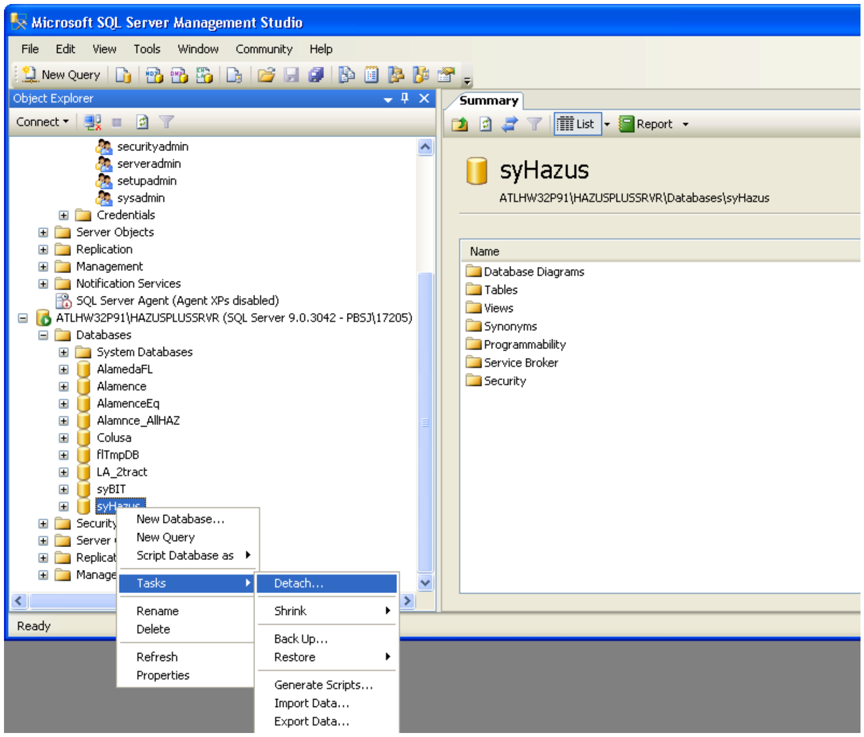


Figure L-9

17. Navigate to the folder that represents the new server (ATLHW32P91 in Figure L-10). Select Database folder and Right click the mouse, Select Attach… database... option as shown in Figure L-10.

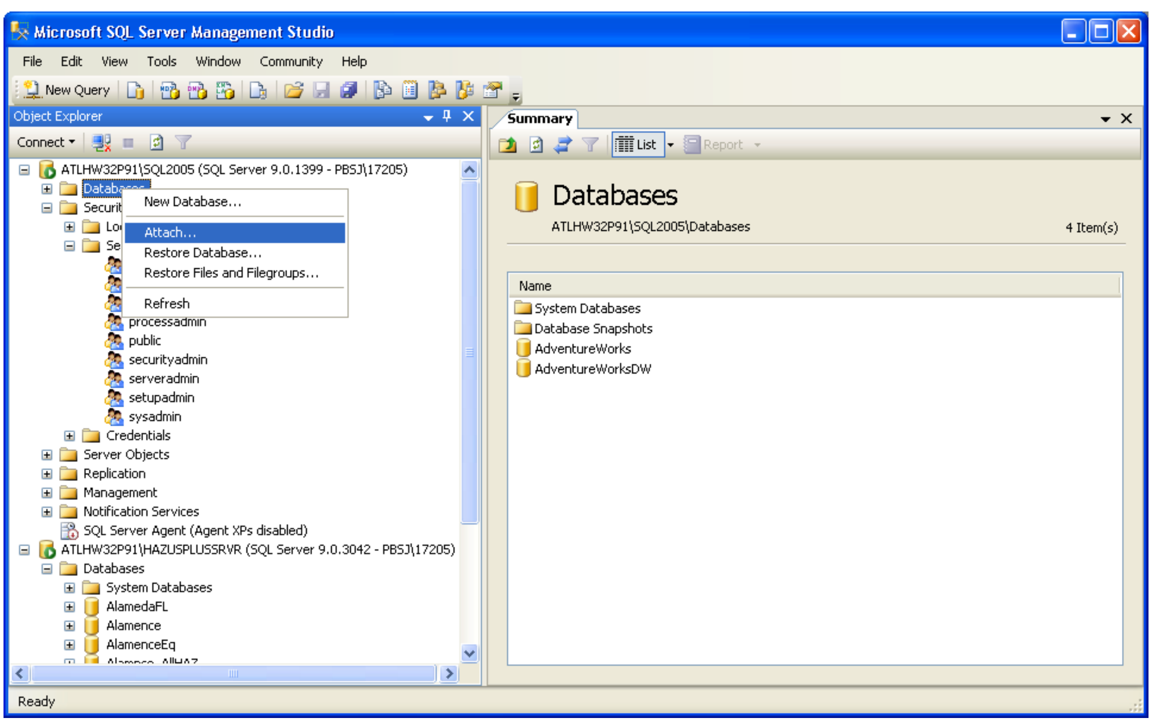


Figure L-10

This will launch the Attach Database dialog as shown in Figure L-11.

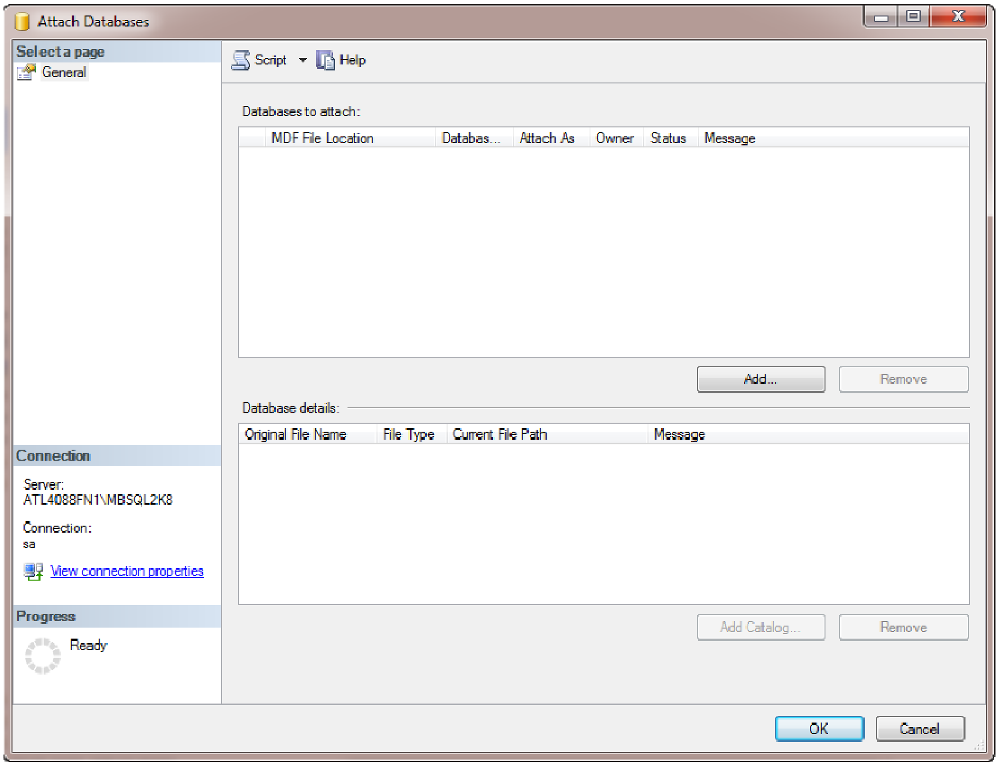


Figure L-11

18. Click Add button and browse to the folder where Hazus-MH is installed. Within Hazus-MH folder open Data folder (Figure L-12).

19. Select SyHazus_Data.MDF and click OK twice

20. You should get a message that the syHazus is attached successfully.

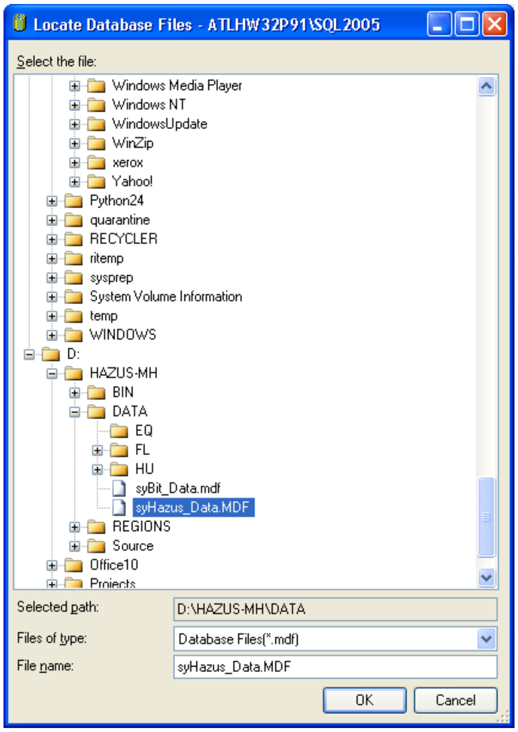

Locate Database Files - ATLHW32P91\SQL2005
Select the file:
Windows Media Player
Windows NT
WindowsUpdate
WinZip
xerox
Yahoo!
Python24
quarantine
RECYCLER
ritemp
sysprep
System Volume Information
temp
WINDOWS
D:
HAZUS-MH
BIN
DATA
EQ
FL
HU
syBit_Data.mdf
syHazus_Data.MDF
REGIONS
Source
Office10
Projects
Selected path:
D:\HAZUS-MH\DATA
Files of type:
Database Files(*.mdf)
File name:
syHazus_Data.MDF
OK
Cancel

Figure L-12

21. Right click the mouse on New Server (**ATLHW32P91** in Figure L-13) in the Management Studio. Select **Properties** from the short cut menu. This will launch the **Server Properties** dialog. Click on **Security** option, and make sure that the Server Authentication is set ti **SQL Server and Windows Authentication Mode** as shown in Figure L-13.

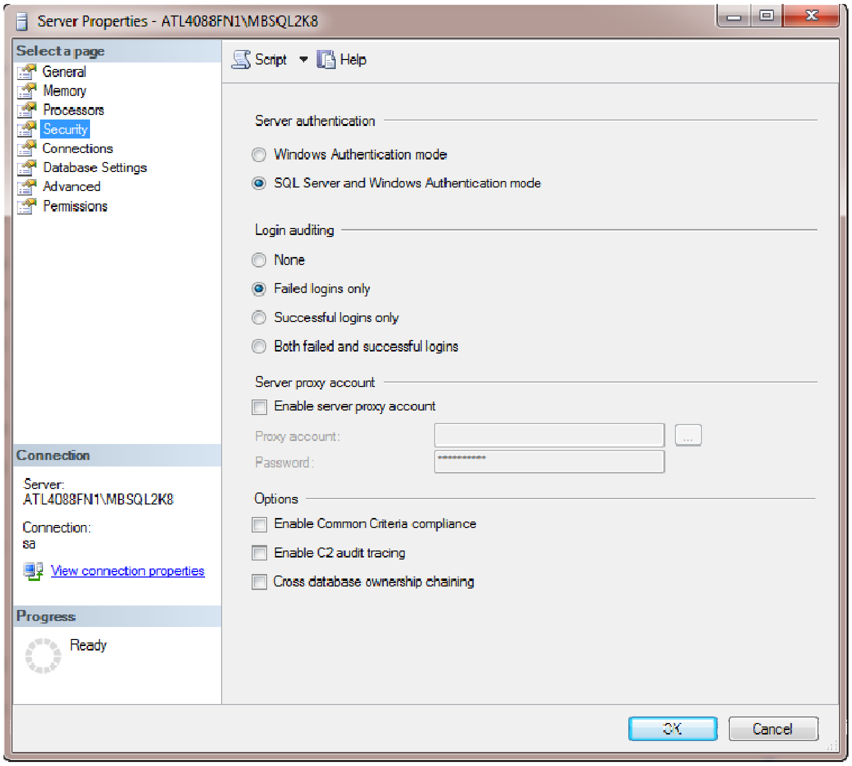


Figure L-13

Hazus-MH is ready to be run from the New SQL Server. Proceed with creating the desired new study regions.

IMPORTANT NOTE:

Steps above are valid if the re-connection from the SQL Server Express edition to the full version of SQL Server is done right after the Hazus-MH setup. If any number of study regions has been created already, then ALL those study regions must be also moved to the full SQL Server 2008 R2 (follow same process above as for syHAZUS database).

L.4 Steps to Re-configure Hazus-MH to Use Original SQL Server Express

Once Hazus-MH has been configured to run with SQL Server 2008 R2 it cannot be uninstalled. Before uninstalling Hazus-MH it's necessary to reconfigure Hazus-MH to run with HAZUSPLUSSRVR, the way it was configured by the installation. Follow the steps outlined below to achieve this (basically, reversing the syHazus database move).

1. Launch SQL Sever Management Studio Manager.

2. Detach syHazus database from SQL Server

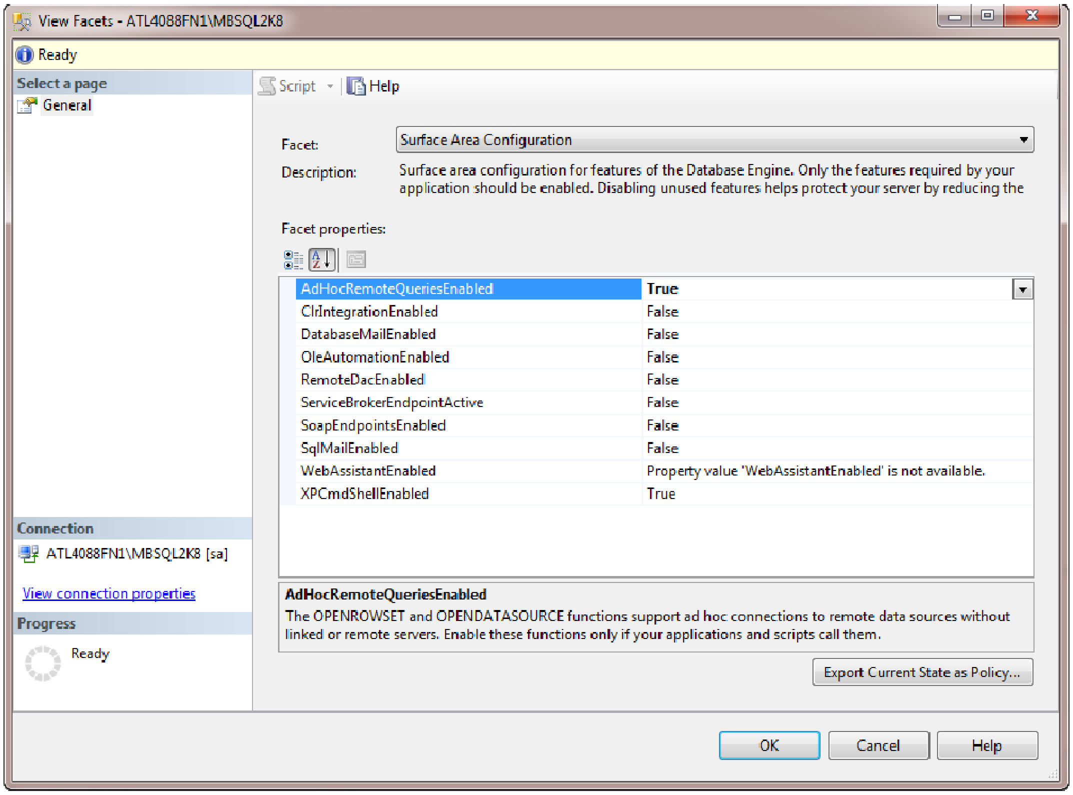
3. Attach syHazus to the HAZUSPLUSSRVR.

4. Launch the SQL Server Configuration Manager from **Start|Programs|Microsoft SQL Server 2008 R2|Configuration Tools|SQL Server Configuration Manager.** Select "SQL Server 2008 R2 Services" from the list.on the left, then select the HAZUSPLUSSRVR instance, right-click, and select Restart.

5. Restart also the full SQL server instance by following the same steps

After you are done with all the steps above, you need to do the following:

- Select the HAZUSPLUSSRVR instance in the SQL Server Management Studio
- Right-click and select Facets
- Make sure the the AdHocRemoteQuriesEnabled option is set to true under the Surface Area Configuration option as shown in dialog below


View Facets - ATL4088FN1\MBSQL2K8
Ready
Select a page
General
Script
Help
Facet:
Surface Area Configuration
Description:
Surface area configuration for features of the Database Engine. Only the features required by your application should be enabled. Disabling unused features helps protect your server by reducing the
Facet properties:
AdHocRemoteQueriesEnabled True
ClrIntegrationEnabled False
DatabaseMailEnabled False
OleAutomationEnabled False
RemoteDacEnabled False
ServiceBrokerEndpointActive False
SoapEndpointsEnabled False
SqlMailEnabled False
WebAssistantEnabled Property value 'WebAssistantEnabled' is not available.
XPCmdShellEnabled True
Connection
ATL4088FN1\MBSQL2K8 [sa]
View connection properties
Progress
Ready
AdHocRemoteQueriesEnabled
The OPENROWSET and OPENDATASOURCE functions support ad hoc connections to remote data sources without linked or remote servers. Enable these functions only if your applications and scripts call them.
Export Current State as Policy...
OK
Cancel
Help

Appendix M:Using Enhanced Hawaii Data with Hazus-MH

Hazus-MH 2.1 includes an alternate (and improved) data set for the state of Hawaii. This data was produced as part of a study performed by FEMA. Enhancements include:

- Completely updated inventory data for the counties of Hawaii and Maui that is based on census blocks instead of the default census tracks
- Inclusion of custom building types (post and pier single-wall construction) unique to Hawaii.
- Updated damage functions and fragility curves

By default, Hazus-MH uses the original HI data set. To use the new enhanced data, do the following:

1. Contact the Earthquake Technical Support line to receive the data. It consists of 2 files: :
    a. `syBoundary.zip`: to be unzipped in the root of the Hazus-MH data inventory folder. If the file `syBoundary.mdb` already exists, make a back-up copy since it must be used if reverting to the original data is needed.
    b. `HI_ENH.exe`: to be unzipped in a folder called HI under the Hazus-MH data inventory folder. Backup also that folder if it already exists.
2. Change the value of the following registry entry (under HKEY_LOCAL_MACHINE\SOFTWARE) from 0 (zero) to 1 to instruct Hazus-MH to use the new data

    ```
    HKEY_LOCAL_MACHINE\SOFTWARE\FEMA\HAZUS-MH\General\HINewData
    ```

    Note: Administrator rights are required to edit the registry.

IMPORTANT NOTES:

1. This dataset was created specifically for use with the earthquake hazard and should not be used with the flood or hurricane models. Due to the changes in damage functions and buildings type, a Hawaii region should not be also mixed with other data from other states.
2. Due to the size of the data, the analysis of the full HI region will fail under Hazus-MH due to limitations in the database size in SQL Server 2005 Express. To work around this limitation, the full version of SQL Server 2005 must be used. Refer to Appendix L of the Earthquake User's Manual for instructions on how to convert Hazus-MH to use the full version of SQL Server.

Appendix N: Changing Hazus-MH Inventory Data Path

By default, Hazus-MH uses the folder `C:\Program Files\HAZUS-MH\Data Inventory`[1] for the location where the default data inventory databases are stored. If the need (like a lack of free disk space) arises, this folder can be moved to another location. To so, follow these steps:

1. Create the new folder in the desired location (for example d:\HAZUS Data)
2. Copy all the existing contents and files in the current default data path to the new location
3. Update the Hazus-MH registry (as shown below) to point to the new location
4. Launch Hazus-MH and test the changes by creating a new sample study region with the state data you have.
5. If step above is successful, delete the data from the original (default) location. If not, check that all the files including the folder structure were copied correctly and retry.

Updating Hazus-MH Data Path Registry

IMPORTANT: Editing the registry requires Administrator rights on the machine. Also great care must be exercised since corrupting the registry might make Windows fail altogether.

1. Under Windows XP, click the "Start" button and select "Run" to open the Run window, type "regedit" in Run window edit box and click the "OK" button to open the Registry Editor.
   Under Windows 7, click the "Start" button and type "regedit" in the search text box and hit Enter.

2. Navigate through the folders listed in the Registry Editor to the following location:

   HKEY_LOCAL MACHINE | SOFTWARE | FEMA | HAZUS-MH | General

3. Now look at the right side of the window and find the entry called "DataPath1". Double click on "DataPath1" to open the Edit String window and enter the full name of the folder on the hard drive that contains the data copied from the DVDs in the edit box. Click the OK button to update the DataPath1 value.

   Make sure the path ends with a "\" and do not change any of the other registry settings. In our example, enter `d:\HAZUS Data\`

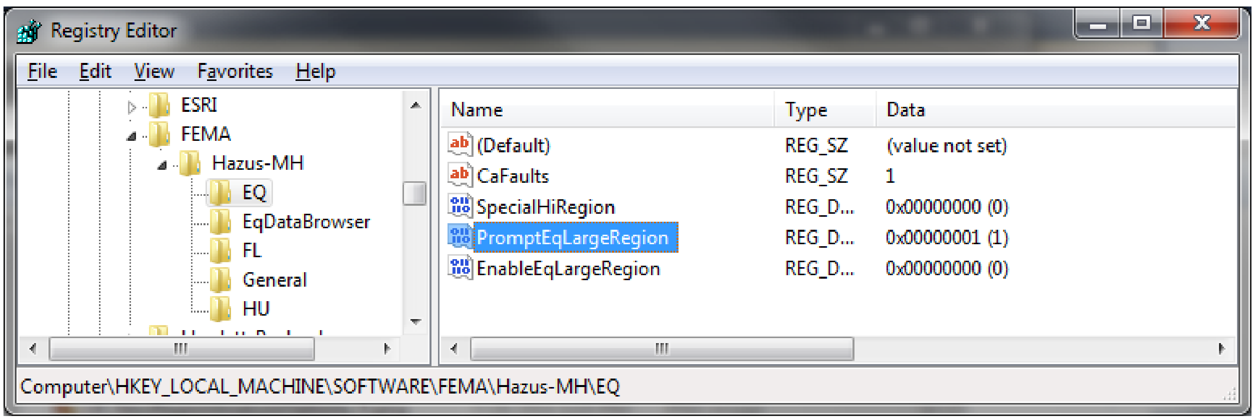
4. Close the Registry Editor by choosing Exit from the File menu of the Registry Editor.

[1] This is the default path provided during the installation which can be overridden by the user.

Appendix O:
Running Earthquake Large Regions in Hazus-MH

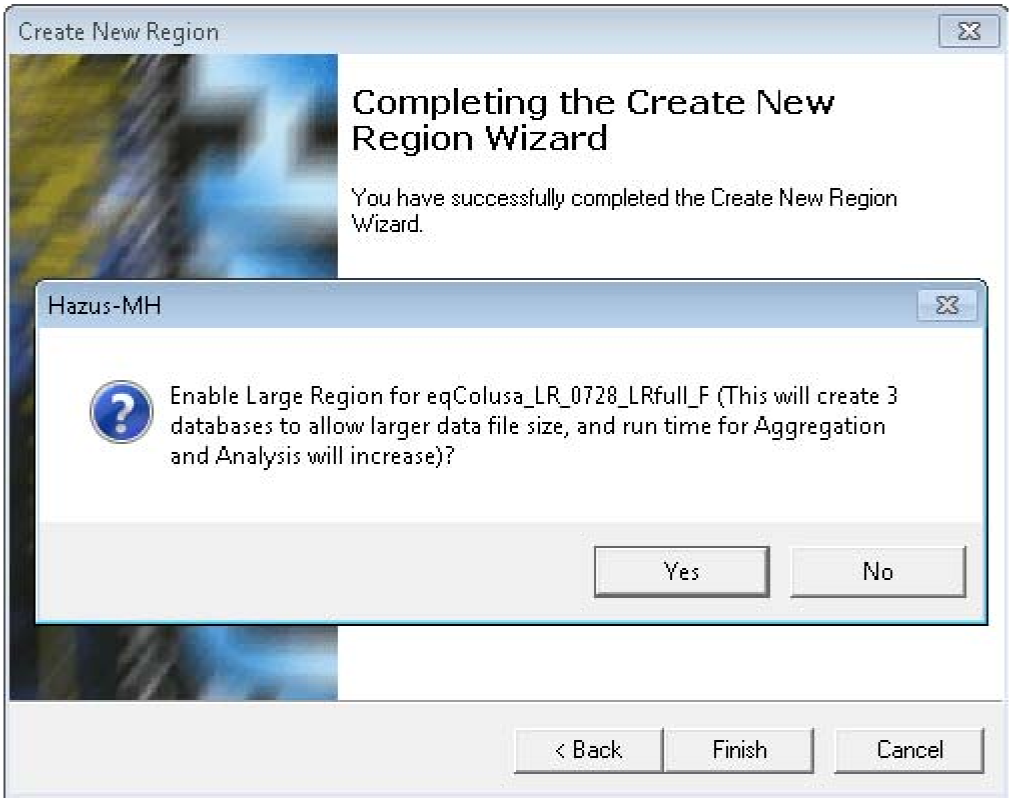
The instructions in this document allow the user to work around the database size limitation in Hazus-MH[1]. This implementation works only for Earthquake-only study region and is not available (yet) to the flood or hurricane study regions.

To use the new Large Region feature, manually edit[2] the HKEY_LOCAL_MACHINE\SOFTWARE\FEMA\Hazus-MH\EQ registry entry "PromptEqLargeRegion". **The default value is 0** (meaning: do *not* prompt for creation of Large Region tables). To use the feature, **set this key value to 1** (*do* prompt for creation of Large Region tables).



When enabled, Hazus-MH will prompt you whether to create Large Region tables immediately prior to region creation (after selecting Finish on the Region Wizard 'Create Region' dialog).

[1] Other alternative around the 8-GB database limit (as mentioned in other sections of this manual) is to use the full version of SQL Server 2008 R2. That has the added benefit of removing the limit for all hazards.
[2] Through the regedit (registry editor) tool. Admin rights are required to use the tool.



When prompted during the aggregation, select 'Yes' if running a very large region (2 large states or more). Hazus-MH will then split the region into 3 databases *behind-the-scene*. As far as usability, the interface is exactly the same for the user, and the only drawback, is that the analysis might take longer to run because of the database split.

To revert Hazus-MH to the default mode and disable the new Large Region feature, manually edit the HKEY_LOCAL_MACHINE\SOFTWARE\FEMA\Hazus-MH\EQ registry entry "***PromptEqLargeRegion***". If it is currently enabled, you will find the value is 1. To disable the feature, **set this key value to 0** (meaning: do *not* prompt for creation of Large Region tables).